SUMMER ACTIVITY PATTERNS OF CETACEANS IN THE LIGURIAN SEA SANCTUARY AND THEIR DIURNAL VARIATIONS

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INTRODUCTION

The cetacean community of the northwestern Mediterranean Sea includes 8 species of which 6 are commonly seen during surveys in the Ligurian Sea sanctuary (Gannier, 1999a): striped dolphin (*Stenella coeruleoalba*), the Risso's dolphin (*Grampus griseus*), the long-finned pilot whale (*Globicephala melas*), the bottlenose dolphin (*Tursiops truncatus*), the sperm whale (*Physeter macrocephalus*) and the fin whale (*Balaenoptera physalus*). For the fin whale, the Ligurian Sea has been described primarily as a feeding area (Orsi Relini *et al*., 1994). From studies on vertical migrations of prey items (Andersen *et al*., 1992; Sardou and Andersen, 1993) and from nocturnal cetacean studies, it is suspected that both pelagic delphinid species and fin whales intensively feed during the night (Gannier, 1996; 1997). For some delphinid species, like the striped and Risso's dolphin or the pilot whale, breeding and calving occur during summer (Aguilar, 1990; Duguy *et al*., 1979; Vallon *et al*., 1979). A complex diurnal activity cycle involving socializing, resting and travelling has already been shown for the striped dolphin (Gannier, 1999b; Gannier and Laran, 1999).

In an area where numerous human-induced perturbations might affect the cetacean status, knowledge on activity and habitat use is vital. We present here results on activity patterns of 6 species, by analysing sighting data obtained during dedicated surveys in the 1989-1999 period.

METHODS

Field

Field surveys took place between 15 th June and 15 th September from a 9 meters sloop (1988-1994) and a 12 meters motorsailer (1995-1999). Observation protocoles remained similar, although the number of active observers varied from 2-3 (1988-94) to 3-4 (1995-99). Boats moved on random linear tracks, either on pre-determined or weather-dependent routes. Upon detection, schools of cetaceans were approached (excepted in Aug. 1999) for duration

ranging from 5 to 20 minutes to collect data on group structure, surface behavior, dive cycles, movements and activity. From 1994 onwards, systematic acoustic listening was conducted, giving important cues to determine odontocete activity. Activity was determined from direct field observation from a list of 4 categories: resting, socializing, travelling and feeding. Occasionally, two categories may have been selected, for example in case of two dolphin sub-groups behaving differently, or in case of incertitude.

For every species, activity classes were determined from objective field information. The main parameters considered were:

- group spatial structure (delphinids)
- dive / surfacing cycle
- speed, variation and homogeneity of movements
- type and frequency of surface behaviors (body parts exposed, flukes / flippers slapped) and type of breaching / jumping (delphinids)
- group interactions (body contacts, pursuits, coordinated behaviors)
- nature and quantity of underwater vocalizations (odontocetes)

Analysis

The area of study is restricted to the northwestern Mediterranean, north of the 41° parallel. Analysis was restricted to sighting conditions with wind inferior or equal to Beaufort 3 and to records of over three minutes in duration. Only records with a maximal observation distance of 400 m (delphinids) and 1000 m (whales) were used.

For each species, a global activity pattern is defined as the frequency of every activity class:

$$Fi = Ni / Nd \quad , \quad \Sigma Fi = 1 \text{ ou } 100\%$$

where Nd is the number of records where activity was determined and Ni is the count corresponding to a given activity class. For sightings with two possible activity classes recorded, a value of 0.5 was counted in each relevant activity class.

Diurnal activity spectra are then obtained similarly by sorting data into four periods:

- morning from 06:00am to 10:00am
- midday from 10:01am to 02:00pm
- afternoon from 02:01pm to 06:00pm
- evening from 06:01pm to 10:00pm

RESULTS

Activity data were present in a total of 605 records (Table 1). Day-time feeding was important for the sperm whale (94.7% of the records), the bottlenose dolphin (64.3%) and at a lesser extent for the striped dolphin (32.7%) and fin whale (36.7%). It was rarely observed for the pilot whale (12.0%), which was often recorded as « resting » (40.0%), like the fin whale (38.6%). Socializing was a frequent activity for the three pelagic delphinids, ranging from 23.4% for the striped dolphin to 28.6% for the Risso's dolphin. Travelling is an important activity component for Risso's and striped dolphin. Thus if we except the sperm whale, all species appear to share most of their activity spectrum between two or more categories. Hence the interest of looking at diurnal variations patterns.

	striped dolphin	Risso's dolphin	bottlenose dolphin	pilot whale	sperm whale	fin whale
N records	**359**	**21**	**15**	**25**	**19**	**166**
resting	10.3	21.4	14.3	**40.0**	0.0	**38.6**
travelling	33.6	28.6	14.3	22.0	5.3	20.5
feeding	32.7	21.4	**64.3**	12.0	**94.7**	**36.7**
socializing	23.4	28.6	7.1	26.0	0.0	4.2

Table 1: Global activity pattern for 6 species.

From this global view, it is not necessary to analyse temporal variation of the sperm whale activity, because of the major importance of feeding. On another hand, bottlenose dolphin records are not numerous enough to be further analysed.

Striped dolphins

Feeding represents 40% of the records in the morning and 71% in the evening; it is very minor during the afternoon. Resting is important during afternoon (29%). Travelling mostly take place from morning to afternoon. Socializing is a frequent activity during midday (28%) and afternoon (31%). Hence, striped dolphins tend to be feeding from the evening to the morning and spend much time from 10am to 6pm in resting / socializing activity (Figure 1).

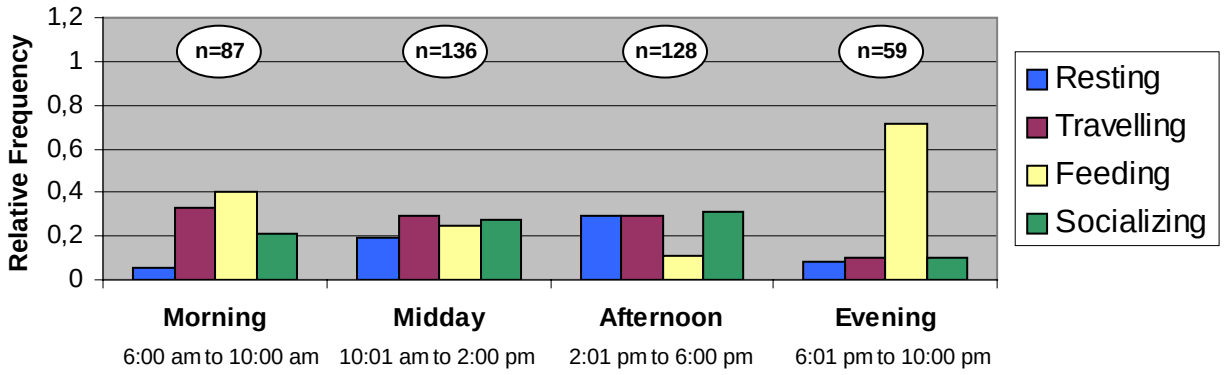

Figure 1: Diurnal activity pattern of the striped dolphin.

Risso's dolphins

Feeding is more frequent during morning and evening (resp. 25% and 50% of the cases), when resting is majoritary during the afternoon (Figure 2). All activity classes are almost equally represented in the midday period. Diurnal activity pattern analysis is limited by relative lack of data for afternoon and evening periods.

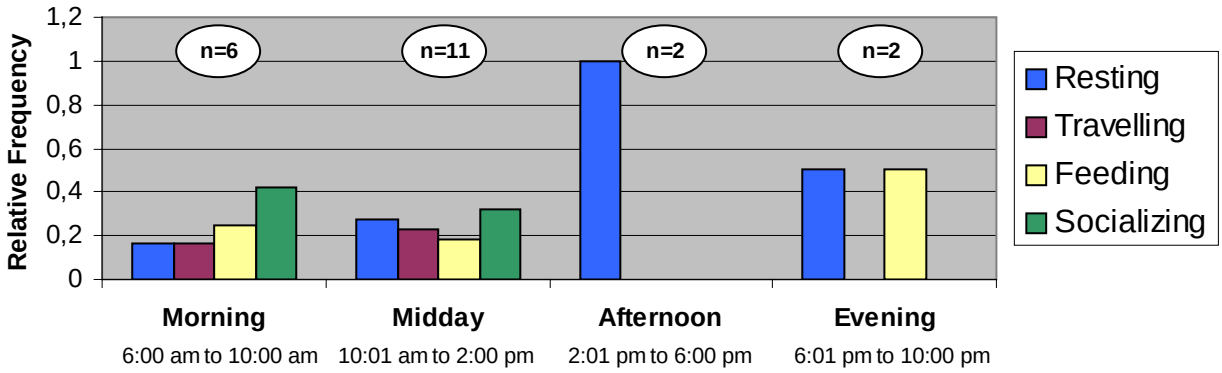

Figure 2: Diurnal activity pattern of the Risso's dolphin.

Pilot whales

Feeding is an important activity during morning (50%) and evening (37.5%), when resting accounts for 62% of the records during midday and 43% during afternoon (Figure 3). No case of feeding between 10am and 6pm has been recorded. The 2pm-6pm is also favorable to socializing, an activity still important during evening. Travelling tends to be more frequent during the afternoon (12% to 31%).

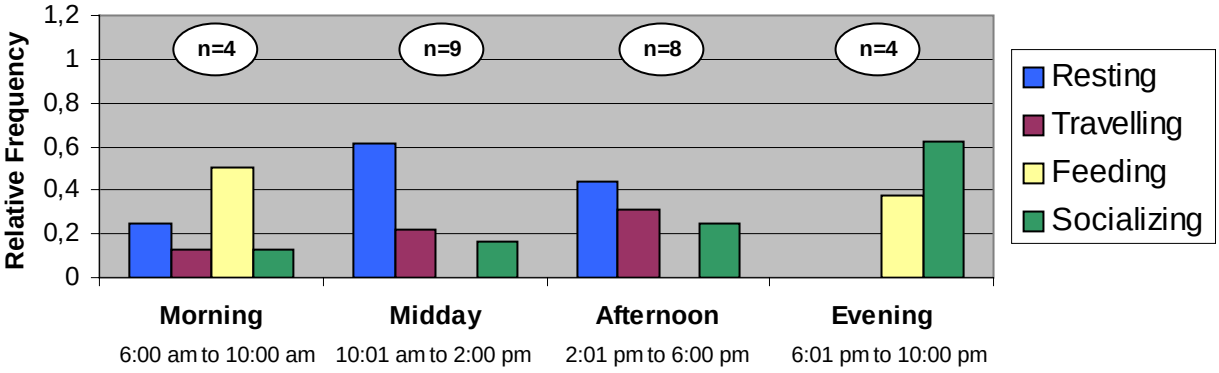

Figure 3: Diurnal activity pattern of the pilot whale

Fin whales

Feeding is observed all day long, but in decreasing frequency from morning (42%) to afternoon (22%). It is a major activity during the evening (74%). Resting animals are increasingly observed from morning (31%) to afternoon (47%). Socializing occurs mostly during midddday and afternoon.

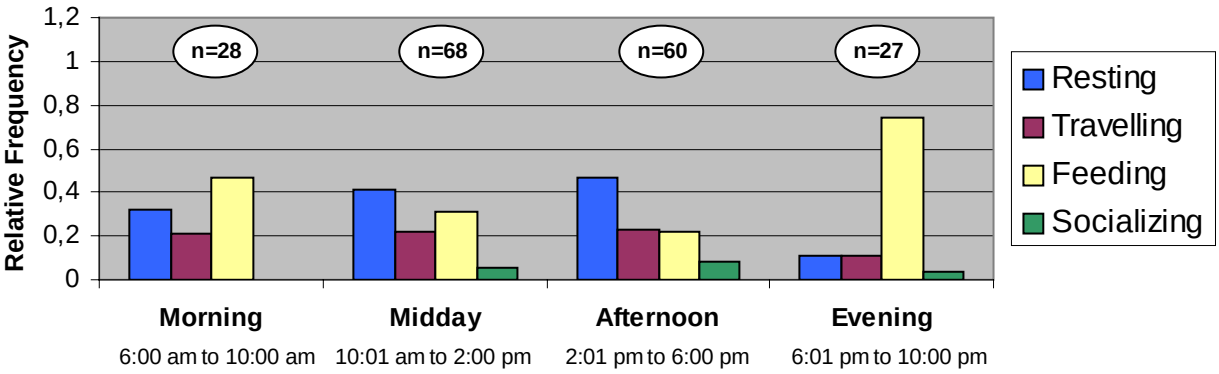

Figure 4: Diurnal activity pattern of the fin whale

DISCUSSION

Our results indicate that socializing is a very minor component for those species not mating or calving during summer, i.e. sperm and fin whales. This is consistent with other studies on pilot whale and risso's dolphin that relate social behaviors to reproductive cycle (Duguy et al., 1979; Vallon et al., 1979). The opinion that pelagic delphinids are mostly night feeders in the Ligurian Sea sanctuary may be debated, since Risso's and striped dolphins are observed to feed during the day, however with lower frequencies than during morning and evening. The striped dolphin is known to be an opportunistic feeder (Würz and Marrale, 1993; Blanco *et al.*, 1994) and Risso's dolphin may rely on both benthic and pelagic cephalopods (Würz *et al*., 1992), such explaining variability in feeding periods related to prey habits. On the other hand, pilot whales seem to feed mostly before, during and after night, presumably because they are more specialized predators, perhaps favoring histioteuthids squids.

Fin whales also exhibit feeding behaviors during day-time, even if with lower frequency. Recent studies (Panigada *et al*., 1999) show that they may feed on migrating euphausids at depth in excess of 500 m, performing prolonged dives. This is in agreement with their favorite prey vertical migration habits (Sardou and Andersen, 1993).

CONCLUSIONS

With the formal creation of the International Sanctuary, research on activity pattern of cetaceans may play a major role when dealing with impact of human activities such as whale-watching or fast-ferry trafic. This study shows that complexity may be the rule rather than the exception.

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