Interactions between bottlenose dolphins with trammel nets in the Sardinia Island

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In the Mediterranean Sea, common bottlenose dolphins (*Tursiops truncatus*) adversely interact with the fisheries, particularly when trammel nets are used. This results in an economic loss to fishermen and incidental catches of dolphins. The first stage to solve the conflict is the evaluation of its nature to describe in which way the presence of trammel nets can influence a bottlenose dolphin population.

This is the objective of the project initiated in October 1999 on the North-eastern coast of Sardinia (Italy). Observations were made by experienced researchers in presence and absence of trammel nets. For each group we recorded on an audio tape: date, start and end time, number of bottlenose dolphin adults and calves, water depth and description of behaviours (focal-group sampling method). Observations were made during daylight hours and during the night with night-vision binoculars. Opportunistic video recordings were also made to document and verify behavioural interaction.

A total of 496 sightings were carried out in over 1420 hours of research of dolphins during 478 days at sea. In presence of trammel nets: 218 sightings were recorded in 161 days at sea, in absence of trammel nets: 278 sightings were realized in 317 days of research. The presence of bottlenose dolphins in the study area has changed with the presence of trammels nets. School size doesn't show any variations with the presence of fisheries. The possible competition between fisheries and bottlenose dolphins on the north-eastern coast of Sardinia may produce when target prey for cetaceans and fishermen overlap close to a FAD (Fish Attraction Device).

Keywords: bottlenose dolphin, fisheries, trammel nets, behaviour, Mediterranean Sea.

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Introduction

Interactions with fisheries are potentially harmful to cetaceans (e.g. depletion of fish stocks, direct kills in fisheries, and incidental captures in fishing gear) and to humans (e.g. gear damage and depletion of commercially valuable fish stocks) (Beddington et al., 1985). There is a long history of interactions between common bottlenose dolphins (*Tursiops truncatus*) and coastal, small scale commercial fisheries in the Mediterranean Sea; where bottlenose dolphins adversely interact with the fisheries, particularly when trammel and gill nets are used.

The first stage to solve the conflict is the evaluation of its nature to describe in which way the presence of trammel nets can influence a bottlenose dolphin population. Studies specifically focusing on fishery-dolphin interactions have been initiated in a few Mediterranean areas (Bearzi, 2002).

Even though these data are from only one bottlenose dolphin study site, it is appropriate to extrapolate to other areas of high prey density. In north-eastern Sardinia the construction of a floating fish farm has been linked to increased bottlenose dolphin abundance and habitat use, and dolphin behavioural changes were recorded as a result of high fish density around the farming area (Díaz López et al., 2001; Díaz López, 2002). Therefore, the objective of this study was to describe in which way the presence of trammel nets can influence a bottlenose dolphin population in an area of a concentrated high prey density.

Methods

Our study focuses on the northern coast of the Gulf of Olbia and southern coast of Gulf of Congianus (Figure 1) where previous work (Díaz López, et al., 2002; Díaz López,

2002) has shown a degree of residency of recognised animals and highlighted their abundance. The town of Golfo Aranci (40º59'N, 009º37'E) encompasses the most representative harbour in terms of trammel nets fishing effort, from which around 30 boats operate.

On the northern coast of the Gulf of Olbia the construction and transformation of a floating marine fish farm, with bass (*Dicentrarchus labrax*), gilthead seabream (*Sparus auratus*) and corb (*Sciaena cirrhosa*), has been linked to increased bottlenose dolphin presence as a result of high fish density around the floating cages in the farming area (Díaz López et al., 2001; Díaz López, 2002).

In order to know the interactions between the dolphins and trammel nets, to conduct behavioural studies and to collect photographic data, the observations both from land and from motor boat were regularly undertaken from 1999 to 2004. All years but 2003 were sampled. The absence of survey trips during the year 2003 is attributed to lack of funding during this year.

Observations were made by experienced researchers all year round in presence and absence of trammel nets. A dolphin "sighting" was defined as a dolphin or a group of dolphins usually involved in the same activity (termed focal group, Shane, 1990a). Beginning of sighting environmental measurements and number of trammel nets will be recorded. Sightings have considered satisfying when the visibility was not reduced by rain or fog and sea conditions were equal or below 3 of the Douglas scale. For each group of dolphins we recorded on an audio tape: date, start and end time, description of behaviour states and number of bottlenose dolphin adults, immatures and newborns. The encounter continued until the group was lost (a group was considered lost after 15 minutes without a sighting). The year was divided into seasons to assess differences in frequency of interactions between the common bottlenose dolphins and trammel nets.

Observations were made during daylight hours between 06:00h and 20:00h and during the last year 2004 night observations were made with night-vision binoculars.

Group follow protocols and continuous sampling methods are based upon Mann's (1999). Continuous recording of dolphin behavioural states will be used to assess duration of states, as well as determine the sequence of states. A focal group of dolphins was observed and onset and ending times of four behaviour states - Feed, Social, Rest and Travel (Shane, 1990a,b) were noted. Opportunistic video recordings using a JVC digital camcorder were also made to document and verify behavioural interaction. Afterwards, each behavioural category was determined with objective parameters. Sightings under 10 minutes long have been selected as too short and they have not been considered in this behavioural study.

Trammel net fisheries also were monitored through interviews with the fishermen of 8 boats based in Golfo Aranci, corresponding to 26% of the trammel net fleet. Information requested from the fishermen included: (1) days of fishing operations, (2) trammel net position at sea (fishing area and depth), (3) interaction with common bottlenose dolphins and (4) bottlenose dolphin mortality data.

Data analysis

Differences in number an duration of sightings of bottlenose dolphin per day among zone by fishing gear combination (i.e. presence trammel nets and absence trammel nets) were tested using one-way analysis of variance ANOVA (Underwood, 1981) followed by Tukey's honestly significant difference test. All data were checked for normality and homogeneity of variances. Data that failed to meet these assumptions were transformed ($\log_{10}x + 1$) and reassessed.

A Correspondence Analysis (CA) (Greenacre, 1984) was carried out using the duration of the behaviours in presence and absence of trammel nets as input data, to describe affinities between behaviours.

Bottlenose dolphin group size and presence of immatures was compared in presence and absence of trammel nets using a non parametric Mann-Whitney *U*-Test (Fowler and Cohen, 1993). A decision level of 0.05 was chosen for all statistical tests.

All statistics were performed with PAST a statistics software package (Hammer et al., 2001).

Results

Over a total of 1796 hours of observation, a total of 496 sightings were carried out in over 1420 hours of research of dolphins during 478 days at sea. In presence of trammel nets: 218 sightings were recorded in 161 days at sea, in absence of trammel nets: 278 sightings were realized in 317 days of research (Table 1).

During the study period 161 trammel net operations were recorded. Fishing trips took place 2-4 weeks per month, or 2-6 days a week. The nets were deployed at sea 1-8 times each week, with soaking time being about 2-12 hours in each net setting. Throughout the entire study area the trammel net operations were conducted close to the shore and from 5 to 63 m of depth (mean = 28.11, SD = 13.47, median = 25, range = 5 - 63).

The number of sightings and duration has changed with the presence of trammel nets. In presence of trammel nets the mean of sightings was significantly higher than in absence (One-Way ANOVA: df= 467, F= 13.36, $p<0.01$). Comparison of average time of sightings detected significant differences with the animals spending more time in the area when trammel nets are present (One-Way ANOVA: df= 467, F= 14.37, $p<0.01$).

ANOVA for number of sightings of the bottlenose dolphins showed that were significantly higher in presence of trammel nets during fall (One-Way ANOVA: df=

467, F= 4.486, p<0.01). However, this was not the case for the duration of sightings where the bottlenose dolphins spent the same time among seasons in the study area in presence of trammel nets (Table 2).

School size and presence of immatures didn't show any variations with the presence of trammel nets (p>0.01, Mann-Whitney *U*-Test) (Figure 2).

The mainly observed behaviour during the sightings was feeding (One-Way ANOVA: df= 1571, F= 575, p<0.01) both with presence an absence of trammel nets (Table 3 – Figure 3).

Incidental takes of bottlenose dolphins in trammel nets are a rare occurrence (3 dolphins in 6 years), 2 immatures and 1 adult. One immature was removed from the nets alive cutting the net.

Conflicts with bottlenose dolphins have been reported in trammel nets but bottlenose dolphins in the study area also interact with gillnets, trawl nets an occasionally with handlines for octopus or squid fisheries. In 6 night fisheries for squids, bottlenose dolphin approached the illuminated area to capture squids.

Discussion

The possible competition between fisheries and bottlenose dolphins on the north-eastern coast of Sardinia may produce when target prey for cetaceans and fishermen overlap close to a FAD (Fish Attraction Device). The common bottlenose dolphin diet is diverse, and likely includes many of the demersal fishes that are the targets of small-scale fisheries (Barros and Wells, 1998; Blanco et al., 2001).

Bottlenose dolphin interactions with trammel nets are complex, in part because both fishermen and dolphins are drawn to areas of high prey density. The presence of a marine fish farm influenced in the presence of dolphins and trammel nets.

Furthermore, common bottlenose dolphins are probably often attracted to fishing nets activities because they make it easier for the dolphins to exploit a concentrated food source.

The association of common bottlenose dolphins with trammel nets may well be a strategy to increase the rate of feeding, while decreasing the energy expenditure associated with foraging. This association indicates the behavioural flexibility of these animals to capitalize on human activities.

Differences between the mean of sightings were present in fall (recruitment period for most of the fish species, Stergiou et al., 1997) with a high presence of dolphins. However the duration of sightings in fall didn't show changes between seasons. It is well known that the recruitment for most of the fish species in the Mediterranean Sea, takes place in shallow water near the coast line (depth<60m) where the trammel nets are sited (Machias et al., 2005). Subsequently, as fish populations decline in the area from fall to spring, because of natural and/or fishing mortality (Local fishermen pers. comm.), the bottlenose dolphins maximize the presence of fish populations near the coast line to interact with the trammel nets.

The negative effects of bottlenose dolphins in trammel and gill net fisheries in the study area are:

- damage to gear in the form of holes torn in the netting as the dolphins attempt to remove fish
- reduction in the amount on value of the catch as the dolphin mutilate or remove caught fish from the net
- loss of both money and time by the fishermen
- reduction in the size of the catch as the dolphins' presence causes fish to flee from the vicinity of the nets.

Beneficial effects of bottlenose dolphin in the area may also occur (local fishermen pers. comm.). These may involve a bottlenose dolphin feeding between the floating cages of the fish farm; the dolphins' presence causes fish to flee out of the fish farm area increasing the presence of fishes close to the nets increasing the chances of success of a fishery.

Associations with trammel nets may be harmful in that it may expose bottlenose dolphins to greater risk of incidental catches. It is also probable that young cetaceans are caught because of their inexperience with fishing year (Nelson, 1990). Young animals may learn safe movements around nets by watching conspecifics.

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Table 1. Number and duration of sightings when sampling was carried out.

Trammel nets	*Observation Effort*	*Number of sightings*	*Research Effort*	*Sighting Effort*	*Days at Sea*
Presence	38757 min	218*	30927	10159**	161
Absence	69006 min	278	54297	12380	317
Total	1796 hours	496	1420 hours	375.6 hours	468

* ANOVA: df= 467, *F*= 14.37, p<0.01; **ANOVA df= 467, *F*= 13.36, p<0.01

Table 2. Summary of ANOVA comparing number and duration of sightings among trammel nets presence/absence and between seasons. Statistically significant (p<0.05) results shown in bold.

Source		**Winter**		**Spring**		**Summer**		**Fall**	
	df	F	p	F	p	F	p	F	p
Nº Sightings	467	0.959	0.327	0.040	0.840	1.607	0.216	27.310	**0.0001**
Duration of sightings	467	2.40	0.123	0.116	0.733	0.816	0.374	0.006	0.937

Figure 1. Map of the north-eastern coast of Sardinia showing the location of the fish farm and the area were the present study was carried out.

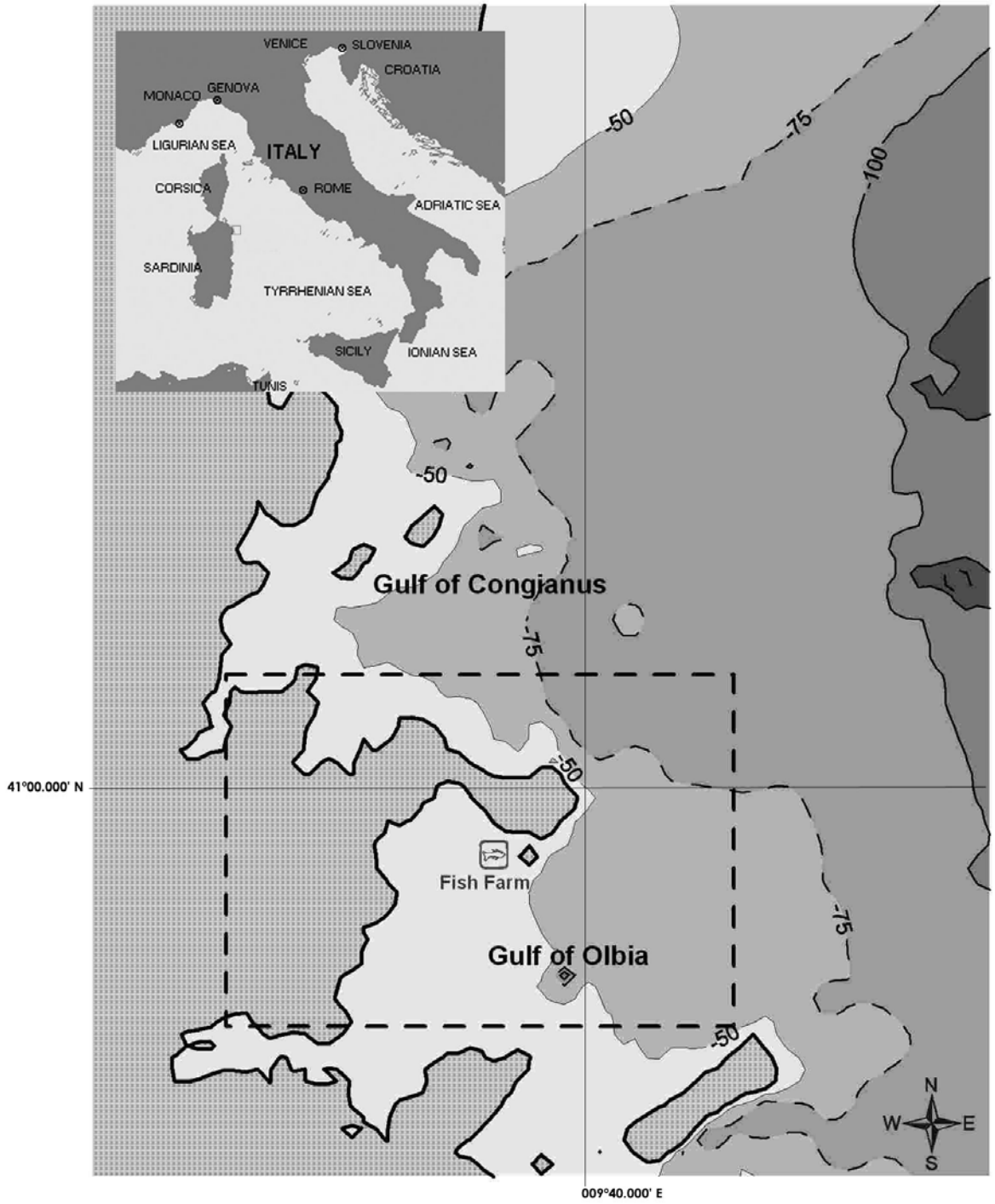

Figure 2. Group sizes in presence (1: mean = 4.52, SD= 3.74) and absence (2: mean 4.61, SD= 3.82) of trammel nets.

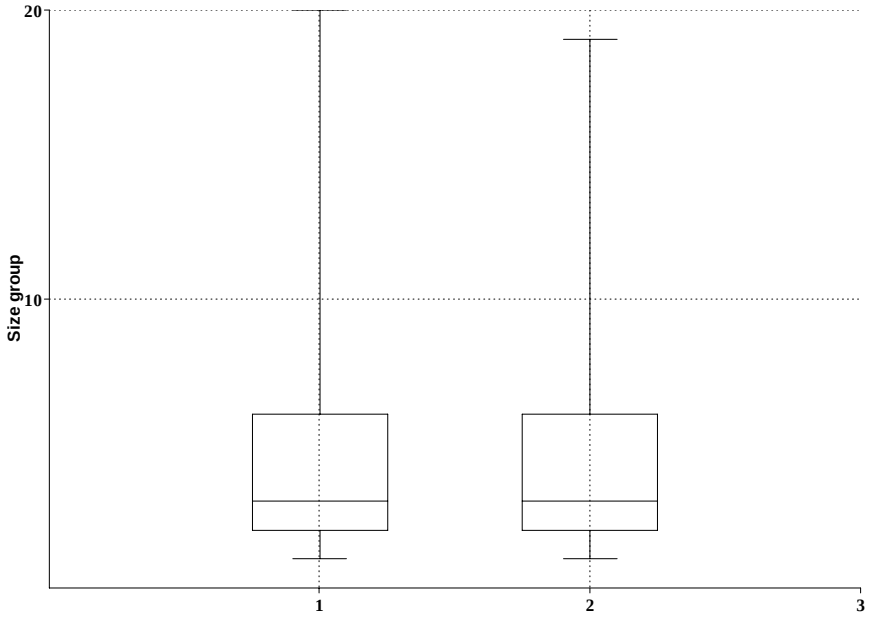

Figure 3. Correspondence analysis of the behavioural states: F: Feed, Tr: Travel, S: Social, O: Other. Axis 1: Eigenvalue= 0.308 (43.78% of similarity); Axis 2: Eigenvalue= 0.2212 (31.42% of similarity). Red cross: presence of trammel nets; Blue squares: absence of trammel nets.