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EDITORS: P. G. H. EVANS AND E. O'BOYLE

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INTRODUCTION

The Fifteenth Annual Conference of the European Cetacean Society was held at the Frentani Conference Centre in Rome, Italy between 6th and 10th May 2000. It was attended by over 420 people from 33 countries.

The theme this year was "Marine protected areas and other approaches for the management of threats to marine mammals", and speakers invited to give keynote addresses to this theme included: Enrique Crespo on "Aquatic Mammals in South America: Problems and Perspective Views for Conservation", Bernd Würsig on "Marine Mammals and Aquaculture: Conflicts and Potential Resolutions", Tundi Agardy on "The Use of Marine Protected Areas in Cetacean Conservation", Giuseppe Notarbartolo di Sciara on "The International Sanctuary for Mediterranean Cetaceans: Transiting from the Institutional to the Implementation Stage", Michael Donaghue on "Management of Hector's Dolphins in New Zealand", and Andy Read with a report on a "Workshop on Acoustic Harassment Devices". In addition to these, there were 30 other talks and 200 posters.

Associated with the Conference, there were workshops on the following themes: acoustic harassment devices, collisions between cetaceans and vessels, the use of controlled exposure experiments for investigating effects of anthropogenic noise on marine mammals, European studies of *Tursiops*, and there were meetings for students and for those working on pinnipeds.

The Society is very grateful to the Conference Organisers Giancarlo Lauriano and Fabrizio Borsani of ICRAM, their team of local helpers, Marina Barberini, Simone Canese, Stefano Di Muccio, Caterina Fortuna, Michela Giusti, Valentina Rapi and Vincenzo Rafti, ICRAM's administrative personnel, and ECS Treasurer, Roland Lick, who played an important role in the organising of registration and membership fees. Special thanks also go to Ms I. Ferri (Animal and Nature Conservation Fund, Rome).

We also gratefully acknowledge the following bodies for their generous sponsorship of the conference: Istituto Centrali Per La Ricerca (ICRAM), Castalia Ecolmar - the Italian Ministry of the Environment Marine and Anti-Pollution Service, and Lega Pesca.

A Conference Scientific Committee was chaired by Fabrizio Borsani and also comprised Anne Collet, Greg Donovan, Peter Evans, Jaume Forcada, Toni Raga and Emer Rogan. The following persons have reviewed abstracts: Alex Aguilar, Peter Bannister, Peter Best, Arne Bjørge, David Borchers, Fabrizio Borsani, Mark Bravington, Doug Butterworth, Phil Clapham, Chris Clark, Enrique Crespo, Greg Donovan, Peter Evans, Jaume Forcada, Claudio Fossi, Jonathan Gordon, Phil Hammond, Lex Hiby, Rus Hoelzel, Vincent Janik, Toshio Kasuya, Finn Larsen, Christina Lockyer, Tony Martin, Giuseppe Notarbartolo di Sciara, Todd O'Hara, Adrian Raftery, Toni Raga, Randall Reeves, Peter Reijnders, Emer Rogan, Ursula Siebert, Paul Thompson, and Nick Tregenza.

Contributions have been arranged broadly by subjects, and within subjects, they are arranged alphabetically. All abstracts were subject to a review process and represent all those submissions that were accepted for the conference. Extended summaries have been edited to improve clarity and to maintain a uniformity of presentation. For the benefit of contributors to future Proceedings, instructions are given at the back of this volume. Please follow the guidelines carefully; most contributors have not followed them closely and this creates much extra work for the editors.

A very great deal of effort has gone into the editing and production of these Proceedings. In this connection, I should like to thank my co-editor Ellen O'Boyle for her invaluable help at all stages of its production. Finally, I should like to thank Giancarlo Lauriano and Fabrizio Borsani for all their help with the organization of this Conference and Roland Lick for his help with printing the Proceedings.

Peter G.H. Evans

ACOUSTICS

ECHOLOCATION AND CAVITATION

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INTRODUCTION Dolphins in the wild live in a fairly noise environment. The marine noise is made up of:

- physical effects: the sound of crashing waves, rain, earth movements, etc.
- biological noise: the broadband noise of snapping shrimps, the noise of fish
- man-made noise: shipping, drilling, dredging and industry.

The hearing of dolphins is adapted to natural sounds such as physical effects and biological noise, while it may be adversely affected by anthropogenic sounds. Man-made noises may be subdivided as follows:

1) low frequency noises (< 10 kHz), caused by the ship's own machinery and motion, seismic profiling systems (explosives, sparks and "air guns"), and drilling, dredging or other industrial activities;

2) high frequency noises (from 10 to 500 kHz), created by cavitating ships' propellers and transducers, cavitation bubble implosion used to probe the underwater environment (Cannelli *et al.*, 1990), and by sonar systems.

In captivity, dolphins are affected only by anthropogenic noise. A very general summary of the main causes of noise in pools may be subdivided as follows:

1) low frequency noise, caused by water circulation systems and filtration plants, and vibrations caused by distant human activities and transmitted with little attenuation through the ground and into pools;

2) high frequency noise, produced by cavitating pumps (Tirelli, 1997).

Anthropogenic low frequency sounds in the natural habitat differ from those in pools, while much of anthropogenic high frequency sounds come from cavitation either in the wild environment or in artificial tanks. Therefore, studying the effect of high frequency cavitation noise on the physiology and acoustic behaviour of dolphins is of importance both for dolphins that live in captivity and wild dolphins, although only the latter can escape from them. The acoustic waves resulting from bubble collapse are characterised by a very wide spectrum, containing powerful high frequency harmonic components (Shutilov, 1988), similar to that of sonar signals of dolphins. Besides waves generated by dolphins and by cavitation-bubble implosion, there are no other marine organisms or devices with similar characteristics in the world. For this reason it could be interesting to investigate how similar the features of waves of cavitation-bubble implosion are to those of sonar signals of dolphins, and if a similar mechanism could generate both. In 1997, three bottlenose dolphins (one male, called Robin, and two females, named Violetta and Betty) were housed at the Palablu of Gardaland (Fig. 1). Palablu was built using materials and a design that would reduce sound reverberation and man-made low frequency sounds. However, high frequency noises caused by pump cavitation have been measured in all four pools since June 1997. Efforts were immediately made to suppress these noises, but we succeeded only in suppressing the high frequency peak of cavitation noise above 200 kHz (i.e. above the supposed detection threshold of dolphins). Only recently (since autumn 2000), the cavitation of the three centrifugal pumps (Fig. 2b) that provide water circulation into the pools was suppressed, leading to a rise of about 3 m between the pumps and the surface of the sucked water. The aim of this study is to describe the acoustic behaviour of Robin (Fig. 2a) during the period of high frequency cavitation noise (1997-2000), and after their suppression (in 2001).

MATERIALS AND METHODS This study was conducted in the Gardaland pool, called Palablu, between October 1997 and May 2001. From 1997, signals produced by Robin, Violetta and Betty were recorded at least three days every month. Since 1999, the signals produced by the other dolphins housed later at the Palablu (Amada, Squeak, Hector, Teyde) were also regularly recorded. However, for this study only, Robin was chosen because he was present in the Palablu from the beginning and in contrast to Violetta and Betty, was not involved in events (illness, pregnancy) that could affect acoustic behaviour. The recording equipment used in the research includes: a hydrophone (Bruel Kjaer 8105), charge amplifier (Bruel Kjaer 2635), and tape recorder (0-500 kHz; dynamic – 55 dB), for broadband signals; underwater camera and video recorder, and digital oscilloscope (HP

54520A). For signal registration the B&K 8105 has a flat frequency response up to 160 kHz, the sensitivity drops after 160 kHz at approximately -60 dB/decade (-18 dB/octave). For this reason, the recording system used does not give an accurate representation of the dolphin's pulse shape (the highest components of its spectra are attenuated), and, in particular, it does not give accurate information on the amplitude of highest frequency components generated by cavitation. Recordings were made regularly (two hours of recordings collected randomly in a session of three days every month). However, in only three sessions in 1997 and 1998, two sessions in 1999, and one session in 2000, were waves from cavitating pumps detected and recorded, together with Robin's sonar signals. Echolocation recordings were made while Robin was swimming freely with the other dolphins in the pools used for the research. Both acoustic signals were digitalized at a sampling frequency of 5 MHz (512 samples in 100 m). The first and second moments in time and frequency, the Gabor time width T_G and bandwidth B_G, the peak frequency f_p, and the Q parameter (B_G / f_p), were calculated on a MATLAB platform. Since signal shapes were influenced by the limited frequency range of the hydrophone (0-160 kHz), we focus upon the frequency distribution of the signals and their trend in relation to either Robin or the pumps.

RESULTS AND DISCUSSION The spectra of Robin's click signals (a typical click waveform is shown beside the picture of Robin), recorded in the same sessions as the cavitation noise, are shown in Figure 2a, while Figure 2b shows the spectra as a long series of waves (an example is given near the illustration of the pump) produced by cavitating pumps for the years 1997, 1998, 1999 and 2000. As shown in Table 1, the features in time and space of the cavitating signals recorded in 1997, 1998 and 2000, are very stable. The lowest frequencies of the main spectra are c. 200 kHz, and the highest c. 400 kHz; the frequency peak is between 275 and 300 kHz (Table 2); and the Gabor bandwidth is around 105 kHz (Q ≅ 35%). The cavitation spectra recorded in spring 1999 are similar in shape but scaled to c. 100 kHz in frequency with respect to the above values: the lowest frequency is 300 kHz; highest frequency is 600 kHz; peak frequency is 430 kHz; and the Gabor bandwidth is 224 kHz, Q ≅ 52%. In 2001, cavitation noises were suppressed. The click signals of Robin appear to have some relationship to them: the spectra extend up to 250 kHz, and the peak frequency is between 130 and 175 kHz in the years 1997, 1998, and 2000. On the other hand, when cavitating noises have frequencies above 300 kHz (1999) or are absent (2001), click signals produced by Robin extend only up to 150-175 kHz, and the peak frequencies are between 60-70 kHz. Figure 3 shows the spectral power density produced by Robin (on the right) and by the pumps (on the left). Although the amplitudes of the two sets are not comparable because of the limitations of the hydrophone, the trend of Robin's spectral power density is similar to that of the pumps: both reach a maximum in the winter of 1998, an average value in autumn 1997 and a minimum in spring 2000. It seems that Robin can detect signals with frequencies from 200 kHz up to at least 300 kHz, as suggested by Popper (1980), and tries to mimic them both in frequency and amplitude. However, Robin seems also to be able to produce frequencies above 200 kHz.

The similarity of the ratio Q = B_G / f_p between acoustic waves resulting from bubble collapse (34-52%), and click signals (35-77%), is remarkable (Table 2), considering that there is no other known mechanism capable of generating such a broad ratio except for dolphin bio-sonar and cavitation. The similarity between echolocation and cavitation signal shapes is also surprising (Fig. 2). Both signals are characterised by strongly non-linear, large oscillations, abruptly rising from and collapsing to 0. On the other hand, the differences in the complexity of their spectra are considerable: the harmonic components at high and low frequencies are much more numerous in click signals than in cavitation signals. All these results suggest that echolocation signals may be generated by a mechanism (bubble implosion) similar to cavitation. In fact, despite the fact that a great deal of attention has been devoted to the subject, the problem of how clicks are produced remains unsolved.

CONCLUSIONS

- Contrary to general opinion, it seems that a bottlenose dolphin (Robin) can detect frequencies from 200 kHz to at least 300 kHz.
- The acoustic behaviour of Robin, faced with the noises produced by cavitating pumps, was to mimic the cavitation signals.
- The similarity of the ratio B_G / f_p between signals produced by cavitation and click signals is remarkable.
- The spectral shapes of both the cavitation signals and click signals are close.

These results suggest that click signals and cavitation signals may be generated by a similar mechanism.

ACKNOWLEDGEMENTS We acknowledge the support provided by the staff of Gardaland Dolphinarium. This study would not have been possible without the support and advice of the technical service of Gardaland, particularly engineer Franceso Vianello and Nicola Bertaiola.

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Table 1. Acoustic features in time and space of pump cavitation signals and Robin's clicks

PERIOD	SOUND SOURCE	TIME MOMENTS (μs)				FREQUENCY MOMENTS (kHz)			
		Barycentre		T_G		Barycentre		B_G	
		mean value	st. dev.	mean value	st. dev.	mean value	st. dev.	mean value	st. dev.
autumn 1997	pump	41.5	14.8	2.3	0.2	307.4	19.3	103.0	19.1
	robin	16.8	4.3	6.4	2.6	119.1	12.7	48.8	9.5
winter 1998	pump	35.9	13.8	2.4	0.2	285.6	15.5	101.2	16.6
	robin	34.5	8.8	9.2	2.1	133.9	24.8	62.7	12.1
spring 1999	pump	35.9	23.4	2.5	0.6	425.3	13.7	224.1	6.7
	robin	20.6	4.6	6.2	0.8	85.8	8.7	46.6	4.8
spring 2000	pump	45.5	16.5	2.3	0.3	332.0	26.9	117.4	22.9
	robin	21.3	8.0	8.3	2.2	109.4	29.6	65.9	22.9
spring 2001	pump	-	-	-	-	-	-	-	-
	robin	13.3	0.5	6.4	2.5	92.7	24.9	42.6	14.6

Table 2.. Relationships between the frequency peaks and Q values of cavitation and echolocation signals

PERIOD	SOUND SOURCE	N° OF CLICKS	FREQUENCY PEAK (kHz)	$Q=B_G$/*frequency peak* (%)	ENERGY (V^2)	UNCERTAINITY PRINCIPLE
autumn 1997	pump	9	300.0	34.4	0.3	0.2
	robin	4	130.0	37.5	4.5	0.3
winter 1998	pump	30	275.0	36.8	0.4	0.2
	robin	16	175.0	35.8	9.1	0.6
spring 1999	pump	78	430.0	52.1	0.1	0.2
	robin	46	60.0	77.7	0.8	0.3
spring 2000	pump	8	305.0	38.5	0.1	0.2
	robin	182	130.0	50.7	1.0	0.5
spring 2001	pump	-	-	-	-	-
	robin	230	65.0	65.5	48.7	0.5

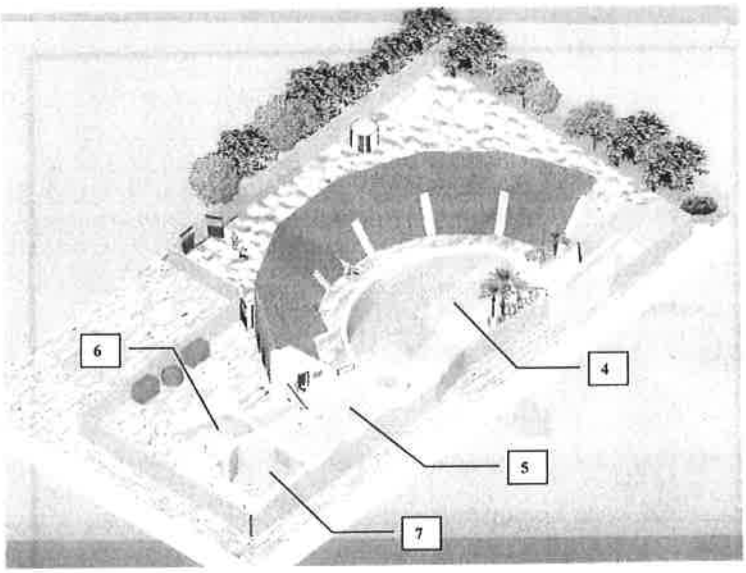

Fig. 1. Dolphinarium Palablu of Gardaland, built in 1997. It is structured in four intercommunicating pools covered in PVC to reduce the echoing. The larger pool (n°4) is adapted to shows, the mean one (n°5) to acoustic recordings, one of the smaller (n°7) is a nursery and the other (n°6) is destined to blood samples.

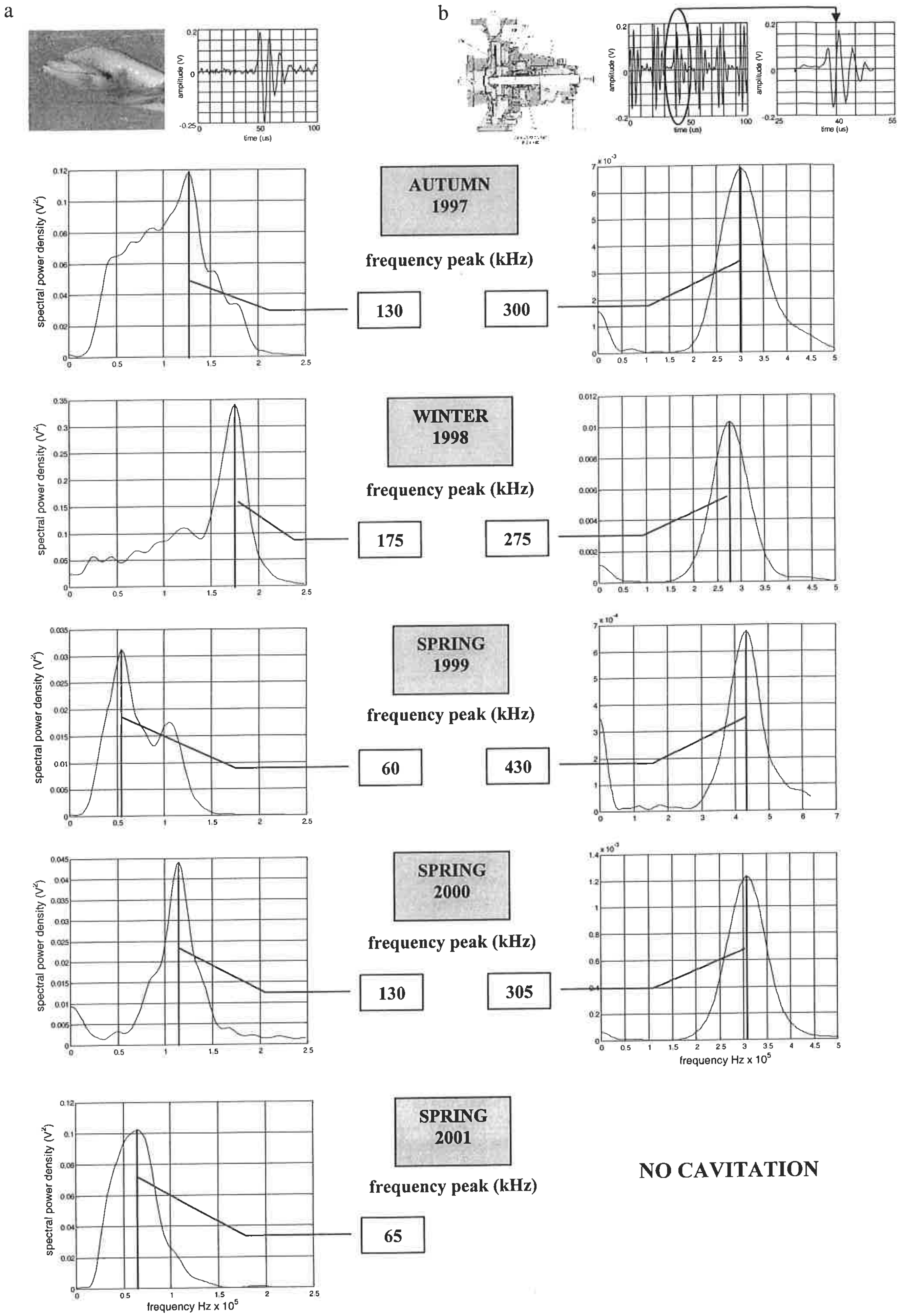

Fig. 2 – Series of synoptic recordings. (a) Robin echolocation spectra. (b) Pump cavitation spectra.

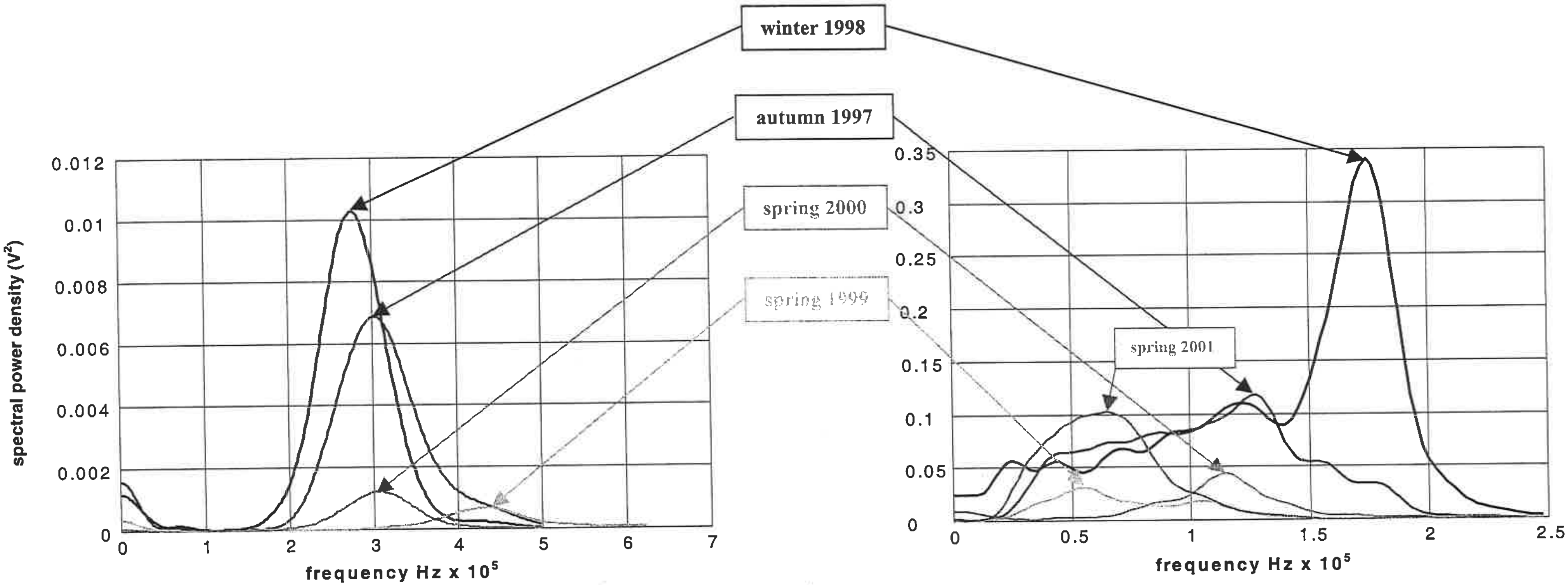

Fig. 3 – Series of the spectra produced by the pumps (on the left) and by Robin (on the right) during the period of study

ACOUSTICALLY DERIVED SIZE DISTRIBUTION OF SPERM WHALES IN THE MEDITERRANEAN SEA

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INTRODUCTION Sperm whales (*Physeter macrocephalus*) vocalisations consist primarily of series of clicks, emitted almost continuously while animals are diving. These clicks are unique to the species and are made up of a number of regularly spaced pulses resulting from multiple reflection of the initial sound pulse within the head of the animal. The spacing between the pulses in a click, termed Inter-pulse Interval (IPI), has been demonstrated to be related to the size of the animal. Through a knowledge of this relationship, it should be possible to assess the geographic size distribution of sperm whale acoustically, without having to spot and approach the animals. In the Mediterranean sea, the distribution of sperm whales is poorly known, while in other oceans it has been shown to vary according to sex and age composition of the groups. One of our longer term project aims is to assess whether the analysis of the clicks could provide an insight into the size distribution of sperm whales within the Mediterranean Sea.

MATERIALS AND METHODS Our recordings were collected during four summer surveys of different regions of the Mediterranean: the north-western basin, the south-western basin, the Tyrrhenian Sea and the Ionian Sea. A mono hydrophone was used, towed behind a 12 metre motor sailing boat. The recording equipment consisted of a Sony WMD6 analogue recorder and a TCD-7 DAT recorder. The best quality sequences were sampled onto a computer hard-disk using a Cambridge Electronic Design (CED) 1401 laboratory interface (Goold and Jones, 1995), using a sampling frequency of 62.5 kHz. The sequences were band pass filtered to retain frequencies between 2kHz and 6kHz, and analysed with the CED Spike 2 software. Wherever a clear pulsed structure was observed within a click, the first 3 pulses of the click were marked, and the first and second inter-pulse intervals (IPI) were calculated. When a single whale was distinguished, the mean IPI of the sequence was used to estimate its body length after Gordon's equations (1991):

$$\text{Body length} = 9.75 - 0.521\ SL + 0.068\ SL^2 + 0.057\ SL^3 \qquad (1)$$

$$\text{Body length} = 4.833 + 1.453\ IPI - 0.001\ IPI^2 \qquad (2)$$

where SL is the Spermaceti sac Length (in m): SL= IPI × speed of sound in spermaceti / 2. The sound velocity used was $1430 m.s^{-1}$ (Goold *et al.,* 1996).

RESULTS A total of 38 recording sequences were retained for IPI analysis. Among them, 25 click sequences where from single animals, emitting 'usual clicks' during deep feeding dives. In the 13 other sequences, several animals were vocalising at the same time so that one animal could not be distinguished from another. These sequences included either 'usual clicks' from several diving animals, or social vocalisations such as codas and chirrups. The IPI results calculated for each region are summarise in Table 1. Overall, the IPI ranged from 2.4 to 6.0 ms. When comparing IPI measurements between different regions of the Mediterranean, the north-western basin showed significantly greater IPI values than the other surveyed areas (Kruskall-Wallis Tests). In the north-western basin, the IPI's were 5.3ms long on average, with minimum value of 4ms. In the other regions, the IPI's were significantly smaller, with mean values of 3.9ms, 2.8ms and 4.4ms in the South-western basin, the Tyrrhenian Sea and the Ionian Sea respectively. The south-western basin and the Ionian Sea showed a relatively wide data spread, with large 95%CI and IPI values laying from 2.6ms to 5.7ms.In contrast, the IPI's measured in the North-western basin were distributed more closely around the mean, with 95% of the IPI ranging between 5.1ms and 5.6 ms. Thus the IPI's in the North-western basin were significantly larger and more consistent, while they were more evenly spread in the Ionian and South-western basin.

For the 25 recording sequences in which only a single whale was evident, the body length extrapolated from the mean IPI, ranged from 9.3 to 13.2m for equation (1), and from 8.3m to 13.5m for equation (2) (Table 2). Thus, it appears that both equations give reasonable length estimates for the measured whales. Figure 4 shows that small individuals (estimated size less than 9.5m) were present in the south-western basin, the Tyrrhenian and the Ionian Sea, while in the north-western basin only larger animals, of estimated size above 10.5m, were detected.

DISCUSSION The distribution of IPI values indicates that the IPI's were consistently greater in the North-western basin than in the other areas. Extrapolating for body length with equations (1) & (2) shows that whales detected in this region were around 12 m long on average. Thus the results suggest that the whales heard in the Northwestern basin were principally large animals, thus probably sexually mature. These results were consistent with those of Pavan *et al.* (1997), which gave mainly length estimates of 11-12m for whales detected in this area. Sexual maturation in males begins at about seven to eleven years of age and a length of 8.7 to 10.3m (Rice 1989), and is not complete until the age of 18 to 21, and a body length of 11-12m, at which time the animal is regarded as sexually mature (Rice, 1989). As males approach physiological sexual maturity, they decrease in sociality and rarely cluster together in close group as females do (Reeves and Whitehead, 1997). The wider IPI distribution found in the southwestern basin and the Ionian sea might indicate a more heterogeneous population of animals in these regions, including calves, juveniles and adults. Individual size estimation indicated animals of around 8 and 9 m long were present in these areas. These results were consistent with our visual observations (Gannier *et al.* In prep.). In fact, nursery groups were observed in the three regions where small whales were acoustically detected. In the northwestern basin, no such social structure has ever been observed, and the sightings consisted mostly of solitary animals. Pavan *et al.* (1997) also showed that large males (13 -14 m long) were present in the southern regions of the Mediterranean (South Tyrrhenian Sea and Ionian Sea). Our results tend to be consistent with a previous study carried out in the Northern Atlantic (Adler-Fenchel, 1980), which showed that sequences recorded at lower latitudes, where females and immature males were expected, had shorter IPIs than those from higher latitudes where only large males are found.

CONCLUSIONS Manual measurement appears to be an accurate method of obtaining inter-pulse interval (IPI) data from sperm whale recordings. The study shows that the analysis of click waveforms may be an appropriate technique to asses the geographic distribution of animals by body size. Coherent results were found and tend to indicate a regional segregation of males (long IPI) from the groups of females with young (wide range of IPI data). Further work comparing IPIs with reliable length measurement is however desirable in order to calibrate and cross-check the expressions relating IPI and total length.

ACKNOWLEDGEMENTS We are grateful to Marineland and the Conseil Regional de Provence-Côte d'Azur for having funded this study. We thank all the members of the GREC who benevolently participated in the surveys.

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Table 1. Results of Inter-Pulse Interval (ms) measured in the 4 regions of the Mediterranean

Region	N	Mean IPI (ms)	StDev	SE	Min	Max
Northwestern basin	14	5.34	0.56	0.15	4.09	5.97
Southwestern basin	11	3.91	1.13	0.34	2.59	5.57
Tyrrhenian Sea	3	2.82	0.41	0.24	2.36	3.17
Ionian Sea	10	4.39	1.03	0.33	2.94	5.69

Table 2. Results of the individual length estimates for the 4 regions investigated

	Region	N	Mean length (m)	StDev	SE	Min	Max
Equation (1)	Northwestern basin	15	11.8	1.1	0.8	9.9	13.2
	Southwestern basin	5	11.7	1.8	0.6	9.5	13.2
	Tyrrhenian Sea	1	9.3	-	-	9.3	9.3
	Ionian Sea	2	10.3	1.1	0.7	9.5	11.0
Equation (2)	Northwestern basin	15	12.3	1.3	0.3	8.6	13.4
	Southwestern basin	5	12.1	1.7	0.7	9.2	13.5
	Tyrrhenian Sea	1	8.3	-	-	8.3	8.3
	Ionian Sea	2	10.5	1.8	1.3	9.2	11.7

WAVELET FEATURE BASED CLASSIFICATION METHODS APPLIED TO HARBOUR PORPOISE SONAR SIGNALS

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INTRODUCTION High-resolution examples of echolocation signals were captured from two harbour porpoises during the 2-year EU-funded project EPIC 'Elimination of Porpoise Incidental Catch' (Lockyer *et al.*, 2000) at the Fjord & Belt Centre, Denmark. This study, which involved partners in Denmark, Sweden and the UK, included tests of acoustic signals for 'aversive' or 'attractive' characteristics.

As the pulsed sonar signals of porpoises have remarkably similar amplitude and spectral characteristics, identifying which animal was the source of recorded echolocation activity can be difficult. During these studies it was noted that when a stimulation signal ceased, the porpoises would immediately interrogate the position of the source using echolocation. These studies have demonstrated that synthesised signals closely emulating the porpoise's own echolocation pulses will reliably stimulate 'investigative' echolocation behaviour. A robust classifier has been developed based on a novel 'Admissable Wavelet Packet Transform' and Linear Discriminant Analysis technique for use with recordings of underwater behaviour to identify the individual that is actively echolocating. The method can be implemented on a fast PC and may be further developed for use as an 'on-line' analysis tool.

MATERIALS AND METHODS The male and female harbour porpoises studied, were rescued in April 1997 from a herring 'pound net' fish trap at Kørsor, West Sealand. By June 1999, around the time of the recordings they had grown significantly (female: 47.5 kg, length=148 cm; male: 40.8kg, length=138 cm). These porpoises were held for study in Denmark under a special licence issued to aid research into methods of reducing porpoise mortalities in bottom-set fishing nets.

High-resolution examples of mid-water 'on-axis' sonar signals were captured using a Tektronix TDA420 digital oscilloscope. Echolocation pulse trains were also recorded using a high-speed instrumentation tape recorder (Racal Storr 4 DS - 30"/s, 150 kHz bandwidth). These signals were recorded from a small 12.5 mm ball hydrophone (Sonar Products Ltd - HS150) positioned immediately adjacent to the stimulation source transducer. The position and orientation of the animals within the enclosure was recorded on time-coded video.

A preliminary analysis of the data recordings revealed that significant amplitude and phase modulation is frequently present in porpoise sonar signals interrogating a target. The modulation appears within each pulse after a short but fairly constant delay which cannot be explained by external multi-path effects (Figures 1 and 2).

ANALYSIS Before attempting to analyse the large volume of echolocation sequences recorded on the instrumentation recorder a means of identifying the echolocation signals originating from each animal was required. The set of over-sampled digital recordings captured via the oscilloscope was first examined in the laboratory for features that would allow these data to be partitioned between the two animals. A sub-set of these data files included the reported identity of the source animal. The classification of these signals proved difficult as both animals produced very similar signal spectra with overlapping variations in pulse shape and phase which helped to mask the more obvious cues. Source levels were not considered a useful discriminator, although the transmission loss could be estimated as path lengths could be determined from the video record. Peak frequencies in the power spectra were examined as body size was expected to affect this. Juvenile porpoises have been shown to operate at higher frequencies than adults (Kamminga & Wiersma, 1981; Goodson *et al.*, 1995; Goodson & Sturtivant, 1996), and the larger animal (in this case the female) was expected to transmit at a frequency slightly below that of the smaller male. The application of a simple Fast Fourier Transform to these signals did not, however, discriminate reliably and the variable phase shift observed within individual pulses may partially explain this. The novel use of a Wavelet Transform approach gave much better results, and this is the technique summarised here.

THE WAVELET TRANSFORM CLASSIFIER A Wavelet Transform (WT) (Mallat, 1998; Farooq & Datta, 2000) performs a constant 'Q' (Quality Factor) analysis of a signal by projecting it on a set of basic functions whose scale varies with frequency (Equation 1). A mother wavelet is shifted and scaled to generate additional wavelet functions that are orthogonal to each other. This WT signal processing approach decomposes the signal into low pass and high pass components, and then down-samples it by 2. The filters used for decomposition permit perfect reconstruction, and the WT functions appear orthogonal with finite impulse responses. These are called conjugate mirror filters.

A wavelet is a function $\psi \in L^2$ (3) (i.e. a finite energy function) with zero mean and is normalised ($\|\psi\| = 1$). A family of wavelets can be obtained by scaling ψ by s and translating it by u.

$$\psi_{u,s}(t) = s^{-1/2}\psi\left(\frac{t-u}{s}\right) \quad (1)$$

The Continuous Wavelet Transform (CWT) of a finite energy signal **f(t)** is given by:

$$CWTf(u,s) = \int_{-\infty}^{+\infty} f(t).s^{-1/2}.\psi^*\left(\frac{t-u}{s}\right)dt \quad (2)$$

where ψ^* (.) is the complex conjugate of ψ (.). The above equation can be viewed as convolution of the signal with dilated band-pass filters.

The Discrete Wavelet Transform (DWT) of a signal $f[n]$ with period N is computed as:

$$DWTf[n,a^j] = \sum_{m=0}^{N-1} f[m].a^{-j/2}.\psi^*\left(\frac{m-n}{a^j}\right) \quad (3)$$

where m and n are integers. The value of a is equal to 2 for a dyadic transform.

Using a digital signal processing approach the DWT decomposes the signal into low pass and high pass components and then down-samples these by 2. The decomposition of the signal $f(t)$ proceeds into two components, $f(t)_{lp}$ a low pass version and $f(t)_{hp}$ a high pass. A second level of decomposition is then applied to the $f(t)_{lp}$ signal only, and the $f(t)_{hp}$ is left untouched. Thus a DWT gives a left recursive binary tree structure, where the left branch represents the lower frequency band. A more general form is the Wavelet Packet Transform (WPT) [6] which tries to decompose the lower, as well as the higher, frequency bands, thereby giving a balanced binary tree structure. For the purpose of classification, the required features might come from some specific frequency bands, which sometimes may not be extracted by DWT (because it only splits the lower frequency band). The drawback of WPT is that it contains a high level of redundant information. Thus for the purpose of feature extraction, we propose the use of the Admissible Wavelet Packet Transform (AWPT). By using the AWPT transform, any selected frequency band can be split to enhance discrimination for classification purposes, and the method offers some advantages when applied to biological data (Goodson *et al.*, 2001)

As the sampling frequency of the porpoise clicks was 10 MHz, the Nyquist signal bandwidth is 0-5 MHz. By applying the decomposition by DWT, this band is split into two: a low pass band with frequency 0-2.5 MHz, and a high pass band of 2.5-5 MHz. A second level of decomposition splits the lower band again into two (i.e. 0-1.25 MHz and 1.25-2.5 MHz). By applying six successive levels of decomposition, the seven bands obtained are: 0-78 kHz, 78-156 kHz, 156-312 kHz, 312-625 kHz, 625-1,250 kHz, 1.25-2.5 MHz and 2.5-5 MHz. The last four frequency bands carried no significant energy from the biological signals, and can be discarded. The second band has maximum energy, and may contain more discriminatory information so this band is further decomposed and split into two (78-117 kHz and 117-156 kHz). Energy of the wavelet coefficients in these four bands is calculated and used as features for the male and female classification process. A Linear Discriminant Analysis (LDA) classifier (Fukunaga, 1990) was implemented and the results obtained are shown in Table 1.

LDA is a tool used for multi-group data classification and dimensionality reduction. It tries to minimise the ratio of within-class scatter to between-class scatter and thereby attempts to achieve maximum separability. A 'within-class' scatter matrix defines the scatter of samples around their respective class mean. A 'between-class' scatter matrix defines the spread of the mean vectors around the global mean. LDA tries to separate the different group data by forming a linear decision boundary between them.

RESULTS As the data set included 11 digital recordings where the animal's identity was known, these were divided into 'training' and 'test' data sets. To increase the size of these small data sets, additional samples were created by the addition of white Gaussian noise to produce degraded signal-to-noise ratio versions (SN=10 dB and 15 dB) giving a total of 24 examples with 15 male and 9 female clicks. In order to generalise the results, three different mutually exclusive combinations of training and test examples were then examined.

Table 1 illustrates the approach, using averaged energy data from the case of one training set in each frequency bin. The LDA classifier correctly assigned the female test examples in all of these combinations. However, this classifier consistently rejected a single degraded SN example (15 dB signal-noise ratio) derived from a male, and incorrectly assigned this to be a female in both the training and test combinations.

DISCUSSION & CONCLUSIONS The Admissible Wavelet Packet Transform provides a classification technique that may be automated and implemented in real time. In this application, it appears to be acceptably robust and should work with relatively noisy signals containing significant phase and amplitude modulation. The approach may also offer advantages when attempting to classify target echo data.

The objective of achieving a satisfactory discrimination between these two animals, using only frequency domain features extracted from individual echolocation pulse waveforms, was broadly achieved using this AWPT approach. However, the methods employed have examined 'whole pulse' waveforms. It seems clear that if the initial 4 to 5 cycles of the harbour porpoise waveform which precede any significant phase or amplitude modulation effect can be isolated, then this signal segment may permit alternative methods to be reconsidered.

The porpoise echolocation waveforms which we have examined confirm the observations of Kamminga and Wiersma (1981) who showed that harbour porpoise echolocation signals frequently include a phase modulated component, and we concur with their speculation that the addition of a delayed replica signal may be the cause. However, the observed delay is remarkably stable and too short to be caused by an external multipath reflection via the water surface. Within the melon waveguide structure internal reflections do not appear possible (Goodson *et al.*, 2000). Closer to the source, the mechanical adjustment of a hypothetical 3D acoustic mirror, to switch on or off a delay path of some 26 μs (4 cycles @ 150 kHz), implies controlled movement in the order of 15 to 20 mm (30-38 mm/2, estimated from the sound velocity in similar tissue). Since the morphology (Cranford *et al.*, 1996) does not support such a capability, we can reject both internal and external reflections as the probable cause. We prefer the simpler alternative that both MLDB structures can operate in combination to initiate closely spaced pulse-pairs with a minimum separation of at least 20 μs.

ACKNOWLEDGEMENTS The support of the European Commission DG XIV is gratefully acknowledged. Omar Farooq acknowledges funding support from the Commonwealth Commission (British Council). Special thanks are due to our project EPIC partners, the staff of the Fjord & Baelt Centre and to all of our colleagues who participated in the original field trials.

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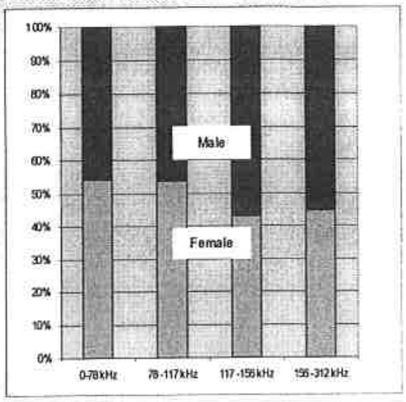
Table 1 - AWPT confusion matrix of the classification results with an example of Linear Discriminant Analysis.

Matrix of the AWPT Classification

		Training		Testing	
		Male	Female	Male	Female
Male	(Case 1)	9	0	5	1
Female	(Case 1)	0	6	0	3
Male	(Case 2)	8	1	6	0
Female	(Case 2)	0	6	0	3
Male	(Case 3)	9	0	5	1
Female	(Case 3)	0	6	0	3

Training and testing utilised 11 (known ID) examples - This small data set was extended to 24 by creating 10 db & 15 dB degraded signal-to-noise versions by the addition of Gaussian white noise. *Note - This classifier rejected a single degraded 15 dB s-n 'male' example and consistently classed this as a 'female' in all training and test combinations.*



Admissable Wavelet Packet Transform frequency bins.

Case 1 Training Set comparing male/female energy. *(averaged for illustration purposes)*

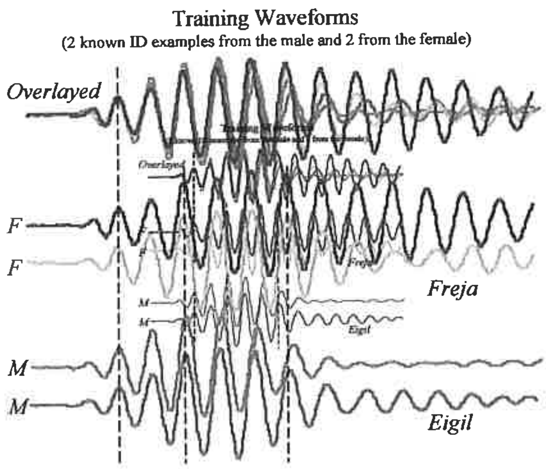


Fig. 1. Porpoise echolocation pulses recorded from the male *'Eigil'* and female *'Freja'* showing the slightly different centre frequencies together with some amplitude modulation. Note - The first 4 cycles do not include modulation.

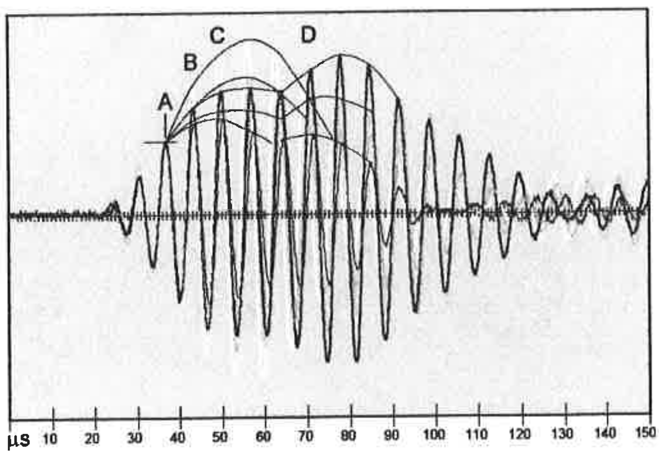


Fig. 2. Eigil - 5 click samples from the male porpoise overlaid after normalising their amplitudes at the 3rd cycle (**A**). The signals increase in amplitude to the 4th cycle (**B**) after which the envelope either increases or decreases (**C**) suggesting summation with a similar signal component delayed some 3.5 to 4 cycles (**D**).

THE STRUCTURE OF RISSO'S DOLPHIN (*GRAMPUS GRISEUS*) VOCALISATIONS: AN INNOVATIVE APPROACH

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INTRODUCTION The purpose of this study is to determine the vocal repertoire of what is believed to be a locally stable population of Risso's dolphin (*Grampus griseus*) in the Ligurian Sea, Mediterranean, using an objective method of analysis.

The traditional model assumes that a repertoire consists of acoustically discrete signals: whistles, pulse trains, and clicks. A recent theory (Murray, 1997) postulates that clicks and whistles may be at the opposite ends of a continuum (with pulse trains in the middle).

MATERIALS AND METHODS During summers 1997 and 1998, cruises to study Risso's dolphins were conducted in the Ligurian Sea, in an area included in the Sanctuary for Cetaceans of the Ligurian Sea (Fig.1).

During six spatially and temporally distinct sightings, 720 minutes of Risso's dolphins vocalisations were recorded. Underwater acoustic recordings were obtained using an Horizontal Line Array (HLA) connected to a DAT recorder (Tascam DA-P1) through an amplifier and a high-pass filter set at 500 Hz. Sampling frequency was 48 kHz. Overall frequency of the response is 600 Hz - 5 kHz.

The first step was to determine the type of vocalisation by visual inspection of spectrograms. A total of 145 pulse trains, 100 whistles and 69 clicks trains were characterised; all spectrograms were made with frame length 512 points, FFT size 1024 and overlap 50%.

The second step was to determine the physical structure of these vocalisations. Waveforms corresponding to the spectrograms previously mentioned, were studied down to the single pulse.

RESULTS AND DISCUSSION The waveform corresponding to a click train is equal to a long series of sinusoids where individual pulses are made of a short series of sinusoids spaced over time. Waveforms of pulse trains and whistles are quite similar, the only change is the time interval between pulses that diminishes gradually in the transition from click to pulse train until the interval between pulses cannot be measured any more: these can be termed passage pulse train-whistle. At the basis of all the emitted sounds, there are pulses. The signal is graded as a function of the time diminution between pulses.

Studying spectrograms and corresponding waveforms is crucial to obtain an objective idea about animal vocalisations. In fact, studying spectrograms alone could be misleading: spectrograms change a lot according to analysis parameters. Changes in the corresponding waveform are mainly the time intervals between pulses.

Risso's dolphins produce a wide variety of sounds. Most of the vocalisations are clicks, pulse trains, or whistles. The waveform analysis shows that clicks and whistles are at the opposite ends of a continuum with pulse trains in the middle so there are discrete sinusoidal pulses that, with a gradual diminution of the time interval between them, become continuous sinusoidal waves (Fig. 2, 3 and 4).

CONCLUSIONS Risso's dolphin vocalisations are graded like the false killer whale (*Pseudorca crassidens*) vocalisations considered in Murray (1997).

A graded structure of the vocalisations implies further considerations about their function and production mechanism. In fact a graded structure may carry high content of information in all signals emitted, since sounds that are found within clicks, pulse trains and whistles all transport information. All vocalisation types may therefore have echolocation and/or communication functions. Graded sounds with an emotional function were described for primates. Graded sounds in primates are associated with members that live very close to each other in a group. These kinds of sounds are often used with visual and tactile signals to minimise the problems of communication due to the fact that intermediate sounds also transport information (Goodall, 1986). We can speculate that sounds used by Risso's dolphins could have a role as emotional signals similar to those of land mammals. The same was proposed by Thomsen *et al.* (1999) for killer whale (*Orcinus orca*) whistles. The social structure of population of Risso's dolphin studied describes this kind of situation well: dolphins are very social and spend much time in the presence of conspecifics in a fission-fusion society (Gaspari *et al.,* 2000). Dolphins spend a lot of time in visual contact, and during sightings it is possible to see tactile contact between animals.

The graded structure of Risso's dolphin vocalisations also suggests that a single production mechanism may produce all of the observed signals.

We emphasise here the importance of studying vocalisations by as objective methods as available, in order not to fall into the misleading habit of subdividing calls into arbitrary categories to which specific functions are attributed.

ACKNOWLEDGEMENTS Special thanks go to Tethys Research Institute and to all the volunteers that helped in data collection. The first author is particularly thankful to Lucio Lessini, Stefania Gaspari, and Arianna Azzellino with whom she spent a lot of time in search of Risso's dolphins during the research cruises.

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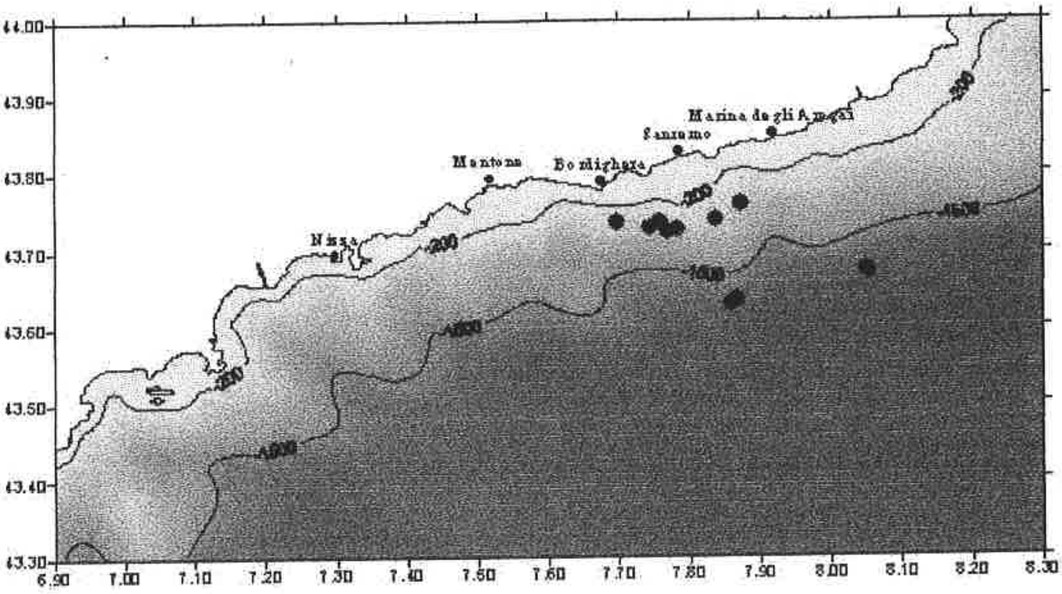

Fig. 1- Risso's dolphins sightings in the research area during the period of study.

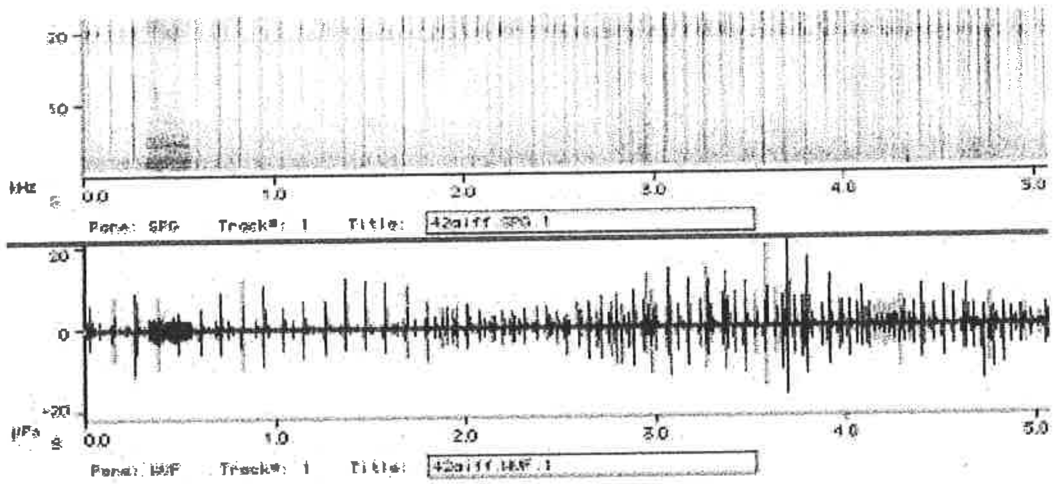

Fig. 2- Spectrogram (top panel) with the corrispondent waveform (bottom panel) showing a pulse train (horizontal banding) preceded and followed by a clicks series (vertical lines) (*frame length* 512 *points, FFT size* 1024, *overlap* 50%).

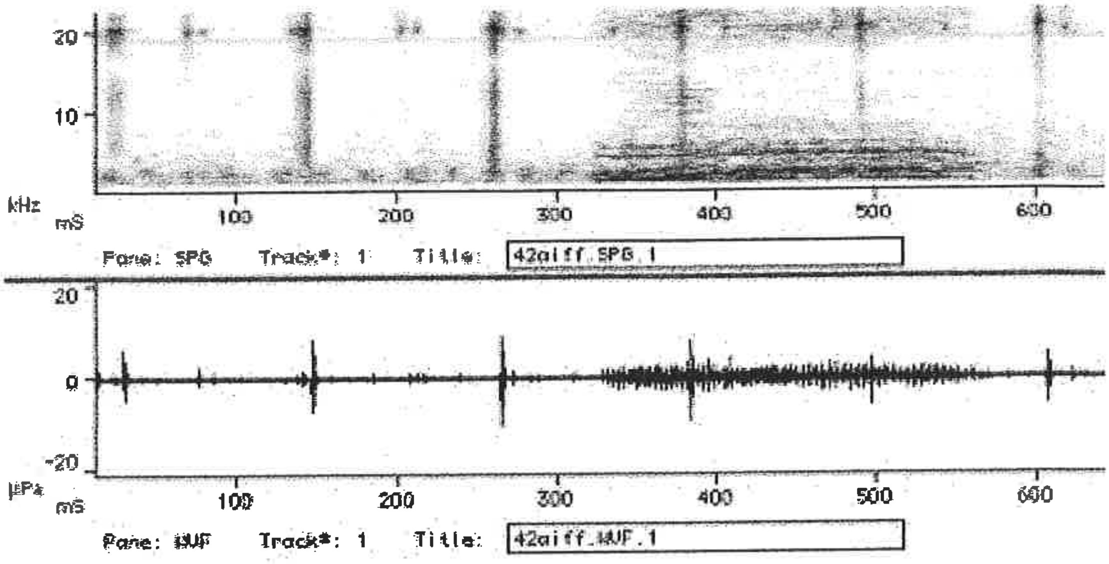

Fig. 3- A close-up view of the spectrogram and the corrispondent waveform of the pulse train and 3 clicks before it. The time interval between clicks is 118.5ms. (*frame length* 512 *points*, *FFT size* 1024, *overlap* 50%).

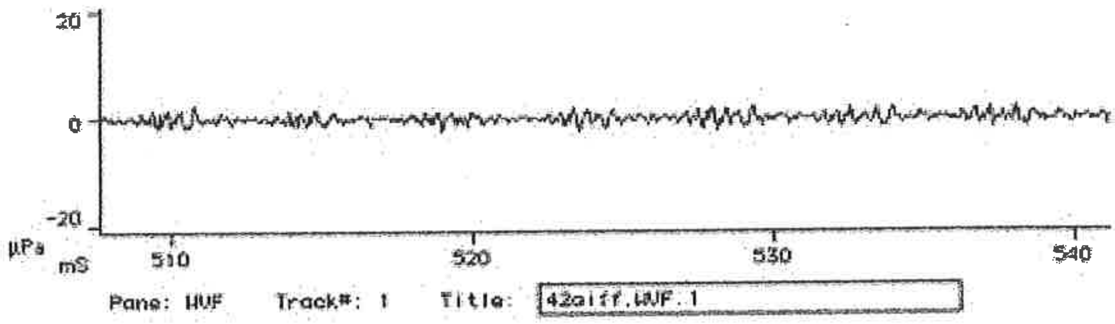

Fig. 4- The waveform is a close-up view of the two previous waveforms correspondent to the area between 510 and 540ms.: the end of the pulse train. It is possible to see that the time interval between the impulses gradually reduces and the signal is quite like a series of continuous sinusoids. (*frame length* 512 *points*, *FFT size* 1024, *overlap* 50%).

DISTRIBUTION OF PINGERS IN THE NORTH SEA

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Landings statistics from 1998, which is the year with the latest available data, for the Danish North Sea bottom set gillnet fisheries are used to estimate the extent of areas ensonified by pinger signals if all Danish bottom set gillnets were equipped with pingers for reduction of by-catch of harbour porpoise. It is shown that the areas in the North Sea will be rather small, and that they probably will not have a great influence on the behaviour and movement of the porpoises. The results appear after calculations based on the landing statistics reports from the cod, turbot, plaice and hake fisheries, and information on the effort of the fishermen in the same fisheries for the years 1993-1998.

The North Sea is divided into ICES-squares, and the amount of gill net in km, the number of pingers, and the percent coverage is calculated for each square on a weekly basis. 1652 of these square-week combinations appeared and were used in the later analysis. The results show that more than 90% of the combinations have coverage below 2%, and that the maximum coverage of a square is 13%, equivalent to more than 900 pingers, assuming an effective pinger distance of 400 m. The final conclusion is that 6700 pingers are needed to cover the entire Danish gill netting fishery in the North Sea.

COMPARISON OF ACOUSTIC SIGNALS AMONG THREE ODONTOCETE SPECIES (*GRAMPUS GRISEUS, PHYSETER MACROCEPHALUS, GLOBICEPHALA MELAS*) RECORDED IN A NATURAL ENVIRONMENT

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INTRODUCTION The appearances of Risso's dolphin, pilot whale, and sperm whale are very different to each other, and all three species present striking contrasts to the general notion of dolphin shape and form. Even their melons, that are believed to be sound projectors for echolocation, have different anatomical structures in each of three species that differ significantly from the classic form of dolphin melon. It is possible, even if not yet demonstrated, that specific anatomical structures may create rather different acoustic signals. The objective of this work is: (1) to present some features (spectrum and bandwidth, pulse duration, pulse repetition rate, pulse modulation) extracted by sequences of pulses emitted by each of three species in their habitat; and (2) to compare these features among the three species.

MATERIALS AND METHODS The observations were carried out on board of StudioMare research vessel "Jean Gab", a 17.7 m wooden cutter equipped for underwater listening with towed hydrophones (system response 10 Hz-20 kHz) and underwater vision (underwater Panasonic CCD Camera WV-KS152 previously placed). Audio and video signals are synchronously recorded with a BETACAM support (BETACAM SP Sony), that had a range-recording of 0/20 kHz; therefore the results about the clicks of Risso's dolphin (*Grampus griseus*) should be under-estimated. The videos recorded were analysed by a Studio DC10 video bluster which allows one to collect also single shots for further computer image analyses. The audio signal is recorded also on an analogue support system.

The routes were chosen to optimise sightings and were determined daily on the basis of previous sightings. Particular attention was paid to follow the bottom topography and depth profiles. No trip was performed in conditions greater than sea state 5 (Beaufort).

All recordings were kept in the waters of Archipelago Pontino-Campano which has been the object of a long-term study on cetaceans since 1991. In this area from spring through to autumn, in different periods, we have recorded almost regularly seven species of cetaceans: striped dolphin, *Stenella coeruleoalba*; bottlenose dolphin, *Tursiops truncatus*; common dolphin, *Delphinus delphis*; Risso's dolphin, *Grampus griseus*; long-finned pilot whale, *Globicephala melas*; sperm whale, *Physeter macrocephalus* and fin whale, *Balaenoptera physalus* (Mussi *et al.*, 1998, 1999).

Sperm whale recordings concern a young (or a female) individual (12 m long) encountered off from Ischia island in 3/8/00, the distance of the sighting point from the coast was 13.6 km and the depth 850 m.

Risso's dolphin recordings relate to a school of approximately 20 individuals, they are seasonally resident in the coastal waters of Ischia, and have been photo-identified and studied since 1998 (Miragliuolo *et al.*, this vol.).

Pilot whale recordings relate to a single stable pod of five individuals that are seasonally resident off Ventotene Island. All individuals have been photo identified and studied since 1995 (Mussi *et al.*, 1998, 2000).

The laboratory's analysis (Azzali *et al.*, 1999) was conducted as follows: the recorded signals were monitored with a H.P. digital oscilloscope 54520 A; every single signal was digitised on floppy disk; at a second time this digitised signals were processed using MATLAB m-file language to extract the statistic, time and frequency parameters of the single signals;

Using the statistical parameters, a matrix of the euclidean distances was calculated; the values in the matrix indicate the distance among the three species considered; the two nearest species (most similar) were combined to form one cluster, the third species formed a second cluster with one of precedent species; the clustering procedure was represented with a dendrogram.

RESULTS The vocalisations of the three species were first analysed separately:

Sperm whale (*Physeter macrocephalus*)
We found two type of signals (Fig. 1A). The first type (sperm whale 1) presents a low rhythm (one or two pulses per second) and a broad spectrum (1200-3000 Hz) with peak at 2100 Hz. The second type (sperm whale 2) presents a rhythm 3-4 times higher, with the frequency distributed between 0-900 Hz (peak frequency at 100-200 Hz).

Long-finned pilot whale (*Globicephala melas*)
The signals analyzed (Fig. 1B) for this species present a frequency distribution between 0-2000 Hz, with a peak frequency at 250 Hz; but there are two other peaks: at 400 Hz and at 750 Hz.

Risso's dolphin (*Grampus griseus*)
The signals considered (Fig. 1C) for this species have a frequency distribution between 0-2000 Hz, with a peak frequency at 400 Hz.

Similarity Matrix The structure of the above-mentioned signals has been analysed using the method described by Azzali *et al.* (1998, 1999). The first type of sperm whale click (low rhythm) is very distant from the signals emitted by the other two species (Table 1); the maximum dissimilarity has been found with Risso' dolphin signals. The second type of sperm whale click (high rhythm) is very similar to the signals emitted by the other two species (Table 2), but, again, Risso's dolphin signals are the most dissimilar. for both sets of signals, the structure of the dendogram is the same (see Fig. 2). It is possible that the first type of sperm whale signal represents an echolocation click, whereas the second type represents a vocalisation signal similar to those emitted by the other two odontocetes.

CONLUSIONS This study seems to indicate that there is some relationship between the size of animals and their acoustic features; indeed the two largest animals (sperm whale and long finned pilot whale) have acoustic signals more similar to each other than to the Risso's dolphin..

Moreover, this investigation points out that the sperm whale is able to emit at the same time and for a long period, two signals with very different structure.

This study represents preliminary findings from a long-term project, during which will be utilised recorders with a wide bandwidth to obtain more reliable data.

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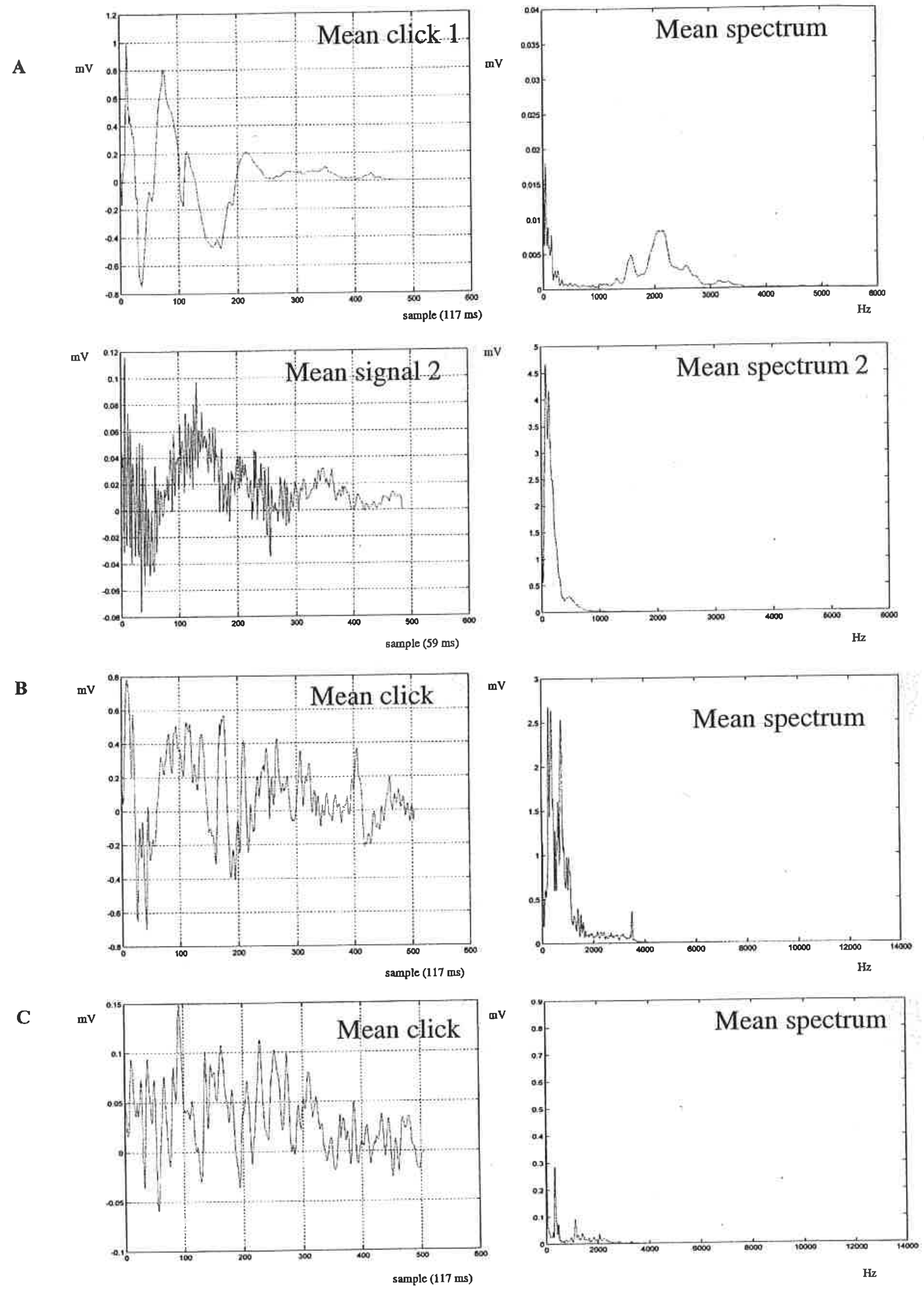

Fig. 1 - signal's mean waveform and mean spectrum of sperm whale (A), long finned pilot whale (B) and Risso's dolphin (C)

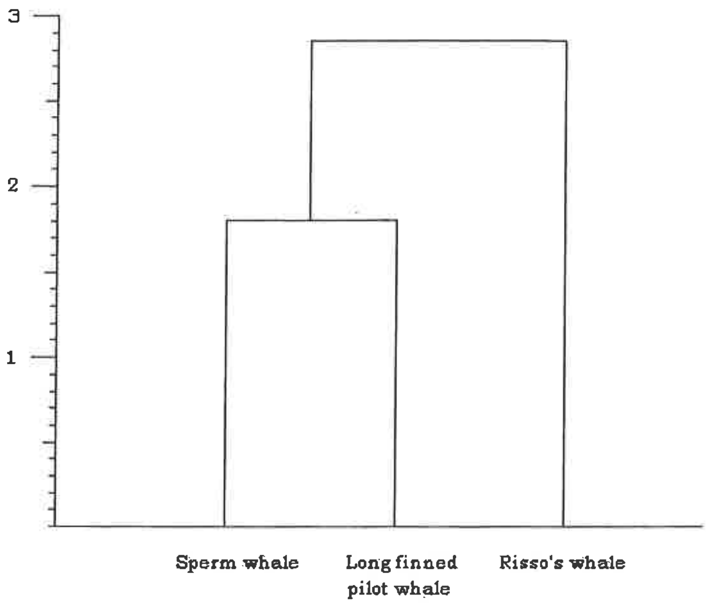

Fig. 2 – dendrogram referred to Table 2

Table 1 - distance's matrix with first type of sperm whale's click

	SPERM WHALE 1	RISSO'S DOLPHIN	PILOT WHALE
SPERM WHALE 1	0	64.426	63.320
RISSO'S DOLPHIN		0	2.024
PILOT WHALE			0

Table 2 - distance's matrix with second type of sperm whale's click

	SPERM WHALE 2	RISSO'S DOLPHIN	PILOT WHALE
SPERM WHALE 2	0	2.870	1.817
RISSO'S DOLPHIN		0	2.024
PILOT WHALE			0

VARIATIONS IN PATTERNS OF SIGNATURE WHISTLE DEVELOPMENT AMONG MATERNAL LINEAGES OF FREE-RANGING BOTTLENOSE DOLPHINS

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Signature whistles of 68 bottlenose dolphin calves were visually compared to those of their mothers. Recordings were made over a period of 25 years during temporary capture-release projects in Sarasota, Florida. Overall, male calves were more likely ($p < 0.05$) than female calves to produce whistles similar to those of their mothers, but a complex picture emerged when family lineages were examined. Analysis of a sub-sample of 18 female bottlenose dolphins with multiple (2-5) calves showed a variety of different patterns. Nine mothers had no calves with whistles similar to their own, regardless of sex, whereas all calves of two mothers produced similar whistles, regardless of sex. Two mothers had male calves with similar whistles, and female calves with different whistles. Finally, five mothers had early calves with different whistles, and later calves with similar whistles, regardless of sex. We are currently conducting quantitative longitudinal analyses of whistles of sixteen of the mothers that were recorded on at least five occasions (and up to 11) over periods ranging from 5 to 23 years. Preliminary data indicate that changes in both frequency range over time and contour were more likely to occur in the whistles of mothers with at least one calf that produced a similar whistle. Changes were less likely to be seen in the whistles of mothers whose calves all produced different whistles.

THE RATE OF SIGNATURE WHISTLES IN SEPARATION/REUNION CONTEXTS AMONG SEMI-FREE BOTTLENOSE DOLPHINS

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It has been hypothesised that signature whistles of bottlenose dolphins *(Tursiops truncatus)* evolved to enable group cohesion in an opaque environment. Previous studies have shown that signature whistle rates increase during separation/reunion events, this is especially true for mother-calf pairs. We investigated the 'cohesion hypothesis' under the unique conditions given at Dolphin Reef, Eilat, where a group of ten bottlenose dolphins was living in a spacious netted area containing a constant opening to the sea. During the time of the study, five dolphins, aged 1.5-6.5 years, regularly went out to the open sea. All were born at the site to three different mothers, which were present during the study. Although sender identification was not possible in general, an analysis of the group's vocal behaviour during separations should show an increase in the signature whistle rate of the involved individuals. 63 hours of recordings were collected during a two-month period, in which separations and reunions between mothers and their offspring, both inside the netted area and involving offspring leaving to the open sea, were sampled (n=270). Vocalisations were analysed for the occurrence of signature whistles before and after each event. Comparisons were made with data collected when mother and offspring were swimming together. Analysis revealed significant differences in the whistle production. The rate of the mothers' and the offsprings' signature whistles were (1) higher when they were separated than when they were swimming together; (2) higher before than after a reunion; (3) The mothers' signature whistle rate was higher than those of the offspring when they were separated, both inside the area and outside; and (4) no correlation was found between the mothers' signature whistle rate and the age of the offspring. The results strongly support the 'cohesion hypothesis'.

BEHAVIOUR

SOCIAL AND STOCK STRUCTURE OF ATLANTIC WHITE-SIDED DOLPHINS, *LAGENORHYNCHUS ACUTUS*

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Atlantic white-sided dolphins (*Lagenorhynchus acutus*) are a pelagic species, found primarily along the continental shelf in the temperate and sub-polar waters of the North Atlantic, from the U.S. and Canada to central west Greenland. Little is known about its social and stock structure, and life history of this species has been extracted from stranding data. This study used molecular genetic techniques to look at the social and stock structure of animals stranded, by-caught or biopsied in the following areas: Gulf of Maine; Cape Cod, MA, USA.; Gulf of St. Lawrence, Canada; Sable Island, Nova Scotia, Canada; and the Faroe Islands. Microsatellite markers from nine loci were amplified for all animals (n=208), and the mtDNA control region was sequenced for 43 animals. Although it has been suggested that three distinct stocks exist in the Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea, exact haplotypes of mtDNA were found across the North Atlantic, indicating that no definite stock structure exists. However, Fisher's method combining test results across microsatellite loci was significant (P <0.001), indicating that perhaps there is stock structure that has yet to be reflected in mtDNA. Within large stranded groups (n=46 and 88), high values of relatedness were not found (R=0.024 and 0.013, respectively), suggesting that these larger aggregations do not comprise a single familial group. However, higher relatedness values (R=0.146) and exact mtDNA haplotypes were found in a smaller stranded group (n=6), suggesting that *L. acutus* form small matrilineal groups rather than the extended matrilines found in some other odontocetes. In the Northwest Atlantic, *L. acutus* are by-caught in various fisheries, with a total mean average mortality (n=223) exceeding the potential biological removal in the Gulf of Maine. Determining the behaviour and stock structure of *L. acutus* could help in the future management of this species

VIGILANT BEHAVIOUR OF GREY SEALS, *HALICHOERUS GRYPUS*, IN RELATION TO TIME SINCE HAUL OUT, AND GROUP SIZE

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INTRODUCTION On a falling tide, grey seals, *Halichoerus grypus,* will haul out onto exposed sandbars, ledges or beaches, and lie quietly for several hours. In areas with less tidal amplitude, seals may haul out on suitable sites throughout the day (Terhune and Brillant, 1996). Possible advantages of hauling out include rest (Krieber and Barrette, 1984), predator avoidance (da Silva and Terhune, 1988), and thermoregulation (Ling *et al*., 1974).

Seals, once on a haul out site, spend most of their time scanning and resting (Terhune, 1988). Individuals spend more time resting and less time scanning as group size increases, and are made aware of disturbances by other members of the group. This suggests that grey seal grouping on haul out sites evolved as an anti-predator strategy (Terhune, 1985) and as a way to maximise time spent asleep (Krieber and Barrette, 1984).

The objective of this study was to test the hypothesis that vigilance of grey seals decreases with time since haul out, and as group size increases. An additional aim was to examine whether position and orientation of an individual within the group had an effect on the amount of time spent in vigilant behaviour.

METHODS Grey seals were observed on West Hoyle Sandbank, West Kirby, England. The sandbank where the seals haul out is 0.5-1 mile from an observation site based on Hilbre Island (Fig. 1).

Observations were made between 1200 and 1730 hours, on a falling tide, and the study was conducted from the 18th March to the 22nd October 2000.

This study extended, and so built upon the methodology described by Terhune and Brillant (1996).

Any movement that increased the visual field of the seal was defined as a scan, and the total scan time of a seal during a 3-minute single observation period was measured, using cumulative time stopwatches (Terhune and Brillant, 1996).

A focal animal that had just hauled out was selected at the beginning of each observation session. For a 3-minute observation period, the scanning times of this seal were observed and recorded. After this elapsed time, a second subject, that appeared to be dry (having been hauled out for 21 minutes or more), was observed for three minutes and its scan times recorded. Observations were then alternated between the initial focal animal and the second subject until each individual had been observed for a total of 21 minutes (7 x 3-minute observation periods each).

At the end of the first observation session, a second, newly hauled out seal became the primary focal animal, and the initial seal became the second subject. Thus, a comparison could be made between the scanning times of a newly hauled out seal under similar conditions to the scanning time of a seal that had been resident for at least 21 minutes.

At the beginning and end of every observation session, the total number of seals hauled out on the sandbank was recorded, as was the orientation and position of the focal animal within the group.

T-tests were carried out on the following: (1) the first and last scan durations of all seals, (2) the first and fourth scan durations of all seals, (3) the initial observation scans of resident seals and the initial scans of new arrivals, and (4) total amount of time spent scanning by newly hauled out seals and resident seals.

RESULTS The durations of initial scans by newly hauled out seals ranged between 135 and 257 s per 180-s observation period ($X = 86$, s.d. = 43, $N = 8$). Average scanning times of newly hauled out seals decreased over time since haul out (Fig. 2). The initial scan durations were significantly longer than the fourth scan durations ($t = 9.47$, $df = 9$, $p < 0.0001$).

The durations of initial observation scans by seals hauled out for 21 minutes or more ranged between 14 and 102 s per 180-s observation period ($X = 33$, s.d. = 29, $N = 8$). Average scanning times of seals resident on the sandbank for 21 minutes or more decrease over time (Fig. 2). The initial observation scan durations were not significantly longer when compared to the fourth ($t = 1.68$, $df = 9$, $p = 0.13$). Average scan duration actually increased at the 7th observation period (Fig. 2).

There were significant differences between the initial observation scan of an individual resident seal and the initial scan of a new arrival ($t = 8.26$, $df = 12$, $p = <0.0001$). Significant differences were also found when the total amount of time spent scanning by newly hauled seals were compared to that of those individuals resident for 21 minutes or more ($t = 4.94$, $df = 12$, $p = <0.0001$).

The average scanning times of individual seals did not decrease as group size increased (Fig. 3).

Arriving seals tended to haul out where there was available space. 37.5% positioned themselves on the periphery, at either end of the group, orientated towards the water. 37.5% hauled out near the front centre of the group. Individuals on the periphery of the group orientated towards the water spent longer scanning than those peripheral seals facing away from the water (X = 90 +/- 29 s vs 31 +/- 29 s). Newly hauled out seals positioned at the front centre of the group spent longer scanning than those resident for 21 minutes or more found at the same position (X = 82 +/- 8 s vs 36 +/- 5 s). In addition, newly hauled out seals positioned at the periphery, spent longer scanning than those found in the same place, but having hauled out 21 minutes earlier (X = 86 +/- 33 vs 48 +/- 17 s).

DISCUSSION AND CONCLUSIONS A decrease in scanning can be partly attributed to time since haul out, but position and orientation of individuals within the group also needs to be considered.

Individuals in the centre of a group may enjoy greater security than those at the edge (Bertram, 1980) who are exposed to a greater predation risk, and thus display increased vigilance. However, greater vigilance in newly hauled grey seals appears to be also related to the disturbance associated with the arrival of new individuals and presumably potential competition for space.

The smallest group size recorded was 100. In a large group, overall vigilance has reached the maximum value of 100 percent when the group is at a much smaller number (Bertram, 1980). Harbour seal, *Phoca vitulina concolor*, group sizes in the Bay of Fundy, Canada, once they exceeded ten, showed little further reduction in scanning duration (Terhune, 1985). In a small group, most seals would be considered peripheral, whereas in larger groups, such as those found at Hilbre Island, most individuals are central. This perhaps offers a possible explanation as to why the average scanning times of individuals did not decrease as group size increased.

The location and orientation of seals on haul out sites favours individual escape into the water (Terhune and Brillant, 1996) and individuals are alerted to disturbances by the actions of other group members (da Silva and Terhune, 1988). During the 6th and 7th observation periods, a sailboat approached the group causing an overall increase in vigilance. If peripheral seals were vigilant only to detect conspecifics that might displace them from their location on the haul out site, we would not expect the entire group to react to the actions of a single seal (Terhune and Brillant, 1996).

The results of this study support the hypothesised relationship between vigilance and time since haul out. The behaviour patterns of the grey seals at Hilbre Island Local Nature Reserve may have evolved as an anti-predator strategy for grouping on haul out sites.

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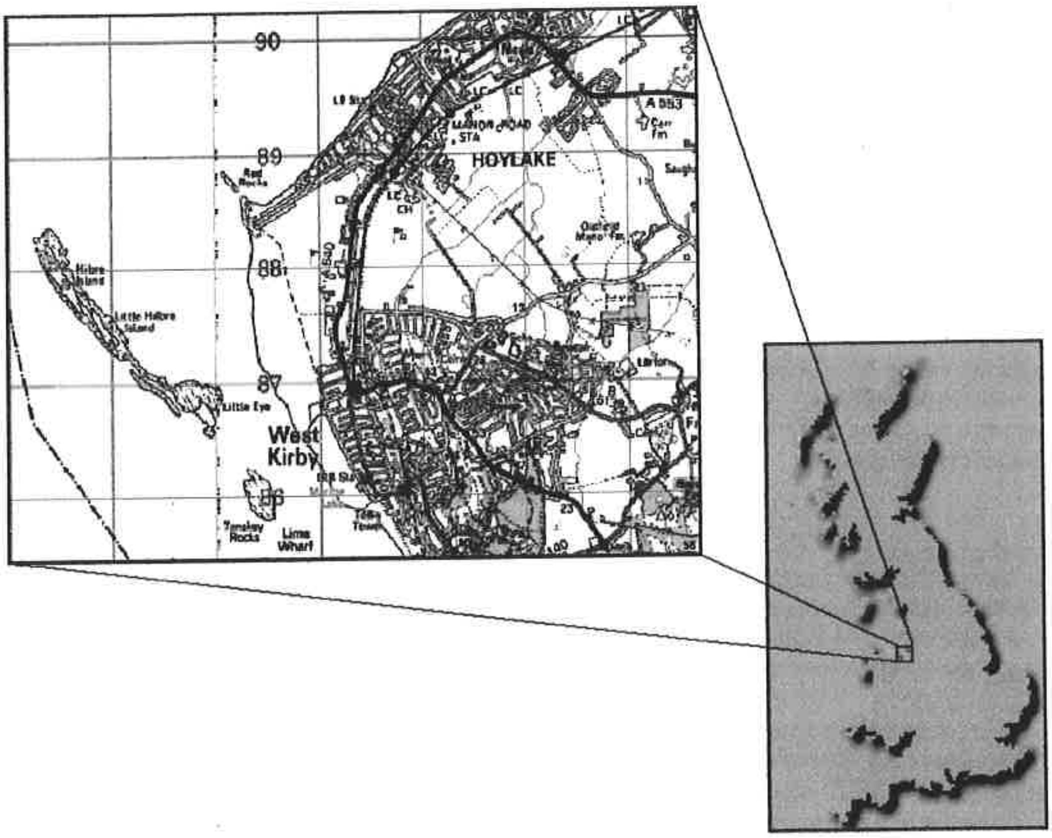

Fig. 1. Study site, Hilbre Island Local Nature Reserve, West Kirby, Merseyside, England

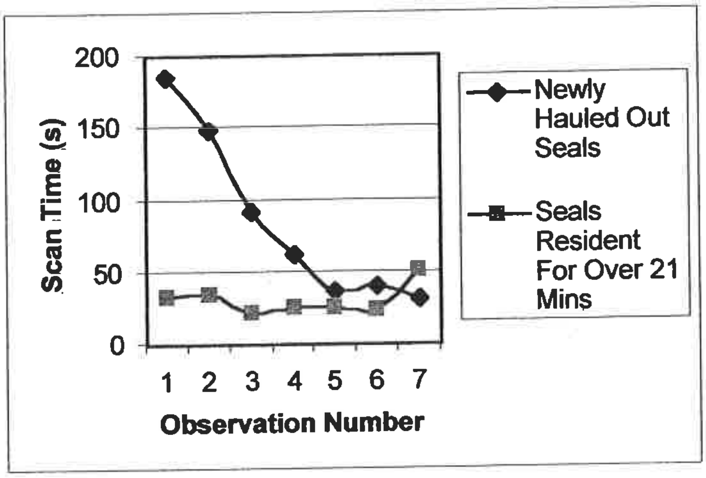

Fig. 2. Mean scan times of newly hauled out grey seals compared to individuals resident for 21 minutes or more per 180 s time period

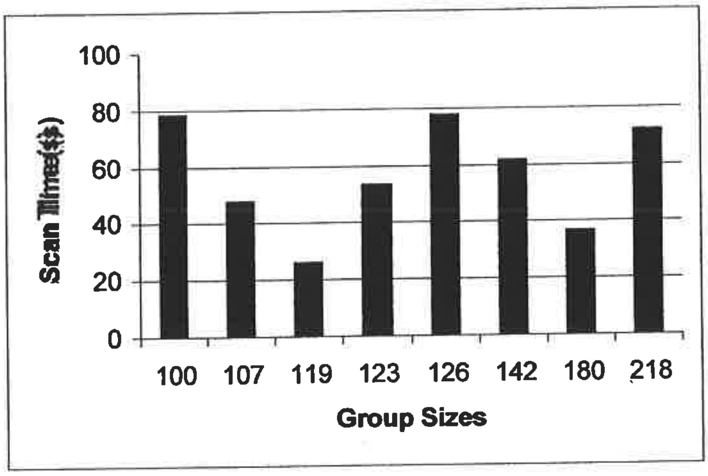

Fig. 3. Mean total scan times of grey seals per 21 minute observation period, relative to group sizes on the haul out site

PORPOISE SEXUAL PLAYS: WHO DECIDES?

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This study investigated the role of a female harbour porpoise in initiating, accepting and rejecting sexual behaviour. It was carried out at the Fjord and Belt Centre, Denmark, June-September 1999. Behavioural observations consisted of 3-hr sessions, 4-5 times weekly, using behavioural recording software. Focal observations were made of states and events. Duration and frequency were calculated relative to time that the female was in sight. The sexual season was mid -July to mid-August. The only previous study of courtship behaviour in harbour porpoise (Anderson and Dziedzic, 1964) suggested females initiated sexual behaviour. The morphology of harbour porpoises would suggest a 'sperm competition' model for mate selection, with the male as initiator. This study supported the sperm competition theory, i.e. the male seen as the initiator. However, the female took an active role in accepting, rejecting and terminating sexual behaviour, depending on her sexual condition (confirmed by cellular changes on vaginal swabs). Outside the sexual season, the female was seen to 'Roll' away from the male during mating attempts. No successful intromissions were seen following 'Roll'. During the sexual season, the female demonstrated a new behaviour termed 'Hover', indicating the cessation of other activities and inclination of the genital area toward the male during mating attempts. Seven of the eleven successful intromissions were seen following 'Hover'. This is the first time these behaviours have been recorded. The female also became more aggressive toward the end of the sexual season, possibly indicating the end of her receptive period. The ability to signal sexual readiness and effect the outcome of mating attempts may help females to attract suitable mates and control the paternity of their offspring. Future confirmation of these results could be useful for determining when females are sexually receptive, which may be useful for field studies and captive breeding programmes.

TEMPORAL VARIATIONS IN THE BEHAVIOURS OF ADULT GROUPS OF HUMPBACK WHALES IN THE BREEDING GROUNDS OF GORGONA ISLAND (COLOMBIAN PACIFIC COAST)

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Data from six breeding seasons (1991-95 and 1997) were used to obtain fortnightly frequencies of the behaviours recorded in the area for five group categories (singer, solitary non-singer, duos, trios and large groups). The frequencies for three broader classes gathering related behaviours (Passiveness, Socialisation and Aggressiveness) were also calculated as well as total and relative abundance of adult groups along the season. Results allowed us to establish that in different groups, behavioural frequencies may present four distinct fluctuation patterns (almost constant to three peaks). Variability from one group to another was striking at all levels. In each case, one particular behaviour did not show the same temporal patterns, and, moreover, Passiveness, Socialisation and Aggressiveness occurred in different proportions. In lone individuals passiveness prevaiiled, in duos socialisation, in trios surface activity, whilst in large groups it was aggressiveness. The most obvious feature was that, in spite of global variability, higher activity levels were concentrated into two particular fortnights. All groups tended to show aerial displays most often at the end of July, when aggressiveness of large groups was also at a maximum. However, in duos and trios, the latter was concentrated in the second fortnight of August coinciding with the peak of maximum abundance of groups in the area. It is well known that aggressiveness for males is linked with competition for access to females (the limiting resource), hence this is not really surprising. However, this was not the case for large groups. Therefore, our results highlight the role of another factor bringing about this behaviour. Availability of females, determined by migratory chronology of reproductive classes, undoubtedly plays an essential role in temporal variation in the social dynamics of adult groups within the breeding season.

SOCIAL ORGANISATION OF A COMMON DOLPHIN COMMUNITY IN THE EASTERN IONIAN SEA: EVIDENCE OF A FLUID FISSION-FUSION SOCIETY

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INTRODUCTION Very little is known about the social organisation and social behaviour of the short-beaked common dolphin (*Delphinus delphis*) in the wild, mainly due to the pelagic habits of the species. In the eastern Ionian Sea, however, a community inhabiting neritic waters has been the subject of a longitudinal socio-ecological study since 1993. About 100 individuals have been photo-identified, most of them being consistently re-sighted across years. This study provides the opportunity to examine patterns of social affiliations within the community.

MATERIALS AND METHODS Consistent photo-identification surveys were conducted from 1996 to 1999 from 4.7 m rubber or fibreglass keel inflatable craft powered by 40-50 HP outboard engines.

Photo-identification was performed following Würsig and Jefferson (1990), recognising individuals by means of long-lasting natural markings on their dorsal fins, such as notches and pigmentation patterns of the characteristic white patch.

Each sighting was subdivided in "sets" (Bearzi *et al.*, 1997); the focal group comprising the set was defined according to Shane (1990) as "any group of dolphins observed in apparent association, moving in the same direction and often, but not always, engaged in the same activity". Members of the focal group usually remained within approximately 100 m of each other and were all potentially photo-identifiable.

Since the intermixing between groups was very frequent, individuals were considered associated if they were members of the same set or cluster of sets within a single sighting (Slooten *et al.*, 1993).

Between 1996 and 1999, a total of 253 sightings were made, during which 61 adult dolphins carrying marks suitable for long-term identification were photo-identified. To reduce small sample biases, amongst the 61 distinctively marked animals, 47 individuals sighted on five or more different days were selected for social structure analysis.

In order to avoid overestimations of association levels, association between individuals was quantified using the simple-ratio (SR) index (Ginsberg and Young, 1992), defined as follows:

$$SR = \frac{x}{x + y_{ab} + y_a + y_b}$$

where the variables indicate:

x = number of observation periods during which individuals A and B were observed together;
y_a = number of observation periods during which only A was observed;
y_b = number of observation periods during which only B was observed;
y_{ab} = number of observation periods during which A and B were both observed in separate groups.

Analyses were performed with the aid of the SocProg software package, developed by Hal Whitehead (University of Dalhousie). In order to perform a cluster analysis, association values were converted into a distance coefficient following the formula "1 - simple-ratio index".

RESULTS AND DISCUSSION In general, association indices were very low (median=0.04, SD=0.077), with only five dolphin pairs showing a SR≥0.5 (Fig. 1). Low-level associations (SR≤0.25) were found for a majority of pairs (98%). A high proportion (64%) of the 1,081 possible pairs was observed, indicating that individuals associated at least on an occasional basis with most other community members. These findings suggest that membership of groups was highly fluid, with little evidence of long-term social bonds.

A dendrogram depicting the result of a cluster analysis is shown in Fig. 2. The analysis did not enable us to identify obvious social sub-units within the community, most of the links between individuals being at high levels of distance coefficient (SR≤0.25). This, together with the high proportion of observed associations between pairs of animals, suggests that individuals were likely to be all socially linked, directly or indirectly, to form a single social unit.

Despite the absence of a clear sub-structure in the society, a Monte Carlo test of random association based on permutations of data sets showed that associations were non-random ($p<0.001$; 30,000 permutations), indicating the presence of preferred and avoided associations between pairs of animals. In particular, 83 pairs (7.7%) were found to interact non-randomly ($p<0.05$), either because of preferred association, or avoidance.

CONCLUSIONS The community was characterised by high rates of intermixing between groups (fluidity), resulting in a complex social network where distinction of long-term companionships seemed to be weak. Nevertheless, patterns of preferred association, disassociation and avoidance were apparent, since interaction between individuals was significantly different from random. These findings are strongly suggestive of a fission-fusion social structure resembling those found in coastal common bottlenose dolphins (*Tursiops truncatus*). The highly fluid social system of this common dolphin community is likely to reflect local ecological features, such as an unpredictable and patchy prey distribution and a low predation pressure (Clapham, 1993).

ACKNOWLEDGEMENTS Sebastiano Bruno benefited from an Emily B. Shane Award granted in 1998. We are grateful to Ada Natoli and Sabina Airoldi for contributing to field data collection, and to Ada Natoli and Stefania Gaspari for their help during the analyses. Thetis SpA and the Venice Natural History Museum provided logistic support.

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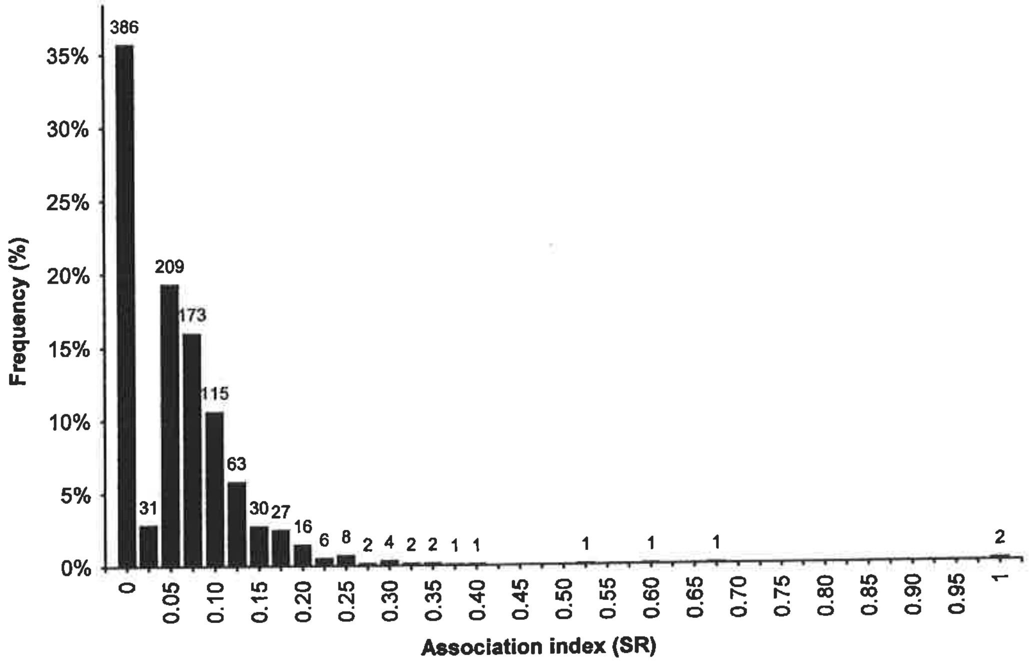

Fig. 1 Frequency distribution of the association indices.

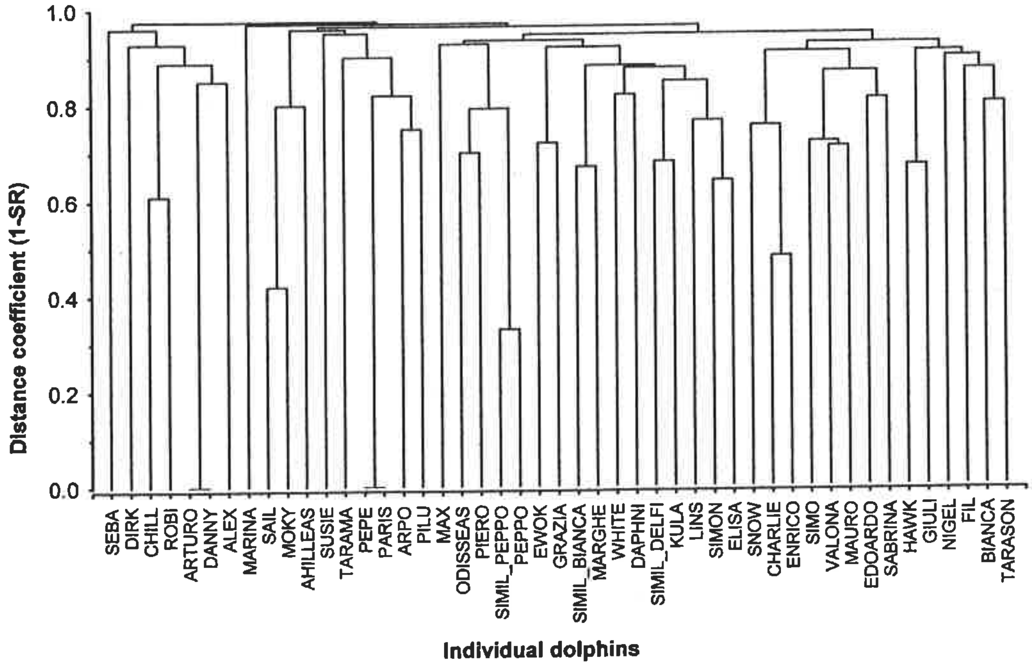

Fig. 2 Dendrogram derived from a cluster analysis depicting the social network ("average linkage between groups" method).

ANALYSIS OF BEHAVIOUR BETWEEN GROUP CLASSES OF ADULT HUMPBACK WHALES IN THE WINTERING GROUNDS OF COLOMBIA, SOUTH AMERICA

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This paper presents the first behavioural study of adult groups of humpback whales on the breeding grounds of Gorgona Island, Colombian Pacific coast. Data were collected during six breeding seasons (1991-95 and 1997), using the *ad libitum* sampling method. 430 groups classified into five categories (singer, solitary non-singer, duos, trios, and large groups) were sighted, and 36 distinct behaviours were recorded in an ethogram. In order to characterise each group, we analysed the frequencies of their behaviours.

Some general trends were observed: while the number of behaviours and the swim speed increased with group size, the time spent diving decreased. Only 14 behaviours (38,9%) were common to all the groups and three (8,3%) were related to particular ones. In detail, lone individuals used to spend a lot of time underwater and to present very few surface activities except for aerial displays, which furthermore were significantly higher in the non-singers. Duos were fairly active but with low frequencies and tended to be joined by other animals. The structure of trios was very stable, and their activity spectra, swim speed, and dive duration all dramatically changed. Much more active than the preceding groups, they showed behaviours linked to the first levels of aggressiveness. Large groups were characterised by their aggression and highest rates of surface activities, as well as exclusive elements such as lunging and loud blows. Behavioural characteristics of this humpback whale population are consistent with studies made in other breeding areas. It would be interesting to explore the relationship between frequencies of common behaviours and their social context in order to improve our understanding of their functional significance.

ESTIMATING MARINE MAMMAL ABUNDANCE AND IMPACT ON SALMON IN TWO SCOTTISH ESTUARIES

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INTRODUCTION The number of marine mammals, especially seals, seen in the estuaries of the city of Aberdeen, in Northeast Scotland, have increased over recent decades. The increase is coincident with a general trend for the Scottish seal population. Seals are often observed eating large salmonids at the water surface within the estuaries and, on occasion, in the rivers themselves (TJC, GJP, JRGH personal observations). Such observations are a cause for concern regarding the potential impact of seals as predators of commercially important riverine salmonids.

This study partly addresses the fisheries concerns, and provides a quantitative assessment of marine mammal impact on salmonid stocks within Aberdeen's river estuaries.

METHODS Marine mammals were observed in the estuaries of the Rivers Dee and Don, which enter the North Sea within the city of Aberdeen, UK. Observation scans were made every 10 minutes over 1,095 one-hour blocks for two full years (Carter *et al.*, 2001). Observations were focused in two study periods from April 1993 to March 1994 (Pierce *et al.*, 1994) and April 1995 to March 1996 (Carter and Pierce, 1997). Details of the marine mammal species present, and their behaviour, were recorded on each scan. When seals were observed feeding at the water surface, an attempt was made to identify the prey item, as either salmonid, unidentified roundfish, flounder, or other species. Seal scats were collected from the haul out sites in the River Don estuary, and analysed for fish bones, scales and otoliths.

RESULTS During the study period, the marine mammals observed were harbour seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*), harbour porpoise (*Phocoena phocoena*) and bottlenose dolphin (*Tursiops truncatus*). The frequency, over 1,095 hours of observation, when one, or more, individuals of each species were seen (Table 1) shows harbour seals were the most commonly observed marine mammal, and harbour porpoises the least. The mean number of harbour seals per hour, observed swimming during daylight (Figure 1) for the River Don (a) and River Dee (b) show a clear seasonal variation, with a distinct summer (May to August) minimum and winter (November to February) maximum. The mean numbers of seals observed in each month, except for August ($t=2.185$, $df=119$, $p<0.05$) and November ($t=2.270$, $df=91$, $p<0.05$), is not significantly different between the two rivers.

Eight seal scats collected at a haul-out site on the River Don in 1996 yielded 608 marine fish otoliths, of which 480 were from whiting (*Merlangius merlangus*) and 99 from sandeels (Ammodytidae). The remaining 29 otoliths were ascribed to other gadoid and flatfish species.

Identified prey items taken by seals in each river during the study period (Figure 2) show more salmonids and unidentified roundfish were eaten on the River Dee (b) than on the River Don (a) with a reverse relationship for flounder. In addition, the greatest numbers of fish were consumed during May and from September to December. These data, when seasonally adjusted and extrapolated over the entire year, estimate that seals take 178 large salmonids from the River Don estuary, and 698 from the River Dee estuary.

Harbour porpoises were only observed once during the study, while bottlenose dolphins were observed more frequently (Figure 3) but only in the River Dee. Furthermore, numbers of dolphins observed varied from 1 to 25 animals during a single scan, with a distinct seasonal (January to May) peak.

DISCUSSION Marine mammals in the Dee and Don estuaries show marked seasonality in terms of abundance and foraging behaviour. Numbers of seals observed in the two rivers were not significantly different on a monthly basis, being lower during May to July, which corresponds to the breeding time of local seals (Thompson *et al.*, 1997) when seals might be expected to be absent from the rivers.

Feeding on River Don flounder correlates with the coincident presence of seals and flounder, as reported for the Ythan estuary (Rafaelli *et al.*, 1990). The peak period for foraging on salmonids and unidentified roundfish in both rivers falls between September and December, coincident with peak seal and salmon numbers and when salmonids undertake their spawning migration (Smith and Smith, 1997). Low water temperatures at this time may cause poikilothermic salmonids to be more susceptible to predation, indeed scat analysis indicated that riverine seals feed both at sea and within the estuaries.

Bottlenose dolphins show a strong seasonal occurrence within the River Dee estuary, with a peak between January and May. The occurrence of dolphins in the Dee estuary coincides with dolphins being less frequently seen in the Moray Firth (Wilson *et al.*, 1997). The dolphins seen at Aberdeen may not be from the Moray Firth population. It would be a useful extension of this survey to investigate long-range dolphin migration patterns within the northern North Sea via photography for identification of individual dolphins.

Putting seal predation of riverine salmonids in perspective, foraging impact estimates on salmonid populations presented here are an order of magnitude less than numbers taken annually by anglers on the Rivers Don and Dee (Fisheries Research Services, unpublished data).

ACKNOWLEDGEMENTS Many thanks go to J. Houseman, Prof. Peter Boyle, and staff at FRS Marine Laboratory, Aberdeen and Scottish Natural Heritage.

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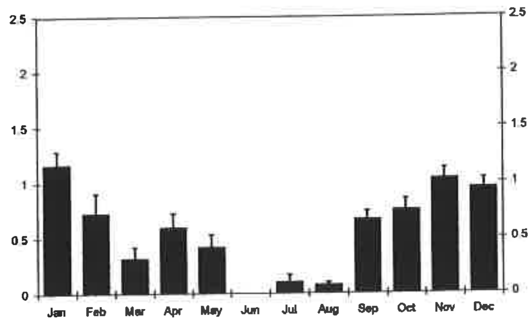
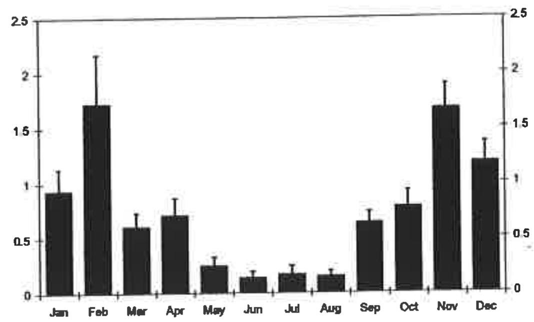
Table 1 The number of occasions when at least one individual of each species was observed, during 1,095 hours of observation

Harbour seal	*Phoca vitulina*	8,864
Grey seal	*Halichoerus grypus*	172
Bottlenose dolphin	Tursiops truncatus	27
Harbour porpoise	*Phoecoena phoecoena*	1

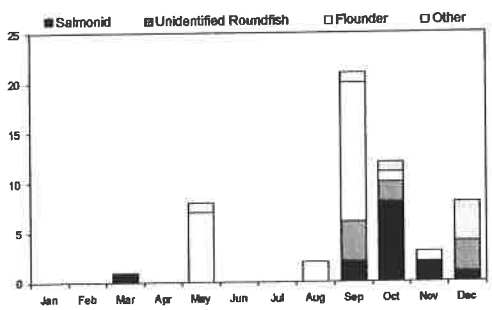


a)

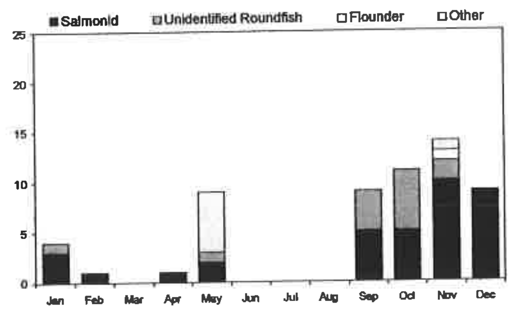


b)

Fig. 1 Mean (± SE) number of swimming harbour seals observed per hour, in each estuary during daylight, over the study period, for a) River Don and b) River Dee.



a)



b)

Fig. 2 Number of prey items observed to be taken by harbour seals, over the observation period, for a) River Don and b) River Dee. Prey items were identified as salmonid, unidentified roundfish, flounder or other.

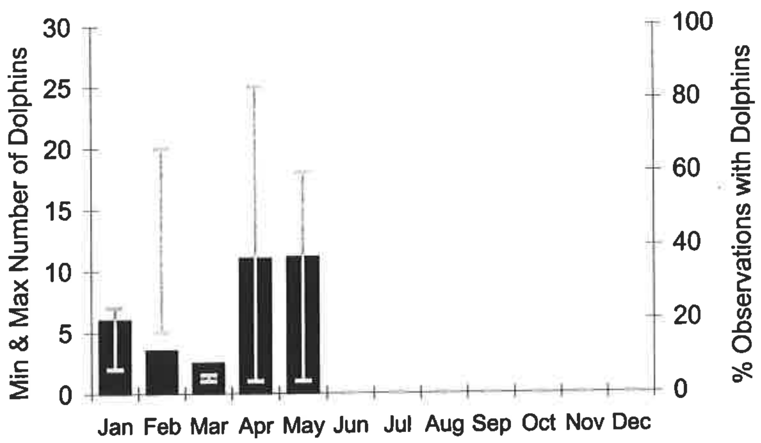


Fig. 3 The proportion (%) of observations when dolphins were observed in the estuary of the River Dee over the study period (Bar). The minimum and maximum numbers of dolphins seen during single observations in each month is also shown (Line).

MEDITERRANEAN FIN WHALES, *BALAENOPTERA PHYSALUS*, FORAGING OFF THE EASTERN COAST OF SICILY, IONIAN SEA

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INTRODUCTION Fin whales are seasonally present in the Eastern Ionian Sea during late spring and summer (Giordano *et al.*, 1995) but little has been reported concerning their abundance and habitat use in the Ionian Sea, although it has been suggested that their presence could be a feature of a migration within the Mediterranean Sea (Marini *et al.*, 1995).

In the spring of 1999, a group of five Mediterranean fin whales, *Balaenoptera physalus*, was sighted off the southern coast of the Ionian Sea for three days. On this occasion, the behavioural surveys had showed that most of the time the whales engaged in a behaviour similar to that described by other authors as feeding. This group was feeding on surfacing swarms of krill that were later identified as *Meganictyphanes norvegica*, the main food of fin whales in the Mediterranean Sea.

MATERIALS AND METHODS The study area is located in the Gulf of Noto along the south-east coast of Sicily and is a topographically shallow area of about 50 km^2 between Capo Passero and Capo Murro di Porco.

Boat surveys were conducted from 26 to 28 May 1999 during the daylight hours using the Coastal Guard Vessels within the Gulf of Noto. In three days of observation, a total of 56 nautical miles was covered and 23 hours were spent at the sea with 19 hours of sightings.

The co-ordinates of whale sightings were acquired using Coastal Guard Vessels GPS and their daily position was later visualised using ArcView software. Photographs of whales were collected with 35-mm cameras equipped with 80-200 mm f.2.8 zoom lenses and motor drives. ISO 400 black/white print, ISO 400 and Kodak Ektachrome ISO 100 color slide film were used. All photographs were compared manually using the procedures developed previously by Gannier and Gannier (1997), and Agler (1990, 1992). An effort was made to photograph each animal from both sides to include the head, dorsal fin and chevron.

Four surface zooplankton samples were taken with a scoop, then filtered out and preserved for the laboratory analysis. The collected samples were classified using the methodology shown by Trégouboff and Rose (1957).

RESULTS Fin whales were seen and monitored for the entire survey period, for c. 8 hours every day. By photo-identification analysis, we were able to recognise five individuals, two decidedly larger than the other three. Four individuals were positively identified and one of them was previously observed and identified northward along the Strait of Messina (Tringali *et al.*, 1999).

During afternoon sightings, it is seldom possible to observe underwater feeding behaviour from a boat-based survey. However, the exceptional calmness and clarity of water during our surveys allowed our team to clearly watch underwater and surface behavioural events.

Group size varied between two and five individuals, often with subgroups of two or three individuals swimming within 10 m from each other. Several instances of side-swimming (mostly on the right side) with the white ventral side clearly visible from the surface were observed, and, in particular, one individual with throat distention was observed while the water spilled out of the contracted mouth just below the surface. Fin whales showed a routine activity of near-surface slow and steady swimming (about 3-4 knots), short dives (3-6 minutes), and occasional deep dives. All individuals had distinct feeding behaviour patterns, most of them previously described for fin whales (Watkins and Schevill, 1979).

Zooplankton surveys
The zooplankton samples revealed the presence of the euphausiid, *Meganyctiphanes norvegica* (Sars 1857), at a juvenile stage. Indeed, they lacked mature sexual organs (thelycum or spermatheca in females, petasma in males), and measured total lengths of between 13.8 and 17.2 mm (Mauchline and Fisher, 1969; Trégouboff and Rose, 1957; Costanzo and Guglielmo, 1976).

The presence of pelagic fish such as *Thunnus t. thynnus* (Linnaeus, 1758), *Mobula mobular* (Bonnaterre, 1788) and *Sardina pilchardus* (Walbaum, 1792) was also noted, probably attracted by the abundance of prey items.

North-east Atlantic and Mediterranean fin whales have a special relationship with the krill *M. norvegica*, and indeed it is their exclusive food during summer feeding (Kawamura, 1980). Studies on faecal samples of fin whales conducted in the Ligurian Sea showed the predominant role of this euphausiid in their diet (Orsi Relini and Giordano, 1992; Orsi Relini *et al.*, 1992).

Meganyctiphanes norvegica is abundant in the north-western Mediterranean Sea where fin whales are frequently encountered, and has been sporadically observed also in the Ionian Sea (Franqueville, 1971). Guglielmo (1969) observed wide swarms stranded along the Ionian coast of Sicily between November and April, and suggested that some sort of passive mechanisms could have brought the krill to the surface from deep and intermediate waters.

The strong seasonal variability of the cyclonic circulation in the Ionian Sea (Tziperman and Malanotte-Rizzoli, 1991), coupled with the cool waters, often upwelled to the surface by the northwesterly winds along the Sicilian coasts (Le Vourch *et al.*, 1992) make this area likely to be associated with the accumulation of *Meganyctiphanes*. Consequently, the presence of pelagic fish and cetaceans is likely associated to the patchiness and variability of the euphausiids.

CONCLUSIONS This study highlights the seasonal presence of the Mediterranean fin whale in eastern Sicily, and indicates that within the oligotrophic Mediterranean basin, the Ionian Sea could play a very important and under-estimated role as a feeding ground for fin whales. However, further investigation is needed in order to better understand the biological and oceanographic features of the Ionian area in relation to the seasonal presence of fin whales.

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MIRROR DIRECTED BEHAVIOURS OF BOTTLENOSE DOLPHINS TESTED IN A LARGE OPEN-SEA ENCLOSURE

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INTRODUCTION Encounters with images reflected by mirrors are a well-known tool to study particular communicative behaviours or cognitive abilities in various kinds of mammals and birds (Todt, 1986). In some spectacular cases such devices were used to examine even accomplishments of self-examination, e.g. in primates (Gallup, 1970; Gallup *et al.*, 1995) and dolphins (e.g. Marino *et al.*, 1994; Marten and Psarakos, 1994, 1995). Currently, we have conducted a series of mirror tests with a group of ten bottlenose dolphins (*Tursiops truncatus*) living semi-free in a spacious open-sea enclosure (Dolphin Reef, Eilat). The aim of this study was to elucidate how specific biological variables (e.g. activities shown before a test) and also experimental variables (e.g. mirror properties or place of presentation) would affect the dolphins' behaviour to our device. In addition, we wanted to find out how the dolphins would deal with the problem of perceiving two presumably contracting kinds of information, one extracted by their sonar system and the other extracted by their visual system.

METHODS The study was conducted with a group of ten bottlenose dolphins (*Tursiops truncatus*) including one adult male, four adult females, and five juveniles. All adults were living in the study site (Dolphin Reef, Eilat) for more then eight years, and all younger animals were born there. The site covered an area of water of ca. 14,000 square metres. Dolphins could voluntarily leave the site by a gate, and some of them used it several times per day for excursions to the open sea. Because of an excellent water quality, ID procedures were not a problem. - Since special sections of the site were used by the public, our study required a number of preparations. In particular, we examined the spatial distributions of dolphins within the site and tested especially whether and when they preferred to stay at particular areas, for instance, in relation to specific events such as shows or visits by human swimmers (Todt and Hultsch, 1996). The results of such data sampling provided a baseline for selecting the positions where we placed our experimental devices (such as mirrors) or our recording equipment (such as underwater cameras and hydrophones). Details about these methodological prerequisites, and also about the dolphins and their normal behaviours have been published elsewhere (Veit and Bojanowski, 1996; Bojanowski, 1999).

During this study, the dolphins were exposed to commercial mirrors (size: 0.6 x 1.2 m) presented in two alternative versions; i.e. with reflective properties on either one side (= simple mirror) or both sides (= double mirror). For control, plates of metal, wood, or glass without mirror properties or mirrors covered by an opaque foliage were presented. All devices were fixed in a vertical position with 1 m space between their upper edge and the water surface. As soon as a given device had been positioned in the site area, a standardised acoustical stimulus was broadcast, which served as a sign for the start of a given test. There was evidence from pilot studies that the dolphins indeed paid attention to this starting signal. Tests (n=33) were made at different places in the site and in a random succession. They had a duration of 15 min each, and were distributed over several days with longer breaks between tests 15 & 16 (11 months) and tests 28 & 29 (3 months). Before, during, and after each test, the dolphins' behaviour was recorded audio-visually (i.e. by underwater cameras & hydrophones). ID procedures and also behavioural analyses followed methods published elsewhere (Todt and Hultsch, 1996; Brensing *et al.*, 2001).

RESULTS All dolphins approached the test area up to a distance of 3 m, when a novel device was presented. But, whereas subjects did not swim closer to any of the control devices, they inspected every type of mirror from a distance of less than 2 m. In seven of the ten dolphins such visual inspections were followed by a number of specific mirror-directed behaviours that were performed either individually or in a pair-wise manner. On the other hand, such encounters showed several changes over time. This development was independent of mirror properties. After the third experiment, only four individuals continued to visit and encounter the mirrors (Fig. 1).

Dolphin Behaviours Above all, we did not find evidence for a kind of self-examination, but rather observed activities that were known as constituents of normal social interactions in this species. Activities shown when a dolphin was less then 1 m apart from a mirror included the following types of behaviour: AC = Approach until mirror contact. BB = Big blow of air produced just before touching a mirror by nose or snout. VI = Visual inspection by directing one or both eyes towards the mirror. HJ = 'head-jerking', performed in front of the mirror by rhythmical movement of head and with mouth clapping. In most cases, HJ was accompanied by pulsed sounds (= PS) that had a similar structure as PS vocalised during agonistic interactions between dolphins. SM = shoving or pushing the lower part of a mirror by nose or snout. RM = riding on a mirror by taking a position above its upper edge and obviously trying to push it down. The performance of both SM and RM resembled properties that are typical characteristics of social play. Thus, they were taken together and classed as playful BD = 'bulldozing' (see also 'rough-and tumble play' - Veit and Bojanowski, 1996). Therefore, BD and likewise both SM and RM were categorised as playful behaviours. Data illustrating the time budget of the listed behaviours are given in Figure 2.

Mirror Properties Data analyses revealed the following results: First, mirror shapes affected the behaviour of two individuals. One dolphin placed itself above the other one, if the long edge of a mirror was arranged vertically. But dolphins contacted a mirror side by side to each other, if the long edge of a mirror was arranged horizontally. Second, during tests with simple mirrors, dolphin behaviours were directed to the reflecting side only; whereas during tests with double mirrors, they were clearly directed to both sides of a mirror. In addition, encounters with double mirrors lasted significantly longer than encounters with simple mirrors. Finally, when after a number of preceding tests, the reflecting side of a simple mirror was covered by an opaque foliage, only one of the dolphins (Nana) showed AC and VI. Afterwards, however, this individual removed the foliage by its mouth and transported it to a distant location within the study site. In summary, all trials documented that the dolphins responded to mirror properties that clearly were related to the quality of images to which a given mirror provided visual access.

Comparison across tests In order to examine effects related to (1) the locality the of mirror presentations, (2) the activity of dolphins during such presentations, and (3) the serial succession of dolphin encounters with mirrors, we conducted data comparison across tests. Here, we considered only those tests during which our subjects had been presented with an identical mirror device. Analyses of these variables revealed the following results: First, dolphins did not approach mirrors that were presented close to the marginal areas of the study site; thus the locality of an experiment had an effect of its outcome. Second, a similar result was obtained for the subject's activity. In other words, when the dolphins were engaged in a specific activity, e.g. communal fishing, none of them approached a mirror. Finally, previous experience with a mirror influenced the probability of attending an experimental session. So, for instance, there was a form of habituation along with a series of tests conducted during the same session, and also a decline in the number of dolphins approaching a mirror (Fig. 1). On the other hand, however, one of the subjects (Nana) continued to encounter a given mirror over more than 30 tests. Analysis of Nana's behaviour indicated that this dolphin began to monopolise the test device.

DISCUSSION The aim of this study was to examine whether and how bottlenose dolphins that were living in an open sea enclosure and here had free access to a huge set of attractive resources would deal with the chance to encounter a mirror or other experimental devices. Therefore, and because our test setting did not include prerequisites for an investigation of self-examination, it is not surprising that we did not find evidence for this accomplishment (Madsen and Herman, 1976). On the other hand, our data showed that all subjects distinguished non-mirror devices from mirrors, and additionally directed their behaviours to the images reflected by a mirror.

Our finding that mirror encounters were composed of behaviours that normally account as species-typical constituents of social interactions, is in line with the results from other authors (Overstrom, 1983; Veit and Bojanowski, 1996). A similar correspondence concerned the portion of time that dolphins spent in close proximity of mirrors (Marten and Psarakos, 1995), and also the considerable inter-individual and age-related differences among dolphins (Bojanowski, 1999). Together with some dynamical properties of behaviour, e.g. a repetitive but nevertheless highly variable pattern performance, these differences resembled typical characteristics of social play (Todt, 1983). Such characteristics were particularly prominent during performances of SM and RM. Thus, it could be challenging to compare the complex of playful 'bulldozing' to other kinds of playful encounters of dolphins (Veit and Bojanowski, 1996), but also to the complex of playful 'wrestling' described for primates (Todt, 1997).

From a functional perspective, the mirror encounters of dolphins can be taken as a process that begins with a phase of exploration, continues with a phase of playful behaviours, and finally can lead to a phase of practical usage or monopolisation, respectively. A similar sequence has been documented for comparable behaviours of non-human primates (Todt, 1983). Hints adopted from such primate accomplishments suggest two explanations for our dolphin results: First, the progression from exploration to play and the performance of playful mirror-directed behaviours can be interpreted by a reward effect that here could have been caused by the visual mirror reflections.

CONCLUSIONS We conclude that the dolphins after mirror exploration were readily able to distinguish a mirror image from a real dolphin (see also Marten and Psarakos, 1995); and thus their playful mirror encounters could have been both stimulated and rewarded by the illusion of a dolphin-like counterpart. Second, we hypothesise that the mirror monopolisation displayed by one individual (Nana) had induced the observed decrease in playful mirror encounters of the other dolphins. To test our hypothesis, we have now started new mirror experiments with isolated individuals. This novel study are also designed to examine further our conclusion about the processing of visual illusions in bottlenose dolphins.

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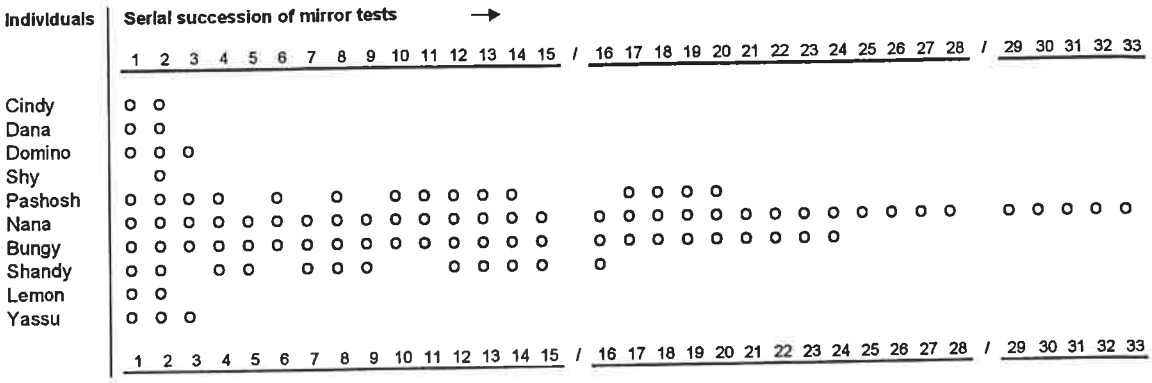

Fig. 1. Inter-individual and serial differences in mirror encounters of dolphins.
Circles represent tests during which a given dolphin had encountered a mirror. Tests 15/16 and 28/29 were separated by temporally extended experimental breaks. Subjects are listed on the left (Cindy = adult male; Domino, Dana, Shy = adult females; Pashosh, Nana = juvenile females; Bungy, Shandy, Lemon, Yassu = juvenile males). The initial phase (1st, 2nd and 3rd test) consisted of exploratory behaviours shown by all subjects; whereas the subsequent tests were composed by playful encounters performed by four dolphins. However, after test 25, one individual (Nana) began to monopolise a mirror (see text & Fig. 2).

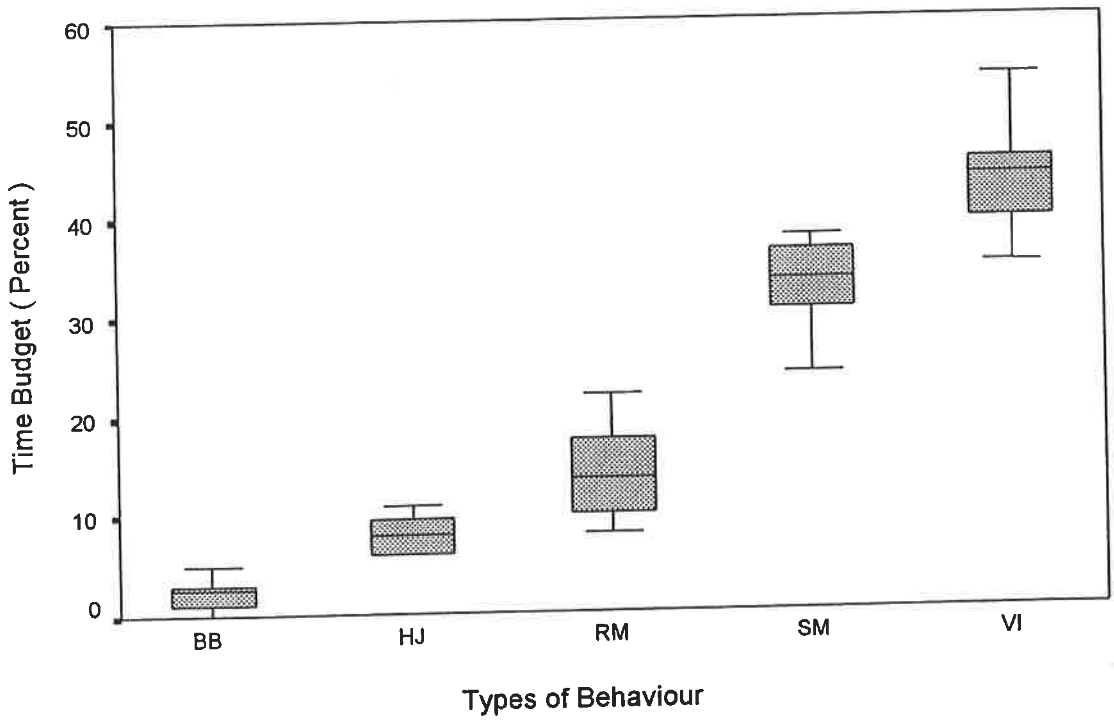

Fig. 2. Time budget of mirror-directed behaviours. Boxplots give means per test (calculated for tests 10 to 15). Here, data of two consistent dolphins (juveniles: Bungy & Nana) are pooled for each type of behaviour. Symbols: BB = Big blow of air; HJ = head-jerking; RM= riding upon mirror; SM = shoving mirror; VI = Visual inspection of mirror. The sequential dynamics of these behaviours documented playful encounters.
(For further details see text)

DOLPHIN-WATCHING ACTIVITY AS A SUSTENIBLE INDUSTRY IN MARINE PROTECTED AREAS: INFLUENCE ON BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) BEHAVIOUR

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Dolphin and whale watching is becoming a popular ecotourist activity in European Marine Protected Areas. In some Mediterranean areas, it is even suggested that incentives be provided the fishery industry into this new activity. Although there are some studies on dolphin-boat interactions, more information is needed to understand the impact of these interactions for the management of this new industry. This study presents the results of interactions between bottlenose dolphins (*Tursiops truncatus*) and dolphin-watching tour boats in Bunbury (Western Australia) during the summer season (January 2000).

Sixty hours of both acoustic and surface behaviours have been collected with focal group sampling at three minutes. The results show that the presence of the tour boat can influence the frequencies and the duration of the behaviours and the structure of the groups. The types and frequencies of direct inter-relating behaviour between boats and dolphins have also been analysed. In more than 80% of the cases, dolphins change their behaviour between 3 to 9 min. after the boat's arrival: frequency of feeding and resting decrease significantly ($P<0.01$; $P<0.05$) while travelling increases ($P<0.01$). The mean duration of behaviours is significantly reduced ($P<0.01$: feeding, resting; $P<0.05$: socialising). The group structure is also influenced, as dolphins tend to spread in smaller groups in presence of the boat ($P<0.01$). Only sporadically do they return to the same behaviour as before the boat arrival.

The direct inter-relating behaviour shows a positive response (e.g.. bow-riding) in 18% of the cases, while dolphins have a negative response (aggressive or avoiding behaviour) in 26% of cases; for the rest, the response is neutral (swimming around the boat). The results highlight how and which ecological factors could be influenced by dolphin-watching activities and show a direction for the management of this new industry.

ROLE AND IMPORTANCE OF SUBMARINE CANYONS ON THE CONTINENTAL MARGIN FOR THE SUMMER DISTRIBUTION OF CETACEANS IN THE NORTH-WESTERN MEDITERRANEAN SEA

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INTRODUCTION Many publications indicate that cetaceans frequent preferentially the continental slope, especially its upper part, and also particularly submarine canyons around the world (Kenney and Winn, 1987, on the NE coast of the United-States; Jefferson, 1991 for the Monterey canyon in California; Mullin *et al.*, 1994, in the Gulf of Mexico; and Hooker *et al.*, 1999, near the Nova Scotia coast). What influence does the site and its characteristics have on the distribution of tòp predators like cetaceans? Which factors determine their distribution?

All these indications encourage us to look at the situation in the Mediterranean Sea, where studies about relationships between environmental factors and cetacean distribution are quite recent but scarce, mostly brief or based on time-lag biological data. Studies deal either with small areas or with large ones, and none treat precisely the utilisation of a canyon. Our objective is to determine the role and the importance of canyons of the continental margin for the summer distribution of cetaceans in the Northwestern Mediterranean Sea.

MATERIALS AND METHODS This work is based upon data gathered from 1991 to 1998, during the months of June to September, over an area off the coast of France, from the Spanish frontier to the Italian one and to the south of Corsica. We retained only data concerning the continental margin, that is to say, from the coast to the 2,000 metre depth bottom contour. We focused our attention on the canyons and the area between them called inter-canyon, in two regions (Maps 1 and 2) where both of these features occur:

- Provence, where canyons are relatively narrow with steep head, and in the vicinity of the Northern Mediterranean Current (NMC) such as Cassis, Toulon, Magaud, Saint-Tropez, Estérel and Var. The inter-canyon area is present but small.
- Corsica (western part of the island) where canyons are narrow and short, hence small, and specially cross the shelf, such as Calvi, Porto, Sagone, Ajaccio and Saint-Florent. The inter-canyon area is quite extended.

We used standardised line transect methods, aboard 12 to 30 metre motor sailing boats, at a speed of 5-7 knots, and with three permanent observers. This allows a concentration of observations from 0.55 to 2.06 obs./km_mn^2 (Gannier, 1995).

Only nautical miles (nm) covered, with a sea state and wind conditions ≤ Beaufort 3, were retained in this study, totalling 4,426 nm over the continental margin, 3,331 over canyons, and 1,095 over the inter-canyon areas. Each transect was measured (software KARTO 7.1, Cadiou 1996), and divided into one nautical mile sections (+/- 10%). We calculated the position and the time of the end of each section. All observations of cetaceans were noted at the end of a nm, according to their position (latitude, longitude).

As soon as a cetacean is detected, we note his angle and distance from the trajectory of our boat with the help of the vertical graduations and the compass integrated into binoculars (STEINER Commander III). These measurements enable us to locate the animal accurately on a map (S.H.O.M., 1:250 000) when it was >0.5 nm distant from the boat's position, and then read its " real " geographical coordinates, and the depth at its position. Species, number of animals, structure and composition of groups, behaviour, and heading were also noted.

We made 371 encounters from seven different species (fin whale, sperm whale, Civier's beaked whale, long-finned pilot whale, Risso's dolphin, bottlenose dolphin and striped dolphin), for a total of 3,581 individuals.

Canyons are theoretically defined by the 200 to 2000 m depth contours. But since we want to know their influence on cetacean distribution, we need to take into account hydrological processes that occur mostly at the head and along the edges of canyons (Hickey 1995; Durrieu de Madron, 1994) beyond these topographical limits. So we decided to draw limits specifically for each of the canyons in relation to their configuration, with the help of the GIS, MapInfo 3.1 and Karto 7.1 over a digitalised bathymetric map (S.H.O.M.).

RESULTS The results show that the number of different species encountered is slightly higher in canyons (7) than outside (5), and concern notably the "teuthophagous" species in Corsica and rare ones like Cuvier's beaked whale *Ziphius cavirostris* over the entire study area.

The overall relative abundance of each species is higher in canyons than outside (Fig. 1). We used a Wilcoxon paired sign of ranks test with data from four years (1994 to 1997) for which we had good survey effort over the entire study area, and obtained a $p=0.06$, which we accepted as significant.

We classified the behaviours, followed by the majority of individuals in the group encountered, in one of these categories: travelling, feeding, resting, and playing/socialising.

Analyses of the behavioural data (Figs. 2 to 4, and Table 1) confirm the importance of canyons for three major trophic categories, mainly for feeding for odontocetes and socialising for teuthophagous species. The percentage of newborn animals observed in canyons compared with inter-canyon areas further supported this last finding (Fig. 5).

Each canyon is specifically utilised and exploited by cetaceans during the summer period (David, 2000), and some canyons are more attractive than others, namely: Saint-Florent, Cassis and Magaud (Friedman test, $p=0.03$).

DISCUSSION In this part of the northwestern Mediterranean Sea, the continental margin is influenced successively either by continental water (Rhône in the Golfe du Lion and Var in Provence) or by upwellings, or by the NMC and its associated thermohaline front. Interactions between the NMC and canyon's topography generate upwellings and eddies, with stronger currents over the canyon's flanks and head. These hydrological processes bring nutrients that allow or enhance productivity and concentrate or attract all the elements of the trophic chain. In addition, the behaviour of most marine organisms, like euphausiids, squids and fishes, lead to a near permanent food supply for predators. These animals are swept away during their vertical diurnal migrations and are trapped at the head of canyons. Moreover, the upper slope and canyons are spawning areas for several species of squid and fishes, which gather and school there during the summer. In those situations, canyons become areas of important concentration, abundance and species diversity, and thus are attractive for cetaceans.

We can add that not only does biological richness influence the distribution of cetaceans, but certainly also the prey type, their availability, accessibility, patches of concentration, and frequency of occurrence of these patches. Because canyons are topographically fixed, the hydrological processes occurring locally should be regular, and thus canyons could be a regular source of food.

The canyons most frequented by cetaceans seem to be those where meanders and eddies of the NMC occur, forced by the topography of the coast.

CONCLUSIONS This study shows the importance of the continental margin, and in particular sub marine canyons, in the summer period, their trophic role for cetaceans, but also the social role for teuthophagous species.

Since results from studies in different parts of the world are similar, it seems that the influence and importance of canyons are common throughout the world, even if modalities and intensities depend on hydrological, topographic and biological contexts. We can therefore suppose that similar results should be found in Mediterranean areas presenting patterns like ours, as for example in the Balearic Sea. Could this area act like a mirror of the Liguro-provençal one? Or would it act like a complementary area? And could we imagine looking at the Liguro-provençal Sea like a huge canyon, and the Alboran Sea too?

Although canyons are attractive sites for cetaceans, some of them are more frequented than others. Factors explaining this would be the size of the canyon and its distance from coast. Both parameters influence physical oceanography and availability of potential resources for cetaceans. Because canyons are rich in species diversity and abundant in cetaceans, and since most of them are near the coast, they become good places for whale-watching. It could be a priority to protect the more important ones, like Cassis or Magaud where a lot of animals feed and mate, especially since most of them are included in a recently created International Sanctuary.

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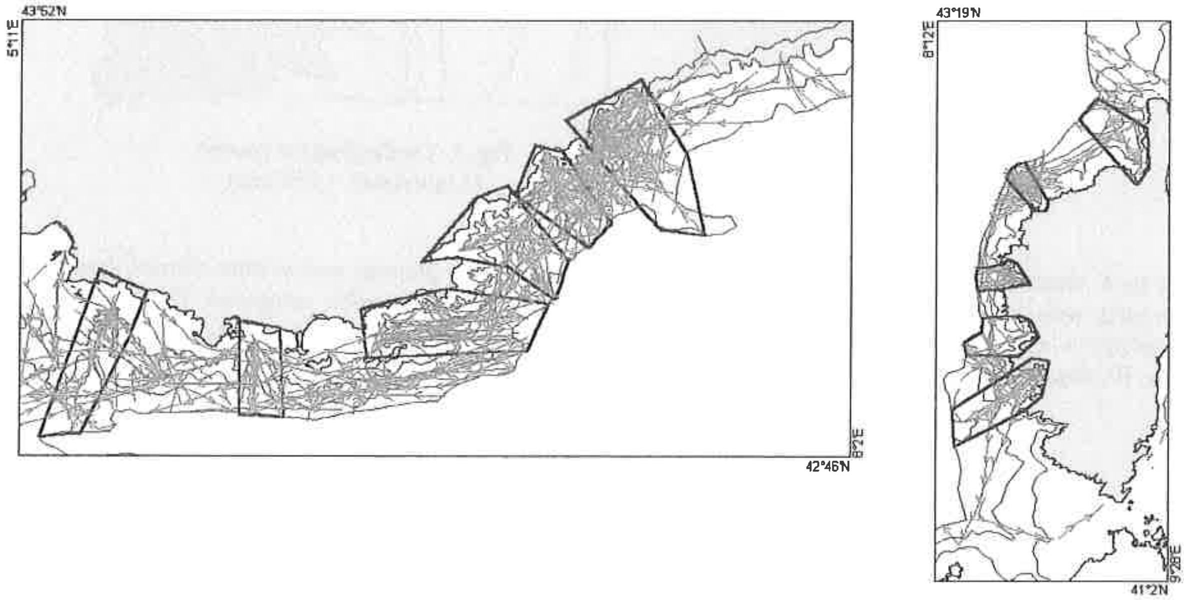
Table 1. Number of individuals per nautical mile showing one of the four behaviours, in canyons and inter-canyons areas for three trophic categories.

	Undetermined	Feeding	Travelling	Resting	Socialising
Fin whales in canyons	0.0060	0.0030	0.0039	0.0006	0.0012
Fin whales in inter-canyons	0.0064	0.0000	0.0091	0.0009	0.0000
Teuthophagous species in canyons	0.0135	0.0201	0.0222	0.0024	0.0318
Teuthophagous species in inter-canyons	0.0146	0.0073	0.0091	0.0000	0.0000
Striped dolphins in canyons	0.1861	0.2699	0.2309	0.0258	0.0129
Striped dolphins in inter-canyons	0.2612	0.1443	0.1434	0.0411	0.0484



Maps 1 and 2. Survey effort off the coast of Provence (left) and around Corsica (right), and contours of the main canyons studied.

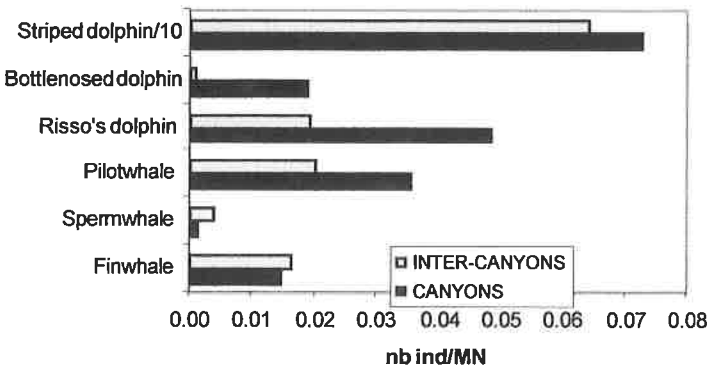


Fig. 1. Relative abundance of cetacean species in canyons and inter-canyon areas

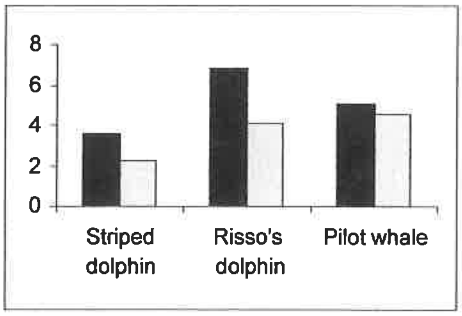


Fig. 5. Percentages of newborn individuals of three species in canyons (black) and inter-canyon areas (grey)

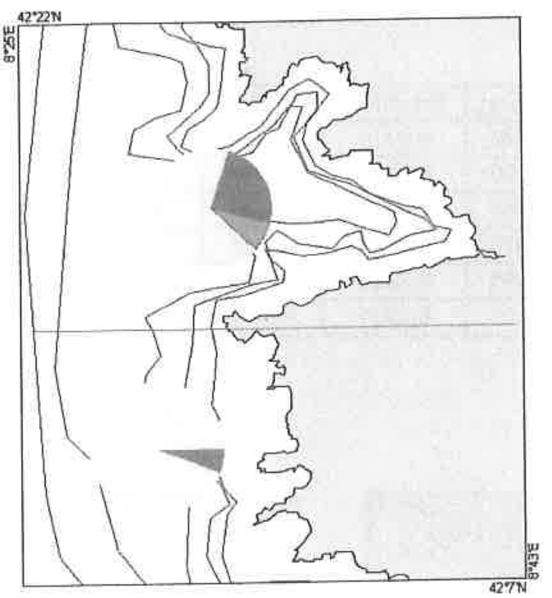


Fig. 2. Fin whales
(1 individual = 2200 mm)

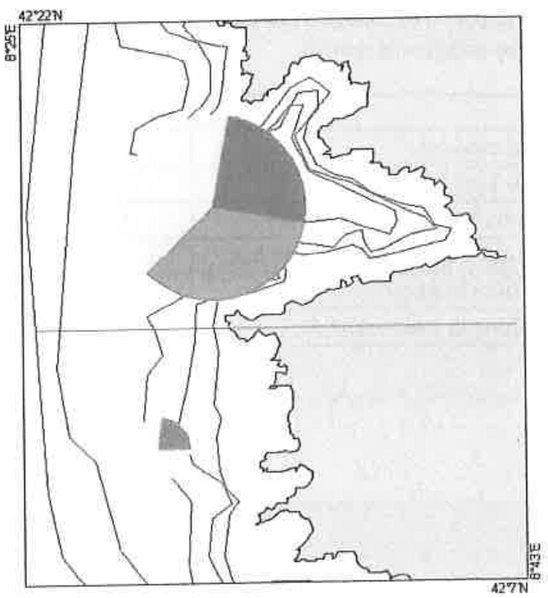


Fig. 3. Teuthophagous species
(1 individual = 550 mm)

Figs 2 to 4. Number of individuals seen in canyons (upper part of the picture) and in inter-canyon areas (lower part), with the proportions of four behaviours encountered, for three trophic categories: Fin whales, Teuthophagous species and Striped dolphins. The behaviours are from dark to clear grey: Socialising, Feeding, Resting, Travelling, and undetermined (see below, right).

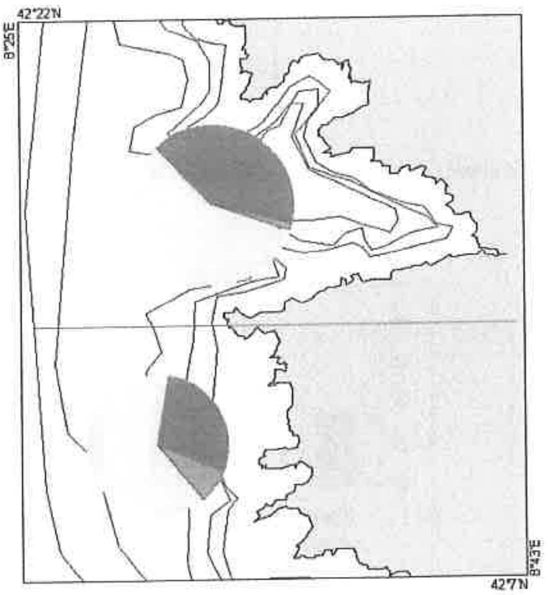
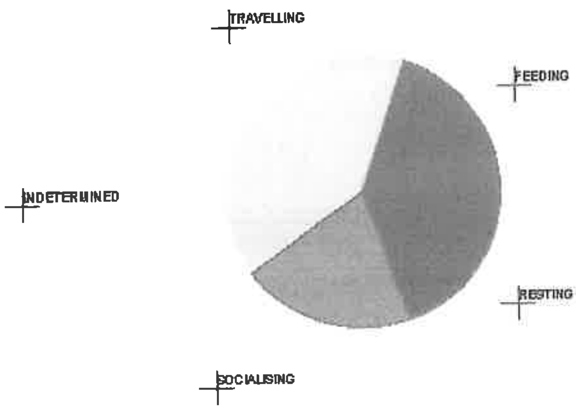


Fig. 4. Striped dolphins
(1 individual = 60 mm)



LATERALISATION OF VISUAL AND AUDITORY PROCESSING IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS, T. GILLI*)

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In that study, we focused on the dolphin's spontaneous eye preference when performing a complex cognitive task. The information arrived through two different modalities (visually and auditory): the dolphins had to show associations between a particular tone and a geometrical figure changing in size and dimension (2 D and 3 D) presented on an underwater touch screen. We worked with three female bottlenose dolphins. In order to visualise and touch an underwater target, the dolphins had to come closely to the touch screen (distance <1m) and to properly position themselves using monocular vision (left or right eye) and/or binocular naso-ventral vision. In the first place, the high scores of correct answers tended to demonstrate an ability of the dolphins to associate an auditory signal obtained by passive listening to a visual signal presented on an underwater touch screen. Then, the three subjects showed a spontaneous tendency to use monocular vision rather than their binocular naso-ventral visual field. And finally, contrary to previous studies, two subjects tended to use preferentially their left eye when looking at the targets on the underwater touch screen. Does this phenomenon imply a right hemisphere dominance? Contrary to humans, is the dolphin brain better organised to impose structure on auditory data than on visual data? Further analysis is required to understand the role of each cerebral hemisphere in visual combined with auditory processing.

OSTRICH POLITICS PUT HARBOUR PORPOISES AT RISK

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Little is known of harbour porpoise foraging behaviour, although it is likely that porpoises become entangled in their search for food. Three porpoises were kept at the Fjord & Belt Centre, in a semi-natural open design pool with entrance of tidal flow and different live fish. They are often seen searching for fish in a vertical position, with both their eyes and their sonar apparently orientated toward the bottom, i.e. *bottom grubbing*. If common, this behaviour would impact on the chance of porpoises detecting even acoustically-enhanced nets. It was thus further investigated.

Observations were conducted of both natural behaviour of the animals (focal sampling on undisturbed animals) and the behaviour initiated in front of an observation window by releasing live fish at the bottom (direct observation and filming through fixed cameras, acoustic recordings).

The time spent by the three porpoises in bottom grubbing varied from 0 to 30%, with an average of 2.4%, 5.6% and 8% respectively. From mid-August, the juvenile female was observed bottom grubbing significantly more (>10%). The frequency per hour varied between 0 to 97, the bottom grubbing bouts lasting between 0.2 sec to 172 sec. The distance travelled during a bottom grubbing bout was 18 m. The porpoises used their sonar extensively, with high repetition rates (peaks over 600cps), frequently making upward head jolts synchronised with sudden changes in repetition rate, likely to elicit a startle response in hidden fish. Porpoises, satellite tagged in Danish waters, dive mainly to the sea-bed (Teilmann *et al.*, 2000) and the main bulk of their prey is bottom dwelling fish (Lockyer *et al.*, 2000). Thus bottom grubbing is likely to be an important activity in wild porpoises in these waters, and this casts doubt on the potential efficiency of passive methods for reducing by-catch relying on the elimination of nets by porpoise sonar.

EVOLUTION OF A BOTTLENOSE DOLPHINS POPULATION IN THE NORTH-EASTERN WATERS OF SARDINIA (ITALY)

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INTRODUCTION Very few long-term studies on bottlenose dolphin (*Tursiops truncatus*) populations have been carried out in the Mediterranean Sea up until now. A comprehensive study on the behavioural ecology of a resident population of bottlenose dolphins in the waters of north-eastern Sardinia started in 1991. Summer observations were discontinuously carried out up to 1998, but since 1999 a constant monitoring of the area started again, and it is carried out throughout the year (except in summer months).

The area includes about 80 square nautical miles of water with a depth up to 100 metres, with large and small islands and a complex shoreline (Fig. 1).

In 1992, a fish farm has been built up just in the area: the surface of the cages was less than 1 ha, their volume being of 30.000 m^3 and containing about 174 tons of fish biomass. In 1995, the plant was completely transformed and now covers about 2.4 ha and contains about 800-1000 tons of fish biomass.

MATERIALS AND METHODS Since observations have been carried out by the same research group, the same or similar methodologies have been adopted so the results that were recorded in the different periods are really comparable. A first study was carried out from 1991 to 1994, and observations were recorded both from independent boats, trawlers and shore-based observation points (Arcangeli *et al.*, in press; Marini *et al.*, 1996).

About 976 hours of observations were carried out from 1991-94, with 894 hours from 1999-2000. Sightings are recorded only from the shore-line and from boats close to a floating fish farm (which was built in 1992). Spotting and observations of the animals were carried out with the naked eye and 12x40 and 12x50 binoculars. Photographs have been taken by an automatic 35 mm reflex camera with 35-80 and 100-300 zoom lenses.

Sightings were considered satisfactory when the visibility was not too much reduced by rain or fog and sea conditions were equal or below 3 of the Douglas scale. To record the behaviour, an *ad libitum* method (Altmann, 1974) was chosen, with the sequences of observed behaviours by the focal groups dictated to a tape recorder.

RESULTS In the first period (1991-94), dolphin sightings (n=99) were relatively rare (Fig. 2), and the mean school size quite small, with a larger observed school of ten animals (Fig. 3).

Dolphins were shy and lacking confidence around boats. Animals were accustomed to follow trawlers to chase cephalopods and fishes in front of the nets: hard predation on trammels was carried out, causing serious damage to the nets.

Photo-identification processes were very hard to undertake because it was difficult to approach the animals and their dorsal fins were extremely "clean", with very rare notches or scars: no more than seven animals were identified and few of them had permanent notches. Anyway, apparently all the animals in the area that brought scars had been identified after some time (Fig. 4).

Nowadays, the number of sightings per hour has increased dramatically (n=225) (Fig. 2); mean school size is larger (R=1-17) (Fig. 3); dolphins are easy to approach, and notches and scars are more frequent, with the number of photo-identified animals still growing up after two years. "Old" animals, that had been identified since 1987, are still seen in the area, but "new" ones are constantly identified (Fig. 4).

DISCUSSION AND CONCLUSIONS The nourishment coming from the farm gave rise to an increase in the presence of "wild" fish in the surrounding area, and this trophic availability probably creates a "*sponge*" effect towards groups of dolphins originally living outside the area.

While, in the past, low numbers of animals in the area limited any competition, now that new animals are coming some kind of competition could occur (e.g. sexual competition) causing the evident scares on the dorsal fins.

Dolphins operate opportunistically in groups of different size, adopting different feeding strategies in different areas (offshore, inshore, close to the fish farm) (Díaz López, B. *et al*, in press): they have been seen feeding on dead fishes discarded by the farm or escaping from the nets of the cages, too, while in the past they have never been observed eating fishes that were discarded by trawlers.

Unlike in the past (Marini, 1994), the presence of dolphins in the area is nowadays conditioned more by the fish farm than the fishery activities: however, feeding on fishing gear seems to remain an important resource for dolphins. During winter season, dolphins seem to stop to follow trawling boats, preferring to feed on nets close to the coast.

Moreover, the fish farm clearly changed the presence and behaviour of bottlenose dolphins in the area.

Clearly, the radical change in trophic availability seems to be the main reason for the transformation of the presence and behaviour of the dolphins: this seems to be the first well documented case in the Mediterranean Sea of an alteration of the behaviour and ecological dynamics of a population of bottlenose dolphins to be driven by the human altèration of the environment.

ACKNOWLEDGEMENTS The research has been carried out in co-operation with the Compagnie Ittiche Riunite Fish Farm (C.I.R), the support of the Ferrovie dello Stato (Italian railways) and of *L'Immagine Foto Video* di Golfo Aranci. Our thanks also go to the numerous friends and field assistants who have been working with us during the project.

Special thanks go to the people of Golfo Aranci and to Manuela Brovelli for her help in sightings and analysis of data.

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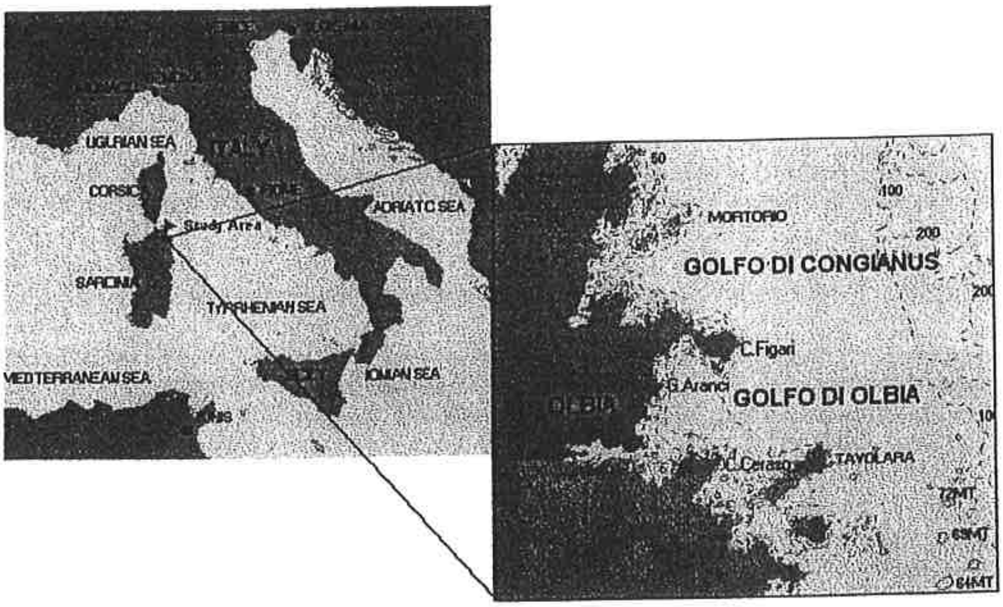
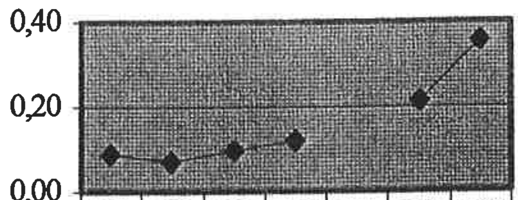
Figure 1. Study area





	1991	1992	1993	1994	1995-	1999	2000
S/H	0,09	0,07	0,10	0,12		0,21	0,36

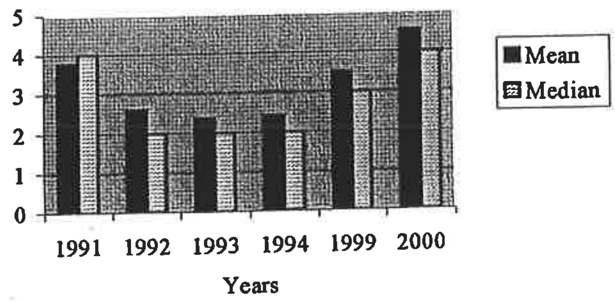
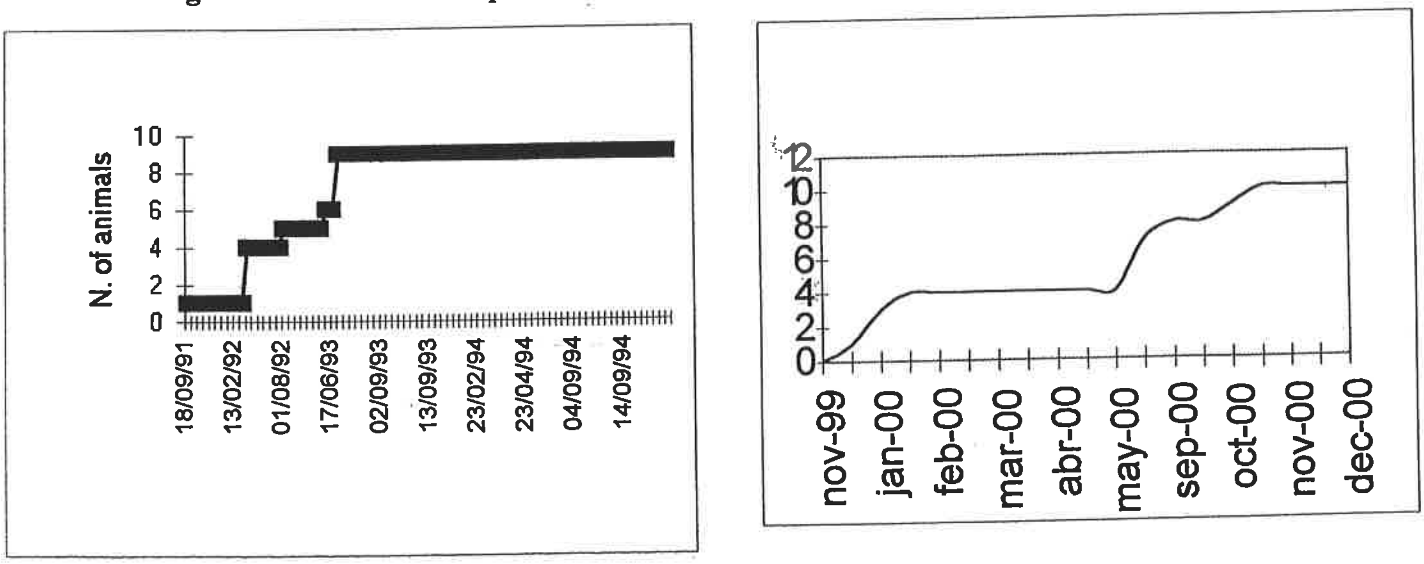


Fig. 2. Sightings per hour

Fig. 3. Group size

Fig. 4. Cumulative rate of photo identification of new individuals over time



KILLER WHALE UNDERWATER TAIL-SLAPS: KINEMATICS OF A FEEDING BEHAVIOUR IN THE FIELD

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Co-operative hunting by killer whales *(Orcinus orca)* has been reported in a number of descriptive studies. However, no previous study has provided a quantitative analysis of the kinematics of killer whale attacks on fish. Killer whales feeding on herring (*Clupea harengus)* in a fjord in northern Norway were observed using underwater remote-controlled video. The whales herded herring into a tight school close to the surface, while periodically lunging at it and stunning the herring by slapping them with the underside of their flukes while completely submerged. Killer whales then ate the stunned herring one by one. Successful tail-slaps occurred in synchrony with a loud noise. This noise was not heard when the tail-slaps occasionally "missed" the target, suggesting that the herring were stunned by physical contact. The kinematics of tail-slapping were analysed in detail. Tail-slaps consisted of a biphasic behaviour, i.e. two phases with opposite angles of attack, a preparatory phase and a slap phase. During the slap phase, the maximum angle of attack of the flukes was 47° on average. The maximum speed of the flukes was 2.2 lengths s^{-1} (14 m s^{-1}) while the maximum acceleration of the flukes was size-independent and was 48 m s^{-2}. The theoretical maximum number of herring hit by a tail-slap ranged between 10-47 individual herring. Given the high performance of the tail-slaps in terms of speed and acceleration, we suggest that tail-slapping by killer whales when feeding on schooling herring is a more efficient strategy of prey capture than whole-body attacks, since acceleration and manoeuvrability are likely to be poor in such large vertebrates.

IMPACT OF TOURISM ON INDO-PACIFIC BOTTLENOSE DOLPHINS (*TURSIOPS ADUNCUS*) IN MENAI BAY, ZANZIBAR

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The aim of this study was to investigate whether adherence to guidelines would reduce negative impacts from dolphin tourism on dolphin behaviour. The study was conducted in Menai Bay, Zanzibar, where commercial dolphin tourism has been a growing industry since 1992. A research program was initiated in 1998, and behavioural changes among the dolphins, which could be related to the tourist activities, were noted at an early stage. In November 1998, a set of draft guidelines was produced and boat drivers were also briefed on how to responsibly approach and drive their boats around the dolphins. However, little improvement in boat-driving behaviour has been observed since then. In this study, observations were made from tourist boats engaged in dolphin watch and swim operations, as well as from a research boat. Changes in group activity (resting, travelling, socialising and foraging) during boat approaches and occurrences of stress related behaviours (leaps, tail-slaps and coughing) during 30-minute follows were studied using scan sampling of groups. Approaches and follows, in which the guidelines were followed, were compared with when they were violated. The results showed that the dolphins were more likely to change their group activity during boat approaches when guidelines were violated. Furthermore, stress-related behaviours were significantly more frequent during follows when guidelines were violated. This indicates that the behaviour of Indo-Pacific bottlenose dolphins in Menai Bay is significantly affected by the dolphin tourism in its present form. The adoption, implementation, and enforcement of suggested guidelines could be an important step towards a sustainable development of the dolphin tourism in Menai Bay.

HOW DO SATELLITE TAGS AFFECT HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) BEHAVIOUR?

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Satellite-linked telemetry has successfully been used in monitoring the movements and diving behaviour of small cetaceans in the open sea. It is, however, uncertain to what extent attachment of satellite transmitters affects the behaviour of these animals. The aim of this study was to observe behavioural changes of a captive harbour porpoise tagged with a satellite- and VHF transmitter. A mature female harbour porpoise was kept in an outdoor, floating pen in a bay at Neeltje Jans, The Netherlands, during the study period (May 2000 – June 2000). A satellite dive recorder was attached to the dorsal fin of the animal on the 16th of May. The behaviour was observed for a short time every day, and intensively in the beginning and end of the study period. The transmitter was removed after one month due to skin problems. The behavioural data were collected using focal sampling by two different observers, and by digital video monitoring. Diving data recorded by the transmitter were also analysed. Short term behavioural changes were clearly observed. On the day of the tagging, the porpoise spent 51-62% more time at the surface, and the frequency of "logging" increased 4-6 fold compared to the days before tagging. Furthermore, satellite dive recorder data showed a change in dive patterns between the attachment day and the two following days. Long-term effects of satellite transmitter attachment were not so evident. Diving behaviour showed no clear change, though the porpoise had a tendency to dive deeper and longer in the last period of the study. This study suggests that significant changes in short-term behaviour can be expected when observing small cetaceans tagged with satellite transmitters and, therefore, such changes should be taken into account

SHARED FRIENDS OR SHARED RESOURCES? THE SOCIAL STRUCTURE OF BOTTLENOSE DOLPHINS USING THE SHANNON ESTUARY, IRELAND

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Many studies of resident bottlenose dolphin populations have revealed loosely associating fission-fusion communities. This paper presents the findings of a twenty-five month study on the social structure of a population of individually identified bottlenose dolphins using the Shannon estuary on the west coast of Ireland. This population appears to be semi-resident with a seasonal migration into the estuary during the summer months. Photo-identification of uniquely marked dolphins encountered during 45 standardised boat surveys provided data relating to the association of these individuals with respect to school membership. Over 90% of all dolphins encountered were found in schools rather than alone, with a median school size of 5 animals. In total, 17% of all possible dyads (pairs of individuals) were observed with a mean simple ratio association index for dolphins sighted at least four times of 0.07. An association matrix derived from individuals sighted at least four times in fully photographed schools was found to differ significantly from a random structure using an iterative permutation test. Associations were examined with respect to age class and gender, and no evidence of sex segregation, single sex alliances or cohorts was found. In common with studies of other populations, the bottlenose dolphins using the Shannon estuary can be considered to consist of a single community of loosely associated individuals. The temporal changes in the abundance of dolphins in the Shannon may preclude the development of a complex social structure. However, hierarchical cluster analysis and principal co-ordinate analysis identified three assemblages of individuals within the Shannon population. Harmonic mean transformation of the locations of encounters with members of these three assemblages revealed a degree of habitat partitioning. The possibility that resource sharing rather than partner affiliations could be driving the social behaviour of this population is discussed.

BEHAVIOURAL AND HORMONAL CHANGES IN A FEMALE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

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A male and a female harbour porpoise, 6-7 years old, have been kept since April 1997 in a semi-natural environment at the Fjord and Belt Centre, Denmark. This offered a unique opportunity to investigate the sexual cycle of the female in term of behaviour and hormonal changes. The present study covers the period March 2000 – February 2001. Plasma was collected 1-3 times a month and oestrogen and progesterone levels were analysed by ELISA. Vaginal smears were collected 1-3 times a week, allowing in particular to confirm matings by looking at sperm occurrence and concentration. Behavioural observations consisted of 2-3 hr sessions carried out in the evening after trainers and visitors had left. Behaviours were recorded by focal sampling as states and events on a workabout using a behavioural study software. Duration or frequency was calculated relative to the time the female was visible. We focus here on the changes over time of the duration of two states: grooming (touching bout, without erection) and sexual activity (porpoises within two body lengths and erection), and the changes in frequency of one event: mating attempt (the male has an erection and tries to mate). These changes are compared with the variation in sperm abundance on smears and changes in oestrogen and progesterone levels. Grooming was observed during the whole period, and peaked from mid-July to mid-August. Sexual activity was observed from March to November and peaked from mid-July to mid-August. Sperm was observed in the vaginal smears from July to September. Progesterone and oestrogen levels varied between <1-17 ng/ml and <0.1-1.8 ng/ml, respectively. Successful matings appeared much more limited seasonally than the sexual activity of the male. Hormonal levels varied, but without exhibiting a clear seasonal pattern. A detailed image of endocrine ovarian activity requires more frequent sampling.

TUNISIAN BALAENOPTERIDAE

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Since 1889, we have made a count of 34 balaenopterids that have stranded or were accidentally caught in fishing gear in Tunisia. We found that the majority (27) of these cetaceans were found along the south-east coast near the edge of the continental shelf where it widens and opens out to form the Oriental Basin of Mediterranean Sea. Three species were certainly identified, there are fin whale *Balaenoptera physalus*, minke whale *Balaenoptera acutorostrata*, and humpback whale *Megaptera novaeangliae*. Another species was tentatively identified as a sei whale *Balaenoptera borealis*. These results suggest that these balaenopterid whales may be more frequent in the southern Oriental Basin than is indicated in the Occidental literature.

BEHAVIOURAL REACTION OF BOTTLENOSE DOLPHINS TO BOAT ACTIVITY

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The home range of coastal cetaceans often includes areas where human activities can be extensively developed. This may lead to negative effects, in the short- or long-term, or induce positive reactions from animals. The coastal bottlenose dolphin population of *île de Sein*, France, mainly remains within a small area, that corresponds to the harbour entrance. The animals mainly use this site in summer, when the sea traffic is at a maximum. There are two categories of dolphin behavioural responses to the presence of boats: positive (approach) and negative (escape). A third one is defined and corresponds to "no reaction". A study of interactions between bottlenose dolphins and human activities was conducted in summer 1996. The group was present at the harbour entrance for 20% of the observation time. Of approximately 2,000 boat movements observed on this site, a quarter occurred in the presence of dolphins. "No reaction" accounted for 78% of the situations observed. Due to the narrowness of the navigation channel, we assessed the minimum distance between boats and the group to rarely exceed 200 metres. The dolphins reacted positively according to the speed and movement of the boat. At speeds >2.5 m/s, the situation usually observed was that a few individuals approached the boat to wave-ride. The interactions were short in time and distance covered. The longest took place when the boat changed its route to approach the dolphins and remain close to them. No negative reaction was observed during this study. The maritime traffic of *île de Sein* could probably be considered as marginal in terms of group disturbance. However, a considerable increase in the boat activity resulting from the development of the Marine National Park may rapidly have a negative impact on the presence of bottlenose dolphins in this area.

DIVING BEHAVIOUR AND LOCAL MOVEMENTS OF GRAY WHALES (*ESCHRICHTIUS ROBUSTUS*) WITH CALVES IN SAN IGNACIO LAGOON, BAJA CALIFORNIA, MEXICO

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We investigated the diving behavior and local movements of female eastern Pacific gray whales (*Eschrichtius robustus*) with calves in San Ignacio Lagoon, Baja California, Mexico, during the winter season of 1999 and 2000. Multi-Sensor/VHF tags were attached via suction cups with magnesium release mechanisms set at four hours. Data on depth, duration, tilt, temperature, and light intensity were recorded at 10-second intervals. In 1999, tags were deployed successfully on eight occasions, recording a total of 14.5 hours of diving data. Three characteristic dive type patterns were distinguished, long dives (>1 minute), short dives (<1 minute) and "clustered" dives, i.e. a long dive followed by 1 to 4 short dives. 311 dives were recorded, 59% of these being long dives, and 23% clustered dives. Overall mean dive duration was 2.16 min (max. 10.5 min). Maximum dive depth was 20.75 m. Two different dive profiles were observed: V and U-shaped dives. Bouts of up to five extended U-shaped dives (up to 8.8 min long) following each other were recorded. Three whales rested extensively near the surface. Resting is an important part of the dive characteristics of cow-calf pairs in the lagoon. In 2000, twenty-two VHF transmitters were successfully deployed on female gray whales with calves, using a crossbow. Movements were noted for up to nine successive days, including night movements. Cow-calf pairs used the whole lagoon area, moving extensively and even periodically leaving the lagoon. Most animals preferred the middle and lower lagoon area, cows with older calves preferring the lower lagoon zone. These data demonstrate extended periods up to 2 to 3 days outside the lagoon, i.e. in the Bahía Ballenas (BB) region. It suggests that the BB area is important and should be included in the conservation plan of the lagoon area.

TESTING ASSOCIATION AND RESIDENCE PATTERNS AMONG AGGREGATIONS OF FORAGING MINKE WHALES

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INTRODUCTION North Atlantic minke whales are known to forage independently for the most part. Nevertheless, individuals form mobile local aggregations across the season in prime feeding areas, some with annual sighting histories >10 years. Information on these aggregations: composition, association patterns, distribution and temporal specificity is a necessary part of any integrated coastal zone management plan (MPAs), including non-lethal population estimators. Non-random associations lead to underestimates of abundance; temporary emigration and short residence patterns lead to over-estimated abundance.

METHODS Monte-Carlo methods were used to test temporal-spatial associations among 55 individuals sighted at least twice in two consecutive years (1999 and 2000), and 31 individuals sighted at least twice for the first time in 2000 against the hypothesis of random distribution on the feeding grounds at the head of the Laurentian Channel (LCH), St. Lawrence Estuary. Individuals were recorded and identified daily, weather permitting (wind speeds ≤20 knots), using the DEM method of photo-identification (Tscherter and Lynas, *submitted*). If an individual was identified at least once on day *x* during the season (June to September), it was considered to have been a resident on that day. Based on the mean number of resident days for whales identified during 2000, we used a lower bound of five (non-zero) combinations from each dyad for analysis (no. of net animals tested = 22 and 9, respectively). The half-weight index (HWI) for association values was chosen and ten sets of 50 iterations were used to test the null hypothesis. We also tested a subset of seven individuals which were recorded foraging primarily in a spatially restricted area of the feeding grounds, using five sets of 50 iterations.

RESULTS We found no evidence of non-random association among temporal aggregations of minke whales foraging in the LCH region. HWIs ranged from 0.034 to 0.152 and the overall Monte-Carlo p value = 0.78. The Monte-Carlo p value for the spatial subset = 0.44. Mean seasonal residence time was five of a possible 75 days (SD = 4.47; range = 1 (0.3^{-d}) to 21; no. of individuals = 126), and was independent of whether animals had a sighting history or were new to the area (2 x 10 contingency test, X^2 (0.05) = 18.31; p = 0.05; n = 118, df = 10). Twenty-six percent of individuals were resident on one day only, and 90% on ten or fewer days. One-third of the whales were resident on 2-4 days consecutively. Of those resident on ten or fewer days, 64 had been identified in previous years, whilst 49 were newly identified in 2000. Ten percent were resident on eleven or more days across the season, although not necessarily consecutively. All had first been identified prior to 2000.

DISCUSSION The finding of non-associative random aggregations of minke whales on the LCH feeding grounds means it is unlikely that abundance models using capture-recapture methods based on natural or genetic markers underestimate the population numbers. On the other hand, the degree of variability in residency patterns is such that it is likely to result in un-equal capture probabilities (high heterogeneity) and overestimations of abundance, because models treat individuals no longer resident in a survey area as though they were present but not captured. Similarly, such a highly mobile population, with 26% exhibiting very short residence times (from several hours to a day), presents problems for line-transect models of abundance. If whales move out of an area ahead of survey vessels, the population will be underestimated. Alternatively, if the survey vessels are eclipsed by the same individuals along the track line during darkness or heavy sea states, they will be recounted and the population will be overestimated. The actual influence of these effects, and whether or not they would cancel each other out, remains to be investigated.

THE BEHAVIOUR OF A GROUP OF STRIPED DOLPHINS *STENELLA COERULEOLBA* LIVING IN A PORT FOR A WHILE

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INTRODUCTION A group of seven striped dolphins *Stenella coeruleoalba* inhabited a port in the south of France, from 24th September to 13th October, 2000. The animals set out again gradually but the two individuals remaining changed behaviour and appeared increasingly apathetic and indolent.

Description of the Phenomenon On 24th September, 2000, a group of striped dolphins decided to inhabit the port of the island of les Embiez (Var, France) and remained there for twenty days. These animals returned to sea in small groups: two of them left the port during the night of 17th September, three others on 1st October, and the last one on the 4th October. This last dolphin displayed pathological symptoms, and disappeared on 13th October. This study investigates the behaviour of the last two dolphins (Z1 et Z2), between 2nd October and 13th October. Z2 disappeared on 4th October, and was found dead on 9th October. Its autopsy did not reveal any prey remains in the stomach

MATERIALS AND METHODS

Types of behaviour: During the day, observations were carried out every fifteen minutes, with naked eyes and from the quay. During the night, this regularity was not respected. Three main behaviours were determined with some subdivisions for each type (cf. Table 1):

Resting: - long: long semi-still periods at the surface (with almost no apnoea), individuals circling at a range of less than one metre from each other, and swimming very slowly in the same direction and with synchronised movements;
- light: presence of apnoea, with no long periods of surfacing; swimming slightly faster.

Medium active behaviour: distance between individuals >1 m, swimming slowly on average, sometimes in different directions. The movements are not synchronised any more, some possible discrete aerial displays.

Active Behaviour: - play and/or socialising: fast swimming, aerial displays
- hunting: diving, fast swimming, long apnoea
- concentrated hunting: diving, travel at a steady speed, aerial displays possible.

Changes in the behaviour of the last two individuals: First, the investigations showed some variation in the behaviours displayed, and the locations occupied for different periods of the day. Those animals hunted particularly in the evenings and during the night in the eastern part of the harbour and outside of it, and rested during the day in the western part of the harbour. We also observed that generally as the day proceeded, the intensity of each type of activity slackened. Thus, one can see that for the second time period of the day, in the Rest category, "Long rest" changed from 14 to 0% (which could be interpreted as a reduction in the quality of rest of the animal). The last animal, which remained alone, hunted with less energy than when with the group. One notes in the second time period of the day, that for category AB, the subdivision Concentrated Hunt decreases by 14 to 0%. Moreover, the foreign bodies found in the pre stomach of Z2 (roots and rhizomes of Posidonies, branches and stems of shrubs, pieces of plastic, and 30 cm of braided cord) indicated that Z1 consumed these intentionally. For the first time period, it is the category Active Behaviour that generally decreased compared with the other two types of behaviour (from 11 to 0%). The category Medium Active Behaviour appeared to increase: it represented neither resting nor hunting but rather an intermediate lethargic state. Z1 tended to behave increasingly apathetically until the evening of the day of its disappearance when we noticed a small new lease of energy.

A particular event that we noticed was that this animal would accept dead fish given by a human (which enabled one to administer some medicine to it without any stress), and it allowed Eric Demay, a cameraman specialising on dolphins, to take a fish hook from its gum (a three-pronged fork deeply planted in its gum, which prevented it closing the mouth and consequently from hunting). The entire operation took almost 30 minutes during which the animal allowed Eric to touch it, then placed even its beak on his hands. The extraction itself lasted ten seconds and the dolphin allowed itself to be restrained without any struggle.

DISCUSSION The decline in intensity of the activities and particularly in relation to hunting probably led Z2 to stop eating anything. The material found in its stomach and the fish hook in the gum of Z1 showed clearly how much human activities can be damaging for wild animals.

The interactions between the dolphins and man led us to ask us several questions particularly with regard to the feeding and the responsibility for taking medical care of wild animals. Eric Demay has proposed to organise a meeting with all the local marine users in order to establish a code of ethics for better management of such an event in the future.

CONCLUSIONS The question of the cause of this event all the more deserves to be asked because this seems to have been a unique case (nobody from the MARMAM list knew of a similar event with striped dolphins - Gauthier Chapelle, *pers.comm.*). Of course, it is not excluded that such events have already occurred but remained undetected. Nevertheless, the case of Les Embiez remains exceptional. Several assumptions would explain the unusual appearance of a group of striped dolphins in a harbour:

As supposed by the local fishermen, the animals could have followed a fish school and found themselves captive in the port because of something that affected their orientation or perception of the environment. They were observed leaving the port at the end of each day but their home range was not known.

One or several of them were possibly subjected to disease before entering the port. As in the case of some mass strandings, the entire group may have accompanied a sick individual into the harbour. Or it could be that it was the prolonged stay in the port which made the last animals apathetic.

It should be noted that the shooting of mines was carried out not far from the island of Les Embiez (offshore of the Cape Sicié) by the French Navy during the weekend prior to their appearance.

Also one should note that the animals present were probably young individuals, perhaps derived from a larger group, since large aggregations of juveniles being frequent at that time.

Lastly, on several occasions and in various parts of the French coast, there have been cases of solitary bottlenose dolphins *Tursiops truncates* taking up residence in an unusual place. In some cases, certain local conditions may have discouraged them from leaving. It may be that such a phenomenon occurred in Les Embiez.

ACKNOWLEDGEMENTS I am grateful to Pierre Beaubrun for his scientific advice. Thanks also go to the residents of Les Embiez Island who hosted me, the Paul Ricard Society, the Oceanographic Institute, and the harbour master's office of *Saint Pierre les Embiez.*

Table 1. Development of the behaviour of the last two individuals

Period of the day	*Behaviour*	**Z1 and Z2 from 2 to 4-10**	**Z1 from 5 to 10-10**	**Z1 from 11 to 13-10**
from 7h to 16h45	*Rest*	60%	65%	62%
	*long	37%	41%	24%
	*light	23%	24%	38%
	Medium	29%	27%	38%
	Active	11%	8%	0%
	*play/social.	6%	4%	0%
	*hunting	2%	4%	0%
	*hard hunting	3%	0%	0%
from 17h to 6h45	*Rest*	21%	30%	11%
	*long	14%	11%	0%
	*light	7%	19%	11%
	Medium	44%	37%	55%
	Active	35%	33%	34%
	*play/social.	5%	2%	17%
	*hunting	16%	29%	17%
	*hard hunting	14%	2%	0%

WHY AND WHEN THE SEXES SHOULD SEGREGATE

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In this presentation, I examine a particular aspect of the social life of odontocetes: sexual segregation (SS). SS is best defined as a behavioural pattern in which individuals segregate with others of their own sex outside of defined breeding periods. Although SS is common among group-living mammals, it is still poorly understood. Several hypotheses have been proposed to explain why and when the sexes segregate in ungulates. They invoke sex differences in predator avoidance, forage selection, activity budget, social motives, as well as scramble competition. I selected a few of the best-studied odontocete species as natural field tests for these hypotheses. As most factors invoked are affected by body size, I made parallel sets of predictions for sexual size-dimorphic species (SSDS) and non-sexual size-dimorphic species (NSSDS). SS patterns found among SSDS are more pronounced than those observed in NSSDS. This finding is consistent with the activity budget hypothesis which predicts that as body size differences increase, the costs of male-female activity synchronisation should increase and hence lead to more pronounced SS. However, females from several species do not segregate according to their reproductive condition despite additional costs associated with activity synchronisation. This suggests that benefits from social philopatry can outweigh the costs imposed by differences in activity rhythms. Sex differences in predation risk may also contribute to SS in several SSDS. Harbour porpoises, however, constitute an interesting exception where females may trade off security to match the requirement of their exceptional annual reproductive cycle. As was found in ungulates, predation risk and activity budget hypotheses best explained SS in odontocetes. Social philopatry, however, plays a predominant role in odontocetes. This review emphasises the need for increased understanding of the social lives of odontocetes and the value of comparative approaches.

ANALYSIS OF THE SOCIAL STRUCTURE OF SHORT-FINNED PILOT WHALES (*GLOBICEPHALA MACRORHYNCHUS*) LIVING OFF THE SOUTH-WEST COAST OF TENERIFE USING PHOTOGRAPHIC DATA COLLECTED FROM WHALE-WATCHING VESSELS

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In order to assess the population size and social structure of the short-finned pilot whales found off the coast of Tenerife, trained "Proyecto Ambiental Tenerife" conservation volunteers took photographs of these cetaceans' dorsal fins from whale-watching vessels operating from the island's southwest coast. Since very little recent scientific information has been reported on this population, and given current pressure to create a marine protected area around the south coast of Tenerife, the results of this research are particularly relevant. Between July 1997 and November 2000, over 13,800 photographs were taken, and 290 different, highly distinctive individuals were identified. 95 individuals were seen only once and therefore classed as "transient" animals and removed from further analysis. Out of 1,222 sightings, mean sighting duration was 17 minutes and mean estimated group size was 13 animals. The data were analysed using 'SocProg' (Whitehead, 1999) to test the null hypothesis of random association between individuals, and to investigate temporal patterns of these associations. Permutation testing showed that patterns of association between individuals were significantly different from random. Lagged association rates indicate a population made up of groups that remain relatively stable over the four-year study period. Whilst this study utilises recently developed mathematical techniques, it also supports previous research suggesting that this pilot whale population comprises strongly associated resident groups, along with transient animals. We argue that Tenerife's large whale-watching fleet should be seen not as a potential threat to the population it depends on, but as a force supporting research, and promoting education and conservation.

INTERACTIONS BETWEEN KILLER WHALES (*ORCINUS ORCA*) AND THE RED TUNA (*THUNNUS THYNNUS*) FISHERY IN THE STRAIT OF GIBRALTAR

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INTRODUCTION Sightings of killer whales have been reported in the area of the Strait of Gibraltar for more than 500 years. (Bayed and Beaubrun, 1987; Aloncle, 1964; Morcillo, *pers. comm.*). This area is also very important for tuna fisheries. The red tuna migrates every year throughout the Strait of Gibraltar, entering the Mediterranean Sea in spring to breed, and leaving the Mediterranean Sea in summer (Rodriguez 1964). For the last 500 years, the traditional way of fishing red tuna has been the Almdraba (pound nets), where the killer whales were interacting in the Strait and in close tuna fisheries areas (Morcillo, *pers. comm.*). This large, fast-swimming fish species appears to be the main fish prey of killer whales in the area in spring and summer. In the last decade, fishermen have been starting to use drop lines to catch the red tuna, and it is just this interaction that is the topic of the study. This research project started in 1998 in the Strait of Gibraltar, using different whale-watching boats.

METHODS During 1998, interviews with fishermen were carried out in order to know exactly where the fishing boats were seeing the killer whales, and the possible interactions with them in the area of Tarifa. This area was considered the "killer whales area" (Study area I in Fig. 1) in this study, and the only place where whale- watching trips for orca were taking place. (Fig.1). In the summers of 1999 and 2000, 16 dedicated whale-watching trips for killer whales were carried out, with one or two experienced observers onboard in the study region. These trips had an average duration of 3:5 hrs and two different boats, of 7 and 9-m length, were used for this purpose between 22nd July and 20th August of both years. Data concerning number of individuals, social structure, and general behaviour were recorded, and pictures of the dorsal fins were taken for identification purposes in each of the sightings, although not all the animals were photographed in each sighting due to the whale-watching conditions.

Observations regarding the depredation of tuna from the drop line by killer whales, as well as the reactions of the fishermen, were also recorded. Furthermore, the number and type of fishing vessels observed around the group of animals were also identified.

RESULTS 7,637 nm were sailed in the rest of the research area, (study area II in Fig. 1). 1,084 sightings of common dolphins (*Delphinus delphis*), striped dolphins (*Stenella coeruleoalba)*, bottlenose dolphins (*Tursiops truncatus*), long-finned pilot whales (*Globicephala melas*), sperm whales (*Physeter macrocephalus*), and fin whales (*Balaenoptera physalus*) were recorded, but no killer whales were observed in this area. Killer whales were only observed in what we call the "killer whale area" - study area I in Fig. 1.This area is centred 5 miles north of Tangier, next to the sea mounts "Monte Tartesos", "Cañón de Bolonia" and "Cresta Kmara". In both seasons of 1999 and 2000, of 16 killer whale dedicated whale-watching trips, 12 sightings of killer whales were recorded in study area I. In 75% of the total sightings, an average of 8.62 (SD 0.769) individuals were recorded. Eight individuals were identified. The sightings had a maximum of nine and a minimum of seven animals. Photos of the animals' dorsal fin were taken in ten of the sightings, which were classified in three categories: bad, good, and excellent, and only the 158 pictures included in the last two categories were taken into account for photo-identification purposes. Eight of the killer whales were captured on film more than once during 1999 and 2000. The animals were observed during a total of 19 h. 11 min. The behaviours recorded were socialising - for 36 min. (3.1%), and feeding - for 18 h. 35 min. (96.9%). Killer whales were always observed in the presence of fishing boats, where the average abundance was 102 within a radius of 700-1000 m. Witnessed interactions consisted of either removing the fish from the drop line hooks or biting the captured fish.

DISCUSSION

The group of killer whales

The data reveal the presence of a stable group of at least eight individual killer whales in the "killer whale area", while the identification of a ninth needs confirmation. Although the trips were conducted only in a small part of the Strait of Gibraltar, killer whales were not sighted in the remaining part of the study area. Other areas such as the eastern and western part of the Strait and other seasons are not included in this work. The feeding behaviour observation, and the fact that no attack of killer whales upon other prey was observed, suggest that the main diet during the summer period should be red tuna.

Interactions with Fisheries

According to the records, when the fish is being lifted, the killer whales try to steal or bite it. This competition for the same resource (red tuna fish) is the main reason why so many interactions between killer whales and fisheries have been described in the region for a long time. At certain times, it seems that fishermen really dislike these killer whale attacks, and they can even throw stones over them, or try to scare them by riding the boat over them. On 26th July 2000, a sound like a shot being fired was recorded, but it was not possible to clarify if it was only to threaten the animals or to hurt them. Beside this, the fast development of the whale-watching platforms in the area (5 to 6 boats are expected in summer 2001) (Urquiola and de Stephanis, 2001), the presence of some research vessels (3 boats are expected in summer 2001), the interests for the mass media (local and international TV channels), and the local political problems regarding the fishing international agreements could create management problems between these sectors and the fishing community, and could interfere with this killer whale group.

CONCLUSIONS In the summers of 1999 and 2000, a group of eight animals at least regularly took advantage of the presence of a drop line fishery west to the Strait of Gibraltar, to obtain easy food by stealing hooked fishes. This group has probably specialised in this feeding strategy. Clear interactions between fishing boats and killer whales exist in the area during the summer. These interactions and the depletion of the red tuna stocks due to over-fishing is likely to result in negative impacts on both killer whales and fishermen in this area. Management procedures should be developed, to preserve killer whales and the interests of fishermen.

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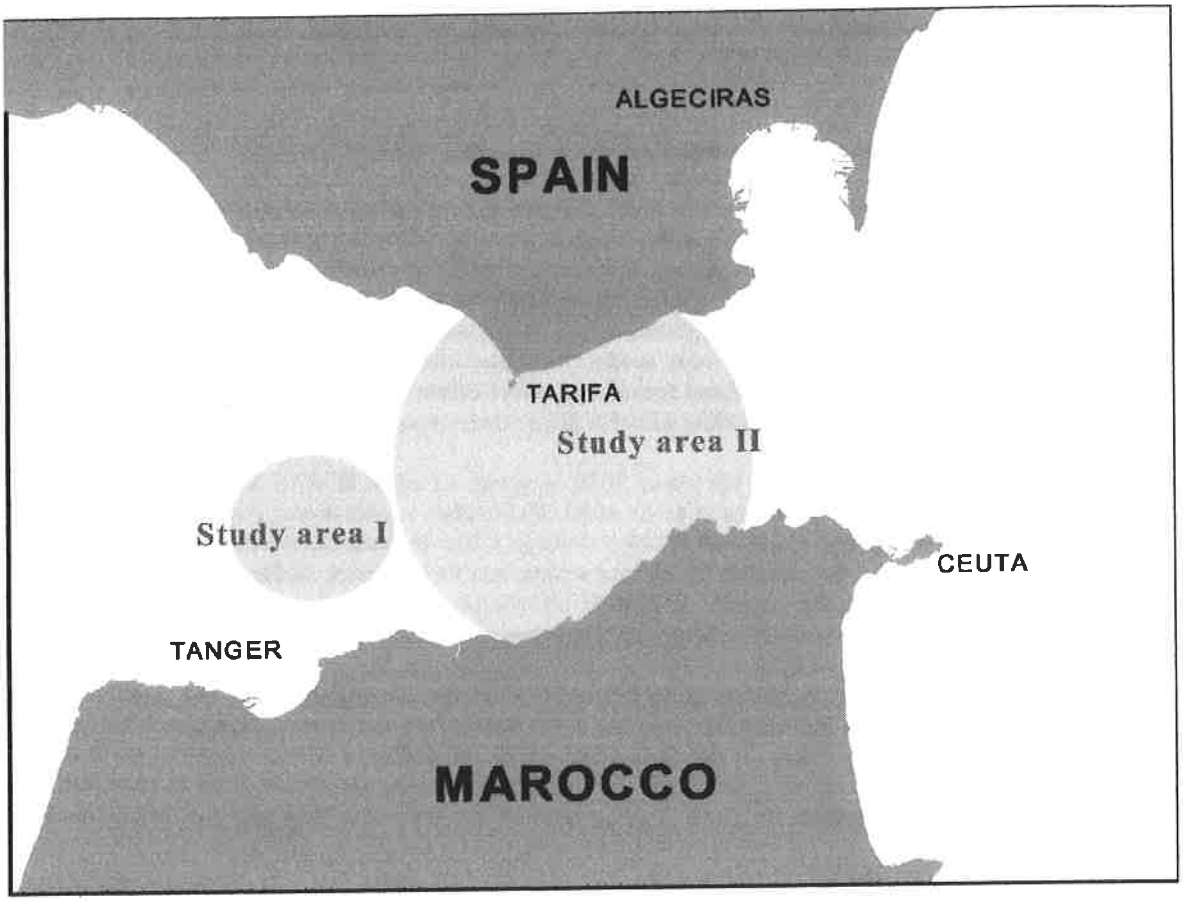

Fig.1 Study Area

BEHAVIOUR OF FREE-RANGING WHITE-BEAKED DOLPHINS IN ICELANDIC WATERS

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INTRODUCTION White-beaked dolphins, (*Lagenorhynchus albirostris*) are only found in North Atlantic waters and they can be observed close to shore in Icelandic waters.

The purpose of this study was to describe the daily behaviour of white-beaked dolphins.

MATERIALS AND METHODS The behaviour of white-beaked dolphins was studied from a whale-watching vessel from about 09:00 h to 24:00 h in 190 observation-periods during the summers of 1998, 1999, and 2000. The day was divided into "morning" (09.00-11.30), "noon" (11.30-13.30), "afternoon" (13.30-17.30), and "evening" (17.30-24.00). The study area was the south-eastern part of Iceland around Reykjanes Peninsula and mainly Faxaflói Bay (see Fig. 1).

Behaviour was categorised as resting or swimming slowly, travelling, feeding, and socialising. Dolphins swimming fast in one direction were categorised as travelling. Feeding dolphins were often showing surface activity. We observed fish on the fish-finder when passing an area with feeding dolphins. Group size was noted, as well as any correlation between behaviour and group size.

RESULTS A significant difference in behaviour during a day was found (chi^2, $p<0.05$). White-beaked dolphins fed throughout the day, but they were most likely seen travelling around noon. Socialising, which is characterised by a variety of jumps, was most prominent in late afternoon and evening (see Fig. 2).

White-beaked dolphins feed on sandeels, (*Ammodytes* sp.) during the summer months. Sandeels bury themselves at night and feed during the day. This correlates with the feeding behaviour of white-beaked dolphins during the day. A similar correlation is found for Atlantic white-sided dolphins, (*Lagenorhynchus acutus*) in the Great South Channel (Gowans and Whitehead, 1995).

Group size was also correlated with behaviour (see Fig. 3) and a significant difference was found (Kruskal Wallis, $p<0.05$). A small group size was observed when white-beaked dolphins were travelling (2-5 individuals); a larger group size when they were feeding (10-15 individuals); and finally the largest group size was observed when they were socialising (30–100 individuals).

Additionally, newborn calves were observed in May or early June. Mating was observed in late July and August.

DISCUSSION White-beaked dolphins exhibit a daily variation in behaviour, which also has been found for other species like the bottlenose dolphin (Shane, 1990). In that study, bottlenose dolphins fed in the morning and late afternoon; travelling was most common in the afternoon; and socialising was most common in the evening. A similar pattern was found for the behaviour of white-beaked dolphins (Fig. 2).

A larger group size was observed when white-beaked dolphins were socialising and a small group size, when they were travelling (Fig. 3). The same is found for the bottlenose dolphins (Shane, 1990).

CONCLUSIONS White-beaked dolphins show daily variations in their behaviour, travelling mostly at noon and socialising mostly in the afternoon. Group size was correlated with behaviour with the largest groups observed during socialising. Similar patterns of behaviour and group size have also been described for the bottlenose dolphin (Shane, 1990).

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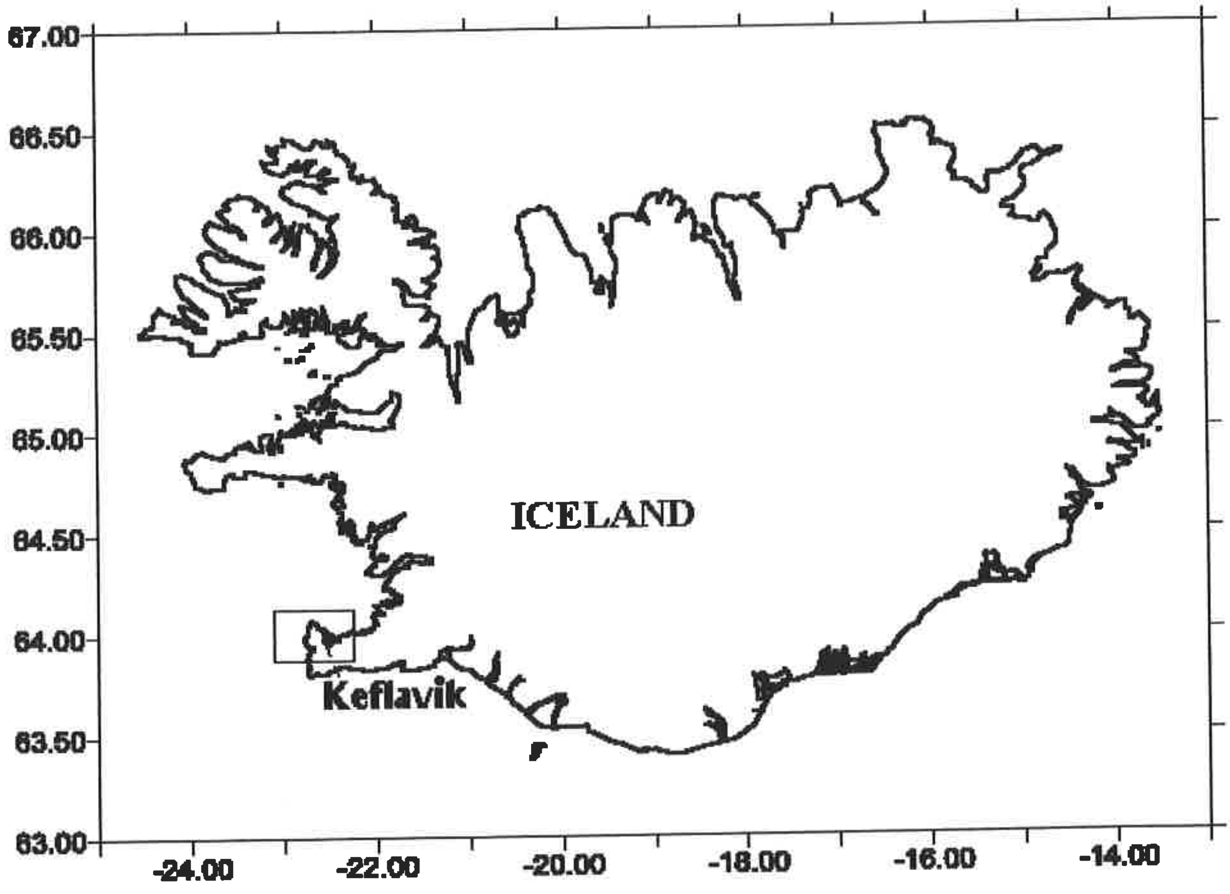

Fig. 1 Study Site near Keflavik in Iceland

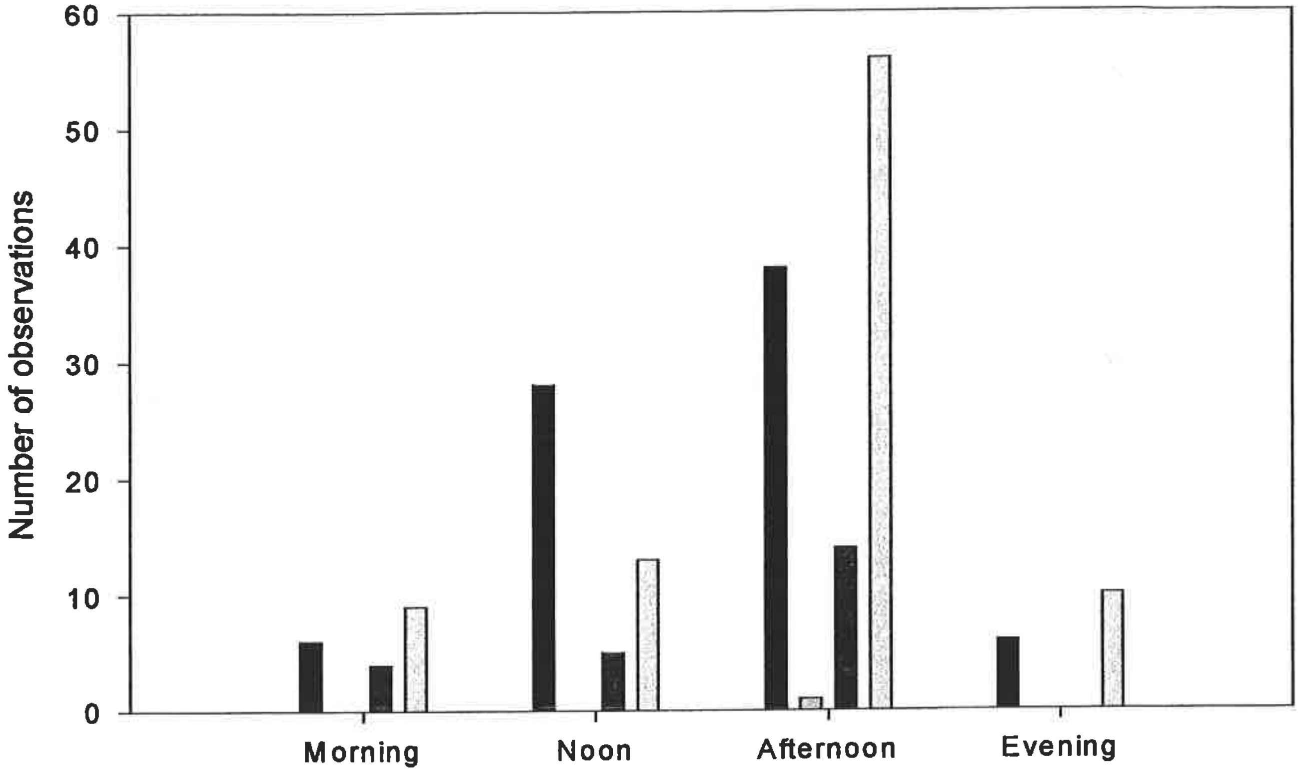

Fig. 2 Daily variation in behaviour

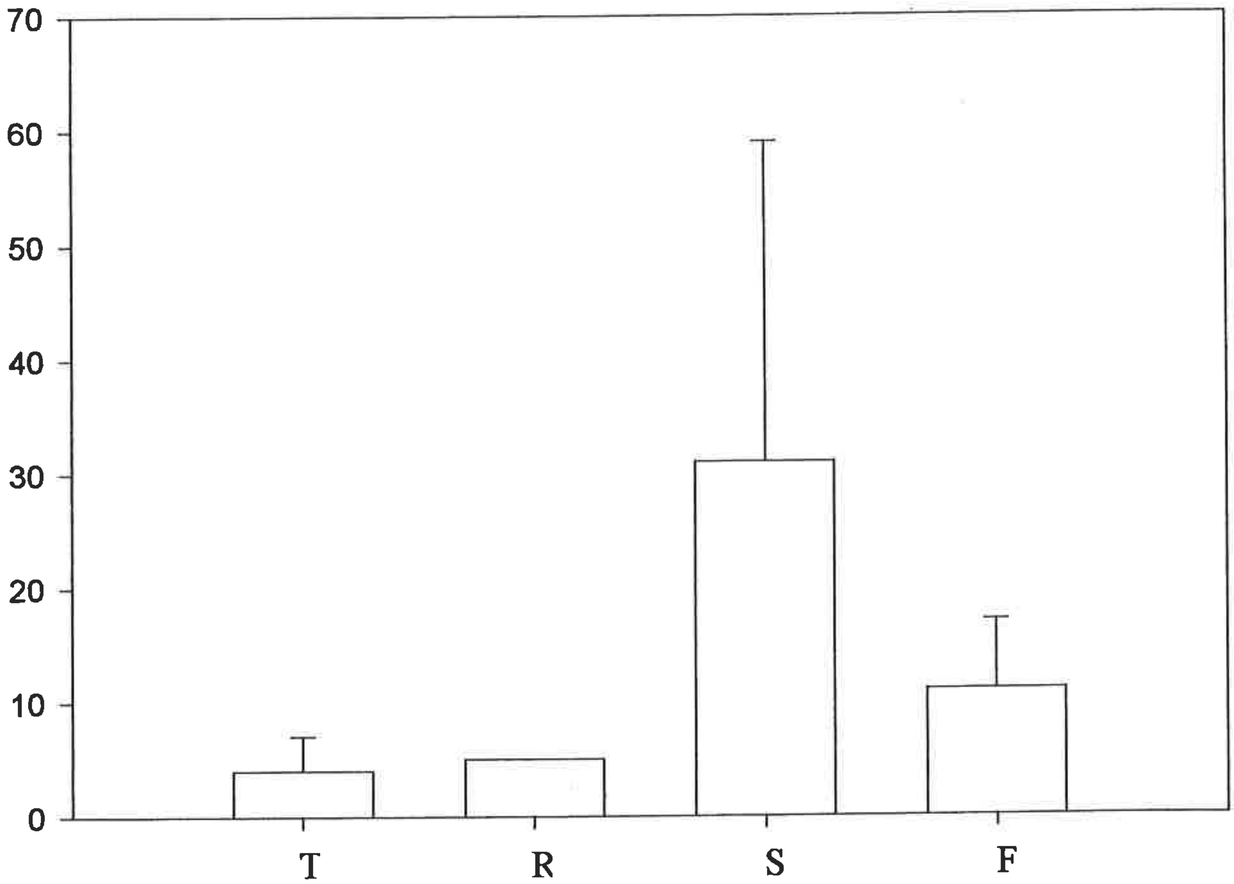

Fig. 3 Average group size in different behaviour categories
(T = travelling, R = resting, F = feeding, S = socializing,)

THE DEFINITION OF BEHAVIOURAL CATEGORIES IN MEDITERRANEAN FIN WHALES (*BALAENOPTERA PHYSALUS*) ON THE BASIS OF SWIMMING - SURFACING PARAMETERS

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INTRODUCTION The Corsican-Ligurian-Provençal Basin has been recently declared an International Marine Sanctuary for Cetaceans. For this reason, a better knowledge of every aspect of the biology and the behaviour of the marine mammals living in the Ligurian Sanctuary is the baseline for every conservation measure. It is well known that fin whales concentrate in this area during summer. The fin whale is the most common mysticete inhabiting the Mediterranean Sea. The population size, during the summer, is estimated at 3,500 individuals in the western region and many authors agree on the fact (see, for example, Relini *et al.*, 1992; Forcada *et al.*, 1995) that the Sanctuary is probably the primary feeding ground for the Mediterranean fin whales. Since these animals forage in the water column, their behaviour is inconspicuous to a surface-based observer. The aim of this study was to define, by means of a passive tracking technique, some behavioural categories on the basis of swimming-respiratory patterns.

MATERIALS AND METHODS Research cruises have been conducted during the summer period from 1995 to 2000 aboard a 18-m long sailing vessel. The study area stretched between the Western Ligurian coast and the North-Western Corsican coast. The PASSIVE TRACKING technique we adopted was based on the use of a laser range-finder (LEICA Vector DAES 1500 Laser Class I, 7x42), also equipped with a magnetic compass, and interfaced with a GPS (Lafortuna *et al.*, 1998). A dedicated software (Highwhale) has been used to link the boat position to the whale bearing and range, obtaining the real position of the whale and the track of the animal. The respiratory activity has been simultaneously determined using an event-recorder (Psion Organiser II) (Jahoda *et al.*, 1993). The software has been used also to calculate four variables relating to respiration, five to the dive cycle, and six to locomotion. Multivariate statistics - Principal Component Analysis (PCA) and Correspondence Analysis (CA), have been used respectively for the selection of variables and categorisation of behaviours.

RESULTS Thirty-four samples have been collected from 1995 to 2000, for a total of 34 h 35 min. of observation. We considered only "undisturbed" whales, i.e. no other boat was present during the behavioural sampling and our boat remained still or slow moving at a distance of about 100-150 m from the animals. The breathing activity of a whale is characterised by a prolonged underwater period (Dive) followed by a surface phase (Surfacing). The "log-survivorship" function (Fagen and Young, 1978) has been used to distinguish these two phases; with such a method, a cut-off value of 26 secs was found, so we defined as a Dive a blow interval exceeding 26 sec., whilst Surfacing was the sum of blow intervals not exceeding this value. The PCA (Principal Component Analysis) (Fig.1) has been used to reduce the set of swimming-respiratory parameters employed in the statistical classification of behavioural activities. Parameters selected by means of PCA were Dive Time, Surface Time, Surface velocity and Diagonal of the covered area. Dive Time and Surface Time were respectively the means of the dive and surface phases; Surface velocity was the whale speed during the surface phase; Diagonal was the length of the diagonal of the area covered from the whale during the sampling period, normalised for the duration of the observation.

The formula used for the calculation of the Diagonal parameter is:

Diagonal: $\text{Sqr}((\text{max lat.} - \text{min lat.})^2 + (\text{max long.} - \text{min long.})^2)/\text{TF}$

TF= sampling duration (sec)

The CA (Correspondence Analysis) (Fig. 2) was used to outline homogeneous groups of samples with similar characteristics. Groups resulting from the CA were associated to different behavioural categories such as: 1- DIVE, 2- TRAVEL, 3- DIVE-TRAVEL and 4- MILLING-REST. Fig. 3 shows the mean values per behavioural category normalised by the global mean. From such a histogram, the differences among categories appear evident. In fact, DIVE is characterised by dive duration significantly higher than the other categories (ANOVA: $F=4.76$; $p<0.05$); TRAVEL presents higher values (ANOVA: $F=4.76$; $p<0.01$) for the Diagonal; DIVE-TRAVEL is in between the first two categories, and MILLING-REST has significantly higher Surfacing values (ANOVA: $F=3.74$; $p<0.05$). Diving data collected by a v-TDR have been coupled, where possible, with the passive tracking data, allowing a 3D representation of the fin whale's movements. Three paired samples were available. TDR data confirmed the CA behavioural categorisation. An example of the 3D graph is presented in Fig. 4; in this case, the TDR-profile confirms the DIVE category assumption.

CONCLUSIONS On the basis of passive tracking four behavioral categories have been defined: a DIVE category, associated to a feeding activity; a DIVE-TRAVEL, a half-way between DIVE and TRAVEL, possibly related to a foraging; a TRAVEL and a MILLING-REST categories, whose interpretations are intuitive. Our results allowed to define a preliminary Time Budget of Ligurian fin whales during the summer season: 41% of the time is dedicated to foraging (DIVE-TRAVEL); 32% to feeding (DIVE); 21% to a MILLING-REST; 6% to TRAVEL (Fig. 5). This evidence highlights the need for protective measures against the potential disturbance sources in the Ligurian Sanctuary where these animals have probably their most important feeding ground.

ACKNOWLEDGEMENTS This study would have not been possible without the help of many people. We would like to thank all the volunteers who helped in the field. We thank especially Eletta Revelli, Simone Panigada, and Margherita Zanardelli for TDR data. Many thanks to our skipper Ignazio Cavarretta, to Leica Vector, and to Portosole, Sanremo, Italy, for support and hospitality.

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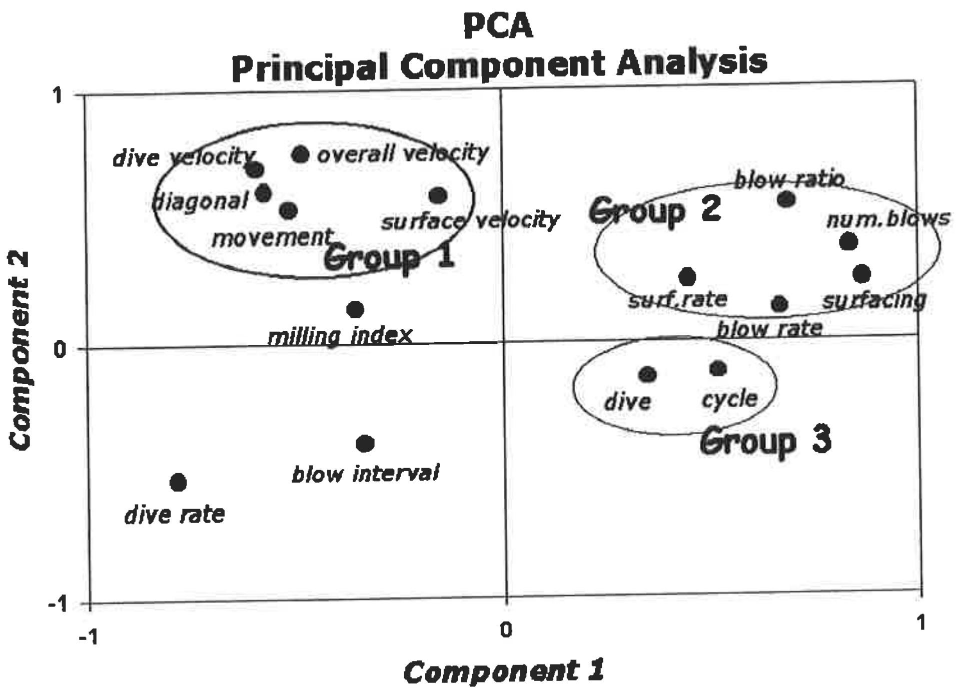

Fig. 1. Principal Component Analysis

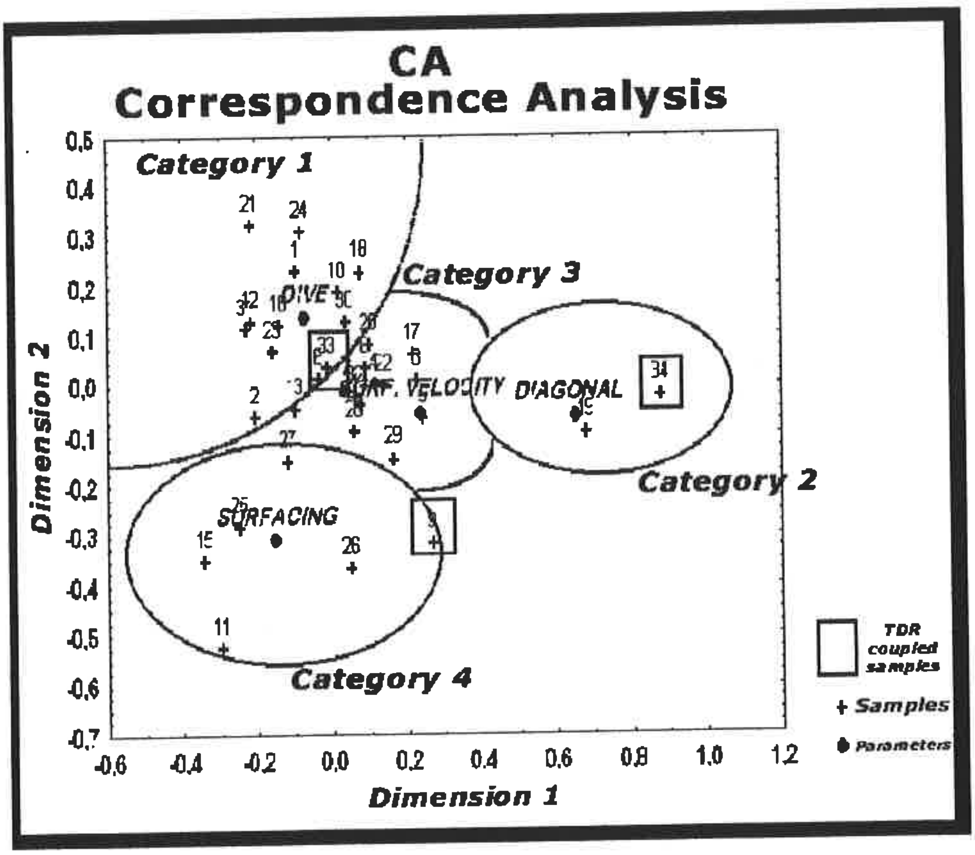

Fig. 2. Correspondence Analysis

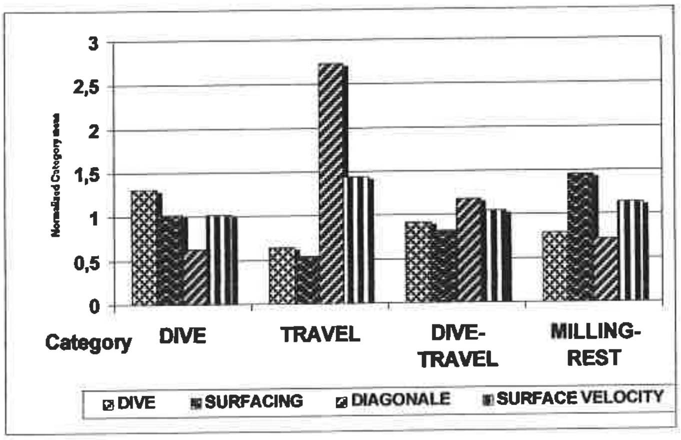

Fig. 3. Mean values per behavioural category

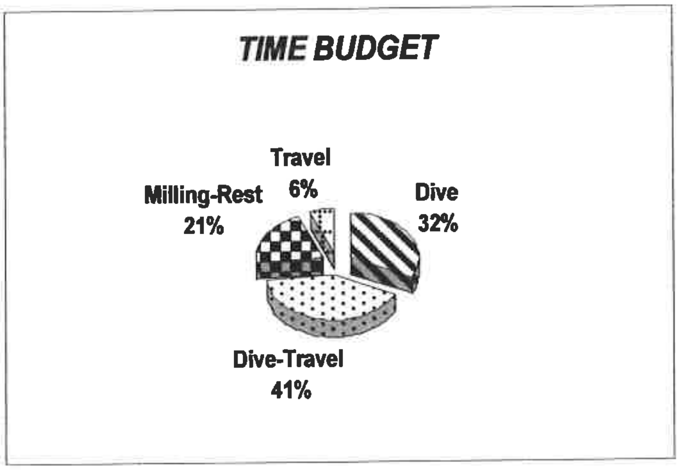

Fig. 4. Time budget

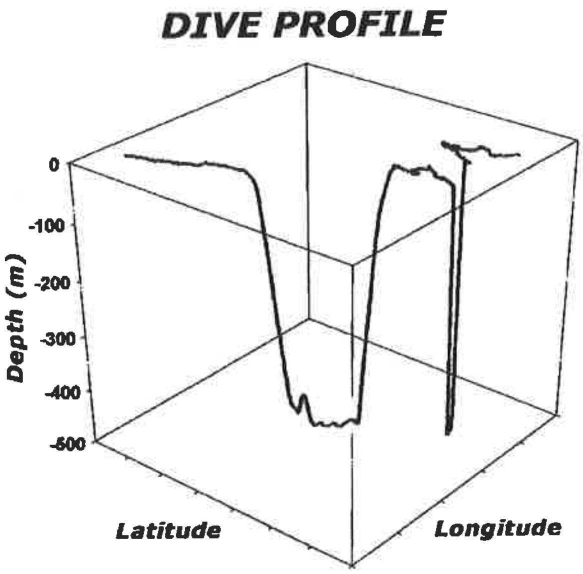

Fig. 5. Profile of a whale dive

EFFECTS OF DISTURBANCE ON DAILY RHYTHM AND HAUL-OUT BEHAVIOUR IN HARBOUR SEALS (*PHOCA VITULINA*) IN THE TIDAL ESTUARY OF DOLLARD

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INTRODUCTION This research has been done for the Seal Rehabilitation and Research Centre of Pieterburen. The seal population of Dollard was chosen because a high percentage of seals under one week of age and even premature ones with very low weight being observed at the Seal Rehabilitation & Research Centre Pieterburen came from this population.

Seal pups in difficulties recovered from the Dollard represent 4.8% of the population, while ones coming from other localities do not exceed 1.4% (Table 1).

The average weight of the pup seals coming from the Dollard was 8.9 kg while the average weight of all the pups received at the S.R.R.C. was 10.1 kg (Table 2). This suggests that in the Dollard population, there were more young seals abandoned by their mothers than in other areas, and that nutrition for those animals was scarce.

In this study, we analyse the responsibility of disturbance caused by coastal navigation on a breeding colony of common seals (*Phoca vitulina*).

METHODS AND STUDY AREA Dollard is the tidal estuary of the Ems River on the boundary between Germany and the Netherlands. When this study was made, c. 100 common seals (*Phoca vitulina*) were counted by plane in the Dollard area. The study area is a protected zone where sailing is not allowed from 15th May to 1st September, except for local fishing boats, the Coastguard, the Rijkswaterstaat boats, and the Agriculture, Nature Management and Fishery Ministry boats. This study has been made by the direct observation of seals on the sandbanks, and the seals were not marked for this research. We never disturbed the seals to obtain information, but we recorded all forms of disturbance.

The area was completely submerged during high tide, while the sandbanks emerged for about 8-9 hours per low tide period. Observations took place during low tide periods, from five hours before until three hours after high tide, but only during daylight. Observations took place between 5th August and 21st September, 1993. From the observation point, three sandbanks were visible, on which we identified seven haul-out sites marked with letters of the alphabet (see Fig.1).

RESULTS **Seal frequency on the sandbanks.** The average daily peak of seal numbers was 59 at the end of the nursing period and the beginning of the mating season. This was followed by a slow and gradual decrease in seal number on the sandbanks, with an average of 32 individuals in September (Fig. 2).

At site A, there were seals every day and pups were born. On this site there was a larger number of seals of all age classes. At sites C/D, there were seals of almost the same size, and a pup was seen only once on 23rd September.

When the sandbank was completely underwater, the group did not abandon the area immediately but swam around the submerged sandbank.

The average number of seals during low tide periods without disturbance was almost constant (Fig. 3), peaking 2-3 hours after low tide, while, when disturbance occurred, it decreased soon after low tide (i.e. when the boats entered the area).

The relationship between numbers of seals observed and daylight hours is shown in Fig. 4, in which we noted a constant increase in the numbers of seals hauling out from an average of 40 individuals at 06:00 h to about 60 at 20:30 h.

Movements. All the seals hauled out at A rested during the entire period of low tide. On the other hand, the seals hauled out at C or D did not spend the entire low tide period in those sites. During the central part of low tide, those seals moved towards the external part of the area (E) and returned before high tide. Seals hauled out at F and G only during times of disturbance.

Disturbance. We considered fishing boat disturbance, because other kinds of boat were not allowed to enter the study area. Fishing boat disturbance was quite frequent (one on three low tide periods) and homogeneous (same size of boat and same activities).

The seals could hear the fishing boats already at a distance of almost 1 km, when the boats had just entered the protected area. This distance might change depending on the direction of the wind and the biological period of the seals. Soon after the seals noticed the boat, they were more alert but without moving until the boat reached a distance of about 20 metres, when the seals moved towards the water, entering it when the boat approached the haul-out site.

The percentage of seals leaving the sand bank because of a boat decreased from about 100% in August to 50% in September. In August, 75%, of the seals leaving the sand bank, did not return at all during the same low tide period, while in September, almost all the seals that escaped into the water, hauled out soon after the boat had passed (Fig. 5).

Female seals appeared to be more sensitive than large males, whilst the pups persisted in following the females into the water even after weaning.

DISCUSSION AND CONCLUSIONS During the summer, common seal (*Phoca vitulina*) haul out in the study area every day during low tide. The majority of seals frequent site A. Sites C and D apparently showed age segregation, in accordance with the findings of Kovacs *et al.* (1990).

The seals which hauled out at site A spent all the low tide period on the same sandbank, while those which hauled out at C or D made cyclic movements with the flood tide, from the interior site to the outer one and then back again. These movements always took place in the same direction as the stream. A peak in the number of seals at each low tide period occurred towards its end.

The average number of hauled-out seals in the various daylight hours shows a maximum in the evening, as was found by many authors (Kovacs *et al.*, 1990; Stewart, 1984). In particular, Walker and Bowen (1993) noticed an increase of 48% in the evening, whilst in this study, the equivalent increase was 33%.

We consider as disturbance occasions when the seals simultaneously enter the water. According to Brader (1975), more than half of the observed cases of disturbance caused by fishing boats were strong ones, and Doornbos (1980) considered boats to be the major cause of moderate and strong disturbance; in our study, it varies from moderate to strong according to the time of the year.

We confirmed that females more readily moved after disturbance than large males, as Newby (1973), Van Wieren (1981), and Doornbos (1980).

We agree with Van Wieren (1981) that strong disturbance can have direct negative effects on weaning of pups, with the possibility for a mother to lose her pup before it is weaned, and indirectly with interference in lactation and consequent under-feeding.

Seals remain on the sand bank for about eight hours every low tide period, of which about five hours is before the tide turns, and three hours after it. Common seal pups are unable to suckle in the water until they are 8-14 days old (Wipper 1975), so the longer they can stay on dry land, the longer they can suckle. Boats entering the area soon after low tide cause the seals to escape into the water, and the pups to lose three hours on the bank out of the eight every time they are disturbed. The disturbance occurred once every three low tide periods, which means about one hour every low tide period, or 12.5% of the time necessary for suckling.

We conclude that disturbance has greater consequences during the suckling period. Under-feeding of young seals seems not to depend on shortage of food in this area, but on shortness of lactation due to boat disturbance. An underfed pup cannot develop a fat layer and will get into a poorer condition and thus can be exposed to disease. Seals need undisturbed places where they can haul out and suckle their pups in order to keep the populations healthy.

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	Provenience	
1	Ameland	0,16%
2	Schiermonnikoog	0,22%
3	Rottumeroog - Rottumerplaat	1,18%
4	Eemshaven	1,44%
5	**Dollard**	**4,83%**

Table 1. Percent of pups recovered at SRRC in relation with each population size coming from 5 areas along the Dutch coasts.

	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	
Ameland	12.25	8.7	13	11.5	10.65	-	10	9.6	11.5	**10.9**
Schiermon.	7.2	9.8	10.66	10.15	10.35	8.6	11.6	9.9	-	**9.8**
R'plaat	12.25	11.25	11.27	9	10.5	9.3	9	10.4	12.07	**10.6**
Eemshaven	-	8.1	12.82	9.2	9.87	10.05	-	12	9.9	**10.3**
Dollard	8.3	9.3	-	8	-	8.4	10.4	9.4	8.8	**8.9**

Table 2. Weight and averages of pups (younger than one week) recovered at SRRC coming from 5 areas along the Dutch coasts from 1990 till 1998.

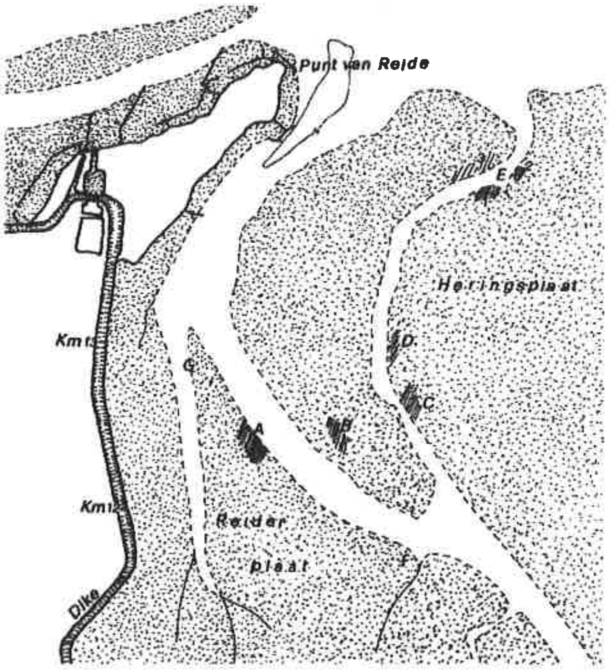

Figure 1. the study area with haulout sites

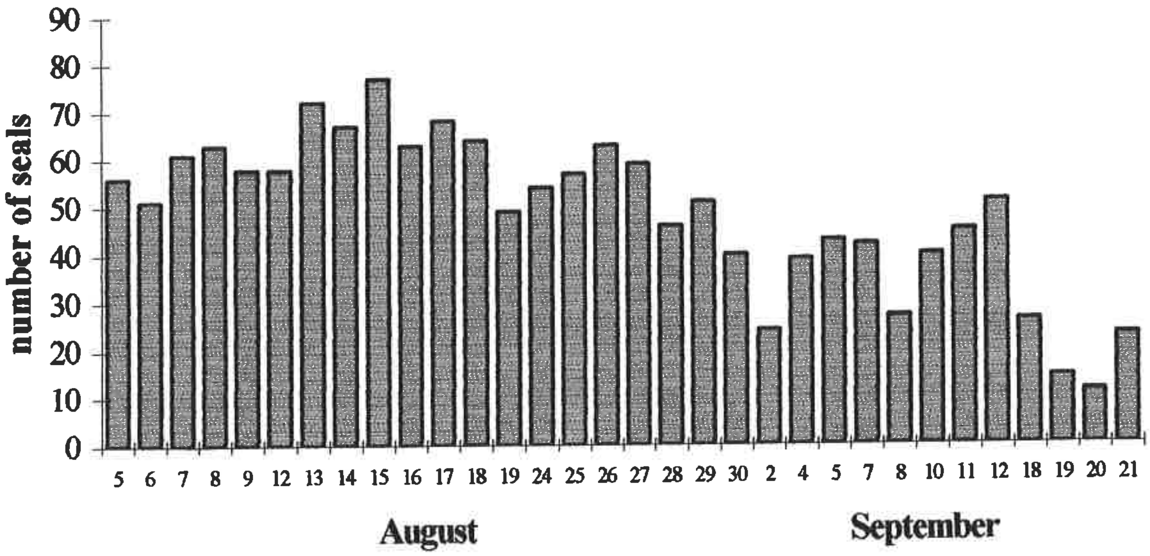

Figure 2 Hauled out seals for each day during the whole observation period

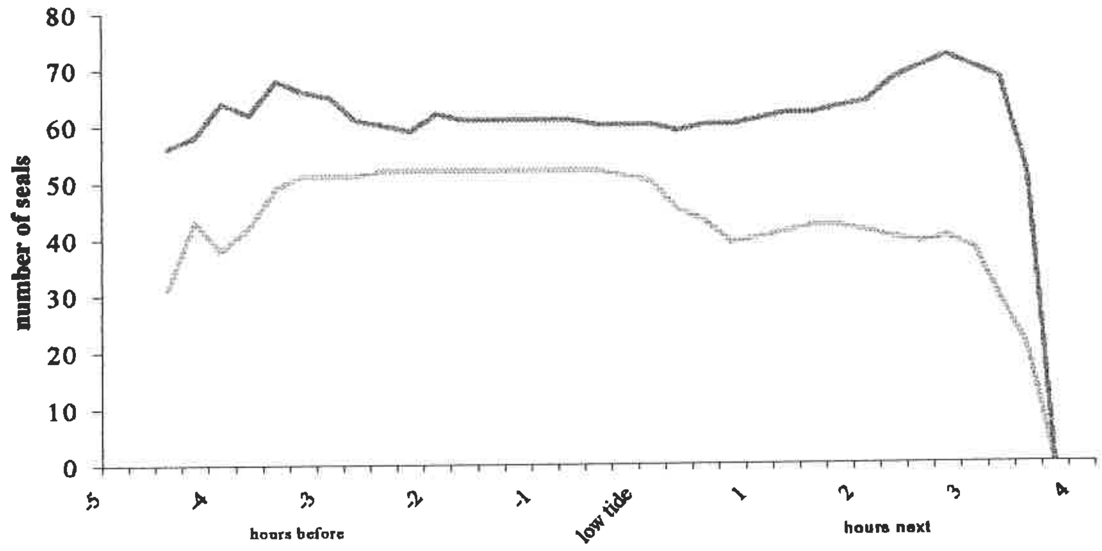

Figure 3 Grey: average number of seals in relationship to the hours before and next low tide of periods without disturbance; Light gray: average number of seals of all periods

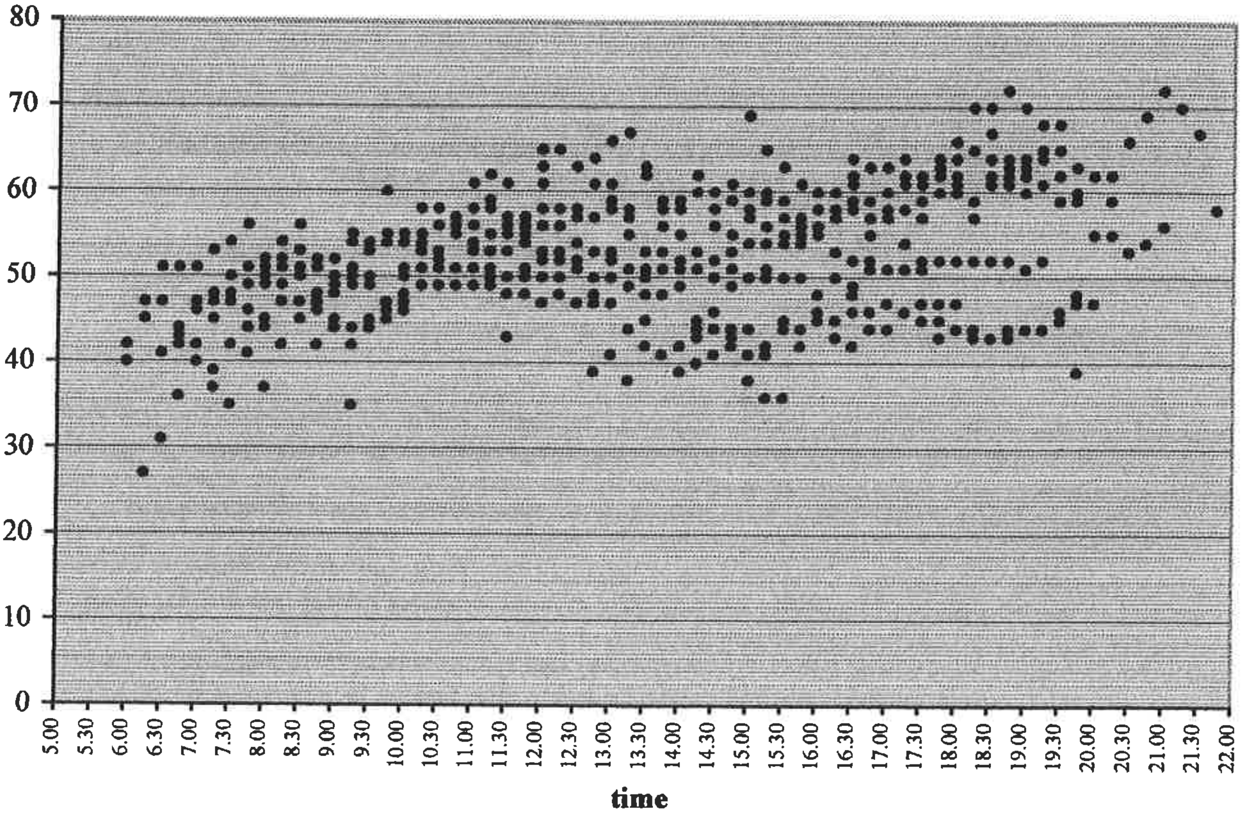

Figure 4 Distribution of the number of hauled out seals on daylight hours

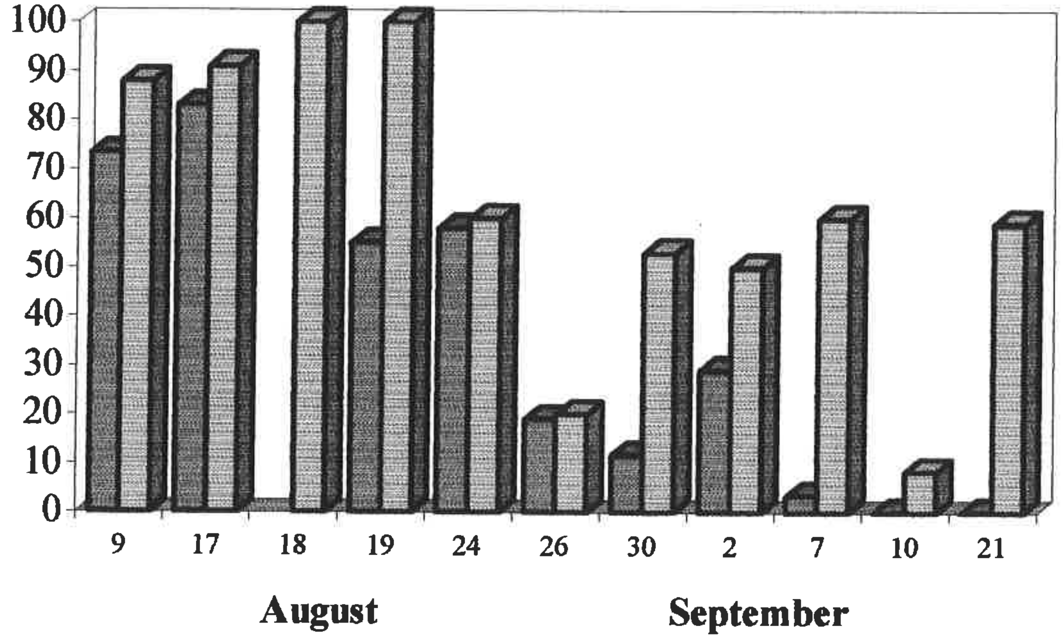

Figure 5 Light gray: percent of seals which enter the water in case of disturbance; Gray: percent of seals which do not return on the sandbank after disturbance

SATELLITE- AND RADIO-TRACKING STUDY OF MOVEMENTS OF KILLER WHALES IN THE WINTERING GROUNDS OF HERRING IN NORWAY

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Two young female killer whales (*Orcinus orca*) were equipped with satellite linked time-depth recorders and VHF tags in early December 2000 in the wintering grounds of Norwegian spring spawning herring (*Clupea harengus*). The aim of the project is to study home range, seasonal movements and diving behaviour of killer whales, focusing on interactions between herring and killer whales. This presentation describes the results from December-January.

Before tagging, the whales were captured using the method developed for live-capture of killer whales in Iceland. Whale 1 belongs to the NC-pod, which has been regularly sighted in the wintering grounds since 1983. Whale 2 belongs to the NY14 pod, which has been sighted only five times. Position data was received from whale 1 for a 50-day period and from whale 2 for a 21-day period. However, diving data continued to be transmitted, indicating that the tags were still attached. Both whales were VHF tracked a month after tagging to ensure that the tags were attached properly and the behaviour of the whales normal.

Photo-identification studies had indicated that killer whales were stationary in the wintering grounds of herring from October to January. However, the satellite tracking data shows that both pods undertook extensive migrations to and from the area in December. The longest migration was performed by whale 1 which moved 700 km south of the wintering grounds where she stayed for a minimum of three days before returning. The herring stock remained in the wintering area until mid-January when the southward spawning migration commenced. Whale 1 was moving out of the fjord at this time. The study is the first one to use satellite tags in studying killer whales and the results show that this method can bring significant insight into our knowledge of their area use and home range.

PREGNANCY IN BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*): BEHAVIOURAL AND RESPIRATORY ASPECTS

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INTRODUCTION Since 1995, a behavioural research programme on pregnancy and mother-calf relationships in bottlenose dolphins has been conducted in the Rimini Dolphinarium, Italy.

Given that detailed quantitative behavioural aspects of gestation and parturition in dolphins have been rarely described in reproductive reports, the objective of this study was to systematically investigate behavioural patterns and respiratory activity during the last quarter of pregnancy, in order to assess specific trends while approaching parturition.

METHODS Subject of the study was "BETA", a pregnant female bottlenose dolphin (*Tursiops truncatus*), 16 years old, who gave birth to her first calf in the Rimini Dolphinarium on June 26th, 1997. She was housed in the same pool with two other wild adults (a male and a female), and two captive-born calves (a male and a female).

A specific ethogram including 52 different displays organised into five main categories (Locomotion & Postural, Social, Play, Aerial Behaviour, and Bubbles) was first set up and then used for the data collection. Focal animal (Altmann, 1974) sessions lasting 30 minutes were carried out to systematically monitor the patterns during the last quarter of gestation. Total and weekly frequency and duration were scored by means of a video camera and Observer 3.0 software. Respiratory rates ["Dive times" and "Roll intervals" as defined by Watson and Gaskin (1983)] were also collected during dedicated sessions lasting 15 minutes each. Both behavioural and respiratory observations were randomised among 3-hr periods and balanced for equal representation within a week and at different times of the day (observational phase: from 08:00 h to 20:00 h). Data were analysed by mixed-model factorial ANOVA.

RESULTS AND DISCUSSION A total number of 92 h of behavioural observations (corresponding to 184 sessions) and 24 h of respiratory monitoring activity (corresponding to 96 sessions) were performed over the study period.

"Locomotion & Postural" patterns were the most common activities seen, both in frequency (81.6%) and duration (97.3%) (Fig. 1). "Social" displays were also well represented (frequency=10.7%; duration=2.5%) as well as "Bubbles" (frequency=6.6%). As for weekly trends in behavioural categories (Fig. 2), significant variation within "Social" ($F=3,10$; $df=11$; $p<0.0001$) and "Bubbles" ($F=2,80$; $df=11$; $p<0.0057$) groups were seen, both showing a steady decline during the last four weeks of pregnancy. According to McBride and Kriztler (1951), this result could be related to the tendency of the pregnant female to withdraw from associating with other animals as birth approaches.

The total frequency and duration of behavioural displays are presented in Table 1. Among "Locomotion & Postural" category, "normal swim" display was strongly exhibited by the subject (total duration >70%) as a possible result of her segregation during the last four weeks of pregnancy (see Fig. 1). However, the isolation showed by BETA did not exclude the manifestation of some remarkable "Social" displays such as "contact", "chase" and "body slam". As reported by Kinoshita *et al.* (1999) and Joseph *et al.* (1999), these behavioural aspects are typically displayed in nervousness and discomfort contexts related to gestation. Furthermore, the last week of pregnancy was characterised by an expected and impressive increase of "flexion" and "ventral arch", confirming both the stressed state of the female and the approach of parturition (Tavolga and Essapian, 1957; Krames and Krames, 1996). Finally, as already reported by Kinoshita *et al.* (1999), our data confirmed that aerial behaviours such as "breaching" were clearly related to birth given its peak frequency a few days before parturition.

As for weekly trends in respiratory activity (Fig. 3), the subject showed clear changes in respiratory rates ($F=1,70$; $df=9$; $p<0.0001$), with plateau values increasing from 26-28 secs up to 33-35 secs during the last three weeks before birth. This result seems to be similar to what described by Joseph *et al.* (1999), even if they only reported a general quantity of "irregular breathing" related to parturition.

The high mean values exhibited during the last three weeks before parturition appeared to be connected with the slow "normal swim" activity seen. In fact, the female appears to conserve energy in her movements in order to maintain both cardiac and respiratory rhythms similar to the levels recorded during rest (see Williams *et al.*, 1992 for details).

CONCLUSIONS It is well known that the great majority of bottlenose dolphin pregnancies fail to produce a live calf (Van Bonn, 1999). Moreover, since captive studies on pregnancy appear to be mainly focused upon both physiological and veterinarian reports, a better understanding of the behavioural aspects of gestation - as those described in this study - could possibly benefit from a multidisciplinary approach addressed to find out the highest risks of loss of births.

Finally, learning about specific periods of the pregnancy could improve our knowledge on the reproductive behaviour of dolphin females, as well as mother-calf interactions, which are crucial to develop useful models of social evolution, socio-ecology, social behaviour, or population dynamics (Whitehead and Mann, 2000).

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Table 1. Behavioural Displays - Total Frequency and Duration

DEFINITION AND REFERENCE	FREQUENCY		DURATION	
	% total ethogram	% intra-category	% total ethogram	% intra-category
LOCOMOTION & POSTURAL	***81.6%***	***100%***	***97.3%***	***100%***
Swim normal posture (Renjun *et al.*, 1994)	32.2	39.5	72.7	74.8
Swim open mouth (Martinez and Klinghammer, 1995)	8.1	9.9	-	-
Pool rub (Herzing, 1996)	7.4	9.1	4.2	4.3
Rest (Renjun *et al.*, 1994)	6.3	7.7	5.4	5.6
Swim side (Nelson and Lien, 1994)	5.3	6.5	2.4	2.5
Exploratory behaviour (Herzing, 1996)	3.8	4.7	2.5	2.6
Swim random (Sobel *et al.*, 1994)	3.1	3.8	4.2	4.3
Porthole stand (Tizzi, 1995)	2.3	2.8	2.4	2.4
Swim belly-up (Shane, 1990)	1.8	2.2	1.4	1.4
Shaking flipper (von Streit and von Fersen, 1996)	1.5	1.8	-	-
Roll (Renjun, 1994)	1.4	1.7	-	-
Lying (Herzing, 1996)	1.4	1.7	1.3	1.3
Approach (Herzing, 1996)	1.4	1.7	-	-
Somersault (Anonymous at Monkey Mia, Australia 1995)	1.2	1.5	-	-
Vertical stand (Herzing, 1996)	1.1	1.3	0.8	0.8
Flex (Tavolga and Essapian, 1957)	0.8	0.9	-	-
Loop (Martinez and Klinghammer, 1995)	0.7	0.8	-	-
Ventral arch (von Streit and von Fersen, 1996)	0.7	0.8	-	-
Head jerk (Herzing, 1996)	0.6	0.8	-	-
Spy hop (Shane, 1990)	0.4	0.6	-	-
Dorsal arch (von Streit and von Fersen, 1996)	0.1	0.2	-	-
Stop (Anonymous at Monkey Mia, Australia 1995)	0	0	-	-
Jerk (Nelson and Lien, 1994)	0	0	-	-
Fluke out (Norris *et al.*, 1994)	0	0	-	-
SOCIAL	***10.7%***	***100%***	***2.5%***	***100%***
Contact (Nelson and Lien, 1994)	4.7	43.9	-	-
Chase (Saayman *et al.*, 1973)	1.2	11.3	1.0	41.6
Body slam (Anonymous at Monkey Mia, Australia 1995)	1.2	11.3	-	-
Rubbing (Tavolga and Essapian, 1957)	1.0	9.3	-	-
Tail hit (Anonymous at Monkey Mia, Australia 1995)	0.7	6.5	-	-
Bonding (Anonymous at Monkey Mia, Australia 1995)	0.7	6.5	1.1	42.5
Rostrum hit (Anonymous at Monkey Mia, Australia 1995)	0.2	1.9	-	-
Push (Pilleri, 1986)	0.2	1.9	0.2	9.8
Directed open mouth (Herzing, 1996)	0.2	1.9	0.2	6.1
Bite (Saayman *et al.*, 1973)	0.2	1.9	-	-
Tail slap (Shane, 1990)	0.1	0.9	-	-
Nibbling (von Streit and von Fersen, 1996)	0.1	0.9	-	-
Jaw clap (Tavolga and Essapian, 1957)	0.1	0.9	-	-
Squeeze (Anonymous at Monkey Mia, Australia 1995)	0.1	0.9	-	-
Flipper slap (Shane, 1990)	0	0	-	-
Belly presentation (Saayman *et al.*, 1973)	0	0	-	-
Homosexual behavior (Renjun, 1994)	0	0	0	0
Attempting mate (Anonymous at Monkey Mia, Australia 1995)	0	0	0	0
PLAY	***0.2%***	***100%***	***0.2%***	***100%***
Play with objects (Renjun, 1994)	0.2%	100%	0.2%	100%
AERIAL BEHAVIOUR	***0.9%***	***100%***	-	-
Breacking (Pilleri, 1986)	0.5	55.6	-	-
Leap (Shane, 1990)	0.3	33.3	-	-
Slap (Martinez and Klinghammer, 1995)	0.1	11.1	-	-
BUBBLES	***6.6%***	***100%***	***0%***	***100%***
Bubble (von Streit and von Fersen, 1996)	4.0	60.7	-	-
Bubble stream (Anonymous at Monkey Mia, Australia 1995)	2.1	31.8	-	-
Torus (Herzing, 1996)	0.5	7.6	-	-
Bubble interest (Pace, 2000)	0	0	0	0
Bubble contact (Pace, 2000)	0	0	0	0
Tail-made bubble ring (Pace, 2000)	0	0	-	-

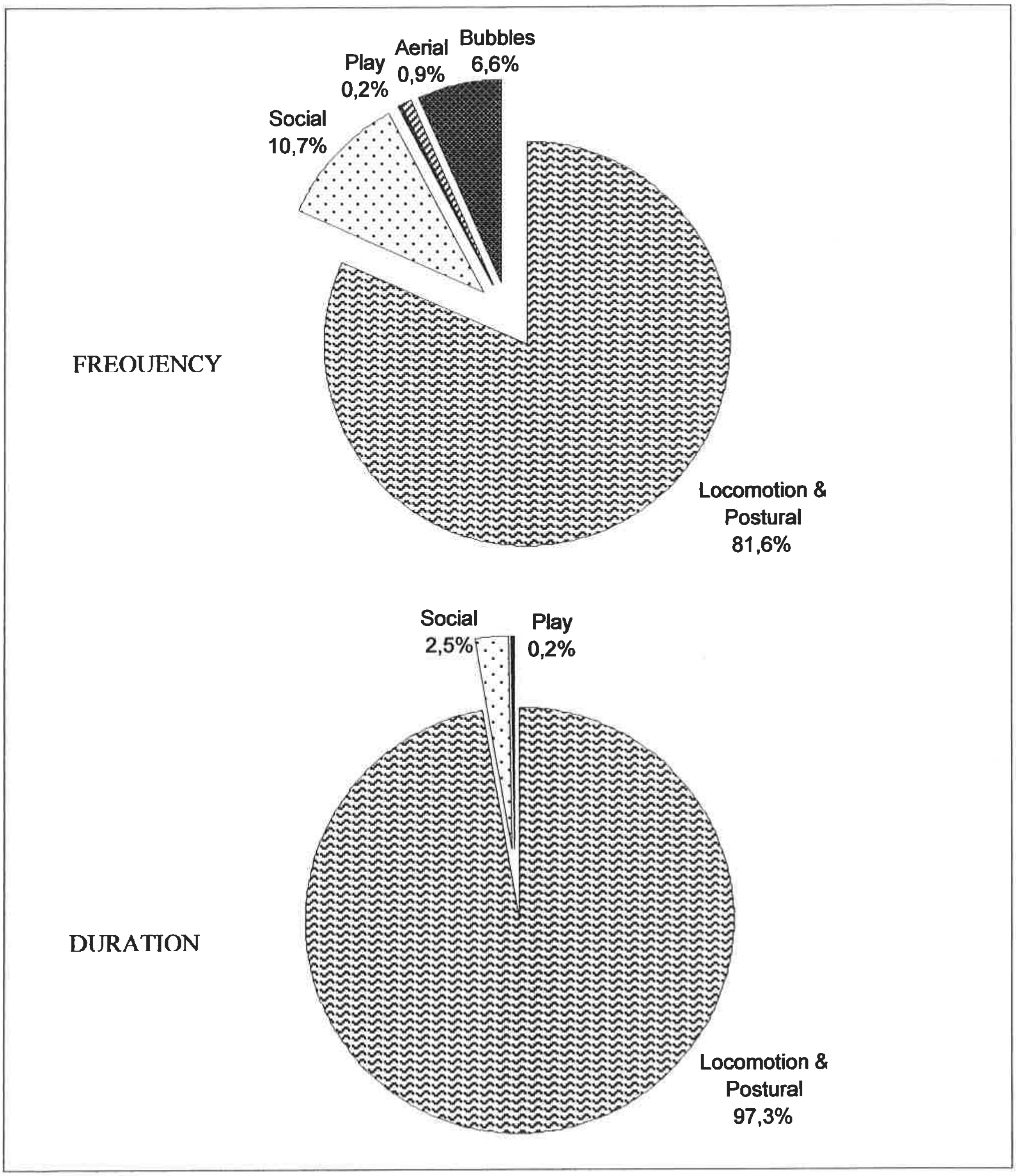

Fig. 1. Behavioural Categories Distribution (Total Frequency and Duration)

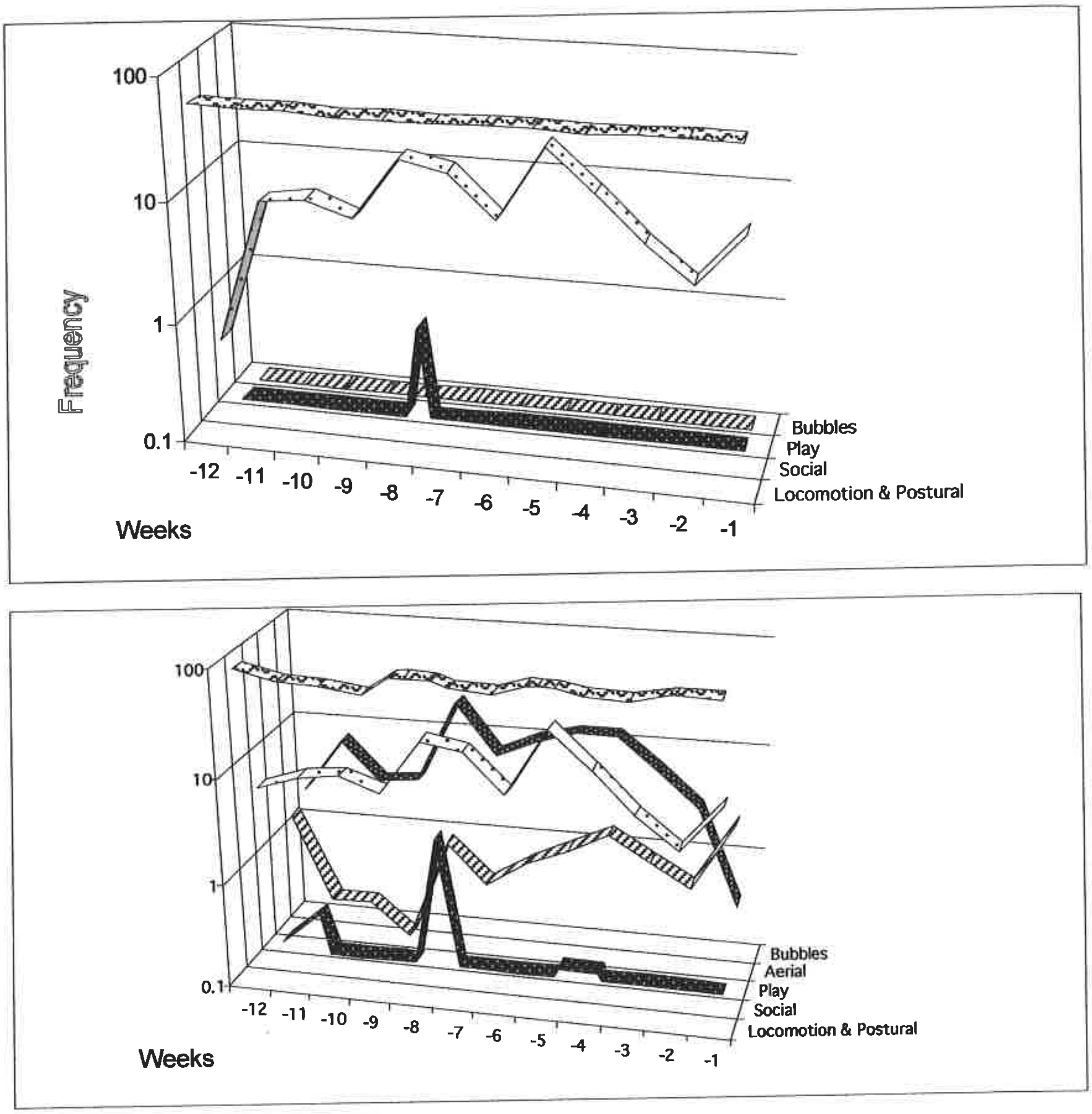

Fig. 2. Behavioural Categories Weekly Trend (Hourly Frequency and Duration)

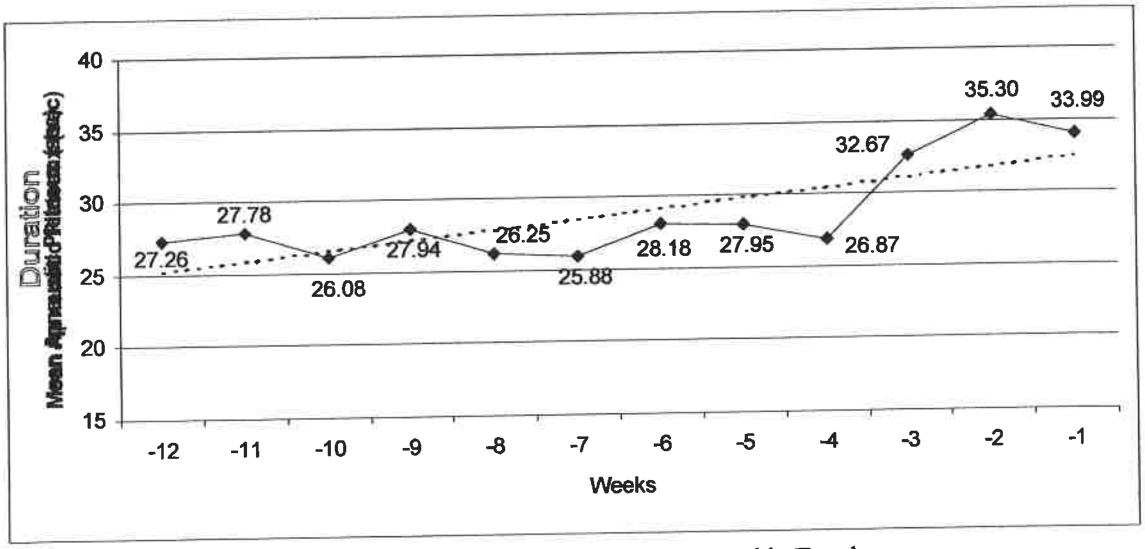

Fig. 3. Respiratory Activity Weekly Trend

A CASE OF OPPORTUNISTIC FEEDING: BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS*, INTERFERENCE WITH THE EUROPEAN ANCHOVY, *ENGRAUILIS ENCRASICOLUS*, FISHING IN THE GULF OF CATANIA (IONIAN SEA)

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INTRODUCTION The interference of dolphins to fishing is a serious problem, not only to safeguard the dolphins but also for the damage that they do to fishing-nets. Several times in the Gulf of Catania, fishermen were observed using hand–made bombs to drive away bottlenose dolphins from typical small gillnets called "menaide". The bottlenose dolphins take advantage of this artisanal fishery to feed on anchovies and, in the process, cause damage the fishing-nets.

This gillnet type is used to fish for sardine, anchovies, mackerel, bogues, etc., and it has different type of mesh to catch a particular type of fish. Its shape is rectangular with a length of c. 360 m. and a height of c. 25 m. (Fig. 1). The net is cast and left to drift closer to the fishermen for about 20-40 minutes.

MATERIALS AND METHODS The study area, roughly 95 km^2, is situated in the Gulf of Catania and 170 surveys were carried out from October 1997 to October 2000. The surveys were equally distributed in all months each year and were carried out using fishing-boats as an observation platform. An outboard-powered inflatable was used to get near the animals for photo-identification. The fishing-boats and the animal positions were taken at regular intervals using a GPS-38 Garmin.

Field procedures, largely inspired by Shane (1990 a, b) were designed to describe the observed behaviours of local bottlenose dolphins and to collect consistent information during long-lasting observation sessions at sea. All the pictures were taken with a 35 mm F90X using a 80-200 mm ID/f 2.8; 300 mm f 4.5 lenses.

The predominant behavioural activities of the focal group were continuously observed and recorded at 5-min intervals. All the data collected were analysed using GIS techniques to produce seasonal interference maps and to evaluate the bottlenose dolphin distribution in the study area in relation to this type of fishery.

RESULTS During 70 surveys, single groups of 2-3 bottlenose dolphins were usually sighted with a maximum of eight individuals. This resident group had been photo-identified and studied since 1996.

Small groups of bottlenose dolphins were sighted several times near the port of Catania, shortly before the fishing-boats left harbour. It appeared that they were waiting to follow the fishing boats because they were afterwards sighted near the gill-nets cast by the fishermen (Fig. 2). The fact that the dolphins fed on the entrapped fish was confirmed by the torn nets that were observed after the sightings.

Opportunistic feeding behaviour showed a constant annual trend with peaks in activity during the spring-summer period (Fig. 3). This trend is correlated to the large fishing activity that occurs during this period and has the effect of reducing the availability of fish. For this reason, the greater fishing effort of handicraft fishing units (autumn-winter and spring-summer periods) coincides with the greater presence of bottlenose dolphin only for the months of April and June.

The anchovy is a gregarious fish that forms very large flocks that approach the coasts in spring and in summer. This behaviour was studied in the Gulf of Catania by Dulzetto (1940) and by Tortonese (1967c), and it was connected to the plankton richness during these periods of the year.

CONCLUSIONS The data collected during this study showed that sightings of bottlenose dolphins are more frequent during fishing activities. Bottlenose dolphins take advantage of the anchovy fishery for feeding, and in the process, damage the typical small drift nets using the study area.

The presence of fishing boats in the Gulf of Catania appeared to influence the foraging strategy of the dolphins. In fact, the observed opportunistic behaviour in association with fisheries is perhaps best exemplified by feeding. (Leatherwood, 1975; Barros et *al*., 1990; Balance, 1992)

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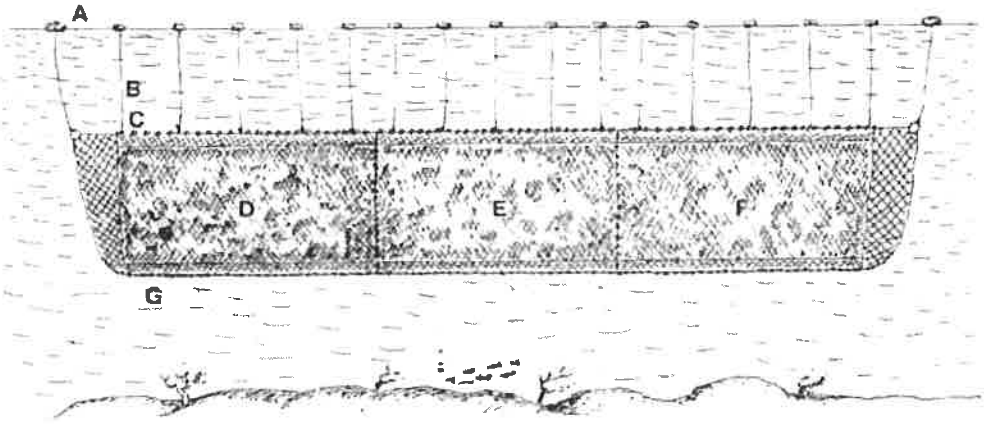

Fig.1. The small gillnets called "menaide" for the anchovy fishing in the Gulf of Catania

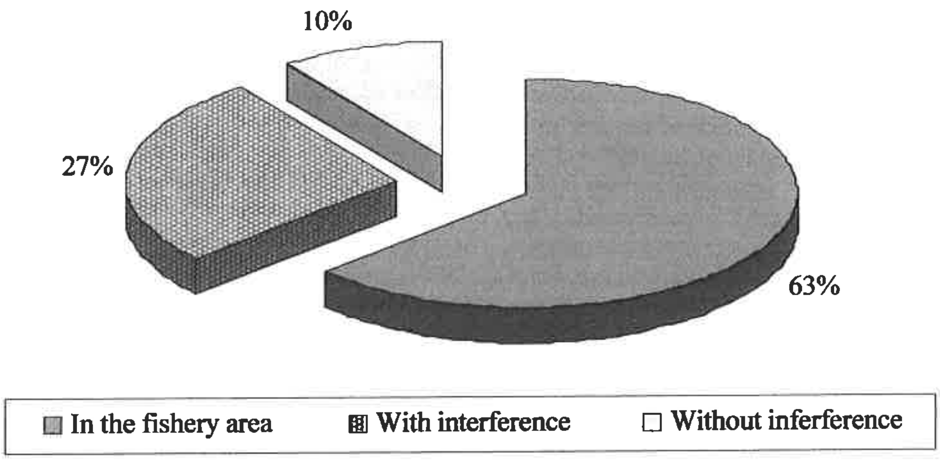

Fig.2. Bottlenose dolphins interference to the fishing activities between 1997-2000

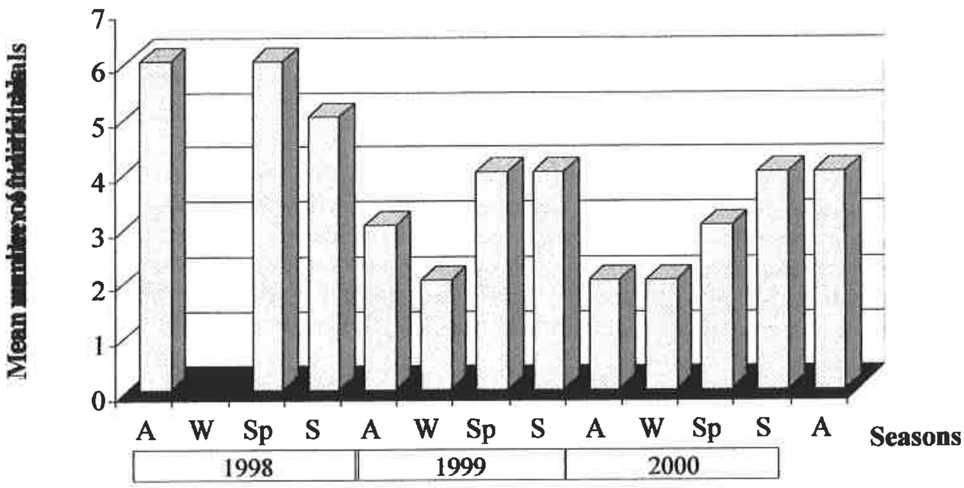

Fig.3. Seasonal mean number of individuals for group

IS TEMPORAL-SPATIAL DISTRIBUTION PREDICTED BY LUNAR PHASE?

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INTRODUCTION Among cetaceans, numbers of individuals within particular habitat areas naturally vary. Such variability can have a pronounced affect on habitat use and exploitation, on commercial human activities such as fishing, whale watching, and eco-tourism, and even on the outcome of population parameter estimates such as sightings and capture-recapture surveys.

During two consecutive seasons of minke whale *Balaenoptera acutorostrata* censuses in the Laurentian Channel Headwaters (LCH) region of the St. Lawrence estuary, we identified from 1 to 54 individuals daily (DEM photo-identification method) in a well-defined foraging area 200 km^2. The question arises whether or not such variability in local numbers is predictable and what mechanism(s) might be involved.

METHODS Individuals were identified daily, weather permitting (wind speeds $\leq$20 knots), using photographs of their natural markings. Estimates were made of the number of individuals available for photo-identification and of the number of animals successfully identified. Date, time, GPS position, and general behaviour also were recorded for each subject, and ventilating profiles were made of those animals already in the catalogue. Tides and moon-phases were plotted against daily frequencies of estimated numbers and animals identified.

RESULTS Overall, inter-seasonal daily numbers peaked throughout September in 1999; whereas during 2000 a similar peak occurred during August. We first tested whether numbers estimated and identified were coincident with, or predicted by the distribution of conspecifics in contiguous areas to the east and west. We found that it was not (R^2 <0.001). Neither were numbers predicted by height of tide, P <0.001 (Spearman rank correlation; p ranged from 0.477 to 0.020 for R^2 regression values in each tidal cycle: all but one were non-significant). Nevertheless, periodic increases were recorded coincident with the second and fourth quarters of each lunar cycle prior to spring tides, followed by decreases in first and third quarters. These quarterly numerical differences were significant (1999 and 2000; one-way, non-parametric ANOVA: $0.025 < P < 0.05$; weighted mean of daily frequencies per lunar cycle, Figs. 2 & 3). Both second and fourth quarter (spring) tides precipitate increased water movement, particularly, as in this case, in the Fjord and estuarine habitats. This may have the effect of concentrating prey items and advecting them at the surface where they are more readily exploited by increasing numbers of whales. We have recorded concurrent elevated ventilation rates (84/h, SE=2.26, n=35) among foraging whales on the rising spring cycle, indicative of increased surface feeding. However, sighting rates examined three days on either side of each new and full moon displayed an unpredicted decrease of 59% on average, despite abundant water movement.

DISCUSSION Runge and Simard (1990), and Simard *et al.* (1986a) suggest that euphausiids are delivered from the open gulf to the LCH by the tide, and the advection of deep water causes them to accumulate in dense aggregations, particularly along the north shore of the LCH area. Tidal forces also contribute to the development of fronts, up to five times daily (Ingram, 1985), and to internal interfacial wave formation in the area (El-Sabh, 1979). Accumulation and retention of floating and swimming planktonic organisms in frontal zones, attributable to purely physical processes, has been modelled by Franks (1992). Similarly, Olson and Backus (1985) have demonstrated that young depth-keeping fish (*Benthosema glaciale*) are concentrated vertically by a factor of five along convergent frontal flows.

Runge and Simard's (1990) model maintains that euphausiids do not rise above 50 m depth during daylight hours because of negative *photo taxis*. Nevertheless, fronts and internal waves occur regardless of the time of day, but coincident with the daily tidal flow. Concentrated zooplankton prey items (*Calanus* sp., *Meganyctiphanes norvegica* and *Thysanoessa raschi*) together with predatory fish (*Mallotus villosus,* Bailey *et al*., 1977) often are visible to the naked eye at the surface whenever fronts and internal waves are manifest, and these observations correlate perfectly with surface foraging activity. Ichii and Kato (1991) indicate that frontal areas are also important feeding grounds for Antarctic minke whales.

It is our hypothesis that the number of minke whales using the LCH region increases, concomitant with the increasing prey-concentrating function of convergent fronts and interfacial waves as the lunar cycle progresses towards a climax during each spring tide, and that these numbers decline again before rising slightly at each neap tide. Empirical evidence suggests that at maximum water movement during spring tides, however, these cells are overwhelmed by the sheer volume of water flowing through the channel head. Consequently, normal convergent action is disrupted and its prey-concentrating function neutralised. This explains the precipitous drop in daily numbers of whales at peak water flow, and the absence of surface feeding activity. Certainly, the whale behaviour is now well documented. It remains for the oceanographic and biological mechanisms to be investigated.

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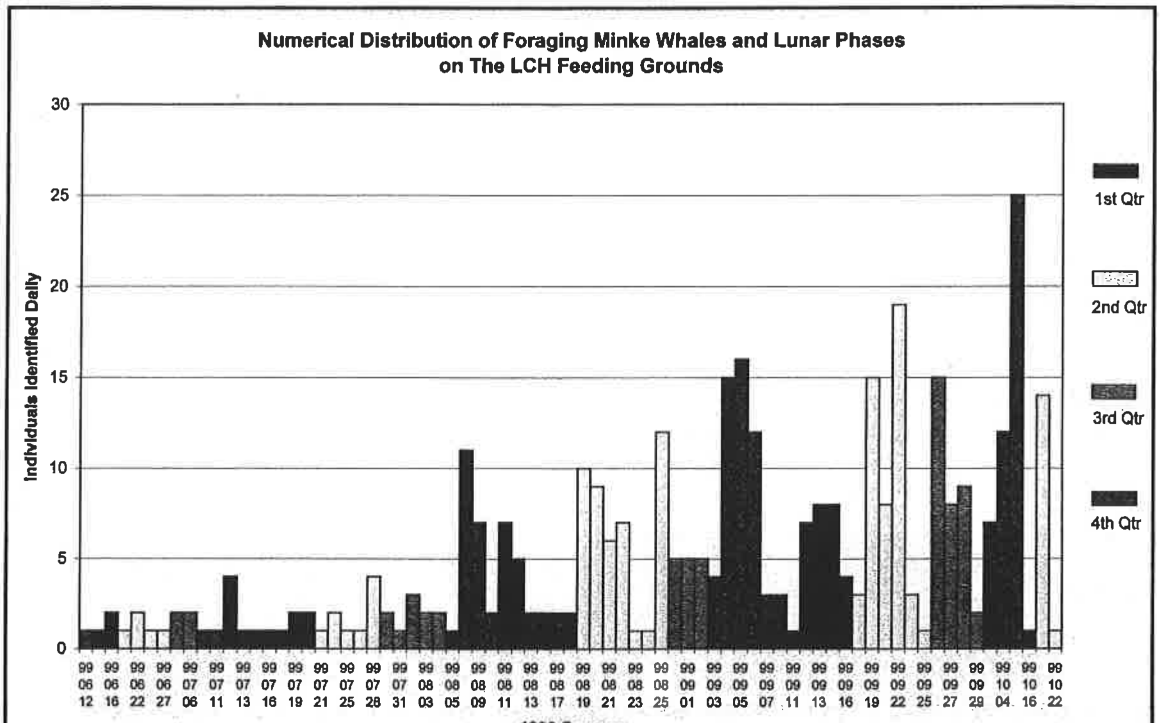

Fig. 1. Numerical distribution of foraging minke whales and lunar phases on the LCH feeding grounds - 1999

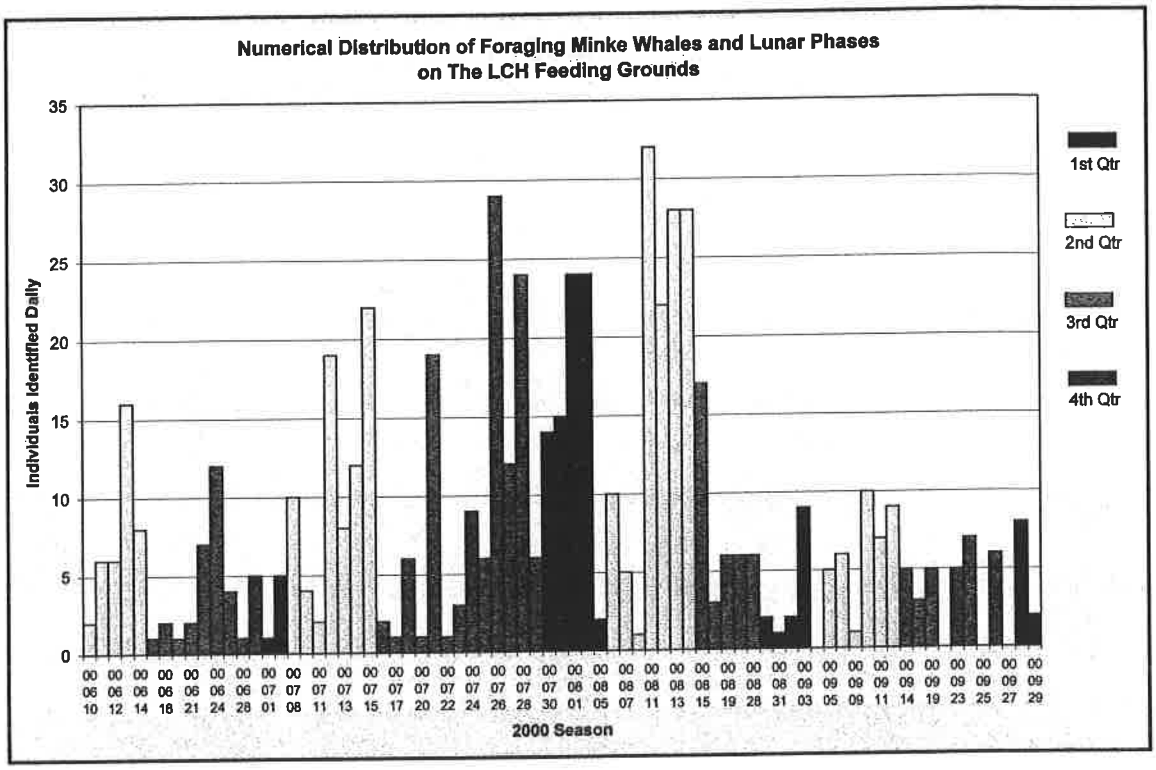

Fig. 2. Numerical distribution of foraging minke whales and lunar phases on the LCH feeding grounds – 2000

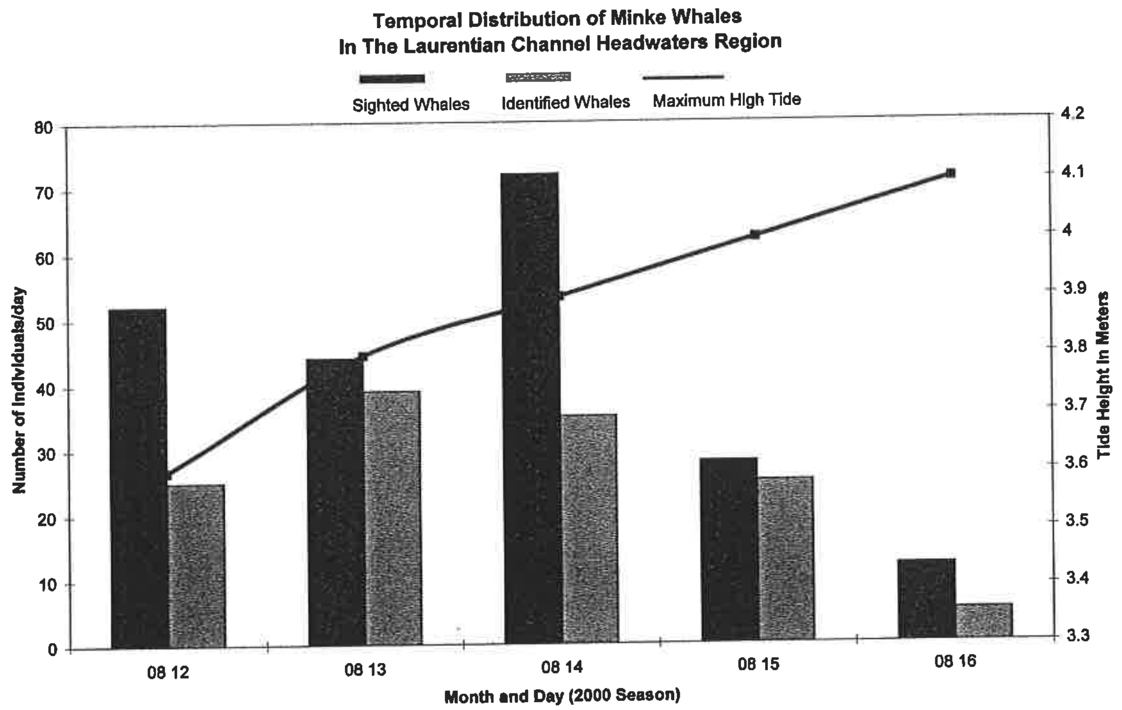

Fig. 3. Numerical distribution of foraging minke whales in the Laurentian Channel Headwaters Region

FEEDING BEHAVIOUR OF KILLER WHALES IN NORTHERN NORWAY

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INTRODUCTION Killer whales (*Orcinus orca*) occur from October to January in the wintering grounds of their main prey, the Norwegian spring-spawning herring (*Clupea harengus*). The killer whales use different methods in catching herring: carousel, travel and subsurface feeding (Simila and Ugarte, 1993; Simila, 1997). It has been suggested that environmental factors, as well as the size and depth of herring schools, affect habitat use and, especially, feeding behaviour of killer whales (Simila, 1997, Ugarte, 2001).

In 1990-95, herring wintered in two relatively narrow fjords, Tysfjord and Ofotfjord, and killer whales were mainly feeding in shallow areas and on herring schools located close to the surface (Simila, 1997). Since 1995, the wintering grounds of herring have shifted to a larger and more open fjord system (Rottingen *et al.*, 1994).

We investigated whether any changes have taken place in the feeding behaviour of the Norwegian killer whales since the shift in the wintering area of herring. We also quantified and compared surfacing patterns of whales engaged in different behaviours, to find evidence of co-operation between individuals.

METHODS The study was conducted in Vestfjord-Tysfjord area, northern Norway (Fig. 1). Vestfjord is a large, open and unprotected fjord system (~200 km length, ≤90 km width, 200-600 m, up to 900 m depth). Tysfjord is a narrow and sheltered inner tributary of Vestfjord area, with a complex bottom topography (57 km length, 14 km width, ≤900 m depth). Data on killer whale distribution and feeding behaviour, and on herring distribution in the fjord system were collected in October-December 1996-99. Data on surfacing patterns of whales engaged in different behaviours were collected in October-November 2000. Observations were made from a 12-m sailing boat equipped with GPS and an echo-sounder, by randomly traversing the study area. Data on herring were recorded from 08:00-18:00 h (depending on the length of the day) every 10 minutes in the absence of whales. When whales were present, data on whales and herring were recorded every 5 minutes. Whale behaviour was classified as resting, travel/foraging, or feeding (three categories as described below). Frequencies with which different types of feeding behaviour were encountered were analysed (Chi-squared tests) in relation to study period (1990-93 (Simila, 1997) vs 1996-99) and water depth (<50 m, 50-100 m, 101-150 m, >150 m).

Surfacing intervals of male killer whales were recorded with a DAT-recorder and analysed with an event recorder (programmed in Visual Basic). When whales were observed together, we tested whether surfacing events occurred independently: surfacing intervals of pairs of whales observed together were compared with simulated random surfacing intervals (Mann-Whitney and Kolmogorov-Smirnov tests). The random intervals were generated using the individual surfacing interval data for the two whales.

Feeding behaviour Carousel feeding comprises two phases: herding and feeding. During the herding phase, the whales herd a school of herring into a dense ball, and drive it to the surface. The whales also engage in lobtailing, porpoising, releasing bubbles, and flashing the white underside of their body to the fish. During the feeding phase, the whales stun fish using underwater tailslaps and are highly vocal. Fish are often seen jumping at the surface (Simila and Ugarte, 1993). Subsurface feeding normally takes place in deeper waters. The whales spend less time around the school than during carousel feeding. Whales are milling in a limited area in a less co-ordinated manner, lobtailing and porpoising periodically. Herring schools are not brought to the surface and whales have never been observed to use bubbles (Simila, 1997). During travel-feeding, whales travel in the same direction in a loose formation, stop occasionally, and feed individually (Simila,, 1997).

RESULTS During 1996-99, killer whales were mainly observed in Vestfjord. Subsurface feeding was the most commonly observed feeding behaviour and carousel feeding was observed less often than in 1990-93 (Fig. 2). Travel-feeding comprised 30% of all feeding encounters in 1996-99, and 15% in 1990-93. The relative frequency of carousel feeding encounters decreased with increasing water depth whereas travel and subsurface feeding encounters increased with depth (Fig. 3).

During 1996-99, herring was present as extensive "layers" throughout the Vestfjord area. Some small, localised, herring schools were observed in relatively shallow waters (20-100 m) but these were absent from the mid-sections of the fjord system. In 1990-93, small herring schools were observed frequently in areas of <200 m depth and in areas with variable bottom topography in Tysfjord, especially during the vertical migration of herring (Simila, 1997).

Average surfacing intervals differed significantly between all activity states, except between travel-feeding and travel foraging. Surfacing rates were highest during sub-surface feeding (2.7 min^{-1}) as compared to 1.7 min^{-1} for travel-feeding and 1.1 min^{-1} for resting killer whales.

Significantly non-random surfacing patterns were observed for pairs of whales during travel-feeding (2 out of 5 pairs), travel/foraging (3 out of 5) and resting (5 out of 7; see Fig 4).

DISCUSSION **Feeding behaviour and herring distribution** After 1995, as the herring stock size increased significantly (Rottingen *et al.*, 1994), the stock was most dense in the inner Vestfjord, an area with relatively homogenous bottom topography. This shift in herring wintering grounds has changed the feeding behaviour of killer whales. Carousel feeding, which is performed almost exclusively in shallow waters (<50 m), has become less common and the use of travel-feeding technique has increased. Studies conducted in Tysfjord show that killer whales were feeding mainly on small schools of herring in shallow areas or in areas with variable bottom topography (Simila, 1997). It has been suggested that small herring schools occur more commonly in such areas and that killer whales are able to take an advantage of the bottom topography when herding herring schools. Killer whales in the Pacific Northwest have also been observed to take an advantage of the areas with shallow depths and high bottom topography when feeding on salmon (Heimlich-Boran, 1988; Nichol, 1990). Although shallow areas and underwater seamounts are present in Vestfjord, both killer whales and herring were present mainly in deeper water. This study suggests that killer whales do not use carousel feeding techniques in such habitat.

Surfacing pattern The surfacing rate during travel-feeding was lower than during subsurface feeding, consistent with lower oxygen consumption and thus providing evidence that killer whales consume less energy when travel-feeding. This may indicate that deep dives are not made during travel-feeding behaviour. Travel-feeding is probably an opportunistic feeding technique used to capture fish that whales find close to the surface.

Some evidence of synchronisation between individuals was seen when the whales were engaged in travel-feeding and travel/foraging, but in particular during resting. While synchronisation during foraging might be expected if the animals are co-operating to enhance feeding success, synchronisation of surfacing in resting animals is more likely to indicate relationships, suggesting genetic relatedness and/or social structure within a group (Hamilton, 1964; Jacobsen, 1986; Whitehead, 1996).

ACKNOWLEDGEMENTS This project was partly funded by the University of Aberdeen. We would also like to thank Fernando Ugarte, Teo Leyssen and Taija Tuominen for their valuable help in the field

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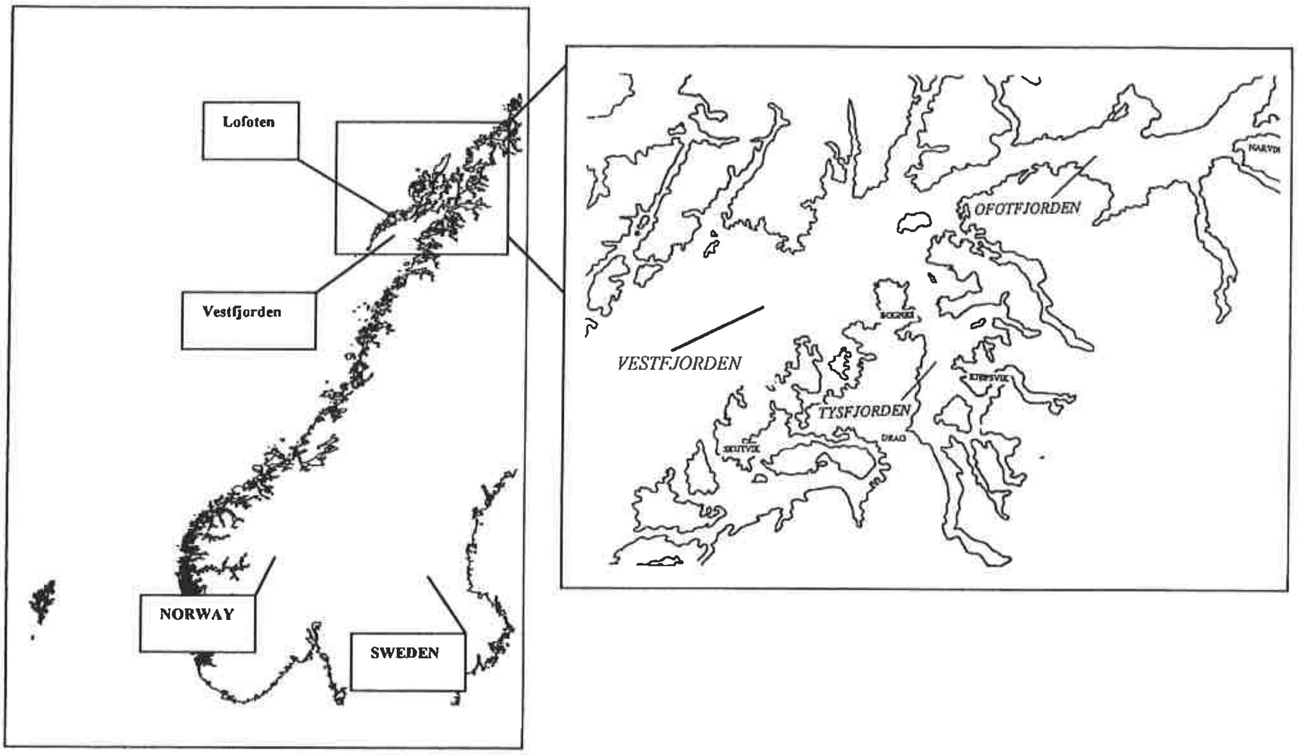

Fig. 1. Study area in Lofoten comprising Vestfjord and Tysfjord

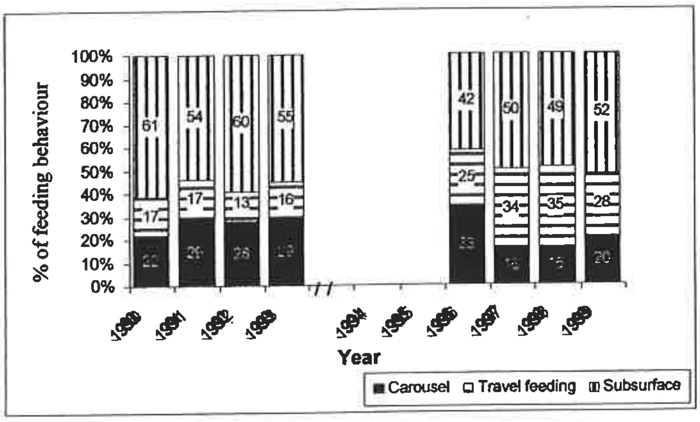

Fig. 2. Annual summaries of feeding behaviour. Percentage of feeding encounters during which a) carousel b) travel, and c) subsurface feeding were seen

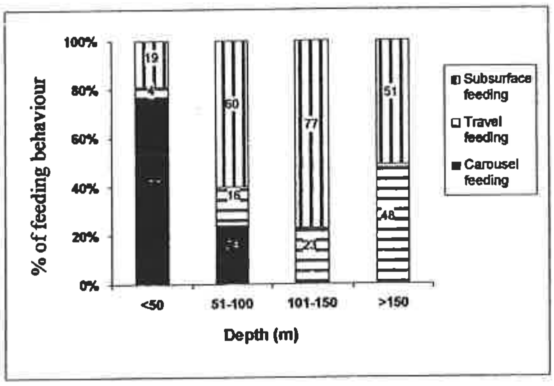

Fig. 3. Relative frequencies of different feeding behaviours in relation to depth of the water column.

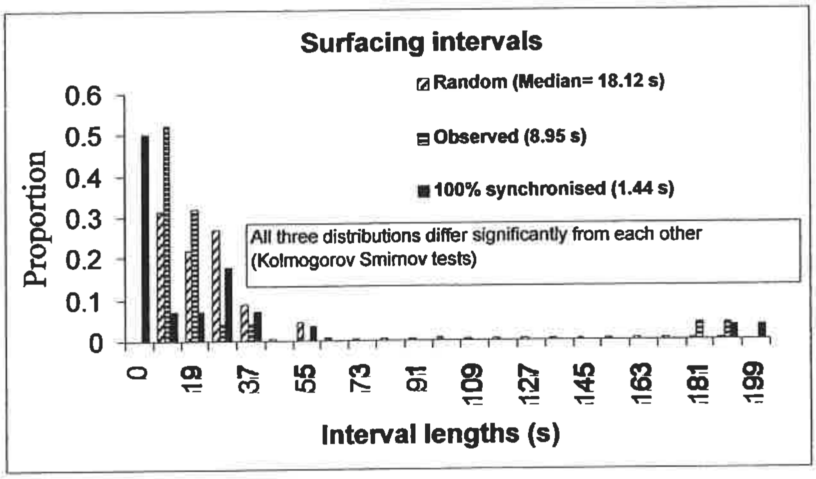

Fig. 4. Surfacing intervals for a pair of male killer whales during resting. Intervals are times between observed surfacing events, regardless of which whale was involved. Predictions for random (independent) and 100% synchronised surfacing were generated using individual surfacing data. The whales resting are synchronised to some degree in their surfacing pattern, with a shorter median surfacing interval than would be expected if they surfaced independently.

BEHAVIOUR OF AN ADULT MALE SPERM WHALE IN A SHALLOW FJORD IN NORTHERN NORWAY

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INTRODUCTION Sperm whales (*Physeter macrocephalus*) are common off the Norwegian continental shelf, with high concentrations off Andøya, Northern Norway (Christensen *et al.*, 1992). However, an adult male spent two months in a shallow fjord, 150 km away from its closest natural habitat, and eventually stranded there. The present work describes the behaviour of this unusual observation.

MATERIALS AND METHODS Observations of the sperm whale were made in Kvalvika and Storfjord. Kvalvika is a bay with a maximum depth of 52 m. Two rivers run into the western part. It opens to the Lyngenfjord, which has a depth up to 240 m. Storfjord is a continuation of the Lyngenfjord. It is 50 m at the deepest and a river runs into its end.

Observations were made during daylight hours, either from land or from small boats. The presence of potential prey in Kvalvika was investigated by SCUBA divers. Surface and dive times were recorded and compared with the diving behaviour of feeding sperm whales off Andøya (Sarvas, 1999). Sound recordings were made using Offshore Acoustics hydrophones (6-14 kHz re 1 v/mPa) and DAT-recorders (20 Hz - 22 kHz re 1 v/mPa). All sound analyses were made using SpectraPlus software. Identification pictures of the edge of the tail were matched against catalogues of sperm whales identified off Andøya (Lettevall, 1998) and in the North Atlantic (Huele *et al.*, 2000). After the whale stranded, it was sexed and length measurements as well as tooth samples were obtained. The age of the whale was estimated from the growth layer groups (GLGs) of two teeth (Lockyer, 1981).

RESULTS On 22 February, 1999, local residents spotted the sperm whale close to shore in Lyngenfjord, 10 km north from Kvalvika. The whale entered Kvalvika on 23 February and remained in the bay until 7 April. On 9 April, the whale entered Storfjord, where it stranded during high tide on 28 April. As the tide ebbed, the whale fell on its side and died.

From 6 March to 28 April, 45 hours of observations were made on 12 days. A conspicuous depression behind the head of the sperm whale and the aspect of the body indicated that the animal was undernourished. No potential prey was observed and there was no indication of foraging.

The whale moved in predictable patterns. While in Kvalvika, it either remained close to the river mouth or swam between the opening and the shallow parts of the bay. Fluke-ups were seldom observed. Dive cycles could be classified as either short (1-15 min) or long (21-49 min). Compared to feeding sperm whales off Andøya, the long dive cycles were generally shorter and the short dives were more frequent. Surface periods lasted 1-13 min, whereas in Andøya they typically last 5-9 min.

The whale was mostly silent while diving, except for occasional clicks, codas and previously undescribed sounds produced as bubbles escaping from the blowhole. Clicks were often produced while the whale was at the surface, changing the orientation of its body. A total of 363 codas, composed of 3-7 clicks, were recorded. Five-click codas dominated the sample. Preliminary analyses indicate that the blowhole sounds were pulsed, of low frequency (<1.5 kHz) and of relatively long duration (>2 s), sometimes overlapped by clicks or codas.

There were no matches with any of the pictures in the ID catalogues. The whale was 15.4 m long and at least 35 years old.

DISCUSSION The sperm whale may have remained in areas with low salinity (fjords, river mouths) as a way to re-establish its water balance, after dehydration due to lack of food. The reason for the whale's under-nourishment is unknown.

• Lack of foraging and the shallowness of the water, might explain the abundance of short dive cycles, as well as the lack of echolocation while diving.

• Echolocation at the surface could have been for orientation.

• Codas have not been recorded among male sperm whales feeding off Andøya. In this case, codas may have been an indication of stress.

• Blowhole sounds were made as air exited the blowhole and could either be related to poor physical condition or, alternatively, communication or stress signals.

ACKNOWLEDGEMENTS The Andenes Cetacean Research Unit and The Norwegian College of Fishery Sciences funded the fieldwork. Børge Damsgård and Anna Bisther provided DAT-recorders. The local residents lent us boats and provided valuable information about the whale's behaviour and whereabouts. Audun Rikardsen lent his boat and got his hands dirty during the sampling after the stranding. Erland Lettevall and Ruben Huele looked for ID matches. Christina Lockyer and her collaborators carried out the age estimation analysis. Catherine Denardo commented upon the language. Godstrek AS did the lay-out. Hvalsafari AS sponsored the printing of the poster. We also want to thank all those who helped during the fieldwork.

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DO FISH HAVE COUNTERMEASURES TO AVOID CAPTURE BY ECHO-LOCATING ODONTOCETES?

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For odontocete cetaceans, echolocation is an effective means of hunting mobile prey in poor visibility. To be useful, the technique requires that the prey themselves cannot hear and avoid the sounds. Most fish perceive only low frequency vibrations and so would be unaware of the approach of an echo-locating odontocete. However, recent studies suggest that members of the clupeid or herring family can detect high frequency sounds. The factors promoting the evolution of this unusual hearing are unknown but detection of echo-locating odontocetes has been suggested. The aim of this study was to determine whether herring respond to odontocete type echo-location sounds and, if so, to test whether their responses are appropriate to reduce their probability of capture. Experiments were carried out in a large indoor tank and a sea-pen. Small schools of fish were exposed to a variety of playbacks. Broad-band click sounds caused feeding fish to cease foraging, drop in the water column, and begin to school actively ($n=10$, $P<0.05$). Fish already schooling, dropped in the water column, and increased their swimming speed ($n=25$, $P<0.01$). Control playbacks of electronic silence and an acoustic deterrent device for marine mammals (pinger) did not elicit such responses ($n=10$ & 25, P=NS). The observed manoeuvres were applied to an acoustic model using a simulated hunting bottlenose dolphin as the predator. The responses of the fish that were observed in the experiments would significantly reduce the probability that the hunting dolphin could detect them. Clearly we can no longer view all fish as acoustically passive prey and must consider potential anti-predator countermeasures when interpreting the foraging behaviour of odontocete cetaceans.

SOCIAL OR NOT – THAT IS ZEE QUESTION? THE BEHAVIOUR OF A SUB-ADULT HARBOUR PORPOISE

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Harbour porpoises are subjected to by-catch rates, which are not sustainable and are biased towards younger animals of the 0-1 year age class. The reason for this is not yet understood. Because of its size and generally elusive behaviour, the porpoise is difficult to study in the wild and little is therefore known of its behaviour, especially in terms of social interactions and mother/young relationship. A thorough understanding of these, however, would help understanding the by-catch situation and effective ways of reducing it. This study investigated the social behaviour of a sub-adult female harbour porpoise. The investigation took place at the Fjord & Belt Centre, Denmark, in June-September 1999, where a one-year-old female, Nuka, was introduced to a male and a female porpoises, both 4-5 yrs of age and sexually mature. Nuka was rescued from a pound net and it is likely that this caused the separation between her and her mother. Focal sampling of behaviours (as states or events) was conducted in 3-hr sessions, 4-5 times weekly, using a behaviour recording software. The young female spent most of her time alone (81%), while she was, among other activities, swimming freely alone (58%), foraging (8%) and playing (6%). Nuka spent 7% of her time with the male and 10% with the adult female. This activity pattern changed on a seasonal basis. Until mid-August, 75% of the time was spent swimming alone, subsequently increasing abruptly to 94%. This increase in independence of Nuka coincided with an increase in both play (often chasing free-ranging fish) and bottom grubbing behaviours. In general, this pattern may help explain the dramatic increase of by-catch at the end of the summer. The increase in independence, play and feeding behaviours, coupled with a lack of familiarity with fishing gear, could place sub-adult porpoises at a higher risk of entanglement.

PRELIMINARY RESULTS ABOUT NUMERICAL DISCRIMINATION IN THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

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INTRODUCTION Number–related skills is an appropriate field to study the abilities of animals to generalise abstract categories, because number is not a certain characteristic of an object in the way that is colour, shape or material. Although several studies have shown a wide range of numerical abilities in terrestrial animals (Boysen and Capaldi, 1993), very little is known about these skills in aquatic mammals (Mitchell *et al.*, 1985). Furthermore, the possible biological implications of number-related skills should be discussed because both food consumption (e.g. food items per time) and social relations (e.g. offspring-size and number of females etc.) could offer a species a certain advantage.

A basic, but essential part of number-related skills is "relative number judgement" as defined by Davis & Pérusee (1988). Therefore, the aim of this present study was to investigate whether a captive bottlenose dolphin can learn to discriminate visual stimuli that only vary in the numbers of elements they contain. "Blue", a 10-year old bottlenose dolphin was trained to discriminate various stimuli representing "few" and "many" elements. The number of elements per stimulus used during the training ranged between 1 and 5. After the initial learning of the first stimuli pair, "Blue" reached the criterion (≥85% correct choices) for the following pairs already before the end of the first session. Afterwards, his ability was tested for variation concerning the shape, size and pattern of the elements to demonstrate that his performance only depends on numerical qualities. Subsequently the animal was tested with new stimuli of intermediate as well as higher numbers of elements. Choices of these new stimuli were never reinforced (catch trials) due to tests of Blue's ability to generalise what he had learned during training phase. The number of elements used during tests ranged between 1 and 10. The preliminary results indicate that the animal could generalise the concept "few" and "many".

MATERIALS AND METHODS The subject of the present study was a 10-year old male bottlenose dolphin. He had to discriminate between simultaneously displayed stimuli representing "few" and "many" elements. A whistle-blow indicates the subject to leave the target and to push the stimuli that contain more elements with his rostrum, so that it flipped backwards. During the discrimination phase, the experimenter was hidden behind a plastic curtain (Fig. 1a - 1b). The left-right position of the correct stimulus was alternated quasi-randomly (Gellerman, 1933). The experiment was divided into a training-, a control- and a testing-phase. During a training session, the animal learned to discriminate 1 vs 5. After reaching 85% correct performance, this stimulus pair was used to habituate "Blue" to un-reinforced trials (catch-trials). Subsequently he was trained with the number pairs: 1 vs 4, 1 vs 3, 1 vs 2.

Training Phase: After a successful performance, the animal was also trained with a stimulus pair varying in: surface, shape and pattern of elements (Table 1).

Testing Phase: During the Testing Phase , new values were mixed with training stimuli and tested without any reinforcement or feedback (catch-trials).

RESULTS

Training Phase

For the first stimuli pair (1 vs 5) Blue needed 13 sessions to reach criterion. His performance remained stable even after establishing catch trials (Fig. 2a). For the following numbers (1 vs 4, 1 vs 3 and 1 vs 2), the criterion was already reached in the first session (Fig. 2b). These results suggest that "Blue" could generalise after the first training pair and already had learned the concept.

Testing-phase

During testing, "Blue" demonstrated that he could order new numbers based on the concept of "few" and "many" (Fig. 3). Step by step, he was required to discriminate stimuli that only differ by one element. The subject reached the criterion if the maximum number of elements for one stimulus did not exceed five or otherwise the difference between a stimulus pair had to increase (up to five).

CONCLUSIONS The faster learning after the initial training pair suggested that "Blue" could already generalise the learned concept. During the testing phase, the subject could also discriminate new and never reinforced stimuli, demonstrating that he could order new stimuli on a serial numerical scale; knowing that 3 is more than 2, but 4 is more than 3. But obviously he had more difficulties to discriminate stimuli with higher numbers of elements, which only vary by a few items. These effects can be explained by the law of Weber. For increasing numbers, the absolute difference between items maintain a constant, but the relative difference decreases and therefore is harder to distinguish.

To test whether the subject can really generalise the learned concept, he receives advanced reversal training: the correct stimuli are those which contain more elements. For this purpose, the animal will be trained with the stimulus pair 1 vs 5, and 1 vs 4. Afterwards, "Blue" will be tested with the numerical combinations of 1 vs 3 / 2 vs 3 / 3 vs 4 / 3 vs 5. The successful performance of these stimulus pairs could give evidence about concept learning and use in the bottlenose dolphin.

ACKNOWLEDGEMENTS The authors would like to thank the Fundación Marineland Mallorca for enabling the present study to take place at its facility. Furthermore, S.Y. would like to thank Deborah Morrison's team for their help, suggestions, patience and friendship. She would like to thank Gloria Fernandez for her logistic support and Luuk Morel for his help. Special thanks go to the staff of the dolphinaria Zoo Duisburg, who taught S.Y. the first principles of behavioural training. The project was supported in part by a Ph.D. grant to S.Y. of the Deutscher Akademischer Austauschdienst (DAAD).

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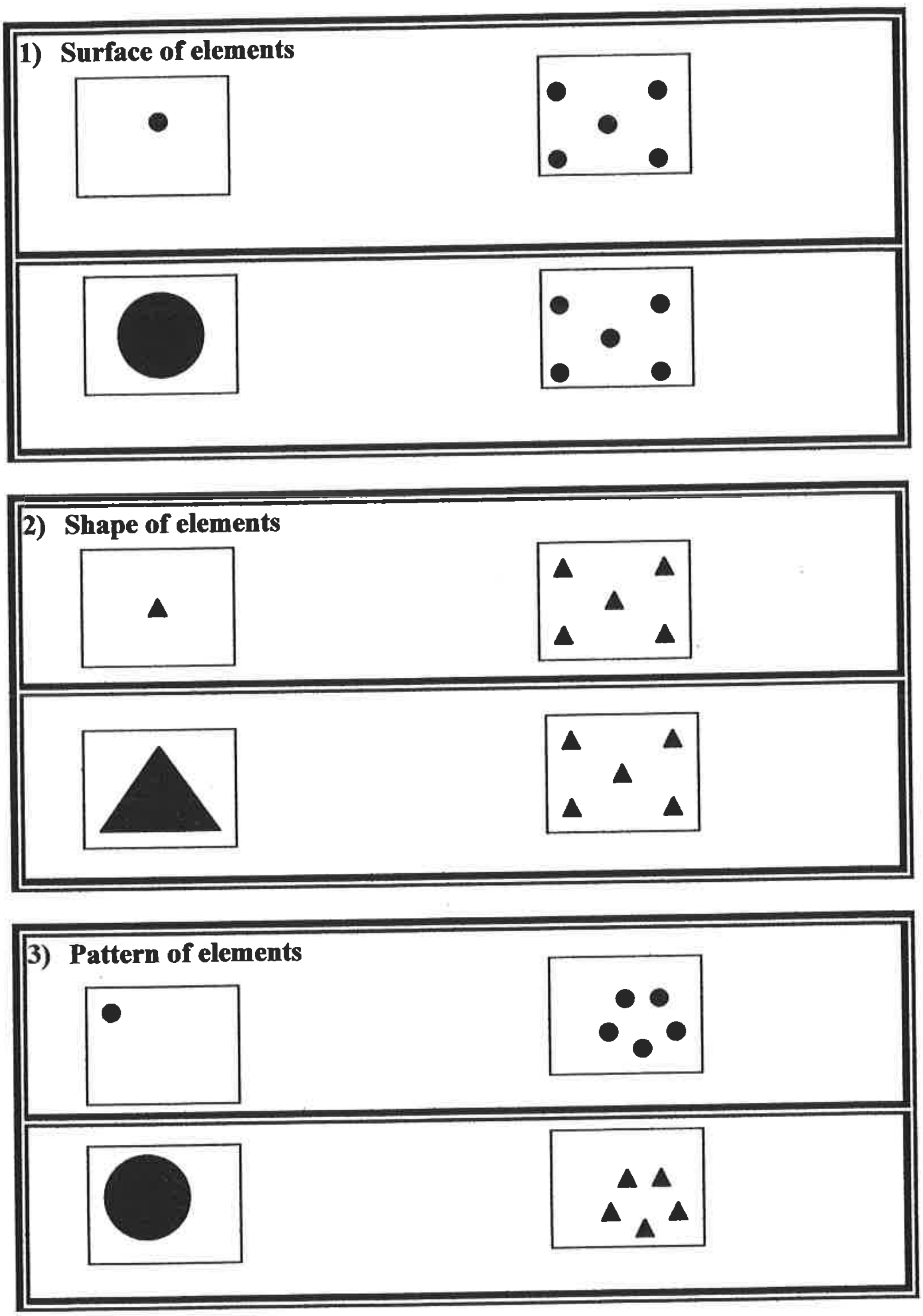
Table 1. Example of stimuli pair used during training phase. All stimuli conditions were also verified for 1 vs 4, 1 vs 3 and 1 vs 2



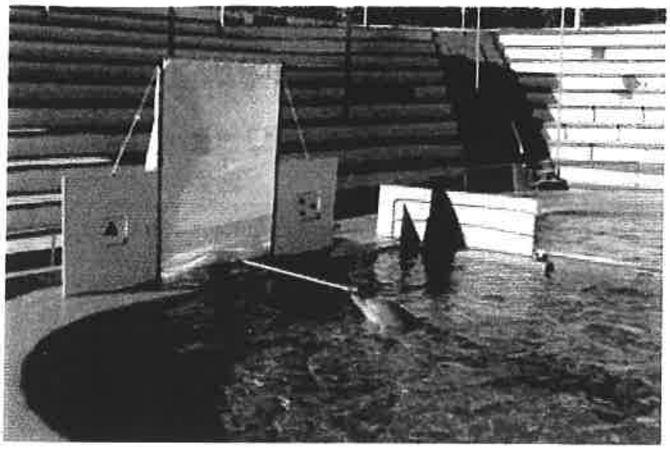


Fig.1a) Overview about the testing situation with the apparatus, the stationing device and the position of the dolphin watching towards the revealed stimuli

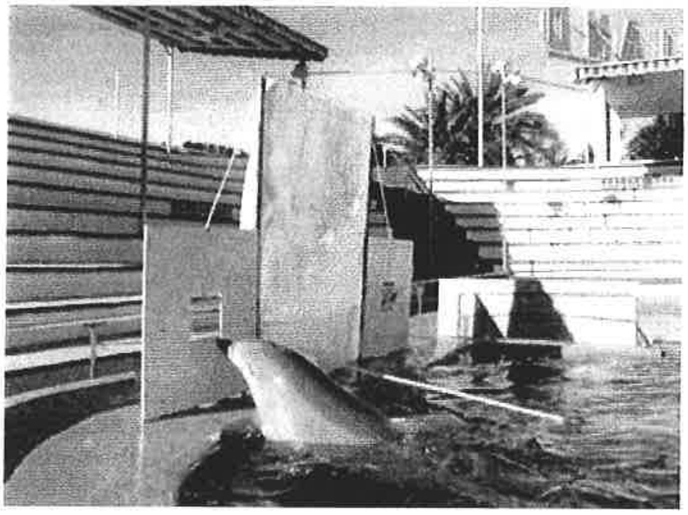


Fig. 1b) The dolphin leave the target to touch one of the displayed stimuli with its rostrum. Only choices with the stimuli being completely flipped backwards were considered.

Training session with 1 vs 5

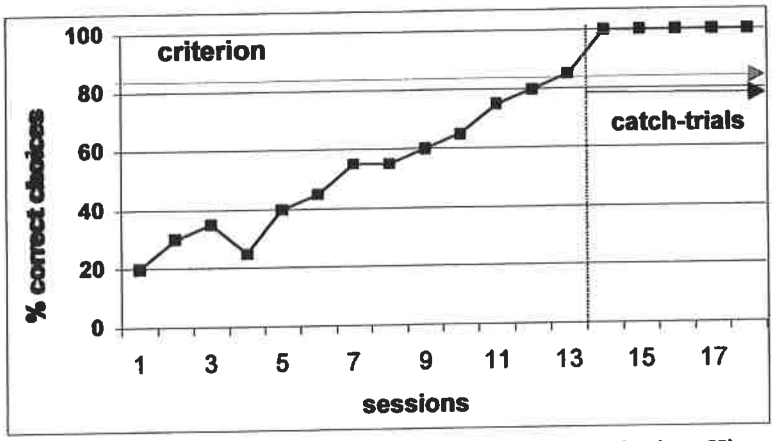


Fig. 2a). For the first stimuli pair "Blue" needed 13 sessions to reach criterion. His performance remained stable even after establishing catch-trials.

Trainingsession with 1 vs 4

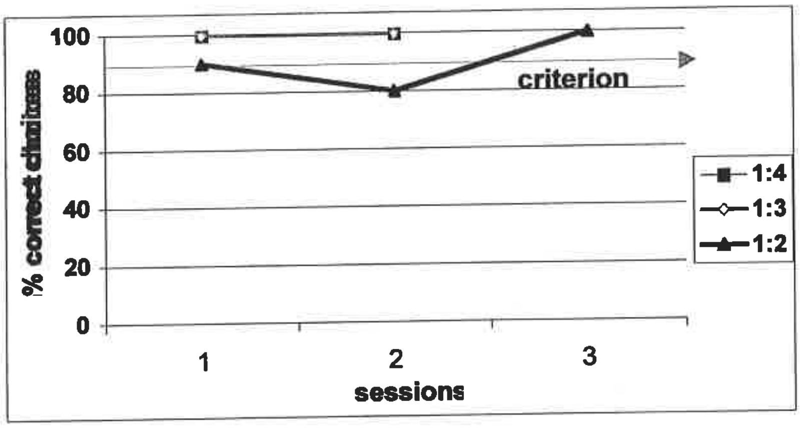


Fig. 2b). For the following number-pairs criterion was already reached in the first sessions.

Results for Testing Phase

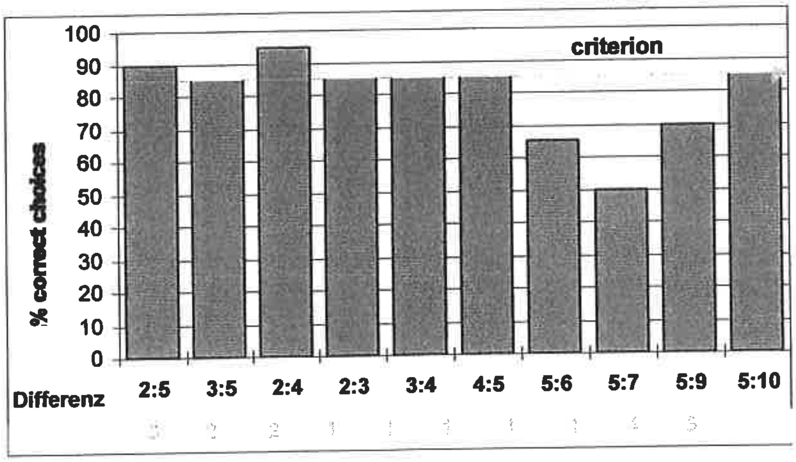


Fig. 3. "Blues" performance during testing phase: The animal could order new stimuli on a serial numerical scale. Obviously he had more difficulties to discriminate higher values.

CONSERVATION/MANAGEMENT

AGE- AND SEX-SPECIFIC MORTALITY RATES OF HARBOUR SEALS IN THE WADDEN SEA

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Harbour seals in the European Wadden Sea recovered rapidly after their epidemic mass die-off in 1988, suggesting favourable life history parameters in the surviving population. In order to establish relevant mortality schedules, dead strandings were collected on the Wadden Sea coast of Schleswig-Holstein, N-Germany, in 1989–98. Ages-at-death of seals were determined from tooth cementum growth layers, and considered to form a mortality (kdx) series for males and females. However, because the yearly number of seals being recruited had changed drastically over the past decades, age-class frequencies had to be corrected by means of census data in order to indicate the probability of a seal dying at age x. Combined with known harbour seal fertility data (Lotka's formula), estimated mortality rates correspond to an intrinsic rate of increase of 13%. In both males and females, mortality during the first year was around 35%, but fell to only 2% per year at age 2–4. Mortality in adult females appeared stable at 4% per year at least until age 15, whereas male mortality increased markedly between 8 and 15 years of age (6–14% per year). These figures are lower than most published mortality rates for harbour seals, but are perfectly consistent with observed population trends. Although still uncommon, the use of age-at-death data from dead strandings for assessing marine mammal life table parameters is encouraged, particularly where material is abundant and population trends are known.

THE USE OF MARINE PROTECTED AREAS IN CETACEAN CONSERVATION

T. Agardy

Marine protected areas are typically utilized to serve one of two broad objectives: 1) habitat projection, or 2) prevention of fisheries overexploitation. Corollary or secondary objectives for their establishment also include preserving traditional uses, education or awareness-raising, and establishing an eco-tourism industry, *inter alia*. The form that this spatial management takes in any specific place, and thus the objectives that it serves to fulfill, will largely depend on the nature of threats affecting the particular coastal or marine system. Thus if threats result from destructive fishing, habitat loss or degradation due to development, or pollution, the marine protected area is established with the overall goal in mind of habitat preservation and/or habitat restoration. Where proximate threats have to do with overharvest of resources beyond sustainable limits, the marine protected area takes the form of a fisheries reserve in which special restrictions on take are implemented. In addition to this straightforward use of marine protected area tool, there are examples where habitat destruction and fisheries over-exploitation are not major factors, yet marine protected areas are implemented nonetheless. This may occur when a general lack of awareness about the importance of marine area exists, or when too few economic benefits are being derived to make an area seem valuable and therefore worthy of conservation attention. In these cases the coastal or marine ecosystem can become vulnerable to future threats, and marine protected areas can be implemented proactively.

Clearly, any conservation tool that acts to either preserve habitat, maintain fisheries production, or raise awareness and perceived value of marine ecosystem will benefit not only coastal or marine system in general but also the species these ecosystems contain. Thus cetaceans stand to benefit from all effective marine conservation measures.

However, marine protected areas can be planned specifically to help conserve threatened cetaceans by protecting either the habitats upon which they depend, their food sources, or the cetaceans themselves, by instituting special regulations to restrict activities that directly harm the species. To make marine protected areas maximally effective in conserving cetaceans, however, the design of the protected area and the management regime instituted within it must specifically address the human activities that threaten, or might in the future threaten, the cetacean populations. This requires objective analysis of threats to cetacean populations, as well as spatial assessments to determine where these threats may be concentrated. A systematic and strategic use of marine protected areas to conserve cetaceans can then be built on a foundation of such a spatially referenced set of threats analyses. Recent marine reserve designations and the emergence of marine protected area networks reflect this new level of rigor in the use of protected areas.

REDUCE NOISE, DELAY HABITUATION AND REDUCE HARBOUR PORPOISE BYCATCH – CONFLICTING OBJECTIVES?

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The two-year EU-funded EPIC (Elimination of Porpoise Incidental Catch) project investigated the possibility of optimising "beacon mode" pingers, and explored two new concepts using sound to reduce by-catch. 1) "Interactive" pingers which only transmit deterrent sounds when triggered by the porpoise's own sonar. Such transmission "on-demand" will considerably reduce the acoustic energy contributed to the water and will also delay the habituation process. 2) "Acoustic masking" of the weak sonar echoes returning from fish prey. This can be achieved by transmitting low-level noise, concentrated within the narrow bandwidth of the porpoise's sonar signal. It should discourage porpoises from foraging inside an area exposed to the noise and should be totally insensitive to habituation.

The experiments were performed in controlled conditions using captive porpoises at the Fjord & Belt Centre, Denmark. The reaction of the animals was monitored with behavioural observations (focal sampling) and with a dorsal fin datalogger, carrying heart rate, swim speed and dive depth sensors. The results show that the three different "beacon mode" sounds investigated were similar in terms of deterrent effect, which was sustained with signal durations reduced to 1/4 of the "traditional" 300 ms. No sign of habituation was observed over three weeks, with four sound sessions per day. With the "interactive mode", the porpoises were much more wary in the vicinity of the transducer, than in the "beacon mode" tests. Occasional emissions of "attractive" sounds, designed to encourage the porpoises to echolocate towards the device, may be required with this mode. Preliminary tests with such signals were carried out. The "sonar masking" experiments were hampered by bad weather, but encouraging preliminary results were obtained. Live fish released in a test area initiated persistent natural foraging. The presence of the porpoises in this area was clearly inversely correlated to the local masking noise intensity.

RISK ASSESSMENT FOR FUTURE MANAGEMENT OF A HUNTED DEPLETED BELUGA POPULATION (*DELPHINAPTERUS LEUCAS*)

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INTRODUCTION The Cumberland Sound beluga *Delphinapterus leucas* population has been studied for twenty years and is located in the south-eastern part of Baffin Island, Canadian Arctic (Fig. 1). This population has been traditionally hunted by the Inuit community, and, since the last century, by commercial companies. The population is now considered to be genetically isolated (DeMarch *et al.*, 1999). The present index of the population size was estimated to be only 10% of the early 1900s (Brodie, 1971; Mitchell and Reeves, 1981). This population index seems to have stabilised to 400-600 animals, with an established quota of 35 permitted animals hunted per year (Richard and Orr, 1986; Richard *et al.*, 1990).

A prospective risk analysis is a useful method in the case of a population vulnerable to catch pressure and whose future management is risky. Also it is a good way to reduce possible errors in population growth probabilities when there are scarce data on biology and population dynamics. A simple projection model coupled with a Monte-Carlo resembling method was used to simulate the variability and uncertainty of the available parameters of the Cumberland Sound population (Richard, 1999; Burgman *et al.*, 1993).

MATERIALS AND METHODS In the analysis, the parameters were chosen randomly from a probability density function covering their uncertainty and variability. The Monte-Carlo trajectories obtained in the resulting graph summarise probability bands of population growth. The trajectory ranges represent increasing risk from bottom to top, with the true population growth below each trajectory (Fig. 2). The projection has been run for ten years. The undesirable event was defined to be "no increase" of the population. The parameters are the total estimate of the population size determined from aerial counts corrected by a dive factor, catch options, and population growth rate (Richard *et al.*, 1999; Kingsley, 1998). The mean of this calculated growth rate is higher than the mean of a published odontocete growth rate (beluga and narwhal, *Monodon monoceros*) (Table 1) (Wade, 1998; Kingsley, 1998). Due to this difference, two projections were run, one with the calculated growth rate and another one with the published growth rate.

RESULTS AND CONCLUSIONS The projection using the estimated growth rate from Cumberland Sound, showed little or no risk of decline until a catch option of 70 animals hunted per year was reached (Table 2). This is illustrated, in the resulting graph, by the lowest trajectory, which is close to the broken bold line representing the limit of the undesirable risk (Fig. 2). The projection using the published growth rate showed a 10% to 25% risk of decline for a catch option of only 40 hunted animals per year, illustrated in the resulted graph by the lowest trajectory occurring far below the limit of the undesirable risk (Table 2).

To put these modelling results in context, a comparison with the historical change of the population and variation in catch records is essential. A large decline in the population has been observed for the first half of the 19th century to about 10% of the population in the early 1900s. Until the 1960s, the estimated catch was estimated at 60-400 hunted animals per year. Between the 1960s and the 1980s, the catch record was estimated at 40-150 hunted animals per year, and the population was still declining (Mitchell and Reeves, 1981; Brodie, 1971; Richard and Orr, 1986). This is not in keeping with the results of the first projection using the estimated growth rate that shows almost no risk of decline for catch options of 80-100 animals hunted per year. A retrospective trend analysis made with the estimates of the total population size from the last decade showed a slow increase of this population with recent catches of 35-50 hunted animals per year. This is not in keeping either with the second projection results that show up to 25% risk of decline for a catch option of only 40 hunted animals per year.

In conclusion, there must be an error in one or even both of the growth rates used in the precautionary approach. The estimated growth rate could have been over-estimated due to a potential bias in the calculation of the abundance indices used in the model; a bias is also possible for the use of the correction factor in the estimations. The published growth rate could have been under-estimated due to the probable uncertainties in the species' biological knowledge. The real growth rate is likely to be situated between the two growth rates used in this risk analysis. The conservation issue of the risk analysis is that, in the absence of more precision on the biology and dynamics of the population, this analysis provides a good conservative solution for a management decision.

ACKNOWLEDGEMENTS Thanks to all the Fresh Water Institute staff that work on belugas from near and far, in particular to Jack Orr and Bridget DeMArch. Also a special thanks to Klaus Hochheim, Christine Michel, Kim Howland, Lianne Connyers and Melanie Toyne for their precious help. And finally, I give thanks to my family.

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Table 1. Estimated and published beluga growth rate

	Lower confident limit	*Mean*	*Upper confident limit*
Estimated growth rate	1.04	1.10	1.17
Published growth rate	1.00	1.04	1.07

Table 2. Results of the two projection types

Projection using Cumberland sound beluga growth rate:

Catch options (number of animals hunted per year)	Risk of decline of the population
0 to 50	0%
60	1%
70	1%
80	1 to 5%
90	5 to 10%
100	10%

Projection using Odontocete published growth rate:

Catch options (number of animals hunted per year)	Risk of decline of the population
0 to 20	0%
25	1%
30	1 to 5%
35	5 to 10%
40	10 to 25%
45	25%
50	33%
55	50%
60	50 to 67%

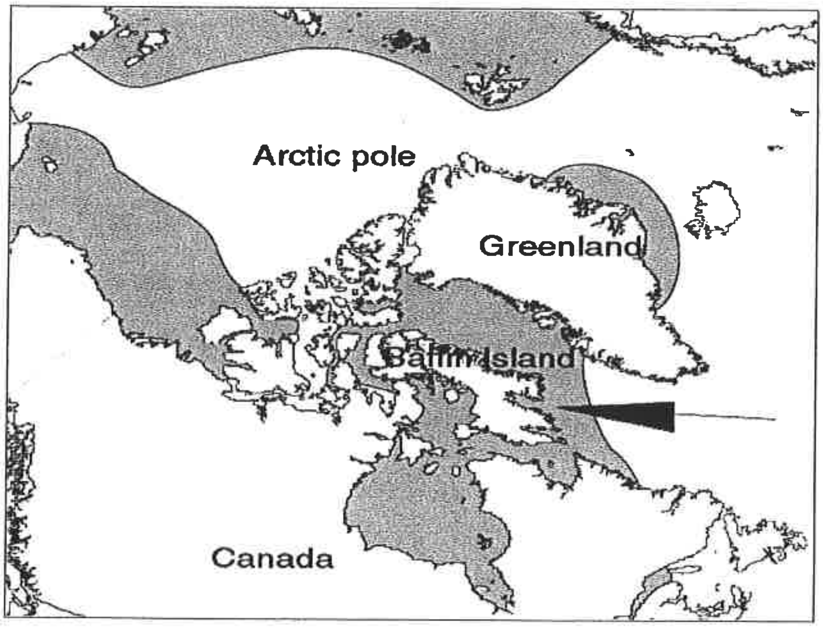

Fig. 1. Cumberland Area and beluga distribution area

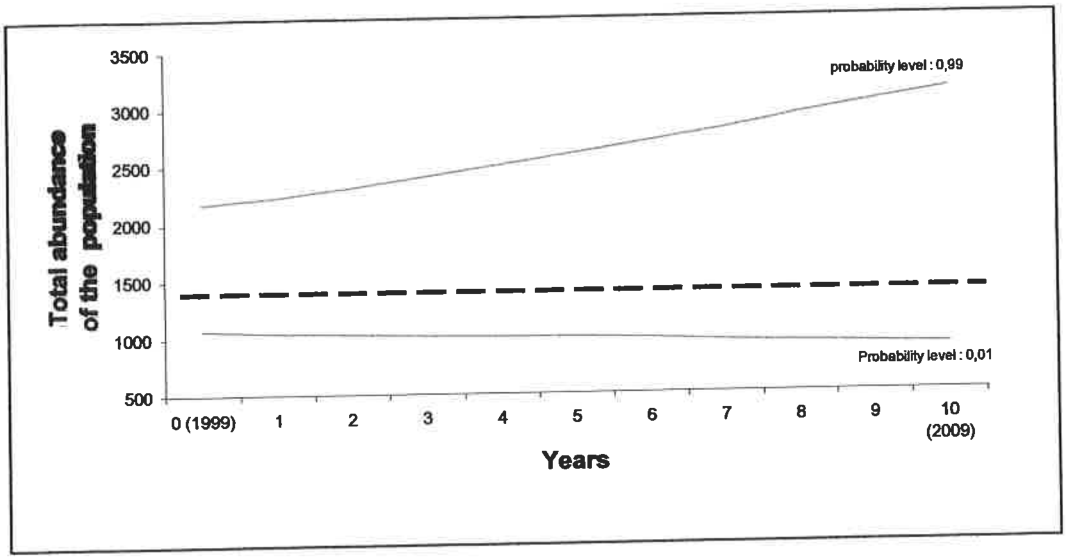

Fig. 2. Evolution probabilities of the population, given by the published growth rate projection with a scenario of 40 animals hunted /year

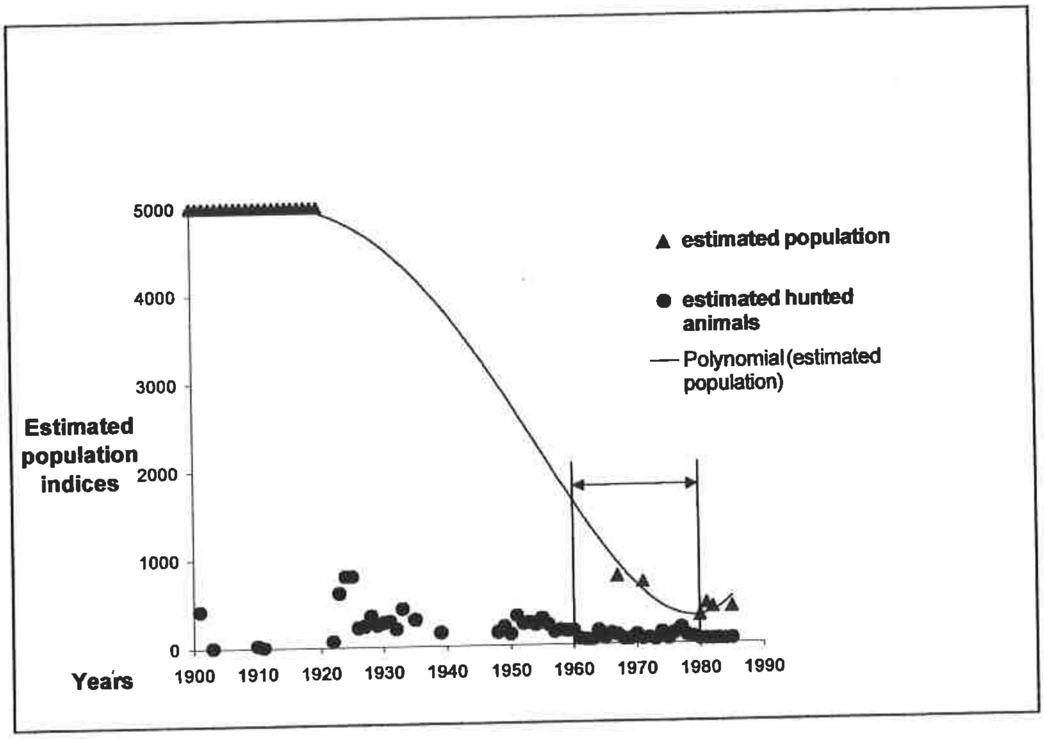

Fig. 3. Dynamics of the Cumberland Sound population before 1986

FIRST EXPERIMENT ON THE FIN WHALE (*BALAENOPTERA PHYSALUS*) VISUAL DETECTABILITY ON BOARD A HIGH -SPEED FRENCH CRAFT IN THE NORTHWEST MEDITERRANEAN SEA

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INTRODUCTION It is well known that most of the Mediterranean fin whale population concentrates, in summer, in the northern part of the Occidental basin. In this season, sea traffic is at a peak, and ships have a high potential risk to collide with large cetaceans. Our goal was, in order to ensure the safety of whales, boats and passengers, to compare how a large cetacean can be detected on board a High Speed Craft (HSC), and on a motor sailing boat.

MATERIALS AND METHODS The experiment took place from 31 July to 06 Aug 1999. During this period, sea state and wind conditions were ≤3 Beaufort. Trips were conducted, applying the line transect method, from Nice (French continent) to Calvi (90 nm) or L'Ile Rousse (Corsica, 96 nm) since these two harbours are very close. The parameters for the HSC were: 14 crossings, 12 of them at 34-36 knots and two at a lower speed, three permanent observers (one scientist and two officers on duty) and eye level at 13 m [range of theoretical detection (rth) = 13 km]; for the motor sailing boat: four crossings at 7-8 knots, three permanent observers and 3 metres for eye level [rth = 6 km].

RESULTS

Numbers of fin whale contacts by travel Although observation effort was 10 times less aboard the HSC [0,107 observer/km^2/minute on the HSC, and 1,012 observer/km^2/minute on the sailing boat], indices of contact of fin whale are similar on the HSC (1,17 contact/travel) and on the sailing boat (1,25 contact/travel), but only if the total angle of observation covered forward was ≤100° (Table 1).

Sightings early in the morning and later when returning Sightings of fin whales aboard HSC were higher when going to Corsica early in the morning (13 sightings, six crossings) than later when returning (five sightings, six crossings) (Fig. 1). The opposite situation was noted on the sailing boat since whales were so numerously observed on both trips: four and six sightings respectively when going or returning, during four crossings.

Attention on board of HSC The crew's attention (two persons) was very accurate in the first 0.5 nm in front of the HSC (75% of their sightings), whereas 62% of the lone scientist's sightings were made beyond (Table 2). This clearly shows that one confirmed observer, focusing his attention on cetacean detection, can be of great help by indicating very early to the crew the located individuals.

Who sees where? Ranges of angles of primary detection indicated that the crew appeared to have a tendency to be vigilant on the right side for fin whale (Fig. 1). Such a tendency was also found for crew detection of small dolphins: 11 sightings werer reported on the right side compared with three on the left for the 14 crossings.

CONCLUSIONS Up to a speed of 36 knots, fin whales could correctly be detected from the HSC, but only on condition that one dedicated observer would cover a total angle not exceeding 100° wide forward. Similar sightings rates were also noted in terms of the mean group size of whales encountered: 1.33 individuals on each boat. The fact that aboard HSC, fin whales are more often detected early in the morning than in the middle of the day has no explanation. It is possible that they move away from the route after the first shuttle service, but we have to confirm this particular behaviour. The disparity observed is not due to meteorological conditions because they never change when going or returning. It is also definitely the case that the reflection of the sun on the sea was not the cause because this disruption was highest early in the morning. It is impossible that the phenomenon is due to relaxation in the watch because passengers and craft security are important rules aboard. More serious is the possibility of a modification in fin whale behaviour during the day. Such a tendency remains to be studied, but we have recorded that fin whale headings were north or south-west early in the morning or in middle of the day, whereas they were south-east later, at least until nightfall. In fact, this observation is already put into practice by some crews who, depending on weather, attempt to return exactly along their outward route.The tendency of the crew to observe on the right side of the HSC can be explained by a) the reflection of sunrise or sunshine on the sea which is always on the left during the crossings, b) due to the ergonomics of the seats, or c) because all the controls are on the right side of the navigation bridge.

A complementary but more detailed study has been set up on board the HSC of the SNCM company (France), to Bastia, Calvi or Ajaccio, from Nice. This work is planned to cover all the 2001 traffic period, that is to say until December, for one week in every two.

ACKNOWLEDGEMENTS We are grateful to the Board, Officers and Crews, of the *Société Nationale Maritime Corse Méditerranée* (SNCM Company), for their logistic support and collaboration.

Table 1. Numbers of fin whale contacts by travel

Forward angle covered	100°	180°
High Speed Craft	1.17	1.25
Motor sailing boat	1.25	2.25

Table 2. Cumulative percentages of primary sightings made on board of the HSC, by kind of cetacean (fin whale/dolphins) and by observer (Sc = Scientist, Cr = Crew).

Distance of detection	FIN WHALE Sc	FIN WHALE Cr	DOLPHINS Sc	DOLPHINS Cr	TOTAL Sc	TOTAL Cr
6 n. milles – 5 – 4 n. milles	100				100	
4 n. milles – 3 – 2 n. milles	87	100	100	100	93	100
2 n. milles – 1 – 0.5 n. mille	69	75	77	93	72	89
0.5 n. mille – 0	38	75	54	79	45	78
Number of sightings	*16*	*4*	*13*	*14*	*29*	*18*

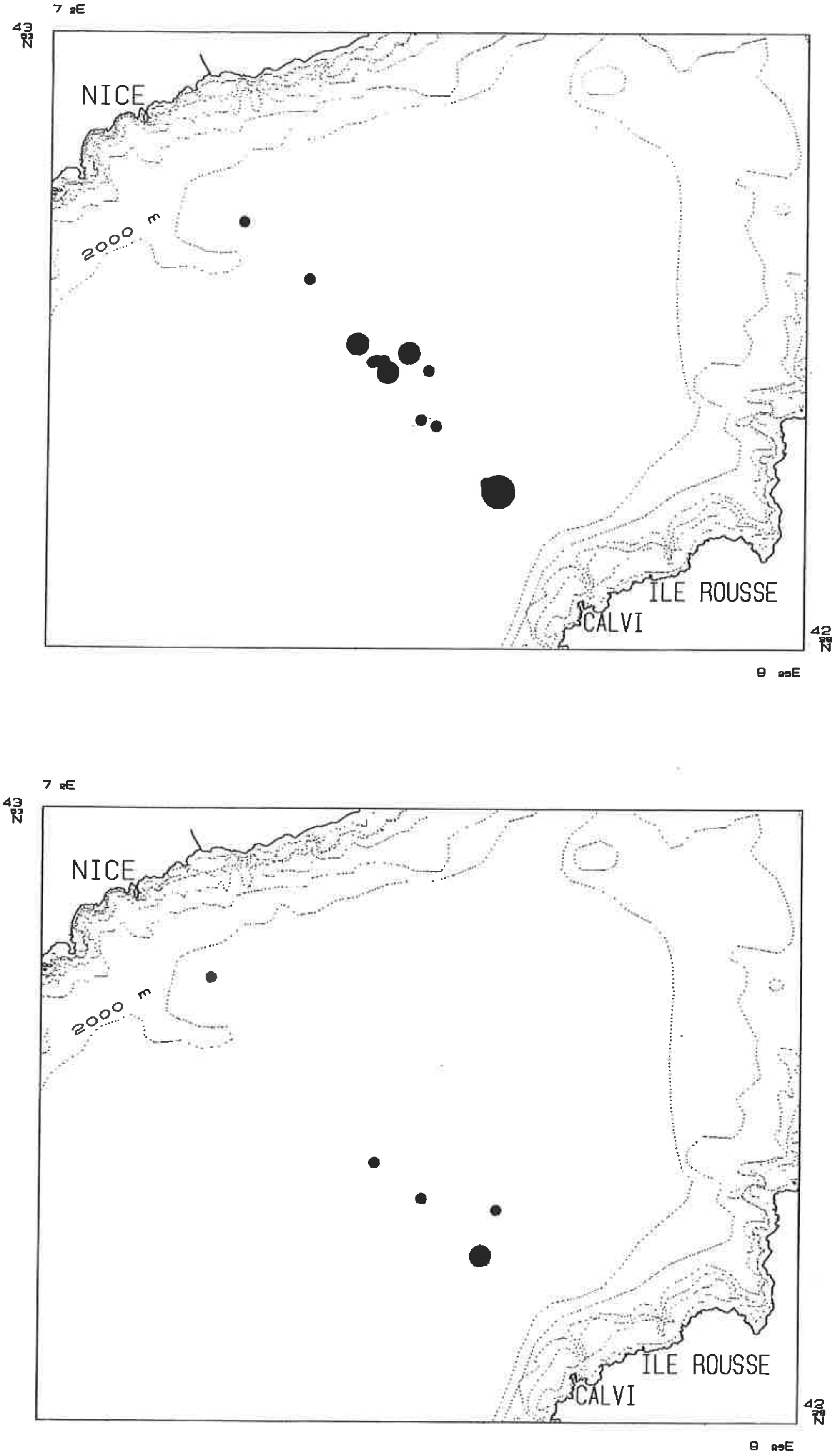

Fig. 1. Sightings of fin whales on board of the HSC:
above – when going to Corsica
below – when returning to France

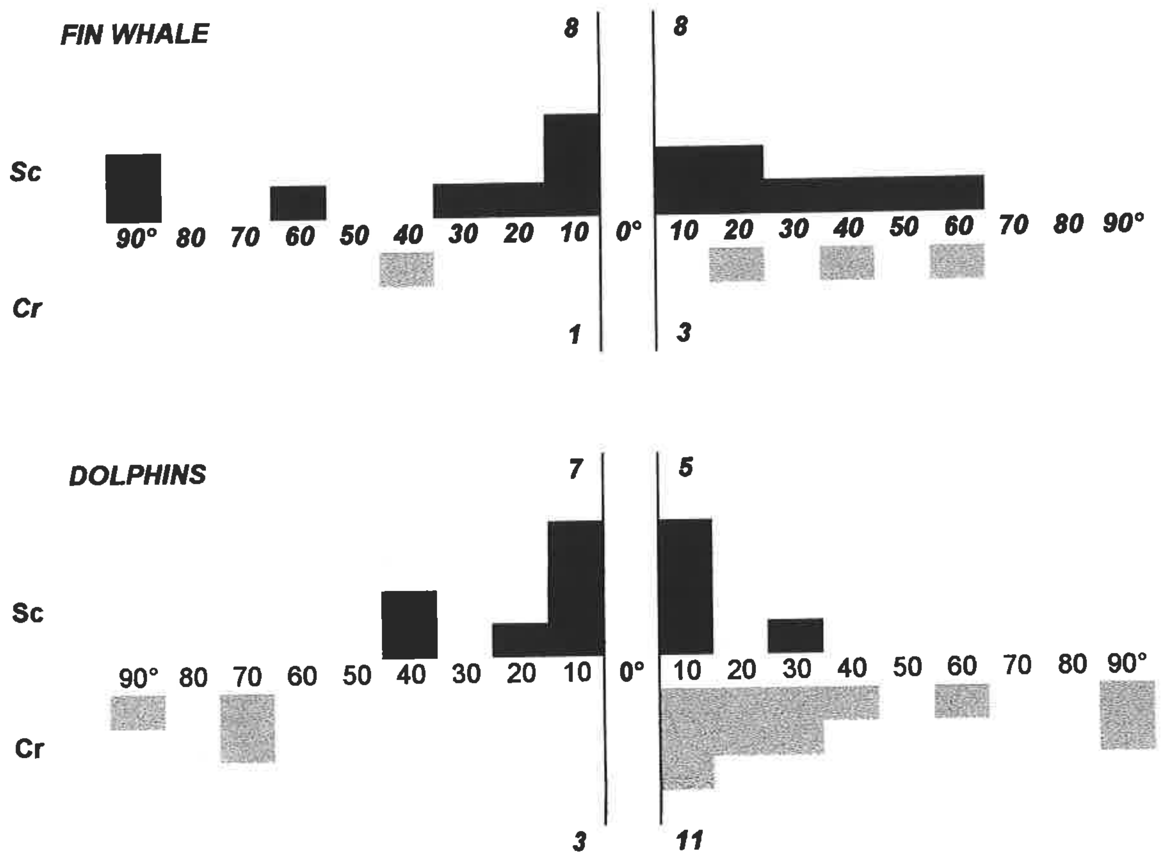

Fig. 2. Compass bearings of cetacean sightings aboard HSC, by type of cetacean (fin whale and dolphins) and by observer (Sc = Scientist, Cr = Crew)

IMPACT OF SAC DESIGNATION ON THE CONSERVATION STATUS OF BOTTLENOSE DOLPHINS *TURSIOPS TRUNCATUS* IN THE SHANNON ESTUARY, IRELAND

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The Shannon estuary is home to the only known resident group of bottlenose dolphins in Ireland and was declared a candidate marine SAC in April 2000. Under the Irish Wildlife Bill (2000) a nominate SAC can be managed as a SAC once declared and advertised locally. Although bottlenose dolphins are listed on Annex II of the EU Habitats Directive, which requires member states to designate sites for their conservation, the main motivation behind the SAC designation was the management of the rapidly expanding dolphin watching industry in the estuary. Commercial dolphin-watching has been actively promoted since 1995. Between 1995 and 1998, around 200 trips per annum carried approximately 2,500 visitors. In 1999, there was a 60% increase in visitors to around 4,000 and in 2000, this increased by at least 300% to over 12,000.

SAC designation has provided a powerful legal framework for the management of dolphin-watching and other threats to the dolphins and their habitat. The Conservation Plan for the estuary includes a list of notifiable activities which require permission from the Minister before they can be carried out within the SAC. These include commercial dolphin-watching, and the Conservation Plan seeks to limit the total time on dolphins. Since SAC status, a number of initiatives have taken place including establishing a management group incorporating stakeholders, local authorities and semi-state and national bodies, and a tour boat monitoring programme. Since SAC status, there has been a huge increase in awareness of the importance of the estuary for dolphins. This has resulted in commissioned research into the impact of some industrial developments on the dolphins, and a study to determine the potential effect of organochlorines on the dolphins.

A review is made of the impact of SAC designation on the conservation status of the dolphins, identifying constraints and assessing whether designation is fulfilling its objectives.

RETINOL AND MARINE MAMMALS

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INTRODUCTION Retinoids, also known as vitamin A, are a group of closely related compounds that include retinol, retinal, retinyl palmitate and retinoic acid, among other minor compounds. Retinol, the main vitamin A compound, is a fat-soluble primary alcohol of low molecular weight; it is an essential nutrient in humans and other mammals. Vitamin A plays a key role in vision, growth, the regulation of the proliferation and differentiation of many cell types and in the maintenance of the reproductive, endocrine, and immune systems (Blomhoff *et al.*, 1991).

Because several chemical pollutants are known to depress body levels of Vitamin A, and thus impair reproductive capacity and immune competence, this group of compounds is foreseen as an informative biomarker for pollutant exposure. Also, in populations whose biology is well known, tissue levels of Vitamin A may be used to infer diet and, indirectly, population identity.

Despite its relevance to the assessment of population status, published reports on Vitamin A tissue concentrations and dynamics in marine mammals are very limited. Here we review the information available to assess the current state of knowledge and identify research priorities.

DISTRIBUTION IN TISSUES

In mammals, the liver is the main storage site for retinoids (50-80% of total in the body). However, extrahepatic tissues such as kidneys, adipose tissue, lung or testis, also play a significant role in the storage and mobilisation of retinol. Due to homeostatic mechanisms, retinol levels in plasma are constant despite the usual variation in dietary supply and reserve stores; they only decrease when storage tissues are extremely depressed. Table 1 shows the distribution of vitamin A in different tissues of pinnipeds.

MAIN BIOLOGICAL FACTORS AFFECTING INDIVIDUAL VARIATION

Similarly to humans and terrestrial mammals, tissue concentration of retinol in marine mammals varies according to at least the following factors:

Sex

Very few studies have addressed sex-related variation of retinol levels in marine mammals. In cetaceans, these are limited to a study on the blubber of harbour porpoises (Borrell *et al.*, 1999) and in pinnipeds to some surveys on the liver and/or blubber of grey seals, hooded seals, harp seals and Australian fur seals (Schweigert *et al.*, 1987, Rodahl and Davies, 1949, Southcott *et al.*, 1974). Differences in retinol levels between sexes appear to vary among tissues and species, but, as a general rule, adult males show higher levels than females (Figure 1). It is likely that lactational transfer from mothers to their calves contributes to this difference (Simms and Ross, 2000).

Age

A positive relationship has been established between blubber retinol and age in harbour porpoises (Borrell *et al.*, 1999) (Figure2). Other data are restricted to pinnipeds, in which there is also a positive relationship between age and retinol levels in liver and/or blubber in most cases (Table 2). This relationship, also observed in humans and other mammals, appears to be the result of a decrease in the circulatory clearance of retinol and other liposoluble compounds with age, coupled with a higher than necessary intake of retinoids via diet, which leads to a build-up of retinylester concentrations with age (Krasinski et al., 1990, Maiani et al., 1989).

Other Factors

Malnutrition, cancer, and disease of the liver and kidney have been proved to decrease retinol levels in humans and rats, but no data are available in marine mammals.

Future research should focus on the effect of age, sex and other biological characteristics of individuals on the retinol tissue levels in marine mammals

EFFECT OF CHEMICAL POLLUTANTS ON RETINOL

A number of organochlorine compounds alter the metabolism of Vitamin A, although the intensity of this effect varies considerably between animal species. In mammals, it has been observed that exposure to PCB, dioxin (TCDD) and

DDTs very frequently leads to depletion of vitamin A storage in different tissues due to increased mobilisation from storage sites, especially the liver, and, subsequently, to increased degradation (Kelley *et al.*, 2000)

In all available studies in marine mammals, relating organochlorine compounds and Vitamin A tissue levels, a decrease in plasma retinol is observed when loads of PCBs or other organochlorines are high (Table 3). According to these studies, and in contrast to rats, vitamin A levels in plasma of pinnipeds decrease after exposure to organochlorine compounds. Unfortunately, other tissues in these animals were not analysed so there are no data on the processes of mobilisation between the various tissues. Presumably, due to homeostatic mechanisms, the retinol depletion caused by PCBs might be much less evident in plasma than in other tissues such as liver or blubber.

Given that past epizootics affecting marine mammals have been associated with high levels of organochlorine compounds and depressed immune competence, retinol levels in the blubber of marine mammal populations may be a potential non-destructive biomarker of exposure to organochlorine compounds, particularly TCDD and PCBs.

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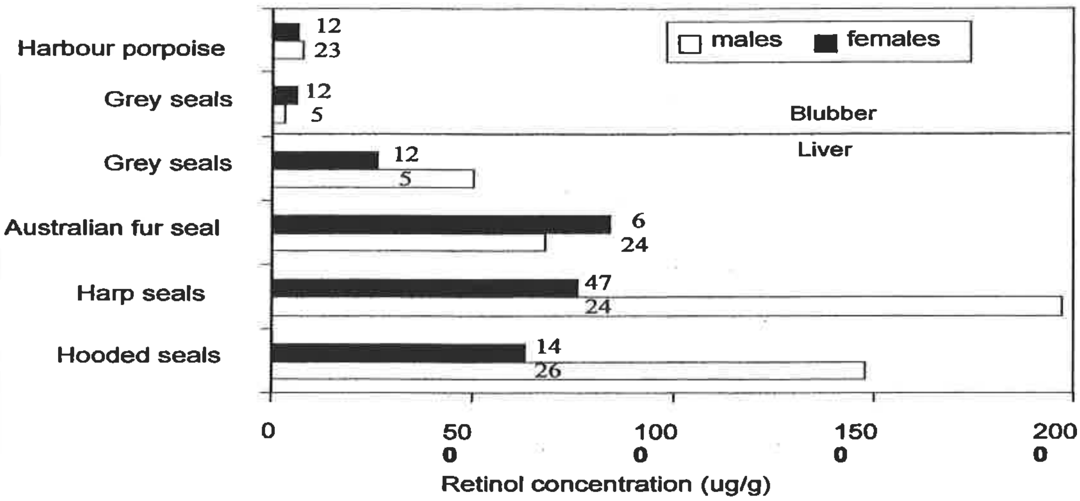

Fig. 1. Comparison between retinol levels (μg/g)
in different tissues of males and females of marine mammals

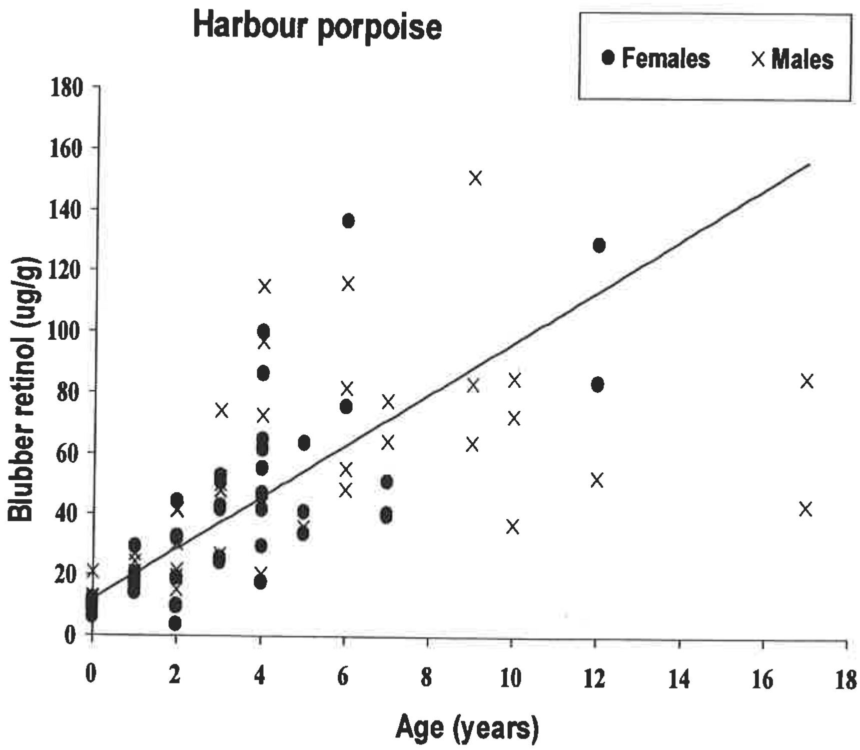

Fig.2. Relationship between blubber retinolconcentration (μg/g)
and age in male and female harbour porpoise from Greenland

Table 1. Levels of retinol (μg/g) in various tissues of different species of pinnipeds

SPECIES	N	LIVER	BLUBBER	SERUM	KIDNEY	LUNG	REFERENCE
Greenland seals	1	720	3.6	-	1.8	0.9	Rodahl and Davis, 1949
Grey seal	6	609±395	45±10	0.2±0.1	8±3	-	Schweigert and Buchholz, 1995
Baltic ringed seals	7-9	175 ±33	21.6±3.4	-	-	-	Käkela et al., 1997
Lake Saimaa ringed seals	12	51± 10	6± 1				Käkela et al., 1997

Table 2. Age trends in liver and blubber retinol levels in different species of pinnipeds

SPECIE	N	LIVER	BLUBBER	REFERENCE
Australian fur seal	24*	↑**		Southcott et al. 1974
Grey seals	65	↑"	↑"	Schweigert et al. 1987
Hooded seals	60	↑"		Rodahl and Davis, 1949
Greenland seals	145	↑"		Rodahl and Davis, 1949
Lake Saimaa ringed seals	12	↓**	↑**	Käkelä et al. 1997
Spitsbergen ringed seals	12	↑	↓	Käkela et al. 1997
Baltic ringed seals	9	↓	↑	Käkela et al. 1997

*only females, **significative $p<0,05$," statistics not performed
↑positive and ↓ negative trend between age and retinol levels

Table 3. Characteristics of the studies indicating a negative relationship between plasma retinol levels and organochlorine pollutant exposure in marine mammals, including the polar bear

Species	Location	n clean	n polluted	Pollutant	Study	References
Harbor seal	captive	12	12	Ocs	Experi-mental	Brouwer et al.1989
Harbor seal	captive	11	11	Ocs	Experi-mental	De Swart et al. 1994
Northern elefant seal	California	17	14	Ocs	wild	Beckmen et al, 1997
Grey seal (pups)	Norway	51/regression		PCBs	wild	Jenssen et al. 1995
"Polar bear"	Svalbard/ Russian Arctic	??/regression		PCBs	wild	Skaare et al, 2000

BREACHING OLD BOUNDARIES - AN INTEGRATED APPROACH TO MARINE MANAGEMENT

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The Moray Firth in NE Scotland hosts a variety of marine-based industries, a large human population and a small population of bottlenose dolphins (*Tursiop truncatus*). In 1996, it was presented as a candidate Special Area of Conservation (cSAC) under the EU Habitats Directive to protect the dolphins. A range of government organisations are responsible for managing the cSAC, and their remit includes a) an inclusive approach, b) public entitlement to input, and c) statutory requirements integrated with the voluntary approach. This study demonstrates how these independent bodies used an integrated, inclusive and voluntary approach to produce and implement a management scheme. The Moray Firth Partnership co-ordinated management scheme. A Management Group, comprising representatives from the relevant authorities, was established to oversee the process. A series of working groups, which included local experts, those involved and other interested parties, were set up to focus on specific activities and produce draft management recommendations. The draft scheme then went to widespread public consultation. Continuous information was provided in a variety of media. Although this approach is time-consuming, difficult and more complicated than simply imposing laws, the benefits are multifold; involving people incurs a sense of ownership and the voluntary approach minimises resistance, both of which provide opportunities, and help ensure compliance. A co-ordinated approach identifies areas of overlap, and provides an integrated rather than piecemeal approach to management Long term results cannot yet be evaluated but in the short-term, co-operation has been excellent and reaction positive, the key areas of concern have been highlighted, public awareness of the issues is greater, and communication between groups has increased. Marine protected areas provide a good focus for management but marine species are often highly mobile, and it is essential that management measures can both extend outside the boundary and be flexible and evolving.

AQUATIC MAMMALS IN SOUTH AMERICA: PROBLEMS AND PROSPECTIVE VIEWS FOR CONSERVATION

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The problems faced by aquatic mammals in South America are much like those they face in other parts of the world, including incidental and direct catch by fisheries, competition for fishing resources, and habitat loss. Most of the species are insufficiently known; with few exceptions, information about abundance and population trends is minimal for most of them. Although most countries have legislation or regulations for conservation, incidental mortality or by-catch are not considered as variables in fishery management models and decision making. At the international level, regional agreements should be promoted between countries sharing similar problems, *e.g.* the Action Plan for the Conservation of Marine Mammals in the Southeast Pacific, signed by five countries. The Atlantic region still lacks such an agreement. Coastal or marine protected areas provide spatially marginal protection. In many cases, however, interaction with humans occurs beyond the reserve borders, and the species is protected only seasonally and within a limited area. In this case the problem seems to have no solution, unless human activities are controlled in some other way. The management of aquatic mammals should be considered within the general context of natural resource management, and even more general political and economical agendas. Increased unemployment and poverty, and decreased educational levels during the 1990s have resulted in reduced state control over private developments and investments with high environmental costs and loss of habitat. Conservation strategies should include highly trained human resources, co-operation between research and conservation groups, agreements at the national level with NGOs and the private sector, international agreements for shared species or habitats, and a balance between international and regional policies. Brazil provides a very important example in the form of an Action Plan and a Standing Committee of experts.

OCCURRENCE, DISTRIBUTION AND HABITAT USE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AROUND THE ISLANDS OF FAIAL E PICO (AZORES)

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INTRODUCTION Previous work suggested the existence of a resident population of bottlenose dolphins (*Tursiops truncatus*) around the islands of Faial and Pico (Azores) (Mendes, 1999).

Since 1999, a programme of monitoring and photo-identification of bottlenose dolphins is being undertaken in the Azores, with particular attention to three Special Areas for Conservation. This programme intends to learn more about the biology and ecology of this population, in order to gain insights that can contribute to a management plan of the population in those particular areas.

The aims of the present study were to determine the occurrence and distribution of the dolphins in the study area, and to assess the habitat use of the population.

METHODS Between March 1999 and November 2000, 102 boat-based surveys were conducted around the islands of Faial and Pico, using a small inflatable boat. Fifty surveys were dedicated to photo-ID corresponding to 130 hours of observation effort, and 52 were opportunistic surveys done with the help of land-based observers from whale-watching operators. Twenty-five hours were spent observing and photographing the animals.

Every time a group of bottlenose dolphins was encountered, the group size was estimated, and behaviour noted before approaching the group. The presence of calves was registered. To study habitat use, the main study area was divided into four sub-areas: North of Faial, South of Faial, South of Pico, and the Channel between Faial and Pico. For each one, a sighting index was calculated based on the number of schools sighted per hour of observation. A re-sighting index was calculated for each season, taking into account the number of surveys with re-sightings in relation to the total number of surveys where bottlenose dolphins were sighted.

Kruskal-Wallis ANOVA was used to study differences on group size related to season. Chi-square tests were used to compare the number of sightings per area, number of groups with calves per season, and number of re-sightings per season.

RESULTS Bottlenose dolphins were encountered in 39% of all surveys, corresponding to 56 schools. Median group size was 9.5 (SE=1,0). A significant relationship was found between group size and season, with larger groups encountered during the summer (Fig. 1).

The frequency of occurrence of animals in the four sub-areas was different. The channel was the area preferred by the animals where the most common behaviour was feeding.

The analysis of photograms resulted in a catalogue with 441 photos, corresponding to the best photos of 94 individuals. Twenty-four of these individuals were re-sighted in consecutive surveys, with a total of 69 re-sightings, distributed across all seasons. No significant differences were found in the re-sighting rate per season (Fig. 2).

Groups with calves were seen in every season. A significant relationship between groups with calves and season was found (Fig. 3).

DISCUSSION Median group size was 9.5, which is lower than the value found by Mendes (1999) for the same area. However, we should remember that this author's work was conducted during spring and summer, and in the present work, group size was found to be dependent upon season, presenting larger values for the summer. In addition, her study area was considerably larger, and included offshore areas, and thus had higher probability of encountering oceanic populations with larger group sizes. Our estimation of group size is in agreement with other values given for coastal populations of bottlenose dolphins (Acevedo-Gutiérrez, 1999).

Most of the animals were sighted in the channel between the islands of Faial and Pico. The topographic characteristics of this area are responsible for the formation of strong currents and turbulent zones. Other authors documented a preference by bottlenose dolphins for areas with the same characteristics (Lockyer and Morris, 1986; Liret *et al.*, 1994; Wilson, 1995).

Most of the 24 individuals re-sighted were seen more than once, several months apart. This suggests that those individuals use the study area regularly, showing some degree of residency.

Re-sightings were distributed across all seasons, and no significant differences were found between seasons. However the re-sighting index was lower in the summer, which could suggest seasonal movements within the Archipelago. Alternatively, this may be explained by the presence of oceanic groups that come nearshore during that season while feeding or travelling. This is consistent with group size being larger during the summer.

Previous work indicates a reproductive peak in spring and autumn (Scott *et al.*, 1990), which does not occur with our data. Groups with calves were seen in every season, most of them occurring in summer and winter. Spring had the lowest values. Absence of data on age or length of the calves prevents us from predicting the season of their birth. We may not see them, often because they are small and do not approach the boat. On other hand, the temperate climate of the Azores might enable occurrence of births all year around. However, this is a subject that needs to be further investigated.

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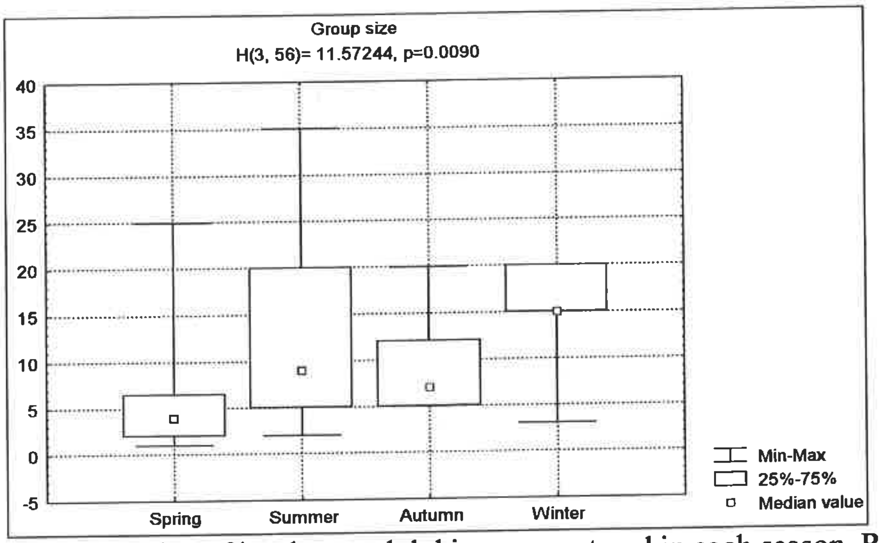

Fig. 1 – Median group size of bottlenose dolphins encountered in each season. Results of Kruskal-Wallis ANOVA are presented in the graph.

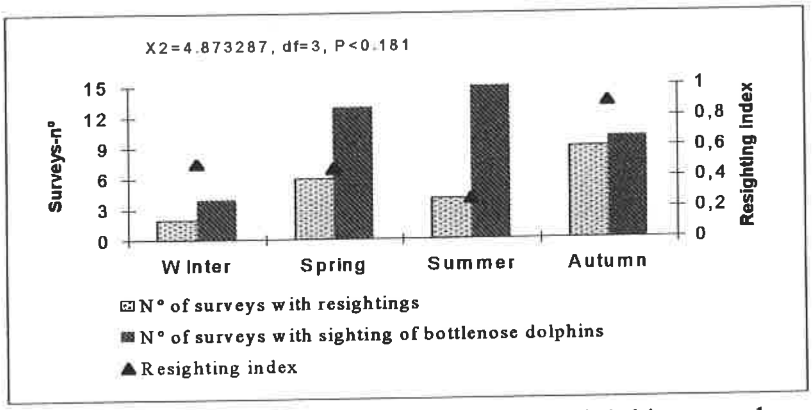

Fig. 2 – Number of surveys with sightings of bottlenose dolphins, number of surveys with resightings and resighting index per season. Results of Chi-square test are presented.

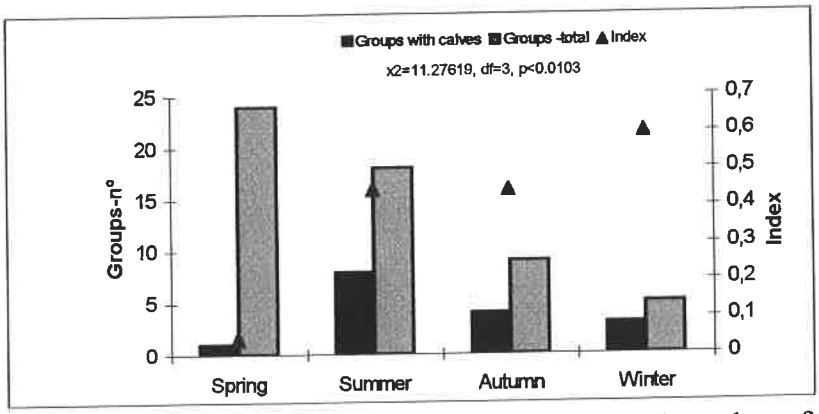

Fig. 3 – Number of bottlenose dolphin groups encountered and number of groups with calves per season. Results of Chi-square test are presented.

HEAVY METALS IN GRAY WHALES (*ESCHRICHTIUS ROBUSTUS*) AND IN SEA WATER AND SEDIMENTS OF OJO DE LIEBRE LAGOON IN MEXICO

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The concentration of 12 elements (copper, zinc, iron, manganese, lead, vanadium, nickel, chromium, cadmium, mercury, arsenic and selenium) were measured in skin, bone, muscle and kidney of eight gray whales (*Eschrichtius robustus*) stranded during the 1999 breeding season on the coast of Ojo de Liebre Lagoon in Mexico, which forms part of the "El Vizcaíno" Biosphere Reserve.

The gray whale has a unique feeding strategy among Mysticeti, of filtering sediments to obtain food. In recent years, this feeding behaviour has been recorded inside the lagoon. The concentration of lead from all tissues was significantly higher compared with previous studies. Copper, zinc, iron, manganese, lead, vanadium, nickel and chromium were also measured from the sediments; and copper, lead, and mercury from the water of the lagoon.

From the sediments and water, it was determined that the levels of copper were also significantly higher compared with those reported elsewhere. The lead concentrations in tissues were then correlated with that of water and sediments, in order to establish if there was a relationship between the concentration of this metal from tissues of the whales and those from the sediments and the water. The same was done in the case of copper. Further, the results showed that there was no statistically significant correlation between the concentrations. It could therefore be established that the higher levels of lead in tissues showed little relationship to the levels of lead from the lagoon. For copper, it could be established that despite the higher concentrations of copper from the lagoon, the whales do not bio-accumulate the metal into their tissues to reach toxic levels.

MONITORING OF *TURSIOPS TRUNCATUS* POPULATIONS IN SIX DIFFERENT MARINE PROTECTED AREAS

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INTRODUCTION The riparian states of the Mediterranean Sea, conscious of the economic, social, health and cultural value of the marine environment of the Mediterranean Sea area, fully aware of their responsibility to preserve and sustainable develop this common heritage for the benefit and enjoyment of present and future generations, recognising the threat posed by pollution to the marine environment, its ecological equilibrium, resources and legitimate uses and mindful of the special hydrographic and ecological characteristics of the Mediterranean Sea and its particular vulnerability to pollution, have agreed in 1975 to launch an Action Plan for the Protection and Development of the Mediterranean Basin (MAP), and in 1976 to sign a Convention for the Protection of the Mediterranean Sea against pollution (Barcelona Convention).

In 1992, with the Habitats Directive, the fundamental purpose is to establish a network of protected areas with the aim of maintaining the widest distribution of threatened habitats and species, among which are the bottlenose dolphin.

In 1995, phase II of the Action Plan was adopted for the protection of the marine environment and sustainable development of the coastal areas of the Mediterranean as well as substantial amendments to the Convention and their Protocols regarding also 19 marine mammal species.

In 1996, the Agreement of the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area is aimed at the conservation of cetaceans in these regions and pay special attention to the creation of MPAs (Marine Protected Areas) to achieve this (ACCOBAMS) (Bou, 1995,1999).

Although killing of cetaceans in Mediterranean waters is illegal, many die after becoming entangled in fishing nets, buoy-nets and long-lines. A less obvious threat is ghost nets – large amounts of fish netting lost at sea which may drift for years, entangling marine life. There are a host of other threats to cetaceans including ship strikes, oil spills and chemical pollutants, acoustic pollution from vessels, and the depletion of cetacean food stocks through commercial fishing operations.

Cetaceans are particularly vulnerable to broad-scale changes in the marine environment because of their high positions in marine food chains (Wells, 1991). Furthermore, cetacean populations are difficult to monitor, making it hard to evaluate the effects of threatening activities on populations.

Because of this lack of information about cetaceans, and the uncertainty about their status, the Nature Conservation Department of CTS start a research activity in some coastal marine areas with the aim to have a better knowledge of cetacean populations and status changes in order to understand the influence of threats on any changes in status detected. In fact, the study of the relationship between distribution and abundance of wildlife and habitat parameters (environmental variables) is needed for decision makers regarding the management of natural resources (Hui, 1985).

MATERIALS AND METHODS Since 1996, the Nature Conservation Department of CTS, an Italian environmental organisation, started the "Bottlenose Dolphin Project" by preliminary surveys along the coasts of Maddalena Archipelago National Park, Villasimius, Tuscan Archipelago National Park, Tavolara Island, Gonone Bay in Sardinia and Pelagie's Archipelago in Sicily; all those areas represent coastal or marine protected areas. The "Bottlenose Dolphin Project" started to collect systematic data on trace metal and organochlorine contamination on stranded dolphins in order to determine causes of mortality (Podestà *et al.*, 1997), and to examine the tissues of new stranded animals.

What are the objectives of the "Bottlenose Dolphin Project"?

- Increase knowledge on dolphin populations, including degree of residency in the areas, to estimate their population size and habitat use, and to examine the dolphins' behaviour;
- Define conservation measures for the species;

- take action to reduce the incidental mortality of marine mammals;
- reduce or manage the effects of disturbance on marine species of conservation interest, arising from use of the marine and coastal environment;
- reduce adverse environmental impacts on the key habitats of marine or marine-dependent species.

"Bottlenose Dolphin Project": 417 sightings were made and 1,375 animals were observed. Figure 1 shows the increase of dolphin sightings during the years of the Project.

Now, effort is made to define rigid criteria from habitat studies well-suited for long-tem conservation; these activities and data from different areas will be processed using a multiscale GIS (Geographical Information System). Such a tool allows one to relate some environmental parameters to the intensity of spatial utilisation of the bottlenose dolphin *Tursiops truncatus* (Liret *et al.,* 1999).

RESULTS In the study areas, our observations have demonstrated that the dolphin population is stressed by:

Fast ferries The fast ferry industry is growing more rapidly than any other sector of the world transport market; fast ferry services now operate in many areas of known cetacean abundance, and there is evidence of their noisy presence. Dolphins inhabiting a largely enclosed sea area surrounded by vertical rock faces and subjected to regular fast ferry traffic might well be vulnerable. Sound propagation in deep water is also likely to be quite different (Browning and Harland, 1999).

Noise pollution It is internationally recognised that noise pollution is a far more threatening form of pollution for cetaceans than previously believed: cetaceans are dependent on their auditory capacity for communication and geographic identification. Interference with this ability is a potential threat to survival (Evans, 1996).

Fishing activities Dolphins following trawlers and feeding on their by-catch: this opportunistic feeding behaviour was observed in all the study areas. This point was carefully checked and it was noted that each population uses different behavioural patterns (Corkeron *et al.*, 1990; Fertl, 1994).

Fish farm Bottlenose dolphins were observed foraging near fish farm cages near Tavolara island, Villasimius, and alongside the Lampedusa coastline. The behaviour was studied in a total of 100 hours of observations in the three areas. Bottlenose dolphins may have learned in recent times to take advantage of this new food source. This fish farm industry appears as a major source of pollution and degradation within cetacean habitats (Parsons *et al.,* 1999).

Shipping The southern regions of Maddalena Archipelago National Park and Bonifacio Straight are specially important maritime areas with a substantial volume of commercial and recreational shipping activity. Shipping can impact cetacean populations through collisions and noise disturbance (Evans, 1996)

Some incidental takes were observed at Lampedusa island. One dolphin that was foraging along a fish farm was killed from a collision.

In all the study areas, it appears that the dolphins were sighted especially in the morning hours of the day, when shipping is less present.

CONCLUSIONS The current human activities within these marine protected areas represent a threat to the populations of cetaceans living there; however, continued management is required to prevent losses from potentially threatening activities, such as increases in gill net and drift net fishing. Regionally, potential threats to cetaceans include oil spills, accidental capture in fishing nets, pollution, and uncontrolled ecotourism.

Those direct sources of mortality or damage are fairly linear, with potential causes and effects readily envisioned. There remain, however, other activities or management actions that impact upon populations in ways not anticipated. Such unintended consequences may not be apparent for long periods of time and may even result from decisions initially taken in the best interests of a population. Understanding or predicting these effects often requires more knowledge of ecosystem structure and function than has been available.

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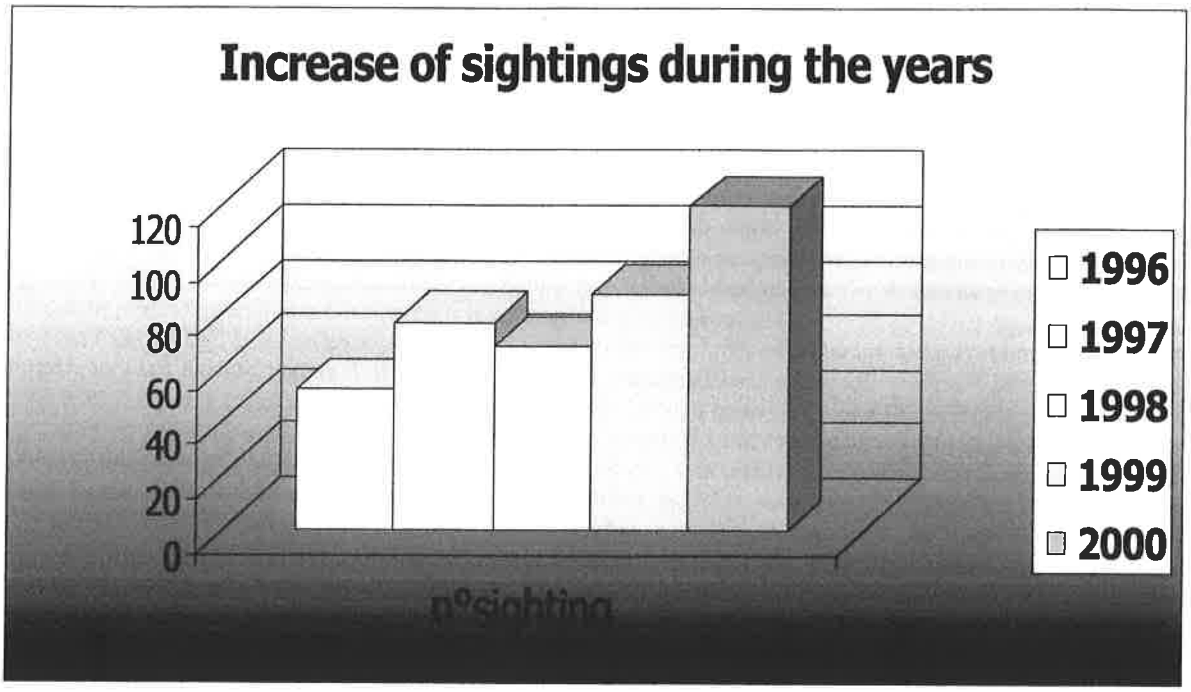

Fig. 1. Changes in bottlenose dolphin sightings rates, 1996-2000

NATIONAL MARINE PARK OF ALONNISOS, NORTHERN SPORADES: EVIDENCE ON THE EFFECT OF *IN SITU* PROTECTION ON THE MEDITERRANEAN MONK SEAL POPULATION

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The Mediterranean monk seal, *Monachus monachus*, is a critically endangered species (IUCN, 1996). Its world population is estimated to be 400-500 individuals, with two main surviving groups in Greece in the Eastern Mediterranean, and in Mauritania and Morocco on the Atlantic coast of Northwest Africa (Reijnders *et al.*, 1993). In Greece, the species is widely distributed in both Aegean and Ionian seas (Adamantopoulou *et al.*, 1999). The highest priority and the most effective conservation measure for the species is considered the *in situ* protection of important monk seal populations through the creation of a network of Special Areas of Conservation. The first such area in the Mediterranean is the Northern Sporades island complex in Greece, where the National Marine Park of Alonnisos Northern Sporades (NMPANS) was established in 1992. Since its establishment and up to the present date, a number of projects have been implemented as necessary elements of an effective management plan. Two key projects are the guarding of the area against illegal activities, and the monitoring of the seal population. The guarding project has resulted in gradual but significant reduction of illegal activities ,and an almost complete cessation of human activities within the Core Zone of the Park. In parallel, the analysis of the data collected on the status of the monk seal population showed a high pup survival rate (84% for the first two months of the pup's life), and a significant increase of the use of terrestrial habitat and of birth numbers especially in the Core Zone. Thus, the results of the above-mentioned projects show a positive effect upon the status of the monk seal population in the area. This is the first concrete evidence for the effect of *in situ* protection on this highly endangered species.

MANAGEMENT OF HECTOR'S DOLPHIN IN NEW ZEALAND

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Hector's dolphin, *Cephalorhynchus hectori*, is New Zealand's only endemic cetacean, with a population in the low thousands. Its habitat is shallow, turbid coastal waters, and it is therefore especially vulnerable to entanglement in bottom-anchored gill nets (set nets). The small remnant population in the North Island (most likely <200 animals) is genetically distinct from the much larger South Island population. Conservation management of Hector's dolphin is a high priority for the New Zealand government, especially since the development of the New Zealand Biodiversity Strategy. Two government agencies are involved - the Department of Conservation and the Ministry of Fisheries. Management strategies have drawn on elements of both the Marine Mammals Protection Act 1978 and the Fisheries Act 1996. Voluntary measures have also been adopted by some commercial fishers (including the use of acoustic warning devices or 'pingers' specifically developed for Hector's dolphin). Establishment of New Zealand's first marine mammal sanctuary at Banks Peninsula in 1988 under the MMPA has been complemented in the South Island by area closures under the provisions of section 15 of the Fisheries Act, which allows the Minister of Fisheries to set Maximum Allowable Levels of Fishing-Related Mortality for marine mammals accidentally taken in commercial fishing operations. In the North Island, an extensive consultation process involving government officials, fishers and environmental groups has resulted in a consensus proposal to close off most of the known habitat for remaining dolphin pods to all commercial and recreational set net use. A comprehensive research programme is underway in the North Island to learn more about this remant population and its trends.

ESTABLISHING METHODS TO MEASURE THE QUALITY OF BOTTLENOSE DOLPHIN HABITATS IN A SPECIAL AREA OF CONSERVATION IN WALES

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A candidate Special Area of Conservation (cSAC) has been established in Cardigan Bay, Wales for its resident bottlenose dolphin population. Effective management requires better knowledge of the key factors influencing the condition of bottlenose dolphin habitats and distribution of potential prey species in the region. This project trialled methods for a) determining the distribution and abundance of potential benthic fish prey species within and adjacent to the cSAC; b) determining any correlation between benthic prey species and their abundance in relation to habitat type; and c) assessing the distribution of the dolphins with regards to benthic prey abundance using GIS. Forty-six beam trawls were conducted over seven substrata types between February and September 2000. Substrata were identified primarily from previous RoxAnn acoustic discrimination. A total of 37 fish species were identified. Most fish were benthic species, the exceptions being herring (pelagic), Norway bullhead, cod, and poor cod (all midwater/benthic). The six most abundant species were dragonet, solenette, poor cod, scaldfish, grey gurnard, and spotted ray; and, in terms of biomass, poor cod, plaice, dragonet, spotted ray, solenette, and lesser spotted dogfish.

Overall abundance of the main species, and species diversity, were highest in the eastern part of the management area where effort-corrected bottlenose dolphin sightings were also greatest. Using GIS, the relationships between various environmental parameters, bottlenose dolphin and benthic fish distributions were examined. Multivariate analyses indicated a relationship with differences in seabed surface roughness rather than substratum type alone. Individual species substratum preferences were also detected, although mainly in terms of negative preferences. To better understand what determines dolphin distribution in the cSAC, sampling is recommended at select nearshore locations known to be favoured by dolphins where substratum mapping has not been conducted; and other fishing methods adopted that sample pelagic potential prey species like bass and sea trout.

THE POSITIVE PSYCHOLOGICAL IMPACT OF WHALE WATCHING – AN INVESTIGATION INTO CHANGES IN THE PERCEPTIONS OF ECO-TOURISTS OVER THE COURSE OF WHALE-WATCHING EXCURSIONS IN TENERIFE, CANARY ISLANDS

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A great deal of anecdotal evidence exists in most popular media for the psychologically or physiologically restorative effects of human interactions with cetaceans, but little theoretically grounded research exists to back these claims. This study utilised the transactional model of stress and emotion to analyse the psychological impact of a common recreational activity involving cetaceans, whale-watching. A quasi-experimental one-group pre-test-post-test design was used to investigate the effects of a whale-watching experience, aboard eco-tourism vessels operating from the south-west coast of Tenerife, on tourists' perceptions of their environment, mood, and health concerns. Already validated psychometric measures of primary appraisal, state affect, and health anxiety and symptom/treatment experience, were distributed to 189 tourists at two stages in their excursions: as they waited on the boat prior to departure (pre-test) and again after they had seen whales and/or dolphins from the boat (post-test). Paired-sample t-tests revealed significant changes in all psychological factors measured between pre-test and post-test. Appraisals of potential for loss and threat in surroundings fell, as did unpleasantness of state affect, and health concerns. Appraisals of challenge in one's environment rose, as did arousal level of mood. However, the tourists' scores regarding symptom/treatment experience did not change, suggesting that the observed effect is working on people's perceptions of health and illness, and not altering long- or short-term memory of symptom experience. Additionally, several possible mediators of these perceptual changes were examined. Trait anxiety levels amongst the sample were found to interact significantly with changes in primary appraisal from pre- to post-test. These results suggest that the experience examined appears to have a positive psychological effect on tourists, and may have applications in health psychology. Limitations of this study are discussed, and implications for future psychological and health research are tentatively mapped out.

INTERACTIONS BETWEEN FISHING ACTIVITIES AND CETACEANS IN THE NORTHERN ATLANTIC COAST OF SPAIN

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During 1999 and 2000, we studied interactions between fishing activities and cetaceans on the north-east coast of Spain. According to previous studies, this area has the highest level of conflict in Iberian Atlantic waters.

In Cantabria, these interactions appear to be limited to a few harbours, while in the Basque Country (Fig. 1) they are more widespread. Consequently, this study focused on eight harbours on the Basque coast chosen because they have the largest fishing fleets.

To monitor the most conflicting fishing operations, we interviewed:

- 107 fishermen, two of whom were interviewed on board fishing vessels, to assess the attitudes of fishermen towards this interaction and to evaluate the magnitude of the conflict.
- 13 students of the Marine Fisheries Polytechnic Institute of Pasaia, to ascertain the attitudes and degree of awareness about the conflict among those students expecting to become fishermen in a few years.
- 114 students of two secondary schools located in fishing towns, to determine the awareness of the youngest population with regards dolphin conservation and conflicts.

Of the fishermen interviewed, 58% reported that they deliberately kill dolphins for human consumption (Fig. 2). This activity was particularly frequent among those involved in the tuna fishery, in which vessels remain offshore for long periods. In most cases, dolphins are killed simply as a source of fresh meat. However, dolphins are also taken even when boats return daily to harbour. Only 2% of fishermen denied the existence of these practices, and 40% refused to answer. It is thought that a proportion of those who did not answer knew about these practices and were very probably involved in them. No significant differences in answers were found between ports.

Among the fishermen who admitted to hunting dolphins, the majority reported that this was an occasional practice, except in one of the ports (Orio), where most considered this a relatively frequent practice and, on occasions, very frequent (Fig. 3).

Fishermen from five of the eight ports surveyed estimated that deliberate dolphin kills were restricted to some boats, while in the remaining three ports, these practices appeared to be widespread (Fig. 4).

Bottlenose dolphins (*Tursiops truncatus)* seem to be the preferred target species, and account for about 20-50% of dolphin kills. Common *(Delphinus delphis)* and striped dolphins *(Stenella coeruleoalba)* are overall more frequently killed but, because their populations are much larger, the impact of this practice is probably smaller.

Dolphins are mostly hunted using a toggle harpoon, which along the coast is known as "*delfinera*" (indicating that this harpoon is for this specific purpose, since "delfín" means dolphin in Spanish). Most vessels carry several of these harpoons and, frequently, each fisherman has his own.

In the Marine Fisheries Polytechnic Institute of Pasaia, 54% of students were aware of deliberate dolphin kills for human consumption in the Basque Country, but considered it only an occasional practice.

The interviews also reflected the occurrence of some incidental catches of dolphins. Of the 107 fishermen interviewed, 32 (30%) reported having found dolphins entangled in their gear during the previous year. The purse seine fishery accounted for 72% of these entanglements (n=23).

Of the secondary students surveyed, 86% reported that cetaceans were in danger of extinction, and 99% believed that protection was necessary. 60.5% of these secondary school students identified deliberate kills as one of the main conservation problems that affect small cetaceans in Spanish waters. It is worth noting that 25% of these students had at least one close relative who was a fisherman.

The bottlenose dolphin is a protected species both by Spanish national regulations and international agreements. However, since kills take place offshore and the dolphin meat is not commercialised, the control over, and regulation of, these activities are difficult to enforce.

Awareness programmes directed to the collectives involved, that is to say, fishermen and their close relatives, are considered the main instrument by which to reduce deliberate dolphin catches. Funded by the Ministry of the Environment (Directorate for Nature Conservation), The Marine Mammal Research Group of the University of Barcelona is currently assessing the usefulness of educational campaigns to mitigate this conflict in the Basque country.

ACKNOWLEDGEMENTS This study would not have been possible without the collaboration of fishermen. We are also grateful to all the members of the fieldwork team that participated in the collection of data, especially R. Casals and M. Gilabert. This study was funded by the Spain's Ministry of the Environment (Directorate of Nature Conservation) and the Government of the Balearic Islands.

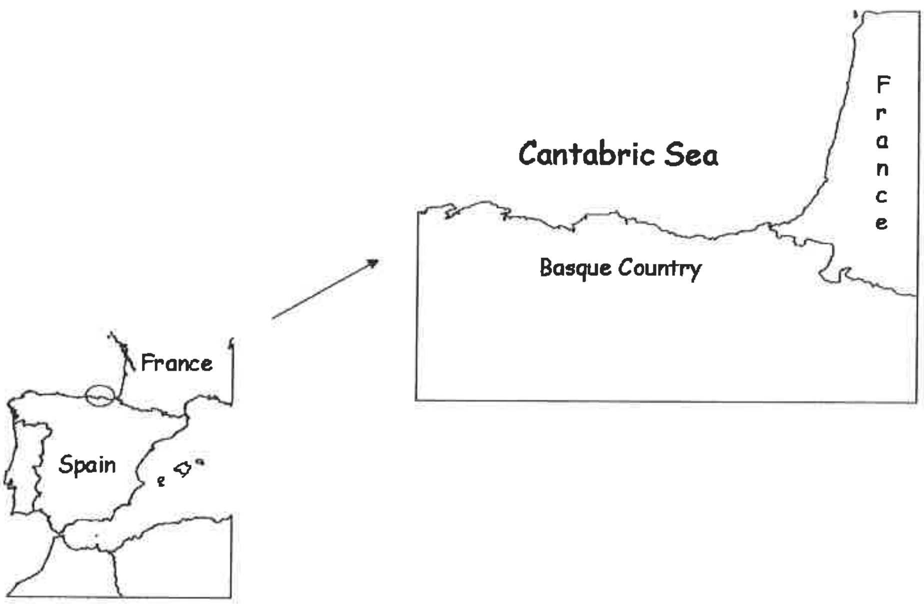

Fig. 1. Study area (Basque country)

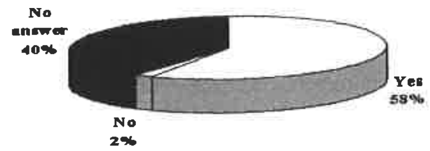

Fig 2. Answers to the questions wether dolphin are caught for human consumption in the interviews to fishermen

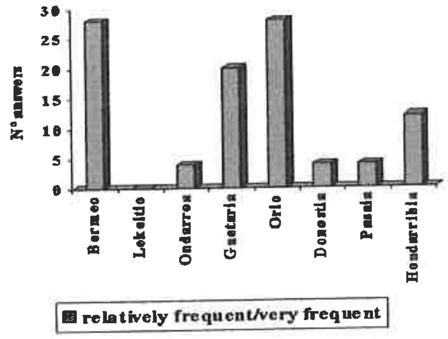

Fig 3. Frequency of deliberated dolphin kills for human consumption in different harbours

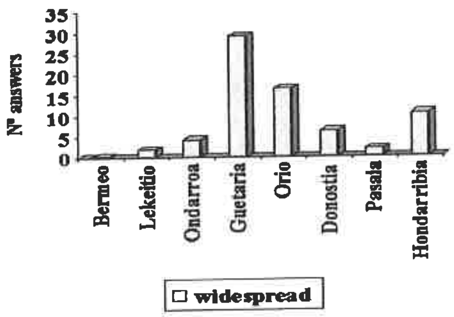

Fig 4. Extension of deliberated dolphin kills for human consumption in different harbours

CETACEANS STRANDING IN MADEIRA ARCHIPELAGO (PORTUGAL) FROM 1991 TO 2000

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The Madeira Whale Museum started in 1991 to collect information on the stranded cetaceans in the Madeira archipelago, with the objectives of gathering general information on the biology and ecology of the species present in the archipelago's waters. From 1996 onwards, a stranding network was established with the help of the authorities and volunteers. The work went a step forward to trying to identify the causes of death and possible human threats to the cetaceans on post-mortem exams.

Between 1991 and 2000, fifty strandings were recorded in the coasts of the archipelago (Madeira, Porto Santo, Desertas and Selvagens Islands). Most of the animals were identified down to the species (n=43). These were from the following nine species: fin whale *Balaenoptera physalus* (1 animal), minke whale *B. acuturostrata* (2), pygmy sperm whale *Kogia breviceps* (2), sperm whale *Physeter macrocephalus* (5), Sowerby's beaked whale *Mesoplodon densirostris* (1), Cuvier's beaked whale *Ziphius cavirostris* (4), short-beaked common dolphin *Delphinus delphis* (22),spotted dolphin *Stenella frontalis* (2) and bottlenose dolphin *Tursiops truncatus* (4). The remaining seven animals were identified down to genus (1 - *Balaenoptera*), family (4 - Delphinidae and 1- Ziphiidae) or suborder (1-odontocete).

It was not possible to do a full post-mortem examination in 52% of the animals. For the ones that an examination was performed, 46% died of natural causes, 29% of confirmed causes related to human activities (direct killing, acoustic impact, ship collision, or ingestion of plastics) and 25% were suspected of being anthropogenic-related deaths.

All deaths of confirmed or suspected human origin (12) occurred between February and May, with one exception, in August. The stranding of animals dying of natural causes peaked in February and April, most of them in poor nutritional state. The anthropogenic-related cetacean deaths in Madeiran waters are of different origins, with nearly half of them being intentional (almost all of them dolphins), although there is no local tradition in killing dolphins for meat consumption or for other use.

INTERACTIONS BETWEEN BOTTLENOSE DOLPHINS AND ARTISANAL FISHERIES IN THE BALEARIC ISLANDS: MAY ACOUSTIC DEVICES BE A SOLUTION TO THE PROBLEM?

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INTRODUCTION The bottlenose dolphin (*Tursiops truncatus*) is the most common cetacean around the Balearic islands. Its coastal occurrence, together with the fact that the artisanal fleet operates near the coast, facilitate the occurrence of severe interactions between this cetacean species and fishing activities. Dolphins take fish from trammel and gill nets, producing losses to the fishing industry and damage to the gear; this results in harassment and deliberate dolphin kills by fishermen. Moreover, some dolphins die when they become entangled in the nets when approaching them to consume fish. A study carried out by the GRUMM of the University of Barcelona in 1992-95 showed that about 30 bottlenose dolphins die around the Balearic Islands every year as the combined result of entanglements and direct kills. In October 2000, a project was started to assess the effectiveness and practicality of using acoustic devices (pingers) to keep dolphins away from the nets and, in this way, reduce both entanglements and damage to the gear.

Acoustic devices For the study, we used Aquamark 100 pingers, distributed by Aquatec Subsea Limited (UK). Once activated by being submerged underwater, the devices emit eight wideband frequency-modulated waveforms with harmonic energy in the 20 kHz to 160 kHz band. Devices measure 150 x 45 cm and weigh 400 g. Pingers were mounted inside a plastic hose to protect them from physical damage. They were attached to two floaters to ensure neutral buoyancy.

Experimental design The study was conducted in the waters around the Bay of Alcudia (Fig. 1). Fishing vessels were based in the harbour of Alcudia, Mallorca (39º50'39''N – 003º08'25''E) and made daily fishing trips. A first survey was conducted between October-November 2000 during the red mullet (*Mullus surmuletus*) fishing season. This fish is considered a main prey of bottlenose dolphins. A second survey took place in February-March 2001 during the fishing season of the cuttlefish (*Sepia officinalis*). This species is not believed to be an important prey for dolphins although they are attracted to the gear by the presence of other fish species that are secondary targets of the gear. Table 1 shows the characteristics of gear type and fishing practices.

Pingers were attached at the float line of trammel nets every 150 metres. In this way, no part of the net was more than 75 m away from a pinger. Thus, 20 pingers were used for 3000 metres of net. To avoid the influence of fishermen on the outcome of the experiment, we included a control set of nets that were equipped with pingers that were not functioning. The crew of the fishing vessels did not know which of the sets of pingers was operating and which was only fake. In addition, a third set of nets without pingers was used as a non-pinger control group.

To establish the effectiveness of pingers, the following variables were controlled:
1.- Catches of targeted species
2.- Occurrence of new holes and damage to the nets after fishing operations
3.-Dolphin sightings around the nets

All participating boats had an independent observer on board for the duration of the study. These observers were the only persons in charge of attachment and replacement of pingers, and the collecting of information on location of net sets and resulting catches.

Back in the harbour, observers counted and marked each new hole and/or other damage on randomly selected 250 metres of net from each monitored boat .

In order to obtain more information on the occurrence of dolphin predation on nets in vessels without observers on board, a boat with two researchers patrolled the bay of Alcudia while fishing operations were carried out. Whenever a dolphin interaction took place, the fishermen involved communicated this information via VHF to the patrolling boat. This allowed researchers to reach the site of the interaction in a few minutes.

RESULTS Both studies were planned in co-ordination with fishermen, selecting periods when interaction with dolphins appeared to be more frequent. Nonetheless, although sightings of dolphins were common, observations of dolphins catching entangled fish were exceptional.

Table 2 shows the total effort and kilometres of net monitored for each of the two campaigns.

Red mullet study

1.- Figure 2 shows the catch of target species (kg of red mullet/50 meters of net) for each net. Although it initially appears that nets equipped with active pingers catch fewer fish, the differences were not significant (p=0.09).

2.- No significant differences were observed (p=0.08) in the count of new holes larger than 20 cm after each fishing set (Fig. 3). Average number of new holes in each stretch (50 m) ranged from 2-6, resulting in 120 to 360 for the total of 3000 m of net set. A total of 407 new holes bigger than 20 cm were counted in the 1400 metres of net monitored by the three boats.

3.- During the 28 observed fishing operations, dolphins were observed feeding on the nets on only one occasion. This happened in a net equipped with non-functional pingers.

Cuttlefish study

1.- Figure 4 shows the average catch of cuttlefish per stretch of net. No significant differences were observed between the three kinds of sets (p=0.42).

2.- An average of 1.9±2.1 (range 0-7) holes per 50m of net was observed (Fig. 5). Although nets equipped with functional pingers presented a higher average, no significant differences (p=0.12) were observed with the other two groups of nets. A total of 33 new holes larger than 20 cm were counted in the 750 metres of net monitored for the three boats.

3.- No dolphins were observed during the time that the nets remained at sea in any of the 45 fishing operations monitored.

CONCLUSIONS Results of these first trials indicate that:

- Pingers have no significant effect on the catch of targeted species, neither on those that constitute dolphin prey (red mullet) nor on non-target species (cuttlefish). Pingers may be considered as a passive element in the fishing gear.

- Because no dolphins were sighted feeding on the fish and, according to the fishermen, dolphins did not predate nets during the trials, the new holes that appeared in the periodic counts cannot be related to dolphin interaction but were probably produced during the setting and hauling of nets.

- Fishermen were not consistent in the identification of new holes caused by dolphin interactions nor in the origin of the half-bitten fish that remained entangled in the nets. Therefore, it is necessary to develop a methodology that permits the assessment of interaction with nets without having to use indirect techniques such as the counting of holes or the weighing of the catch.

- Further research is needed to evaluate the amount of damage caused to the nets by dolphins. The population size of bottlenose dolphins in the area, and, in particular, of those predating upon the nets, should be determined to assess the potential impact of incidental catches and deliberate kills.

ACKNOWLEDGEMENTS This study would not have been possible without the collaboration of fishermen, who readily accepted observers on board their vessels. We are also grateful to all the members of the fieldwork team that participated in the collection of data, especially C. Bertran, J. Gonzalvo, M. Coll, M. Valls, C. Carreras and V. Sempere. Special thanks are due to Toni Grau of the Conselleria d'Agricultura i Pesca who assisted the research team in the design of the surveys. This study was funded by Spain's Ministry of the Environment (Directorate of Nature Conservation) and the Government of the Balearic Islands.

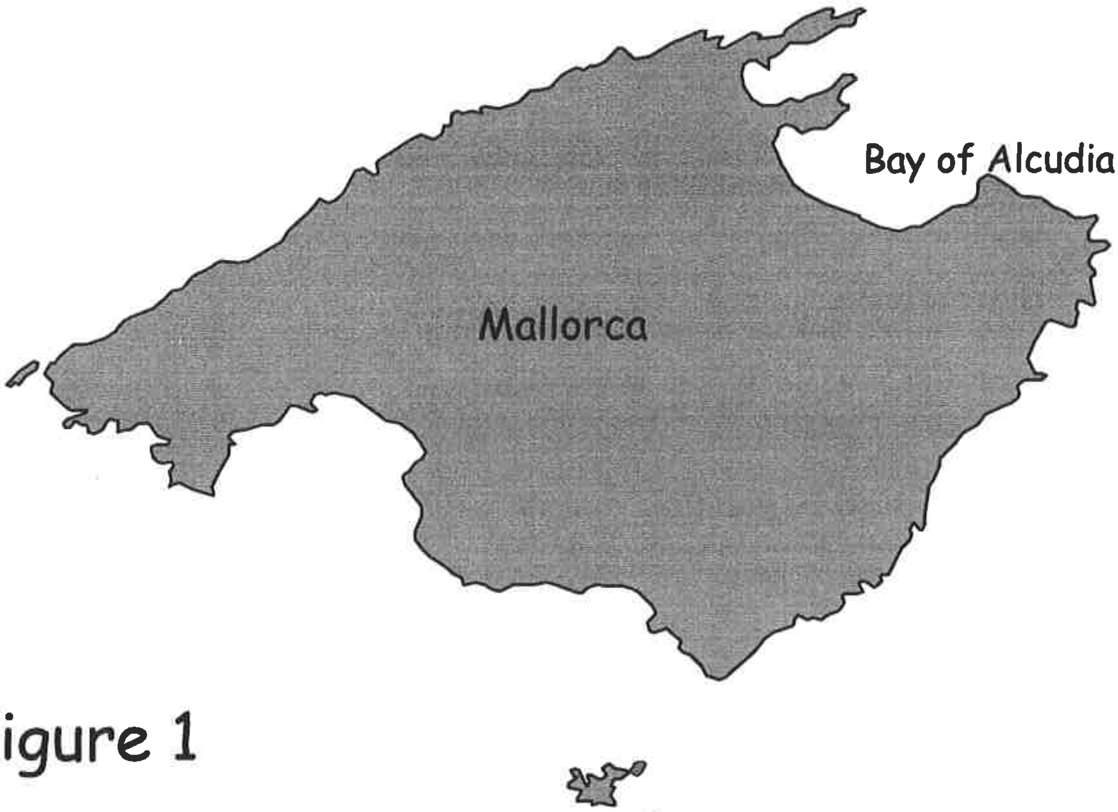
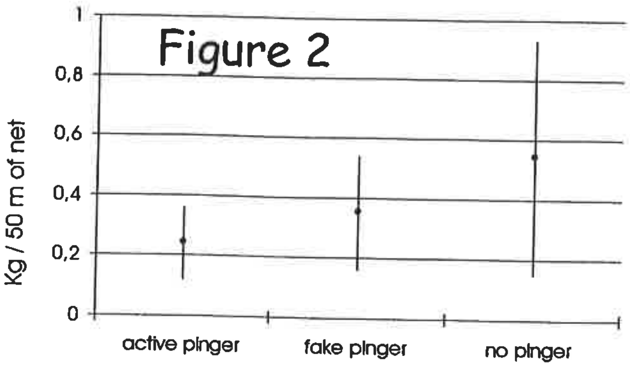
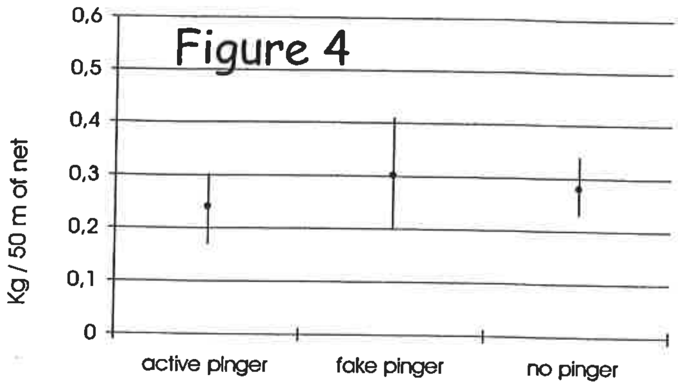
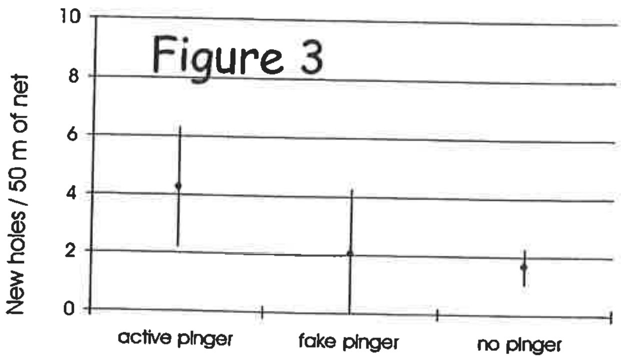


Figure 1







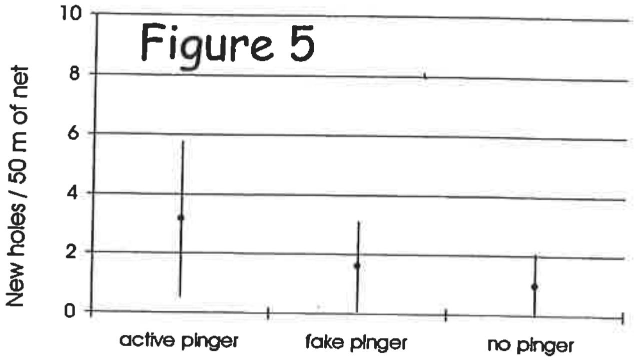


Table 1

Target species	Research campaign	Net mesh size	Average hours of net in the water	Average metesr of net set/boat
Red mullet (Mullus surmuletus)	Oct-Nov'2000	25 mm	3,1±0.9 h	3000
Cuttlefish (Sepia officinalis)	Feb-Mar'2001	50 mm	16,8±1.4 h	3000

Table 2

	Red mullet	Cuttlefish	Total
N° of fishing operation	28	45	73
Kilometers of net monitored			
Functional pingers	21.3	23.1	44.4
Fake pingers	20.6	21.3	41.9
No pingers	12.1	25	37.1
Total	54	69.4	123.4 Km

THE BOTTLENOSE DOLPHINS OF TEIGNMOUTH, ENGLAND: A PILOT STUDY

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The primary aim of this project was to establish why there was a group of bottlenose dolphins (*Tursiops truncatus*) entering Teignmouth bay, during the summer months. This was investigated by conducting a series of both land- and boat-based watches during the period 5 th July - 29th August, 1999. A number of factors were investigated to establish the reasons why; these included monitoring of environmental variables, investigating any possible interactions with boats, and considering the pressures imposed by the local fishing industry. In addition, photo-ID was also conducted to identify the individual members of the group.

Statistical analyses show that the dolphins' movements do not vary according to the environmental factors. There was, however, a highly significant relationship between the occurrence of dolphins and the numbers of boats in the bay. Dolphin frequency was low when the numbers of boats was high. Although dolphins were often attracted to boats (e.g. bow-riding), there were a few cases when dolphins were driven offshore by boat traffic. Analyses on the behavioural observations demonstrate a significant relationship between the dolphins' behaviour and both the type of craft (motor or non-motor) and whether it was moving or stationary.

The occurrence of dolphins in the bay is explained by a combination of factors. The primary reason appears to be for food, but social interaction and play are important factors, indicated by the frequent interactions with a disused wave rider buoy. The main cause for concern, however, are negative interactions with boating craft, leading to disturbance and potential injury. This area is highlighted for further research.

EVIDENCE FOR AN ANGLO-SAXON DOLPHIN FISHERY IN THE NORTH SEA

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INTRODUCTION Documentary evidence shows that cetacean fisheries were active in North-west Europe from as early as the 9th century AD, particularly along the western coasts from Biscay to Flanders (Tardif, 1866; Fischer, 1881; Lestocquoy, 1948; Musset, 1964; Gardiner, 1997). For example, in AD 832, the Parisian Abbey of St Denis had a fishery on the Cotentin peninsula in Normandy for catching *crassi pisces* - porpoises or whales (Tardif, 1866). By contrast, existing evidence for such fisheries in the British Isles before the 11th century AD is far less convincing (Gardiner, 1997).

Excavation of a high status Anglo-Saxon settlement (dated between the 7 th-10 th centuries AD) at Flixborough, close to the Humber Estuary in eastern England, yielded a huge quantity of vertebrate remains. More than 50,000 identifiable fragments of mammals, birds, and fish were present, including the largest archaeological sample of cetacean tooth and bone fragments yet found in Britain. Analysis of these remains provided a unique opportunity to examine how the animals were obtained and utilised.

RESULTS AND DISCUSSION

Species present Almost all of the remains are from a single species, the bottlenose dolphin (*Tursiops truncatus*) (Fig. 1). They are found throughout deposits in all phases of the excavation, indicating that they were exploited over the entire sequence of occupation at the site, from the late 7th or early 8th to the late 10th century AD (Table 1). The only other species that were identified from the site are the minke whale (*Balaenoptera acutorostrata*) and a fragment that may be from pilot whale (*Globicephala melas*) or killer whale (*Orcinus orca*). Unlike the dolphin remains, those of these larger species are few in number and do not appear in the assemblage until the 9th century (period 4-5b).

Butchery Most of the skeletal fragments are from skull, mandible, ribs, dorsal and lumbar vertebrae (Fig. 2). Few cervical and no posterior caudal vertebrae are present in the assemblage; neither are there any bones from the flippers. The postcranial elements are those associated with the main muscle blocks and meat was evidently the primary objective, while the presence of cranial fragments may indicate that these animals were also utilised for their oil, substantial quantities of which are found in the head and in the lower jaw.

Evidence of butchery, in the form of cuts and chop marks, is present on many of the bone remains (Fig. 3). Transverse cuts across the spinal column are consistent with the separation of the dolphin carcasses into manageable pieces, for transport from the coast to the site. Other marks are consistent with the removal of the main muscle blocks associated with the spinal column and ribs, and in one case the removal of the oil-bearing tissue from the skull. It appears that only the most useful parts were brought to the site where meat and oil-bearing tissue was then removed.

A fragment from the rostrum of a minke whale is intriguing and may reflect an early example of the use of baleen, which is of course associated with the upper jaws. The presence and butchery of a minke whale squamosal bone is almost certainly associated with the separation of the skull from the mandible. This may have been done to facilitate transport of the skull. However, it is also possible that it remained attached to the large tongue which was highly prized.

Stranding or hunting? The exploitation of cetaceans at Flixborough was clearly systematic, involving the selective use of the more valuable parts of the animals, which were almost all of one species. But were the bottlenose dolphins at Flixborough actively hunted, by driving them ashore, netting or harpooning, as they have been in numerous fisheries around the world in recent times (Mitchell, 1975), or were the remains from naturally stranded animals which had been opportunistically scavenged?

Figure 4 shows the proportion of all stranded animals from the North Sea coast of Britain (Caithness to Straits of Dover, not Northern Isles) for the four species most commonly recorded in the published reports (Harmer, 1927; Fraser, 1934, 1946, 1953, 1974; Sheldrick, 1989; Sheldrick *et al.*, 1994). There is a significantly higher frequency of porpoise strandings in all decades, and a higher overall frequency of white-beaked dolphin strandings than of bottlenose dolphin or minke whale strandings. If we assume that the North Sea cetacean fauna has not changed markedly between the 10th and 20th centuries AD, then we might expect a close correspondence between the species represented in the Flixborough assemblage and the stranding records, if the remains were mainly or exclusively from stranded animals.

This is clearly not the case. Why are there so many bottlenose dolphins, but no porpoises, which would surely have been more plentiful, nor any white-beaked dolphins? Of the four species mentioned, harbour porpoises, bottlenose dolphins and minke whales frequently venture close inshore and even into estuaries (Evans, 1991; Watson, 1981; Jefferson *et al*, 1993), where they might fall prey to an inshore fishery. However, bottlenose dolphins and minke whales are larger, more conspicuous, and more easily approached by boats than are porpoises which perhaps explains why they were selectively targeted.

Age and size profiles The bottlenose dolphin remains are nearly all from animals which were adult or approaching adult size, estimated as 275-350 centimetres in length, and some are slightly larger than any of our modern comparative specimens from waters around the British Isles (Fig. 5). The focus on adult dolphins and those approaching adult size strongly suggests the selective hunting of larger animals, with harpooning the most likely method - given that netting or driving would capture animals of all ages indiscriminately.

The low frequency of minke whale remains, compared to those from bottlenose dolphins, does not necessarily indicate that minke whales were rarely exploited during Saxon times. The few fragments from minke whales are all from juvenile animals, estimated to be about 450 centimetres in length, but larger animals may have been flensed where they were beached and the heavy skeletal parts left behind.

Evidence of possible over-exploitation The stranding records also show that bottlenose dolphins have rarely been recorded near the Humber estuary since 1913. However, these records from the eastern coast of Britain indicate that there have been periodic changes to the distribution of bottlenose dolphins within the North Sea, as has likewise been noted from Denmark (Kinze, 1995). Although the species is now concentrated off the western coasts of the British Isles and in the Moray Firth, the remains from Flixborough clearly show that bottlenose dolphins were present around the Humber estuary during the 7th to 10th centuries AD. The presence of bottlenose dolphins in an area that they do not currently frequent may of course be due to natural fluctuations in their distribution, but an alternative and intriguing possibility is raised by consideration of the relative frequency of cetacean bones in the Flixborough assemblage (Fig. 6).

On the basis of these data, an increase in the importance of cetaceans could be argued for the later periods of occupation at Flixborough. Does this reflect an intensification of hunting of bottlenose dolphins, which eventually led to the extinction of the resident population? It has been suggested that the zenith of whale hunting further south in the English Channel took place a little later, during the 11th and early years of the 12th century AD (Musset, 1964). Increasingly intensive exploitation of the Humber bottlenose dolphins during the Saxon period may have led to their eventual demise from the region during the subsequent high mediaeval period.

CONCLUSIONS The data from Flixborough provide the first reliable evidence for the systematic exploitation of dolphins and whales by an indigenous fishery in the British Isles. It was established at least by the late 7th century AD and significantly pre-dates the high mediaeval period when cetacean exploitation and consumption, by high status members of society, is traditionally held to have begun. It appears to have focused almost exclusively upon a resident population of bottlenose dolphins that was present in or around the Humber estuary at that time, and the fishery may even have played a part in the extinction of the species from local waters. Through the study of modern and ancient DNA sequences, these unique remains will be used to compare the genetic diversity of extant and ancient populations. This will allow us to explore the origins and diversity of currently threatened populations of bottlenose dolphins around the British Isles.

ACKNOWLEDGEMENTS Deborah Jaques and Cluny Johnstone (Department of Biology, University of York) analysed the vast vertebrate assemblage from Flixborough, Chris Loveluck (Department of Archaeology, University of Southampton) co-ordinated the post-excavation programme, and supplied the archaeological information. Excavation and analysis of the remains from Flixborough was funded by English Heritage.

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Table 1. Cetacean remains from each excavation phase, identified by comparison with recent specimens.

Phase	2-3a	3b	4-5b	6	6iii
T. truncatus	++	++	++	++	++
B. acutorostrata			+	+	+
Globicephala/Orcinus				+	

Phase 2-3a - late 7th-early 8th centuries AD, phase 3b - mid-late 8th century AD, phase 4-5b - 9th century AD, phase 6 - 10th century AD, phase 6iii - late 10th-early 11th centuries AD.
+ = <10 fragments, ++ = >10 fragments, fragments matching *Tursiops*, but possibly from other species of similar size, have been included

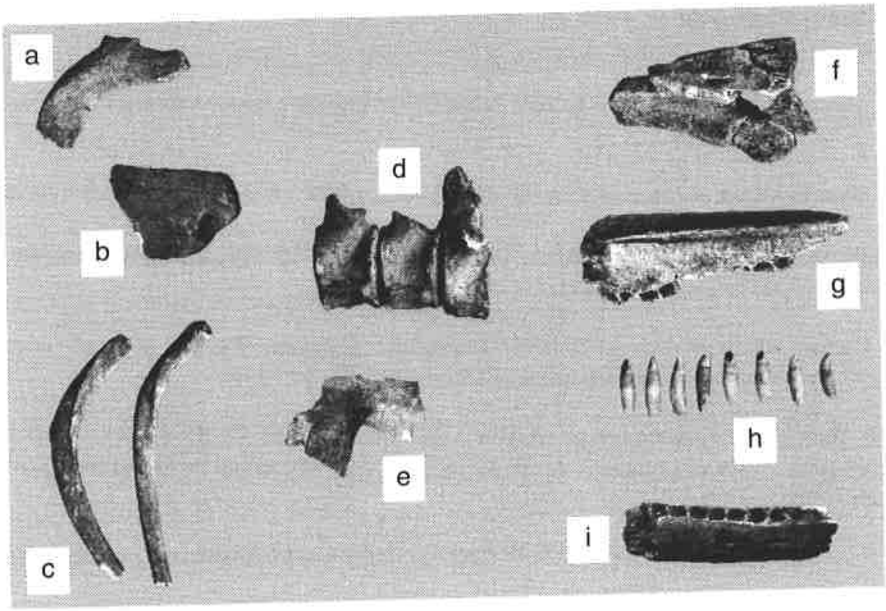

Fig. 1. Bottlenose dolphin remains from Flixborough. **a** - first rib, showing butchery marks. **b** - sternum. **c** - ribs. **d** - lumbar vertebrae, posterior chopped vertically through centrum. **e** - scapula. **f** and **g** - premaxillae/maxillae. **h** - teeth. **i** - mandible

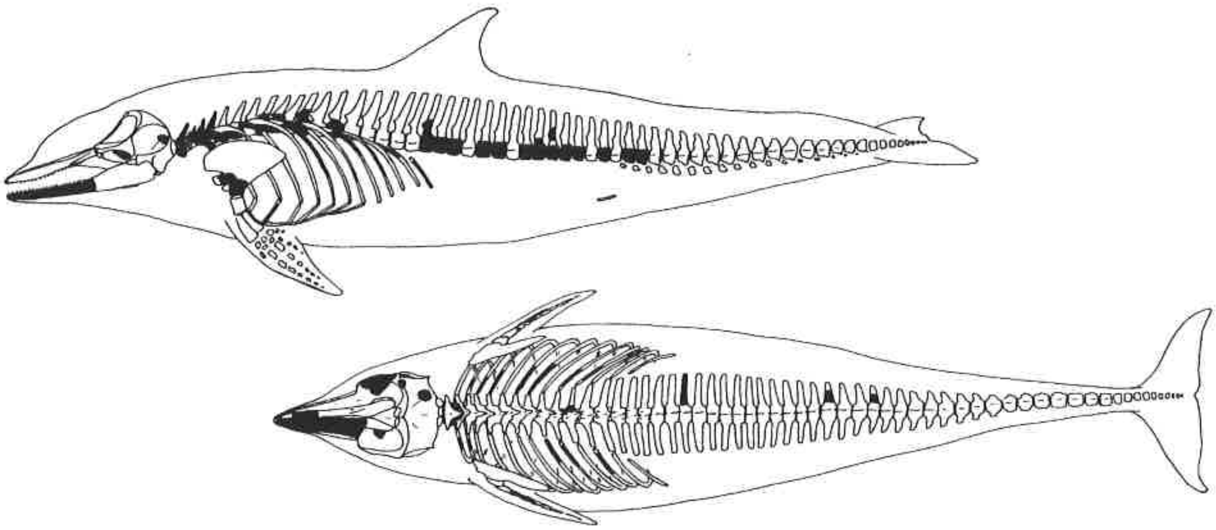

Fig. 2. Skeletal elements present in the dolphin remains

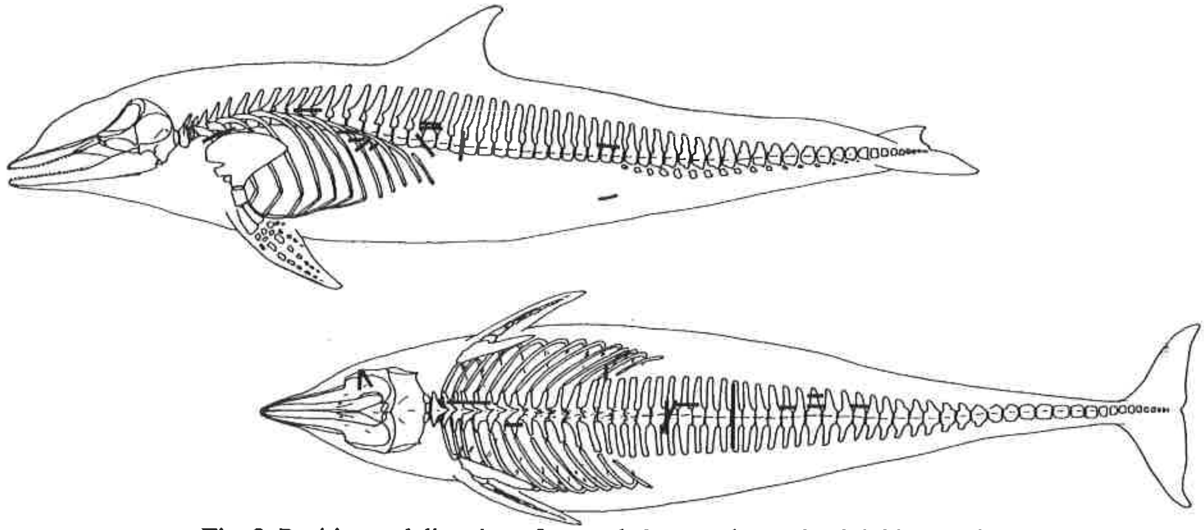

Fig. 3. Position and direction of cut and chop marks on the dolphin remains

Fig. 4. Proportion of all published strandings records from the North Sea coast of Britain

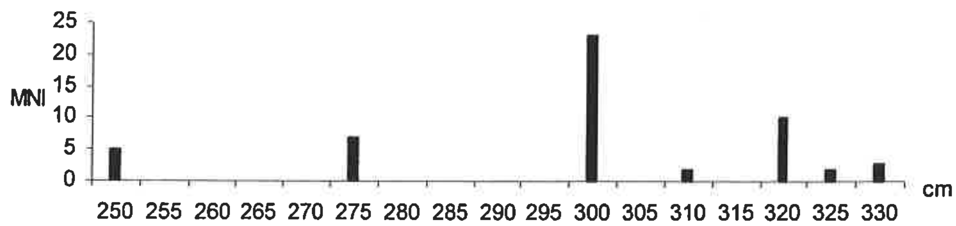

Fig. 5. Estimated lengths of minimum number of individual (MNI) dolphins in the remains

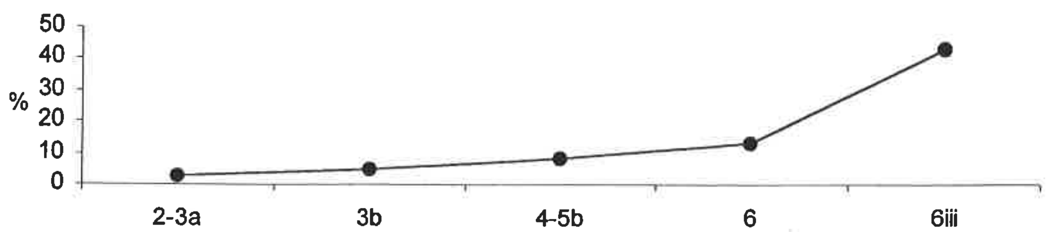

Fig. 6. Proportion of cetacean bones in the wild mammal assemblage, for each phase of occupation

MERCURY BIOLOGICAL HALF-LIVES IN MARINE MAMMALS OVERESTIMATED BY A FACTOR 10 TO 20

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For more than two decades, mercury biological half-lives in marine mammals were widely accepted to range between 500 days and 1,000 days. These figures were based on a methyl203Hg radio-isotope labelling experiment on live harp seal *Phoca groenlandica* and on whole body Hg to age calculations on a series of bycaught striped dolphins *Stenella coeruleoalba*.. A major amount of marine mammal daily methylmercury intake through food is, however, eventually found as detoxified tiemannite (HgSe) granules in liver and other organs, thereby losing its toxicological significance, but also largely influencing overall half-life calculations. Along the idea of irreversible storage, tiemannite has no biological half-life as such, and will force a total mercury based half-life calculation to the previously reported figures.

A re-evaluation of the biological half-life on the basis of methylmercury intake in a multi-compartment uptake-excretion model brings the mercury biological half-life down to an average of 50 days. Data fit with actual data series for MeHg intake and Hg and MeHg accumulation patterns in southern North Sea harbour porpoise *Phocoena phocoena*. The methylmercury biological half-life in marine mammals therefore seems to be of the same order as reported in man

SEASONAL DISTRIBUTION AND ABUNDANCE OF CETACEANS OFF THE WEST COAST OF IRELAND

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The limited amount of research west of Ireland has indicated that the continental shelf and slope, as well as the deep abyssal plain provide important habitats for many cetaceans, including species that are highly vulnerable or rare. The study area for the current project includes all three habitat types and encompasses the offshore waters to the south-west and west of Ireland, stretching south from the Goban Spur to the Porcupine Seabight, Rockall Trough and west to the Hatton and Rockall Troughs. The primary objective of the study was to identify major concentrations of cetaceans in these waters and evaluate seasonal trends in their abundance and distribution using visual and acoustic monitoring techniques.

Between July 1999 and January 2001 ship-based surveys were conducted, primarily on vessels of opportunity (e.g. research vessels, fishery protection vessels, ferries). Full surveys were possible when the vessel was holding a steady course and travelling at a relatively constant speed. A total of 284 person-days were spent at sea, most of which (181 person-days) were during the summer/autumn months (May–October).

A total of 1,253 individual cetaceans of 15 species have been recorded on effort during the project's first 19 months. Four species of mysticetes and 11 odontocete species have been identified in 167 encounters to date. The most commonly encountered species were common dolphins (*Delphinus delphis*), harbour porpoises (*Phocoena phocoena*), long-finned pilot whales (*Globicephala melas*) and Atlantic white-sided dolphins (*Lagenorhynchus acutus*). Limited habitat association patterns were noted for certain species, including long-finned pilot whales, harbour porpoises, and minke whales (*Balaenoptera acutorostrata*). An individual sighting of note was that of the extremely rare northern right whale (*Eubalaena glacialis*) over the Hatton Bank during May 2000.

A THEORETICAL MODEL TO EVALUATE THE RISK TO ORGANOCHLORINE COMPOUNDS (OCS) IN MEDITERRANEAN STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

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Many studies document the chemical stress related to organochlorine xenobiotics in stranded and free-ranging Mediterranean cetaceans, but there does not exist a statistical evaluation of the real risk of these compounds to the marine mammals. Collecting ecotoxicological data on cetaceans is important for several reasons. First, cetaceans have no sweat/sebaceous glands nor gills, so they are relatively closed systems. Besides acting as a thermal barrier and an energy reserve, blubber isolates the skin from the rest of the body, which in turn reduces any exchange between the two. Fat-soluble contaminants usually build up in blubber, which is metabolised only during illness, pregnancy, lactation, migration or food scarcity; the stored contaminants are mobilised along with fat reserves. The largely teuthophagous striped dolphin (*Stenella coeruleoalba*) is known to accumulate in its blubber, very high levels of liphophilic substances such as organochlorine compounds (OCs).

The aim of this study was to establish a theoretical model to evaluate the risk of HCB, DDTs and PCB congeners, in specimens of Mediterranean striped dolphins. Using a mathematical formula resulting from the knowledge of the length and age of 62 stranded specimens, it was possible to estimate the age of the striped dolphins, fixing physical maturity at ten years. Afterwards, all individuals are considered as adult. This valuation was very important for the discussion of possible differences in contaminant burden between males and females.

The differences in OC levels in the blubber from stranded and free-ranging specimens allow us to assess the risk of different chlorinated xenobiotics in this species of Mediterranean cetaceans, taking the living population as a control sample, and considering these animals to be in good health. For the highest toxic compounds, with teratogenic, mutagenic, carcinogenic and estrogenic capacity, the level beyond which there can be toxicological risk for the striped dolphin is indicated.

RISSO'S DOLPHIN HARASSMENT BY PLEASURE BOATERS OFF THE ISLAND OF ISCHIA, CENTRAL MEDITERRANEAN SEA

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INTRODUCTION Since 1991, a long-term study on the cetacean fauna off the island of Ischia has been conducted by Studiomare. The geomorphology of the study area, including productive submarine canyons, seems to play a role in the nearshore abundance of cetaceans - possibly attracted by local prey availability. Risso's dolphin, *Grampus griseus*, striped dolphin, *Stenella coeruleoalba*, common dolphins, *Delphinus delphis* and bottlenose dolphins, *Tursiops truncatus*, are seasonally present in these waters, used as a feeding and breeding ground (Mussi *et al.*, 2001). The area is also used as a feeding ground by fin whales, *Balaenoptera physalus* (Mussi *et al.*, 1999).
Risso's dolphins appeared to be seasonally "resident" and were regularly re-sighted nearshore, based on photo-identification data collected between 1998-2000.

THE HARASSMENT EVENT An example of the impact of pleasure boating on cetaceans is presented to highlight the disruptive potential of unregulated human-dolphin interactions in the Mediterranean Sea. The observation took place near the Cuma submarine canyon.

On Sunday 27 August, at about 10:00 h, dolphins were sighted by pleasure fishermen 0.7 miles off the southern coast of Ischia. The Risso's dolphin group included 16 adults and 3 calves and was apparently travelling above the 300m-depth contour. By 11:00 h, a number of pleasure boats had joined the travelling group of dolphins. The number of boats kept increasing (Fig. 1). At 12:00 h, the Harbour Master's office was alerted, and its officers contacted StudioMare members to prevent harm to the animals. By means of the Harbour Master's inflatable we reached the group at about 13:00 h. By that time, the animals had moved to the northern side of the island, thus managing to cross and "survive" the heavy traffic of speedboats and hydrofoils that connects the port of Ischia with the nearby city of Naples.

StudioMare members found the Risso's dolphin group in Lacco Ameno, a large enclosure and popular beach where about 400 boats were randomly anchored. The dolphins were surrounded by over 100 other boats with their engines turned on. All these boats kept harassing the animals by heading towards them at high speed every time they surfaced (Fig. 2), with sudden changes of route and continuous attempts to approach the animals at close quarters apparently in order to take pictures or "interact" with them. The animals were increasingly "penned" by the boats into the enclosure, and ended up on a sea bottom that was only 3 m deep (Fig. 3). By this time, all group members showed clear signs of distress and seemed to be unable to orientate. They swam erratically at high speed, with no directionality, often colliding with each other. One of the calves observed in the group was seen spinning and swimming in circles, apart from the others.

"Breachings", "surfings", "tail slaps", "head stands" and "spy hops" were repeatedly performed by several adult individuals. Inter-blow intervals were relatively short (about 60 sec). As StudioMare members tried to prevent a mass stranding by placing the inflatable boat between the animals and the beach, the group responded by splitting in two tight subgroups, one of which included the calves.

None of the pleasure boaters appeared to realise what was really going on: they all seemed to be excited to see the animals at close quarters.

THE "RESCUE" Through a two-hour effort, StudioMare members finally managed to create an area clear of pleasure boats. As soon as the "opening" was about 400 m wide, the animals associated in a single tight group, and slowly started heading offshore (Fig. 4). The group was "escorted" at a distance while it moved into safer waters. At 16:00 h, the observations were stopped due to unfavourable sea conditions.

DISCUSSION The occurrence of this kind of dramatic human-dolphin interaction is becoming everyday routine in the busy summer months. On the day preceding the reported observation, a disoriented and distressed lone Risso's dolphin calf was found in the harbour of Mergellina (Naples). Moreover, the day after the reported observation, we found a freshly dead striped dolphin calf with the skull opened wide by a propeller strike. He was an 80cm long male.

Interestingly, national newspapers and television often provide quite a different picture to the wide public. Regarding the Risso's dolphin event, the news reported the dolphins enjoying a "summer party" in the coastal waters of the island. Timely management measures to protect and conserve cetaceans in this key area are clearly needed.

ACKNOWLEDGEMENTS Many thanks to Ischia Island Harbour Master and to the photographer Enzo Rando.

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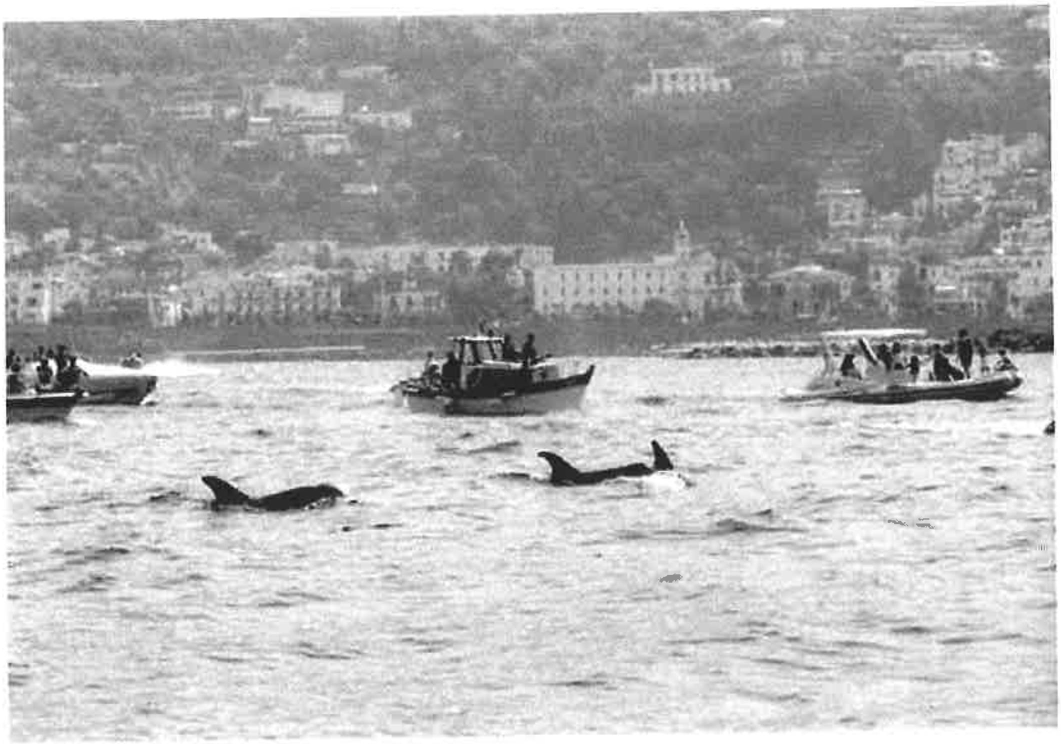

Fig. 1. Risso's dolphins followed by pleasure boaters

Fig. 2. All the boats kept harassing the animals by heading towards them at high speed every time they surfaced

Fig. 3. The animals were increasingly "penned" by the boats into the enclosed bay

Fig. 4. As soon as the "opening" between the boats was about 400 m wide, the animals slowly started to head offshore

CETACEAN INTERACTION WITH SMALL SCALE COASTAL FISHERIES: IMPLICATIONS FOR CONSERVATION AND DAMAGE LIMITATION IN THE NORTHERN AEGEAN, GREECE

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INTRODUCTION: THE PROBLEM OF DOLPHIN DAMAGE Damage to the nets of small-scale coastal fishermen caused by cetaceans in the Mediterranean is reaching endemic proportions (Wurtz *et al.*, 1992, Silvani *et al.*, 1992). The estimated cost of such damage runs into tens and probably into thousands of Euros annually.

For most coastal areas of Southern Europe, aside from tourism, small-scale coastal fisheries play a highly significant role in the local economies. These fisheries not only maintain a particular and specific culture, but also sustain a whole industry, including dock workers and market traders. Therefore, problematic marine mammal and small-scale coastal fishery interactions continue to pose not just ecological concerns, but serious social and economic problems as well.

The nature and scale of problematic interaction is not consistent across either the geographical area or individual species. In the Northern Aegean Sea, severe gill and trammel net damage is reported on a daily basis. Specifically the problem is that dolphins attack the fish caught in the nets, resulting in net destruction. As a consequence of this reported increase in interaction, for cetaceans it is not so much the risk of bycatch as in other areas, but rather of the fishermen attacking the dolphins directly and specifically.

AIMS AND METHODOLOGY OF THE STUDY Currently, while there have been a trickle of population and behavioural studies on individual marine mammal species (Frantzis, 1996, Marini *et al.*, 1995a), almost nothing has been done regarding problematic interaction. In essence, it was felt that an approach to a 'joined up' problem had never been taken in a 'joined up' way. Therefore, the broad aim of this study was to establish a preliminary investigation encompassing the welfare of both small-scale coastal fisheries as well as local cetacean populations. Substantially then, the study attempted to explore the nature and scale of dolphin damage to coastal fisheries and, where possible, make preliminary recommendations for management that could both reduce damage frequency and help secure cetacean populations.

The study was undertaken in cooperation with the Hellenic Fisheries Research Institute. This was operated over the period 1/7 to 1/9, 2000 at the Gulf of Kavala in the Northern Aegean. Data was captured using daily structured questionnaires with a group of 12 boats. In particular, questions were designed not only to assess the nature and extent of dolphin damage sustained, but also to establish the cause of damage, since this should properly determine appropriate management strategies. Fishermen were shown illustrated cards with which they were able to identify the different dolphin species.

Popular conceptions among fishermen and, indeed, other studies (Marini *et al.*, 1995b) theorise damage as simply a result of dolphins taking an 'easy option'. However, this has not been sufficiently nor rigorously established and at least two other explanations can be put forward. For example, it remains unknown if age is a significant factor, for old dolphins finding hunting an increasing struggle, fishermen's nets may represent the only viable food source. Alternatively, or perhaps additionally, it could be that fish stocks are so low that dolphins have little choice but to compete with fishermen for the same stock.

Due to the limited resources available and the preliminary nature of the study, the data gathered were based around two explanations, 'Dolphin Delinquency' and 'What, no fish?'. These attempted to explore the extent to which dolphins deliberately and specifically attack fishermen's nets, and the extent to which low fish stocks may be responsible.

RESULTS FROM THE 'DOLPHIN DELINQUENCY' HYPOTHESIS This hypothesises that dolphins' motivation for attacking nets is because those fisheries offer an easy target. In other words, cetaceans are targeting the fisheries directly and specifically.

The results, shown in Figure 1, found overwhelmingly that the main culprit was the coastal bottlenose dolphin (*Tursiops truncatus*). Damage reported for the two pelagic species was virtually negligible.

Observed and reported activities for bottlenose dolphins (*Tursiops truncatus*) are shown in Figure 2. Almost half of all activity witnessed was spent feeding from fishermen's nets; this compared with 0% observed feeding from nets (the 0% is expresssed as 'Resting' in Fig. 2) for both pelagic species (striped dolphin *Stenella coeruleoalba* and short-beaked common dolphin *Delphinus delphis*).

Total damage inflicted was correlated by catch type (i.e. the species targeted by the net used) to establish whether or not specific species were being targeted by dolphins. The results, which can be seen in Figure 3, showed a strong correlation with red mullet (*Mullus surmuletus*), a known prey of the bottlenose dolphin. Prawn (*Peneus kerathurus*) is not known as a favoured prey, but there was a high catch of pilchard (*Sardina pilchardus*), which is a known prey. It is worth mentioning that the fish heads were mostly left uneaten in the damaged net, and thus the identification of the targeted species was possible.

A final remark concerns the comparison of the total damage inflicted to gill nets, when compared with the total damage inflicted to the trammel nets, shown in Figure 4. It is evident that most of the damage occurred in trammel nets, which represented the majority of nets surveyed at the time of the study, and so may have affected the outcome of this comparison.

Overall, results were insufficient to confidently establish whether or not these cetacean species attack nets due to ready availability or greed. However, pelagic dolphin species do not appear to target these small-scale coastal fisheries.

Results for bottlenose dolphins suggested otherwise. Certainly they are responsible for the vast majority of the damage, and do appear to be targeting specific fish species. However, motivation remains unclear, since attacks can still be reasonably explained by the 'What, no fish?' hypothesis, and the theory of old dolphins being mainly responsible.

RESULTS FROM THE 'WHAT, NO FISH?' HYPOTHESIS This hypothesis was based around the fact that small-scale coastal fisheries and cetaceans exploit the same resources. Continued human expansion and developing fishing technology could mean that fish stocks are so low that dolphin attacks are motivated by desperation. Unfortunately, there are no data readily available for general fish stocks in the area, and therefore we have attempted to collect circumstantial evidence.

Figure 5 shows the type and incidence of use of counter-measures reported by fishermen. With the exception of shooting, all counter-measures were reported as completely ineffective.

The most remarkable findings are displayed in Figure 6. Results show a clear trend, suggesting dolphins are reluctant to feed around humans. Seventy five percent of all attacks took place when only a single caster was present in the area, with no other human presence in the vicinity. While bottlenose dolphins were shown to target certain species, they do not appear to target fishermen directly or specifically.

Overall, results were insufficient to confidently establish whether or not fish stocks were so low as to cause dolphin desperation and motivate attacks. However, the evidence gathered is persuasive, and although it does suggest dolphins targeting particular fish species, it is difficult to sustain the 'Dolphin Delinquency' theory.

The fact that the bottlenose dolphin is the main culprit is also to be expected under conditions of 'What, no fish?'. Small-scale coastal fisheries are in direct competition with coastal cetaceans. Finally, we must conclude that the bottlenose dolphins are targeting prey which they would normally hunt, and actively avoid human contact.

A useful indicator would have been a time series comparison of the amount of fish landed over a sufficient period (a decade or more). Unfortunately, official figures on tax returns from annual landings are somewhat unreliable. Certainly, fishing fleet numbers have remained the same with no new licences being issued, following a 10-year freeze by the European Union.

CONCLUSIONS: PRELIMINARY MANAGEMENT RECOMMENDATIONS Even though the study was preliminary, results were sufficient that some preliminary strategies to reduce problematic interaction could be suggested.

Establishing dolphin motivation for attacking small-scale coastal fisheries is crucial, since the cause will ultimately determine appropriate management strategies. If 'Dolphin Delinquency' is proved, then the solution lies with changing or preventing dolphin behaviour. If 'What, no fish?' is proved, then the solution rests with human exploitation of marine resources becoming sustainable. It is possible that the problem involves a combination of the hypotheses. While this study was unable to prove either hypothesis conclusively, it can offer three practical suggestions aimed at reducing damage and securing cetacean populations.

Fishing in groups of two or more: Results showed damage could be drastically reduced, as dolphins tend to avoid groups. Such a strategy costs nothing, an important consideration for small-scale coastal fisheries, and it could be implemented immediately.

The elimination of illegal mesh size: The use of small (as well as illegal) mesh size (18 mm) for prawn catches was widely observed and resulted in substantial levels of pilchard bycatch, which is a favourite prey for bottlenose dolphins. The use of larger mesh size would reduce bycatch and present a less appetising target, even if, according to the fishermen, less prawns will be captured. This measure also would cost nothing to implement, while being highly effective.

A reduction in shared catch type: This is unlikely to prove a popular solution, but since the results did suggest that bottlenose dolphins do target the same fish species, reducing competition for the same targets could help reduce damage. A slow-down in fishing for certain species may also allow fish stocks to recover.

Correctly establishing the balance of factors leading to dolphin induced damage is absolutely vital since, fundamentally, the different factors suggest radically different strategies. Whilst the preliminary study was able to confidently establish that coastal dolphins target the same resources, many questions remained unanswered regarding the explanation for this. In particular, it is crucial that, besides the study of the dolphin populations, more work is done to ascertain the level of fish stocks, not only to help settle the question of dolphin damage, but also for the continued sustainability of small-scale coastal fishing. Specifically regarding the question of dolphin damage, further work using photo-identification techniques should go a long way to uncovering the theory that dolphin damage is caused by elderly/ specific individuals.

The scale of such further work should include the entire Mediterranean, especially since cetacean interaction is not consistent and varies according to environmental conditions. Fish stocks are an altogether more serious problem, potentially for both cetaceans and people. Therefore, work to develop more accurate appraisals of fish stocks should rightly encompass all European sea territories.

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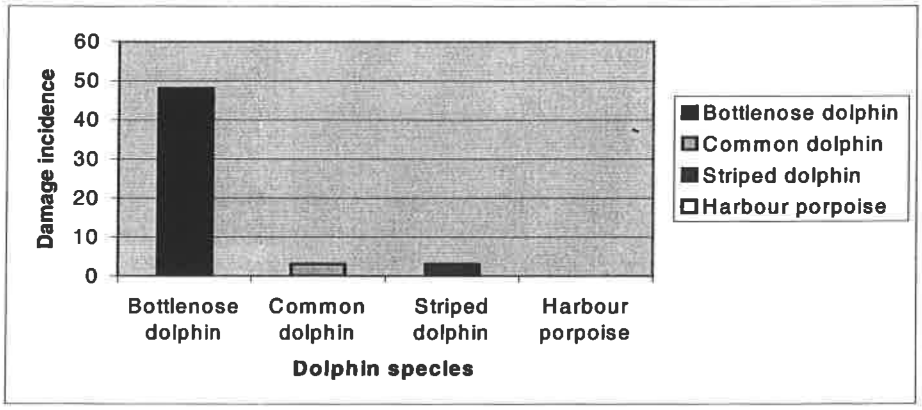

Figure 1: Comparing between the species of dolphin responsible for damage to fisheries in the Gulf of Kavala at the time of the study.

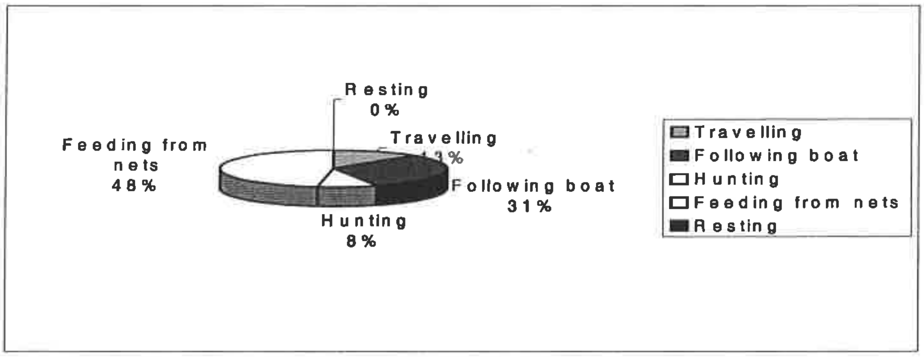

Figure 2: Observed activities for bottlenose dolphins (*Tursiops truncatus*).

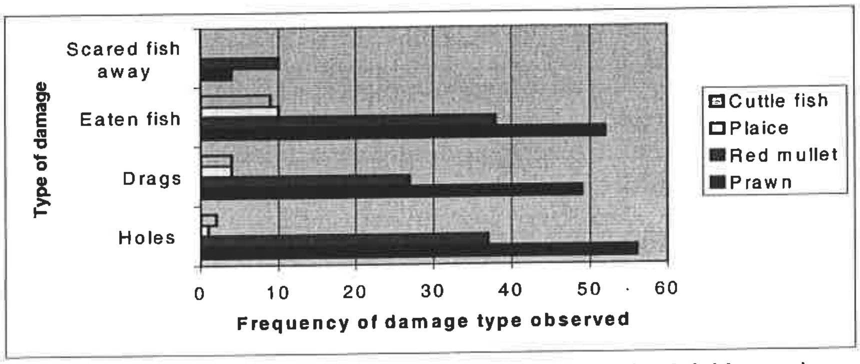

Figure 3: Showing total combined damage inflicted by dolphin species according to the target catch type.

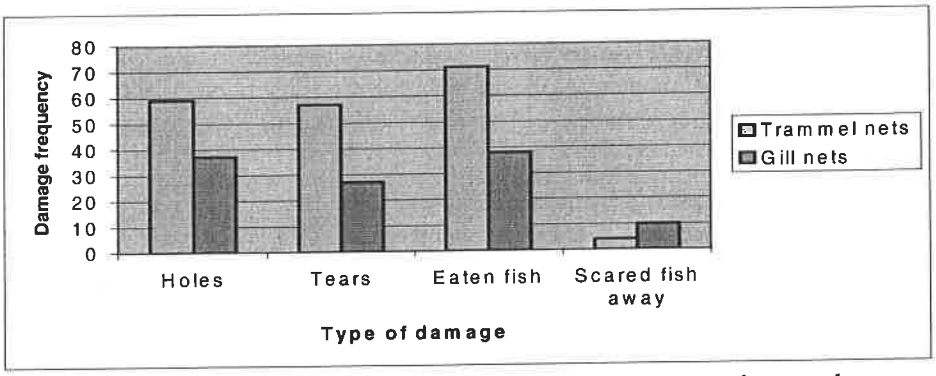

Figure 4: Comparing the total damage inflicted to gill nets and trammel nets.

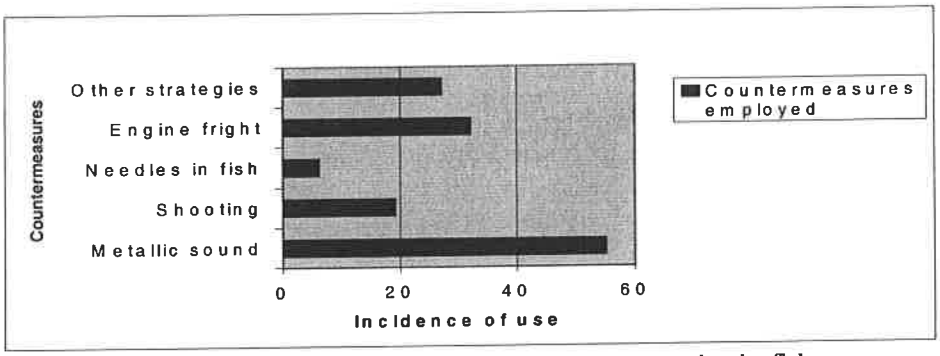

Figure 5: Countermeasures employed against cetaceans by the fishermen.

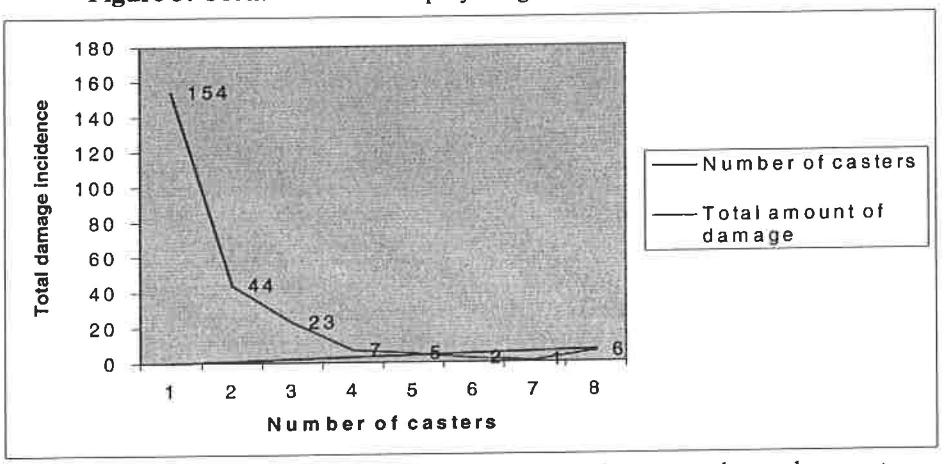

Figure 6: Correlating the number of casters in the area to the total amount of damage inflicted by dolphins.

CONSERVATION POLICIES FROM A REGIONAL TO A NATIONAL APPROACH: THE FORMULATION OF THE ITALIAN ACTION PLAN FOR THE CONSERVATION OF CETACEANS

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The conservation of wild living resources is a principle that has recently entered into the environmental policy of many countries, as a result of dramatic changes of attitude towards the need to preserve the natural environment. An Italian National Action Plan for the conservation of cetaceans was formulated by ICRAM and submitted to the Ministry of the Environment, Marine Protection Service, to support national compliance with the standing regional directives, and, in particular, the Protocol of the Barcelona Convention on Specially Protected Areas and Biological Diversity, which recently entered into force.

The Plan is composed of two parts: 1) priority activities to be carried out within the triennium 2001-2003, and 2) a detailed review on the conservation status of the most common Mediterranean cetaceans, and an analysis of the reported or potential threats faced by the animals.

The plan identifies 22 actions having high priority levels, which fall within the following domains: a) conservation actions within marine protected areas; b) eco-toxicology and population studies on free-ranging cetaceans; c) research on stranded cetaceans; d) mitigation of negative cetacean-fisheries interactions; e) establishment of cetacean information centres; f) creation of data and tissue banks; and g) capacity building and professional training. Each action is described with reference to the issues raised in the second part of the Plan in order to highlight the conservation priorities and consider each case in context. Guidelines are provided on the best methodological approach and timetables are defined for each activity. Measures for gauging the progress of the National Action Plan over the course and at the end of the three-year period are indicated.

THE SUBMARINE CANYON OF CUMA (SOUTHERN TYRRHENIAN SEA, ITALY), A CETACEAN KEY AREA TO PROTECT

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INTRODUCTION The waters off the island of Ischia (Gulf of Naples) have been monitored for a long-term study on cetaceans since 1991 (Mussi *et al*., 1997, 1998). From 1997, the research focused in the area on the north coast of the island, corresponding to the submarine canyon of Cuma (Pennetta *et al*., 1998), a particular habitat characterised by a remarkable biodiversity and concentration of pelagic fauna (Mussi *et al*., 1999). The aim of this work is to examine closely the distribution of the different species of cetaceans, with particular attention to the area corresponding to the submarine canyon of Cuma (Fig. 1), in order to include this area (at least the more coastal part of it) into the future perimeter of the marine protected area proposed by Italian Ministry of Environment, named "Regno di Nettuno" (islands of Ischia, Procida and Vivara). Every summer, we could observe in the area large groups of common (*Delphinus delphis*), striped (*Stenella coeruleoalba*), bottlenose (*Tursiops truncatus*) and Risso's dolphins (*Grampus griseus*). Feeding and mating behaviours were observed for all species. Newborns were sighted in July and August. The area is also used as a feeding ground by fin whales (*Balaenoptera physalus*), the most common species in the canyon. During cetacean surveys in the area, the presence also of some pelagic fishes as *Mobula mobular*, *Thunnus* sp., *Xiphias gladius* and sea birds as *Calonectris diomedea*, *Puffinus puffinus* and *Larus ridibundus,* was noted. The analysis of fin whale faecal material revealed the presence of crustacean exoskeletons belonging to the euphausiid *Meganyctiphanes norvegica*, a key species in the pelagic trophic web.

METHODS During the periods 09/07-31/08 (1997); 03/07-19/08 (1998); 20/03-10/05 (1999), the observations occurred on board the "Barbarian", a 15 m sailboat equipped for underwater listening with towed hydrophones. From 20/06 to 30/08 (2000), following the wreck of the lab boat, the studies were continued on board of "Jean Gab", a 17.7 m long cutter equipped, in addition to the previous system, with an underwater video camera fixed at the bow of the boat. Audio and video signals were synchronously recorded with a BetaCam support. The routes were chosen to optimise sightings, and were determined daily on the basis of previous sightings; particular attention was paid to following the bottom topography and depth profiles. No trip was performed in conditions greater than sea state 5 (Beaufort). Shots were made using automatic cameras with objectives 70-200 mm/F2.8 zoom, films Kodak Ektachrome 200 ASA, with exposure time less than 1/250 sec. Along with weather conditions (sea and wind), distance from the coast and water depth were also recorded.

RESULTS 211 trips have been carried out, with 2970 nm covered, for a total amount of 197.6 hours of direct observation, and 166 cetacean sightings. The most common species was fin whale with an amount of 66 sightings (Table 1). In the studied area cetaceans reveal a coastal habit, the average depth of the sighting was 197 m (±128.2 SD, range 2.5-700), and the average distance from the nearest coast was 4.1 km (±2.9 SD; range 0.05-14.4). Sightings were located on the bank of Forio, or mostly on the bathymetric lines of 200 and 300 m off the north coast of Ischia. This area, corresponding to the promontory of the island defined by Punta Vico and Punta Cornacchia, represents the most coastal part of the canyon of Cuma where a great concentration of cetaceans takes place. The canyon of Cuma is a large deep submarine valley, which, starting from the areas close to Cuma and Ischia island, reaches a maximum depth of 800 m between the islands of Ischia and Ventotene. This canyon represents a great sedimentary basin for materials which are carried along the coast by Volturno and Garigliano rivers (Gulf of Gaeta); the canyon increases the upwelling speed and acts also as conveying duct to the waters of the deep basin (De Pippo *et al.*, 2000). The shelf area of the Ischia island in front of the canyon is characterised by *Posidonia oceanica* (sea grass) beds, rocky banks, and rocky cliff with coralline formations.

All species of odontocetes used the area of Cuma either as breeding or as feeding ground. In 27% of the sightings, mating and socialising were recorded (Table 2). The abundance of food resources probably favours the weaning of calves without wasting energy; in fact, in Cuma we had a high number of newborns in dolphin groups. The peak of cetacean births (Table 3) corresponds to the period of maximum tourists crowding along the coast of Ischia, so newborns have today to face a new threat constituted by the screws of the speed pleasure crafts. The presence of the rare common dolphin with 38 sightings is also notable. The Mediterranean short-beaked common dolphin and its habitat are today at risk because of the probable joint effect of high levels of pollution, accidental or deliberate capture in fishing gear, decrease in resources because of over-fishing, intense sea traffic, and general degradation of the habitat. In the Cuma area, it was possible to observe periodically a large group of about 80 individuals of common dolphin. Photo-identified individuals, re-sighted from 1997 to 2000, suggest that it is a unique group which resorts to the utilising the area in the most favourable period.

CONCLUSIONS The submarine canyon of Cuma is a very important habitat close to the northern coast of the Ischia island where a particular pelagic assemblage can be found. The constant presence of whales and dolphins, pelagic fishes and marine birds is related to the geological and ecological characteristics of the area. The strong impact of the boats on cetaceans is becoming an everyday routine especially in summer: distress and disorientation, collisions (Fig. 2-3) and deaths by propeller strike (Fig. 4). Timely management measures to protect cetaceans in this key area are clearly needed, regardless of its inclusion in the area proposed for the Marine Park.

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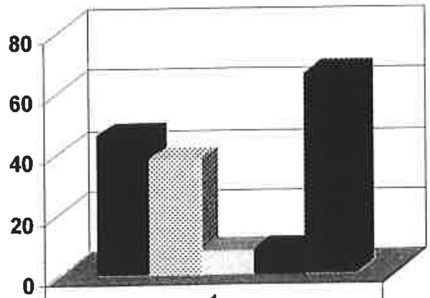
Table 1: Sightings for species



	1
striped dolphin	46
common dolphin	38
bottlenose dolphin	8
Risso's dolphin	8
fin whale	66

Table 2: Observed behaviour

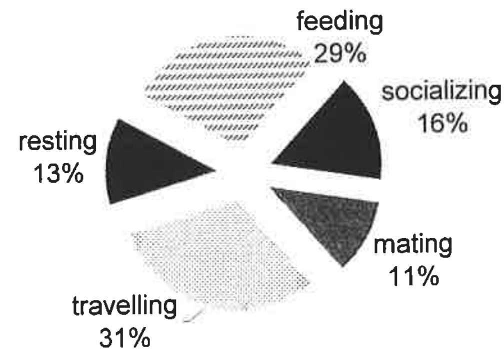
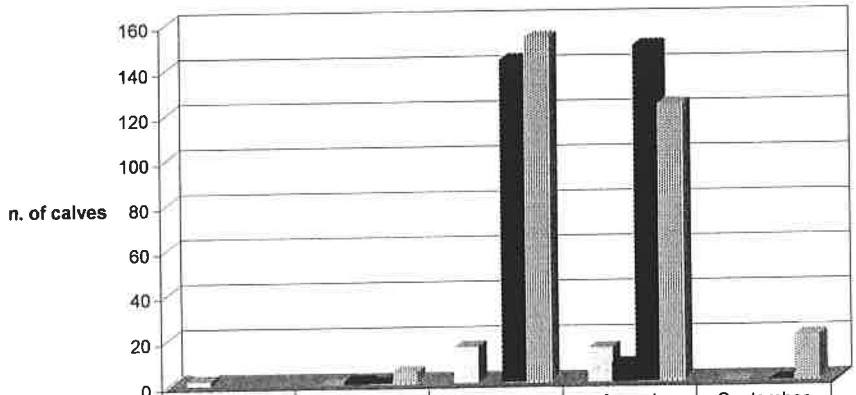


Table 3: Seasonal distribution of calves in Odontocetes' groups



	May	June	July	August	September
Risso's dolphin	2	0	16	15	0
bottlenose dolphin		1		8	
common dolphin		0	143	149	0
striped dolphin		5	153	123	20

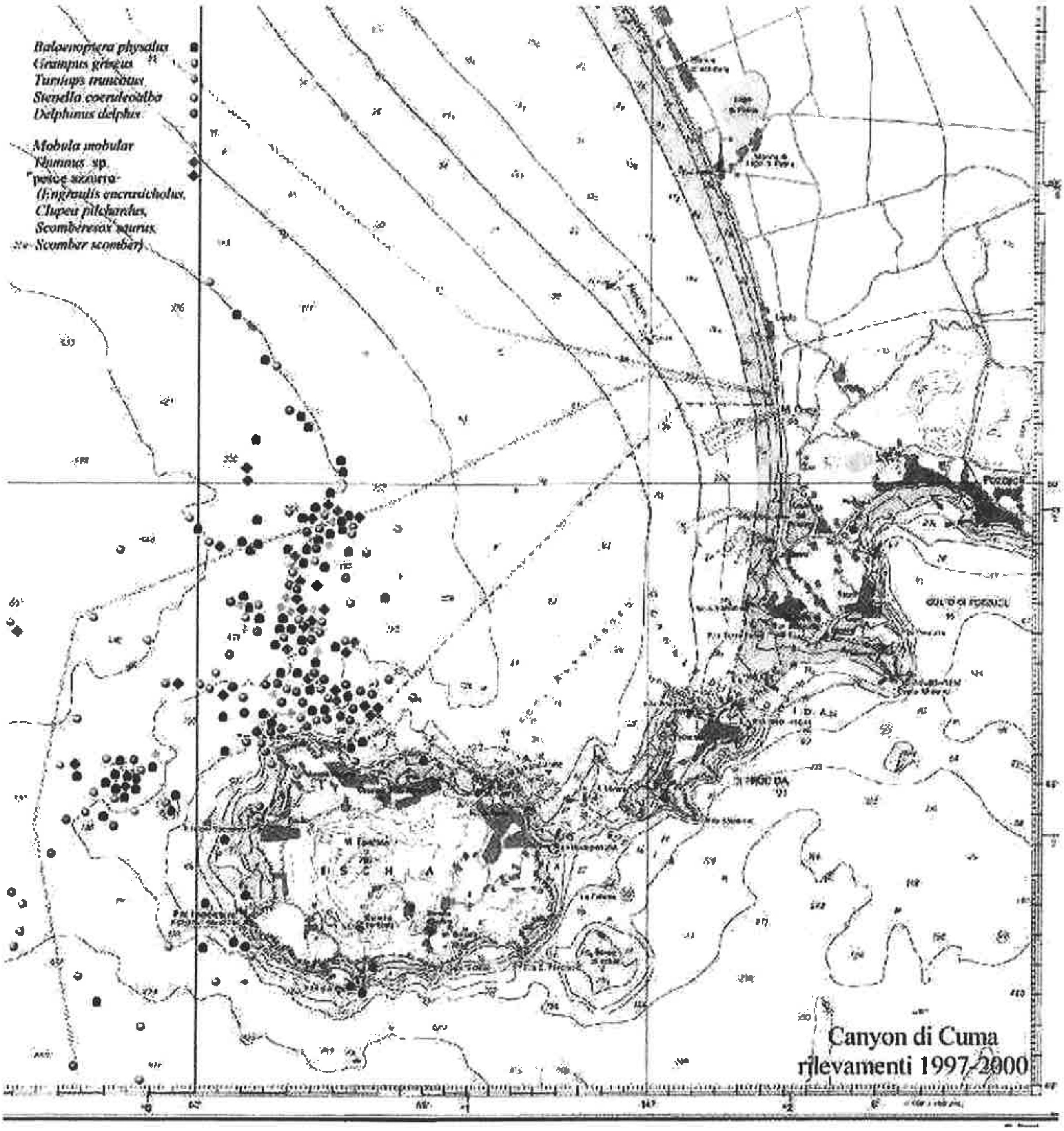


Fig. 1 Map of the study area

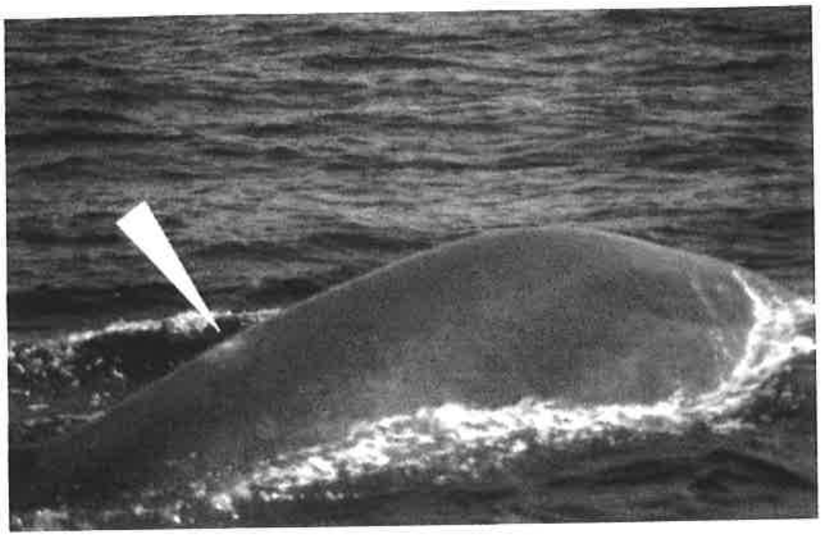


Fig. 2: The impact of fin whales with the shipping companies is documented with difficulty.

Fig. 3: Traces of collisions remain on the bodies of the cetaceans under form of scars or cuts on the back.

Fig. 4: A 80cm long striped dolphin with the skull wide opened by a propeller strike.

APPROACHES TO MINIMISING PORPOISE ENTANGLEMENT IN THE CELTIC SEA GILLNET FISHERY

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Porpoise mortalities in gill and tangle net fisheries in the Celtic Sea are thought to be unsustainable. At the request of fishermens' organisations, we established a trial to determine the efficacy of three possible bycatch reduction methods.

We examined the use of pingers (dukane netmark 1000), floating headropes (megafloat) and closed areas, and assessed their efficacy for bycatch reduction. Observers spent 160 days at sea, and monitored 418 strings of nets being hauled, equivalent to 30,000 km hours of fishing effort. Approximately 40% of this fishing effort involved strings of nets equipped with pingers.

One porpoise was observed entangled in pingered strings and 18 in unpingered strings. Among unpingered strings of nets, 273 strings were equipped either in part or in full with floating headropes. Nets with floatropes accounted for around 5,000 net km hours and were associated with 10 porpoise entanglements. Nets with traditional floats accounted for around 10,000 km hours of fishing effort and were associated with six porpoise entanglements. Bycatch locations showed very little distributional clumping.

We aggregated bycatch and effort into a grid of latitude and longitude cells and looked for areas that might be candidate fishery closure zones in order to minimise bycatch. No such area could be found. We conclude that at the present time, pingers are the only effective tool available for reducing porpoise bycatch in the Celtic Sea to levels that are sustainable, according to criteria established by the International Whaling Commission and under the Agreement for the conservation of Small Cetaceans of the Baltic and North Seas.

INTERACTIONS BETWEEN SMALL CETACEANS AND ARTISANAL FISHERIES OFF SAN JOSE, NORTHERN PERU

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INTRODUCTION Although the Peruvian Ministry of Fisheries (MIPE) outlawed the exploitation of small cetaceans since 1990, reiterating this ban in a ministerial decree (No 3241-94-PE) in 1994, and with a law (Law No. 26585) in 1996, and taking stricter measures of enforcement, a high number of small cetaceans still die each year in incidental and directed fisheries along the coast of Peru, and their meat continues to be sold and used for human consumption (Van Waerebeek *et al.*, 1994, 1997, 1999). Besides, the use of their meat and blubber as bait for the shark fishery has increased (Van Waerebeek *et al.*, 1999). In northern Peru, Burmeister's porpoise (*Phocoena spinipinnis*) represents the species most frequently captured (Van Waerebeek and Reyes, 1994; Van Waerebeek *et al.*, 1997, 1999). This may be a consequence of the type of fisheries (inshore artisanal fishing operations) and of the coastal habits of the species (Reyes and Van Waerebeek, 1995). Regular monitoring of interactions between small cetaceans and fisheries in Northern Peru has been carried out mostly at the fishing ports of Chimbote and Salaverry by members of the Peruvian Centre for Cetacean Research-CEPEC (Van Waerebeek and Reyes, 1994; Van Waerebeek *et al.*, 1997, 1999). The wharf of San Jose, among other ports from this region was monitored only occasionally by CEPEC (Van Waerebeek and Reyes, 1994; Van Waerebeek *et al.*, 1994, 1997, 1999). According to the Instituto del Mar del Peru (IMARPE), a governmental research institute, San Jose is characterised by the continuous landings of small cetaceans (Arias-Schreiber, *pers. comm.*). The Burmeister's porpoise is the most frequently entangled cetacean at this wharf (Van Waerebeek and Reyes, 1994; Van Waerebeek *et al.*, 1994, 1997, 1999). With this in mind, a fishery observer scheme was implemented in 1997 in San Jose to monitor cetacean bycatch by the artisanal fisheries, in an attempt to gather information necessary for population management of the resource.

THE ARTISANAL FISHERY OF SAN JOSE

Located near the city of Chiclayo in Lambayeque (06° 46'S, 79° 58'W), the fishing community of San Jose specialises in an artisanal inshore fishery directed mainly towards elasmobranch species (sharks and rays) and the flounder (*Paralichthys adspersus*). The fishing gear mostly used is the multifilament nylon gillnet, locally called 'cortinera', and which receives different names according to the target species and the mesh size. The 'clara' has a mesh size of 200-300 mm and is set to capture elasmobranch fish. The 'menuda' has a mesh size of 120-146 mm and is directed towards large schooling fish such as 'bonito' (*Sarda chiliensis*) and 'suco' (*Paralonchurus peruanus*). According to the fishing method, these cortineras can be a set cortinera, to capture demersal species such as rays (eagle rays *Myliobatis chilensis* and *M. peruvianus*, guitarfish *Rhinobatos planiceps*, 'basha' *Rhinoptera steindachneri*, etc), sharks (blue shark *Prionace glauca*, 'tollo fino' *Mustelus mento*, 'tollo mama' *M. whitneyi*, 'tollo manchado' *Triakis maculatus*, etc) and flounders; or drift cortinera, set for hammerhead sharks (*Sphyrna zigaena*) and other pelagic species. The artisanal fleet includes small open boats (8–11 m) with a capacity of 8–11 tons. Their number increases during the summer season (Castañeda, 1994).

MATERIALS AND METHODS The study period in San Jose lasted from August 1997 to May 1998. Two different methodologies were combined: independent onboard observer schemes, and systematic port interviews.

Independent on board observer schemes

One observer was placed on board cortinera boats selected at random to witness the fishing operations. The data collected included the number of cetaceans by-caught by species, the characteristics of the fishing gear and methods, as well as the fishing effort. It should be noted that the observers could not sample fishing trips continuously because of limited funds. Fishermen were asked to bring incidentally taken animals to the port for biological examination whenever possible.

Systematic port interviews

Systematic interviews of skippers and/or crews were carried out, to obtain a more complete overview of cetacean mortality. Fishermen were interviewed daily when returning from sea, and asked for data on target species, bycatches of marine mammals, as well as on the fishing effort and fishing gear used. Catch estimates were stratified per month as in earlier studies (Read *et al.*, 1988; Van Waerebeek and Reyes, 1990). Monthly mortality rates (bycatch/trip) were then compared to those obtained with the observer scheme methodology.

RESULTS

Fishing effort 5% of the fishing effort, expressed as the number of trips per boat, was sampled (n = 1594). Two species of small cetaceans, Burmeister's porpoise and long-beaked common dolphin (*Delphinus capensis*) were affected by entanglement with cortinera nets, targeting elasmobranchs, flounder, scianids, scombrids, carangids, ariids, and pomadasyids. The animals had already died when the nets were retrieved on board. Other species affected by the bycatch were green turtles (*Chelonia mydas*), olive ridley turtles (*Lepidochelis olivacea*), and hawksbill turtles (*Eretmochelys imbricata*). The fishing areas preferred by the artisanal fleet of San Jose were: La Casa, Bodegones, Palo Parado, Puerto Eten, Huaca Blanca, San Jose, Isla Lobos de Tierra, and Isla Lobos de Afuera. The total fishing effort developed by the cortinera fleet of San Jose during the period of study is represented in Figures 1-3. The total bycatch of small cetaceans per fishing effort during the study period was estimated at 640.26 ± 495.06 small cetaceans.

Fifteen small cetaceans were caught during onboard observations, of which 80% were Burmeister's porpoise and 20% common dolphin (Fig. 4). During the interviews, 81% Burmeister's porpoise and 19% common dolphin captures were recorded (Fig. 5). Onboard observations and the results of the interviews showed a poor correlation index ($r^2 = 0.11$). However in both cases, Burmeister's porpoise represented the highest percentage of the cetacean bycatch.

DISCUSSION Until now, the scientific collection of data on cetacean exploitation in Peruvian fisheries had been done by monitoring the takes at fish terminals, surveying beaches in the vicinity of wharves and harbour facilities as well as near-by dumps for discarded skeletons, organs and scattered bones and, incidentally by interviewing fishermen (Read *et al.*, 1988; Van Waerebeek and Reyes, 1990, 1994; Van Waerebeek *et al.*, 1997, 1999). The implementation of an onboard observer pilot programme to assess cetacean mortality in Peruvian artisanal fisheries was the major goal of the present study. Northridge (1995) recommended to establish observer schemes in fisheries suspected of having significant marine mammal bycatch. Van Waerebeek *et al.* (1999) stressed the need to develop novel methods for monitoring cetacean takes due to difficult sampling conditions as a result of enhanced control by port authorities in many fishing terminals.

The results of the present study showed that the Burmeister's porpoise and the long-beaked common dolphin were the species most affected by San Jose coastal fisheries, as a consequence of entanglement in multifilament nylon gillnets. When the two methodologies used in this study were compared, the results could not be correlated, possibly because of a bias in the data collected on board as a consequence of the observer presence during fishing activities and inexperience in collecting data. Fishermen knew that captures of cetaceans are prohibited and may have hidden the cetaceans during the interviews to avoid sanctions. Although the number of dolphin and porpoise bycatch seems to be low, the total number may be much higher considering that only a small percentage of the fishing effort was sampled due to limited funds, that the fishing effort of the fleet may vary according to the season, and that there was not enough control of the total number of the boats operating in the area. The data presented here suggested that the mortality of small odontocetes was due to truly accidental entanglements in coastal gillnets. Concerns about the impact of the extensive use of gillnets on coastal species of cetaceans have been expressed previously (Van Waerebeek *et al.*, 1997, 1999). Hence, onboard observation programmes should be continued along the central and northern coast of Peru to further assess mortality rates of small cetaceans and marine turtles, species also affected by the bycatch.

ACKNOWLEDGEMENTS The author sincerely thanks M. Arias-Schreiber, main researcher of the Area of Marine Mammals of IMARPE laboratory in Lima, for the help with funds and encouragement in field work. This work would not have been possible without the collaboration of David Sarmiento, Antonio Mosquera, and the dedication of all independent observers, who spent many months monitoring the port activities and fishing trips. The author also thanks Dr M-F. Van Bressem for the constructive criticism of this manuscript.

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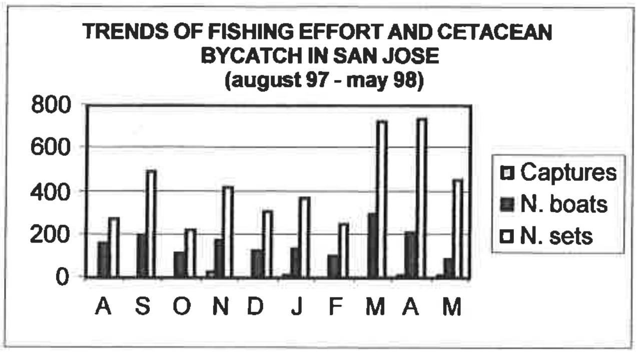

Fig. 1. Trends of Fishing Effort and Cetacean Bycatch in San Jose (Aug 97-May 98)

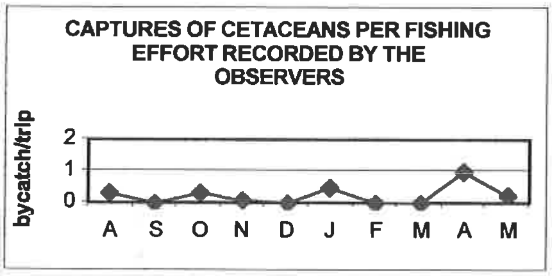

Fig. 2. Captures of cetaceans per fishing effort recorded by observers

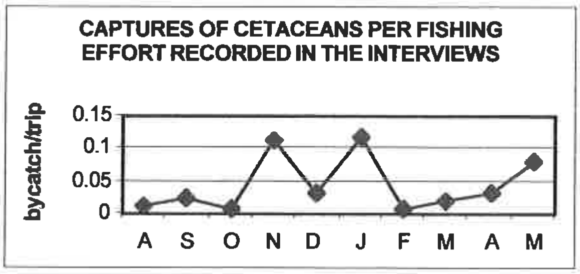

Fig. 3. Captures of cetaceans per fishing effort recorded in Interviews

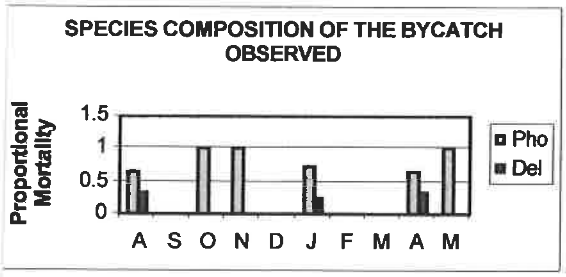

Fig. 4. Species composition of the bycatch observed

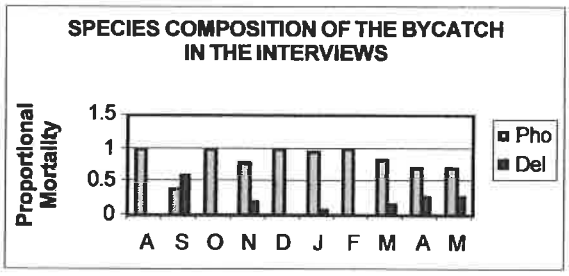

Fig. 5. Species composition of the bycatch in the interviews

AN INVESTIGATION OF ANTHROPOGENIC FACTORS AFFECTING SIGHTINGS OF BOTTLENOSE DOLPHINS *TURSIOPS TRUNCATUS* OFF THE DORSET COAST

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INTRODUCTION The Durlston Marine Research Area (MRA), a voluntary marine nature reserve off the coast of Dorset, southern England, has been the focus of a long-term and continuing study of bottlenose dolphins *Tursiops truncatus*. The MRA, as defined for the purpose of this study, is the stretch of coastline ranging west of Peveril Point to east of Anvil Point and to the far seaward horizon (Fig. 1). The coastal waters of southern England are one of the more intensive shipping areas in the world for both commercial and leisure activities. The MRA, in particular, is subject to heavy tourist pressure during the summer months. It is also adjacent to a major area of oil exploration. Effective management of inshore waters for marine wildlife has necessitated the study of anthropogenic factors influencing the MRA. The main sources of possible anthropogenic activity considered in this study are commercial shipping (including a fast-ferry service), leisure boating and seismic testing. The aim of this study is to conduct a screening analysis of the data available to determine whether further research is warranted into the influence of anthropogenic factors on cetaceans within the MRA.

METHODOLOGY This study had focused upon quantified effort-related visual surveys, supplemented by underwater acoustic studies and anthropogenic activity historical records. Photo-identification records have also proved relevant. These data have been compared on a chronological base-line with 13 years of Bottlenose Dolphin sighting data so as to assess any possible anthropogenic influences.

Sightings Study

A team of trained, experienced volunteers has conducted quantified effort visual surveys from the cliffs overlooking the MRA. A core watch of 30 hours per week has been maintained since 1995 (Williams and Browning, 1998). Opportunistic sightings, from the whole of the Dorset coast and to a lesser extent the Isle of Wight, have been collated since 1988. To validate the opportunistic data, only sightings that have been corroborated by photographic evidence or other independent sighting reports, have been included in this analysis. To avoid duplication of data, the analysis has been based on dolphin-days rather than the total number of dolphin sighting reports. A dolphin-day is defined as a day when bottlenose dolphins have been observed irrespective of group size and/or the number of times they have been sighted during that day. Furthermore, sightings made at different times on the same day that are positioned remotely from one another are counted as one dolphin-day. It is accepted that this may incur an underestimate of sighting-days but generally is thought to have little effect on the overall trend. Photo-identification mark-recapture techniques have also proved useful in identifying individual animals and pods to assess whether it is the same animal(s) that are exposed to anthropogenic factors over time.

Boat Traffic Study

Sightings of vessels in the MRA were logged by the Durlston Dolphin Watch team from 1996 as an integral part of the surveys. The protocol involved counting the number of vessels passing through the MRA and classifying each vessel into one of seven categories of vessel type. Weekend sightings of both boats and dolphins are underestimated as the data relied almost entirely on casual sighting reports. Using mean estimates of speed for the different vessel types to calculate dwell time in the MRA, the data have been extrapolated to consider the percentage of time dominated by boat traffic noise within the MRA. Particular attention has also been given to the Condor Express – the UK's fastest ferry. In March 1997, the Condor Express was transferred to a new twice-daily service from Poole to the Channel Islands for the period March to October. Previous research (Browning *et al.*, 1997; Browning and Harland, 1999) has detailed the underwater acoustic output of Condor Express in the MRA, and considered the implications for cetaceans over a short-term period. Consideration in this study is given to the role of the Condor Express in anthropogenic activities within the MRA in a wider, long-term context.

Seismic Testing Study

Since the beginning of this study in 1988, seismic testing surveys have been carried out in September and October 1994 and December 1998 to February 1999, in Poole Bay, 2.5 km from the Marine Research Area. In 1994, 15 airguns, firing every 12 seconds, were used by BP in Poole Bay (Hunt Oil UK commenced seismic testing in French waters at the same time as BP using 19 airguns firing every 6 seconds at 2000 psi.). In 1998/9, a 4-gun array of Sodera G.I. airguns, with a total generating volume of 600 cubic inches were deployed. Total power of the array was 15.8 bar meters in 0–128 Hz range, 2000 psi. JNCC guidelines for seismic surveys were employed on each occasion.

RESULTS

Bottlenose Dolphin presence and distribution

Bottlenose dolphin sighting-days within the MRA generally increased from 1988 to 1996, with a peak in 1994 of 80 dolphin-days. From 1996 onwards, there has been a general reduction in dolphin-days (Fig. 2). Although the MRA is the main focus of this study, Figure 2 includes the dolphin-days for the whole of the Dorset coast to demonstrate that although dolphin-days declined in the MRA from 1996 onwards, the levels of dolphin-days for the Dorset coast have remained relatively constant during this time.

A yearly analysis of the mean seasonal distribution of dolphin-days in the MRA has shown a pattern of two peaks per annum, in the spring and the autumn (Fig. 3). The survey data supplied by the 'dolphin watchers' have not been corrected for effort since statistical tests on the data from 1995–2000, presented in Figure 4, indicate no significant difference in the number of hours watched per year. (Spearman's Rank test: Rs = -0.625, non-significant).

Anthropogenic Influences

a) Boating Activity

Boat traffic activity within the MRA peaks in July and August (Fig. 5). This increase is due principally to leisure boating rather than commercial traffic, which is generally constant over the year (Fig. 5). The activity of vessels considered to have a greater noise output, such as jet skis and motor boats, also increases during July and August.

Calculating the dwell time for each vessel category using mean speed estimates, Figure 6 demonstrates an estimate of the percentage of time (daylight hours only) dominated by boat noise in the MRA. It is accepted that this may incur an overestimate of time, as it does not account for the overlap of boats present in the area at the same time.

Overlaying the boat traffic data with the dolphin-day data indicates that the fall in summer dolphin-days corresponds with the peak in boat traffic levels in the MRA. The winter fall in sightings is not accounted for by increases in boat traffic levels (Fig. 7).

Figure 8 plots the onset of the Condor Express ferry route through the MRA in March 1997, with dolphin-days from 1988 to the present day. Although superficial, there appears to be an apparent decline in the number of sightings since the commencement of operation of the Condor ferry within the MRA from 1988 to the present day.

b) Seismic Surveys

Figure 9 plots the seismic survey events in 1994 and 1998/99, with dolphin-days since 1988. Again, although superficial, there appears to be an apparent decline in the number of dolphin-days in the year following the seismic surveys in 1994-95 and 1998-99 within the MRA. Other annual declines in sighting days in 1990 and 1993 do not correspond with seismic events. Also, of note, the results of the photo-identification study from 1995 onwards indicated a transition in 1999 from the semi-resident pod of five bottlenose dolphins to a new group of individuals.

DISCUSSION The overall trend in dolphin-days indicates a clear seasonal pattern to the presence and distribution of bottlenose dolphins within the MRA. Analysis of the effort-related data has confirmed that these trends are not an artefact of the number of hours watched.

The coincidence of minimal dolphin activity and maximum shipping traffic during the summer period bears examination. Since the main contributors to the shipping peak are recreational leisure craft, it is possible that these types of craft (yachts, motor boats, jet skis and rigid inflatable boats) must be considered as possible deterrents to a dolphin presence. Disturbance may be due to the high manoeuvrability of the craft or the noise output. Although based on a crude analysis, it is interesting to note that the time dominated by boat traffic noise in the MRA increases from approximately 10% to 70% in the peak summer months. However, the trend in the data also indicates a decline in sightings during the winter months, which is the minimum for recreational boating. If the hypothesis for disturbance by shipping activity is to be deemed sound, then another factor must influence dolphin activity within the MRA during winter. Poor visibility and environmental factors during the winter months may be a possible factor that obscures detection of cetacean presence. Further research using year-round acoustic monitoring to extend the visual surveys and control for the confounding effects of weather conditions are necessary to more accurately assess the presence of bottlenose dolphins during winter months. Such acoustic research could also be extended to develop an enhanced understanding of the specific output and frequency range of vessel types and other anthropogenic underwater noise sources in the MRA.

It must be stressed that the attempt here to consider the role of Condor Express and seismic testing in the patterns emerging from the overall trends of dolphin-days is purely speculative, and no conclusions can be drawn. The apparent, superficial declines in dolphin-days could be the result of many factors most of which fall outside the remit of this paper. In light of the findings of the photo-identification study, it is possible that the transition between pods using the MRA is a major factor in the decline of dolphin-days during 1999 as the area was vacated by one group and the unoccupied area only slowly re-colonised by a different pod. These changes in themselves may be the result of natural cycles in the ecology and dynamics of the original dolphin pod, or perhaps the result of a localised disturbance that displaced the original group, and the area did not become re-occupied until the disturbance ceased. A parallel study into the natural biological factors that influence presence and distribution of bottlenose dolphins along the Dorset coast is required to achieve a balanced understanding of their ecology and conservation needs.

In conclusion, this brief screening study confirms the need for further research into the possible influence of anthropogenic factors on cetaceans in Dorset waters and for this to be set within the context of local bottlenose dolphin ecology.

ACKNOWLEDGEMENTS We would like to thank the Durlston Dolphin Watch team and the Durlston Marine Mammal Research Team Partners Durlston Marine Project partners (BP, English Nature) and the Marine Project partners (WWF-UK, Dorset County Council, the National Trust, Dorset Wildlife Trust and the Friends of Durlston).

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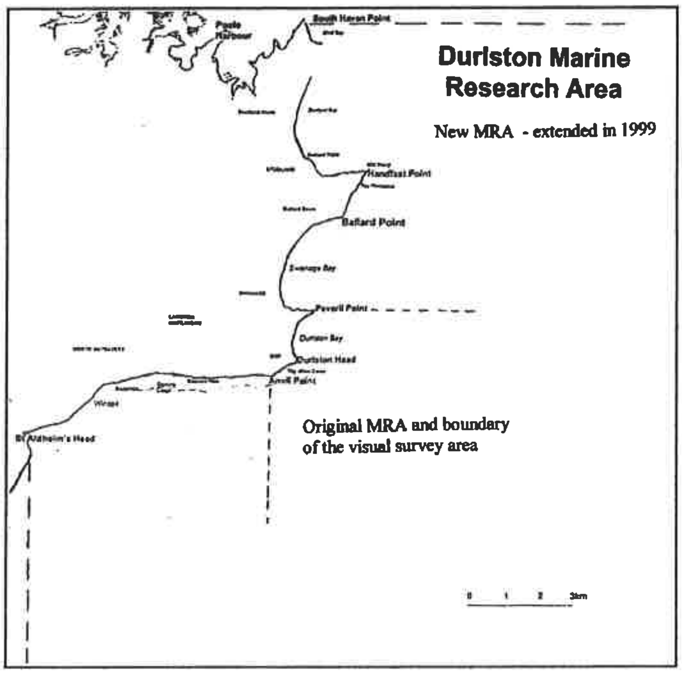


Fig 1. Map of the Durlston Marine Research Area.

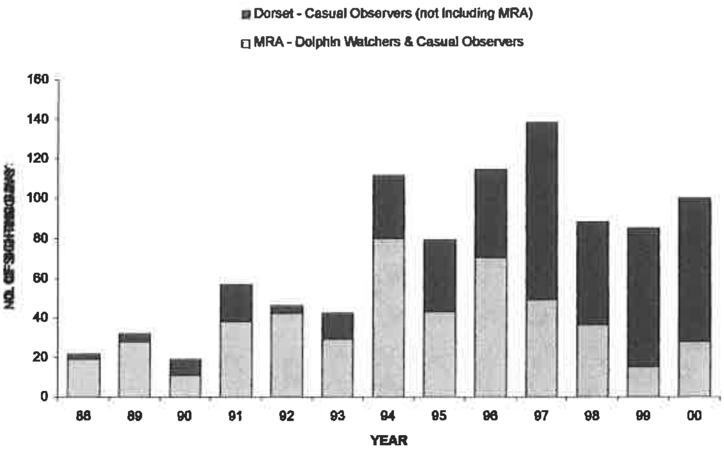


Fig 2. Bottlenose dolphin sighting days 1988–2000

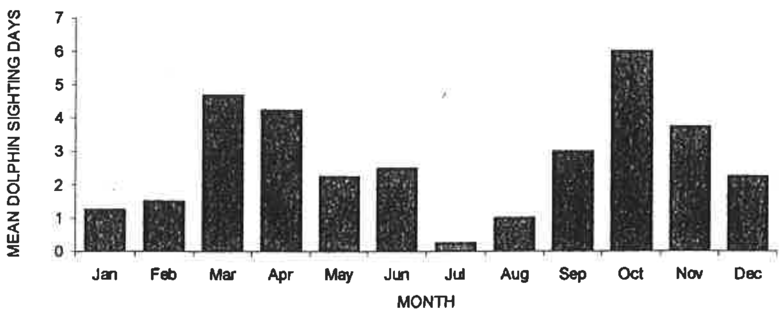


Fig. 3. Mean seasonal distribution of dolphin-days within the MRA, 1997-2000

Fig 4. The number of hours watched and the number of dolphin-days per year.

Year	Total No. of hours watched per year	Total no. of dolphin-days per year
1996	1499	43
1997	1430	24
1998	1369	24
1999	1833	2
2000	1552	15

Fig. 5. Seasonal boat traffic activity in the MRA 1997 – 2000.

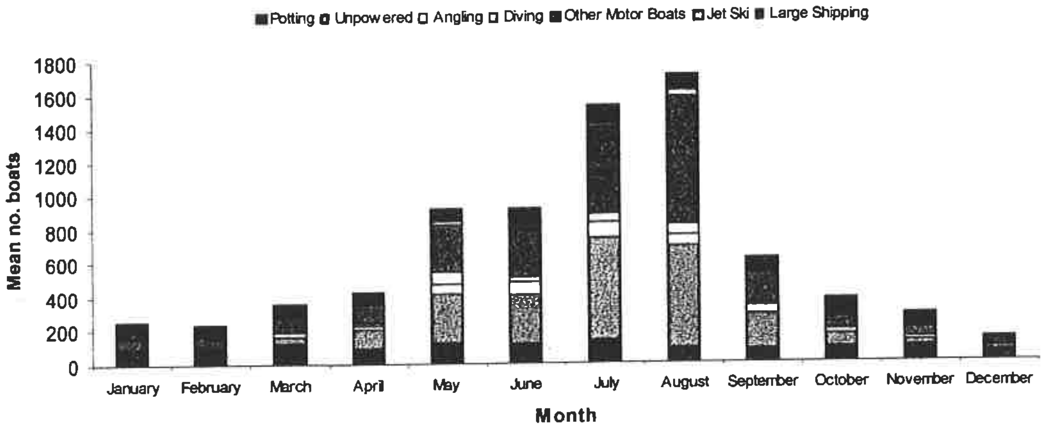


Fig. 6. Extrapolated percentage of time dominated by boat traffic noise within the MRA 1997 - 2000.

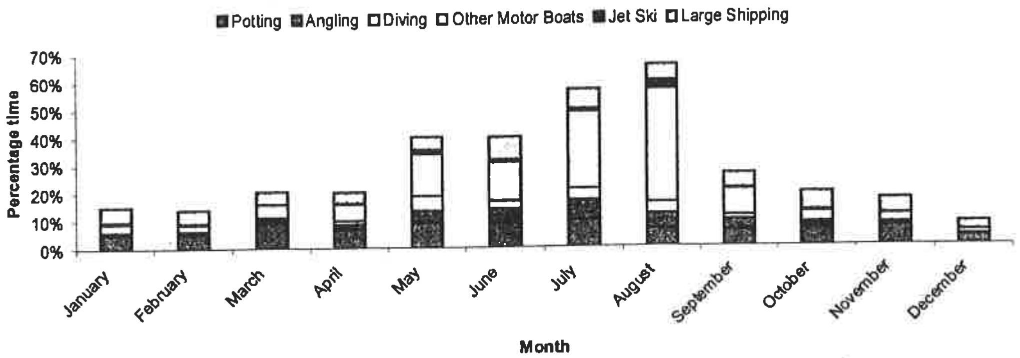


Fig 7. Comparison of boat traffic levels with seasonal dolphin-days 1997 – 2000

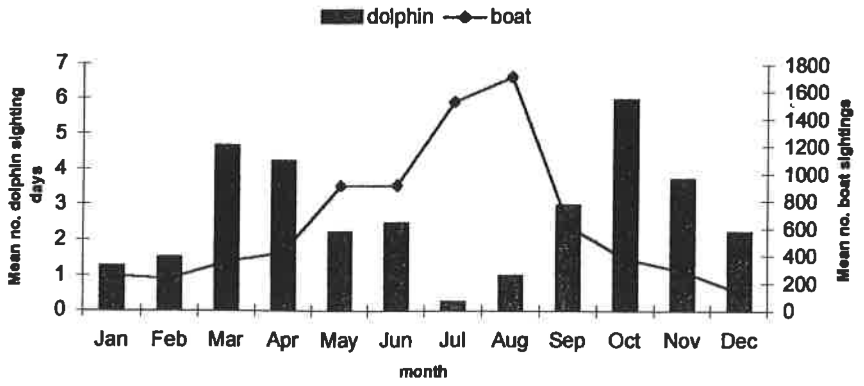


Fig. 8. Comparison of dolphin-days in the MRA 1988 – 2000 with the onset of the Condor ferry service from Poole.

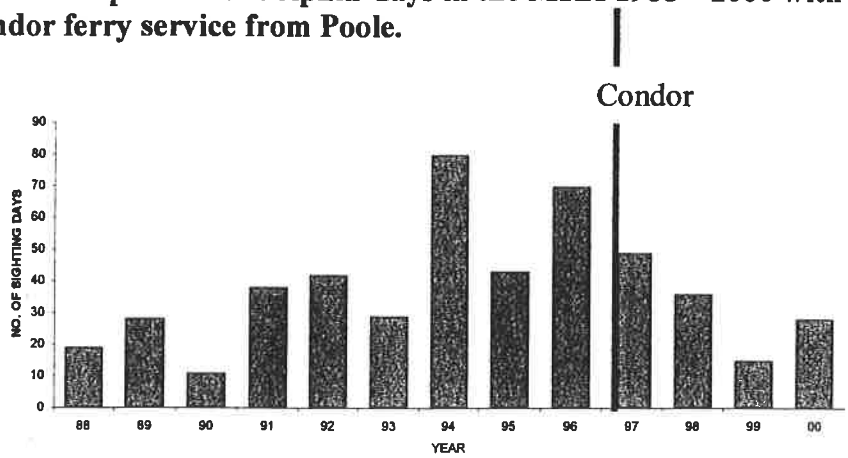
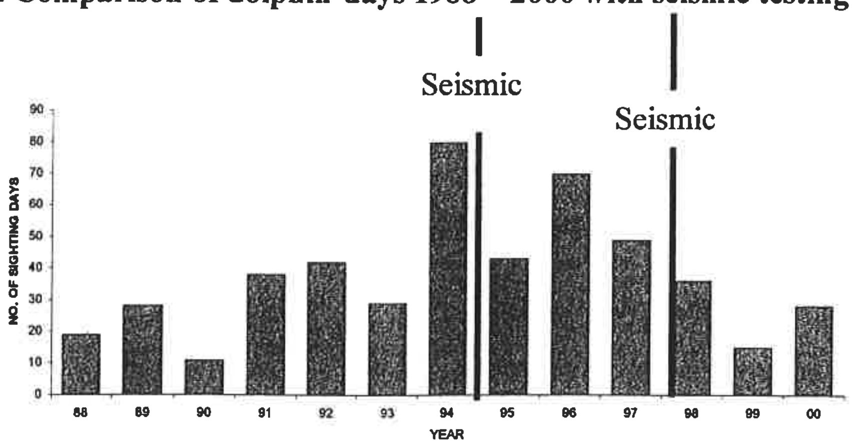


Fig 9. Comparison of dolphin-days 1988 – 2000 with seismic testing events



DISTRIBUTION AND OCCURRENCE OF FIN WHALES IN THE LIGURIAN SEA BETWEEN 1990-99

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Fin whales (*Balaenoptera physalus*) were observed during dedicated cruises in the summer months from 1990 to 1999 in the waters of the recently established Ligurian Sea Cetacean Sanctuary. During 870 days spent at sea, totalling 73,406 km of consistent surveys, 543 sightings of fin whales were made. Whales aggregated in small groups, with a mean group size of 1.75 individuals (mode=1, SD=1.11, N=543, range 1-7). Yearly mean group sizes ranged between 1.4-2.1, with significant differences between years (ANOVA, $P<0.01$). Fin whale sighting frequencies for the entire study area were calculated in terms of number of sightings and number of animals sighted per total distance surveyed in one season. To determine variation in the occurrence of fin whales during summer months, sighting frequency values were calculated for every single month from June through September.

The highest sighting frequencies, in terms of number of whales per distance surveyed, occurred in July and decreased significantly in September (ANOVA $p=0.03$). The mean distance from the coast was 45.7 km (SD=18.1, N=543, range 1.9-113.9 km) with a mean depth of 2,315 m (SD=387.15, N=543, range 65-2,690 m). Depth and distance from the nearest coast differed throughout the study period, with significantly lower values in summer 1990 (ANOVA $p<0.01$). Whales seemed to be evenly distributed in the study area between the Italian-French coast and the island of Corsica. The data collected within this long-term research provide insight on the presence, distribution, and seasonal occurrence of this species while summering in the Ligurian Sea Sanctuary, supporting scientific evidence that may be crucial for the management of this marine protected area, characterised by intense human activities. Moreover, given recent evidence of presence of fin whales in the Corso-Ligurian Basin all year round, similar effort is recommended also during winter months.

USE OF A DIGITAL ACOUSTIC TAG TO DOCUMENT RESPONSE OF THE NORTH ATLANTIC RIGHT WHALE TO SURFACE ACTIVE GROUPS

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North Atlantic right whales (*Eubalaena glacialis*) perform their most conspicuous surface behaviors when involved in surface active groups (SAGs). These surface groups involve 2–20+ whales engaged in social/sexual behaviour at the surface, and often producing particular vocalisations. Preliminary playbacks of vocalisations recorded from these groups have been shown to strongly attract adult male right whales. The digital acoustic recording tag (DTAG), logging both acoustic data from the environment and behavioral orientation data, has proven to be an excellent tool to further investigate acoustic communication used by right whales in the formation of these groups. The DTAG records ambient acoustic data as well as the whale's depth, pitch, roll, and heading. During the summer of 1999 and 2000, these suction cup tags were attached to right whales in the Bay of Fundy, Canada.

Right whales responded to exposures of pre-recorded right whale sounds from SAGs and to sounds produced by actual SAGs in the field. Two playbacks of recorded sound were carried out to tagged whales in 2000. Additionally, three tagged whales joined actual surface active groups while carrying the tag. In both scenarios, the tag sensors recorded subtle, sub-surface responses to sound exposure. These responses included changes in heading and cessation of active swimming which reduced flow noise and made the playback more clearly audible on the tag record. Additional playbacks may be able to shed light on the effective range of communication in these whales by determining what received level of SAG vocalisations is necessary to elicit a response.

MONITORING THE PRESENCE OF CETACEANS IN THE NORTH ADRIATIC SEA: HYPOTHESES OF A RESIDENT POPULATION OF BOTTLENOSE DOLPHIN IN THE GULF OF TRIESTE/GRADO LAGOON AND A MULTIDISCIPLINARY APPROACH TO TEST IT

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INTRODUCTION As recently reported by the RAC-SPA Convention of Barcelona (1995), management and conservation of threatened and endangered species are the necessary measures for sustainable use of marine and coastal biological resources. Most of the cetaceans sighted in the Gulf of Trieste are actually on Annex II of the Protocol concerning specially protected areas and biological diversity in the Mediterranean, requiring protection. Indeed, the presence of marine mammals in the Gulf of Trieste has been well documented since the last century. In 1990, the Natural Marine Reserve of Miramare (Trieste, Italy) started its activity of censusing the marine fauna, including large marine vertebrates. At the same time, it created a group of marine biologists (GPI, actually EST, Emergency Service Team) in collaboration with a veterinarian, for rescuing stranded and injured animals. As result, a review of the cetacean sightings and strandings in the Gulf of Trieste in the years 1990-98 has been presented at the ECS meeting of Valencia (Francese *et al.*, 1999). On the same occasion, the authors presented a new protocol of intervention and a new sighting form. Its aim was to fill the existent gap between researchers and local populations, and to encourage people to signal to an appropriate address the presence of large marine vertebrates in the Gulf of Trieste.

The staff of the Reserve also initiated a regular monitoring activity in collaboration with the Revenue Guard Corps and Harbour Office of Trieste. At monthly intervals, the operators monitor the area of the Gulf along a standard transect in order to check the presence of cetaceans and to define their spatial and temporal distributions. The aim of this work is to present and review the data obtained since 1999.

MATERIALS AND METHODS The data were collected monthly aboard the boats of the Revenue Guard Corps and Harbour Office of Trieste. The routes were pre-defined. Numbers and species of animals sighted, sighting location, local environmental conditions, and activity of the animals, were all recorded.

Whenever possible, animals were photographed. Photos of the dorsal fins were analysed with a magnifying glass, and their main characteristics (shape and nicks) were examined. Highly recognisable individuals were catalogued. A comparison was made between the photographed animals and the identified individuals sighted in the area of Cres and Losinj archipelago.

RESULTS
Sightings: Bottlenose dolphin *Tursiops truncatus* Solitary or couple of animals were sighted between the years 1990- 1998. In only one case, in 1991, a group of 5-10 individuals was present off the Port of Trieste.

Whereas in 1999, the sightings were few (only one sighted animal), in 2000, large groups of bottlenose dolphin have been seen off the coastal water of Lignano (Ud) (Fig. 1). In May, August and October, a group of 6 animals was accompanying by a juvenile. At the beginning of 2001, a group of about 30 individuals was reported resident in the same area.

Risso's dolphin *Grampus griseus* Both in 1999 and 2000, the Risso's dolphin was found out of the Port of Trieste and at the Lagoon of Marano. The last occurrences of this species in the Gulf date back to 1993 and 1996 (Francese *et al.*, 1999).

Striped dolphin *Stenella coeruleoalba* In 1999, an individual was identified in the Gulf. No reports are present for the year 2000.

Fin whale *Balenoptera physalus* In October 2000, a fin whale was sighted for few days in the Gulf of Trieste. The previous report of its presence in the same area dated back to 1976 (Spoto and Lapini, 1995).

Other Species It is also noticeable that there has been an increase in the presence of sea turtles and basking sharks, already well documented in the Gulf of Trieste. We refer especially to the high number of young turtles (*Caretta caretta*) recently caught in Slovenia (W. Zizza, *pers. comm.*), and to the sightings of ten basking sharks (*Cetorinus maximus*) in the Gulf. The landing of one sunfish (*Mola mola*) of about 200 kg by a local fisherman has also been reported at the end of April 2001 (*unpubl. data*).

Photo-identification Photo-identification of some of the bottlenose dolphins sighted was carried out by the staff of the Reserve, wherever possible. Only high quality photographs were taken into account. A total of seven animals were identified with certainty. Three individuals were seen during two different sightings in August and October 2000. None of the locally identified animals has been found in the area of Cres and Losinj archipelago.

Fishing Considering the typical diet of the bottlenose dolphin in the North Adriatic (Fortuna and Canese, *unpubl. data*), most of the fish and cephalopod species caught by fishermen are its potential prey. Therefore, the trends in commercial stocks are indicative of prey abundance in the Gulf of Trieste. In Figures 2 and 3 are reported the total amounts of landings in years 1992–2000.

Environmental parameters The hydrological conditions of the Gulf of Trieste do not differ substantially from those characterising the north-east area of the Adriatic Sea. The area is influenced by the local outputs of rivers, but the latter modify the salinity of the water surface and the upper water layers (Mosetti, 1988).

The trends in salinity and density of the local water during the year are relatively constant from the years 1980-82 (Vinzi and Bussani, 2000).By contrast, there has been a consistent increase in the water temperature of the last few years (Stravisi, 2000). In particular, in the last fifty years, the sea became colder during spring and summer, and warmer during autumn and winter.

Sea ambient noise Preliminary results (Costantini, 1998) demonstrated that the sea ambient noise recorded in Trieste is comparable with that recorded in different highly noisy bays and harbours in USA during World War II, as reported by Urick (1983). This is not surprising, since Trieste has been an important port subjected to high anthropogenic disturbance. The area of the Gulf is indeed heavily exploited by pleasure craft, ships, and cargo boats.

Pollution The coastal area of the Gulf of Trieste is densely populated and industrialised. Anthropogenic inputs are more pronounced during summer, when the thermocline develops. This leads to eutrophication phenomena linked to high concentration of nutrients ,or to a modified bacterial loop in the food web. Pollutants of anthropogenic origin are typically organic compounds (hydrocarbons and solvents), brought to the sea via sewage, and heavy metals, brought by the river (especially mercury until ten years ago), or by industrial waste water. The concentration of these exogenous factors is not very high, but is accumulated in western bottom sediments (lagoon area: Adami *et al.*, 1996), and can support biomagnification.

CONCLUSIONS The Gulf of Trieste has been demonstrated to be a highly anthropogenically affected and exploited area. However, in the last few years, we have observed an increase in the numbers of sightings of cetaceans and of rare or uncommon species. The increase in water temperatures seems to play an important role in this trend. The milder winters, which historically were too cold for the local species to remain in the area, may facilitate animals becoming resident in the Gulf throughout the year. The warming of waters may increase the availability of primary producers (algae and plankton) and consumers. Fishing data confirm that the Gulf is populated by different prey of cetaceans. This means that even if prey abundance is fluctuating between years, animals may shift their diet to the most abundant species in the area. Interestingly, most of the sightings were recorded in 2000, when the capture of molluscs was relatively low, but when local fishermen recorded one of the highest landings of anchovies in the last ten years. Considering that the depth of the area never exceeds 25 metres and presently forms mostly a muddy bottom, it is likely that large vertebrates may capture their prey more easily than in other more deep and rocky locations.

Is the Gulf of Trieste and the surrounding lagoons becoming a suitable habitat for resident population of cetacean and other big vertebrates? The presence of large groups of bottlenose dolphin and the repeated sightings of the same individuals may indicate a tendency towards residency. The presence of a juvenile individual in the groups is also notable. However, we cannot exclude the possibility that increased monitoring activity in the area might be affecting the likelihood of sightings.

The bottlenose dolphin is known to be a relatively tolerant species, living also in disturbed and polluted locations. Pollution or altered ambient noise may therefore be important, but not limiting, factors for this species to remain in the Gulf, if the latter is an important feeding area. Alternatively, we may suppose that the bottlenose dolphin is expanding its feeding movements to more northern latitudes in the Adriatic Sea.

What are the future prospects, and which aspects specially require management? To give an answer, we plan to carry out our monitoring with particular attention to the individual identification of animals. We shall continue monitoring the chemico-physical parameters of the sea-water, as well as the distributions and abundance of fish in the Gulf. We are also considering the possibility of regular monitoring the levels of sea ambient noise in different locations of this area. We will improve EST logistics, with the support of local administrations. In parallel, we would like to initiate data comparison among scientific groups working in the North Adriatic as Italian, Slovenian (related to us in marine protected areas management) and Croatian organisations.

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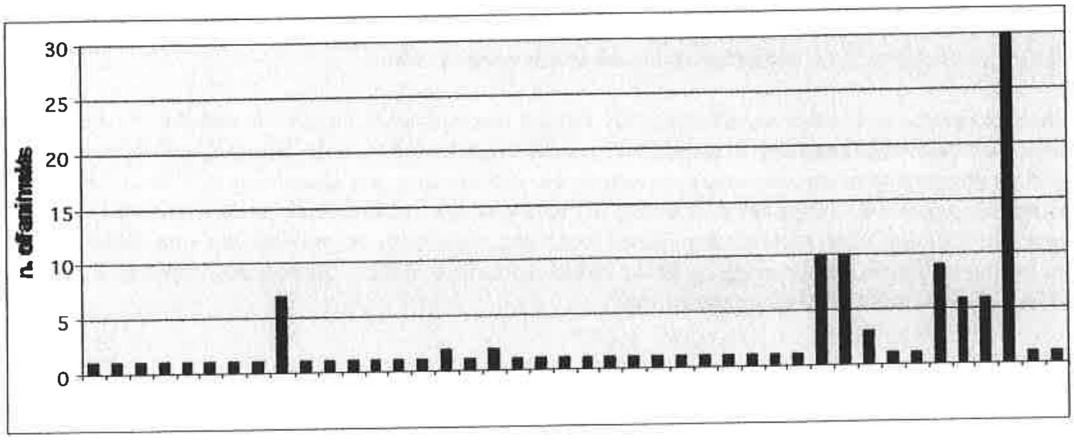

Fig. 1. Group size of the sightings of bottlenose dolphins from 1990 to 2001

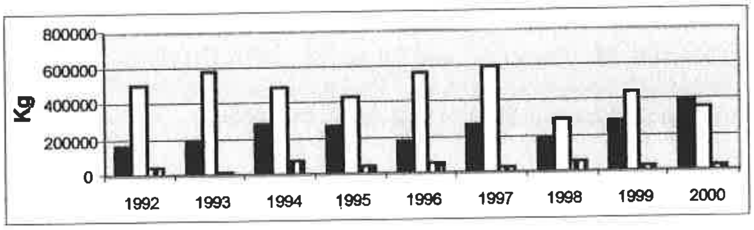

Fig. 2. Total amount of strandings of anchovies (in black), sardines (in white), and mackerel (striped)

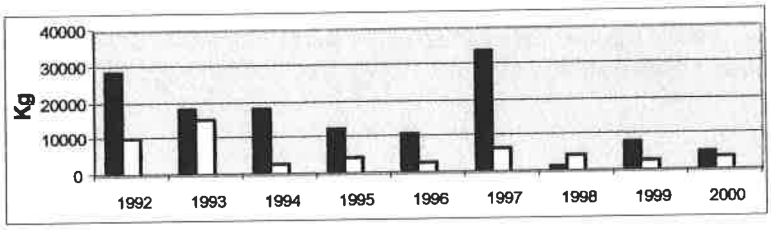

Fig. 3. Total amount of strandings of squid (in black) and cuttlefish (in white)

DESERTAS ISLANDS NATURAL RESERVE: A HOME FOR THE MEDITERRANEAN MONK SEAL

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The Desertas Islands are a group of three inhabited islets (Ilhéu Chão, Deserta Grande and Bugio), situated SE of Madeira at a distance of 11 nautical miles. The Desertas became the last spot with an effective colony of the endangered Mediterranean monk seal, *Monachus monachus*, in the open Atlantic Ocean, after its decline on the main island due to human pressure. Nevertheless, this situation changed during the 1970s with an increase in fishing activity in those islands. Deliberate and accidental killings by entanglement in gillnets caused the population to undergo a steep decline and, in 1988, it was estimated at only 6-8 individuals. In that year, a policy was implemented to protect and monitor the monk seals on the Desertas. In addition, an environmental education programme was established. One main concern was the awareness of fishermen. Finally, in 1990, the Desertas Islands were legally protected. The Nature Reserve includes the three islands and the sea around to a depth of 100 m. It is divided in two parts: a Restricted Area (the southern part) where the seals conduct most of their activities, and a Partially Restricted Area (the northern part) where fishing activity by lines is permitted but in a controlled way, thus allowing fishermen to pursue their livelihood. Otherwise, in those areas where nets were forbidden, alternative forms of fishing were offered to the fishermen. The Reserve is regularly controlled and monitored by boat. Nowadays, the Desertas Islands have security and sustainable conditions for the survival of the monk seals, and the population is estimated to number 23 individuals. Certainly the strategy followed to establish the Reserve, not in an extreme way but integrated into a general management plan with social and educational concerns has been responsible for its success.

MOBILE MARINE PROTECTED AREAS: A SOLUTION TO CONSERVING A DYNAMIC DOLPHIN POPULATION IN AN ENERGETIC ECOSYSTEM

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The Pearl River Estuary, encompassing the territorial waters of Hong Kong, China, and Macau, is a significant habitat for the Chinese white dolphin (*Sousa chinensis*). Little was known of the population, however, until Hong Kong's new port and airport was developed in the dolphin's habitat. This prompted the Hong Kong Government to initiate a study of the local *S. chinensis* population so that a management plan could be established. It was then shown that the dolphin population was also threatened by extensive boat traffic, intensive fishing practises, and pollution through the widespread discharge of municipal and agricultural effluents. Since development had commenced prior to the dolphin study, the first conservation initiatives focused upon ameliorative rather than protective measures. An immediate reaction, in the light of ongoing, extensive coastal development, was to establish a 'dolphin sanctuary'. Before this area was designated, however, the study revealed that individually-identified dolphins frequented different key areas throughout the habitat, of which the 'dolphin sanctuary' was only one. A second (again small, multiple use) marine protected area was then proposed. In Hong Kong, however, where the total marine area is small and, consequently, protected areas are relatively restricted, the protection afforded by so-called sanctuary areas is minimal particularly as recreational and fishing activities are still allowed within them. In addition, during the seven-year duration of this study, the distribution of the dolphin population has changed as various environmental variables have altered. It may, therefore, be more practicable to assign a series of temporary or rotating marine reserve areas which afford stringent protection dependent upon the dolphins' perceived immediate needs. This system would also allow for other marine habitat users, e.g., fishermen, to continue traditional activities, although these might be restricted during certain times.

SPAIN'S MEDITERRANEAN CETACEAN MARINE PROTECTED AREAS PROJECT

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In order to implement the international policies of the EU's "Habitats Directive", the Barcelona Convention, and ACCOBAMS Agreement and Spain's National Biodiversity Strategy, the Ministry of the Environment initiated in 2000, a three-year research programme for the identification of special interest areas for the conservation of cetaceans. This programme, co-ordinated by the University of Valencia involves also researchers from the University of Barcelona and the University of Madrid, as well as the NGO, Alnitak. Together, these research teams cover the integrity of the Spanish Mediterranean as well as the contiguous Atlantic waters included in the ACCOBAMS Agreement. In order to provide the scientific basis for the adequate sizing and siting of future marine protected areas for cetaceans, research aims at identifying the different cetacean populations present in these waters, and analysing their conservation status and habitat use. To reach this objective, a wide array of methods, ranging from aerial and shipboard surveys to molecular analysis techniques, are being used. In addition, the socio-economic context and the human pressure acting on the populations inhabiting these areas is being evaluated. Sighting and stranding data of nine species were compiled and analysed to establish distribution patterns. During 2000, more than 5,800 km were surveyed on effort by the research teams, and 450 sightings of cetaceans were recorded. The striped dolphin (*Stenella coeruleoalba*) and the bottlenose dolphin (*Tursiops truncatus*) were the most abundant species in the areas of Catalonia, Balearic Islands, and Valencia. The striped and common dolphins (*Delphinus delphis*) were most abundant in the southern area of Andalucía, followed by bottlenose dolphins and long-finned pilot whales (*Globicephala melas*). These activities are being developed in collaboration with the Administrations of the Autonomous Governments involved, in order to guarantee that the application of the proposed measures is feasible and harmonious with local policies.

MEETING THE CONSERVATION OBJECTIVES OF ASCOBANS: A REVIEW OF BY-CATCH REDUCTION EXPERIENCES IN THE UNITED STATES

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One of the conservation objectives of the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) is to reduce by-catches to levels below those defined as 'unacceptable interactions.' Achieving this objective has proven to be difficult, and Parties to the Agreement and other bodies, including the European Cetacean Society, have recognised a lack of progress in this regard. Here, I review experiences in the development and implementation of by-catch reduction schemes in the United States, where the legal framework is considerably more straightforward than in the ASCOBANS area. In the U.S., marine mammals are managed under the Marine Mammal Protection Act, which was amended in 1994 to deal specifically with by-catches. An allowable removal level is determined for each stock of marine mammals, using a conservative algorithm. In cases where by-catches exceed this removal level, groups of stakeholders are brought together, in formal negotiations, to develop mechanisms for reducing by-catch mortality. To date, four of these groups, known as Take Reduction Teams, have been formed to address by-catches of small cetaceans. To date, the plans developed by these teams have included the following measures: reduction of fishing effort, time-area closures, pingers, and gear modifications. Several themes are common to the implementation of these plans, including: the necessity of observer programmes to monitor the success or failure of the plan; the requirement for enforcement to ensure compliance with particular measures; and continuing conflicts between the goals of these plans and the general objectives of commercial fisheries management. It is clear that conservation strategies must be tailored to specific fisheries, and that no measure will work in every case. The general approach of incorporating stakeholders in the formulation of conservation strategies has been successful and may be an appropriate strategy within the ASCOBANS area.

AN APPLICATION OF THE *POSEIDON* PROGRAMME: PRELIMINARY COMPARAISON OF FIN WHALE AND HUMAN ACTIVITIES SUMMER DISTRIBUTIONS IN THE NORTH-WESTERN MEDITERRANEAN

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INTRODUCTION Launched in 1995, the POSEIDON programme was conceived by the Tethys Research Institute and the Ecole Pratique des Hautes Etudes, in order to gather reliable information on cetaceans and the distribution of human activities in the north-western Mediterranean Sanctuary and its contiguous zones. In order to do that, data on cetaceans and human activities visually detectable from the sea surface were simultaneously collected each year, in summer, applying standardised methods.

METHODS Data for both categories, cetaceans and human activities, were collected by each of the seven research teams involved during the four-year period, from June to September, using a simplified line-transect method, with at least one observer on duty, and a minimum speed of four knots for the boats.

Sightings were first related to a 20x20 nm grid, and then weighted by survey effort (19070 nm for cetaceans and 14657 nm for human activities) per square for comparison of abundance indices.

This preliminary analysis concerns the years 1995 to 1998, and has been made with a GIS software and non-parametric statistical tests.

RESULTS In this paper, we present examples of the general distribution of six human activities (sailing, merchant and military vessels, ferries, fishing boats and nets) in comparison to that of the fin whale.

Fin whales (Fig 1) are widely distributed over the abyssal plain, with major concentrations in the middle of the Liguro-provençal basin, showing two decreasing gradients of abundance westward and north-eastward. The four preferred areas are mutually statistically different. Highly concentrated over the continental shelf, the presence of fishing boats (Fig. 2) does not overlap at all with the preferred areas of fin whales. Mostly distributed over the slope, fishing gear (Fig. 3) may have a slight influence on fin whales. High indices of oceanic gear in the northern part are likely to be long-lines.

In spite of the difficulty to obtain reliable information on the distribution of military ships (Fig. 4), it seems that military traffic may have little effect upon the distribution of fin whales, except in its northern part.

Widely distributed over the north-western basin, merchant ships (Fig. 5) overlap fin whale distribution in a marked way, especially the preferred area 3 near the provencal coast.

Travelling between the continental French and Italian coasts, and Corsica, ferries and HSC (High Speed Crafts, Fig. 6) cross the entire Liguro-provençal basin, and thus particularly overlap the preferred areas of fin whales.

Since the great majority of sailing vessels (Fig. 7) remain very close to shore, encounters with fin whales only occur rarely.

CONCLUSIONS Based upon visual sightings, investigations of the geographical overlap of human activities and fin whale presence show that there is little evidence for geographical influence of sailing vessels, military ships, fishing boats and nets, upon fin whales, whereas those areas with a high abundance of ferries and merchant ships are likely to affect fin whales. In fact, collisions with large and fast vessels are reported to be one of the major causes of mortality for this species.

Beyond this example, maps of distributions of nine species of cetaceans and of seven broad categories of human activities are now available at different levels of time: for the total period (1995-98), for each year, and for each month (from June to September).

Fluctuations in the abundance of cetaceans between years and months were statistically tested when the quality of data allowed it, and preferred areas for the six most common cetacean species were assessed (fin whale, sperm whale, long-finned pilot whale, Risso's dolphin, bottlenose dolphin, and striped dolphin).

This simple and rapid analysis, and the resulting maps, thus appear to be useful in helping managers of Marine Protected Areas to take accurate preliminary decisions for conservation of cetaceans.

ACKNOWLEDGEMENTS Many NGOs, persons or administrations have joined or helped us during the POSEIDON Programme. We are particularly grateful to Amitiés Sans Frontières (Monaco), Céta-Squale (France), Delphinia Sea Conservation (Italy), Europe Conservation (France and Italy), Groupe de Récherche sur les Cétacés (France), Ministère de l'Environnement (France), Nature et Découvertes (France), Swiss Cetacean Society (Switzerland), WWF-France, and Zotier Richard (France).

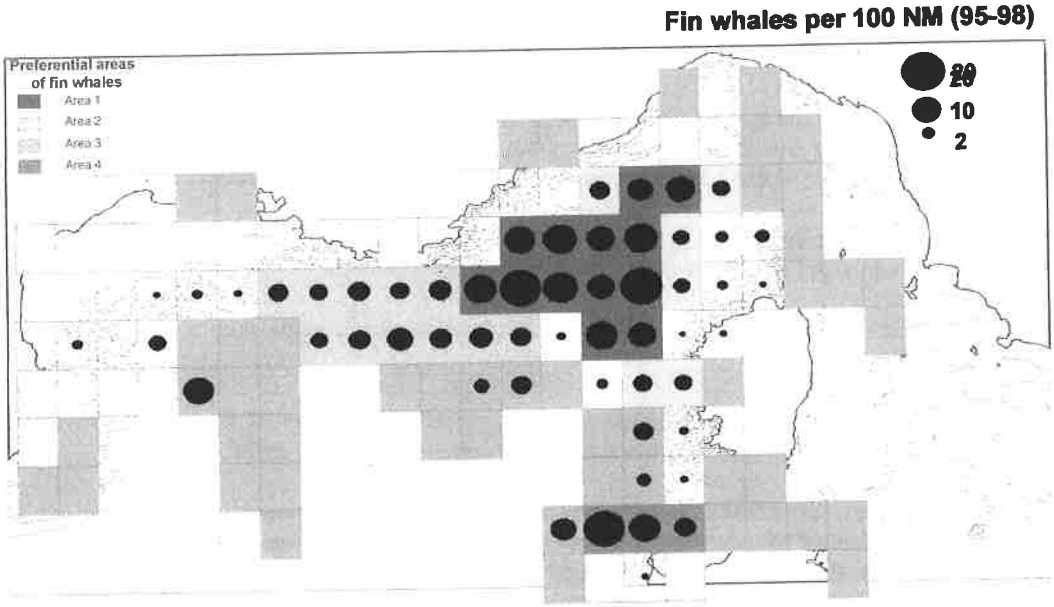

Figure 1 : Fin whales

Fig. 1. Fin whale distribution in the Liguro-provençal basin. Blank squares show insufficient effort (<40 nm), pale shaded squares medium effort (<80 nm), and darker shaded squares show good effort (>80 nm), encompassing part of the preferred areas of fin whales

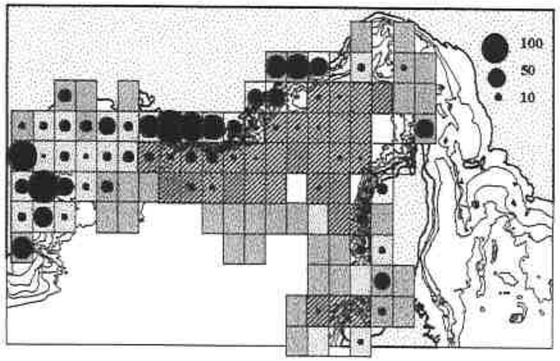

Figure 2 : Fishing ships per 100 NM (1995-98)

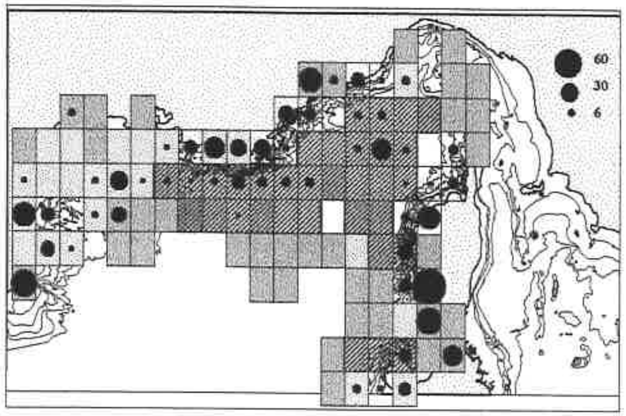

Figure3 : Fishing nets per 100 NM (1995-98)

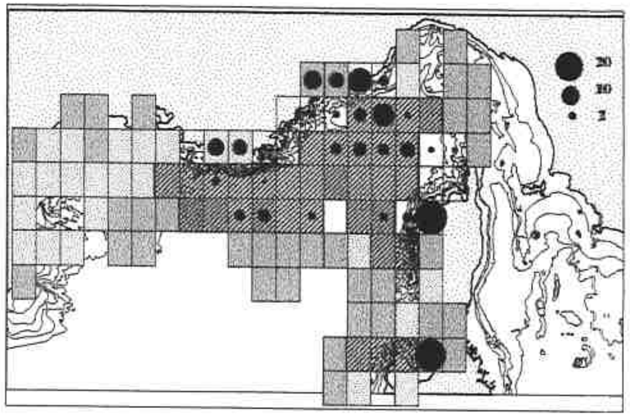

Figure 4 : Military ships per 100 NM (1995-98)

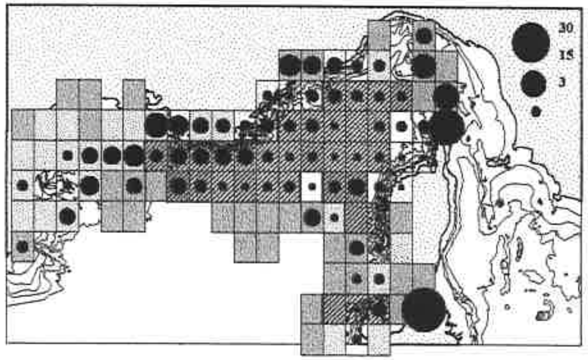

Figure 5 : Merchant ships per 100 NM (1995-98)

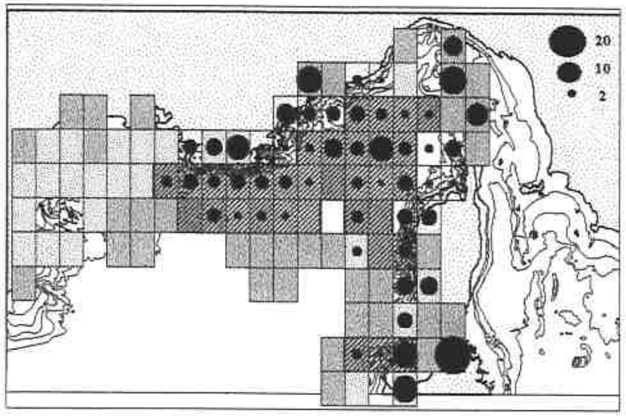

Figure 6 : Ferries and HSC per 100 NM (1995-98)

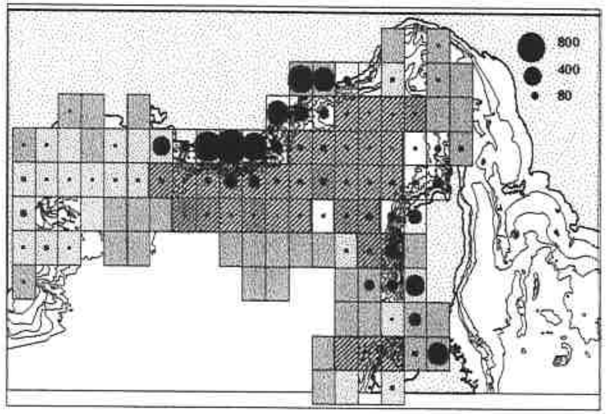

Figure7 : Sailor ships per 100 NM (1995-98)

AREA PREFERENCES OF HUMPBACK WHALES ON A BREEDING GROUND

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The area of the Machalilla National Park in Ecuador forms a breeding ground for humpback whales from June to September. Over the last decade, the whale-watching industry along the coast has increased dramatically, making it important to determine the importance of the coastal habitat for this species. The two-nautical mile zone around the island "Isla de la Plata"belongs to the National Park, and is used for tourist activities such as whale-watching, scuba diving, as well as for sports fishery. Additionally, artesanal and, at times, commercial fishing takes place at the study site.

In June, July, August and September 1998, simultaneous observations from three observation points off the island were made of humpback whales. Information on position, behaviour, group size, and presence of calves was collected. Subsequently, the distribution of humpbacks around the island was analysed in respect to depth, substrate type and exposure.

Humpback whale distribution was significantly dependent upon depth, substrate type, exposure, and the combination of depth and substrate type, as well as substrate type and exposure. In combination with the collected data on behaviour and the presence of calves, the information was used to define areas of high importance to the humpbacks for management purposes.

INCIDENTAL MORTALITY OF CETACEANS IN FISHING GEAR: REVIEW AND SYNTHESIS

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INTRODUCTION The present short paper summarises material documented in a recent report to the CEC (Spencer *et al.*, 2000). We review the literature on fishery by-catch of cetaceans in European waters, and compare the European situation with by-catch management in US waters under the provisions of the Marine Mammal Protection Act. Incidental entanglement in fishing gear causes mortality, in excess of estimated net population growth rates, in vulnerable cetacean populations worldwide (IWC, 1994). Many studies have explored the incidence and causes of by-catch and the efficacy of different mitigation methods (e.g., Di Natale, 1994; Goodson and Datta, 1992; Goodson, 1993; Benke, 1994; Goodson *et al.*, 1994a; Carlström and Berggren, 1996; Couperus *et al.*, 1997a,b; Fertl and Leatherwood, 1997; Tregenza *et al.*, 1997a,b; De Haan *et al.*, 1997; Tregenza and Collet, 1998; Northridge and Hammond, 1999; Kastelein *et al.*, 2000). The paucity of good data on cetacean by-catch rates in European waters reflects the current reliance on short-term project funding and the varying methods of data collection. This makes the identification of patterns difficult.

MECHANISMS OF BY-CATCH The fishing gears most commonly associated with by-catch include set gillnets, mid-water trawls and driftnets (Sequeira and Ferreira, 1994). Most authors conclude that small odontocetes are capable of detecting fishing gear in time to avoid collision and can or do perceive the threat (Au, 1994; Kastelein *et al.*, 2000). The animals should therefore be able to avoid entanglement. The overlap between fish species eaten by cetaceans and targeted by fisheries is clearly relevant, and distraction or changes in the acoustic behaviour due to the presence of prey may increase the risk of entanglement (Au, 1994; Goodson *et al.*, 1994a,b; Goodson and Mayo, 1995; Fertl and Leatherwood, 1997; Morizur *et al.*, 1999). Entanglement in static gear may occur when individuals are not echolocating (Au, 1994; Dawson, 1994). It is less clear why cetaceans should be caught in mid-waters trawls, although animals may be attracted to the noise or to the light lures often used in night trawling (Couperus 1997a; De Haan *et al.*, 1997). Evidence suggests that small cetaceans are in the vicinity of nets far more often than the rate of by-catch would imply, indicating that by-catch events are relatively rare (Tregenza, *pers. comm.*).

DIAGNOSIS OF BY-CATCH Post-mortem diagnostic features indicative of by-catch include lesions caused by contact with fishing gear or removal of the animal from gear, lesions from immersion and evidence of recent feeding (in particular, on the target species of the fishery). Also relevant is the absence of evidence for other causes of death (Hartmann *et al.*, 1994; Kuiken, 1994; Tregenza *et al.*, 1994; Tregenza and Collet, 1998).

CELTIC SEA The Celtic Sea supports fisheries for species such as mackerel, horse-mackerel, tuna and hake. Cetacean by-catches include harbour porpoises (*Phocoena phocoena*), common dolphins (*Delphinus delphis*) and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) (Rogan and Berrow, 1996; Couperus, 1997a; Tregenza *et al.*, 1997a,b; Tregenza and Collet, 1998). Between 1992 and 1994, an observer study of the UK and Irish set gillnet hake fisheries estimated a by-catch rate of 2,200 harbour porpoises per annum (95% CI: 900–3500), some 6.2% of the area population (Hammond *et al.*, 1995; Tregenza *et al.*, 1997a). French pelagic trawls and the Dutch pelagic freezer trawls, targeting herring, mackerel, horse-mackerel and pilchard, caught 3.8 dolphins/100 tows (Tregenza and Collet, 1998), while the Dutch horse-mackerel fishery and the French tuna, sea bass, and hake fisheries operating in the Celtic Sea and the NE Atlantic were estimated to catch one dolphin for every 20.7 tows (Morizur *et al.*, 1999).

NORTH AND BALTIC SEAS These waters are fished principally by Denmark, Britain, Germany, the Netherlands and France (Clausen and Anderson, 1988; Benke, 1994; Kock and Benke, 1996; Carlström and Berggren, 1996) for hake, cod, turbot, sole and plaice. Cetacean by-catch predominantly involves the harbour porpoise. While there have been some systematic studies in the North Sea, Baltic, and surrounding seas, most available data come from opportunistic carcass collection and voluntary reporting programmes (Clausen and Anderson, 1988; Benke, 1994; Kinze, 1994). In Danish waters, 149 harbour porpoise by-catches were recorded between 1980 and 1981 (Clausen and Anderson, 1988), and 62% of animals stranded over a 14-year period showed evidence of by-catch (Lindstedt and Lindstedt, 1989). Lowry and Teilmann (1994) estimated that 7,000 porpoises were by-caught per annum in Danish seas. Carlström and Berggren (1996) estimated an annual by-catch mortality of 2.9% of the porpoise population in the Skagerrak Sea. UK and Danish fisheries combined were estimated to catch up to 112 harbour porpoises per 1000 net.km*hr (Vinther, 1995).

MEDITERRANEAN SEA Fewer data are available about by-catch in the Mediterranean and most of these come from the swordfish driftnet boats (which were banned by the UN General Assembly moratorium in 1991).

Species by-caught range from striped dolphins (*Stenella coeruleoalba*) to fin whales (*Balaenoptera physalus*) (Di Natale and Notarbartolo di Sciara, 1994). Between 1988 and 1989, the cetacean by-catch rate off the Italian coast was estimated at 7,000 cetaceans per annum (Notarbartolo di Sciara, 1990).

BY-CATCH REDUCTION Efforts to reduce by-catch include use of passive and/or active by-catch reduction devices (Goodson and Datta, 1992; Lowry and Teilmann, 1994; Kraus *et al.*, 1995). Most studies conclude that passive reflectors are relatively ineffective, while the active "pingers" have been more successful. Trippel *et al.* (1999) found that pingers reduced the by-catch of harbour porpoises in set gillnets by 77% although the reason for their success was unclear and the authors express concern about habituation. The "prey effect hypothesis" suggests that the pinger emissions may not be directly aversive to the porpoises but rather deter their prey (Kraus *et al.*, 1995; Dawson *et al.*, 1997).

BY-CATCH MANAGEMENT Major considerations in by-catch management include effective communication between scientists and fishermen, and a legislative framework which encourages such co-operation. Take Reduction Teams operating in the US, under the provisions of the MMPA, have found consultation with fishermen to be an effective way to determine practical means of reducing by-catch. The lack of legislation specifically concerning interactions between cetaceans and fisheries is the main obstacle to management of cetacean by-catch in EU waters. While various regulations and directives refer to marine mammals, it is usually in the context of other issues and details of their implementation and enforcement remain to be worked out.

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SHORT- AND LONG-TERM EFFECTS OF WHALE-WATCHING ON KILLER WHALES IN BRITISH COLUMBIA

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A number of cetacean studies have shown that whale-watching causes short-term behavioural changes in individuals, but none have yet demonstrated long-term population effects. This is particularly true in British Columbia, where the population dynamics of killer whales are precisely known, and there is a well-documented history of whale watching activity.

Interaction studies over the past two decades have generally shown that killer whales employ a multivariate array of short-term responses to whale watching that is a function of vessel numbers and proximity. Other significant factors may be vessel size, activity and engine noise, as well as the age, gender, and tolerances of individual killer whales.

Further work is needed to assess whether short-term individual behavioural effects can lead to long-term population changes. Two lines of research that may shed light on long-term effects include comparative studies of populations over time or across broad geographic ranges (*i.e.*, population dynamics, physiology, behaviour, etc.). The other is to develop mathematical models, as we are undertaking, to evaluate possible population effects of whale-watching on the energetics and hearing abilities of killer whales.

FAST FERRIES IN THE STRAIT OF GIBRALTAR: STUDY OF THEIR POTENTIAL IMPACT ON CETACEAN POPULATIONS

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INTRODUCTION Throughout the world, data regarding possible impacts between boats and cetaceans have been recorded. From acoustic disturbance to direct collisions, those impacts are putting under threat populations of different species (Laist *et al.*, in press). This study analyses the potential impact of the high-speed vessels in the Strait of Gibraltar. The Strait is the second most transited channel in the world and, at the same time, an interesting area for cetaceans due to its position between Mediterranean and Atlantic waters, as suggested by the high cetacean biodiversity registered (Fernández-Casado, *et al.*, 1999a, Fernández-Casado, *et al.*, 2000; Cañadas *et al.*, 2000). In 1999, a total of 83,856 boats crossed the channel (N-S and E-W axis), including 17,047 high-speed ferries (de Stephanis, *et al.*, 2000).). The Spanish Ministry for the Environment asked the Spanish Cetacean Society (SEC) to analyse the possible incidence of the high-speed vessel traffic in the Strait of Gibraltar, taking into account the presence in the channel of cetaceans included in the National Catalogue of Endangered Species, as bottlenose dolphin (*Tursiops truncatus*), long-finned pilot whale (*Globicephala melas*), common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), and sperm whale (*Physeter macrocephalus*).

The Acoustic and Vibratory Laboratory of the University of Cadiz (Spain) carried out the study on the possible acoustic impact.

OBJECTIVES

- To locate the potential areas where a possible collision (physical impact) between cetaceans and boats can occur throughout known fast ferry routes in the Strait of Gibraltar, and their overlap with the information on density of sightings for different cetacean species.
- To compile a bibliography about research on possible physical impacts in the study area.
- To determine the frequency spectra of the different fast ferries, and compare them with those relating to cetaceans present in high density areas for fast ferries.
- The proposal of measures, and analysis of options to minimise potential impacts using comparative data.

METHODOLOGY:

Potential Physical Impacts Cetacean distribution maps in the study area were made and compared with the different fast ferry routes. The data considered for the analysis were 1084 sightings recorded from April to October in 1999 and 2000 from whale-watching vessels in the area, and all the different aspects of fast ferries in the area (number, characteristics, routes, etc). The data on the distribution of sperm whales in the Algeciras- Ceuta Channel come from 2000, during CIRCE's survey (February- April).

Sounds Produced The Laboratory of Acoustics and Vibrations of Cadiz University developed frequency spectra of boats and cetaceans. Records of fast ferries were taken using an Offshore-Acoustic hydrophone directly at the entrance of the Algeciras harbour and registered on a Sony digital (DAT) TDC-D100 tape-recorder. Frequency spectra for visualising the acoustic records were undertaken. The STFT (Short-Time Fourier Transform) was applied, dampening the temporal variation between each of the frequencies with a mobile medium filter for 30 samples. Likewise, an average of these windows was made (total average spectrum), which revealed the energy distribution in the frequency bands of the ships. For the spectra of different species, the record (data & sample) used were taken during summer 2000 by the CIRCE research group in the Strait and by ALNITAK in the Alboran Sea.

RESULTS

Identification of Physical Impacts Stranding data gave no evidence of negative physical impacts recorded to date. The fast ferries carried out 24 journeys per day between Ceuta and Algeciras, and a further journey between

Tanger and Gibraltar since January 2001. New lines between Spain and Tanger are expected to run in the summer of 2001. The distribution maps (Figs 1 and 2) show the most frequent areas for sightings of cetacean (for long-finned pilot whales and sperm whales), and the fast ferry routes in the study area.

Frequency Spectrum and Total Average Spectrum of the different boats sampled. In Figs 3 and 4, one can seen the spectra of the different boats sampled.

DISCUSSION

Physical Impacts There is no evidence for collisions in The Strait. Nevertheless, as can be seen from the distribution maps, the area with a concentration of sightings of cetaceans larger than 8-9 m (sperm whale), is the same as that transited by the fast ferries. The opening of a new fast ferry route on a NE-SW axis between Tanger and Algeciras, which directly crosses the area with the highest density of sightings for pilot whales and sperm whales, might increase the collision probabilities with those vulnerable species due to their size and behaviour. A similar case is the Canary Islands where there have already been collisions with a similar scenario as the one expected here with the new routes in The Strait of Gibraltar.

Acoustic Impacts Figure 5 shows that theoretically there is no overlap between the sounds emitted by the cetaceans present in the area and those of the fast ferries. Nevertheless, using data on the frequency range of sounds emitted by the cetacean species present in the Strait of Gibraltar found in the literature, an overlap is possible. The Strait is seasonally important for the presence of mysticetes such as fin whale (*Balaenoptera physalus*), which emits low frequency sounds, and thus could be affected by sounds from fast ferries. Nevertheless, no conclusion can be reached due to the lack of data on the intensity of fast ferry sounds, and potential effects upon cetacean populations. For that reason, studies that focus upon acoustic impacts must take into account not only fast ferry sounds but also those of other boats as well.

Proposed Corrective Measures The peculiarity of the area must be taken into account in order to take effective measures. Not forgetting the precautionary principle, and with this first approach to the problem, the following corrective measures are proposed:

- Possible reduction in boat speed: Different studies (Clyne, 1999; Laist *et al.*, in press) suggests that speed is the most important factor related to the severity and frequency of potential collisions. For this reason, a speed limit of 13 knots in the high-risk area is proposed as the best solution. However, that is not so simple, and normally is not possible. Therefore it is important to promote the agreements with the companies in order to reduce speed and the number of trips as much as possible.

- Installation of a WDA (Whale Detector Apparatus): Using a horizontal echo-sounder, the WDA can detect animals in sufficient time to avoid them, thus reducing the possibility of collisions.

- Changing the fast ferry routes in the high-risk collision zones (i.e. high density areas for cetacean sightings.

- Secondary measures: Training for the fast ferry crew, and the presence of experimental observers onboard.

CONCLUSIONS

1 - The initial and basic conclusion is to accept that the problem exists and measures must be taken to avoid the negative impacts.

2 - All the proposed whale detection systems could be applied, but always with consideration for those that are likely to be most effective (and functioning optimally) for the established area.

3 - Routes and speed are the essential factors related to impacts between boats and cetaceans. Because of that, the speed must be reduced in high-risk collision areas, and the routes must be changed to avoid those areas.

4 More studies on acoustics and the distribution and behaviour of cetaceans are necessary in order to adopt measures for the reduction of negative impacts.

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Fig. 1 Distribution of pilot whales in relation to fast ferry routes

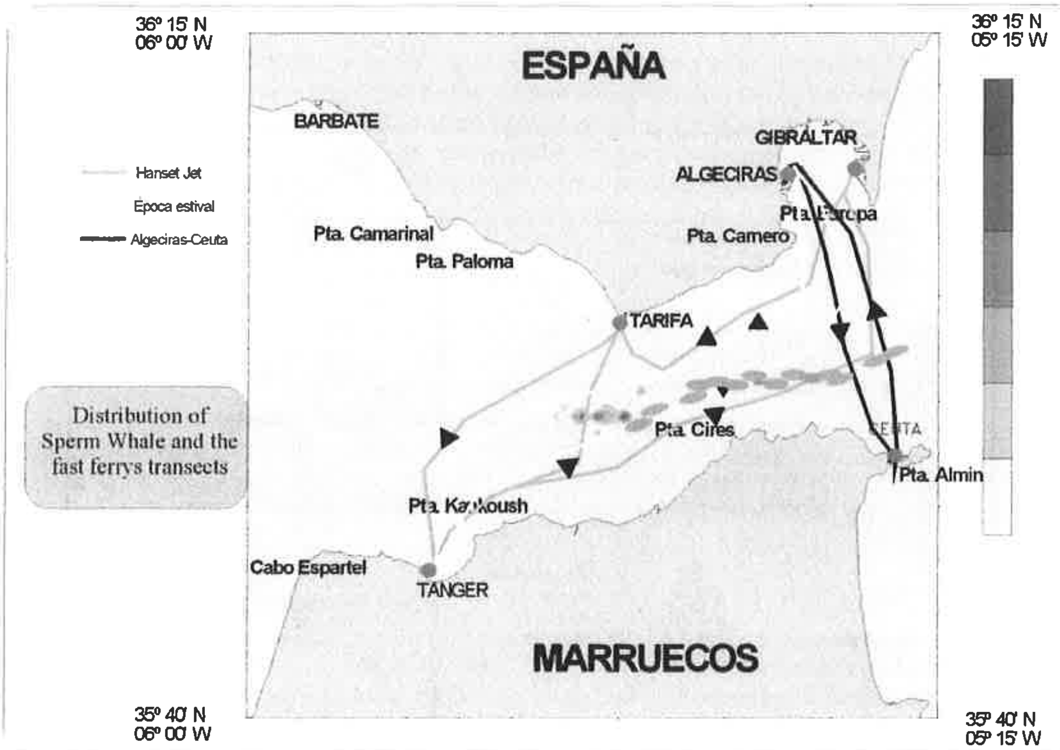

Fig. 2. Distribution of sperm whales in relation to fast ferry routes

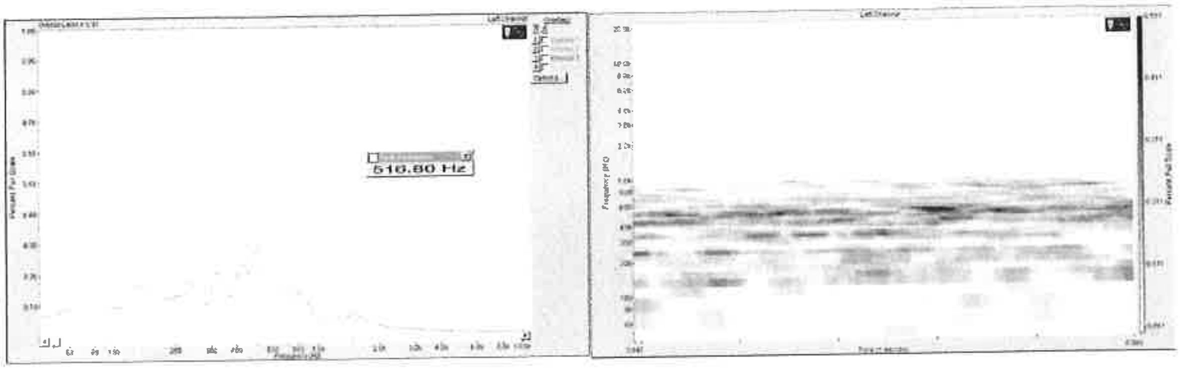

Fig. 3. Sound spectra of fast ferry (Euroferries)

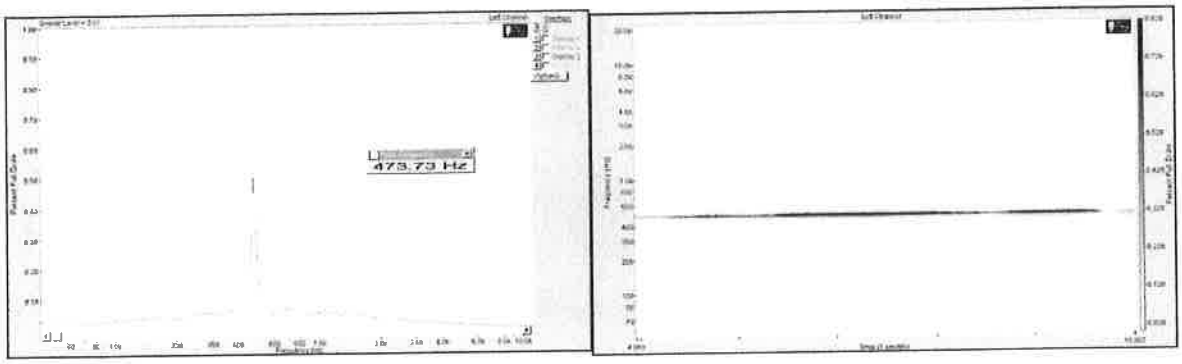

Fig. 4. Sound spectra of fast ferry (Hanset jet)

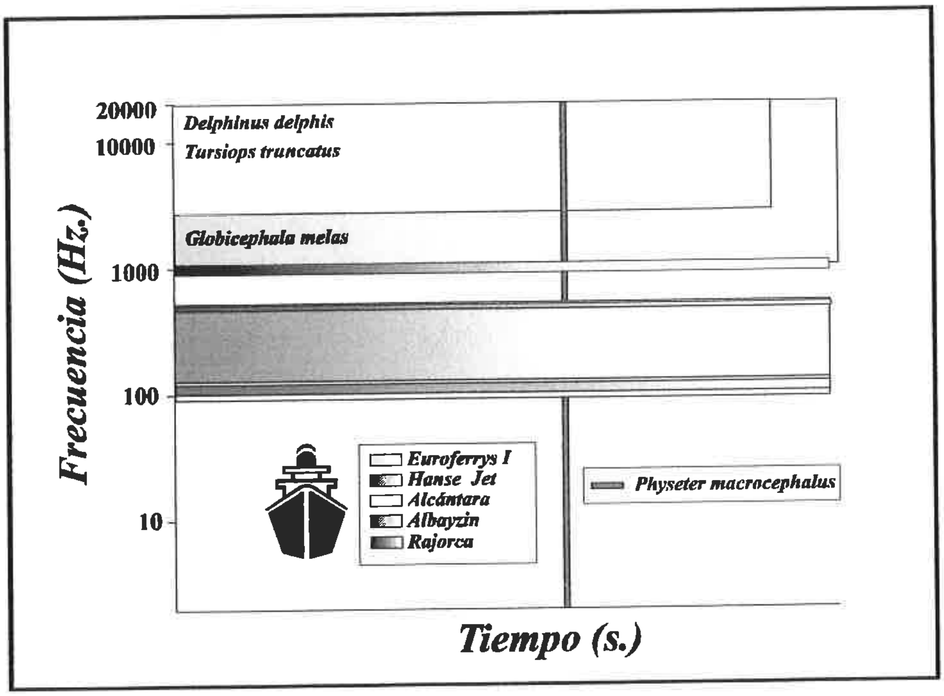

Fig. 5. Frequency overlaps of fast ferries sampled and different cetacean species

THE ECONOMIC IMPACT OF WHALE-WATCHING IN WEST SCOTLAND

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INTRODUCTION The waters around West Scotland have the greatest abundance and diversity of cetaceans in the UK: to date, twenty-four species of cetacean have been reported in this region (Shrimpton and Parsons, 2000). Cetaceans have traditionally been part of Scottish marine heritage and the country's economy. At one stage there were five commercial whaling stations operating in Scotland. However, all cetaceans are now protected in UK waters. Instead of consumptive uses of cetaceans in Scotland, whales are increasingly becoming a tourist attraction and the basis of many businesses such as whale-watching tours and visitor centres.

Whale-watching is defined as "any commercial enterprise which provides for the public to see cetaceans in their natural habitat" (IWC, 1994). (NB although the term "whale" watching is used, the definition also encompasses the watching of dolphins and porpoises).

The current study seeks to determine the importance of whale-watching to the other side of Scotland, in particular the economic impact of whale-watching in rural West Scotland.

DEFINING WHALE-RELATED TOURISM IN SCOTLAND Whale tourism occurs at various different levels and extents. As this current study is primarily concerned with the economic impact of whale-watching, only those operators that were actually using the possibility of seeing cetaceans as a means to attract passengers were included in the surveyed. Whale-tourism operations were sub-divided into four categories for use in this study and these are shown in Table 1 for whale-watching trips and Table 2 for visitor centres featuring whales. The locations of the tour operators that qualify for one of these categories are shown in Figure 1.

MATERIALS AND METHODS The current study investigates whale-watching is coastal Western Scotland; within this area, three study regions were identified for detailed case studies: (a), the Sleat Peninsula (Isle of Skye); (b), Arisaig (Lochaber); and (c), Tobermory (Isle of Mull). These locations were identified according to the following criteria: locales that were traditionally dependent on primary industries, such as fishing and agriculture; rural coastal communities; and bases for marine wildlife tour operators who operate whale-watching excursions.

During the tourist season of 2000, four sets of interview surveys were conducted. The sample groups for these surveys were: boat operators (32) & visitor centre managers (8); tourists on whale-watching trips (324); general tourists visiting the area (673); and local residents (189).From this the perceived importance of this industry for the local community and local tourism could be assessed as well as calculating estimates of the economic value of this specialist sector of the Scottish tourism industry.

RESULTS

What is the importance of whale-watching to the rural West Scotland economy?

Whale-tourism providers were asked whether they thought that whale-tourism was important to the local economy: 47% stated that it was.

Proportion of visitors who came to the area to go whale-watching

Of the tourists surveyed:

- 44% stated that they had been previously aware of whale-watching trips in West Scotland;
- 13.1% said that the whale-watching trips had influenced their decision to visit the region.
- 18.6% had been on a boat trip of some kind during their stay:
    - 6.5% had been whale-watching;
    - 12.1% had been on other non-whale-watching trips.
- 23% stated that although they had not been on a trip yet, they might, or were going to, go on a whale-watching trip during their time in the area.

Of the tourists taking whale-watching trips:

- 22.5% of whale-watchers had come to the area specifically to go whale-watching.
- Of these 3.5% of the total had stayed an extra night in the area in order to go on a whale-watching trip.
- Of the remaining 77.5% of whale-watchers who had not come to the area specifically to go whale-watching, 44 individuals (12.7%) said that they had stayed an extra night in order to take a whale-watching boat trip.
- In total, 16.1% of whale-watchers had stayed an extra night as a *direct* result of whale-watching.

An estimation of the number of extra nights spent in the region as the result of going on a whale-watching trip
The average number of extra nights spent was 1.6. Ninety-one percent of the respondents who stayed additional nights stayed only one or two additional nights. Only one person stayed over 4 additional nights as a result of whale-watching opportunities in the region.

The daily spend of whale-watchers Whale-watchers were asked to provide details of their daily holiday expenditure. On average, the daily spend by passengers taking whale-watching trips was £85.25, of which the cost of the trip was the main expense of the day. Without the cost of the trip, the average expenditure per day was £59.25.

Employment provided by whale-watching in West Scotland A total of 115 jobs were involved in whale-related tourism. Seventy-six jobs were involved with work on the tour boats as skipper, crew or booking staff. 46% of these jobs were seasonal.

DIRECT VALUE OF WHALE-TOURISM In order to determine the value of whale-watching to the rural west Scotland economy each tour operator was asked for their annual passenger numbers, the cost of their trips and running costs. The income was also adjusted by the category of whale-tourism business (e.g. only 10% of Category 3 business was attributable to whales, but 100% of a category 1 operation). These figures were used to estimate the net income from whale-tourism in the region1[1].

In the three survey areas (Skye, Arisaig and Mull) whale-watching provided a direct net income of £109,548 per annum. This is 12.3% of the total tourist expenditure in the three survey areas: a significant part of the economy in these rural areas. When data from all operators was collated, it was estimated that whale-related tourism directly contributed £1,767,971 to the economy of rural West Scotland.

INDIRECT VALUE OF WHALE-TOURISM From the above data: (a), 6.5% of visitors to the region will go on a whale-watching trip; (b), of these whale-watchers 22.5% came to the area specifically to go whale-watching; and (c), 16% (3,172) tourists stayed at least one extra night as a result of going on a whale-watching trip (mean=1.6 extra nights).For the whole of West Scotland the whale-tourism industry results in tourists staying a total 15,856 extra nights in the region, with a resulting £0.9 million of extra revenue coming into the economy of the area.

As 22.5% of whale-watchers came to the area specifically to go whale-watching. This equates to an additional £5.1 million being brought into the economy of rural West Scotland.

DISCUSSION Hoyt (2000) estimated that in 1998 land- and boat-based whale- and dolphin-watching in the Moray Firth generated £477,000 in direct revenue and £2.34 million in total revenue in 1998. Hoyt (2000) also estimated that on the northern islands of Shetland, land-based whale-watching generated £109,000 as indirect spend.

As this study has demonstrated, whale-watching in West Scotland generated £1,767,971 in direct revenue. When combined with the direct revenue generated by the Moray Firth dolphin-watching operations, an estimate of how much money cetaceans bring directly into the Scottish economy would be £2.24 million per annum.

The estimate of indirect revenue generated by West Scotland whale-watching operations in this current study amounted to £6.02 million per annum (associated spend from tourists coming to Scotland specifically to go whale-watching plus the associated spend from extra nights spent as the result of whale-watching trips).

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[1] Unless told otherwise by tour operators the following assumptions (based on information provided by tour operators) were made when calculating this figure:
(a) Owing to the nature of the climate in the region, boat trips were unable to sail on 20% of planned trips in the tourist season.
(b) On average, boats operated at two-thirds capacity.
(c) Only one boat operator continued running all year, however it was considered that the proportion of visitors on winter trips was negligible and, therefore, boats were considered to operate only during the main tourism season (April – October).
(d) For those operators offering child and adult prices, 80% of passengers were taken to be adult passengers and the remaining 20% were assumed to be children.

When the West Scotland figures are added to the indirect revenue generated by cetacean-watching in the Moray Firth and Shetland (£2.34 million and £109,000, respectively; Hoyt, 2000), the total amount of indirect income from whale-watching in Scotland comes to £8.5 million per annum.

A conservative estimate of the total income from Scottish whale-watching (direct plus indirect expenditure) would be a total of £10.7 million.

As a comparison, commercial hunting of whales in the whole of Japan generates £21.7 million per annum (Economist, 2000). The income generated annually by whale-tourism in Scotland brings in half of the Japanese commercial whaling revenue. The overall revenue from tourism in Scotland is £2.5 billion (STB, 2000). Whale-watching plays a relatively tiny role (0.4%) in the total tourism economy but, in the peripheral coastal areas where these businesses are located, the impact is much more significant.

This study has estimated that on average up to 12% of the local tourism revenue in such areas could be attributed to whale-related tourism. In certain small communities this may be significantly higher. The success of one or two small businesses can significantly lift a rural coastal economy and can help to diversify the economy away from reliance on single or declining industries (such as agriculture, forestry and fishing).

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Table 1. Categories and definitions of whale-watching

Category	Definition
1	Marine wildlife tour operator who advertises 'whale-watching' trips (either day trips, charters or cruises). 100% of the operator's income is attributable to using whales and dolphins as a draw for tourists.
2a	Marine wildlife tour operator who draws substantially on cetaceans as a primary species in their marketing but does not specifically mention 'whale-watching'. For example, an operator who states that cetaceans are regularly seen, who uses a cetacean logo or has prominent photographs of cetaceans in their marketing materials. Two-thirds of the operator's income is attributable to using whales and dolphins and a draw for tourists.
2b	Marine wildlife tour operator who draws on cetaceans for marketing purposes to a lesser extent, for example, mentioning that cetaceans are occasionally sighted. One-third of the operator's income is attributable to whales and dolphins.
3	Marine wildlife tour operators who make a brief passing reference to cetaceans in their marketing materials. For example, a statement such as "on our return journey we may be lucky enough to see a porpoise". 10% of the operator's income is attributable to whales and dolphins.

Table 2. Categories and definitions of visitor centres featuring whales

Category	Definition
1	A visitor centre that has cetaceans as its primary theme, with virtually all its display space dedicated to cetaceans. If the visitor centre has a shop, the majority of the merchandise sold in this shop has a cetacean theme. 100% of the centre's income is attributable to using whales and dolphins as a draw for tourists.
2a	A visitor centre that has the marine environment/natural history as its primary theme, with a significant proportion of its display space, entailing several exhibits, devoted to cetaceans. Cetaceans are given a prominent position in the centre's marketing materials and if the visitor centre has a shop, a sizeable proportion (50-75%) of the merchandise sold has a cetacean theme. Approximately two-thirds of the centre's total income can be attributable to using whales and dolphins as a draw for tourists.
2b	A visitor centre which may have a small display area or one exhibit dedicated to cetaceans. Cetaceans may be mentioned in marketing materials as a passing comment. If the visitor centre has a shop, some of the merchandise sold (20-40%) has a cetacean theme. Approximately one-third of the centre's total income can be attributable to using whales and dolphins as a draw for tourists.
3	A visitor centre which may mention cetaceans in a display about the marine environment/natural history. Marketing materials do not contain references to cetaceans. However, the centre has a shop which includes some cetacean related merchandise (10-20% of total merchandise). Only 10%, or less, of the centre's total income can be attributable to whales and dolphins.

Table 3. A summary of the economic impact of whale-watching on the economy of rural West Scotland

Economic activity	Revenue generated (£)
Whale-watching day trips	801,961
Whale-watching cruises	730,500
Visitor centres featuring cetaceans	235,510
Additional (indirect) income resulting from extra nights stayed as the result of whale-watching trips	939,468
Additional (indirect) income from cetaceans drawing tourists to the region	5,085,723
Total economic impact of whale-related tourism in West Scotland	7,793,162

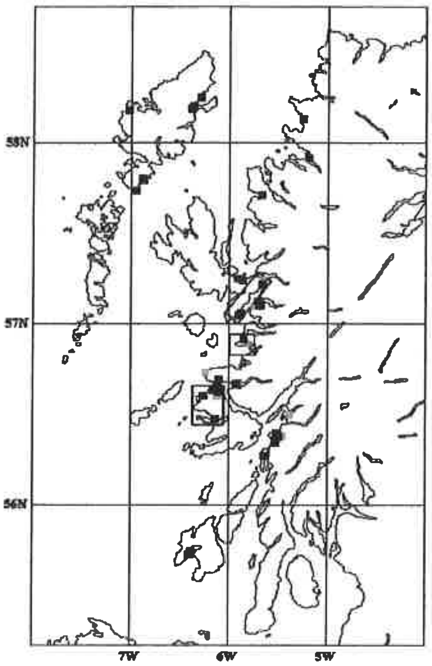

Fig. 1. The distribution of whale-watching operators (black) and visitor centres featuring cetaceans (grey) on the West Coast of Scotland. The outline boxes show the locations of the three survey sites

CHANGING STATUS OF MINKE WHALE (*BALAENOPTERA ACUTUROSTRATA*) IN THE WESTERN ENGLISH CHANNEL

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The western half of the English Channel is a relatively shallow arm of the Atlantic Ocean between southern England and northern France, which is heavily used for shipping, and other marine commercial activities such as oil exploration and fishing. Minke whales (*Balaenoptera acuturostrata*) have a global distribution, and were formerly resident in the English Channel in the first half of the twentieth century, but subsequently declined (Fraser 1990, Williams, 1996). The species was considered extinct in the Channel by the 1960s, with the last published sighting prior to 1966 (Evans, 1992). Following a gap of more than thirty years, minke whales were recorded in the Channel by dedicated Biscay Dolphin Research Programme (BDRP) surveys during the summer of 1997 (third BDRP survey year). Since then, there have been an increasing number of sightings on surveys in a restricted area of the western English Channel, providing strong evidence for a very recent re-occupancy in that area. There have also been a number of casual records off the south coast of England. Minke whales have been recorded in all seasons on BDRP surveys, but the vast majority of records (c. 90%) have been made between June and November. A number of calves have been observed, indicating that adult females may be using the Channel as a nursing ground during the period shortly after calving. The significance of the results in terms of marine protected area designation and management are discussed in this paper.

MARINE MAMMALS AND AQUACULTURE: CONFLICTS AND POTENTIAL RESOLUTIONS

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Two main types of marine-based aquaculture come into potential conflict with marine mammals: 1) extensive raising of shellfish, such as oysters, mussels, and shrimp; and 2) intensive raising of finfish, such as salmon, catfish, and trout. The first takes up space in near-shore waters but does not generally require nets or cages that can entangle or otherwise hurt air-breathing vertebrates. It also does not require supplementary feeding, and therefore is not generally a major attractant for marine mammals and others. However, shellfish aquaculture puts extra nitrogen into the ecosystem, and can change local ecology where tidal and other flushing is minimal. It takes up extensive space in inlets, fjords, and the like, and may compete for limited habitat access with foraging, resting, socialising, and nurturant mammals. The intensive, but generally more localised, farming of finfish often requires supplementary feeding, and both the stock in holding pens and the feed serve as powerful attractants to especially pinnipeds (but toothed cetaceans, river and sea otters, marine turtles, and sea birds are often involved as well). As such, major problems are caused to the industry by destruction of gear and the target aquaculture species; and to the marine animals by shooting, other techniques, and large-scale use of Acoustic Deterrent Devices (ADD's) and Acoustic Harassment Devices (AHD's). No technique has proved highly successful, and the widespread use of ADD's and AHD's is particularly problematic and largely untested. We recommend that due to potential for entanglement, chemical and sound pollution, habitat loss or gross alteration, traffic, and changes in species interactions, all proposed development of marine aquaculture in nature should be subjected to initial evaluations and – as needed – scientific research relative to interactions between the food being raised by humans and the predators that attempt to take advantage of this.

CRITICAL HABITAT

HABITAT USE AND GENERAL BEHAVIOUR ANALYSIS AS A TOOL FOR THE DESIGNATION OF MARINE PROTECTED AREAS

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INTRODUCTION The south-eastern coast of Spain is included in a three-year programme of the Spanish Ministry of Environment for the identification of critical habitats for the conservation of cetaceans, within the context of the creation of marine protected areas for the EU Habitats Directive, the Barcelona Convention and the ACCOBAMS treaty. The analysis of habitat use and the importance of certain oceanographic and physiographic parameters is one of the main targets of this programme, focusing especially on the importance of migration, feeding, and breeding habitats for conservation.

The important productivity and biodiversity of the north-eastern Alboran Sea make this an environment where strong economic, scientific and conservation interests clash. This is especially the case for the waters south of the bay of Almería, a region where many odontocetes share the same waters as fishing fleets, sports fishermen, yachtsmen, divers and cargo ships.

The physical habitat preferences and the behaviour patterns of the five more representative odontocete species of the Alboran Sea have been compared and analysed in order to use it as a tool for the siting and sizing of MPAs.

METHODOLOGY. Data fom 813 sightings (43,498 individuals) of five species from the last nine years were analysed for the study. These species were the common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*), long-finned pilot whale (*Globicephala melas*), and Risso's dolphin (*Grampus griseus*). The research area, in the north-eastern section of the Alboran Sea, was divided into five sub-areas, named A, B, C, D, E for the analysis. Effort was calculated by adding all the nautical miles sailed in each area.

To determine the habitat preferences, we divided the number of individuals sighted in each area by the effort to obtain an encounter rate. The Kruskal-Wallis analysis of variance and the chi-square analysis were used to test it.

The proportion of five categories of behaviour: travelling, feeding, socialising, milling, and resting were compared in five different depth ranges from the coastline to 2000 metres. A chi-square non-parametric test was used to study the relationship between the depth range and those five categories for each species.

RESULTS. The **common dolphin** appeared in all six sub-areas, but showed highly significant differences among them (KW = 33.388, $p<<0.001$) with a clear preference for the bay of Almería, and in second place for the two sub-areas that cover the depths between 200 and 500 m (χ^2=2,986.01, df.=5, $p<<0.001$). As in the case of encounter rate, shown by the shading in Figure 2, group size decreased as we moved to the deeper water areas. An analysis of behaviour showed that foraging and milling were significantly more often observed in the coastal areas from 1 to 200 m (feeding: χ^2=20.03, df.=3, $p<0.001$, milling: χ^2=22.81, df.=3, $p<0.001$), while socialising was more frequent in deeper waters from 500 to 1000 m (χ^2=24.44, df.=3, $p<0.001$), and travelling in the deepest range of over 1000 m (χ^2=14.28, df.=3, $p<0.005$).

The **bottlenose dolphin** showed a clear preference for area E, followed by A and to a lesser extent B. This agrees with findings of the areas of the bay of Almería (A) and the "Seco de los Olivos" seamount (E) as the preferred areas for both a resident group and an immigrant group of bottlenose dolphins in the region. This species was rarely encountered in areas of deeper offshore waters. Only feeding and milling were found to be significantly different when comparing among depth ranges: feeding was more often observed in shallow waters (χ^2=6.13, d.f.=2, $p<0.05$), and milling in deeper waters (χ^2=7.57, d.f.=2, $p<0.025$).

The **striped dolphin** also showed highly significant differences in habitat use in the region (KW = 45.040, $p<<0.001$). The encounter rate shading in Figure 4 clearly shows the high preference of this species for deep waters, being almost completely absent from the continental shelf areas, A and D, and showing a gradient in between from the deepest area to the shallowest (χ^2=20,463.52, df.=5, $p<<0.001$). Only the socialising category of behaviour gave significant results when compared among depth ranges, this category being observed most in deeper waters of over 1000 m (χ^2=17.64, df.=2, p<0.001). Insufficient feeding observations were available to perform a test.

The **long-finned pilot whale** and the **Risso's dolphin** both showed a very similar preference for area G, followed by areas F and C (Risso's dolphin: KW=31.03, p<<0.001; χ^2=928.09, df.=5, p<<0.001; pilot whale: KW=48.52, p<<0.001; χ^2=4,990.64, df.=5, p<<0.001). As in the case of the striped dolphin, these two species were not observed in continental shelf waters. For the pilot whales, only the categories travelling and resting had sufficient observations to be analysed, and only the category travelling for Risso's dolphin, with no significant differences for any of them.

DISCUSSION The six areas analysed are characterised by their important primary and secondary production, which is the result of the Eastern Alboran Gyre. Area A has been highlighted by oceanographical studies (Rubin *et al.*, 1992) as one of the main breeding sites for several commercial and non commercial small pelagic fish that are a favoured prey of the common dolphin (Rubin *et al.*, 1992; Gil, 1992; Cañadas *et al.*, 1999). The behavioural studies confirmed the importance of the area of the bay of Almería as an important foraging habitat for this species.

Area E includes the seamount "Seco de los Olivos", a volcanic mountain rising from a depth of 500 m to 26 m. Apart from inducing upwellings (Rubin *et al.*, 1992), the physiography of the "Seco de los Olivos" aggregates benthic and demersal species, which include several prey species of bottlenose dolphins (Cañadas *et al.*, 1999). It is therefore not surprising to encounter this species more frequently in this area, and to observe it foraging at the depth ranges where those prey species are confined.

The other three species included in the analysis can be catalogued as deep-sea squid eaters. The analysis clearly showed their preference for the areas with depths between 500 and 1500 m (F and C), and especially for area G. Behaviour analysis of these cetaceans in deep waters did not show any significant results, except for striped dolphins that seem to prefer to socialise in deeper waters. Since small cetaceans in these depths will most likely be foraging at night, taking advantage of squid vertical migrations, future studies will include night surveys in these areas using squid capturing devices.

ACKNOWLEDGEMENTS. We would like to thank the Spanish Ministry for the Environment and Earthwatch Institute for the funding of this research programme, the Earthwatch volunteers for their help in the field work, and IFAW for the Logger programme. We would also like to thank James Palmer for his correction of the English, and to Laura Benítez for her support.

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ARRIVAL AND PERMANENCE OF AN IMMIGRANT GROUP OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE NORTH-EASTERN ALBORAN SEA

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INTRODUCTION In order to implement the EU Habitats Directive, the Barcelona Convention, and the ACCOBAMS agreement of the Bonn Convention, a three-year research programme was initiated in 1999 by Spain's Ministry of the Environment, to carry out research for the designation of Marine Protected Areas. The present study, included in this programme, focuses on the bottlenose dolphin (*Tursiops truncatus*), one of the most threatened species in the Mediterranean (Habitats Directive, IUCN, Spanish National Endangered Species Act). The bottlenose population in this basin appears at present to be fragmented, having suffered an important decline over the last decades (Cagnolaro and Notarbartolo di Sciara, 1992, Notarbartolo di Sciara and Demma, 1994, UNEP/IUCN 1994).

In 1992, Alnitak initiated a study in the north-eastern region of the Alboran Sea (Western Mediterranean), focusing on the ecology of several cetacean species including the bottlenose dolphin. In 1997, an important change in population structure was detected. A new group of over 80 dolphins was tracked as it entered the research site, "prospecting" it before settling in a region where they have been observed regularly since then.

METHODOLOGY Data from eight years (1992-2000) of shipboard surveys of cetacean populations have been analysed, focusing on the identity of the populations, their conservation status, and habitat use. Over 7,084 nautical miles (13,148 km) have been sailed onboard the research ship "Toftevaag" in a research site of 10,700 km^2 in the north-eastern part of the Alboran Sea, a region of extraordinary oceanographic characteristics that has been highlighted as specially important for several species of odontocetes (Cañadas and Sagarminaga, 2000; Cañadas *et al.*, 1999a, Forcada and Hammond, 1998). A total of 199 bottlenose dolphin sightings have been made between 1992 and 2000.

Data on distribution, habitat use, behaviour, social structure, and other important population parameters were collected in every sighting, together with a series of environmental variables.

Previous studies in the area (Cañadas *et al.*, 1999a) show two "hot spots" for bottlenose dolphins in the research site: the Almeria Bay, and the Seco the los Olivos (a submarine mountain) (Fig. 1). In order to explore habitat use before and after the arrival of the new group, some analyses were made, comparing these two areas and the rest of the research site. A comparison was also undertaken between some population parameters before and after the arrival of the "immigrant" group, in order to assess whether a change in population structure has occurred.

RESULTS A comparative analysis of the encounter rates before and after the arrival in the research site of the "immigrant" group shows a significant increase in the population density of the species in the area. The encounter rate increased significantly in the research area after the arrival of the new group. (Encounter rate: before = 0.679, after = 1.724, χ^2=38.0, df.=1, p<0.001). Group size changed also significantly, and larger groups were found (Figs 1 and 2). The proportion of calves did not change with the arrival of the new group (Table 1).

Depth was also analysed, but since the variable was not normally distributed, the logarithmic transformation was applied. No differences in depth preferences were detected (Table 1).

Some analyses in behaviour were also undertaken, taking into account five categories: Socialising, Milling, Feeding or Foraging, Travelling slow, and Travelling fast. The χ^2 test showed no differences (χ^2=3,806; df.=4) (Fig. 3).

To analyse habitat use before and after the arrival of the new group, comparisons among the encounter rates in these two important zones ("El Seco de los Olivos" seamount, and bay of Almería) and the remainder of the research area, were made. In both situations, before and after the arrival of the immigrant group, significant differences existed (Table 2), showing a strong preference for these "special places". This analysis also showed no important differences in the habitat use before and after the arrival.

DISCUSSION The arrival of the immigrant bottlenose dolphin group in the research site in 1997 resulted in a series of changes at the population level in the sense that there has been an increase in the density of bottlenose dolphins in the region as well as an increase in group size. However, habitat use and behaviour analysis have shown no significant changes. Dolphins seem to use the same productive regions that the previous resident group used to prefer.

The arrival of this new bottlenose dolphin group in the region occupied previously by a resident group, poses several questions about the relations between the two. The three most obvious questions could be:

1) Has the resident group been excluded from the region by the immigrant group?
2) Have the immigrant group and the resident groups mixed?
3) Are both groups occupying the region in sympatry?

The preliminary results of the photo-identification study indicates that the first option can be eliminated, as there have have been several photographic "recaptures" of individuals of the initial group since the arrival of the immigrant group. Even if photo-identification analysis still needs to be extended in order to be conclusive, the third option of sympatry seems to be the most likely answer.

Unfortunately, the lack of research involving photo-identification in adjacent waters prior to 1997, does not allow us to compare catalogues, in order to determine where these dolphins have come from, and it is therefore difficult to look into the possible reasons for its immigration within the research region. The coincidence of this immigration with other simultaneous oceanographic changes occurring in this region of the Mediterranean, coinciding in turn with the "year of the Niño" (Beaubrun, 1999; Cañadas *et al.*, 1999b) poses the question of how these phenomena could be related.

The north-eastern section of the Alboran Sea, and specially the waters around the Seco de los Olivos sea mount, is known for its important primary and secondary production, aggregating several preferred prey species of the bottlenose dolphin. The arrival and settlement of this immigrant group in the region confirms also the importance of this region for that species in the Medierranean Sea.

CONCLUSIONS No changes in habitat use or behaviour have been detected in the region with the arrival of the immigrant group. At the population level, several important changes have been detected: an important increase in population density, and an important change in social structure, with an increase in group size. The previous status of the immigrant group and the reasons for its immigration are as yet unknownThe south-eastern section of the Alboran Sea is an area of special importance for the conservation of the bottlenose dolphin.

ACKNOWLEDGEMENTS We would like to acknowledge the DGCN (National Environment Agency) of the Spanish Ministry for the Environment for funding the research project. Special thanks go to the Earthwatch Institute for co-funding the project, and all the volunteers who have participated in different campaigns. Thanks also are due to Ángel Baltanás for his comments on this paper.

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	MEAN VALUE "BEFORE"	MEAN VALUE "AFTER"	MEDIAN VALUE "BEFORE"	MEDIAN VALUE "AFTER"	STATISTICAL TEST RESULT.	ASSOCIATED P-VALUE.
Log Depth	2,2964	2,4207	2,3424	2,4771	t- Student = -1,788	0,0761
Calves	0,3333	1,1071	1,0000	0,0000	U Mann-Whitney = 792,5	**0,0234**
Group Size	10,3333	40,0000	10,0000	19,0000	U Mann-Whitney = 934,5	**0,0001**

Table 1. Statistical test results.

	MEAN VALUE "HOT-SPOTS"	MEAN VALUE "OTHER"	RANK SUM "HOT-SPOT"	RANK SUM "OTHER"	U MANN-WHITNEY TEST RESULT.	ASSOCIATED P-VALUE.
"BEFORE"	0.2829	0.0932	4874	4037	1714	**0.0056**
"AFTER"	0.5702	0.0577	14200	9671	3760	**0.0004**

Table 2. Statistical test results for the habitat use analyses.

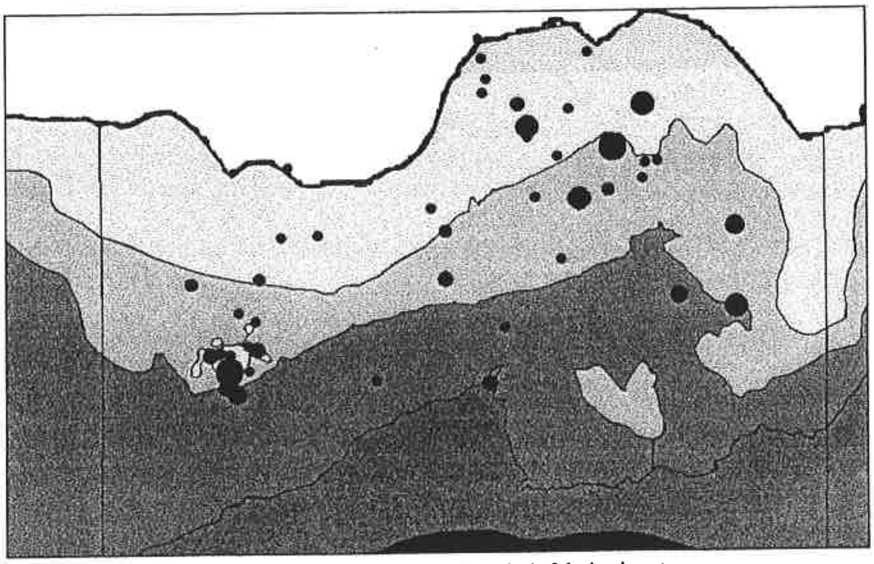

Figure 1. Sightings of bottlenose dolphins before the arrival of the inmigrant group.

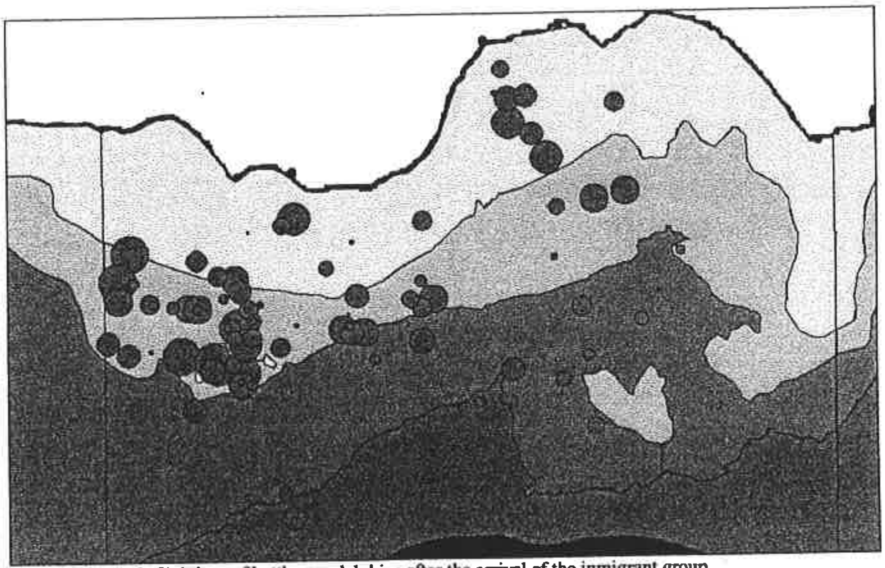

Figure 2. Sightings of bottlenose dolphins after the arrival of the inmigrant group.

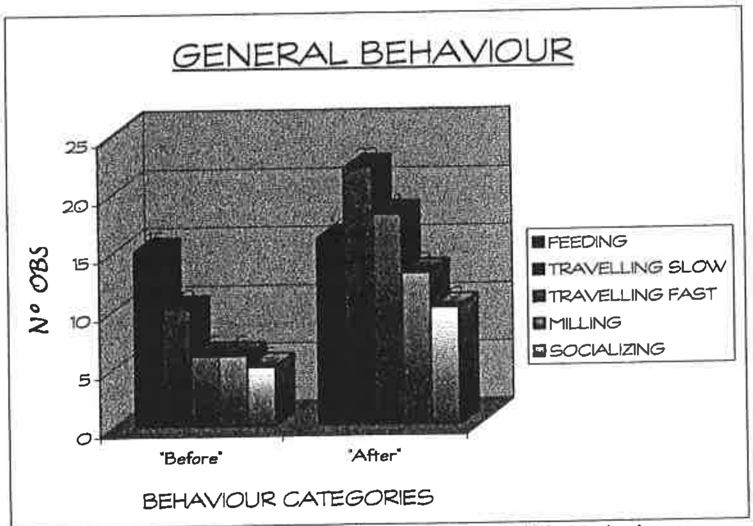

Figure 3. Behaviour frecuencies before and after the arrival of the inmigrant group.

PRELIMINARY DELIMITATION OF AREAS OF INTEREST FOR THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) AND THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN GALICIA (NW SPAIN)

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INTRODUCTION The presence of the bottlenose dolphin (*Tursiops truncatus*) and the harbour porpoise (*Phocoena phocoena*) in the coastal waters of Galicia (NW Spain) is very well documented for hundreds of years. However, there is a lack of knowledge concerning their abundance, distribution, and habitat use.

MATERIALS AND METHODS Between 1990 and 2000, CEMMA and ECOBIOMAR have established annual coastal cetacean-sighting surveys and a stranding network on the Galician coasts.

The criteria used for defining areas of interest for cetaceans were the number of sightings, number of strandings, cetacean utilisation of the area, and a study of the human activities developed in those areas.

RESULTS During the last ten years, 276 strandings and 1977 sightings of both species have been recorded, representing 20% of all cetacean strandings and 72% of all cetacean sightings. Of these data, the bottlenose dolphin represents 60% of the strandings and 96% sightings, with the harbour porpoise accounting for the remaining 40% (strandings) and 4% (sightings) (Martínez *et al.*, 1995) (see Tables 1 and 2).

The distribution of the bottlenose dolphin seems to be divided into at least five different groups, all along the Galician coast. The most important group is located between the Ría of Vigo and Ría of Pontevedra, and includes more than 100 individuals. Some geographical areas in these Rias have been recognised as feeding and play areas.

It is more difficult to estimate population rates and use of habitats for the harbour porpoise, due to the lower frequency of sightings, the low group size, and their shy behaviour.

Based upon all these data, six areas have been defined as zones of special interest for both species, and one more for the harbour porpoise alone (Fig. 1).

CONCLUSIONS This preliminary study has demonstrated the need for more accurate studies about the ecology of these species in Galician waters, and the threats that they face in these areas. All this information will be necessary for the definition of management programmes for these two species included in the National Catalogue of Threatened Species of Spain.

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Table 1. Sightings and strandings of bottlenose dolphins in the six sub-areas

	1	2	3	4	5	6
Sightings	35	151	207	214	375	919
Strandings	3	16	36	32	51	29

Table 2. Sightings and strandings of harbour porpoise in the six sub-areas

	1	2	3	4	5	6
Sightings	3	0	4	1	46	22
Strandings	2	9	10	17	43	28

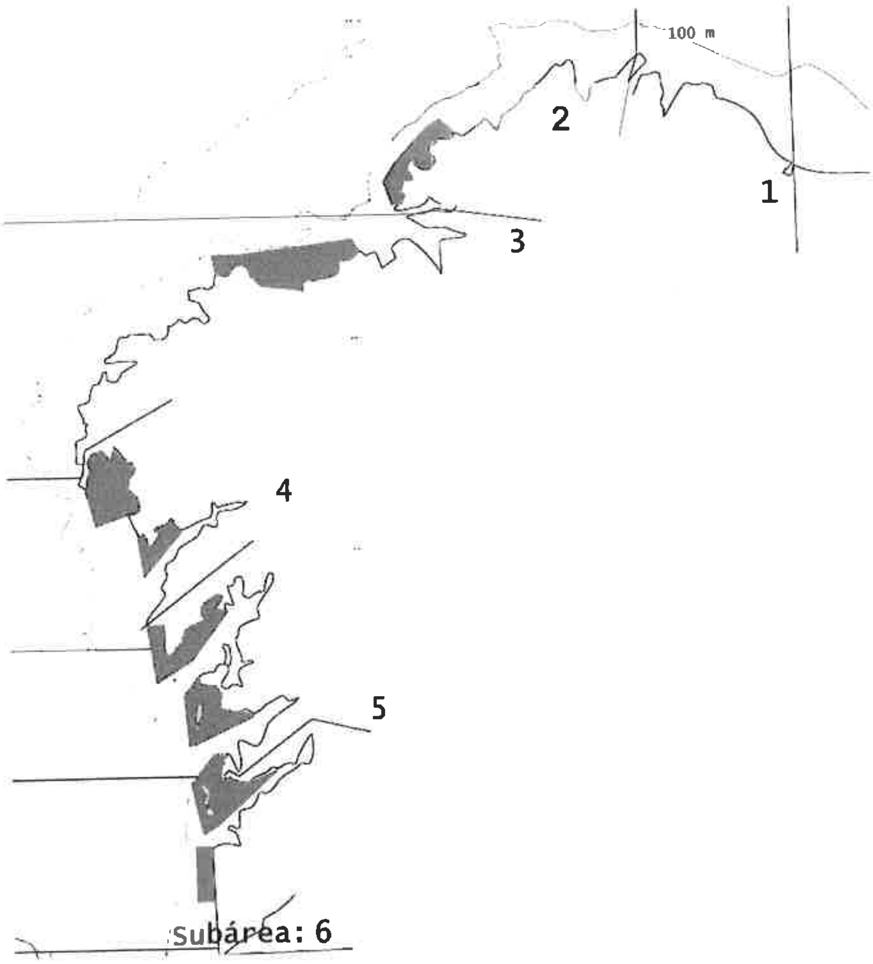

Fig. 1. Dark grey areas define the zones of special interest for harbour porpoise and bottlenose dolphin in Galician waters. The southern area applies only to the harbour porpoise.

A SHORE-BASED SURVEY FOR SMALL CETACEANS OFF SOUTH-EASTERN BRAZIL (1999-2000) WITH EMPHASIS ON THE LONG-BEAKED COMMON DOLPHIN (*DELPHINUS CAPENSIS*)

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INTRODUCTION The Cabo Frio upwelling system (23°S, 42°W) is an anomaly on the west side of the Atlantic Ocean on the coast of Rio de Janeiro state, Brazil. A change in coastal direction from north-south to east-west at Cabo Frio and the proximity of the 100-m isobath, leads to a topography which promotes upwelling of deep South Atlantic Central Water (SACW).

The former Cabo Frio whaling station catch hundreds of large whales in the early 1960s. Although a suitable place for conducting research on cetaceans, only a few studies have been conducted in the area (Gomes, 1984; Azevedo, 1997). The occurrence of large aggregations of small cetaceans in this area seems to be related to these enriched waters.

MATERIALS AND METHODS A shore-based survey was conducted in Arraial do Cabo, south-eastern Brazil from July until October, 1999, and from June until November, 2000. Regular observations were performed during daylight hours on the top of Pontal do Atalaia (22°58'S, 42°01'W), which is a 74 m high prominent headland. Cetaceans were searched by reticule binoculars 7x50mm (TASCO OFFSHORE-54), and a telescope (BUSHNELL).

RESULTS A total of 188 days and 929.4 hours were spent on effort, and resulted in sightings of the following species: long-beaked common dolphin *(Delphinus capensis)*, bottlenose dolphin (*Tursiops truncatus*), Atlantic spotted dolphin *(Stenella frontalis)* and orca (*Orcinus orca*). The long-beaked common dolphin represented 43.4% of all small cetaceans sighted during the surveys (Fig. 1). Group size ranged from two to *ca.* 150 individuals, and was greatest between September and November (Fig. 2). The closest group was sighted 0.44 nm and the furthest 3.27 nm off Pontal do Atalaia. Most groups were sighted in waters less than 100 m depth. Foraging behaviour was observed in 86.3% of the sightings, and, of these, 79% were associated with seabirds (Fig. 3). Calves were present in 73% of all groups sighted.

DISCUSSION Common dolphins are highly variable geographically, and their occurrence ranges across the seas of the entire world (Norman and Fraser, 1937), but is not found in colder waters. This species is associated with a minimum surface temperature of about 14°C as described by Gaskin (1967) in New Zealand. The genus *Delphinus* seems to occur more frequently in areas of high relief than in areas of low relief (Clifford, 1993). The availability of prey species over areas of different relief may be a major factor influencing the distribution patterns of these animals. Food may be more available in a complex aquatic environment; therefore, common dolphins can be expected to become more numerous as the submarine topography becomes more complex.

The distribution of *Delphinus* spp. along the Brazilian coast is poorly known, with a few records of sightings and strandings in south and south-eastern Brazil (Zerbini *et al.*, 1998).

Common dolphins are primarily pelagic, commonly found above depths of 200 m, but inshore forms occur in some areas (Majluf *et al.*, 1989). In several parts of the world, two types of common dolphins appear to exist: a long-beaked coastal type, and an offshore type with a short-beak. Recent research indicates that these two types represent separate species (Heyning and Perrin, 1994). The prey of common dolphins consists largely of small schooling fish and squid, which are abundant in Arraial do Cabo upwelling waters, and in accordance with some authors (Jefferson *et al.*, 1993), these organisms are the main food for *D. capensis.*

Hui (1979) described the seasonal aggregations of *D. delphis* in relation to availability of food in upwelling waters in the southern California Bight. This situation seems to occur off Arraial do Cabo since the occurrence of larger groups increases during spring - summer. In addition, the peak of upwelling in this area occurs in summer which provides favourable conditions for pelagic planktivorous fishes - such as the Brazilian sardine (*Sardinella brasiliensis*) - and neritic squids (*Loligo sanpaulensis* and *L. plei*), supporting one of the most important fisheries in the region (Valentin, 1994).

The food of this species usually occurs in submarine canyons and escarpments in areas of upwelling. The upwelling results in a high density of plankton and , consequently, in a large trophic web and high biodiversity. Some of the major effects of upwelling occur at the base of the food chain, and this situation appears to be reflected in seasonal availability of common dolphin's food and, subsequently, in the local distribution of *D. capensis*.

The nutrient-rich upwelling waters of Arraial do Cabo seem to represent an important breeding, calving, and foraging ground for long-beaked common dolphins. The association of *D. capensis* with these waters is evidence of the complex trophic relations of tropical marine ecosystems. While these speculations are reasonable, no firm conclusions can be drawn until more information is gathered.

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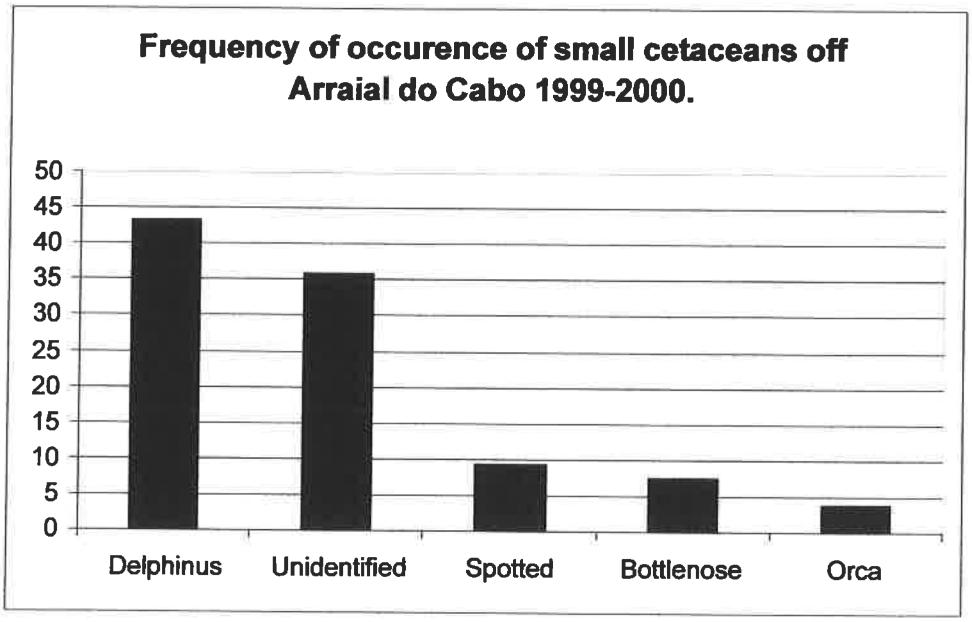

Fig. 1. Frequency of occurrence of small cetaceans off Arraial do Cabo, 1999-2000

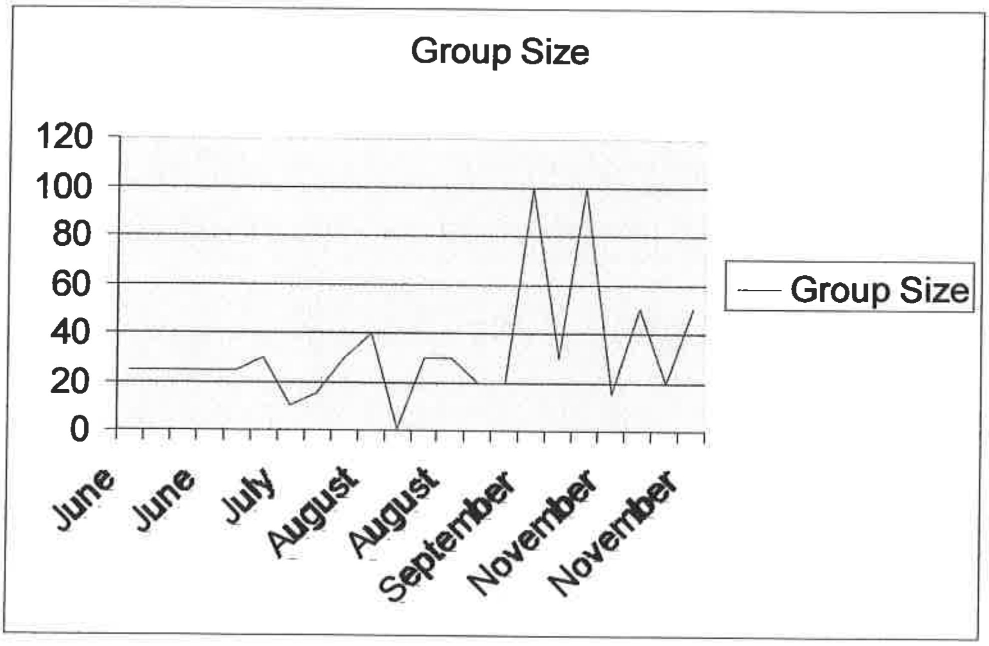

Fig. 2. Seasonal variation in group sizes of *Delphinus*

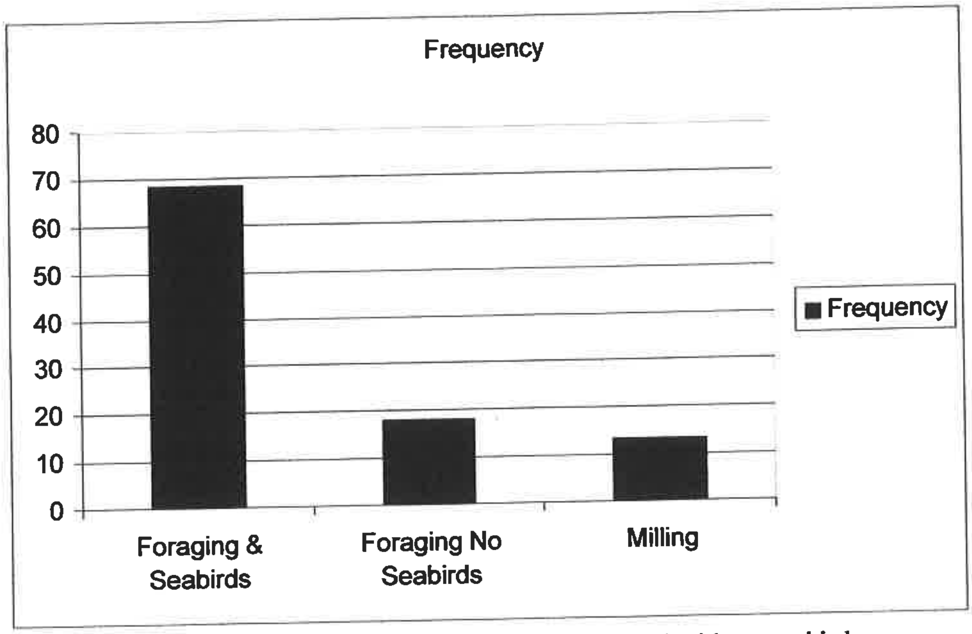

Fig. 3. Frequency of activities with and without seabirds

IS CROATIA READY FOR ITS FIRST MARINE RESERVE DEDICATED TO THE PROTECTION OF CETACEANS?

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Bottlenose dolphins in Kvarneric have been studied using photo-ID techniques since 1990. The size of the community estimated, based on the study season of 1997, places the population at 113 dolphins (95% CI=107-121, SE=6.967), well below the figure of 250 individuals that the IUCN recognise as 'critically endangered' for isolated populations. Our aim is to look at the environmental factors affecting the proposed Dolphin Reserve of the Cres-Lo_inj Archipelago and to determine whether the political and policy framework is currently in place to promote its protection. The proposed Marine Reserve faces many problems. Overfishing, boat traffic, and land-based pollution are all major threats, with a 30% decline in total catch from 1988-90, and a 400% increase of registered boats in the archipelago in the summer months. Only a limited part of the islands is serviced by a sewerage system; most of the sewage is produced is treated in an unsatisfactory manner. All these problems are intrinsically linked to tourism. Tourism on the island peaked in 1987 with over 3 million tourist-nights; this figure declined to 560,000 in 1991, and since the end of the troubles, tourism has once again increased to 1.4 million tourist-nights in 1999. The archipelago itself accounts for over 4% of the total tourist population of Croatia. Even more alarming is the 40% growth of tourism by 2015 proposed by the local authorities. The new national nature protection law currently being drawn up, incorporates the principles of the Bern Convention and ACCOBAMS, and this has fostered the feeling of change towards the environment in Croatia. The realisation that the quality of the environment and tourism are inherently linked, meetings with the Ministry of the Environment and the local authorities have encouraged the belief that the proposal will be met with a significantly more positive attitude than on previous occasions.

ORGANOCHLORINE CONCENTRATIONS IN RESIDENT BOTTLENOSE DOLPHINS *TURSIOPS TRUNCATUS* SAMPLED BY BIOPSY DARTS IN THE SHANNON ESTUARY, IRELAND

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The Shannon estuary is a candidate marine SAC for bottlenose dolphins. Information quantifying potential threats to the dolphins and their habitat is essential for proper conservation management. Bottlenose dolphins resident in the Shannon estuary were sampled using a crossbow to investigate the levels of organochlorine concentrations. Sampling known individuals from a resident group allows the long-term impact of biopsy sampling to be assessed. Eleven OC (HCB, a-HCH, g-HCH, pp-DDE, pp-DDT, pp-DDD, op-DDE, dieldrin, a-chlordane, g-chlordane, t-nonachlor) and 10 individual chlorobiphenyls and the sum of the seven congeners (CB 28, 52, 101, 118, 138, 153, 180) recommended by ICES for monitoring purposes, were analysed. The sex of each sampled animal was determined from DNA analyses of skin.

Between 17-22 September, 2000, tissue samples were obtained from eight dolphins (six males and two females). The strike rate was 100% and tissue samples (both skin and blubber tissue) were obtained from all biopsy attempts. The primary reaction observed to biopsy was a short-term behavioural response. However, the single strong reaction observed resulted from a misplaced hit (which struck the base of the dorsal fin rather than the flank area) and suggests that this technique should only be attempted by experienced researchers in optimum conditions.

ECOLOGY

PHYSICAL HABITAT OF CETACEANS ALONG THE CONTINENTAL SLOPE OF THE WESTERN LIGURIAN SEA

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INTRODUCTION The physical habitat of cetaceans found along the continental slope in the Western Ligurian Sea was investigated. The study area is approximately encompassed between the 50-m and 2000/2500-m isobaths, from Imperia, to southwest of Cap Ferrat (Fig. 1). Surveys were conducted from May to October, from 1996 to 1999, covering an area of *ca.* 3,000 square km, with a mean effort of about 10,000 km year^{-1}.

MATERIALS AND METHODS Sightings data were opportunistically collected from two different sighting platforms: a dedicated 12 m research sailboat, and a commercial whale-watching motor boat (Corsaro). Effort data (course, speed, etc) and sea state were recorded on both ships with a data logging system (IFAW – LOGGER Data Logging Software). Data on position, species, group size, presence of juveniles/calves, were also recorded. A GIS (SPSS, MapInfo) was used to divide the study area into 180 cells, measuring 3×3 nautical miles each, and to integrate sightings data to a set of environmental characteristics, which include bottom gradient, area between different isobaths, length and linearity of the isobaths within a cell unit. Effort was evaluated in terms of km of tracklines per cell unit. Kilometres surveyed on negative sea conditions (presence of white caps, Beaufort higher than 2-3) were eliminated from the total trackline length count.

The amount of effort per cell unit was expressed by the following formula:

$$Ratio = Effort_{cell} / Effort_{tot}$$

Moreover, as a measure of the animal's preference with respect to cells with different environmental characteristics, a *Habitat Score* was defined and computed for every cell, by cetacean species, on the basis of the following formula:

$$\text{Habitat Score}_{\text{norm}} = \frac{\dfrac{n^\circ animals_{cell}}{\max anim_{cell}} \times \dfrac{n^\circ sightings_{cell}}{\max sighting_{cell}}}{\dfrac{km_{cell}}{\text{km}_{tot}}}$$

RESULTS A total of 532 sightings have been reported including all the species occurring in the area: striped dolphin *Stenella coeruleoalba* (67%), fin whale *Balaenoptera physalus* (17%), sperm whale *Physeter macrocephalus* (4%), long-finned pilot whale *Globicephala melas* (1%), Risso's dolphin *Grampus griseus (6%),* Cuvier's beaked whale *Ziphius cavirostris* (4%), and bottlenose dolphin *Tursiops truncatus* (1%). Habitat use and preference were investigated using a Multidimensional Scaling (MDS) analysis that allowed a graphical representation of the cell similarities, independent of their relative geographical position (Fig. 2). Significant differences in habitat selection were found for all the species (Figs. 3a, b, c, d) with the exception of striped dolphin and fin whale, both of which were homogeneously distributed across the area (Figs. 3a and 3b). In particular, fin whale distribution appeared to be more influenced by seasonal variation than by habitat preference. An ANOVA test, applied to the co-ordinates of the cell centroids where each cell contribution was weighted by the *Habitat Score*, has outlined significant differences in different years (latitude: $F=29.04$, $p<0.01$; longitude: $F=7.56$; $p<0.01$). Moreover, a Discriminant Analysis, applied to cell centroids as well, revealed that July whale distribution was skewed eastward with respect to the August distribution, independently from the year of observation (Table 1; Fig. 4). A possible explanation for rthis could be related to the counterclockwise circulation, typical of the area, that might create "east-to-west" patterns in the krill distribution.

For striped dolphins, a group size-dependent habitat use was found (MANOVA Wilks-Lambda=0.92; Rao-R=2.23, $p<0.05$; see Table 2). As before, the MANOVA analysis was applied to cell centroids weighted by their *Habitat Score*. The results suggest that striped dolphins may prefer certain areas for specific activities that require larger group sizes.

Risso's dolphins, Cuvier's beaked whales, and sperm whales occurred in a distinct depth range (Fig. 5), generally corresponding to steeper bottom gradients. With Discriminant Analysis (Table 3), a correct classification was made of 93% of Risso's dolphin, 50% of Cuvier's beaked whale, and 86% of sperm whale sightings, just on the basis of bottom gradient and depth, suggesting for sperm whale a habitat overlapping one of the other two species.

CONCLUSIONS Most of the species present definite habitat preferences. Although striped dolphins and fin whales appeared to be homogeneously distributed across the areas, both showed a differential habitat use respectively as a function of group size and seasonal variations. Deep-divers (Risso's dolphin, sperm and Cuvier's beaked whales) were found associated to a definite depth range and steeper bottom gradients. Discriminant Analysis revealed for sperm whale a certain degree of habitat overlap with respect to the other two species.

ACKNOWLEDGEMENTS This work would not have been possible without the help and support of many people. We wish to thank: Barbara Nani and Marco Ballardini for the many hours spent at sea aboard Corsaro. Their professionalism and scrupulous reporting of sightings data have been indispensable. We thank also all the people (research assistants, collaborators, volunteers, undergraduate students) who contributed to the Tethys fieldwork campaigns, and to Maddalena Jahoda and Carla Almirante for their support, friendship, and precious advice.

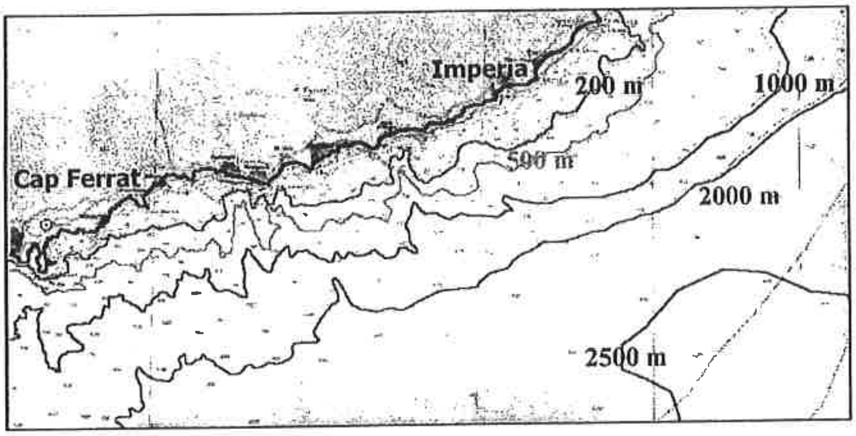

Fig.1: Study Area

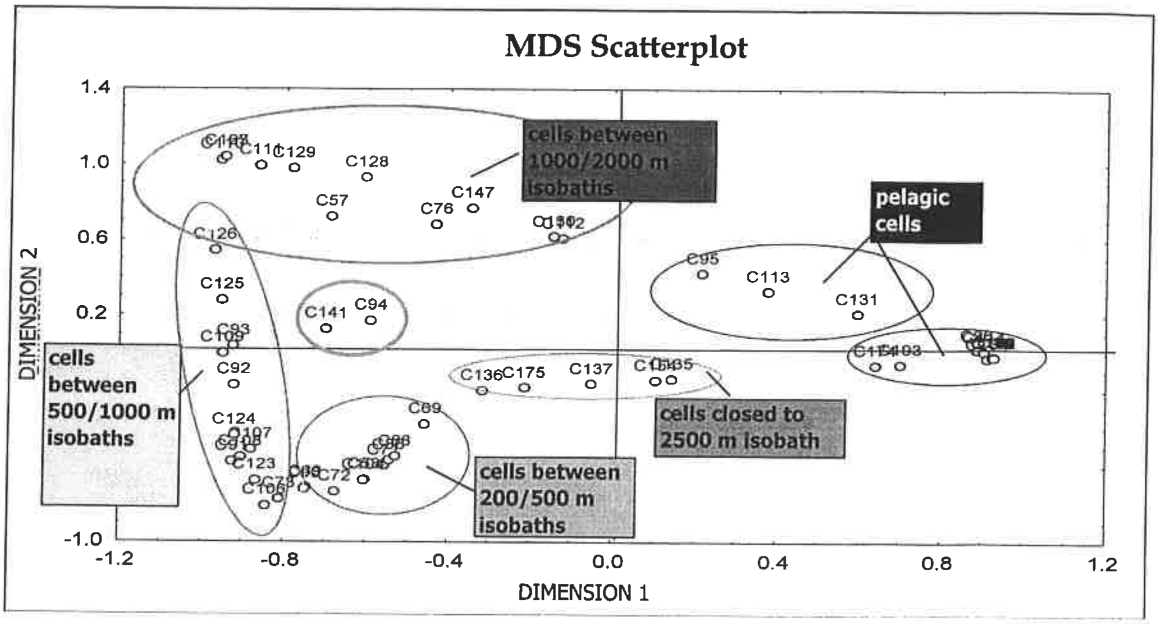

Fig.2: MDS plot of the cell similarities.

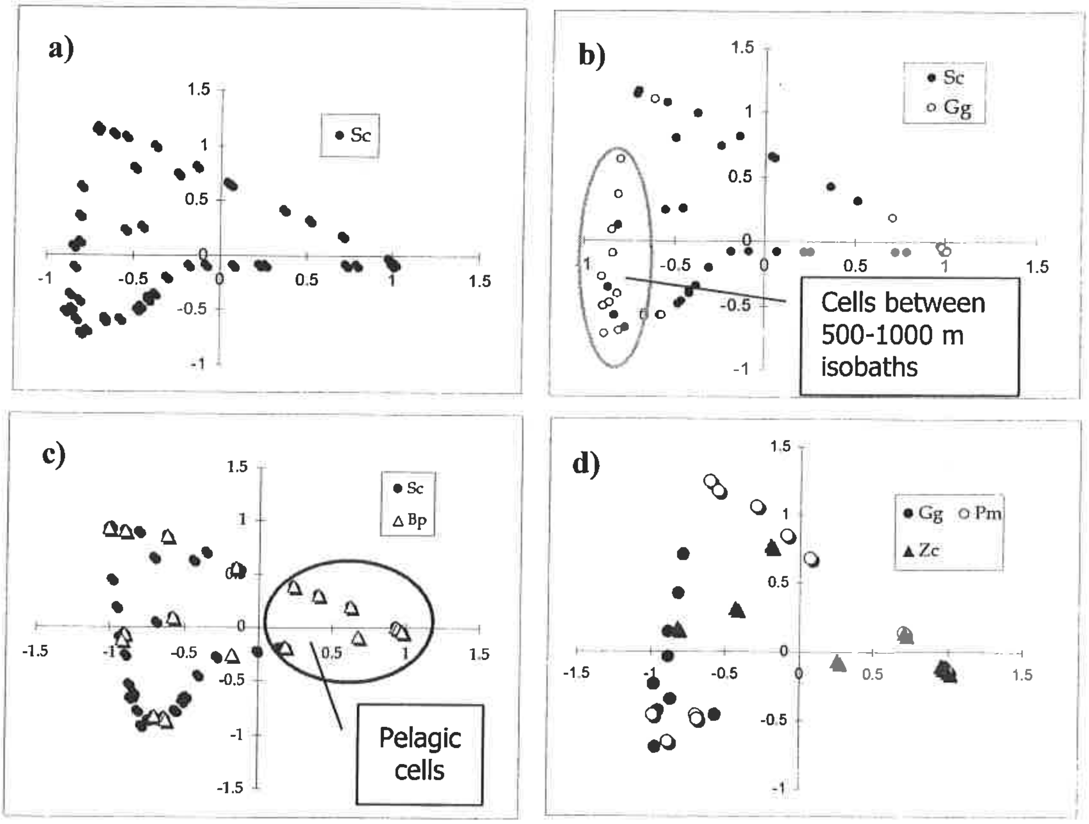

Fig.3: MDS plots outlining different species habitat preferences. Symbols: *Sc*: striped dolphin; *Pm*: sperm whale; *Bp*: fin whale; *Gg*: Risso's dolphin; *Zc*: Cuvier's beaked whale.

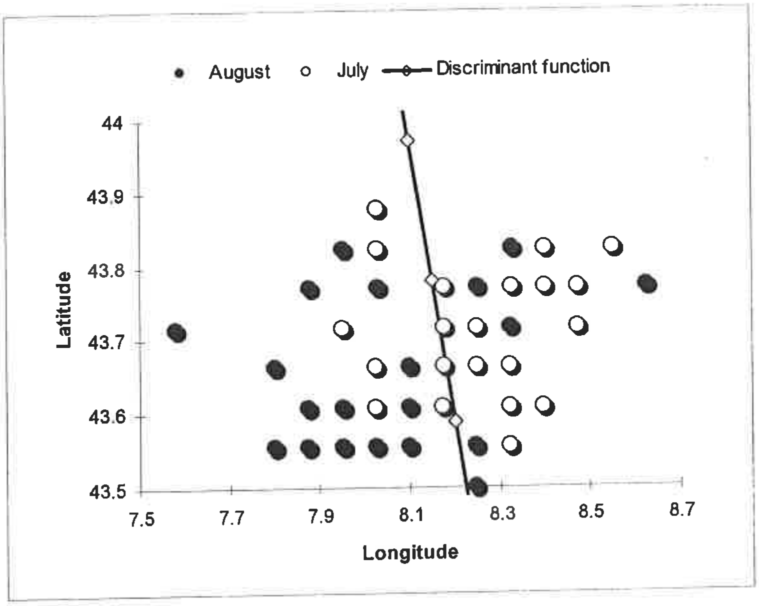

Fig.4: Discriminant Analysis of fin whale distribution in the July/August period.

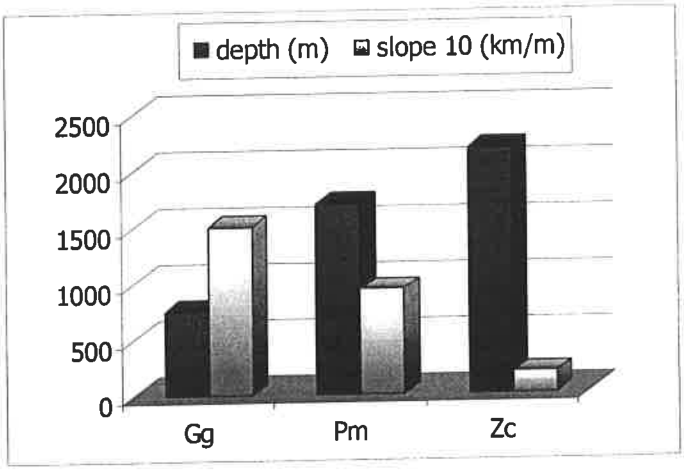

Fig.5: Depth and slope ranges of the deep-diver species: *Pm*: sperm whale; *Gg*: Risso's dolphin; *Zc*: Cuvier's beaked whale.

Table 1: Discriminant Analysis of fin whale distribution in the July/August period

Classification Matrix
Rows: Observed
Columns: Predicted

	% Correct	July p=.50	August p=.50	tot
July	**66.7**	18	9	27
August	**63.6**	12	21	33
Total	**65**	30	30	60

Table 2: MANOVA applied to cell centroids weighted by the Habitat Score

MANOVA 1-Month, 2-Groupsize	Wilks's Lamba	Rao's R	June, July, August df1	df2	p-level
1	0.9881	0.792	4	530	0.531
2	0.9210	2.228	10	530	0.015
12	0.9018	1.406	20	530	0.113

Table 3: Discriminant Analysis of deep-diver species as function of depth and slope. Each cell weighted by its Habitat Score.

Slope-Depth Classification Matrix **Rows: Observed** **Columns: Predicted**	**% Correct**	**Gg p=.333**	**Pm p=.333**	**Zc p=.333**
Gg	**92.9**	13	0	1
Pm	**50.0**	2	8	6
Zc	**85.7**	0	1	6
Total	**73.0**	15	9	13

A PRELIMINARY INVESTIGATION ON CETACEAN HABITAT IN THE LIGURIAN SANCTUARY (SIRENA'99)

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INTRODUCTION The present study is part of a larger programme entitled "Sirena", sponsored by the NATO SACLANT Undersea Research Centre (SACLANTCEN). Its aim is to collect an integrated biological and hydrographic database in order to investigate cetacean distribution in the Ligurian Sea Sanctuary for Cetaceans. Sirena surveys, undertaken during the summer of 1999 from the 3rd to 13th of August, and covering a total of 2,058 km. This offered the opportunity to compare environmental measurements with cetacean sightings on the same spatial-temporal scale (Fig. 1). More than 30 oceanographic and lower trophic level measurement stations (including CTD, fluorescence, small zooplankton abundance, measured acoustically and with plankton net hauls), each spaced 12 nautical miles from the others, have been made by the Italian Navy Hydrographic vessel, the ITS Magnaghi. Concurrently, a visual watch for cetaceans was conducted aboard the ITS Magnaghi and the SACLANTCEN's RV Alliance. Further details about '99 and '00 Sirena surveys can be found in Teloni *et al.* (2001).

MATERIALS AND METHODS Sightings data have been collected along a combined track length of 695 km (ITS Magnaghi) and 1,363 km (RV Alliance), consisting of a total of 529 hours of daylight observations. Ship position, course, and speed were recorded by means of data logging systems present on both ships. Lower trophic level data were collected by means of a profiling package consisting of a Conductivity, Temperature and Depth (CTD) probe, a fluorometer (measuring fluorescence as a proxy for chlorophyll-a), and a Tracor Acoustic Profiling System (TAPS). TAPS in particular collected acoustic volume backscattering data at six frequencies: 265 kHz, 420 kHz, 700 kHz, 1.1 MHz, 1.85 MHz, and 3 MHz. The volume backscattering data from the TAPS were transformed into estimates of zooplankton abundance by means of the matrix inversion algorithm that provides estimates of biovolume, measured in mm^3/m^3, as a function of size-class, employing the non-negative least squares (NNLS) method (Lawson and Hanson, 1974; Holliday, 1977; Greenlaw and Johnson, 1983). Five size-classes have been defined in terms of Equivalent Spherical Radius (ESR): Biovolume BV1: 0-0.375 mm ESR, Biovolume BV2: 0.375-0.725 mm ESR, Biovolume BV3: 0.725-1.725 mm ESR, Biovolume BV4: 1.725-2.475 mm ESR, and Biovolume BV5: 2.475-3 mm ESR.

RESULTS Principal Components and Multiple Regression Analysis were used as exploratory tools to assess correlations among biovolume fractions, chlorophyll-a, and temperature profiles. The analysis was performed using the sum, the mean, and the standard deviation of each environmental parameter, calculated over the entire profile (Fig.2, Table 1). Then Multidimensional Scaling (MDS) was used to assess similarities among profiles of different stations. Euclidean Distance was used as a measure of similarity. All the stations appeared to the MDS as quite homogeneous with few scattering stations and all the others grouped together.

In order to integrate cetacean data and the environmental context, the study area was divided into 816 cell units of 0.1 degree of latitude and longitude by using a customised Geographic Information System (ESRI-ArcView). After that, and in consideration of the intrinsically dynamic nature of the environmental variables involved, rather than rely on kriging techniques to estimate values at unsampled cells, MDS was used instead. Basically MDS was applied to satellite data (averaged on the 5th, 6th, 7th, 13th of August instant photos) of chlorophyll and temperature to obtain a similarity matrix covering all the cells. Then, on the basis of such similarities, the environmental characteristics of the closest cell with a measurement station were attributed to every unsampled cell (Fig.3).

In order to evaluate cetacean preference with respect to different environmental characteristics, a Habitat Score (Azzellino *et al.*, 2001) was used, per cell and by species, on the basis of the following formula:

$$\text{Habitat Score}_{\text{norm}} = \frac{\dfrac{n^\circ animals_{cell}}{\max anim_{cell}} \times \dfrac{n^\circ sightings_{cell}}{\max sighting_{cell}}}{\dfrac{km_{cell}}{\text{km}_{tot}}}$$

A Correspondence Analysis (CA) was used to investigate the degree of habitat selection of the most common species: striped dolphin *(Sc)*, and fin whale *(Bp)*. The CA biplot outlined a largely overlapping distribution of the two species (Fig. 4), and the association of striped dolphin presence with higher concentrations of large biovolume fractions (BV5 and BV4) and lower temperature gradients ($T_{grad} = T_{max}-T_{min}/50$ m). By comparing the cell mean values of each environmental variable for the two species (an unpaired Student's t-test where each record was weighted by the cell Habitat Score was used), CA results were confirmed: striped dolphins were mostly found in cells with higher values BV4, BV5 of chlorophyll (df:=46; t-values: -3.09, $p<0.01$; t-values: 1.89, $p=0.06$; t-values: 3.62, $p<0.01$).

Finally, a linear correlation between Habitat Score of the two species and the environmental variables was investigated by means of a Stepwise Multiple Regression Analysis. Although no clear relationship was found for fin whale, regression results showed clearly the association of striped dolphins with high productivity cells (in terms of chlorophyll-a and BV5), and also inversely correlated to lower temperatures and steeper thermocline gradients (ANOVA for Multiple Regression Analysis F: 17.07; $p<0.01$, see Table 2).

CONCLUSIONS Even though data analysis was performed on a relatively small data set, a few final considerations can be made:

- MDS analysis applied to satellite data can be an interesting alternative to kriging techniques to estimate values at unsampled locations or cells;
- Fin whale and striped dolphin habitats were found to be highly overlapping;
- Striped dolphins presence was found to be associated with chlorophyll/plankton patches, and inversely correlated to lower temperatures and steeper thermocline gradients.

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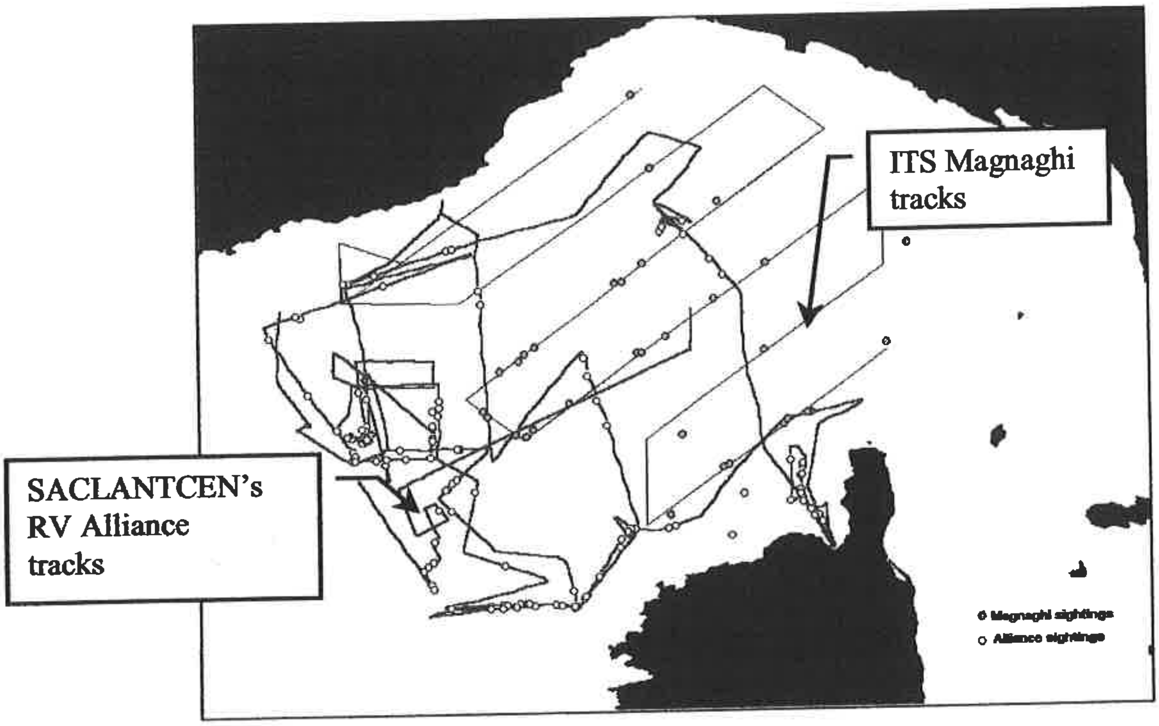

Fig. 1 Survey extent during the Sirena'99 field campaign in the Ligurian Sea Sanctuary for Cetaceans.

Table 1 Multiple Regression Analysis of the environmental variables.

	+/- multiple correlations	explained variance (R^2)
BV1	(+) BV5, (+)Tmax, (-) Tgradient	0.63
BV2	(+) BV3, (-) ChL, (-) BV5	0.48
BV3	(+) BV2, (+) Tmax, (+) ChL*	0.42
BV4	(-) BV5, (-) Tgradient	0.32
BV5	(-) BV4, (+) Tmin	0.34
BV5	(+) BV1, (-) BV2	0.59
ChL	(+) BV2, (+) Tgradient	0.3
ChL	(-) BV1, (-) Bv2, (+) BV3	0.4

all the coefficients were significant (p-level<0.05); ChL was significant with a p-level<0.10*

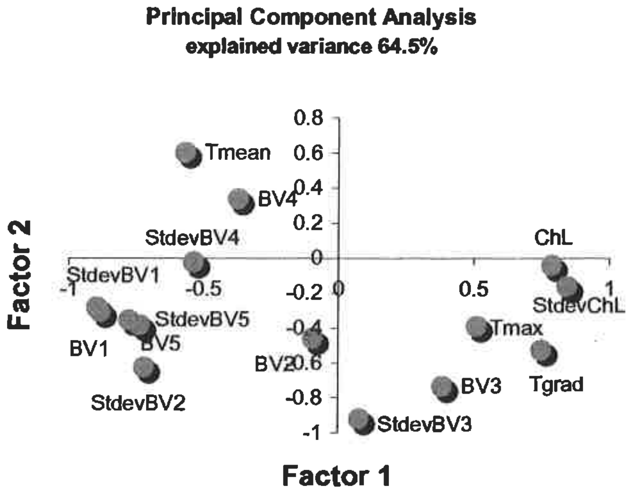

Fig. 2 PCA of the environmental data.

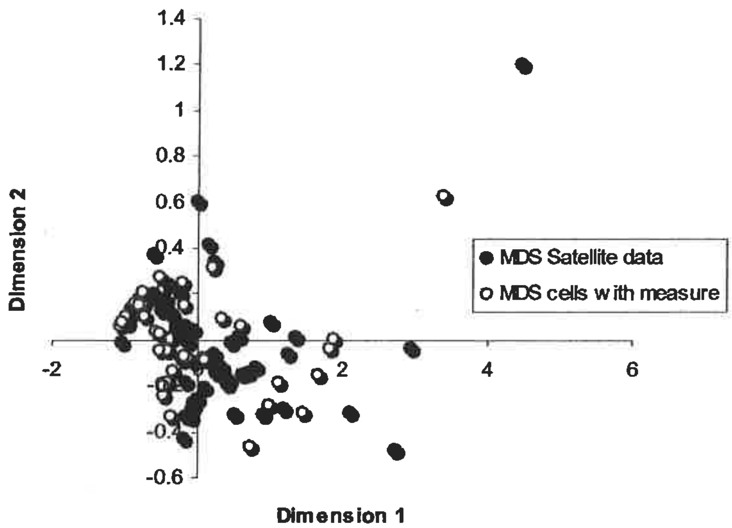

Fig. 3 Multidimensional Scaling plot of the Satellite data.

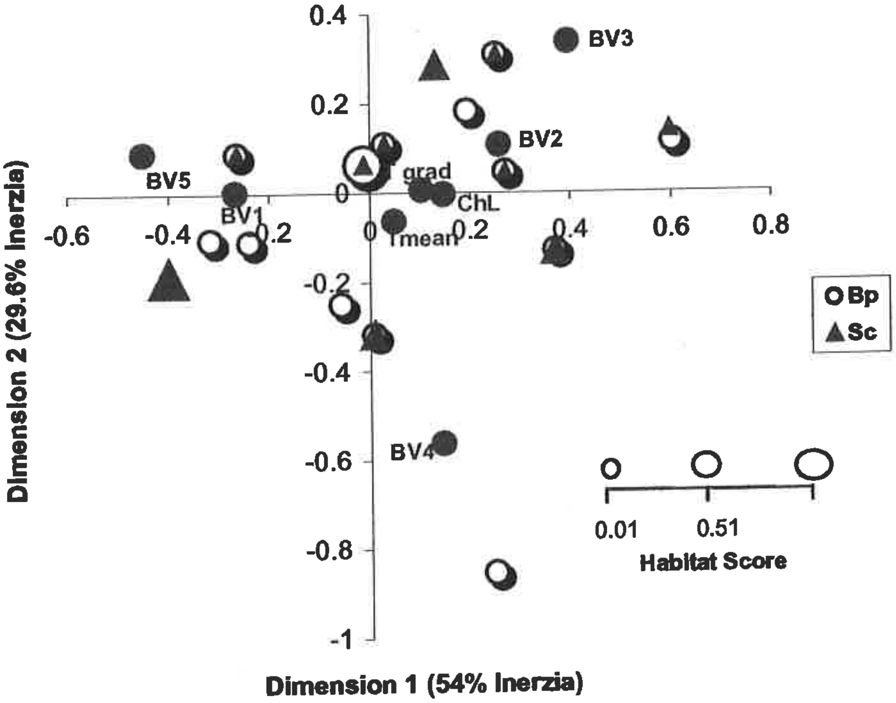

Fig. 4 Correspondence Analysis Biplot: the dimension of the symbols are proportional to the Habitat Score.

Table 2 Regression statistics for striped dolphin's Habitat Score.

Regression Satistics per Dependent Var. **Habitat Score**

R= .89631842 R^2= .80338671 R^2 Aggiust.= .75801442 n = 17

F(3,13)=17.707 p<.00007 Std. Error.: 0.13485

	BETA	ETA Std. Err.	B	B Std. Err.	t(13)	p-level
Intercept			1.698529646	0.415946578	4.083528353	0.001
Tgrad	-1.012456034	0.161317554	-12.77227149	2.035043035	-6.276167764	0.000
ChL	1.060764634	0.166958038	0.029191501	0.004594568	6.353480466	0.000
BV5	0.237983388	0.141786923	2.37689E-05	1.41612E-05	1.678457948	0.117

OBSERVATIONS ON TWO SPECIES OF COMMON DOLPHINS IN THE SANTA MONICA BAY, CALIFORNIA

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Various authors have reported two species of common dolphins occurring in the eastern north Pacific: the short-beaked common dolphin (*Delphinus delphis*) and the long-beaked common dolphin (*Delphinus capensis*). Previous studies show that the two species inhabit offshore and inshore waters, respectively. According to the specimens examined by other authors, these dolphins show different color patterns, total length, and rostral length, in addition to other distinct secondary features. Their data also suggest: 1) the absence of gene flow between these animals in the Southern California Bight, and 2) a wide distribution in tropical and warm temperate waters, in which these species occur sympatrically or have mostly parapatric ranges with some local marginal overlap. Field surveys conducted by the author during 1997-99, show that both species inhabit the Santa Monica Bay, CA. During a total of 40 inshore surveys, 80 inshore/offshore surveys, and 43 offshore surveys carried out in the study area, short-beaked common dolphins and long-beaked common dolphins were observed year-round but only five times at less than 500 metres from shore. In fact, both species appeared to be far more frequent in pelagic waters and in proximity of submarine canyons than in two diverse locations, inshore and offshore, as previously reported. Between these two species, long-beaked common dolphins were the most represented in the study area (long-beaked 59%, short-beaked 41%; N=61). Although both species were sighted during foraging, feeding, and other activities in the same locations of the Bay, no occurrence of mixed schools was observed, which confirms a sympatric range for the study area.

SPATIAL DISTRIBUTION OF FIN WHALES *BALAENOPTERA PHYSALUS* IN RELATION TO OBSERVED AND SIMULATED OCEANOGRAPHIC FACTORS IN THE NW MEDITERRANEAN SEA

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The fin whale (*Balaenoptera physalus*) is the largest marine predator currently observed in the Mediterranean Sea. Each summer, an estimated 1,000 to 2,000 individuals concentrate in the northern part of the Occidental basin (Ligurian Sea and Gulf of Lion), where they mainly feed on the zooplankton (*Meganyctiphanes norvegica*). The aim of this study was to investigate the summer distribution of fin whales in relation to observed/simulated marine environmental parameters. Spatial distribution of fin whales was obtained by combining observations kindly provided by a number of associations and research groups. This resulted in the creation of two large independent data bases (with and without observation effort). Oceanographic data were collected or simulated using the following parameters: sea surface temperature (AVHRR), chlorophyll concentration (SeaWiFS), bathymetry, currents, and forage abundance. The currents were simulated by the OPA dynamical model. Fin whale forage was simulated using a trophic transfer model forced by currents and chlorophyll (transfer from primary production to prey level is parametrised in terms of an efficiency and of a recruitment time and is achieved within waters that are advected by the currents). Using Geographic Information Systems and spatial analytic techniques, we then investigated the relationships between the spatial distribution of the whales and the oceanographic factors over temporal and spatial scales ranging from weeks/nm to seasonal/basin. Preliminary results of the analysis are presented in terms of explained variance, and underline the importance of the Liguro-Provençal current system in explaining the distribution of fin whales.

RECOVERY AND POPULATION CHANGES OF SOUTH AMERICAN SEA LIONS IN NORTHERN PATAGONIA

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South American sea lions (*Otaria flavescens*) are distributed along the coast of Argentina on the south-western Atlantic Ocean. The population was dramatically reduced between the 1930s and the 1950s, and did not show signs of recovery until 1990. The purposes of this paper are to estimate the size and trend of the population located in northern Patagonia, and to analyse changes in the distribution, size and structure of the rookeries. Censuses were carried out during the periods 1983-2000. Total counts were made during the peak of the reproductive season from the field, or by photographs taken from a high-wing aircraft. At least two series of counts were made, allowing a maximum error of 10%. Available data for the period 1972-83 were included. The trend of the population was analysed by the regression of the logarithm of the total number of individuals, pups and non-pups, on the year of the census. During 1998, sea lions were present in 17 rookeries, and the total number counted was 21,048 (population size estimated at 37,886 individuals by 1.8 CF). The number of pups and non-pups showed positive trends which were significantly different to 0 and there were no differences between these two classes ($t=0.075$, $p=0.941$). The trend in the number of pups during the period 1970-98, was significantly positive, and equal to 0.030 (CI 95%=0.024; 0.035; $p<0.001$). All breeding rookeries showed positive trends in total number, and number of pups. One rookery showed significant differences between the rate of change of pups and non-pups. The higher rates of increase in the number of pups in some rookeries are associated to occupancy of new areas by juveniles. In the last decade, small breeding areas were found in areas of juveniles and young males, and in some cases they showed higher rates of increase than the old and well-established breeding rookeries, representing potential colonisation areas.

A USEFUL AND LOW COST METHOD TO APPROACH THE TROPHIC RICHNESS OF AN AREA

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This work is based on data gathered from 1996 to 1997, during the months of June to September, in the north-western Mediterranean Sea. We used a standardised line-transect method, aboard a 12 m motor sailing boat, at a speed of 5 to 7 knots, and with three permanent observers. Only nautical miles (nm) covered with a sea state and wind conditions <3 Beaufort were retained in this study, totalling 2626 nm. The underwater detections were noted each ten minutes. A two-frequency (50 and 200 kHz) echo-sounder detected underwater "biomass", and displayed it on a screen by traces of echoes in blue to red, depending on their strength. These echoes formed layers that we describe and after that transcribe, using a special coding system devised with specialist advice, as "indices of echo richness. This coding takes into account the density (scattered to plain), the thickness and duration of the layer for each colour on each frequency. During our surveys at sea, we noted cetacean species, number of animals, structure and composition of groups, behaviour, and heading. Analyses were undertaken with a GIS and with a Principal Components Analysis, to compare the distribution of the indices of echo richness with that of two cetacean species: fin whale and striped dolphin. The results show that feeding animals are located in areas were we recorded simultaneously lots of echoes on both frequencies. We conclude that this low cost method can be useful as the first step, in order to approach a certain kind of "trophic richness" of an area.

MONITORING THE COASTAL MIGRATION OF THE HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*) OFF SOUTHEASTERN BRAZIL FROM A SHORE-BASED STATION

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INTRODUCTION The Cabo Frio upwelling system (23°S, 042°W) is an important phenomenon on the west side of the Atlantic Ocean off the coast of Rio de Janeiro state, Brazil. A change in coastal direction from north-south to east-west at Cabo Frio, and the proximity of the 100 metres isobath, leads to a topography that promotes the upwelling of deep South Atlantic Central Water (Valentin, 2000). The region is highly productive, sustaining a substantial fishery (Costa and Fernandes, 1993).

A whaling station located at Cabo Frio, now inactive, started its operations in the early 1960's and within four years caught 1,470 whales, including several humpback whales (Williamson, 1975). However, only a few cetological studies were previously conducted in the area (Gomes, 1984; Azevedo, 1997).

MATERIALS AND METHODS Shore-based surveys for cetaceans were conducted at Arraial do Cabo (Fig.1), southeastern Brazil, from June until November 2000. Observations were made during daylight hours from the top of the 74m high Pontal do Atalaia (22°58'S, 042°01'W). Search effort was carried out using 7x50mm reticule binoculars (Tasco Offshore 54) and a spotting scope (Bushnell). For each sighting, the reticule distance was recorded and later used to calculate the radial distance following Lerczak and Hobbs (1998*a,b*). The whales' behavior was also recorded. The presence of calves was determined based on the size difference between the calf and the adult female.

RESULTS A total of 563 hours spread over 122 days were spent on effort. 49 groups of humpback whales, totalling 82 individuals, were sighted. In addition to the humpback whale, the following species were also recorded: eight Bryde's whales (*Balaenoptera edeni*), five southern right whales (*Eubalaena australis*), and two Antarctic minke whales (*Balaenoptera bonaerensis*).

Humpbacks represented 69% of all baleen whales sighted during the survey, with group sizes ranging from 1 to 3 whales (Fig. 2). The first group migrating north was sighted on June 11th and the last on September 24th, while the first group migrating south was sighted on November 2nd (Fig. 3). Two peaks of humpbacks migrating northward were observed off Arraial do Cabo, one on the last week of July and the other on the week ending on August 26th (Fig. 3). The closest group was sighted 0.92 nautical miles and the furthest 9.03 nautical miles from the shore. Calves were seen on three of the six groups sighted during the first peak of the northward migration.

CONCLUSIONS Humpback whales are gregarious and strongly migratory (Leatherwood *et al.*, 1988). On the feeding grounds humpbacks are often found in larger groups than on breeding grounds. Siciliano (1997) described that at Abrolhos Banks, which is the breeding ground for the stock of humpbacks which migrate along the Brazilian coast, the majority of the groups ranged from 1-3 whales. Results from this study also matched his description.

The migration of humpback whales is usually not continuous and exhibits temporal segregation (Dawbin, 1997). The greatest sighting rates off Arraial do Cabo were observed in July and August (Fig. 3). These results are in agreement with those from Siciliano (1997), which reported the greatest sighting rates for the breeding grounds of Abrolhos Banks in August and September. The maximum occupation rate registered at Abrolhos Banks by the same author was in October, when no humpbacks were sighted off Arraial do Cabo. This suggests that most migrating humpback whales, if not all, would have arrived at the Abrolhos Banks breeding grounds by then. Although all humpback whale sightings made off Arraial do Cabo during November were considered to be of animals already on their southward migration, not all whales exibited an evident displacement to the south. In other areas of the world, the southward migration of humpback whales does not seem to exhibit a regular pattern of movement (Paterson, 1984).

Aerial behaviors are closely related to social interactions and are widely observed during migration and at the breeding grounds (Whitehead, 1985). Out of fourteen groups sighted during the second peak of the northward migration, eight groups exhibited aerial behaviors. The majority of these groups seemed to be composed of juveniles and/or adults, as there were no calves present. In contrast, calves were only seen during the first peak of the northward migration. These results suggest the possibility of a sex and age segregated migration of humpback whales along the Brazilian coast, as occurs in other coastal regions where humpbacks migrate through. However, sample sizes for the current study were relatively small, indicating that either humpback whales were traveling further from shore (i.e. beyond our field of vision), or that a number of whales passed close to shore but were missed. Further studies are needed to confirm the hypothesis that a segregated migration of humpback whales also occurs along the Brazilian coast, and also to determine the proportion of whales that migrate relatively close to shore off Arraial do Cabo.

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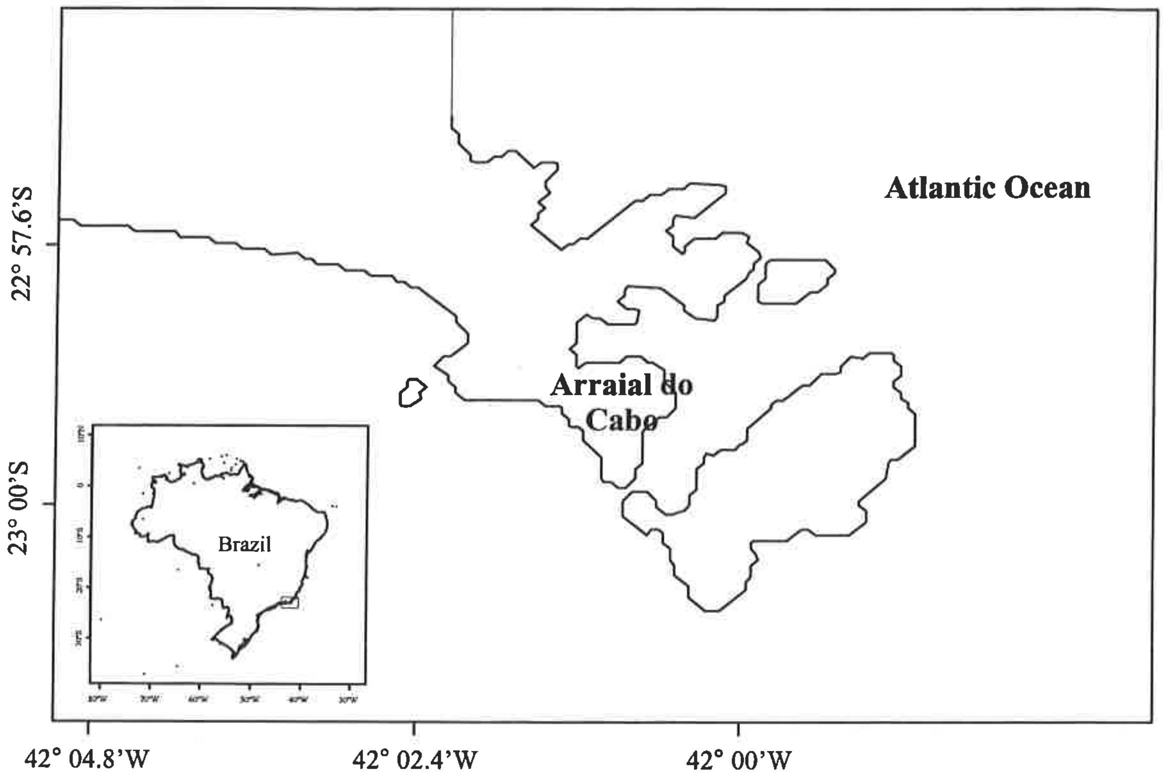

Fig. 1 Map of Arraial do Cabo.

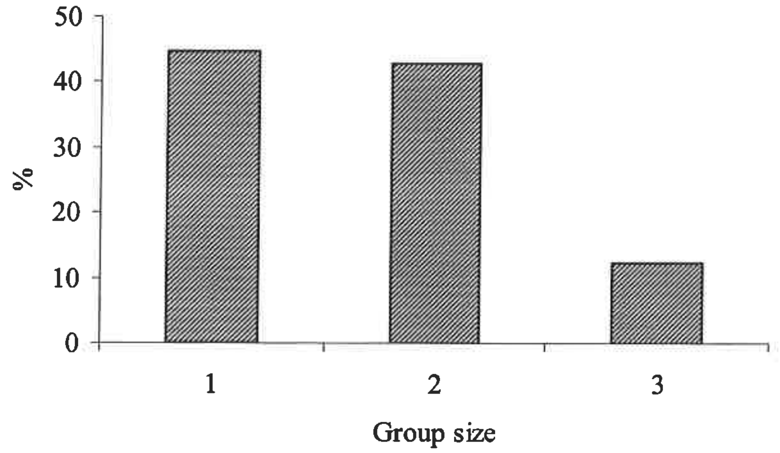

Fig. 2 Group size frequency.

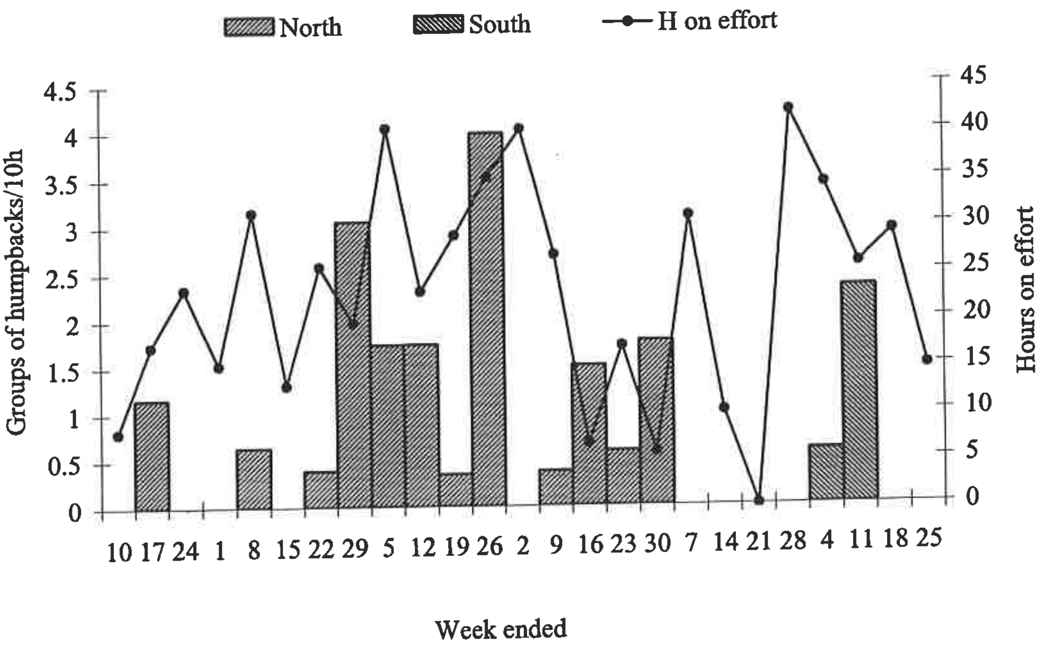

Fig. 3 Groups of humpback whales sighted from Pontal do Atalaia between June and November 2000.

SOME MICROBIOLOGICAL DATA ON BY-CAUGHT HARBOUR PORPOISES IN THE BLACK SEA

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INTRODUCTION As part of the BLASDOL Project, supported by Inco-Copernicus (co-ordinator Prof. Dr. Claude Joiris, and leader of Ukrainian team, Dr. Alexei Birkun), microbiological samples were isolated post-mortem from free-living harbour porpoises. Over a long period (since 1960s-70s), microbial infection in Black Sea cetaceans (including 20 harbour porpoises) was inspected from time to time (Shabaeva, 1972; Tomilin and Bliznyuk, 1981; Birkun *et al.*, 1988; Birkun and Miloserdova, 1989; Birkun, 1994; Gabriela, 1996; Lukina, 1997; Gol'din, 1997; Gol'din and Birkun, 1999). The microbiological material from skin, air-out samples, respiratory tract, internal organs, and rectum of wild and captured animals was examined. Some bacteria and fungi were identified in living harbour porpoises - *Staphylococcus saprophyticus* and *S. epidermidis* (respiratory tract), *Edwardsiella tarda* (lung, liver), *Staphylococcus* spp., *Candida* spp. etc. (skin), with species revealed in kidney, spleen and lymph nodes (Birkun and Miloserdova, 1989). At the same time, such a large group of by-caught harbour porpoises (n=46), incidentally taken from the environment, was put to a microbiological analysis. This work is presented as an extension of long-term monitoring research of the Black Sea cetaceans.

MATERIALS AND METHODS During May 1997 - July 1998, 46 harbour porpoises (*Phocoena phocoena relicta* Abel, 1905) by-caught in fishing gill nets in the Ukrainian (38) and Bulgarian (8) waters were inspected for algal and microbiological analysis. The samples were prepared during necropsies from animal tissues - lung (71), liver (70), kidney (67), spleen (53), and intestinal lymph node (52). In some cases, smears were taken from blowhole cavity (3), umbilical cord (2), milk (6), and skin damage or abscesses (5). The material was sown in a beef-extract broth or Gol'dberg medium (for the isolation of microalgae) and then incubated during 24 hours (37°C). Agar media (beef-extract, blood, egg yolk, and Endo) and tests (catalase, oxidase, indole, and hydrogen sulphide) were used for morphological and cultural characterisation of isolated colonies, and their identification by standard methods (Birger, 1982).

RESULTS AND DISCUSSION The data obtained did not indicate a high taxonomic diversity of micro-organisms - the residents of wild harbour porpoises. On the other hand, we observed some very interesting features in this context.

1. All wild animals were free of microalgae, as we observed in most cases from our previous investigations (Gol'din, 1997).

2. The internal organs in those harbour porpoises that we inspected, were infected mainly by colonies of aerobic sporulating bacteria *Bacillus* spp. This group is known as the active product of diverse anti-microbial substances (about 200), inhibiting a wide number of bacteria and fungi; these include fatty acids and new antibiotics such as biosurfactants with surface-active characteristics (Smirnov *et al.*, 2001). Some marine strains of bacilli were isolated from samples of sea water, sediments, and microbial communities associated with a number of marine animals, including sponges, soft corals (Ivanova *et al.*, 1992), and plaice (Gilmour *et al.*, 1976). The antibiotic action found in *Bacillus* spp. may provide an explanation for the existing microbiological picture. This suggests one should pay more attention to this group during subsequent studies, including detailed identification, cultivation, testing, etc.

3. Obligate anaerobes such as gram-positive cocci, *Sarcina* sp., had a very wide distribution in the internal organs - lung, spleen, intestinal lymph node, abscess and umbilical cord (in one case), and liver (three cases).

4. The composition of conditionally pathogenic microorganisms is relatively limited and includes only ten species (Table 1). Meanwhile, these bacterial and fungal species belong to the group of opportunistic and secondary pathogens, and their presence can be associated with the unfavourable status of the host. Besides, they can be a complicating factor in some diseases.

5. Conditionally pathogenic microorganisms from several taxonomic groups were registered in a variety of organs within the same individual host (14 cases) (Table 2).

6. Conditionally pathogenic microorganisms infected the majority of animals examined (63%) in both sea areas. We recorded a significant difference in the composition of microbial communities of animals in different parts of the Black Sea.

7. In particular, ten species were recorded in 24 porpoises from Ukrainian waters (near Crimea peninsula, mainly from the region of Sevastopol and Kalamita Bay). They included *Proteus vulgaris* in the lung (two cases); *P. mirabilis* in the liver and kidney (one case); *Edwardsiella tarda* in the lung (one case) and kidney (two cases); *Edwardsiella* sp. in the smear from an abscess (one case); *Escherichia coli* in the lung, liver and intestinal lymph node (in two cases), in the kidney (four cases), and spleen (three cases); *Staphylococcus aureus* in the liver and intestinal lymph node (in one case), in kidney (two cases), and spleen (five cases); *S. epidermidis* in the kidney (one case) and spleen (two cases); *Vibrio proteolyticus* (*Aeromonas hydrophila* subsp. *proteolitica*), *Streptococcus* sp. and *Candida* sp. in the lung (in one case).

8. Material from Bulgarian waters (near Primorsko and between Shabla and Kaliakra Capes) was isolated from five individuals and contained only *S. epidermidis* in lung (three cases), liver (two cases) and kidney (four cases), and *S. aureus* in the lung (one case).

9. There is no precise information on the method of microbial penetration into the wild harbour porpoises. The intrusion of microorganisms from sea water during the contact of marine mammals with the marine environment may be one of the existing ways (Birkun and Miloserdova, 1989; Lukina, 1997, etc.). On the other hand, the significant decline in bacterial pollution in the Black Sea coastal zone near the Crimea during recent years (Bespaly *et al.*, 2000) did not lead to any real alteration in microbial infection of marine mammals. In this light, it is necessary to include a complex microbiological analysis of the marine environment and biota into the following research to clarify the nature of inter-specific relations in this sphere.

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Table 1 - Microbiological material from harbour porpoises (*Phocoena phocoena relicta*)

Residence of animals	Microorganisms	Location (number of cases)							
		Lung	Liver	Kidney	Spleen	Intestinal lymphnode	Abscess	Umbilical cord	In total
Ukrainian waters (38)	*Sarcina* sp.	1	3		1	1	1	1	8
	Proteus mirabilis		1	1					2
	Proteus vulgaris	2							2
	Edwardsiella tarda	1		2					3
	Edwardsiella sp.						1		1
	Escherichia coli	2	2	4	3	2			13
	Staphylococcus epidermidis			1	2				3
	Staphylococcus aureus		1	2	5	1			9
	Vibrio proteolyticus (Aeromonashydrophila subsp. *proteolitica)*	1							1
	Streptococcus sp.	1							1
	Candida sp.	1							1
Bulgarian waters (8)	*Staphylococcus aureus*	1							1
	Staphylococcus epidermidis	3	2	4					9
In total		13	9	14	11	4	2	1	54

Table 2 - Versions of mixed infection in harbour porpoises (*Phocoena phocoena relicta*) and their distribution

Residence of animals	Bacteria	Lung	Liver	Kidney	Spleen	Intestinal lymphnode	Umbilical cord	Number of cases
Ukrainian waters (38)	*Sarcina* sp.	+	+					1
	Escherichia coli	+		+				3
	Edwardsiella tarda *Proteus vulgaris*	 +		+ 				1
	Escherichia coli *Edwardsiella tarda* *Proteus vulgaris*	 +		 + 	+ 			1
	Edwardsiella tarda *Staphylococcus epidermidis*	+ 		 +				1
	Staphylococcus aureus *Sarcina* sp.		 +		+ 	 +		1
	Vibrio proteolyticus *Staphylococcus aureus*	+ 				 +		1
	Staphylococcus aureus *Sarcina* sp.			+ 			 +	1
	Proteus mirabilis *Escherichia coli*	 +	+ 					1
	Staphylococcus aureus *Escherichia coli*			+ +				1
	Staphylococcus aureus *Staphylococcus epidermidis*	+ 	 +	 +				1
Bulgarian waters (8)	*Staphylococcus epidermidis*	+	+	+				1
	Staphylococcus epidermidis	+		+				1
In total								15

AGE AND GROWTH OF STRANDED COMMON DOLPHIN (*DELPHINUS DELPHIS*), STRIPED DOLPHIN (*STENELLA COERULEOALBA*) AND HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) ALONG THE GALICIAN COAST (NW SPAIN)

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A total of 673 common dolphins (*Delphinus delphis*), 82 striped dolphins (*Stenella coeruleoalba*), and 101 harbour porpoises (*Phocoena phocoena*) were found stranded along the Galician coast between 1990 and 1999. Tooth samples from 108 common dolphins, 17 striped dolphins and 16 harbour porpoises were analysed for ageing studies. Methods for these purposes were adapted from Hohn & Lockyer (1995). Teeth were cleaned with a 5% pepsin solution and then soaked in the decalcifying agent RDO. Sections were cut at 20 mm using a freezing microtome. Optimum sections were selected from each tooth for counting annual rings.

In common dolphins, estimated age ranged from 1 to 15 in females and from 1 to 12 in males, with age class 2 being the most abundant in females, and age class 3 in males. First-year animals have a size range from 106 to 167 cm for females and from 109 to 124 cm for males. The maximum age recorded in the sample was 15 years for a female common dolphin of 209 cm total length.

Regarding striped dolphins, age data were available for 17 animals. Estimated age ranged from 1 to 23 years, with age class 3 being the most abundant. First year animals have a size range between 104 and 132 cm. The maximum age recorded in the sample was 20 years for a male striped dolphin of 213 cm total length.

Size range for harbour porpoises varied from 106 and 185 cm total length. Ages ranged from 1 to 7 years. The maximum age corresponded to a male of 166 cm total length. Ecological implications of the stranded animals age of these three marine mammal species are discussed in the presentation.

DIET OF HARBOUR PORPOISE *(PHOCOENA PHOCOENA)* IN DANISH WATERS

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INTRODUCTION There are several key questions regarding the diet of Danish harbour porpoises. What do they eat? How much do they eat? Are there differences within an area through time, or differences between areas or between age classes and life history events (e.g. pregnant females versus resting females)? For some of these questions, such as what species are eaten and how much, we can provide answers, but others we still know very little. Answers may help to discover how porpoises are distributed in relation to prey, and also why they are frequently taken as by-catch in bottom-set gillnets.

SAMPLING AND METHODS

Collection of samples

Porpoise carcasses resulting from by-catches in the commercial Danish fleet have been recovered through the existing discard observer scheme, with observers on various vessels operating different gears. However, the main gear type of interest in porpoise by-catches is the bottom-set gill-net. Reports are made using standardised reporting forms, and a compensation of DKK 400 is paid for each intact carcass, and DKK 250 for each data report and jaw / head only, accompanied with by-catch location, net-type, date, etc. By-catches and strandings are also recovered through co-operation with the Fjord and Belt Centre and "Fokus på hvaler" strandings scheme in Denmark. By-caught and stranded porpoises originated from ICES areas IIIa, IIIb, IIIc, IIId and IVb (Fig. 1).

General investigations

Full necropsy reports are made out, and sex, length, girth, blubber thickness, body and organ weights recorded, along with stomach contents and weight, parasite and health status; pathological samples are collected where disease is evident, reproductive organs for maturity status, and teeth for age estimation.

Diet investigations

Stomach contents are investigated for prey composition both by species and subsequently by age/size class. The stomachs are weighed full, then washed out, and food items recovered in a series of graded sieves, and then weighed again empty. Both soft and hard remains of prey (fish eye lens, bones, otoliths, squid beaks, etc.) are used for dietary identification. Size of otoliths and squid beaks can be used to assess relative size/age of prey species. Food remains are stored in 70% alcohol and otoliths are stored dry.

RESULTS

1) Prey analysis The samples comprised material from three geographical areas during the period 1997-99 inclusive. There were 17 porpoises from Skagerrak, Kattegat, and Sound waters, 45 from Inner Danish waters, and 38 from the central North Sea. Both sexes were represented, but females formed only 25-43% of any sample. In all areas, immature animals comprised between 60–82.5% of the sample. The imbalance in sex and maturity status of the animals in the stomach samples merely mimics the imbalance in the recovered carcass samples, where there is always a preponderance of males and juveniles (Lockyer and Kinze, 1999). The results of dietary analysis are shown below by ICES areas by fish type, by percentage frequency of otoliths (Fig. 2), and proportion (Fig. 3).

The most common fish type found is the gadoid (cod-type) fish (25-51%) in all areas, while other types vary in amount. Clupeid (herring) types appear to be taken in all areas (up to 9%) – when available. These two families are generally mid-water pelagic fish, but gadoid fish are also bottom-living. The remaining fish types, apart from scombrid species (mackerel) – under "unspecified" in Fig. 2, and not shown in Fig. 3, are generally bottom-living, and may be taken opportunistically. The presence of gobies (27-56%), sandeels (Ammodytidae) (7-42%), blennies and eels correspond with the observations on "bottom-grubbing" behaviour, where porpoises search vertically head-down on the seabed for fish (Fig. 4). Clearly, porpoises are bottom-feeders in some areas, and this is corroborated by the "bottom-grubbing" habits documented here. This habit has serious implications in fishery management in relation to by-catch mitigation because of the increased likelihood of entanglement with bottom-set nets.

2) Quantity of food Stomach contents of porpoises from both the North Sea and Inner Danish waters, derived from by-catches and strandings, were examined. These were both weighed and sorted acoording to prey type (as indicated in the graphs). The results of weight indicated that stranded animals rarely if ever had little food remains, and that in the by-caught animals, the prey composition did not necessarily bear relation to the fish species targetted in the net fishery in which they were taken. The amounts present in the stomach (chiefly the first chamber) are presented in Table 1, and indicate that a maximum stomach fill approximates to about 1 kg whole food in animals >120 cm in length. This corresponds well with the report that adult porpoises in human care eat up to 1 kg fish per meal; the daily ration being 3.5-5.5kg (*ca.* 7-10 % body weight) (Lockyer *et al*, 1999).

DIFFERENCES BETWEEN GEOGRAPHICAL AREAS, SEASON, AND SEXES

Geographical areas Figs 2, 3 and 5 show that while there are generally common prey preferences in all areas, some fish are scarce or absent and others may predominate in certain localities. Fig. 5 illustrates both the percentage frequency of particular fish otoliths and also the percentage occurrence, regardless of number of otoliths found. The main species in all areas are gadoid fish (cod and mullet), gobid fish (gobies) and ammodytid (sandeel). Pleuronectidae (plaice and flatfishes) and Solenidae (soles) are infrequent, and generally only feature in Area IVb. Ammodytid species are most popular in area IVb (North Sea), clupeid fish (herring and sprats) are more popular in areas IIIa and IIIb (Skagerrak, Kattegat and Sound) where gadoid fish are also most featured. Gobidae appear to be more popular in areas IIIc and IIId (mainly Inner Danish waters). Unspecified species also include mackerel, eels, and blennies. These differences may reflect local abundance and availability of prey. They do not reflect seasonal differences, as we show below.

Season We could not test for seasonal differences because the majority of by-catches come from the third quarter of the year (late summer - autumn) – Vinther (1999). This is also a busy period for strandings, especially for young of the year which frequently die shortly after birth, and also for discarded by-catches that wash up on beaches in all areas (Lockyer and Kinze, 1999). Thus all samples are generally from the same time of year and should be comparable regarding season.

Sexes ICES areas IIIc and IIId have been chosen to investigate potential sex differences in diet because the sample size is largest. The predominant fish types are gobies for both sexes, but males appear to take more cod-type fish and females more sandeels (Fig. 6). Although not tested, this could reflect differences in energy intake and requirements.

CONCLUSIONS The preliminary findings here do not entirely concur with those reported previously where some dietary differences were also observed between North Sea and Inner Danish waters. Overall, gadoids were the most important prey items (found in 62% of the stomachs) followed by clupeids (35%), gobids (30%), and ammodytids (30%) – Lockyer and Kinze (1999). It is worth noting that herring-type fish comprised a more substantial part of food consumption in these earlier years (mainly 1980s and early 1990s), and also that Eschricht (1849) reported that in Danish waters, herring *(Clupea harengus)* was the main prey species at that time, in contrast to the very low intake (1-9%) observed today. This clearly reflects a dietary switch over time because of changed prey availability. It must also reflect a decrease in potential energy intake because cod-type fish have a lower energy density than herring. A question remains over possible seasonal dietary patterns, and it appears that investigation of dietary preferences by sex is worth continuing.

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Table 1. Quantities of food remains in harbour porpoise stomachs: North Sea (ICES area IVb) and Inner Danish waters (ICES area IIIc).

ORIGIN OF ANIMAL	MEAN WEIGHT FOOD, G ± S.E.	RANGE WEIGHT FOOD, G	NO STOMACHS EXAMINED
STRANDED FEMALES	14.3 ± 6.7	0 – 31.0	4
STRANDED MALES	11.3 ± 5.9	0.02 – 43.0	18
BY-CAUGHT FEMALES	217.5 ± 63.6	0.03 – 983.0	8
BY-CAUGHT MALES	145.1 ± 31.4	0 – 717.0	30
TOTAL	172.3 ± 30.9	0 – 983.0	60

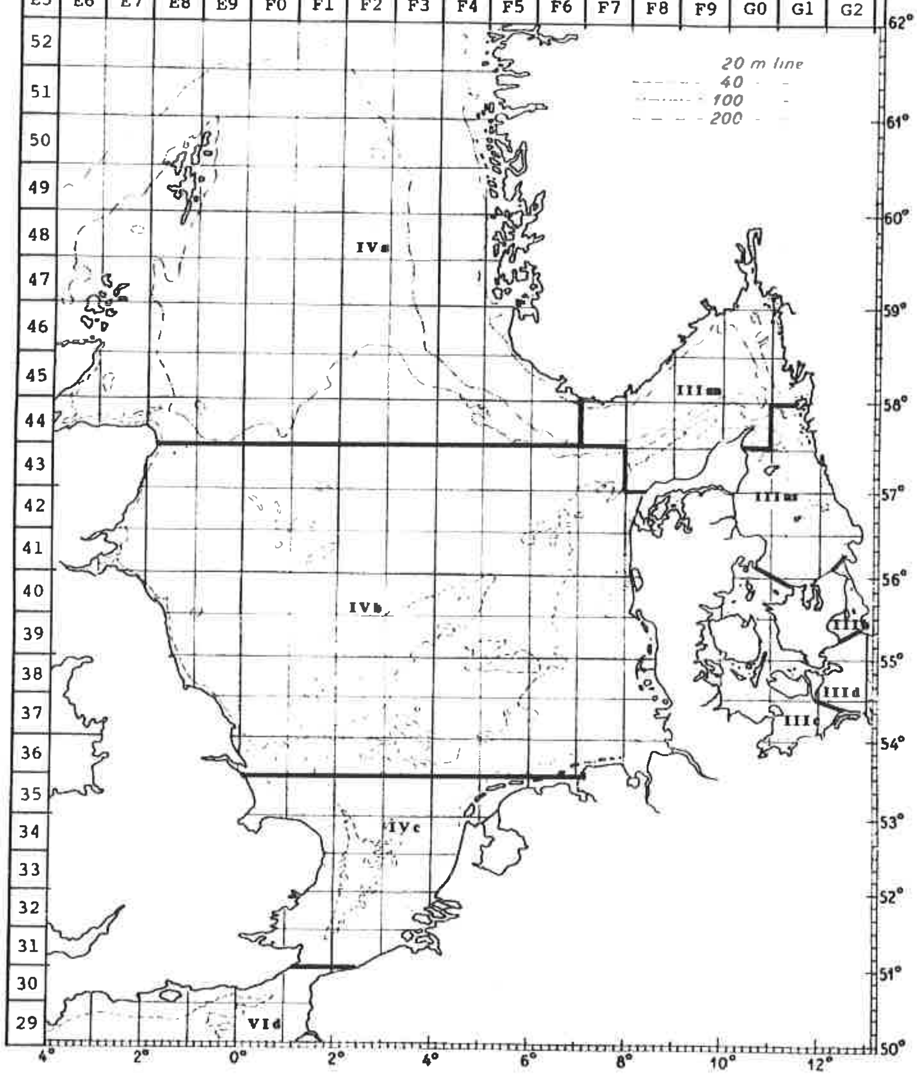

Fig. 1. Map of the North Sea and Inner Danish waters, together with ICES areas and squares, latitude North and longitude West and East.

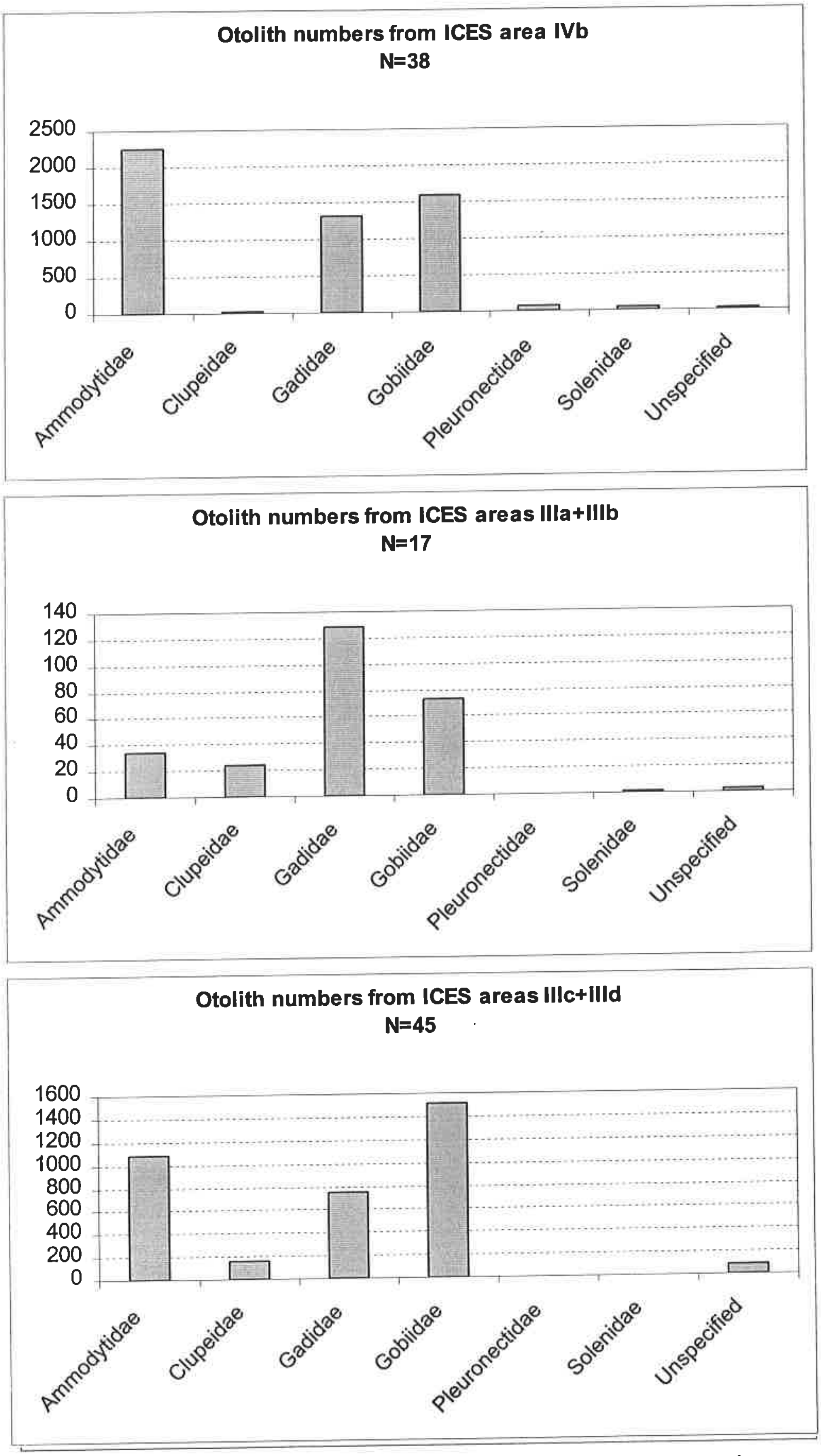

Fig. 2. Frequency distribution of otoliths by fish family recovered from harbour porpoise stomachs.

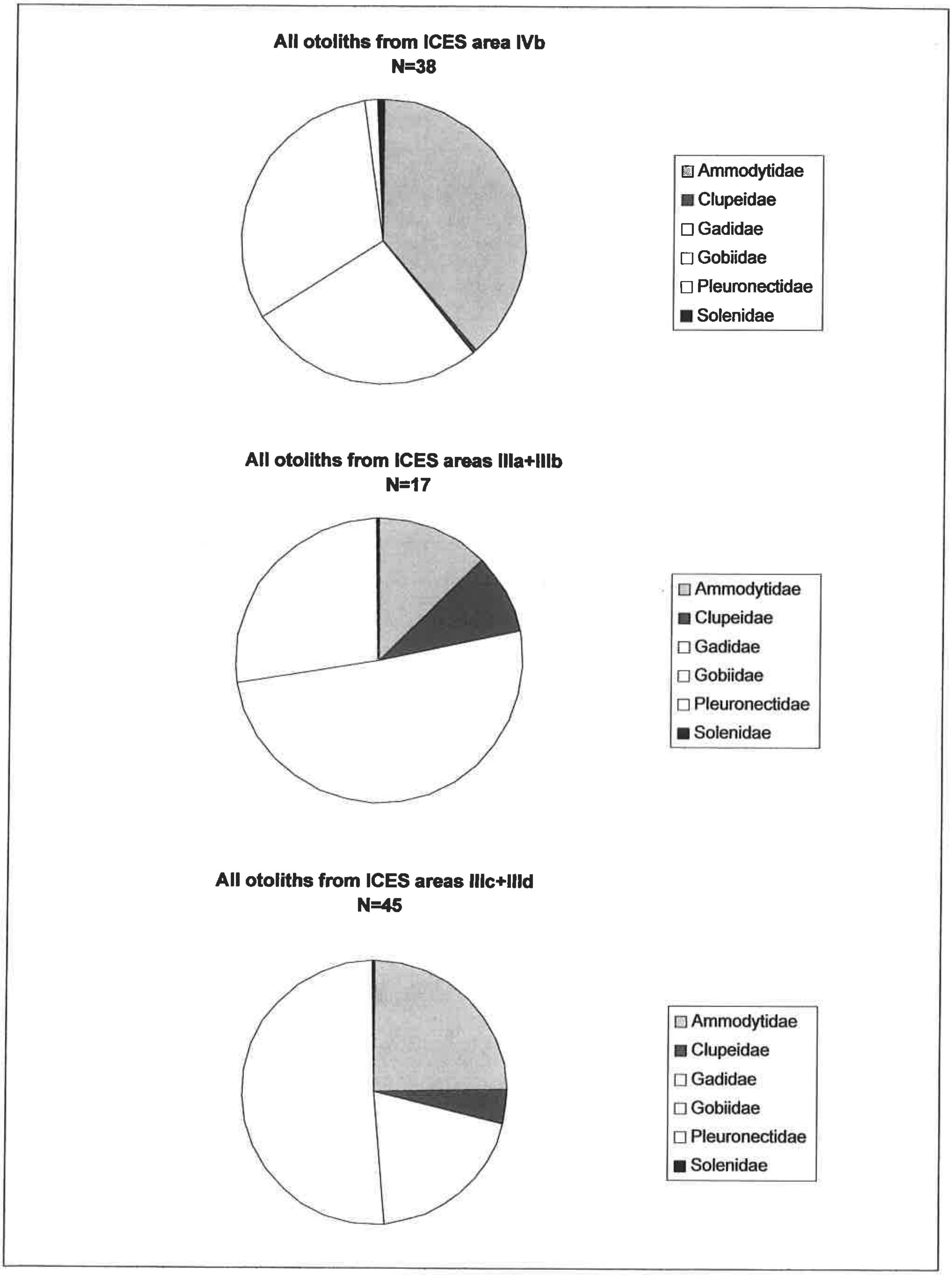

Fig. 3. Proportion of otoliths by fish family type recovered from harbour porpoise stomachs

Fig. 4. Harbour porpoise "bottom-grubbing" for live fish, as seen through an underwater viewing window at the Fjord and Belt Centre, Kerteminde, Denmark. (Photo credit: EPIC project no DG XIV 97/0006.)

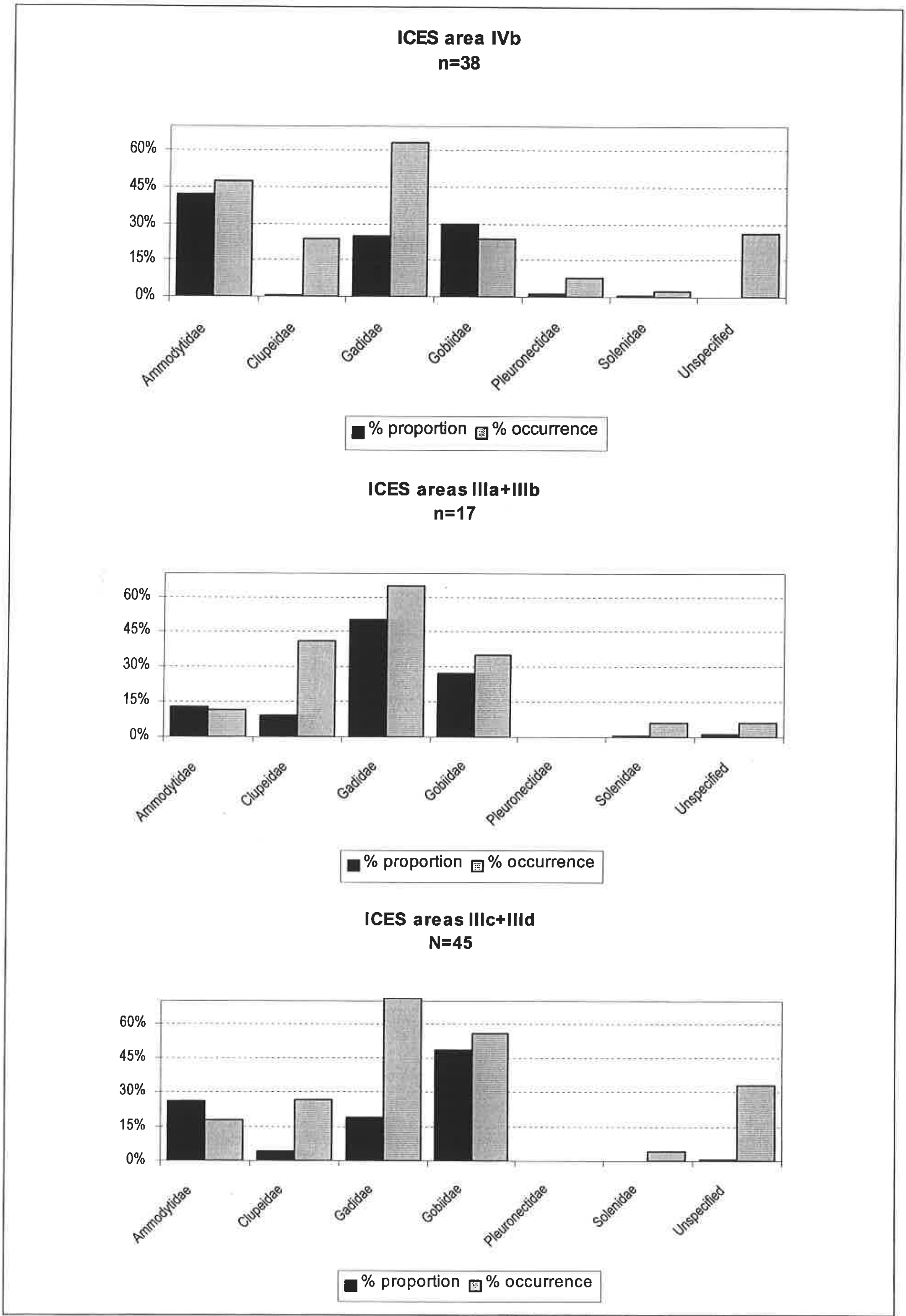

Fig. 5. Proportion and frequency of occurrence of otoliths by fish family and type recovered from harbour porpoise stomachs.

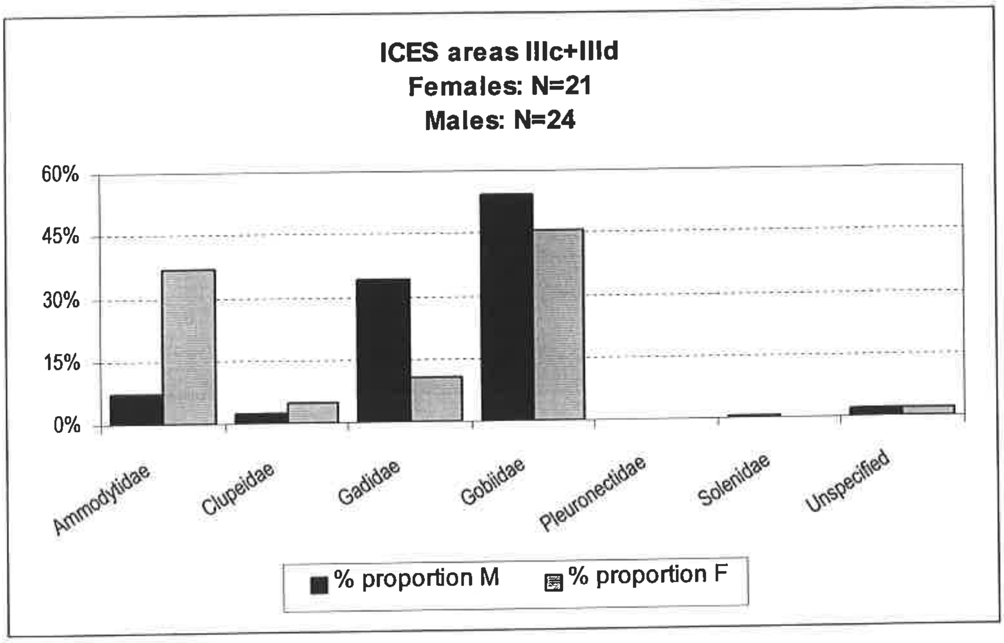

Fig. 6. Prey preferences of porpoise by sex determined from stomach content analysis of fish otoliths.

BOTTLENOSE DOLPHINS IN THE GALVESTON BAY ESTUARY: WHAT IS DRIVING DISTRIBUTION PATTERNS?

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Bottlenose dolphins (*Tursiops truncatus*) occur in many marine ecosystems, including estuaries. Estuaries show gradients of salinity, temperature, and current patterns that influence distribution of organisms, including fish. Approximately 1,000 bottlenose dolphins occur in the Galveston Bay Estuary, Texas. Preliminary studies indicate that distribution is not uniform and that feeding is their main activity (42%), approximately 50% of that being in association with shrimpers. To investigate what are the main factors influencing bottlenose dolphin distribution in Galveston Bay, we selected two subsystems differing in salinity (West Bay and Lower Galveston Bay), which is known to be an important factor in determining prey distribution. The Lower Galveston Bay was further divided into four areas with different physiography, distance to Bay-Gulf passages, intensity of shrimping and boat traffic (Galveston Ship Channel, Back Bay, Bolivar Road, Houston Ship Channel). Boat-based surveys will be carried out in these areas for two years. From 28 July to 18 December 2000, a total of 42 surveys were carried out. We used pre-defined routes to estimate dolphin and shrimper relative density in all five areas. For each group sighted, we used scan-sampling at 5-minute intervals to document number of dolphins and activity. Environmental parameters (sea state, wind, depth, turbidity, salinity and water temperature at the surface) and number of boats were recorded during sightings and at fixed stations. We suggest that distribution is influenced by a combination of abiotic, biotic factors, and anthropogenic activities that optimise feeding. This study is expected to contribute to a better understanding of habitat use by coastal dolphins, and to a more general assessment of habitat requirements for coastal dolphins. This project was funded by Fundação para a Ciência e Tecnologia, PRAXIS XXI/BD/16224/98 and Fulbright.

WHERE ARE MEDITERRANEAN FIN WHALES BORN?

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The Italian coastline represents a significant portiion of the Mediterranean coasts, and covers a latitudinal range of about 12 degrees (in respect of about 17 for the entire Mediterranean). Cetacean strandings can therefore give information on possible N-S migrations of these marine mammals. A debate is open on fin whales *Balaenoptera physalus*, regarding the possibility that some groups are permanently associated with a particular area, such as that of the Ligurian Sea Marine Sanctuary, or that they are obliged to migrate N – S for reproductive purposes. In the latter case the renewal of trophic resources within their ecosystem could be facilitated. Strandings data collected by the Centro Studi Cetacei of the Società Italiana di Scienze Naturali over the period 1986-97 were used to verify times and geographical positions of very young individuals. French records on stranding along the Provençe-Côte d'Azur and Corse coasts were also added (1992-98). Even if the stranded fin whales were not numerous, they mainly consisted of young individuals. Those in the size range of about 5-10 m TL (N=15) were considered new-born or suckling, and were used to map possible calving areas. It was verified that such young individuals occur all year round and in all Italian seas, excluding the Ionian Sea and the Sicily Straits. The majority of them (N=11) are located in a central area, which is mapped with its temperature characteristics during the different seasons.

21 CETACEAN SPECIES OFF LA GOMERA (CANARY ISLANDS): POSSIBLE REASONS FOR AN EXTRAORDINARY SPECIES DIVERSITY

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INTRODUCTION To date, 26 cetacean species are known to inhabit or visit the waters of the Canary Islands (Ritter and Brederlau, 1998), making the archipelago an important area for cetacean observation.

La Gomera (17°15'W - 17°21'W and 28°1'N - 28°14'N) lies about 400 km off the West African mainland in the Atlantic Ocean and belongs to the western Canary Islands. The islands are steep volcanoes surrounded by deep waters close to the coast. Some authors see the oceanographic circumstances as an absence of a shelf (Martin *et al.*, 1992). In the western part of the archipelago, the sea-bottom drops steeply to about 4.000 m into the Canaries basin (Rothe, 1986).

In the south-west of La Gomera, a depth of 2000 m occurs only a few kilometres away from the coast. The climate is mainly determined by the island's position in the north-eastern trade-wind. Water temperatures are approximately 22-24°C in summer and 17-19°C in winter. These temperatures are lower than might be expected for a subtropical region, mainly due to the cold upwelling off West Africa and the cooler Canaries Current (Fernandopullé, 1976).

METHODS The platform for the collection of data were small former fishing boats now being used as whale-watching vessels and operating in the south-west of the island. From 1 September 1995 to 31 January 2000, sightings data were collected during regular whale-watching trips, usually taking place once or twice a day according to sea state and tourist demand.

The sea was scanned by eye for cetaceans by one or two experienced observers. In case of a sighting, data collection began with identifying species to the lowest possible taxa. It also included date, time, position (by GPS), sea state, group size, depth (using a Spanish sea chart SP 517, Instituto Hidrografico, Cadiz, 1995), and the duration of the encounter. Also, the duration of 126 whale-watching trips was determined, which was used to calculate the total sighting effort by multiplying the mean value with the total number of trips.

Additional observations of cetacean sightings were communicated by the whale-watching skippers for the period from 1994 until 1999.

RESULTS From 1 September 1995 to 31 January 2000, 1104 whale watching trips were conducted and 1116 sightings were made. Sighting effort totalled 4306 hours. Whale-watching trips lasted a mean of 3h 54 min (range 37 min - 12h 45 min, n=126). Mean sighting success per month ranged from 55% in November to 96% in April. Fifteen cetacean species could be identified. Moreover, during the period from June 1998 to January 1999, three more species - the Fraser's dolphin (*Lagenodelphis hosei*), the northern right whale (*Eubalaena glacialis*), and the humpback whale (*Megaptera novaeangliae*) were encountered (B. Brederlau, *pers. comm.*). Additionally, the skipper of another whale-watching boat operating in the area reliably reported the sighting of a northern bottlenose whale (*Hyperoodon ampullatus*) in August 1997 (E. Koolmuus, *pers. comm.*). One more report comes from 1994, when orcas (*Orcinus orca*) were encountered and photographed on one day in April (P. Stallbaum, *pers. comm.*).

A complete list of these 21 species, along with the number of sightings, is given in Table 1. The species comprise three mysticete families and seven odontocete families of cetaceans. Six species were seen regularly, i.e. year-round: bottlenose dolphin (*Tursiops truncatus*), short-finned pilot whale (*Globicephala macrorhynchus*), Atlantic spotted dolphin (*Stenella frontalis*), rough-toothed dolphin (*Steno bredanensis*), striped dolphin (*Stenella coeruleoalba*), and Blainville's beaked whale (*Mesoplodon densirostris*, Ritter and Brederlau, 1999), the other species showed up only sporadically. For seven species, the number of sightings was less than ten, with seven species encountered only once (see Table 1). Two species showed a notable seasonality: common dolphin (*Delphinus delphis*), which was observed only from December to May, and Risso's dolphin (*Grampus griseus*), which were only seen during February through June.

The bottlenose dolphin (375 sightings, 32%) is the most frequent cetacean off La Gomera, followed by the short-finned pilot whale (171, 15%.), and the Atlantic spotted dolphin (164, 15%.). Figure 2 shows the relative abundance of cetaceans off La Gomera, demonstrating that the four most abundant species represent 74% of all sightings.

There was a distinct peak in the seasonal abundance of cetaceans with March, April, and May being the months with the most sightings (see Fig. 1). Particularly during April and May, the relative number of sightings was very high and sighting success was never less than 85 %. All of the highest values for sighting success were recorded for April. The month with the lowest average sighting success was November. The sighting frequencies of the three most abundant species, along with the common dolphin, showed the same trend, with most of the sightings being made from March through May.

Only two species were seen close to the shoreline within less a few hundred metres: the bottlenose dolphin quite regularly, and the rough-toothed dolphin on rare occasions. All other species were found more offshore in deep waters. The species differed notably concerning the average values for distance from the coast, water depth and group size. Of the species regularly seen, striped dolphins were found most far offshore with a mean of 4.11 nm and an average depth of 976 m, followed by the short-finned pilot whale (4.05 nm, 932 m). The Atlantic spotted dolphin showed by far the largest mean (82.8) and total (650) group size. Descriptive statistics of the sightings are given in Table 2.

A seasonal variation of group size was found in the Atlantic spotted dolphin, and again there was a peak in the spring. The number of species encountered per month (range 7-13) was also highest in April.

DISCUSSION The number of 21 cetacean species without doubt appears very high. Taking into account the small size of the study area (roughly 100 nm^2), it delineates an area of high species diversity. Up to now, 81% of the species recorded for the Canary Islands, and 64 % of the species recorded for the North-east Atlantic Ocean (see Carwardine, 1995) were observed off La Gomera. A comparison with other island archipelagos in the Atlantic Ocean underlines the fact that such areas represent significant habitats for great numbers of cetacean species: Simas *et al.* (1998) and Steiner *et al.* (1998) found 25 and 18 species, respectively in the Azores, Reiner *et al.* (1996) counted 13 species in the Cape Verde islands.

Especially during spring, the waters off La Gomera seem to concentrate large numbers of cetaceans, both on the species level and the total number of animals. However, the reasons for this concentration are not known. We do not know if the south-west, representing the lee side of the island during most of the year, differs greatly from other areas around Gomera, as conditions for observing cetaceans usually are too rough there. Also, we do not know if this situation holds for other islands of the Canary Archipelago. The area south-west off Tenerife is known to be inhabited by a population of short-finned pilot whales (Heimlich-Boran, 1993). High density of squid, a main prey of pilot whales (Hernandez-Garcia and Martin, 1994), has been suggested as the reason for this residency, but a corresponding proof is missing (Heimlich-Boran, 1993). In the same area, many other cetacean species can be seen (Escorza *et al.*, 1992; Urquiola *et al.*, 1997). A variety of species was found off Lanzarote (Politi *et al.*, 1996), suggesting that a greater number of species can be found all over the archipelago. But data for the other Canary Islands are scarce.

Observational data (Ritter, 1996, unpublished data) indicate that in several delphinid species, surface-feeding activities are more frequently observed off La Gomera during springtime (predominantly March and April) than during other seasons. Also, the main season for the local tuna fishery is in spring. Since tuna occupies a similar position in the food web as do many delphinids, that is another indication for high prey availability during this period.

For many cetacean species, a relationship between distribution and oceanographic features has been reported (e.g. Balance *et al.*, 1998; Evans, 1994; Maze and Würsig, 1998; Perrin *et al.*, 1994; Tynan, 1998). For the short-finned pilot whales off Tenerife, a correlation of distribution and sea surface temperature was found (Montero and Arechavaleta, 1996). Thus it seems reasonable that, during spring, the oceanographic conditions off La Gomera favour high productivity, hence elevated abundance of cetacean prey species and consequently high cetacean abundance in the study area. The main question is: what are the reasons for high productivity, as it is known that the Canary waters usually are oligotrophic, and there is a large mesoscale variability in chlorophyll distribution throughout the archipelago (Aristegui *et al.*, 1997).

The Canary islands lie in a transition zone between the Northwest African coastal upwelling area and the open ocean of the subtropical gyre (Aristegui *et al.*, 1997). Filaments containing upwelling water masses can spread far offshore the African coast (Van Camp *et al.*, 1991) and reach the archipelago. This accounts especially for summer and autumn, when upwelling is strongest north of 25° (Hernandez-Guerra and Nykjaer, 1997). However, the highest near surface values for chlorophyll (>0,5 mg chl a/m^3) are found in March, coinciding with the erosion of the thermocline, i.e. the maximum penetration of the surface mixed layer. Consequently, there is a late winter phytoplankton bloom apparent from January through March (Aristegui *et al.*, 1997).

The Canary Islands - seen as obstacles in a permanent current system such as the Canaries Current - also generate cyclonic and anticyclonic eddies "downstream" of the land-masses (Aristegui *et al.*, 1997). This is a general and recurrent phenomenon in the archipelago, acting as an important source of primary production and generating much of the high phytoplankton biomass during most of the year (Aristegui *et al.*, 1997).

Another possible factor is the island mass effect, leading to the concentration of nutrient-rich waters in the lee side of islands, thus increasing the development of the trophic chain (Hernandez-Léon, 1986; Escorza *et al.*, 1992).

One more influence may be that the islands convey trace elements (such as Fe, Ni, Zn, etc) which may act as limiting factors in the open sea (Cullen, 1991; Martin *et al.*, 1991). As an example, a large increase of chlorophyll in the vicinity of the Galapagos Islands is suspected to relate to the iron input by the islands (Martin *et al.*, 1991).

All these components may interact with each other (e.g. the island mass effect with upwelling filaments and/or cyclonic eddies, etc.), making the situation even more complex. Only direct investigation of the oceanographic and biological parameters such as the plankton and nutrient composition, along with regular cetacean surveys in the archipelago, will help to answer these puzzling questions. Revealing the dynamics of such complex scenarios like the interplay of oceanographic and biological processes needs major interdisciplinary co-operation.

Finally - since we are not aware of any other small area with such a variety of cetacean species, the Association M.E.E.R. proposes to apply protection status to the waters off La Gomera, so as to avoid adverse developments like excessive expansion of whale-watching activities or negative impacts through rapidly growing mass tourism on La Gomera. A protection status greatly enhances public awareness, which is a pre-condition for humans dealing responsibly with their natural environment.

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Table 1: Complete list of cetaceans species encountered off La Gomera (1994-2000).

		(No. of sightings)
	A. Odontocetes:	
1	Bottlenose dolphin (*Tursiops truncatus*)	(375)
2	Short-finned pilot whale (*Globicephala macrorhynchus*)	(171)
3	Atlantic spotted dolphin (*Stenella frontalis*)	(164)
4	Rough-toothed dolphin (*Steno bredanensis*)	(133)
5	Common dolphin (*Delphinus delphis*)	(61)
6	Blainville's beaked whale (*Mesoplodon densirostris*)	(40)
7	Striped dolphin (*Stenella coeruleoalba*)	(30)
8	Cuvier´s beaked whale (*Ziphius cavirostris*)	(7)
9	Risso´s dolphin (*Grampus griseus*)	(6)
10	Sperm whale (*Physeter macrocephalus*)	(5)
11	False killer whale (*Pseudorca crassidens*)	(2)
12	Pygmy sperm whale *(Kogia breviceps)*	(1)
13	Orca (*Orcinus orca*)	(1)
14	Fraser´s dolphin (*Lagenodelphis hosei*)	(1)
15	Northern bottlenose whale *(Hyperoodon ampullatus)*	(1)
	B. Mysticetes:	
16	Sei whale (*Balaenoptera borealis*)	(73)*
17	Bryde´s whale (*Balaenoptera edeni*)	?
18	Fin whale (*Balaenoptera physalus*)	(5)
19	Blue whale (*Balaenoptera musculus*)	(1)
20	Northern right whale (*Eubalaena glacialis*)	(1)
21	Humpback whale (*Megaptera novaeangliae*)	(1)

* Sightings of sei and Bryde´s whales were pooled due to the difficulty to distinguish between these two species.

Table 2: Descriptive statistics of the 11 most abundant cetacean species off La Gomera

a) Distance to coast (nm)

SPECIES	Mean	SD	Min	Max	n
Bottlenose dolphin *(Tursiops truncatus)*	2,36	1,68	0,01	8	238
Short-finned pilot whale *(Globicephala macrorhynchus)*	4,05	1,38	1,5	8	114
Atlantic spotted dolphin *(Stenella frontalis)*	3,97	1,79	1	11	104
Rough-toothed dolphin *(Steno bredanensis)*	2,19	1,43	0,01	8	67
Common dolphin *(Delphinus delphis)*	3,69	1,57	1	10	54
Dense beaked whale *(Mesoplodon densirostris)*	2,74	1,29	0,3	5	26
Striped dolphin *(Stenella coeruleoalba)*	4,11	1,67	1	7	25
Sperm whale *(Physeter macrocephalus)*	5,06	2,00	2,8	7	5
Sei whale *(Balaenoptera borealis)*	5,70	3,99	1	12	5
Risso´s dolphin *(Grampus griseus)*	4,18	3,19	0,5	8	4
Cuvier´s beaked whale *(Ziphius cavirostris)*	5,08	1,58	3	6,8	4

b) Depth (m)

SPECIES	Mean	SD	Min	Max	n
Bottlenose dolphin *(Tursiops truncatus)*	440	450	10	2150	216
Short-finned pilot whale *(Globicephala macrorhynchus)*	932	467	200	2500	108
Atlantic spotted dolphin *(Stenella frontalis)*	955	562	100	2500	98
Rough-toothed dolphin *(Steno bredanensis)*	429	490	30	2500	62
Common dolphin *(Delphinus delphis)*	639	407	150	1750	56
Dense beaked whale *(Mesoplodon densirostris)*	412	378	100	1500	22
Striped dolphin *(Stenella coeruleoalba)*	976	606	150	2250	21
Sperm whale *(Physeter macrocephalus)*	1125	691	350	2000	4
Sei whale *(Balaenoptera borealis)*	1098	696	90	2000	5
Risso´s dolphin *(Grampus griseus)*	850	699	150	1500	4
Cuvier´s beaked whale *(Ziphius cavirostris)*	1275	737	200	1800	4

c) Group Size

SPECIES	Mean	SD	Min	Max	n
Bottlenose dolphin *(Tursiops truncatus)*	14,3	13,1	1	80	230
Short-finned pilot whale *(Globicephala macrorhynchus)*	23,7	10,6	5	53	111
Atlantic spotted dolphin *(Stenella frontalis)*	82,8	181,9	1	650	103
Rough-toothed dolphin *(Steno bredanensis)*	17,7	12,5	1	45	64
Common dolphin *(Delphinus delphis)*	36,3	42,8	3	225	44
Dense beaked whale *(Mesoplodon densirostris)*	3,2	2,0	1	9	26
Striped dolphin *(Stenella coeruleoalba)*	37,5	20,7	9	80	27
Sperm whale *(Physeter macrocephalus)*	3,2	2,6	1	6	5
Sei whale *(Balaenoptera borealis)*	2,0	1,2	1	4	5
Risso´s dolphin *(Grampus griseus)*	10,5	4,0	6	18	6
Cuvier´s beaked whale *(Ziphius cavirostris)*	1,8	1,0	1	3	4

FIGURE 1: Number of Cetaceans sightings off La Gomera (1995-2000) per Months

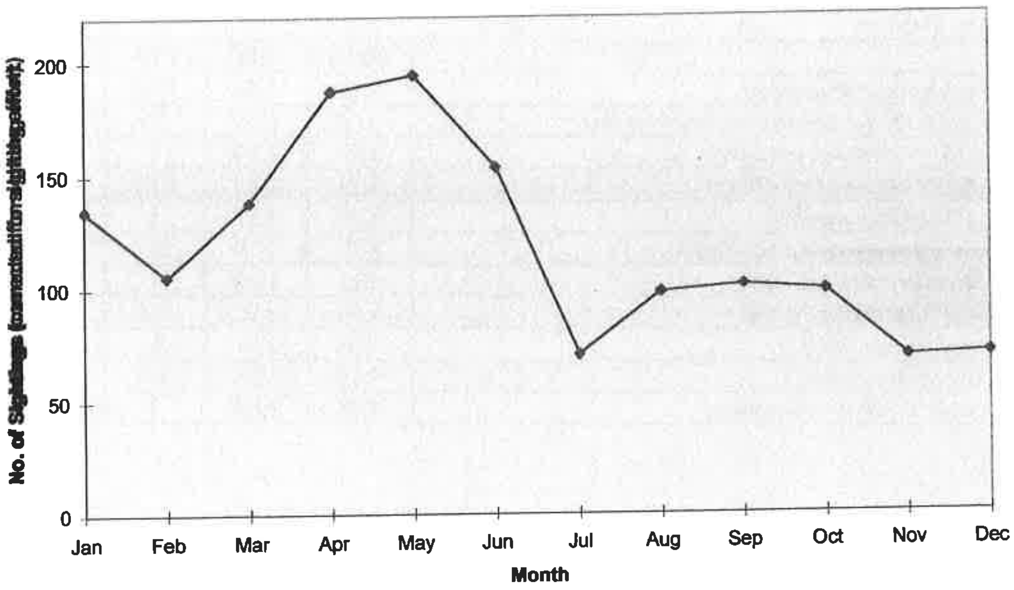
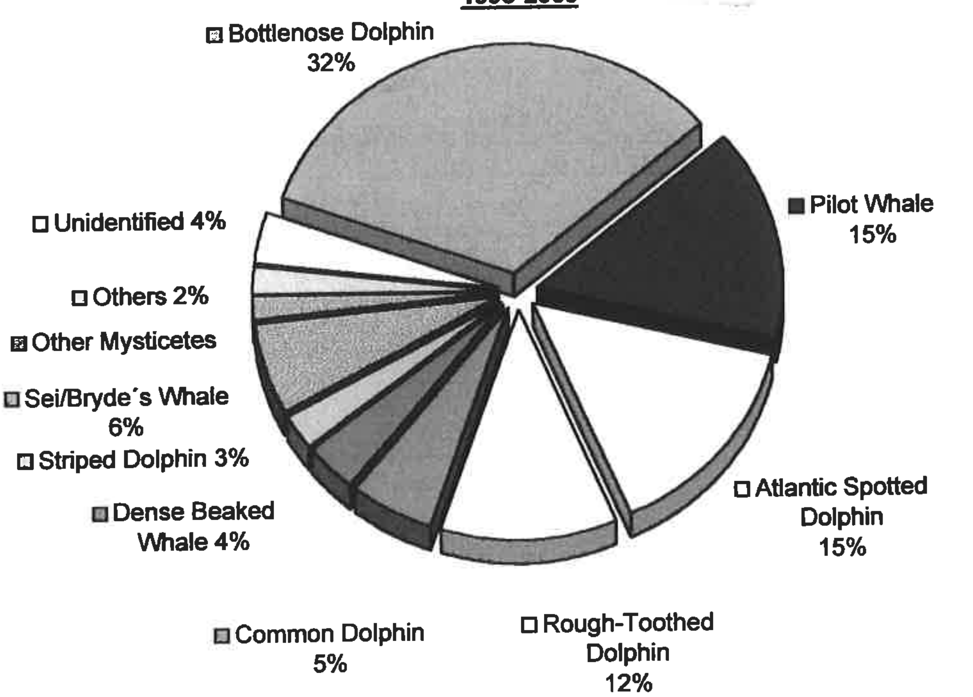


FIGURE 2: Relative Abundance of Cetaceans off La Gomera (Canary Islands) 1995-2000



CETACEANS OF THE CABO FRIO UPWELLING ECOSYSTEM, SOUTHEASTERN BRAZIL: A REVIEW AND COMPARISONS WITH TWO OTHER WESTERN SOUTH ATLANTIC AREAS

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Cetaceans associated with the Cabo Frio upwelling ecosystem (CFUE) were studied since 1998 through boat- and shore-based surveys. The objectives include an evaluation of the nutrient-rich CFUE as critical habitat for cetaceans, and provide information for the management of these waters in relation to existing human pressure, i.e., tourism and oil exploration. Further, we compared the cetacean community associated with the CFUE (23° S) with two others along the Brazilian coast: the north-east coast (5°-10° S) and Abrolhos Bank (17°30'-19° S).

Seven boat surveys covering 744.8 nm were conducted since August 1998, and a shore-based survey was regularly conducted on the top of Pontal do Atalaia (22°58' S, 042°01' W), Arraial do Cabo, from July-Oct 1999 to June-Nov 2000. A total of 188 days and 929.4 hours were spent monitoring cetaceans on the 74 m high Pontal do Atalaia. We compared three aspects of the cetacean community of the CFUE with those of the North-eastern coast (NEC) and the Abrolhos Bank (ABR): species composition, distribution, and relative abundance. We used results from one of the authors (SS) based on surveys during 1988-2000 as well as the available literature.

The CFUE acts as a migratory corridor for humpback and southern right whales which represented ca. 70% of all baleen whales observed. Non-migratory species recorded during shore-based surveys off Arraial do Cabo included: Bryde's whale, orca, long-beaked common dolphin, bottlenose dolphin and Atlantic spotted dolphins. Boat surveys in the CFUE provided new distributional records for four species. The three communities, representing 24 species., were markedly distinct in relation to species composition, distribution, and relative abundance. Species richness is higher in the CFUE (n=18) than the NEC (14) and ABR (8). Only four species were widespread, three were rare, and three were localised. The unique CFUE cetacean community is characterized by species highly associated with upwelling ecosystems.

THE STATUS AND DISTRIBUTION OF BEAKED WHALES (ZIPHIIDAE) IN THE BAY OF BISCAY

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INTRODUCTION Six species of beaked whale (order Cetacea, family Ziphiidae) are known to occur regularly in the North Atlantic (Macleod, 2000). These are northern bottlenose whale *Hyperoodon ampullatus*, Cuvier's beaked whale *Ziphius cavirostris*, Sowerby's beaked whale *Mesoplodon bidens*, Blainville's beaked whale *Mesoplodon densirostris*, Gervais' beaked whale *Mesoplodon europaeus*, and True's beaked whale *Mesoplodon mirus*. All six species have been recorded in the Bay of Biscay (Cresswell and Walker, 1999; Cresswell & Walker, 2001; Gannier *et al.*, 2000). However, due to their apparent rarity, shy nature, and preference for deep offshore waters, references to the distribution of beaked whales in the region are still largely based on a limited number of strandings along the Biscay coasts of France and Spain (Casinos & Vericad, 1976; Castells & Mayo, 1992).

Attempts to ascertain the distribution of beaked whale species based on strandings records are problematic due to the fact that dead cetaceans may be carried on ocean currents for considerable distances before being deposited. The origin of live strandings is equally questionable, as this may involve animals which are sick, having drifted far from their regular range (Macleod, 2000; Weir, 2000). Current knowledge of the status and distribution of beaked whales therefore remains poor, with crude estimates of distribution largely based on a limited number of strandings and post mortem analysis of diet (Olstrom *et al.*, 1993) which has provided indicators of likely habitat preferences.

This paper details information on beaked whale sightings data collated by Organisation Cetacea (ORCA) surveyors during 30 line-transect cetacean surveys of the Bay of Biscay and English Channel between April 1998 and March 2001. During these surveys beaked whales were sighted regularly.

METHODS Between April 1998 and March 2001, ORCA conducted 30 constant effort (continuous) line-transect cetacean surveys of the Bay of Biscay and English Channel from three commercial vessels (platforms of opportunity) and one dedicated survey vessel. Twenty-two surveys were carried out aboard P&O's cruise-ferry 'Pride of Bilbao' which travels along a fixed transect line between Portsmouth (England) and Bilbao (Spain). A further six surveys were conducted aboard Brittany Ferries cruise-ferry 'Val de Loire' which operates a similar, more westerly, fixed route between Plymouth (England) and Santander (Spain). During June 2000, a single cetacean survey was undertaken parallel to the north coast of Spain aboard the cruise liner 'Clipper Adventurer'. Finally, during August 1999, ORCA conducted a dedicated cetacean sighting survey of the southern Bay of Biscay aboard the 40 ft yacht 'Fandango'.

Surveys were carried out by a minimum of two experienced observers on an unlimited distance single line transect. Surveys involved continuous scanning with the naked eye interspersed with occasional scans with binoculars. At half hourly intervals the vessel's position and speed were recorded. Vessel position was recorded using a hand held global positioning system (GPS). At the same time, environmental data including wind direction and force, sea state, swell height, visibility, cloud cover and precipitation were noted throughout the duration of each survey. On sighting a cetacean, a standard recording methodology was adopted. Observers recorded location using GPS, species identity, number of individuals (including age and sex where possible) and behaviour. When conditions allowed, photographs and video footage were taken and analysed in detail. During some surveys, angle and distance measurements to sightings from the transect line were also taken.

SURVEY COVERAGE During 30 constant effort surveys between April 1998 and March 2001, a total of 15,970 km of transect line was surveyed. The majority of these surveys (13,838 km, 86.6%) took place in a sea state of three or below in ideal conditions for locating cetaceans. Sea state during the other 2,132 km of transect survey varied between four and seven. Survey coverage was achieved during nine months of the year, with effort peaking towards late summer (Fig. 1).

RESULTS During the three-year study period, beaked whales were encountered on 55 occasions involving 132 animals. Cuvier's beaked whale was most frequently sighted (23 encounters involving 55 animals), followed by species of beaked whales of the genus *Mesoplodon* (nine encounters involving 28 animals) and northern bottlenose whale (nine encounters involving 25 animals). A further 14 encounters involving 23 animals were identified only to family status (Ziphiidae).

Cuvier's beaked whale: The most abundant and widespread beaked whale (Fig. 3). Regularly recorded beyond the 1,000 m isobath, particularly over deep submarine canyons of the Southern Bay between 43° 30' N and 44° 35' N. Occurs at lower densities over the shelf slope of the Northern Bay between 45° 30' N and 46° 00' N. Cuvier's beaked whale is present throughout the year, suggesting that the population may be resident (Fig. 3).

Northern bottlenose whale: The northern bottlenose whale occupies a similar range to that of the Cuvier's beaked whale (Fig. 3) but is less abundant and highly seasonal (Fig. 2), with all records during late summer (August). All sightings occurred over shelf slope waters of a depth 650 m - 4,000 m between 43° 40' N and 46° 19' N, with the majority of sightings occurring over deep submarine canyons in the Southern Bay.

Sowerby's beaked whale: Recorded with certainty on two occasions; the first (prior to the present study) occurred on 22 August 1995 when two adults were present over the Torrelavega Canyon at an unknown depth. The second sighting, on 23 October 2000, involved three adults over the south-east edge of the Santander Canyon at a depth of 2,100 m (Fig. 3). Both sightings, and a further probable encounter of two on 12 August 1999 close to the 2,000 m isobath, were over the shelf slope of the Southern Bay.

True's beaked whale: Sightings considered to be 'probably' of this species have occurred once during (Fig. 3), and once prior to the present study. One adult was observed breaching on 28 July 1997 followed by two adults (one of which breached 17 times) on 9 September 1999. Grey body colouration, a small rounded melon and a short stubby beak were observed on both occasions. The observers were certain that these encounters were not Sowerby's beaked whale, confirming the presence of a second species of *Mesoplodon* (probably True's beaked whale) in the study area. Both sightings occurred over the shelf slope of the Southern Bay at a water depth of approximately 1,300 m. In addition, sightings involving pods of two and five (including two small calves) on 19 July 1999 and six adults on 6 June 2000, showed some characteristics of this species.

Gervais' / Blainville's beaked whale: Of the nine encounters with *Mesoplodon* beaked whales during the present study, only one (Sowerby's beaked whale) was identified with certainty (Fig. 3). The identity of the other eight encounters remains unknown. Gervais' beaked whale and Blainville's beaked whale are considered rare in European waters north of the Canary Islands and their status in the Bay of Biscay is not known (Cresswell & Walker, 1999). However, recent strandings of both species along the Biscay coast of France suggests that they may be present in the study area (Gannier *et al.*, 2000).

DISCUSSION Sightings data from the study area reveals the likely distribution of beaked whales at sea in the Bay of Biscay. At least four species of beaked whale: Cuvier's beaked whale, northern bottlenose whale, Sowerby's beaked whale and an unidentified beaked whale (probably True's beaked whale) occur with some regularity in the Bay of Biscay. Despite extensive survey coverage over shelf waters in the English Channel and Bay of Biscay, beaked whale species were generally absent, being restricted to one encounter with an unidentified Ziphiidae species, recorded south-west of the Brittany Coast. This is considered to be anomalous. In common with several previous studies of beaked whales at sea (Tove 1995; Williams *et al.*, 1999; Weir, 2000), shelf slope waters were preferred by all species. The majority of all beaked whale encounters, and 100% of sightings of the genus *Mesoplodon*, occurred over the shelf slope and submarine canyons of the Southern Bay. The present study illustrates the importance of oceanic regions with variable topographic relief for members of this rarely sighted and little known family.

The distribution of beaked whales in the Bay of Biscay is likely to relate closely to that of their prey species, which are known from stomach contents analysis to include mesopelagic and deep-water benthic fish and squid which occur beyond the 1,000m isobath (Heyning, 1989; Podesta & Meotti, 1991; Carlini *et al.*, 1992; Gannon *et al.*, 1998). Such dietary evidence, combined with the distributional data from the present study, suggests that, in the Bay of Biscay, beaked whale species regularly dive to great depths in search of their prey, and that they show a preference for shelf slope waters and submarine canyons with associated sea mounts as a favoured habitat.

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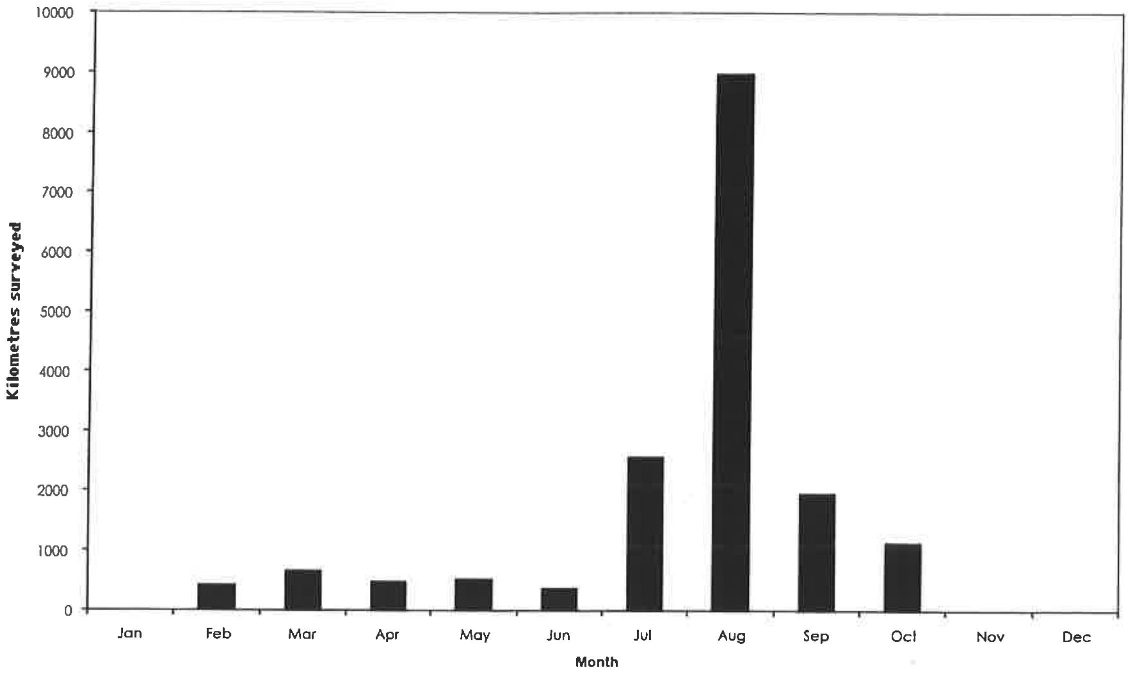

Fig. 1. Monthly survey effort in kilometres during 30 line transect cetacean surveys of the Bay of Biscay and English Channel between April 1998 and March 2001

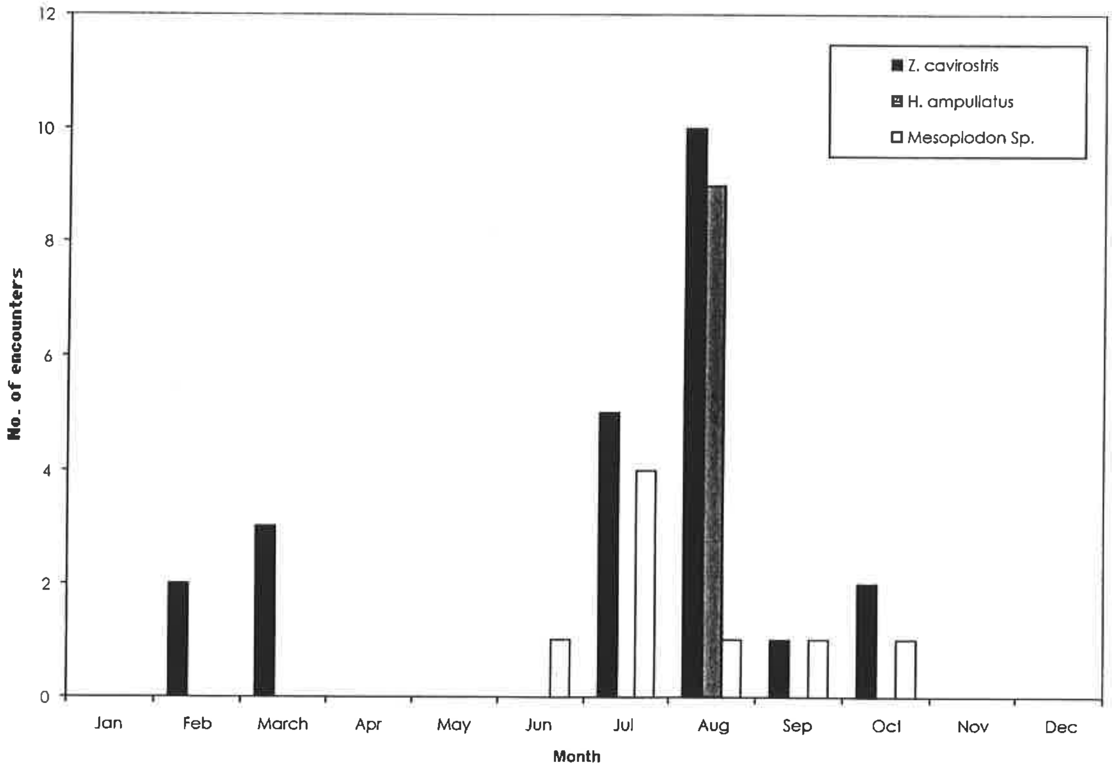

Fig. 2. Monthly distribution of beaked whale encounters during 30 line transect cetacean surveys of the Bay of Biscay and English Channel between April 1998 and March 2001

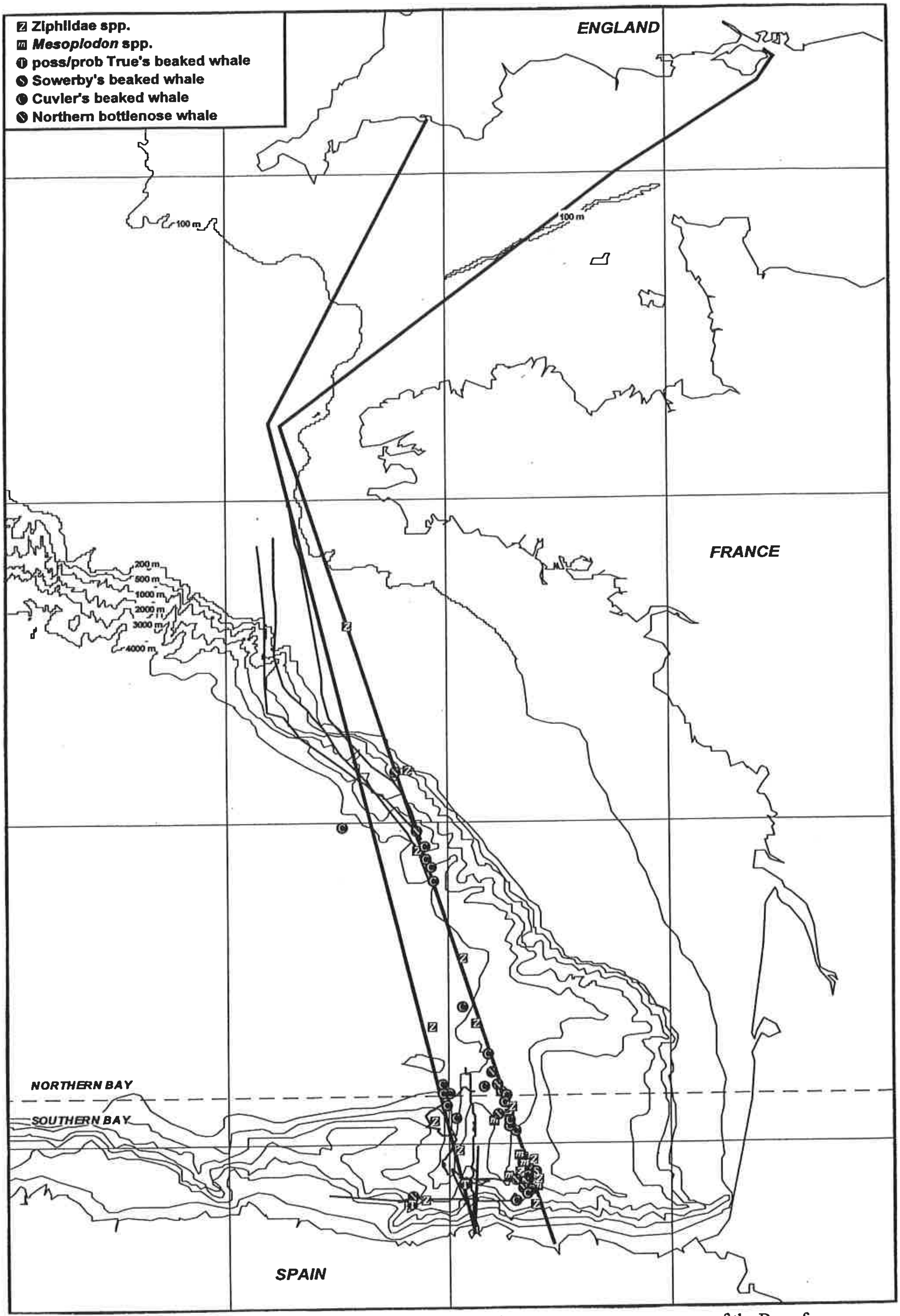

Fig. 3. Distribution of beaked whales (Ziphiidae) during 30 line transect cetacean surveys of the Bay of Biscay and English Channel between April 1998 and March 2001. Thick lines show the location of cruise tracks during the surveys. Thin lines show the European Coastline and bathymetric depths in metres.

FEEDING

STOMACH CONTENT ANALYSIS OF CETACEANS STRANDED ALONG THE ITALIAN COASTS

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INTRODUCTION This work summarises the result of analyses of 19 stomach contents of cetaceans stranded along the Italian coasts during the last 12 years (Table 1).

Eleven bottlenose dolphins (*Tursiops truncatus)*, six striped dolphins (*Stenella coeruleoalba*), and two Risso's dolphins (*Grampus griseus*) were analysed. Four bottlenose dolphins and two Risso's dolphins were found and collected from Fondazione Cetacea Onlus along the Adriatic Sea coast, the others were collected in the Central Tyrrhenian Sea, thanks to the efforts of Centro Studi Cetacei (the Italian National Stranding Network). The prey items were identified at the possible lowest taxonomic category and presented in a semi-quantitative analysis.

MATERIALS AND METHODS The Tyrrhenian Sea specimens, preserved in formalin for some years, were kindly provided by Dr. F. Cancelli (Centro Studi Cetacei in Siena). The samples coming from the Adriatic Sea were collected by Fondazione Cetacea between January 2000 and March 2001.

Stomach contents were analysed using the criteria suggested by Hyslop (1980). Prey items were listed using the Frequency Occurrence Index (F% = (N/Ntot) x 100).

Ingested remains were divided into three main categories for these analyses: cephalopods, crustaceans and bony fishes. The cephalopod identification was made according to Clarke (1986), using biometric and morphological keys. Crustaceans were kindly identified by Dr. C. Froglia, C.N.R-I.R.Pe.M (Ancona, Italy). Fish remains were identified by direct comparison with fresh material and morphological evidences suggested in literature (Soljan, 1975; Mangold and Boletzky, 1987; and Riedl, 1991).

RESULTS

Cephalopods 87.5% of cephalopods found were in striped dolphins, 7.19% in bottlenose dolphins, and 5.3% in Risso's dolphins. In all striped and Risso's dolphins, squid were found. These prey were also present in five of the bottlenose dolphins (54.5%).

The species recognised, with numerical occurrence in brackets, were: *Chiroteuthis veranyi* (76), *Histioteuthis reversa* (66), *Illex coindetii* (57), *Histioteuthis bonnellii* (20), *Todarodes sagittatus* (10), *Octopus vulgaris* (4), *Sepia officinalis* (4), *Loligo vulgaris* (1), *Eledone moschata* (1) and *Bathypolpus sponsalis* (1). The relative presence is shown in Table 2.

Crustaceans The highest concentration of crustaceans (83.3%) was found in striped dolphins. Only five stomachs of 11 Bottlenose dolphins (45.4%) presented these taxa. For both dolphin species, the percentage of crustaceans in bottlenose dolphin was about 25%, but this value may be lower if we consider the two isopods and one copepod as incidental prey.

The identified crustaceans were *Parapenaeus longirostris, Plesionika heterocarpus, Aristeus antennatus, Alpheus glaber, Solenocera membranacea, Goneplax rhomboides* and *Pasiphaea multidentata.* Relative occurrence and a summary by families is presented in Table 3.

Bony fishes Both bottlenose dolphin and striped dolphin had a Frequency Index (F%) of 100%. No item was found in Risso's dolphin. In bottlenose dolphin, we recovered 82 specimens (92.1% of the whole sample), while in striped dolphin there were only seven items (7.9%). According to the data, it seemed that in striped dolphin there was a low preference for fish, even if the frequency was 100%, as quoted in other papers (cf. Würtz 1998; Würtz and Marrale 1991, 1993). The analysis of prey was very difficult for the conservation status of most of the items. In most cases, they could be attributed only to families, with the exception of *Belone belone* (four specimens), *Dentex dentex* (two specimens) and *Sparus aurata* (one specimen). The results are presented in Table 4.

CONCLUSIONS The Risso's dolphin samples confirmed an entirely cephalopod-based diet, in accordance with other Mediterranean data (cf. Bello 1992; Bello *et al.*, 1996).

In striped dolphins, the main prey recorded were squid and crustaceans, also with a higher occurrence than in other Mediterranean collections (cf. Würtz and Marrale 1991; Pulcini *et al.*,1992; Bello 1992a; Meotti *et al.*, 1997).

Bottlenose dolphins appeared to base their diet upon fish, as suggested for example by Miokovic *et al.* (1997) and Würtz (1998), with Gadidae, Sparidae and Belonidae as main prey. As an opportunistic feeder, the species also preys on squid and crustaceans, giving a more complex picture to the analyses.

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Table 1. Cetacean specimens analysed

Code	Species	City	Date	Sex	Event	Cm	Kg	Conditions
Er 38 °	*G. griseus*	Ravenna	3-07-2000	M	Stranding	325	320	Living
"rosa" *	*G. griseus*	Messina	22-04-1992	F	Stranding	274	?	Living
36/89 *	*S. coeruleoalba*	Grosseto	24-07-1989	M	Recovery at sea	203	?	Very advanced decay
16/90 *	*S. coeruleoalba*	Capalbio Scalo	29-03-1990	F (?)	Stranding	183	?	Advanced decay
92/93 *	*S. coeruleoalba*	C. della Pescaia	22-09-1993	F	Stranding	196	?	Moderate decay
152/95 *	*S. coeruleoalba*	Capoliveri	18-12-1995	F	Stranding	210	75	Moderate decay
4/96 *	*S. coeruleoalba*	Marina di Campo	29-01-1996	M	Stranding	214	95	Moderate decay
4/98 *	*S. coeruleoalba*	Orbetello	4-04-1998	F	Stranding	184	62	Moderate decay
13/92 *	*T. truncatus*	S.Stefano	29-07-1992	?	Recovery at sea		?	?
1/93 *	*T. truncatus*	Capalbio	6-01-1993	F	Stranding	245	?	Just dead
58/94 *	*T. truncatus*	Orbetello	27-12-1994	F	Stranding	190	75	Moderate decay
10/94 *	*T. truncatus*	Orbetello	19-03-1994	F	Stranding	166 without head	?	Just dead
7/95 *	*T. truncatus*	Punta Ala	28-02-1995	M	Stranding	219	108	Moderate decay
5/97 *	*T. truncatus*	Capalbio	4-06-1997	(?)	Stranding	about 235	?	Advanced decay
6/97 *	*T. truncatus*	Orbetello	27-06-1997	M	Stranding	250	?	Advanced decay
Er 37 °	*T. truncatus*	Rimini	9-06-2000	F	Recovery at sea	275	220	Advanced decay
Ma 10 °	*T. truncatus*	Ancona	1-08-2000	M	Stranding	265	< 200	Advanced decay
Er 40 °	*T. truncatus*	Rimini	1-02-2001	M	Stranding	190	about 100	Moderate decay
Ma 12 °	*T. truncatus*	Pedaso	21-03-2001	F	Stranding	177	75	Just dead

* Thyrrenian sea
° Adriatic sea

Table 2. Cephalopod species found in the samples

Taxa	*G. griseus*	*S. coerul.*	*T. truncatus*
Sepiidae			
Sepia officinalis		1	3
Sepiolidae			
Brachioteuthidae			1
Chiroteuthidae			
Chiroteuthis veranyi		76	
Cranchiidae			
Ctenopterygidae			
Cycloteuthidae			
Mastigoteuthidae			
Enoploteuthidae			
Histioteuthidae			1
Histioteuthis bonnellii	1	18	1
Histioteuthis reversa	6	60	
Loliginidae			
Loligo vulgaris		1	
Octopoteuthidae			
Ommastrephidae		2	
Todarodes sagittatus		4	6
Illex coindetii		57	
Onychoteuthidae			
Onychoteuthis banksi	2	1	
Thysanoteuthidae			
Argonautidae			
Octopodidae			
Bathypolpus sponsalis	1		
Eledone moschata			1
Octopus vulgaris			4
Ocythoidae			
Tremoctopodidae			

Table 3. Crustaceans found in the samples

TAXA	N°	N°	S. c.	S.c.	T. t.	T. t.
Penaeidae	18		18		0	
Funchalia woodwardi		2		2		0
Parapenaeus longirostris		16		16		0
Aristeidae	4		4		0	
Alpheidae	4		0		4	
Alpheus glaber		4		0		4
Solenoceridae	2		0		2	
Solenocera membranacea		2		0		2
Goneplacidae	1		0		1	
Goneplax romboides		1		0		1
Pasiphaeidae	1		1		0	
Phasiphea multidentata		1		1		0
Pandalidae	7		7		0	
Plesionika heterocarpus		5		5		0
Chlorotocus sp.		2		2		0
Cirolaninae	2		0		2	
Copepod	1		0		1	
	Total		Total		Total	
	40		30		10	

Table 4. Fishes found in the samples

Code	Species	N°	Taxa	Unidentified
Er 37	*T. truncatus*	6	Belonidae (4)	2
13/92	*T. truncatus*	25	Gadidae (25)	0
1/93	*T. truncatus*	5	Gadidae (5)	0
58/94	*T. truncatus*	15	Sparidae (2) Gadidae (12)	1
7/95	*T. truncatus*	5	Gadidae (2)	3
6/97	*T. truncatus*	6	Gadiformes (1)	5
Ma 10	*T. truncatus*	0		0
Ma 12	*T. truncatus*	0		0
10/94	*T. truncatus*	15	Gadiformes (4)	11
5/97	*T. truncatus*	1	Sparidae (1)	0
Er 40	*T. truncatus*	4	Gadiformes (2)	2
92/93	*S. coeruleoalba*	0		0
4/98	*S. coeruleoalba*	1	?	1
4/96	*S. coeruleoalba*	0		0
152/95	*S. coeruleoalba*	6	?	6
36/89	*S. coeruleoalba*	0		0
16/90	*S. coeruleoalba*	0		0
Er 38	*G. griseus*	0		0
"rosa"	*G. griseus*	0		0
		Total		Total
		89		31

FIN WHALE (*BALAENOPTERA PHYSALUS*) SUMMER FEEDING IN THE NORTH-WESTERN MEDITERRANEAN SEA

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INTRODUCTION Former studies carried out in the Liguro-provençal basin (Relini *et al.*, 1992; Orsi Relini *et al.*, 1994; Orsi Relini *et al.*, 1998a and b) and in the coastal waters of Ischia (Mussi *et al.*, 1999) showed that these zones are feeding grounds for summering fin whales. What is the situation in the west of the Ligurian Sea, in the Provençal basin, and off the Gulf of Lions?

MATERIALS AND METHODS The diet of the fin whale is mainly studied by the analysis of faeces. Samples were carried out in the Provençal basin and Gulf of Lions areas, from June to September, between 1994 and 2000, when following whales. Fourteen samples could be dip-netted when they floated on the surface. The sample thus recovered is then sorted and the prey species identified. Mandibles of the prey are then measured (in mm) along the axis from the molar process to the opposite tip under a stereo microscope provided with a micrometric ocular lens. From the length of the mandible (ML), one deduces the total length (TL), by the following mathematical formula (Relini and Capello, 1992):

$$TL\ (mm) = 12.3550899\ ML\ (mm) + 5.1071876$$

RESULTS The 14 samples contained only the euphausiids, *Meganyctiphanes norvegica*, in agreement with the results obtained in the Ligurian Sea (Relini *et al.*, 1992) and north Tyrrhenian Sea (Mussi *et al.*, 1998) in summer.

Temporal evolution during the summering period At the end of June, fin whales exploit a population of *Meganyctiphanes norvegica* composed mainly of adults. Thus the recruitment of young is a little later than in the Ligurian Sea, where they appear from the end of spring (Orsi Relini *et al.*,1998b). It is necessary to wait until the beginning of July in the basin of Provence and Gulf of Lions, to observe a significant recruitment, i.e. that the number of young is higher than the number of adults. Throughout summer, three age classes are maintained based upon estimates of total size: juveniles [13-25 mm], adults [25-30 mm] which reproduce at the end of the first year, and older adult [30-36 mm] which reproduce at the end of the second year (Casanova, 1974). This third size class appears to be very reduced in the Provençal basin and Gulf of Lions in summer. The presence of young seems to be constant from the beginning of July until the beginning of August and towards the end of the summer their mean length grows from 20.4 mm in June, to 21.7 mm in August. As for the adults present in great numbers from the very start of summer, they disperse at the beginning of August.

Spatial evolution heading to the open sea Three stations (A, B and C; Figs 1 & 2) along a transect ranging from a depth of 2000 m to the most offshore waters at the same period (19-27 July), indicates that the juvenile population remains constant, although the total size of the individuals is larger offshore than close to the 2000 m contour. The adult population seems to be absent offshore, certainly due to the particular hydrological phenomena present in this zone.

Hour and depth of sampling Except for one sample collected in water less than 2000 m depth, all the others were recovered beyond this zone, in accordance with the fine-scale whale distribution known in the area of the Provençal basin and the Gulf of Lions (Beaubrun, 1995) which indicates that the waters >2000 m are preferred feeding areas. Sampling was undertaken at various hours of the day, from 06:15 h to 18:00 h, although preferred hours of fin whale feeding are early in the morning, and during the afternoon (Würtz, 2000).

DISCUSSION *Meganyctiphanes norvegica* is a boreal euphausiid species, most typically localised in the north of the Western Mediterranean basin, which offers an exceptionally high density in the Ligurian Sea. This abundance is explained by the existence of divergence in the Ligurian Channel: upwelling to the surface of deep water, which pushes the surface layers towards the coasts, and result in a high phosphate rate involving a proliferation of phytoplankton whose krill allow substantial consumption.

High biomass is generally located north of latitude 43° N. Euphausiids may then be pulled by the Ligurian Current towards the Provençal basin and the Gulf of Lions, helping to explain the small shift in the date of arrival of young individuals in the two areas: spring in the Ligurian Sea, and early July in the Provençal basin and Gulf of Lions.

Station C, situated the farthest from the continental shelf, is where the Ligurian satellite circuit and the Iberian circuit meet. These hydrological phenomena could explain the significant euphausiid populations in that area: young individuals and adults may not be present in the same layers, and are not identically affected by the various currents.

CONCLUSIONS This study shows the importance and abundance, in the summer period, of the euphausiid *Meganyctiphanes norvegica* for fin whale feeding in the Provençal basin and off the Gulf of Lions. These two areas therefore seem to represent a homogeneous continuation of the Ligurian sector. Spatio-temporal variation and the overall distribution of this prey are similar to those already found in the north Tyrrhenian and Ligurian basins, emphasising that all the north-western Mediterranean is a general feeding ground for fin whales.

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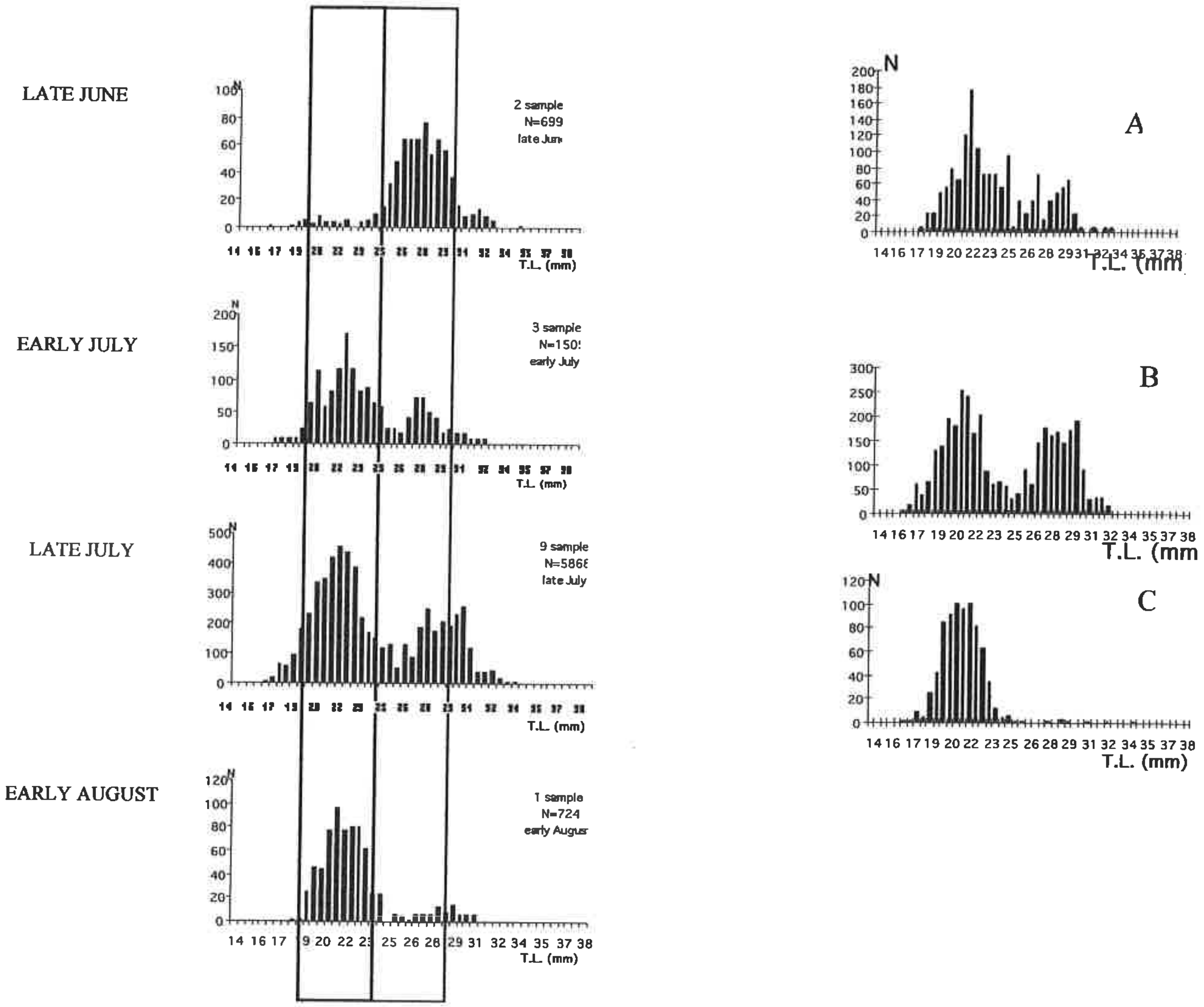

Fig.1. Temporal and spatial evolution of *Meganyctiphanes norvegica* total length

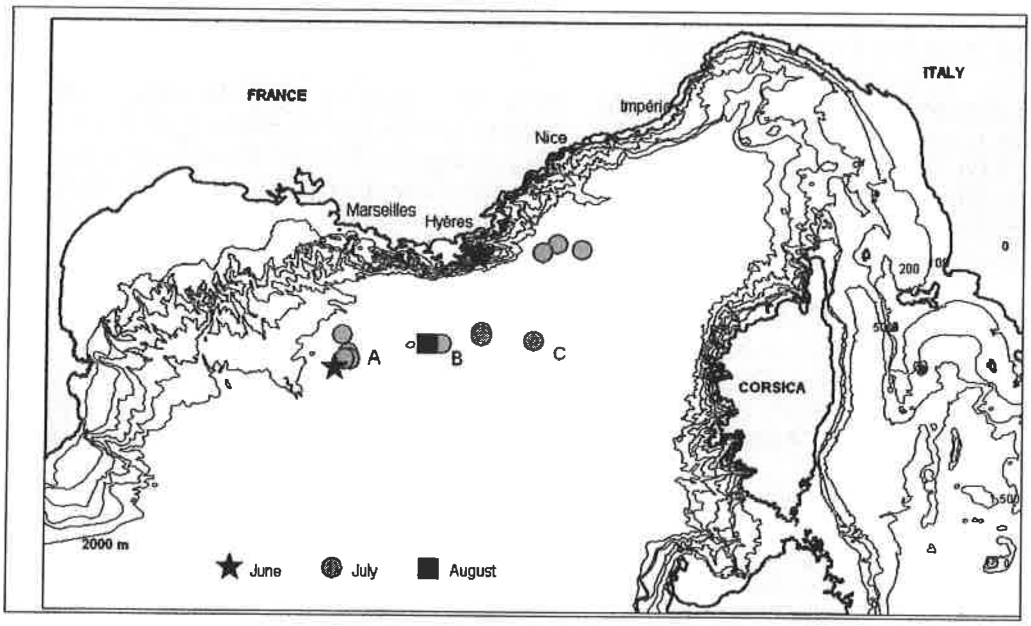

Fig.2. Sampling distribution in the area

BOTTLENOSE DOLPHIN FORAGING ALONGSIDE FISH FARM CAGES IN EASTERN IONIAN SEA COASTAL WATERS

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INTRODUCTION During a long-term behavioural ecology study, inshore bottlenose dolphins (*Tursiops truncatus*) were observed foraging near fish farm cages for gilthead sea bream (*Sparus auratus*), moored alongside the eastern Ionian Greece coastline. This behaviour - which was never recorded before the year 2000 - appeared to represent an adaptive response to: 1) quick development of aquaculture in the area; and possibly 2) reduced food prey availability and consequent need to develop new behavioural strategies for finding food.

MATERIALS AND METHODS Observations were conducted in summer 2000 on three different occasions from inflatable craft powered by outboard engines. The study area was located in the eastern Ionian Sea, in the waters surrounding the island of Kalamos, Greece. The dolphins were found during *ad libitum* surveys that were covering a study area of about 500 km^2.

During this long-term behavioural ecology study (Politi 1998), dolphins were not specifically searched for near coastal aquaculture facilities. Instead, survey routes were chosen to provide an even coverage of the study area. Once spotted, the dolphins were followed during their daily movements over periods of time that could last up to several hours, and behavioural data were systematically recorded throughout.

RESULTS On 8 and 24 June 2000, we made two observations of bottlenose dolphin groups, approaching two different aquaculture facilities at the time when caged fish were being fed by farmers. The dolphins fed alongside and among the fish cages for 1 h 54 min. and 27 min., respectively. The animals moved in subgroups or individually, surfacing alongside the cage perimeters, and performing dives exceeding 60 sec. around the cages. Individual dolphins were seen heading towards the cages or parallel to them before diving. On 11 July 2000, another bottlenose dolphin group approached an aquaculture facility upstream and engaged in foraging near the outer cage perimeter for 23 min. In this case, the caged fish were not being fed by farmers. The three independent observations involved groups of 8, 3 and 7 individuals, respectively. These included photo-identified individuals that were consistently seen in the study area in previous years.

CONCLUSIONS In 1981-2000, the aquaculture production of marine fish in Greece increased by 300%, largely due to the development of cage technologies in inshore waters (Anon, 2000; EEA/UNEP, 2000). Increased nutrient levels, complex substrate and provision of food bait in the proximity of the cages may create a favourable environment, and attract potential bottlenose dolphin food prey.

Free-ranging bottlenose dolphins were never seen feeding near aquaculture facilities over 259 h 7 min. of observations conducted by us between 1993-99 (275 groups observed). In the year 2000, however, 5.7% of the observed groups (N=53) engaged in this opportunistic feeding strategy for 4.9% of the total observation time (55 h 33 min.). Since all behavioural data were obtained during lengthy observation sessions at sea, while following the animals' daily movements, this may provide insight into the relative proportion of time devoted to foraging near fish farm cages, as compared to other activities.

It has been suggested that bottlenose dolphins around the Greek island of Kalamos may be affected by malnutrition. Around 40% of the photo-identified individuals were visibly emaciated, which has been related to a reduced availability of demersal food prey caused by overfishing (Politi *et al.*, 2000). Perhaps as an adaptive response to difficulties in finding food, the dolphins have apparently learned in recent times to take advantage of the new food sources that may have become available in the proximity of coastal aquaculture facilities.

According to local fishermen, the dolphins cause neither direct nor indirect damage to the farming activities, to the caged fish, or to the submerged structures. However, the possibility that dolphins learn to jump into the cages or damage them to gain access to the farmed fish, represents a source of concern for the future. Bottlenose dolphins are known for their behavioural flexibility and their capacity to learn new feeding strategies (Shane *et al.*, 1986). If dolphins ever learn ways of gaining access to the farmed fish, it can be expected that fishermen would react by trying to kill the animals to protect the farmed fish (Würsig, this volume).

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FIN WHALES TUNE THEIR DISPERSION AND GROUPING PATTERNS ON KRILL STANDING BIOMASS

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Fin whales enter the Gulf of St. Lawrence in spring of each year. During summer, individuals travel into the Estuary, as far upstream as the Saguenay - St. Lawrence marine park (1300 km inland), where rich krill aggregations and schooling fish are found. Annual monitoring of whales and zooplankton provides a rare opportunity to examine fin whale feeding ecology.

Photo-identification surveys conducted between June and September, 1994 to 1999, have shown that individual fin whales (n = 70) have prolonged summer residency and high rate of annual return (70% re-sighted during two seasons and 40% in four seasons or more). Although the number of fin whales visiting the study area, estimated from mark-recapture analyses, has shown little inter-annual variation, systematic whale observations made from commercial whale-watching (average 50 trips per season) showed considerable variation in their dispersion. Mean number of fin whales per sighting (within a 2000 m radius), used as an annual index of the dispersion, varied from 1.9 to 7.9.

The lower St. Lawrence Estuary krill standing stock biomass, estimated during zooplankton surveys conducted in September of each year (48 stations along eight transects), also showed high inter-annual variation. Average wet biomass of krill varied between 7.2 and 38.1 $t \cdot km^2$ with the highest and the lowest values found in 1994 and 1996, respectively the year of maximum and minimum fin whale dispersion index.

The inter-annual variability of the krill biomass explains 92% of the inter-annual fin whale dispersion index. We hypothesise that during krill-rich seasons, fin whales disperse to feed on krill patches, whereas during krill-poor seasons, they switch to schooling fish which they hunt in groups. Ongoing analyses of C and N stable isotopes from fin whale skin samples, collected over the study period, should allow us to test our hypothesis.

INTERACTIONS BETWEEN BOTTLENOSE DOLPHINS AND SMALL SCALE FISHERIES IN THE ASINARA ISLAND NATIONAL PARK (NORTH-WESTERN SARDINIA)

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INTRODUCTION Interactions between bottlenose dolphins (*Tursiops truncatus*) and small-scale fisheries represent a remarkable problem in the Mediterranean region (Consiglio *et al*., 1992; Silvani *et al*., 1992; Cannas *et al*., 1994; Di Natale *et al*., 1994) as well as elsewhere (Northridge, 1984, 1991), both in terms of cetacean population concerns and of economic damage to the local fishing industry (Northridge *et al*., 1999). The study, currently in progress, represents the first attempt in the Mediterranean Sea to monitor these operational interactions, by examining the types of gear involved in interactions, and estimating the damage to the local fishing industry both in terms of diminished catches (through removal of captured fish), and of physical damage to the fishing gear.

MATERIALS AND METHODS The study area (Fig. 1) includes the coastal waters of the Asinara Island National Park that extend from 150 to 1000 m from the coast, and fall within the 100 m depth contour. Coastal fishing activities in the study area are carried out mainly by the use of bottom set trammel nets (Ferretti, 2000), having different mesh sizes according to the season, the available target species and legislative restrictions (Lauriano *et al*., in press). According to the local modalities of use in relation to gear selectivity, seasonality, mesh size and daily operation time, trammel nets used by the Stintino Fishermen Consortium (SFC) have been divided into three classes (Table 1). In this paper, we consider only class 2 and class 3 trammel nets; we omit class 1 because it does not seem to be affected by the interactions. Other types of gear used in the study area are traps and long-lines. According to local fishermen, these types of gear are not involved in operational interactions with bottlenose dolphins, and for this reason we decided to omit their investigation, and concentrate our sampling effort on the heavily impacted bottom set trammel nets.

To study the interactions in the area, fishing activities have been monitored by collecting two sets of data: 'direct data' and 'indirect data'.

'Direct data' were collected during shipboard surveys conducted in the period Oct 1999 – Feb 2001, and consisted of the following information: trammel net mesh size; trammel net set and hauling time; position of the extremes (buoys) of the trammel net; total weight of each species caught; and general damage both to the gear (holes, tears), and to the fish caught (bites, remains).

'Indirect data' were collected by means of questionnaires filled in by the fishermen of the SFC in the period Aug 1999 – Dec 2000, coupled with data on landings for the same period, provided by the SFC.

During the surveys conducted to collect 'direct data', a team of researchers was present with an inflatable boat in the fishing area to monitor the occurrence of bottlenose dolphins. In case of dolphin presence, data on group size, group composition, and time spent interacting with the gear (defined as: time spent at <100 m from the line connecting the extremes of the trammel net), were recorded.

For class 2 trammel nets (that are set 24-hours a day), besides monitoring the fishing operations (setting and/or hauling), surveys at different hours of the day were conducted in the study area to detect the possible presence of dolphins. These surveys were conducted on board an inflatable boat travelling at 15 knots. When in the presence of trammel nets at sea, the speed of the inflatable was reduced to five knots (this survey procedure has been defined as 'patrolling'). Mean yield of the trammel nets, expressed as the total catch (kg) of each species ('direct data') or commercial fish categories ('indirect data') per km of net, were compared in case of interaction or non-interaction.

The economic damage (ED) due to the lower fish catch in the presence of dolphins has been calculated as follows:

$$ED = L * l * F * days * P$$

where (L) is fish average loss per kilometre of net, (l) is average net length used daily by each fisherman, (F) is interaction frequency, (days) are days of fishing activities for the target species, and (P) is fish commercial price.

RESULTS **'Direct data'** A total of 31 shipboard surveys and 121 catch analyses (80 on class 3 trammel nets; 41 on class 2 trammel nets) were made.

The total average frequency of interaction was 24.8% (30 sightings on 121 sets). The frequencies of interaction (Fig. 2) for each trammel net class here considered are: 17.1% for class 2 (7 interactions on 41 sets), and 27.5% for class 3 (22 interactions on 80 net sets). The average interaction time (Fig. 2) also differs according to the trammel net class: 7 minutes for class 2, and 22 minutes for class 3.

General damage has been recorded on the trammel nets as well as on the catches. Damage was present in 60% of the times when interactions occurred, and 29% when interactions did not occur (Fig. 3 and 4). In detail, general damage is present in 31.7% of the sets of class 2 trammel nets, and in 38.7% of the sets of class 3 trammel nets.

'Indirect data' A total of 569 questionnaires were completed by the fishermen from Aug 1999 to Dec 2000. The results from these data can be compared to the ones acquired from the 'direct data' set. Interactions have been recorded in 26.9% of the cases (considering the three classes of trammel nets and long-lines together). In detail, interactions occurred with a frequency of 21.6% for class 2 trammel nets (n=292), and 42.5% for class 3 trammel nets (n=153). General damage was recorded 88% of times when interactions occurred, and 15% of times when interactions did not occur. As before, it is possible to distinguish the frequency of occurrence of general damage for the two classes of trammel nets: 37.7% (n=292) for class 2, and 42.5% (n=153) for class 3.

A total of 31 sightings have been recorded in the fishing areas, and 26 animals have been photo-identified. No difference in group size has been found between interacting and non-interacting dolphins (mean = 3.4), while group size differs according to the fishing season (Fig. 5). The presence of newborns is registered in September only.

During the class 2 trammel net season, an overall 5577 min. were spent surveying the study area with an inflatable boat in search of dolphins, and, of this time, 1613 min. were spent patrolling a total of 190 trammel nets (Table 2). No sightings have been recorded while patrolling the trammel nets.

The total mean yield (Fig. 6) (catch per effort unit) is significantly lower when interactions occur only for class 3 trammel nets (ANOVA $F=6.40$; $df=79$; $p<0.05$). The total catch drop is of 7.1 kg/km of net. This trend is confirmed by the 'indirect data' set.

The mean yield reduction is mainly due to a drop in the catches of red mullet (*Mullus surmuletus*) (mean 4.4 kg/km), as Fig. 7 shows ($F=8.65$; $df=79$; $p<0.05$), and, secondly, in *Phycis phycis* and *Pagellus erythrinus*. The 'indirect data' also indicate (Fig. 8) a reduction in the catches (mean 3.6 kg/km) due to a reduction of species belonging to the highest quality commercial class (*Mullus surmuletus*, *Diplodus* spp., *Lythognatus mormyrus*, *Pagellus erythrinus*, *Dentex dentex*, *Pagrus pagrus*, and *Sciaena umbra*).

DISCUSSION The results show the existence of operational interactions between bottlenose dolphins and the small-scale fishery operating in the study area. Strong differences related to frequency, interacting mean time and net yield, have been registered among the different trammel net classes:

Class 2. - low interaction frequencies (F=17.1%);
- low mean interaction time (7 min);
- small decrease in total catches.

Class 3. - high interaction frequency (F=27.5%);
- high interaction mean time (22 min);
- strong decrease in red mullet catches.

Direct observations were compared to the indirect data and a similar trend was found. The above evidence (inclusive of a daily fishing period shorter in class 3 than in class 2) strongly indicates dolphin preferences for the class 3 trammel nets and for its target species. This type of net is set between September and December to capture red mullet, a high valuable species, available during a post-pelagic period in which specimens congregate in neritic waters (Pipitone *et al.*, 1995). During this period, dolphin group size reaches a maximum, and calves are present.

The economic damage (ED) caused by the lower red mullet catch during the period September - December suffered by each fisherman, is:

ED = L * l * F * days * P = 4.4 * 2.25 * 0.27 * 30 * 19.000 = 1.523.610 ITL
(EURO 786.88 – U.S. $ 760.00)

To the economic damage due to the removal of captured fish, physical damage to the fishing gear should also be added.

CONCLUSIONS The interactions between bottlenose dolphins and small-scale fishing activities in the study area seem to be strongly related to a prey preference of the bottlenose dolphins. The interactions mainly occur during late summer and autumn, when the red mullet becomes available for exploitation. The limitation of food resources in the area does not seem to be the cause of the interactions because of the limited period of the year during which it occurs. No incidental capture of dolphins has been registered during the study and according to the fishermen, incidental captures do not seem to occur at all on the trammel nets surveyed during this study. Therefore the interactions seem to be only of economic concern for the fishing community of the area, and not a threat for the bottlenose dolphin population.

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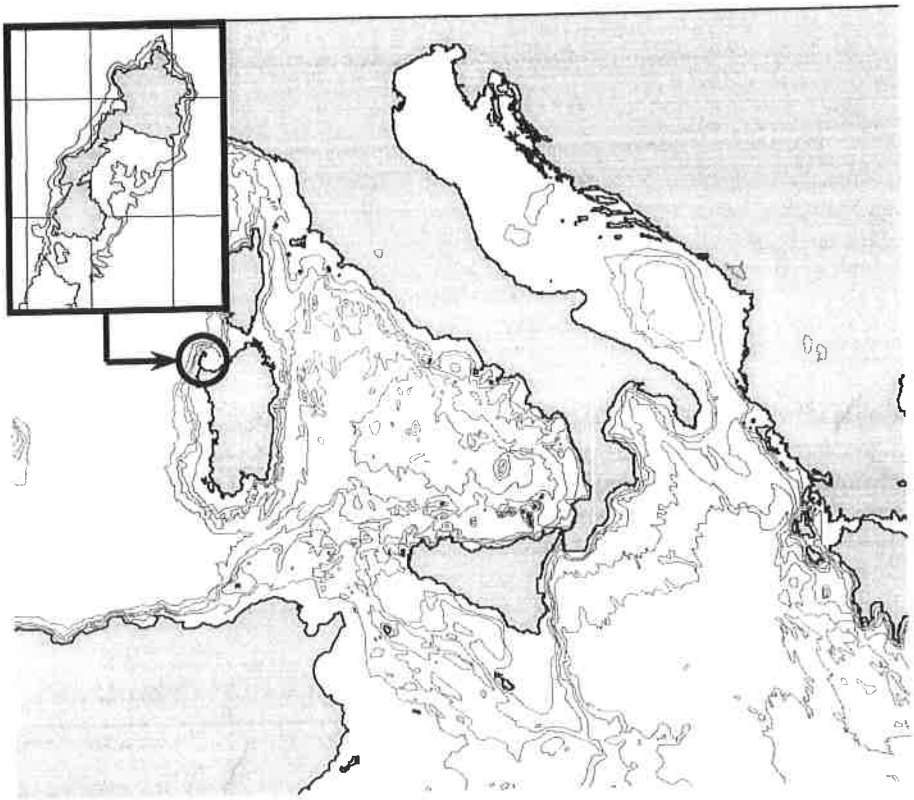

Fig. 1: Study area

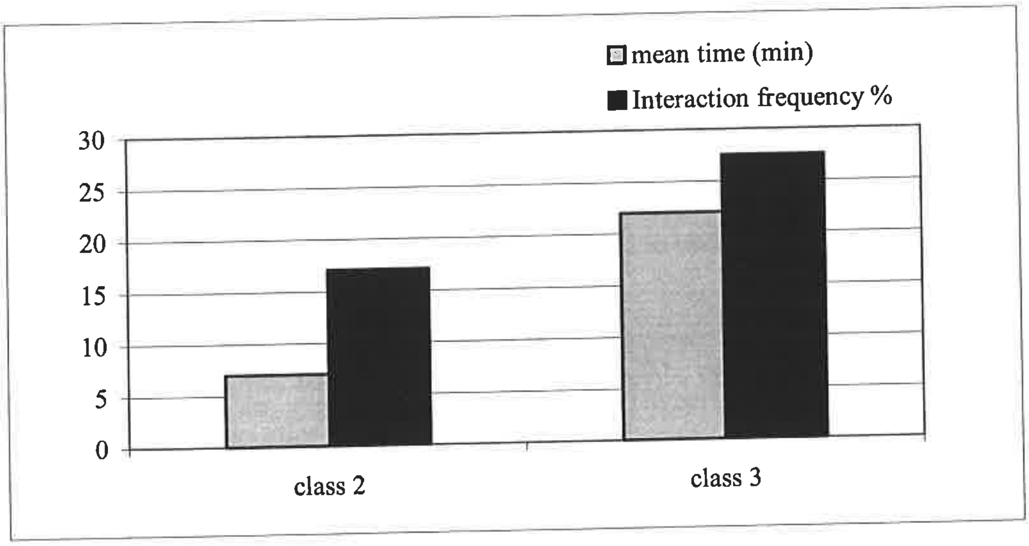

Fig. 2: Frequency and mean time of interaction for class 2 and class 3 trammel nets

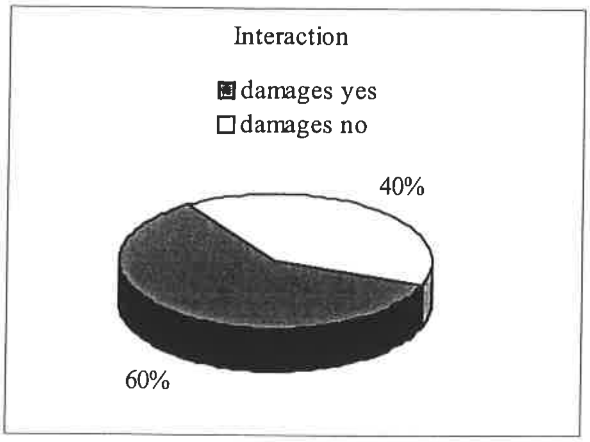

Fig. 3: General damage frequency in case of interaction occurrence

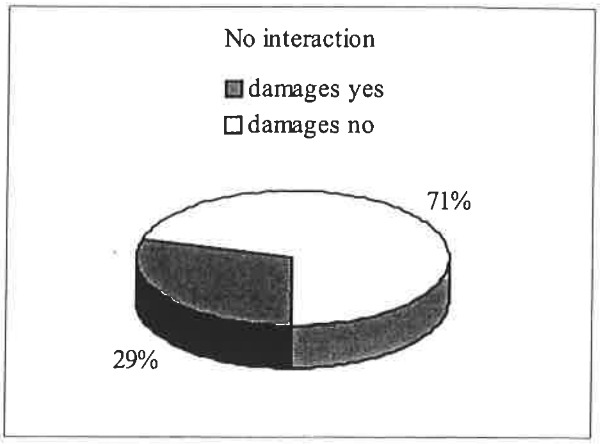

Fig. 4: General damage frequency in case of interaction absence

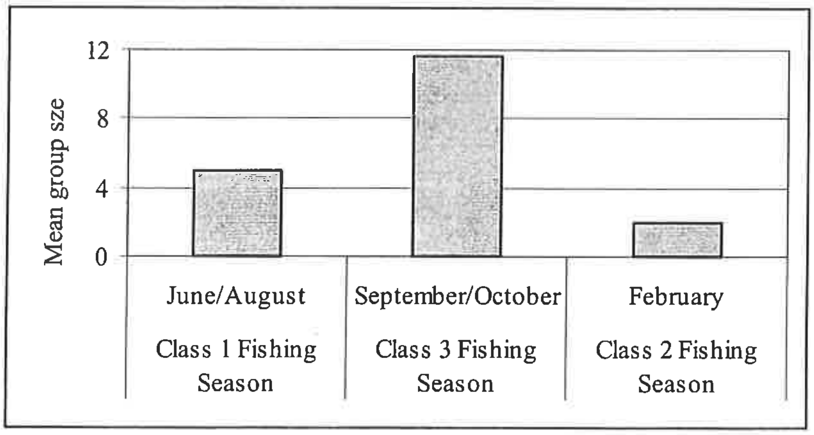

Fig. 5: Variation of bottlenose dolphin group size in the different fishing seasons (1999-2000)

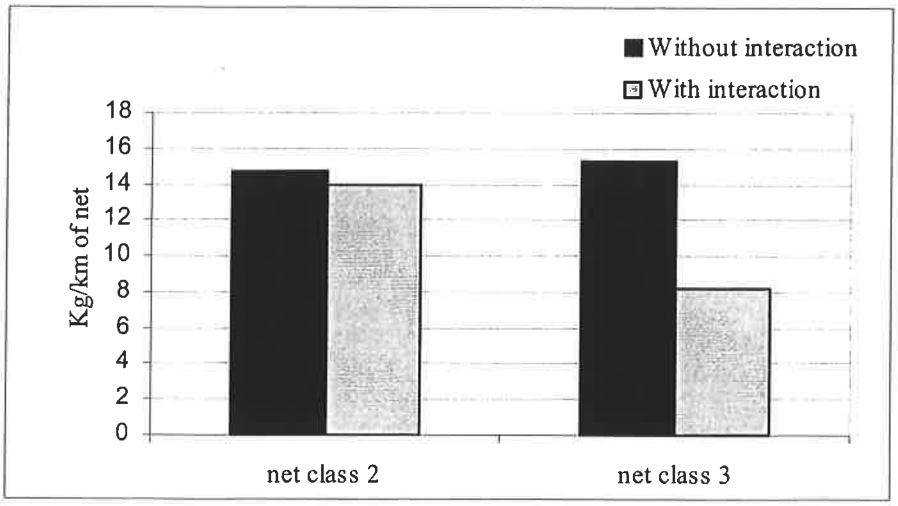

Fig. 6: Total mean yield of class 2 and class 3 trammel nets with and without interaction occurrence

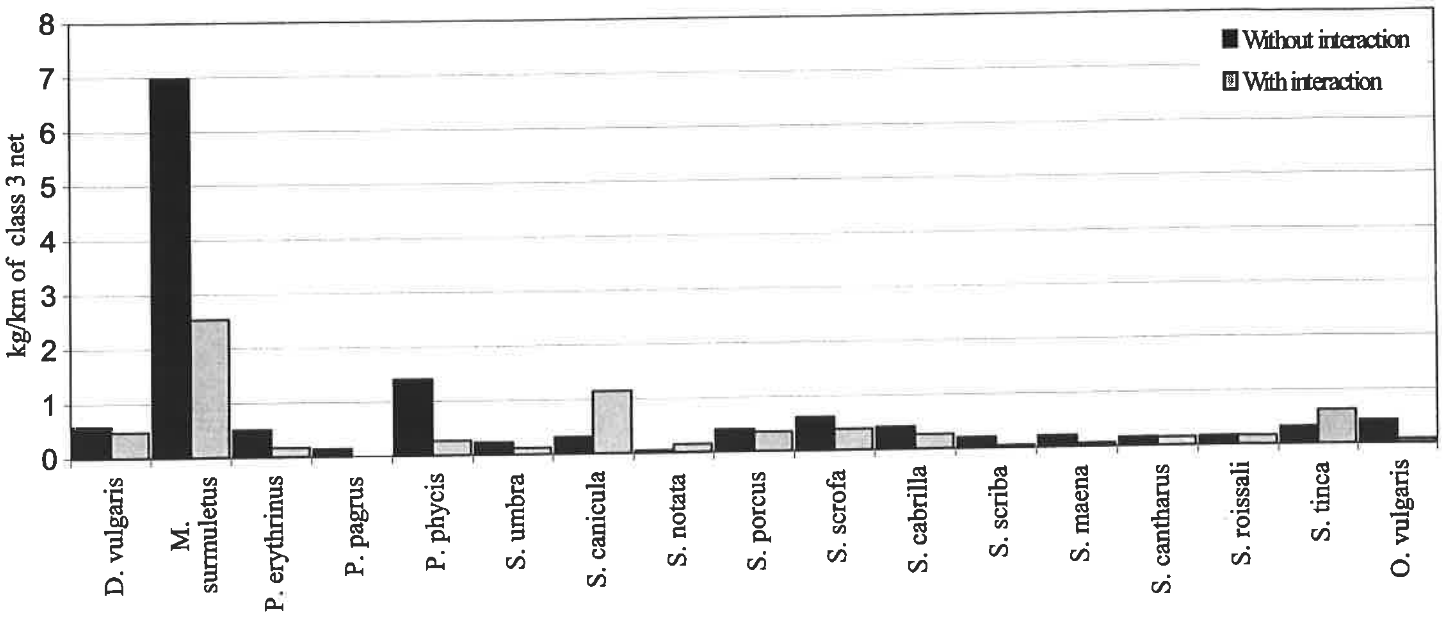

Fig. 7: Mean yield of the most abundant species harvested by class 3 trammel nets with and without interaction occurrence

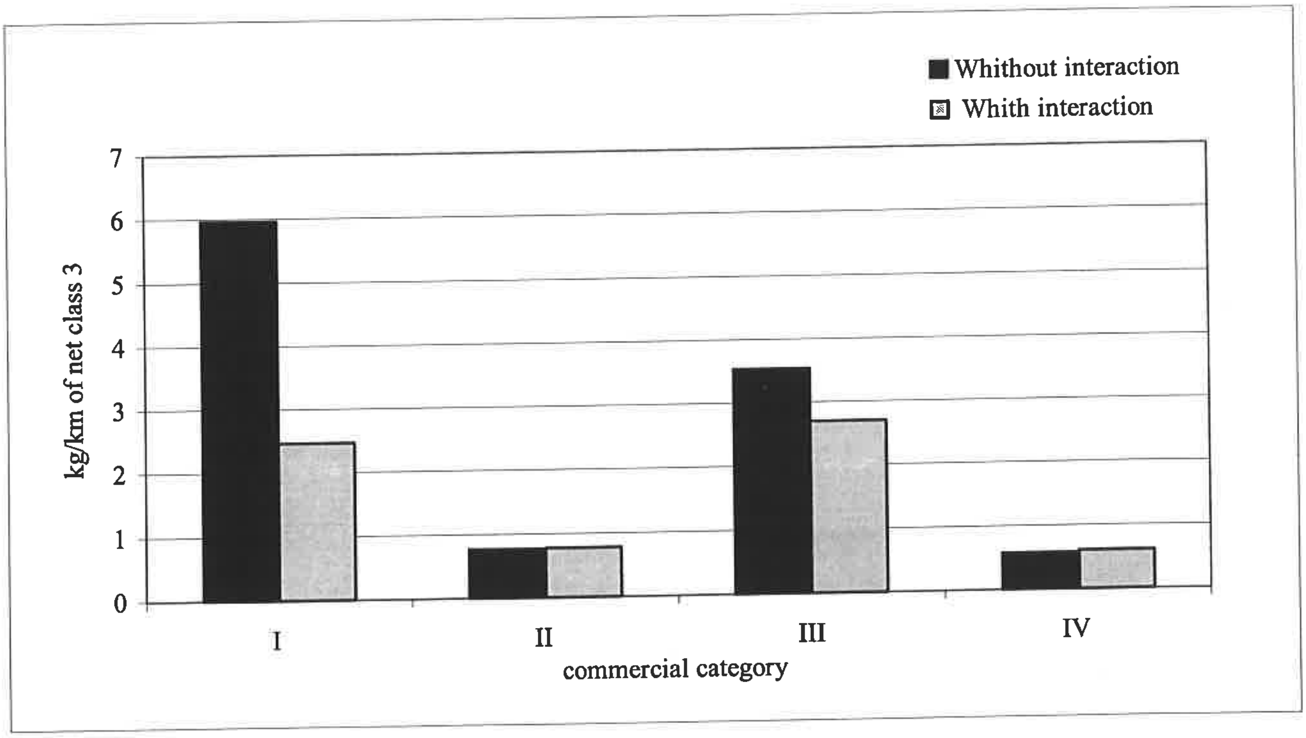

Fig. 8: Mean yield of commercial categories harvested by class 3 trammel nets with and without interaction occurrence

Table 1: Trammel nets used in the study area divided in 3 classes

class	mesh size (mm)	target species	season	using time
1	72 - 64	*Palinurus elephas*	May-August	24 h (all the period)
2	50 -42	*Diplodus spp., Pagellus spp., Dentex dentex, Pagrus pagrus, Sciena umbra*	January-April	24 h (all the period)
	36 - 32	Scorpaenidae, Sepiidae	January-August	24 h (all the period)
3	27	*Mullus surmuletus*	September-Dicember	< 6 h (daily)

Table 2: Time spent patrolling the nets (8/'99 - 8/'00)

Time (min)	Range
635'	dawn – 9.59
637'	10.00 – 13.59
167'	14.00 – 17.59
174'	18.00 – sunset

DOLPHIN INTERACTIONS WITH BOTTOM TRAWLERS IN THE LIGURIAN SEA CETACEAN SANCTUARY

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Many fisheries in the world use trawl nets. The trawl net is a towed net consisting of a cone-shaped net with a cod-end or bag for collecting the target species: fish, squid and crustaceans. Many trawl fishermen often blame dolphins for holes in their nets, and one of the areas with the most frequent complaints appears to be the Mediterranean. The species most fishermen blame is the bottlenose dolphin, which is the cetacean species most often documented to feed in association with trawls.

A research project was undertaken in collaboration with the Regional Park of Migliarino San Rossore e Massacciucoli, in the marine area in front of the park (part of the Ligurian Sea Cetacean Sanctuary), and showed an interaction between bottlenose dolphins (*Tursiops truncatus*) and the local bottom trawling operations.

The dolphins were sighted from the fishing vessel at a mean depth of 60 metres, and at a mean distance of eight miles from the coast. The mean group size was seven individuals. There have not been reported any incidental catches in the area of study. No conflict was observed between the animals and human activities: dolphins were probably aware of the net and the activity of the boats, since engines on trawlers produce a characteristic sound, particularly when changing stages of operation. They appeared at a certain stage when the net was deployed and did not get closer than 50 m from the boat.

In this research project, the collaboration with local fishermen was fundamental. There remains insufficient data available on this kind of interaction in the Mediterranean, and it would be interesting not only to compare types of behaviour of dolphins to each fishing method, but also to make comparisons with new independent observer programmes, and conduct more direct research.

GENETICS AND EVOLUTION

GEOGRAPHIC VARIATION OF *STENELLA COEUROLEOALBA* INVESTIGATED THROUGH GEOMETRIC MORPHOMETRICS IN THREE DIMENSIONS

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INTRODUCTION Geometric morphometrics (Rohlf, 1996) were used to study shape variation (size-free) of Mediterranean versus Atlantic populations of striped dolphins *Stenella coeuroleoalba*, following molecular evidence of limited gene flow between the two (Garcia-Martinez *et al.*, 1999).

MATERIALS AND METHODS Morphometric analyses were run on 3-D Cartesian co-ordinates recorded on 66 skulls belonging to the collections of the Museo Civiuco di Zoologia of Rome (Italy, 22 specimens) and to the Centre Recherche Mammifères Marine, La Rochelle (C.R.M.M., France, 44 specimens). A total of 31 characters were recorded on the right side of each skull by the means of a 3-D Microscribe digitiser. Original co-ordinates were rotated, translated, standardised (centroid size = 1), and superimposed through the Generalised Least Square method using the programs APS (Penin, 2000). Multivariate analyses (Principal Components Analysis) were run on residuals by superimposition, to evaluate the amount of shape differentiation between populations.

RESULTS Vectors of character variation of shape configurations superimposed after transformation (size-free) reveal a high variability of Atlantic *vs* Mediterranean specimens (Fig. 1). Also, the distribution of specimens along PC1 and PC2 (summarising 76.2% of total variance) revealed three distinct clusters for Atlantic specimens, whilst all the Mediterranean sample plot fell within one of the Atlantic clusters (Fig. 2). The pattern is not affected by sexual dimorphism, since males and females widely overlap.

CONCLUSIONS These preliminary results suggest a large and categorised differentiation of the Atlantic populations of striped dolphin with respect to the Mediterranean population, but a wider sample is needed to describe and evaluate the amount and distribution of shape variation.

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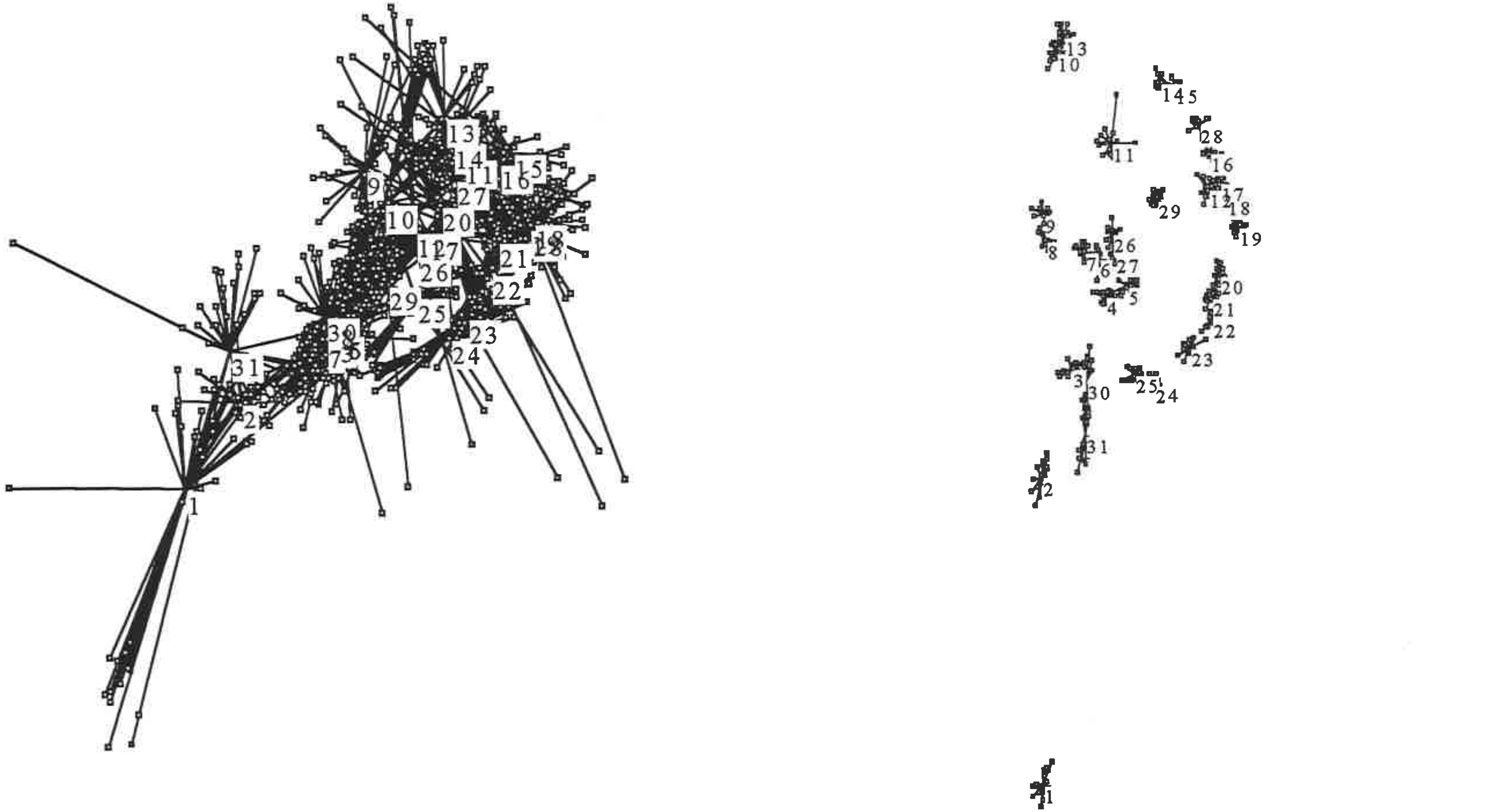

Fig. 1 Landmark vectors of variation from a reference configuration of the Atlantic specimens (A) and the Mediterranean specimens (B)

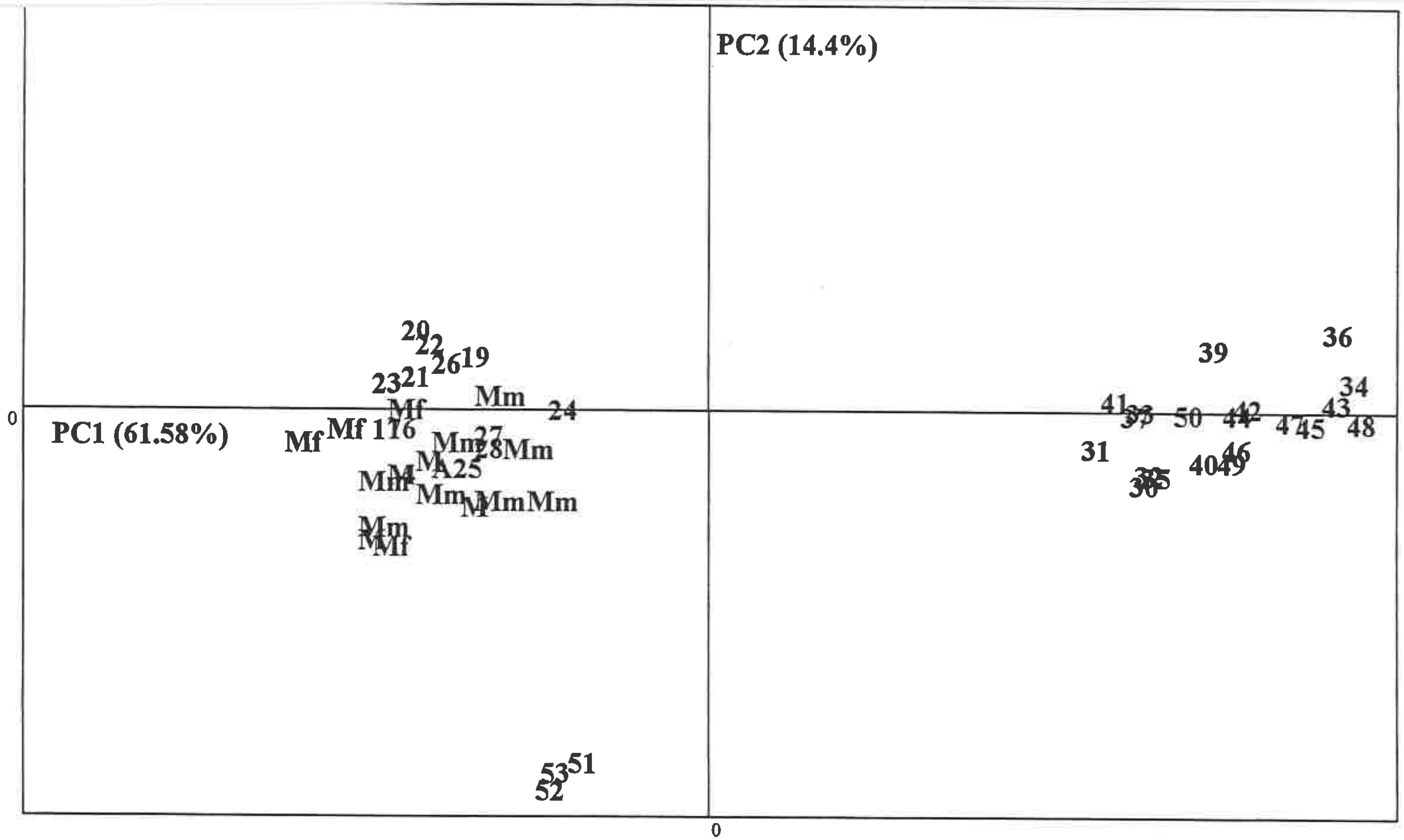

Fig. 2 Distribution of specimens along the first and the second Principal Components of residuals from superimposition of landmark configurations. M: Mediterranean specimen; A: Atlantic specimen; f: female; m: male

A FOSSIL BALAENOPTERID FROM THE PLIOCENE OF SIRACUSA (SOUTHEASTERN SICILY, ITALY)

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The discovery of a fossil Pliocene mysticete in the urban area of Siracusa gave the opportunity to collect a large range of data concerning the Palaeogeography of South-eastern Sicily, and filled a gap in the fossil record. In fact, no published data exist about fossil cetaceans from Sicily, whereas in the peninsular regions of Italy, fossil cetaceans are rather frequent. The excavation has been funded by the Regional Assessorship for the Arts and Environment of Sicily, and carried out by the Cultural Heritage Agency of Siracusa.

The fossil remains, discovered in August 2000 in a courtyard of the General Hospital "Umberto I" of Siracusa during the works for the modernization of the building, are the result of a stranding on a low fossil coastline (actually the coastline is more than 1 km to the east), marked out by conditions of medium/low energy.

Ribs, vertebrae, part of the forelimbs, and a skull with its mandible have been collected despite their high fragmentation. Taxonomic observations could not exclude the possibility that the remains comprised more than one individual. Skull features and the lack of fusion of cervical vertebrae could be related to the family Balaenopteridae, still present in the Mediterranean.

MOLECULAR ECOLOGY OF STRIPED DOLPHINS (*STENELLA COERULEOALBA*) IN THE MEDITERRANEAN SEA

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INTRODUCTION We present a preliminary analysis of the variation of allele frequencies at seven nuclear microsatellites. Four populations from different areas were analysed, and differentiation among all putative populations was found. Samples were collected in different regions of the Mediterranean Sea, and samples from Scotland were included as a reference population.

METHODS AND DATA ANALYSIS A total of 166 samples from three regions of the Mediterranean Sea: Adriatic Sea (22 samples), Tyrrhenian Sea (113 samples), and Spain (15 samples), and Scotland (16 samples) were analysed. The Adriatic region included samples from stranded animals in Croatia (1), Puglia (12), and biopsy samples from Greece (9). The Tyrrhenian region include biopsy samples from the Ligurian Sea (89), samples from stranded animals in Tuscany (22), and Ischia –NA (2). Samples from the Ligurian Sea were also tested as belonging to putative inshore vs offshore populations.

The level of polymorphism was estimated as the number of alleles per locus and the observed heterozygosity (Ho). Homogeneity of allele distributions for all pairs of populations was tested using exact tests (Raymond and Rousset, 1995). Evaluation of possible deviations from the expected HW genotypic frequencies and linkage disequilibrium were performed using Fisher's exact test and the Markov chain method. The level of differentiation among populations was estimated using FST (Weir and Cockerham, 1984), Rho_{ST} (Goodman, 1997). and $(\delta\mu)^2$ (Goldstein *et al.*, 1995). $\delta\mu^2$ is a genetic distance measure for microsatellites, incorporating a feature of the stepwise mutation model. Calculations were performed using GENEPOP 3.1d, FSTAT and RSTCALC Packages.

RESULTS Each locus was tested for linkage disequilibrium and genotype independence was confirmed except for loci EV37 and D08 in the Tyrrenian population. Observed (Ho) and Expected (He) Heterozygosity values are reported in Table 1. The number of alleles detected per locus varied from 9 to 25. All populations had a substantial level of genetic variation as shown by the average number of alleles and gene diversity (Table 1). Tyrrenian and Scottish populations have the highest average number of alleles per locus, while the Spanish population has the lowest. The value of mean observed hetrozygosity, ranged from 0.36 ± 0.02 in the Tyrrhenian Sea to 0.68 ± 0.09 in Scotland.

Hardy–Weinberg equilibrium was tested for each population at each locus, and a significant deficiency of heterozygotes was found for all populations except Spain: the Adriatic population (χ^2 (14 df) = 47.1, P = 0.000); Tyrrhenian population (χ^2 (14 df) = infinity, P = 0.000); and Scotland (χ^2 (14 df) = infinity, P = 0.000). The Adriatic samples reached HW-equilibrium, when samples from Greece and Puglia were separated; however, the Tyrrhenian sample still showed deviation from equilibrium even after separating the Tuscany and Ligurian samples. Genetic differentiation among pairwise populations was estimated as F_{ST}, Rho (Table 2) and $(\delta\mu)^2$ (Table 3). Overall genetic differentiation among the four populations was $F_{ST} = 0.030$, Rho = 0.086.

All comparisons between putative populations showed significant differentiation (Tables 2 and 3, values in bold), except for the comparison between Spain and Adriatic for F_{ST}. Comparison between inshore and offshore samples in the Ligurian Sea were non-significant $F_{ST} = -0.0025$, Rho = -0.0010

DISCUSSION Populations are differentiated within the Mediterranean, especially comparing eastern and western regions, while differentiation between Mediterranean and Scottish populations is even greater. A similar pattern in the Mediterranean Sea has been found for bottlenose dolphins (*Tursiops truncatus*) and common dolphins (*Delphinus delphis*) (A. Natoli and A.R. Hoelzel, *personal communication*).

The test of H-W equilibrium for the Tyrrhenian population showed heterozygote deficiency, which may result from a Wahlund effect (reflecting the mixing of differentiated populations in a single sample set). The Tyrrhenian population is largely represented by samples collected from free-ranging dolphins within and among social groups in the Ligurian Sea. The apparent population structure may possibly be determined by social structure. Analysis of kinship in the Ligurian population (data not shown) revealed that, although groups are fluid, there is some kin-structure within groups.

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Table 1. Nuclear genetic variation by locus and region. Number of alleles (A), observed heterozygosity (Ho), expected heterozygosity (He), standard error (SE)

	Adriatic (22)*			Tyrrenian (113)*			Spain (15)			Scotland (16)*		
	A	Ho	He	A	Ho	He	A	Ho	He	A	Ho	He
KWM1b	6	0.545	0.8	10	0.513	0.67	5	0.8	0.777	5	0.812	0.713
KWM2a	11	0.545	0.893	14	0.451	0.62	9	0.866	0.824	13	1	0.915
KWM2b	8	0.68	0.82	7	0.35	0.51	6	0.733	0.735	9	0.812	0.772
KWM12a	9	0.363	0.595	14	0.424	0.644	7	0.666	0.613	10	0.562	0.621
EV37Mn	8	0.72	0.74	23	0.345	0.71	9	0.6	0.706	14	0.687	0.88
D08	9	0.545	0.815	20	0.407	0.767	10	0.6	0.889	13	0.5	0.921
KWM5c	6	0.136	0.3	8	0.08	0.194	5	0.4	0.408	7	0.437	0.709
Average	8.14	0.5	0.7	13.71	0.36	0.58	7.28	0.66	0.7	10.14	0.68	0.79
SE	0.55	0.08	0.05	2.7	0.02	0.04	0.73	0.04	0.05	0.97	0.09	0.06

* denotes populations which deviate from the H-W genotypic proportion

Table 2. Genetic differentiation among pairwise populations. F_{ST} values are reported in the lower matrix, Rho values are reported in the upper matrix

	Adriatic (22)	**Tyrrenian** (113)	**Spain** (15)	**Scotland** (16)
ADRIATIC		**0.06**	**0.0404**	**0.1761**
Tyrrenian	**0.011**		**0.0347**	**0.1405**
Spain	0.0057	**0.0143**		**0.0956**
Scotland	**0.0726**	**0.0652**	**0.0346**	

Table 3. Genetic differentiation among pairwise populations, $(\delta\mu)^2$ values

	Adriatic (22)	**Tyrrenian** (113)	**Spain** (15)	**Scotland** (16)
Adriatic				
Tyrrenian	**0.149**			
Spain	**0.123**	**0.099**		
Scotland	**0.452**	**0.358**	**0.248**	

Fig. 1. Map of the Mediterranean Sea showing the origin and size of the samples

GENETIC CHARACTERISATION OF THE MITOCHONDRIAL CONTROL REGION OF AN OCEANIC POPULATION OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) FROM THE CANARY ISLANDS

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INTRODUCTION Up to now, 26 cetacean species have been reported in the Canarian Archipelago. This number represents 62% of the species registered in the North Atlantic, and 32.5% of all cetaceans known at the present time, making the Canaries one of the areas with a major species diversity (Martín, 1998). It is known that at least two of these species, the bottlenose dolphin (*Tursiops truncatus*) and the short-finned pilot whale (*Globicephala macrorhynchus*) establish resident populations. In the case of the bottlenose dolphin, the species has been included as "vulnerable" in the "National Catalogue of Endangered Species", which is why the Canarian Government has proposed to include the marine spaces where sightings of this species are frequent in the "Natura 2000" network.

Between January 1999 and June 2000, within a LIFE project, a study of the numbers and distribution of bottlenose dolphins was carried out. The total effort was 137 days (917.9 hours) and 6529.5 nautical miles were surveyed. About 9000 photographs of dorsal fins were taken, which have been used to identify 116 individuals. Moreover, skin samples for genetic analysis were taken from 18 different species, with 25 samples belonging to bottlenose dolphins included in the present study.

One of the aims of the study was to determine if clear genetic differences could be established among the samples taken from several geographic areas. Hitherto, no genetic studies had been carried out for this species in the Canary Islands, which makes this one the first genetic characterisations of the mitochondrial control region for these populations.

MATERIALS AND METHODS The 25 samples used for this study were taken at seven different sampling grounds: north-east (n=1), north-west (n=5) and south coasts (n=14) of Gran Canaria, north (n=1) and west coasts (n=1) of Tenerife, and north-east (n=1) and south-east coasts (n=2) of Fuerteventura (Fig. 1). Besides sample 20 (from the north coast of Tenerife, which was taken from a stranded animal, the other samples were all collected during fieldwork from the research vessel, with a 125 lbs. Crossbow, and using a 2.5 cm. biopsy tip.

Total DNA was extracted using the Phenol-Chloroform method (Sambrook *et al.*, 1989). A fragment of the mitochondrial DNA (mtDNA) control region of about 400 bp was amplified using the primers described in Henshaw *et al.* (1997). Finally a fragment of 389 bp was sequenced and stained on an acrylamide gel with the "Silver Sequence™ DNA Sequencing System" kit from Promega. All samples were sexed by amplifying the SRY gene, as described in Richard *et al.* (1994).

The molecular weight of the amplified fragments was determined using GELWORK 1D software; sequences were aligned with CLUSTAL WIN; and the phylogenetic analysis was performed with MEGA v. 2.0 using the Kimura 2-parameter model, a neighbour-joining method and the minimum evolution bootstrap test (1,000 replications).

RESULTS AND DISCUSSION The analysis of the 25 bottlenose dolphin samples gave 25 haplotypes that indicates a great genetic diversity in the mtDNA control region for this species. These results are consistent with previous studies conducted on bottlenose dolphins in the Mediterranean (Natoli and Hoelzel, 2000), North Atlantic (Siemann, 1994), and Pacific (Wang *et al*, 1999).

The number of substitutions ranged from 0.77% (3 bp) to 4.88% (19 bp). The mean value of nucleotide substitutions was 2.59% (10.08 bp ±0.11). Both types of substitutions, transitions (si) and transversions (sv), were analysed, being the percentage of si higher than the one of sv (60% to 40%). This ratio of 1.5 is in accordance with the dominance of si over sv in the mtDNA of mammals (Brown, 1983). 50% of the total substitutions belonged to the transition AG, which was five times higher than the transition CT. These data may be explained by the correlation between the number of each transition and the (A+G) and (C+T) content of the sequence (P<0.01).

Analysing the cladogram (Fig. 2), at least three different groups of samples can be observed. One of them, which will be named "cluster GC1", contains samples from the south and north-west of Gran Canaria and the ones from the south of Fuerteventura, which means that these three areas are genetically closely related. The second group, cluster "TF", includes both individuals from Tenerife and the one sampled in the north-east of Gran Canaria. The last cluster is almost exclusively formed by animals from the south of Gran Canaria, but also includes one from the north-west coast of Gran Canaria and the one from the north of Fuerteventura. This group has been designated as "cluster GC2".

The only sampled island that seems to have a genetically different population of bottlenose dolphins is Tenerife. The fact that a sample taken in the north-east of Gran Canaria belongs to the "cluster TF" may suggest a movement of animals between both islands along their North coast.

The distribution of the remaining samples between the other two clusters does not correspond to a geographic distribution of the sampling areas although it can be appreciated that samples taken the same day or on consecutive days are genetically closer, that is, they belong to the same group of animals. This is the case for animals Tt1 and Tt2-9/9 or Tt3 and Tt4-15/7 which were sampled during the same sightings and for samples Tt1-4/9 and Tt1-6/9 that, despite being sampled on successive days, belong to the same group (as has been confirmed by photo-ID).

On the contrary, samples Tt1 and Tt2-14/7 were taken the same day but appear in different clusters (GC2 and GC1, respectively). This can be explained by bearing in mind that three sightings were made that day. One of the samples belongs to the first sighting and the other one to the third one. This probably means that there was a temporal association between genetically different groups sharing the same area.

Genetic proximity can also be found between Tt1-16/5/00 and Tt1-22/6 that were sampled far away in time but in the same area, meaning that these animals belong to groups that are faithful to a certain area, as has been ascertained by photo-ID.

In the case of samples Tt1-5/9 and Tt3-28/10, the number of substitutions between sequences is also low, despite the fact that they are from two different islands (Gran Canaria and Fuerteventura). This supports the hypothesis that both populations are not isolated from each other.

Despite the existence of two genetic clusters (GC1 and GC2) in the area Gran Canaria ~ Fuerteventura, there is evidence of contact between them, since one animal which is very characteristic and easy to identify due to its ripped dorsal fin, has been found in association with animals Tt1-17/10 and Tt1-4/9 (from "cluster GC1") and animal Tt1-16/5/00 (from "cluster GC2").

CONCLUSIONS The only island which seems to have a genetic distinct population is Tenerife. Samples taken from animals on the north-east coast of Gran Canaria, south of Gran Canaria and Fuerteventura actually belong to the same area of distribution without clear genetic differences among them. The mixture of samples from north-east of Gran Canaria, and south of Gran Canaria and Fuerteventura forms two clusters (GC1 and GC2), which nevertheless interact. Genetic data in relation to those obtained by photo-ID, suggest a certain degree of residence of the animals in the study area. It would be interesting to complete this analysis with more samples and less variable genes.

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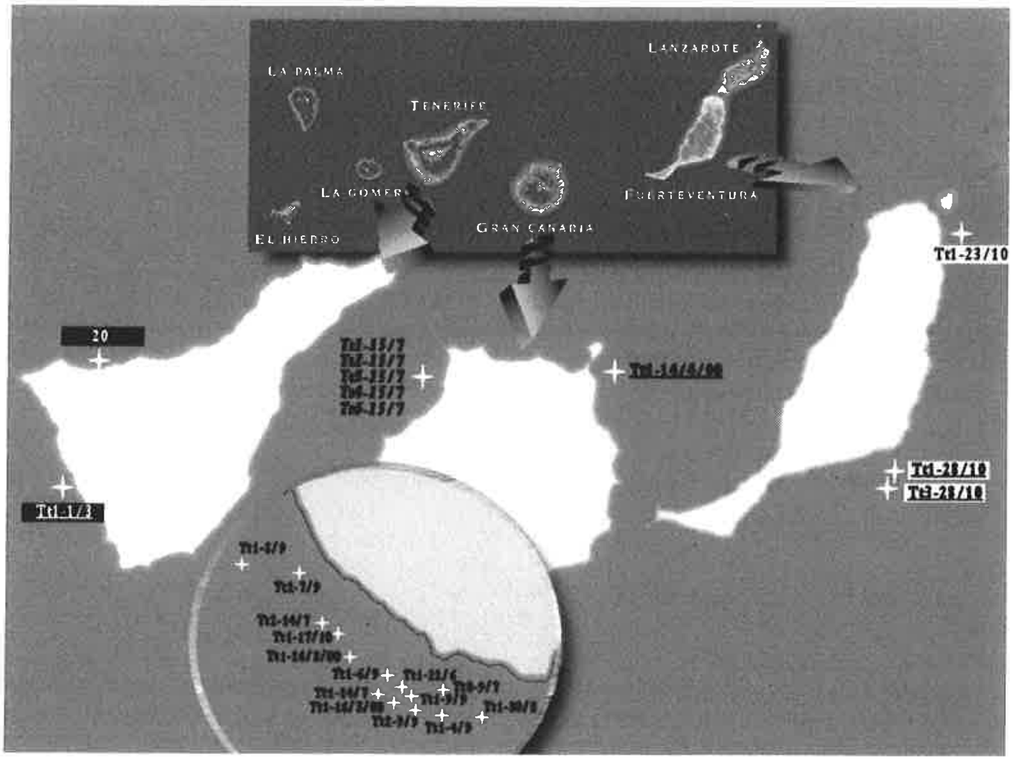

Fig. 1. Map of the Canary Islands showing the sampling grounds

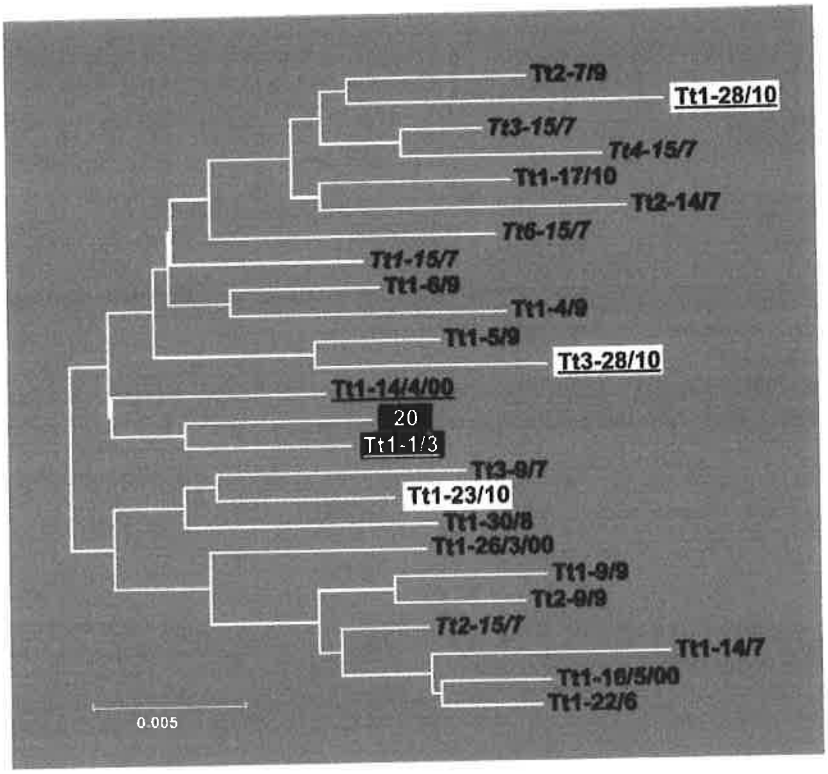

Fig. 2. Phylogenetic tree for the bottlenose dolphin populations of the Canary Islands. Each sampling group is represented by a different font style according to Fig. 1

PHYLOGEOGRAPHY OF MEDITERRANEAN AND NORTH ATLANTIC COMMON DOLPHIN POPULATIONS

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The short-beaked form of the common dolphin is found in the Mediterranean and eastern North Atlantic Ocean. Recent genetic studies have shown differentiation between Mediterranean and Atlantic populations in several species of cetaceans (fin whales, bottlenose dolphin, striped dolphin), and we present here the first study investigating these populations for the common dolphin.

Despite the fact that the common dolphin is typically pelagic in the Atlantic and Pacific Oceans, in the Mediterranean Sea it inhabits primarily coastal regions. Apparently isolated populations are observed in the Alboran Sea, northern Sardinia, south Tyrrhenian Sea, Malta, Aegean Sea, and Ionian Sea. Moreover, in the Mediterranean Sea, common dolphins are undergoing a substantial decline, especially in the north-western part of the basin. The assessment of phylogeography, and stock structure is therefore fundamental to the development of effective conservation and management programmes.

Analyses of five microsatellite loci and sequences from the mitochondrial DNA control region were carried out on 63 samples from different areas of the Mediterranean Sea, and compared with data from eastern North Atlantic and western North Atlantic. Patterns of differentiation revealed in phylogenetic reconstructions, and measures of population structure (F_{ST}) indicate a significant level of divergence between Mediterranean and Atlantic populations.

PHYLOGENETIC RELATIONSHIPS IN THE MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*) WORLD-WIDE, EXAMINED BY MITOCHONDRIAL DNA CONTROL REGION SEQUENCING

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Four morphological forms of the minke whale are known worldwide: North Atlantic (NA), North Pacific (NP) and Southern Hemisphere ordinary (SHO) and dwarf (SHD) forms. Previous morphological studies have suggested specific-level differences between Northern Hemisphere (NH) and SHO minke whales, and that SHD is more closely related to NH minke whales than to sympatric SHO. In order to test this hypothesis, we estimated the phylogenetic relationship among morphological forms of minke whale. We sequenced a segment of the mtDNA control region in 467 minke whales representing the four morphological forms as well as different oceanic regions: Sea of Japan, western and eastern North Pacific from the NP; central and eastern North Atlantic from the NA; two Antarctic regions and Brazil from SHO; Antarctic and Brazil from SHD and a single individual from the Mediterranean coast of Israel. The highest degree of nucleotide diversity was estimated amongst SHO and the lowest amongst the NP (Sea of Japan). The degree of divergence was highest among those comparisons involving the SHO (Brazil or Antarctic). The phylogenetic relationship estimated using the Neighbor-joining method revealed that individuals from the four morphological types defined four separate corresponding clusters, the most divergent being the SHO. The Israel whale clustered with NA. In agreement with the morphological findings, our analyses found that SHD was more closely related to NH than to sympatric SHO. The SHD Brazil appeared to represent an intermediate form clustering with both NA as well as SHD Antarctic individuals. Our results support the view that NH and SHO minke whale should each assigned to separate species and NP and NA to separate sub-species. The use of additional genetic markers is necessary to clarify the phylogenetic status of SHD.

POPULATION STRUCTURE OF HARBOUR PORPOISES IN THE NORTH ATLANTIC: A MULTIDISCIPLINARY APPROACH

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Recently, attention has focused on the use of multidisciplinary approaches to investigate population structure. Following such an approach, genetic and ecological data were used to investigate the population structure of harbour porpoises in the North Atlantic. Bycaught or stranded porpoises were assigned to a population *a priori* following the North Atlantic stocks defined by the International Whaling Commission (IWC). Mitochondrial DNA sequences were obtained from 436 harbour porpoises from eight putative populations across the North Atlantic, and organochlorine profiles were obtained for porpoises from three populations (n = 100) in the North-west Atlantic. Analysis of mtDNA and organochlorine profiles suggested that North-west Atlantic IWC defined stocks are in accordance with biological population structure. Conversely, the eastern North Atlantic IWC stock definitions need revision. Specifically, based on mtDNA sequences, populations in the northern North Sea should be divided into eastern and western components. No genetic differences were detected between southern and northern Norway, although radionuclide ^{137}Cs levels in porpoise muscle (n = 36) differed between these regions, suggesting ecological separation is present. These results demonstrate that ecological and genetic data reflect different time scales. Isolated populations may take thousands of years to become genetically distinct, and even low levels of gene flow can prevent two demographically isolated populations from showing significant genetic differences. In such instances, ecological variables, especially those with long residence times in the body, may be useful in making further inferences regarding population structure. However, as ecological characters are not heritable, these data reflect only the contemporary arrangement of populations. Such populations may have been recently separated and are demographically independent, but have not yet undergone sufficient genetic differentiation to be detectable. Despite this, ecological data may be useful in making inferences regarding population structure in cases where genetic differences are undetectable.

POPULATION GENETICS OF THE MEDITERRANEAN STRIPED DOLPHIN (*STENELLA COERULEOLBA*) AND MOLECULAR ASSESSMENT ON THE EFFECTS OF THE 1990-1992 MORBILLIVIRUS EPIZOOTIC

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In 1990-92, the Mediterranean striped dolphin suffered high mortality due to a morbillivirus epidemic. The ecological impact of the die-off on the extent of the stock had been difficult to quantify due to the lack of data on the population ecology of this pelagic dolphin. In this study, a set of 10 nuclear genetic markers (microsatellites) were used to assess present (and historical) population subdivision in the Mediterranean striped dolphin. We analysed 104 individuals representative of six Mediterranean and one Atlantic locations. All samples were from stranded individuals. These included 59 males, 44 females, and 1 individual of unknown sex. Sixty-one (58.7%) specimens died during the 1990-92 morbillivirus epizootic. Although striped dolphins were shown to be geographically structured within the Mediterranean, gene flow between different regions was found to be high and mostly mediated by males. If, on the one hand, such population dynamics, enhanced by the lack of physical barriers and by the relatively limited and patchy prey distribution, was probably responsible for such a quick spread of the disease across the basin, it also contributed to maintain high levels of genetic variability in the population, which consequently passed through the epizootic episode without showing a genetic signature of population bottleneck.

A NEW DOLPHIN SPECIES IN PATAGONIA - OR THE CONSEQUENCE OF A RARE LOVE AFFAIR?

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INTRODUCTION AND METHODS The waters of the Patagonian continental shelf of Argentina are the habitat for a high diversity of cetaceans, such as dusky dolphins (*Lagenorhynchus obscurus*) and southern right whale dolphins (*Lissodelphis peronii*). In Golfo Nuevo, Península Valdés, daily excursions aboard the vessel of a tourist operator (R. Benegas) were carried out between 22 November, 1999 and 16 March, 2000. During each dolphin sighting (n total=166 sightings) time, position, surface water temperature, group size and behaviour were all recorded, while dolphins with conspicuous features were photographed. A "rare dolphin" was sighted 10 times during this observation period (n= 45.9 h over 32 days), always associated with dusky dolphins. This specimen could not be identified with any of the available dolphin classification keys (Jefferson *et al.*, 1993; Carwardine, 1995).

OBSERVATIONS The "rare dolphin" shares characteristics of southern right whale dolphins and dusky dolphins (Figs 1 and 2). The animals' features are a slender body of approximately 2.0-2.2 m body length. As in southern right whale dolphins, a sharp dividing line separates the black dorsal part from the white ventral part of the body, but the line in the area of the head does not extend below the eyes. The peduncle shows a patch of pale grey, similar to the lateral colour pattern of a dusky dolphin. Contrary to a southern right whale dolphin, the "rare dolphin" has a dorsal fin, which is smaller and more triangular than that of a dusky dolphin and located around two-thirds of the way along the back. Colour pattern of the dorsal fin is very similar to that of a dusky dolphin with its typical half moon shape and pale grey coloration in the posterior part (Fig. 2).

Based on videotape recordings (by L. Pettite), conspicuous aerial behaviour could be analysed: high swimming speeds and almost exploding movements, side slaps, successive high leaps, and a series of low angled jumps (Fig. 1), the animal bouncing with a well-timed flick of its tail as it broke the surface, which also have been observed in *L peronii* (Cruickshank and Brown, 1981, Rose and Payne, 1991).

DISCUSSION Is this "rare dolphin" a hybrid, a new species, or just an anomalous phenotype of a known cetacean? Geographic variation of colour fields and anomalous pigmentation have previously been reported for dusky dolphins *L. obscurus* (Van Waerebeek, 1992; Gallardo, 1912) from the Península Valdés area, exhibiting differences in their degree of melanisation (Würsig and Würsig, 1979; Van Waerebeek, 1992). Relatively pronounced color variation also occurs in the body pigmentation, fluke and flippers of *L. peronii* (D'Orbigny and Gervais, 1847; Philippi, 1893; Lillie, 1915; Fraser, 1955; Aguayo, 1975; Torres and Aguayo, 1979; Baker, 1981; Cruickshank and Brown, 1981; Rose and Payne, 1991), but the presence of the small dorsal fin strongly suggests that the "rare dolphin" does not represent a colour variant of a southern right whale dolphin.

Features of the "rare dolphin" bear resemblance to the spectacled porpoise (*Australophocaena dioptrica*). Adults are 1.3-2.2 m long, and a sharp demarcation exists between the black dorsal and the white ventral part. Female spectacled porpoises have low and triangular shaped dorsal fins (Carwardine, 1995). However, further characteristics of *A. dioptrica*, (typical porpoise body shape, absence of a beak, black patch around the eyes, surrounded by a fine white line) (Jefferson *et al.*, 1993; Carwardine, 1995) do not apply to the "rare dolphin".

The association between dusky dolphins and southern right whale dolphins appears to be common in the entire Southern Hemisphere (Cruickshank and Brown, 1981; Rose and Payne 1991; Van Waerebeek, 1992; Yin, 1999). In winter, some dusky dolphins may migrate out of Golfo Nuevo, similar to conspecifics in Golfo San José (Würsig and Bastida, 1986), probably in order to feed on southern anchovies (*Engraulis anchoita*), found off Mar de Plata from September through November (Brandhorst and Castello, 1971). During the migration up to Mar de Plata (Würsig and Bastida, 1986), they could have contact with groups of southern right whale dolphins, which follow the cold Falkland current (Watson, 1985). Since associations between dusky and southern right whale dolphins were observed in Golfo Nuevo in summer 1992 (R. D. Orri, *pers. comm.*) the copulations and impregnation could have occurred both during winter and summer months, inside or outside the Golfo Nuevo.

Observations of hybrids between different cetacean species have been recorded in captivity (Dohl *et al.*, 1974) and in the field (Fraser 1940; Jørgensen and Reeves, 1993; Berubé and Aguilar, 1998; Spilliaert *et al.*, 1991; Arnason, 1994). Copulations between *L. obscurus* with other dolphin species are common (personal observations).

A hybridisation of *L. obscurus* and *L. peronii* seems to be possible. Le Duc *et al*., (1999) could show with molecular methods how closely related the *Lagenorhynchus* species (except *L. acutus* and *L. albirostris*) are to *Lissodelphis* and they place this species in the same genus.

CONCLUSIONS Based on the intermediate morphological features between *L. obscurus* and *L. peronii* I propose that the "rare dolphin" is an offspring of these two dolphin species. Aerial behaviour of the "rare dolphin" was very similar to previous observations of *L peronii* (Cruickshank and Brown, 1981; Rose and Payne, 1991). Due to its more *Lissodelphis*-like body shape, it is evident that its body movements are more similar to a southern right whale dolphin. Whether the "rare dolphin" observed is a hybrid, a new species, or just an anomalous phenotype of a known cetacean will only be answered conclusively by genetic methods.

ACKNOWLEDGEMENTS This investigation was supported by a grant from Deutscher Akademischer Austauschdienst (DAAD). The Marine Mammal Lab of Centro Nacional Patagónico (CONICET), Puerto Madryn provided logistical support. I am indebted to ASAHI PENTAX, Hamburg, and SURVEYERS-EXPRESS for providing surveying equipment, and to OLYMPUS for a digital voice recorder. I thank R. Benegas for the opportunity to carry out research on board of his vessel, R. Orri for helpful information and L. Pettite for his excellent videotape. Personal thanks go to S. Pavone-Cao for his help in the field and his brilliant ideas. I am grateful to Prof. Dr. B. Culik for his valuable support and comments on this paper.

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Fig. 1. The "rare dolphin" observed in the Golfo Nuevo, Argentina, during a wide and low angled leap with head re-entry

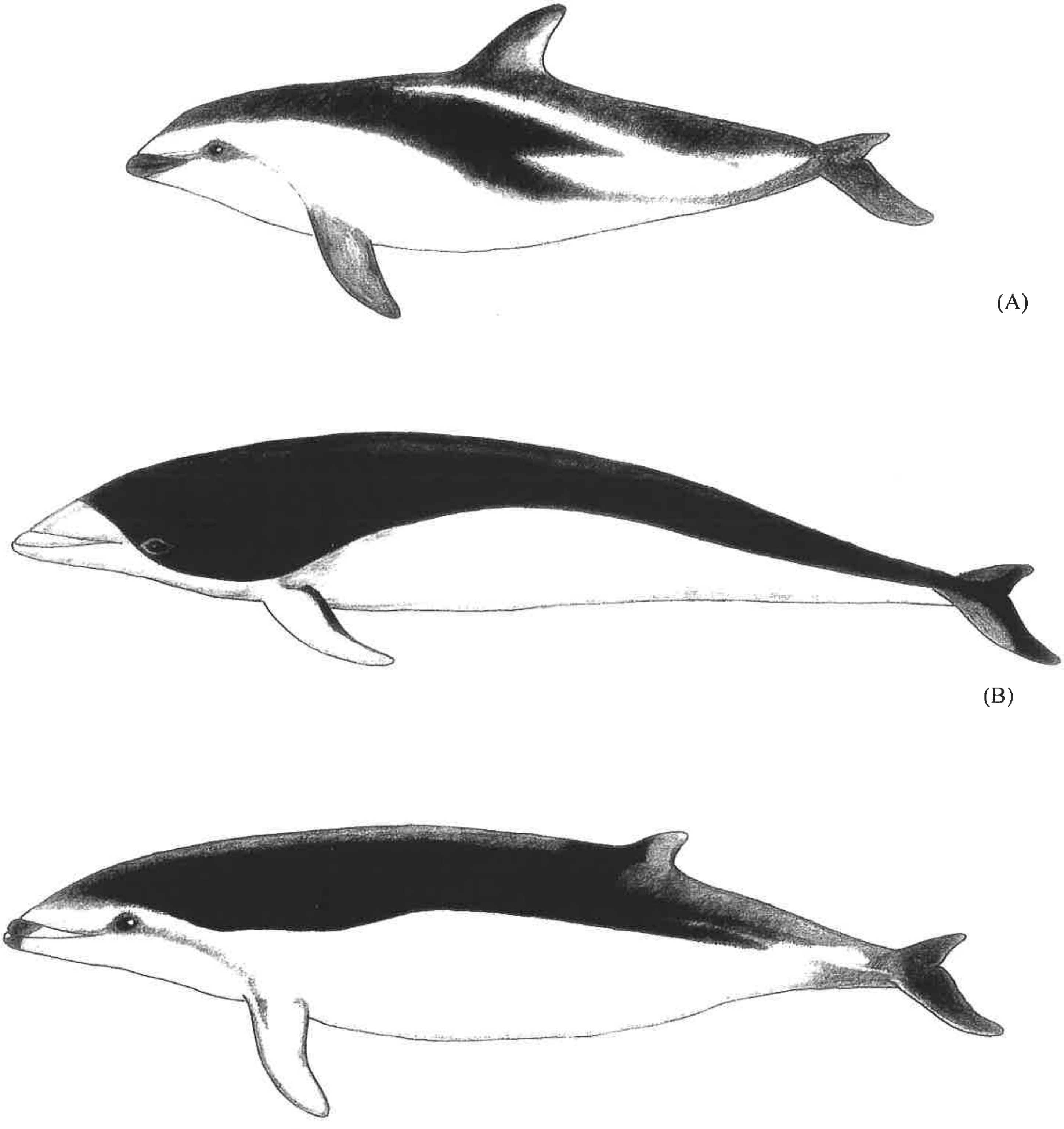

Fig. 2. Morphological characteristics of: (A) dusky dolphin (*Lagenorhynchus obscurus*); drawing according to the most common phenotype, observed in Golfo Nuevo, Argentina; (B) southern right whale dolphin (*Lissodelphis peronii*) according to Cawardine 1995, Torres and Aguayo 1979, Aguayo 1975; and (C) "rare dolphin", based on own photographs, recorded in Golfo Nuevo, Argentina.

LIFE HISTORY

GROWTH LAYERS IN BULLAE TYMPANI OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA RELICTA*)

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Nowadays, the best known hard layered tissue with distinct annual layers in odontocetes is dentine. However, the search for bone laminated structures is useful for a more thorough study of life history events, especially in the cases where the remnants are incomplete. However, the study of mandibula by Watts and Gaskin (1994) showed the irregular character of the bone layering. At the same time, the study of annual laminae in bulla tympani was carried out in mysticetes (Klevezal and Mitchell, 1971; Christensen, 1981, 1995; Klevezal *et al.*, 1987). So bulla tympani was considered a good subject for study in odontocetes.

MATERIALS AND METHODS Bullae tympani from 19 porpoises (in 15 of which the age was determined by counting GLGs in dentine) stranded in 2000 in the Sea of Azov (Ukrainian part) were studied. The bones were decalcified in 5% HNO_3, and paraffin cross-sections 10 μ thick along all the bone with an interval of 300 μ (in the middle part of the bone the interval is 150-200 μ), or from the middle part of the bone were made and stained by Erlich's haematoxylin during 100-140 min.

STRUCTURE OF PERIOSTEAL ZONE AND GROWTH LAYERS IN BULLA Bulla tympani size in harbour porpoises (33-39 mm) does not increase since the perinatal period, and in animals 90 cm long, the bulla already reaches full size, so its growth is characterized by strictly negative allometry. The periosteal zone reaches its maximum thickness in the middle parts of the bone; in the lateral wall, it contains 0.1-0.4 mm regardless of the animal's age, and in the medial wall, it increases from 0.3-0.4 mm in the first years of life to 1.0-1.1 mm in adult animals. During the first years, the periosteal zone consists, as a rule, of the reticular bone tissue (by Enlow and Brown) with large lacunae, and from 3-4 years of age, the dense tissue with regular layers can be seen.

GLG in porpoises, as in baleen whales, is layered by a relatively wide temperately stained layer and a narrow dark stained strip (resting line). At a magnification of x400, it is seen that the resting line consists of a double dark line divided by a very thick unstained lamina. The contrast of neighbouring lines is lower than in dentine and is comparable with that in the bullae of minke whale (Christensen, 1995). The thickness of GLGs in the medial wall decreases with age: in animals with 6-10 GLGs in bulla, the thickness of the first one is about 450 μ, the second one is about 200 μ, the rest are approximately equal and do not exceed 100 μ. In many cases, the first two GLGs cannot be seen or distinguished from each other (in that case, there is a wide layer of dense unlaminated tissue between narrow GLGs and reticular bone tissue). Sometimes, the narrow GLGs are bordered by reticular bone tissue. In one case, in an animal 14 yrs old, the growth layers were not seen at all, and the periosteal zone contained only a dense homogeneous zone. In the lateral wall, GLGs are narrow (60-80 μ), and irregular.

AGE AND BONE LAYERS It is highly probable that GLGs in bulla tympani of porpoises are annuli; their number is equal to that in dentine at ages 6-10 yrs. However, in animals 1-2 yrs old, they are absent or not seen (perhaps they are masked by surrounding tissue or unstained by haematoxylin), and even in adult animals, the number of GLGs is less than in dentine in some sections. Furthermore, the GLGs (some or all) may merge at old age. These circumstances make it difficult for a practical use of GLGs in bullae for life history research at this current stage of study (Gol'din, 2001).

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GROWTH PATTERNS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE GERMAN NORTH AND BALTIC SEAS

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INTRODUCTION Since 1990, the Federal State of Schleswig-Holstein and the Federal Ministries of Environment, Research and Technology, Germany, have been financing a stranding network in order to perform research on stranded cetaceans along the coasts of the North and Baltic Seas. The harbour porpoise (*Phocoena phocoena*) is by far the most numerous cetacean found stranded in Germany, as well as in England, the Netherlands and Denmark (Smeenk and Addink, 1990; SCANS, 1994; Vinther, 1996; Benke *et al.*, 1998). Even though comparable studies have taken place in other European countries, little is still known about the exact birth date and growth patterns of the harbour porpoise of the North Sea and adjacent waters.

METHOD Based on data collected during dissections of harbour porpoises of the North and Baltic Seas, growth patterns of two populations were investigated. Whereas most examinations refer to data of by-caught animals (Lockyer and Kinze, 1999), the information in this study are almost exclusively from stranded porpoises. The animals were all found at the coasts of Schleswig-Holstein, Germany. Growth patterns were best described by the von-Bertalanffy regression model, which has been frequently used before (Lockyer, 1999).

RESULTS AND DISCUSSION With the peak of the birth period at the end of June for the North Sea, and around the end of July for the Baltic Sea, the age of the harbour porpoises was calculated to an accuracy of 1/10. Such accuracy is especially useful for the analysis of the growth patterns of young animals under one year of age. As shown for the North Sea animals, the growth pattern in the first year proves to be significantly different in male and female harbour porpoises. Females under one year of age in the North Sea grow approximately 62 cm within the first year, whereas the males grow only 43 cm in the first year (Figs. 1 & 2). Mean adult lengths for females appear to be about 152 cm for the North Sea and 158 cm for the Baltic Sea, and for males 140 cm and 135 cm, respectively. Differences in length of the two sexes have also been described in other populations (Lockyer and Kinze 1999). Statistical analysis of the data, however, showed no significant difference (<80%) in the growth patterns of adult harbour porpoises, neither within nor between the two populations of the North and Baltic Seas ($p>0.2$) (Fig.3).

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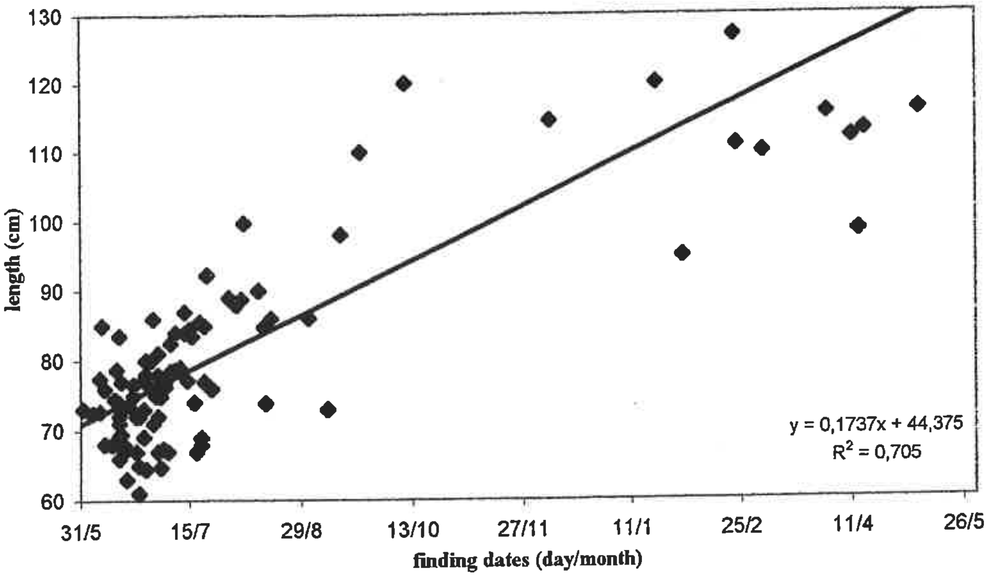

Fig. 1: Length in relation to the finding dates of the first year of life (North Sea females, 1990 – 2000)

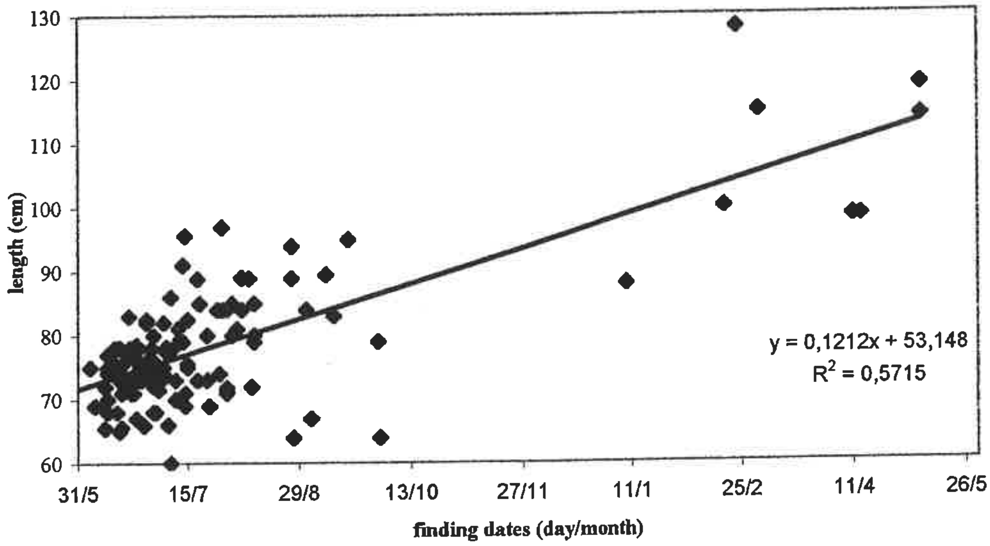

Fig. 2: Length in relation to the finding dates of the first year of life (North Sea males, 1990 – 2000)

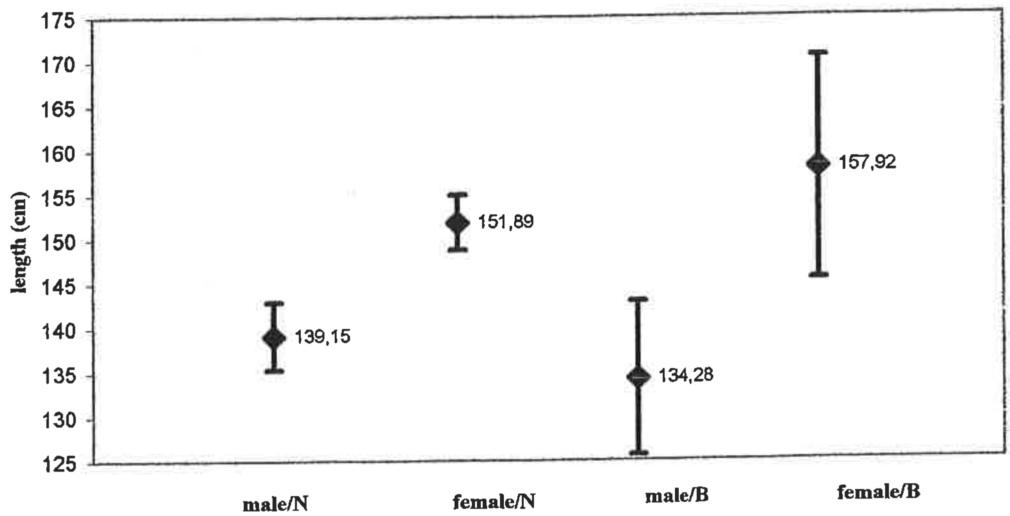

Fig. 3: Asymptotic lengths of male and female harbour porpoises of the North (N) and Baltic (B) Seas (bar = confidence intervals, dots = point estimates)

DOES SIZE MATTER? GONADAL DEVELOPMENT IN THE MALE COMMON DOLPHIN *DELPHINUS DELPHIS*

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There is a severe lack of knowledge on the social structure and social behaviour of the common dolphin, due to the difficulty of examining this species in the wild. However, aspects of their reproductive behaviour can be obtained from post-mortems. Also, analysis of both stranded and by-caught dolphins allow classification of each animal according to the stage of sexual development, and determination of the age and body length at sexual maturity. Testicular development in immature, pre-puberty, and sexually mature male common dolphins was assessed for 189 dolphins collected between 1991-2000. The sample consisted of animals stranded along the Irish and French coasts, and also by-catch samples from Irish and French observer programmes.

Through histological analysis of the testes, it was discovered that individuals could be categorised into one of the following reproductive stages using characteristics of their gonadal morphology; these consisted of immature 1 (I1), immature 2 (I2), pre-puberty 1 (P1), pre-puberty 2 (P2), young mature (YM), active mature (AM), and resting mature (RM). These categories were based on the diameter of the seminiferous tubules, the relative proportion of sertoli cells, interstitial tissue and germinal cells such as spermatogonia, spermatocytes, spermatids, and spermatozoa, activity of the epididymis, and the presence and proportion of spermatogonia within the epididymis. The dolphins ranged in length from 105 cm to 233cm, and from 0.1 years to 27 years of age (as determined by growth layer group counts). Sexually mature individuals ranged in body length from 195 cm to 233 cm in length. Most importantly, however, combined testes weight for all male dolphins varied from 0.0042 kg in immature males to 5 kg in weight for sexually mature individuals, suggesting the likelihood of sperm competition or promiscuity within the species. Seasonal quiescence, and the possibility of a 'rut' period are also assessed.

LIFE HISTORY PARAMETERS OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN SCOTTISH WATERS

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Teeth and tissue samples have been collected from cetaceans stranded around the Scottish coast by the Scottish Agricultural College, Inverness, Scotland since 1992, under a contract from the UK Government's Department of the Environment. One hundred and ninety-six harbour porpoise (*Phocoena phocoena*) teeth and 114 harbour porpoise gonad samples (63 males, 51 females; 1992-99) were analysed as part of DG Fisheries (CEC) Study Project No 97-089.

Maximum age of harbour porpoises in Scotland apparently exceeded 24 years. Maximum sizes recorded were 171 cm for females, and 170 cm for males. On the basis of the histological examination, 48% of male harbour porpoises were considered mature. Maturity was reached at around 120 cm in length. Testis weight increased during the summer months and all the in-season animals were found between June and July. Of female porpoises, 33% were considered mature and the onset of maturity appeared to occur at a length of around 140 cm.

The data were used to construct a simple life table of the Scottish harbour porpoise population, suggesting an overall annual mortality rate of around 0.12. Given that around 20% of recorded mortalities in 1998-99 were fishery by-catches, the annual fishery by-catch rate may be higher than 2%. All figures given are subject to revision as sample sizes increase.

MEDICINE AND DISEASE

MEDITERRANEAN STRIPED DOLPHIN: REHABILITATION CASE

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In May 2000, a striped dolphin (*Stenella coeruleoalba*) was found swimming at the beach of Mataro (Catalunya, Spain). The dolphin stranded a few hours later, and it was transported to the recovery pool of the Centro de Recuperación de Animales Marinos CRAM.

A clinical investigation schedule was established, with periodic haematological and faecal analysis, as well as cytology of the spiracle, and the dolphin was in 24-hour observation each day. Rehydration and systemic anti-biotherapy were established from the onset.

The dolphin was able to feed by itself, and to vocalise. Initial gastrointestinal problems (vomiting, meteorism) ceased on the fourth day of treatment. Atypical behaviour was evident, with surface, circular swimming always in counter-clockwise direction, of approximately two metres diameter, and in the same zone of the pool. Radiography showed no oseous lesions. Sound recording with hydrophones showed no abnormalities. All the clinical parameters were normal, and therefore it was decided to transfer the dolphin to a fenced sea pool. After a few hours, swimming patterns returned to normal.

After 14 days in rehabilitation, it was possible to reintroduce the dolphin to the sea, 16 miles from the coast, in an area where schools of striped dolphin had been sighted. Gathered clinical and behavioural information on this case is of great relevance, due to the lack of documented rehabilitation experiences in this dolphin species.

NASO-PHARYNGEAL MITES *HALARACHNE* SP. (ACARI: HALARACHNIDAE) IN GREY SEALS (*HALICHOERUS GRYPUS*) STRANDED IN NW SPAIN

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INTRODUCTION Among the pinniped species observed along the north-western coast of Spain, the grey seal (*Halichoerus grypus*) is the most frequently recorded. Besides strandings, juvenile grey seals are regularly reported in this area during the winter months. Malnutrition, extreme weakness, and hypothermia were the principal causes of the stranding of these seals.

MATERIALS AND METHODS Between January 1999 and December 2000, five individuals of this seal species stranded alive and were transported to rehabilitation facilities, where three of them were recuperated and released to the open sea. The remaining two died during the rehabilitation attempt, and they were necropsied, tissue sampled, and histopathologically analysed (Geraci and Lounsboury, 1993). These procedures were also carried out with the eight seals found stranded dead. Parasites in the high respiratory tract of the dead seals were examined using standard diagnostic techniques including scanning electron microscopy (SEM). Ultrastructural taxonomic characters were used for their identification.

RESULTS The presence of larval and adult stages of mites belonging to the family Halarachnidae were described in 50% (5/10) of the seals analysed (see Table1). Adult specimens of *Halarachne halichoeri* and a larval form of this species were identified (Furman and Dailey, 1980).

A mean intensity of five mites (1 to 15) was found. In all cases, the mites were located at the naso-pharyngeal portion of the respiratory tract. In one case, some parasites were recovered from the trachea. The skull was opened only in the last three necropsies, and after this procedure, parasites were even recovered from the nasal sinuses.

Abundant muco-purulent nasal exudates were present in all dead seals. Similar muco-purulent nasal discharge and coughing were present in the five live animals, causing respiratory distress. Only in one case, were these respiratory problems associated with a light pulmonary affectation.

CONCLUSIONS The presence of the parasites described in the high respiratory tract of 50% of the seals necropsied, together with the possible presence of *Halarachne halichoeri* mites in the nasal sinuses of the negative ones (skull not opened during the necropsy), appears to be the primary cause of the upper respiratory tract symptoms presented in most of the live seals stranded on the north coast of Spain.

The anti-parasitic drug Ivermectine has been described as a useful agent against marine mammal mites (Dierauf,1990), and the use of it has to be taken into account in live seals with upper respiratory tract symptoms.

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TABLE. 1. Seals stranded in Galicia, during 1999 and 2000. (HRT: higher respiratory tract)

SEAL CODE	ALIVE, DEATH, RELEASED	MITES DETECTED	*Lesions or symptomatology HRT*
HGR99/001	A-D	+	+
HGR99/002	D	-	+
HGR99/003	A-R	-	+
HGR99/004	D	-	-
HGR00/001	D	-	+
HGR00/002	A-D	+	+
HGR00/003	A-R	-	+
HGR00/004	A-R	-	+
HGR00/005	D	-	-
HGR00/006	D	-	+
HGR00/007	D	+	+
HGR00/008	D	+	+
HGR00/009	D	+	+

ORGANOCHLORINE CONTAMINANTS IN MARINE MAMMALS: GEOGRAPHICAL AND TEMPORAL TRENDS CHALLENGE KUZNET'S HYPOTHESIS

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The interpretation of spatial and temporal patterns of variation in organochlorine concentrations in marine mammal populations is complex because of the lack of wide-scale, long term surveys. We selected four well-studied species (bottlenose dolphin, harbour porpoise, fin whale, and harbour seal) and extrapolated global patterns from them. Marine mammals from the temperate fringe of the northern hemisphere, particularly fish-eating species which inhabit the mid-latitudes of Europe and North America, show the greatest organochlorine loads; noteworthy are the extremely high levels found in the Mediterranean Sea, and certain locations on the western coasts of the United States. Concentrations in the tropical and equatorial fringe of the northern hemisphere and throughout the southern hemisphere appear to be low or extremely low. However, the lowest concentrations were found in the polar regions of both hemispheres. During recent decades, concentrations have tended to decrease in those regions where pollution was initially high, but they have increased in regions located far from the pollution source, as a consequence of atmospheric transport and redistribution. It is expected that the Arctic and, to a lesser extent, the Antarctic, will become major sinks for organochlorines in the future.

These patterns of variation seriously depart from the commonly accepted Kuznet's relationship between economic growth and pollution, which is very often taken as a basis for environmental legislation. Thus, environmental management of marine mammals and, more generally, the marine environment should not be based on this principle. Research efforts should focus on the assessment of organochlorine trends in populations living in the currently highly-polluted temperate fringe of the northern hemisphere, and in the polar regions.

BOTTLENOSE DOLPHIN *TURSIOPS TRUNCATUS* HEALTH STATUS AS AN ASSESSMENT OF ENVIRONMENTAL DEGRADATION?

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The Canary Islands represent an area of primary interest in terms of marine mammal biology and health because of the presence throughout the year of 27 cetacean species along with a great concentration of diverse human activities. The growing concern about marine mammal conservation led to the development of a local strandings network, allowing an exhaustive study of the pathologies causing their death. The coastal resident character of bottlenose dolphin *Tursiops truncatus* in these waters points to this species as a suitable marker to estimate the parameters affecting the bio-conservation of this particular marine environment. To achieve the objective of assessing the population health of the local bottlenose dolphin population, a systematic post-mortem analysis of carcasses is routinely carried out at our Veterinary School facilities. We present here the pathological findings of *Tursiops* stranded in the Canary Islands during the period, 1996-2000 (n=11).

The diagnostics showed several processes leading to the death of the dolphins. Most of the animals (n=5) presented a multiorganic failure accompanied by septicaemia and immunodeficiency. Fisheries interactions (n=2) appeared to be the second on the list. Interestingly, we found a case of interspecific interaction, together with thoracic trauma resulting in a cardiovascular failure. Finally, another individual showed an advanced parasitic lepto-meningo-encephalitis caused by a trematode of the *Nasitrema sp*.

The diversity of the pathological processes affecting *Tursiops truncatus* in the Canaries suggests that this species may not be the recipient of a clear predominant human activity-related pathology. Nevertheless, this preliminary conclusion and the relatively small sample size indicate the necessity for a long-term monitoring of those pathological processes in order to define the impact of environmental degradation on this species.

DEVELOPMENT OF A LYMPHOCYTE-TRANSFORMATION TEST FOR PERIPHERAL BLOOD LYMPHOCYTES OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) AND DETECTION OF SELECTED CYTOKINES USING THE REVERSE-TRANSCRIPTION POLYMERASE-CHAIN-REACTION

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Impairment of immune function is suggested to play a contributing role for the increasing incidence of infectious diseases in the harbour porpoise (*Phocoena phocoena*). The purpose of this study was to establish a lymphocyte-transformation-test (LTT) for peripheral blood lymphocytes of harbour porpoises to investigate B and T cell proliferation. As cytokines are important mediators in the interaction of immune cells, the expression of selected pro- and anti-inflammatory cytokines such as interleukin (IL)-2, IL-4, IL-6, IL-10, as well as transforming growth factor (TGF) β and tumor necrosis factor (TNF) α was investigated in mitogen-stimulated lymphocytes using the reverse transcription polymerase chain reaction (RT-PCR).

Using RT-PCR, isolated cytokine-mRNAs were detected in mitogen-stimulated lymphocytes. Primers for IL-2, IL-4, IL-6 were selected from published cDNA sequences of other cetacean species. Primers specific for TNF α and TGF β, as well as for the housekeeping transcripts glyceraldehyde-3-phostate dehydrogenase (GAPDH) and β-actin, were selected from canine cDNA sequences (*Canis familiaris*). After DNAse-treatment, RNA was reverse transcribed and the resulting cDNA was amplified by the Taq-polymerase using a thermo-cycler.

Specificity of the amplicons was confirmed by base-pair length comparison and nucleotide sequence analyses. To evaluate optimal parameters for the LTT, isolated peripheral blood lymphocytes from three harbour porpoises were stimulated with different concentrations of the T cell mitogens Concanavalin A (Con A) and Phytohämagglutinin (PHA) and the T cell-dependent B cell mitogen Pokeweed Mitogen (PWM). Cell proliferation was measured photometrically after 24 h, 72 h and 120 h using the 5-bromo-deoxyuridine-assay, and stimulation indices were calculated.

All investigated mitogens showed the strongest proliferation response after an incubation period of 72 h, using Con A as well as PWM and PHA at a concentration of 2 µg/ml PWM and 5 µg/ml, respectively.

For further studies, *in vitro* assays and molecular biological techniques will allow one to investigate possible impaired immune function in the harbour porpoise.

EVIDENCE OF DISTEMPER IN HARBOUR SEALS (*PHOCA VITULINA*) STRANDED FROM 1990 TO 2000 ALONG THE COASTLINES OF BELGIUM AND NORTHERN FRANCE

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Since 1990, the Marine Animals Research & Intervention Network (MARIN) has been investigating the causes of death of marine mammals stranded along the Belgian and northern French coasts. In a 10-year period, 33 harbour seals (*Phoca vitulina*) were necropsied, 11 dying within one month, July and August, in 1998. Special attention was given to the occurrence of morbillivirus infections in seals.

Immunohistochemistry using two monoclonal antibodies (PDV 1.3 and CDV 1C5) was performed on various tissues. Anti-CDV neutralising antibodies were detected in sera of six animals, with titres varying from 1/8 to 1/128. By immunohistochemistry, specific labelling was undertaken in tissues of five seals. In parallel, RNA was extracted from frozen and formalin-fixed, paraffin embedded tissues and three sets of primers used for RT-PCR amplifying part of the morbillivirus phosphoprotein gene, yielded 78 and 252 base-pairs (bp) respectively. A formalin-fixed, paraffin-embedded lymph node of a morbillivirus-infected fin whale was used as a positive control. Fragments of about 78 bp were generated from both frozen and formalin-fixed, paraffin-embedded tissues (11 seals) while 252 bp were only obtained from frozen samples of three seals. In total, eight seals were positive for morbillivirus infection by two diagnostic methods. Most of the seals were juveniles stranded during summer 1998. These findings suggest that a morbillivirus outbreak occurred in seals, resulting in deaths at that time. This outbreak appears to be the first in the North Sea since 1988.

TRACE METAL CONCENTRATIONS OF HARBOUR PORPOISES FROM THE NORTH AND BLACK SEAS: RELATION WITH THEIR NUTRITIONAL STATUS

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Harbour porpoise, *Phocoena phocoena*, considered an important target species for pollution, has an extended distribution throughout European waters, making it a useful bio-indicator. Trace metal (Cd, Zn, Cu, Pb, Fe, Se, Ni, Cr) levels have been determined, and compared in the liver, kidney and muscles of 41 individuals stranded on the southern North Sea coasts (Belgium and France), and 46 by-caught individuals from Ukrainian coasts. The porpoises from the North Sea were necropsied, and one of the main lesions observed was severe emaciation, characterised by reduction of blubber thickness and atrophy of muscles.

Hepatic and renal zinc concentrations were significantly higher in emaciated porpoises than in normal animals. Other metal levels were similar between the two groups. The highest zinc concentrations (more than 700 µg.g-1 dw) were measured in the livers of juvenile emaciated porpoises at the end of their growth period.

As shown by their higher length to weight ratio and blubber thickness, Black Sea porpoises were in very good nutritional status. This can explain, at least in part, their significantly lower hepatic and renal zinc concentrations when compared to the Belgian porpoises. These results suggest a severe disturbance of the zinc metabolism related to the emaciated status of the animals. Therefore, the nutritional status of marine mammals must also be taken into consideration when using these species as bio-indicators of trace metal pollutants.

FATAL INTERACTION BETWEEN HARBOUR PORPOISES AND BOTTLENOSE DOLPHINS IN CARDIGAN BAY, WALES – IS PREY COMPETITION TO BLAME?

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Violent and often fatal interactions between bottlenose dolphins and harbour porpoises have been recently documented in UK waters. During the period 1991-2000, 467 harbour porpoises found stranded on the coastline of England and Wales were examined at post mortem using standardised methodology. Of these, 17 (six females and 11 males) were diagnosed to have died of physical trauma resulting from violent interactions with bottlenose dolphins. All were found exclusively within the Cardigan Bay area of Wales between 1995 and 2000, and comprised four adults and 13 subadults/juveniles.

External injuries were rarely found, although four animals had skin lesions consistent with bottlenose dolphin teeth marks. Internal injuries characteristic of these interactions included extensive bruising and haemorrhage in the subcutis and underlying muscles (n=17), haemorrhagic tears (often cavitating) of the internal blubber layer (n=16), multiple rib fractures (n=16), pleural tears (n=13), and separation of blubber from underlying tissue (n=7). Other lesions included haemothorax (n=10), brain haemorrhages (n=10), torn spinal musculature in the thoracic region (n=5), pneumothorax (n=2), liver rupture (n=2), and skull fracture (n=2). Nutritional status was classified as good (n=13), good/moderate (n=1) and moderate (n=3). Evidence of recent feeding was found in ten animals. Until 2000, when eight cases were identified, annual stranded harbour porpoise mortality in Cardigan Bay due to fatal interaction with bottlenose dolphins ranged from 0-4 cases. The high prevalence of individuals within this group with recently ingested prey, together with the absence of neonates, suggests that this phenomenon may be due to prey competition in the Cardigan Bay area between harbour porpoises and bottlenose dolphins.

FISHERIES-RELATED TRAUMATIC SHOCK DEATHS IN PYGMY SPERM WHALES *KOGIA BREVICEPS*

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The diagnosis of cetacean by-catch is more than ever under the scrutiny of the scientific community. Although widely reported in certain species, the circumstances of fisheries interactions remain poorly documented and the precise associated pathological processes are still lacking, especially for the species not commonly identified to be interacting with fishing operations. We document here the stranding of three *Kogia* in different regions of Spain (Canarias, Galicia y Asturias) between 1999 and 2001, and discuss the similarity of the clinical and pathological findings as indicative of a possible repetitive fisheries interaction. The three animals, young to adult males, stranded alive and died shortly after beaching. External examination showed no obvious fisheries-interaction-related marks, with the exception of rostral abrasions, and, in one case, penetrating incisions around the mouth. Full necropsies were routinely conducted, and the three *Kogia* were diagnosed to present a traumatic shock due to cervical vertebrae, and skull fractures with spread haemorrhages of the cervical region together with subdural, well-organised haematoma compressing the temporal cortex. In addition to the shared trauma diagnosis, lung congestion, tracheal froth, subcutaneal crassicaudasis, and full urinary bladder were also found. The skull morphology and bone texture of this species may help to understand the specificity of the skull and vertebral fractures found after a violent impact, without the beak fractures commonly described in other better-known by-caught species. In fact, the absence of a prominent rostrum in this species may explain why *Kogia* is not usually reported entangled, and lacks the obvious consequent head fishing-line marks. The latter information, added to the time that the animals survived after the interaction, could have masked to some extent the usual evident fishing marks. Although not being the most obvious candidate for consideration as by-catch, the similarity of the clinical and pathological findings after the stranding in the same circumstances of three animals of the same species in three different regions, suggest that this could well illustrate a diagnostic of fisheries interaction involving *Kogia sp.*

ARE THE MEDITERRANEAN CETACEANS EXPOSED TO THE TOXICOLOGICAL RISK OF ENDOCRINE DISRUPTERS?

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Endocrine Disrupting Chemicals (EDCs) have recently attracted much public and scientific attention. EDCs are a structurally diverse group of compounds that may adversely affect the health of humans and wildlife, or their progenies, by interaction with the endocrine system. They include chemicals used heavily in the past, in industry and agriculture, such as polychlorinated biphenyls and organochlorine pesticides, and those currently used, such as plasticisers and surfactants. In this presentation, the unexplored hypothesis that Mediterranean cetaceans are potentially at risk due to EDCs is investigated. In the Mediterranean environment, top predators accumulate high concentrations of polyhalogenated aromatic hydrocarbons and toxic metals, incurring high toxicological risk. Here we illustrate the need to develop sensitive non-lethal techniques, such as non-destructive biomarkers, for the hazard assessment of Mediterranean threatened species exposed to EDCs. Subcutaneous tissue consisting of skin and blubber, was obtained from *Stenella coeruleoalba, Tursiops truncatus, Delphinus delphis* and *Balaenoptera physalus*. Sampling was performed in the western Ligurian Sea, between Corsica and the French-Italian coast, and in the Ionian Sea.

In this project we proposed BPMO activity in skin biopsies as a potential indicator of exposure to EDCs, such as organochlorines (OCs). Significant differences were detected both in BPMO induction and in OC levels between odontocetes and mysticetes. The odontocetes presented a value of mixed function oxidase activity four times higher and levels of OCs one order of magnitude higher by comparison with the mysticetes. A statistical correlation ($p<0.05$) was found between BPMO activity and organochlorine levels in skin biopsy specimens of males of *Balaenoptera physalus* and also in skin biopsy specimens of the endangered Mediterranean population of *Delphinus delphis*. These results suggest that BPMO induction may be an early sign of exposure to EDCs, and a potential warning for trans-generational effects, related to the exposure of future generations via the placenta and milk.

HISTOPATHOLOGICAL FINDINGS IN THE LIVER OF CETACEANS STRANDED IN THE CANARY ISLANDS (1995-2000)

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From 1995 to 2000, liver samples of 109 cetaceans of different species stranded on the Canary Island coasts have been taken for the corresponding histological study.

After necropsy, hepatic tissues were fixed in 10% buffered formalin, processed and included in paraffin. Histochemical and immunohischemical techniques were performed on liver tissues sections for the microscopical study. Because of the variable times between death and necropsy, varied degrees of autolysis were presented in the same specimens, making assessment of subtle changes difficult and unreliable. However, many of these were preserved in good morphological conditions for study.

Degenerative and inflammatory processes were the most obvious morphological findings observed in many cases. A classification of those histological findings and a comparative discussion with liver diseases presented in other parts are presented.

POSTMORTEM FINDINGS AND CAUSES OF DEATH OF HARBOUR SEALS (*PHOCA VITULINA*) STRANDED FROM 1990 TO 2000 ALONG THE COASTLINES OF BELGIUM AND NORTHERN FRANCE

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Since 1990, the multidisciplinary research network MARIN (Marine Animals Research and Intervention Network) deals with the scientific research of marine mammals stranded along the Belgian and northern French coasts, or by-caught. Causes of death are investigated and toxicological analyses performed on collected samples. MARIN also assists in marine mammal rescues, and transportation of live stranded animals to rehabilitation centres.

A total of 33 harbour seals (*Phoca vitulina*) were necropsied. From 1990 to 1997, only five animals were available for postmortem examination, against 11 in 1998, 7 in 1999 and 10 in 2000. Sex ratios were normal, and animals were mainly juvenile (75%). The major non-human associated causes of death were bronchopneumonia and septicemia. In addition, a series seals showed evidence of a previous by catch and various trauma. Evidence of morbillivirus infections, detected by immunochemistry and Reverse Transcriptase Polymerase Chain Reaction, was obtained in 7 cases. Most of infected seals were pups stranded during the 1998 summer, when 11 seals died in less than 1 month. These findings suggest that a morbillivirus disease caused the strandings. To the authors' knowledge, those were firsts cases of morbillivirus infection in harbor seals in the North Sea since the 1988-1989 outbreak. They indicate that distemper is still present in the seal population. Bronchopneumonia and septicemia were probably caused by secondary bacterial infections due to immunosupression induced by the morbillivirus or by the lack of passive acquired immunity in 2-months old animals.

PATHOLOGY OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) BY-CATCHES RETRIEVED FROM UK GILLNET FISHERIES

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Although criteria for the diagnosis of cetacean by-catch have been established, few reports exist of the pathology of cetaceans known to have died in fishing nets. Between 1993 and 2000, 34 harbour porpoises (17 male, 17 female) by-caught in commercial gillnet fisheries off the UK coast were retrieved for necropsy. Of these, 22 were juvenile/subadults and 12 were adults. The nutritional status of these individuals was classified as good (n=27), good/moderate (n=4) and moderate (n=3).

External lesions consistent with entanglement in fishing gear included linear cuts on the edges of the mouth, fin or fluke (n=33) and circumscribing lesion(s) around the head (n=18). Internal injuries included subcutaneous bruising around the head or scapula (n=13), skeletal muscle tears (n=2), fractured mandible (n=1), and a bitten tongue (n=1). Lesions consistent with the release of a carcass from a fishing net included amputated fin or fluke(s) (n=9), and penetrating incision(s) into the body cavity (n=2). Recent ingestion of prey was found in 30 individuals, and included partly digested or undigested prey contents in the cardiac stomach chamber (n=23) or oesophagus (n=3), and chyle in the lymphatics of the intestinal mesentery (n=20).

Pulmonary findings were non-specific and included bilateral diffuse congestion (n=34), intra-alveolar oedema (n=34), mild multifocal intra-alveolar haemorrhage (n=33), and persistent white or blood-tinged froth in the trachea and bronchi (n=33). Two animals had epicardial petechiae, but pleural petechiae, bullous emphysema in the lungs and evidence of inhalation of seawater were not found. A range of parasitic infections and associated lesions commonly found in harbour porpoises were also recorded in many individuals, although none were considered life-threatening. The findings of this study are highly consistent with existing criteria established for the diagnosis of cetacean by-catch.

PARAPOXVIRUS INFECTION IN HARBOUR SEALS (*PHOCA VITULINA*) FROM THE GERMAN NORTH SEA

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In the summer of 2000, proliferative lesions of the skin and mucosa of the oral cavity were recognised in 24 young harbour seals (*Phoca vitulina*) from a rehabilitation centre in Schleswig-Holstein, Germany. Mucous membranes of the oral cavity especially the tongue, displayed verrucose roundish nodules. Furthermore, the animals developed spherical dermal elevations, approximately 1-2 cm in diameter, with ulceration on flippers, chest, neck and perineum. Biopsy samples were taken from the nodules of three animals, and were processed for light and electron microscopy. One harbour seal died during surgery.

At necropsy, the animal showed a mild tonsillitis in addition to the cutaneous changes. Histological examinations of several skin nodules of the diseased animals revealed a perivascular, lymphohistiocytic dermatitis with ballooning epidermal cells and large eosinophilic intracytoplasmic inclusion bodies within degenerating cells of the stratum spinosum. In addition, there were masses of superficial necrotic debris and bacteria accompanied with exophytic neutrophils. Examination of suspensions prepared from skin lesion by electron microscopy led to the detection of parapoxvirus viral particles. Furthermore, the presence of parapoxvirus was confirmed by PCR. According to the literature, this is the first report of a parapoxvirus infection in harbour seals.

MAXILLAR FRACTURES IN ANIMALS SUSPECTED OF BY-CATCH

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The percentage of animals suspected of by-catch has increased in the last few years on the Catalonian coast. In most cases, the animals were found dead. Those animals suspected of having been by-caught, usually present clean cut-off tails and fins; incision wounds in the abdominal cavity and on the edges of fins, lips and flukes; and multiple evenly spaced parallel incision wounds in the skin, caused by the nets. Until last year, maxillary fractures have not been observed in dolphins rescued by our group.

Two individuals, an adult common dolphin (*Delphinus delphis*) and a juvenile striped dolphin (*Stenella coeruleoalba*), stranded alive. In both cases, physical examination revealed severe traumatic lesions affecting the maxilla. The common dolphin presented a complete bone fracture of the cranial part of the mandible with retraction of underlying soft tissues and haemorrhage, leaving the mandibular bone exposed. The animal died before arriving at CRAMC's facilities. In the second case, a striped dolphin was referred to CRAMC's rehabilitation facilities, from Valencia. Clinical examination revealed beak deformity and an extensive ulcer in the palate. Radiographs indicated a fracture in the maxilla and a fissure in the mandible. The animal died after two days. Besides bone fractures post-mortem evaluations did not reveal relevant pathologic alterations.

Mandibular fractures in cetaceans could only be caused by collision with a hard surface. In normal conditions, the sonar system permits the animal to avoid obstacles. We believe that these mandibular lesions are probably caused by human interaction, more specifically by the animal being struck by a boat. Fractures of mandible and maxilla could have different ultimately fatal effects on the animal: 1) impossibility of hunting and feeding behaviour; 2) infection of the fracture; 3) stress by pain; 4) disruption of the emission-reception function; all together leading the animal to starvation and stranding.

A FIN WHALE STRANDING ON THE MEDITERRANEAN COAST OF TURKEY

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The occurrence of the fin whale, *Balaenoptera physalus,* being the only regular mysticete in the Mediterranean, has been little studied in the eastern part of the Mediterranean, including Turkish coastal waters. In March 2000, a fin whale stranded on Yumurtalik, Adana, on the Mediterranean coast of Turkey. It was female, 1025 cm in body length, and 3260 kg in body weight. Based on the body length, it was probably a calf, and possibly still suckling. The stomach was empty. The body weight shows that the animal died from starvation or malnutrition since a fin whale of this length should weigh 4.5-5 tonnes, according to the North Atlantic fin whale weight/length formula. The blubber was very thin, only 2.0-6.5 cm in thickness, which also supports our speculation. There was no injury externally.

An autopsy revealed that there were numerous worms *Crassicauda* sp. in vena cava along the dorsal side of the liver, but not in the kidney. Thousands of this worm (about 5 mm in diameter and more than 50 cm in length) expanded the vena cava to form a bundle of 10 cm diameter and 1m length. This heavy infection of nematodes may have had some lethal effect on the animal. This is the third stranding case of the fin whale reported in Turkey, following previous ones at Adana in 1974, and Kusadasi in 1998.

GASTRIC PERFORATION AND ACUTE PERITONITIS CAUSED BY *PHOLETER GASTROPHILUS* IN A STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

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A gastric perforation related to *Pholeter gastrophilus* parasitic nodules, with secondary septic peritonitis was diagnosed in a striped dolphin (*Stenella coeruleoalba*) from the Spanish Mediterranean coast. An adult female dolphin, 49 kg weight, and 158 cm length, was found dead, and necropsied.

Main findings were a diffuse sero-fibrinous peritonitis with 1.2 litres of exudate, and multiple gastric parasitic nodules in the glandular and pyloric stomach. One parasitic nodule at the entry of the pyloric gastric compartment presented a deep area of necrosis with perforation to the peritoneal cavity. Layers of fibrin covered the external surface of stomach compartments around the perforation and part of the liver, inducing fibrinous adhesions between them. Other findings were cysts of *Phyllobotrium delphini* in the blubber, and two "Tatoo" skin lesions. Microscopically, parasitic gastric nodules showed a chronic granulomatous reaction associated with trematode ova and flukes, identified as *Pholeter gastrophilus.* Bacterial emboli were observed in blood vessels of the brain, spinal cord, lymph nodes, and tonsil. These bacteria were coccoid organisms, very different from the typical ones found in putrefaction. In tonsils, multifocal areas of necrosis were also associated with bacterial colonies. In the lung, congestion and multifocal haemorrhages were observed. The pancreas presented trematodes in interlobular ducts, mild periductal fibrosis, and a severe multifocal lympoid hyperplasia between glandular parenchyma. *Clostridium spp., Serratia marcescens, Klebsiella pneumoniae* and *Alcaligenes faecalis* were cultured from ascitic fluid.

It was concluded that this animal probably died from septicaemia, as a consequence of septic peritonitis. In our experience, this is the first case of a gastric perforation with septic peritonitis associated with *Pholeter gastrophilus* in a cetacean species. This parasite is commonly found in the pyloric and glandular stomach compartments and duodenal ampulla, without serious pathological consequences for the host. Perforation of gastric compartments in cetaceans has been reported associated with nematode infestation (mainly *Anisakis* spp).

PYOGRANULOMATOUS MYOCARDITIS DUE TO STAPHYLOCOCCUS AUREUS SEPTICEMIA IN TWO HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM THE GERMAN BALTIC SEA AND INNER DANISH WATERS

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Besides parasitically-induced lesions, bacterial infections are the most common disease in harbour porpoises (*Phocoena phocoena*) from European waters. Here we report on two cases of pyogranulomatous myocarditis due to *Staphylococcus aureus* septicaemia found in a stranded, dead harbour porpoise from the German Baltic Sea, and a captive harbour porpoise from Inner Danish waters.

Post mortem examination of the two harbour porpoises was performed according to the Proceedings of the First European Cetacean Society (ECS) Workshop on Cetacean Pathology. Samples were taken for histology, serology, immunochemistry, microbacteriology and parasitology.

Lesions included pyogranulomatous myocarditis, suppurative-necrotising bronchopneumonia and lymphadenitis, suppurative pyelonephritis, osteomyelitis, leptomeningitis and abscessation in lymph nodes and skeletal muscles in the stranded harbour porpoise. The captive animal showed fibrinous suppurative epicarditis and pyogranulomatous myocarditis with abscessation. The portal of entry was suspected to be skin lesions or the respiratory tract.

HISTOLOGICAL INVESTIGATIONS ON THE THYROID GLANDS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM GERMAN, ICELANDIC AND NORWEGIAN WATERS

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INTRODUCTION Thyroid glands represent one of the major target organs for endocrine disruptors. Several toxicological investigations have revealed a high burden of pollutants including DDD, HCHs, and PCBs in harbour porpoises (*Phocoena phocoena*) (Bruhn, 1997). Several of these pollutans have been shown to have endocrine disrupting effects in other species (Aguilar and Borrell, 1995; Bruhn *et al.*, 1995).

Changes in thyroid function and morphology can be induced by PCBs, as has been shown in rats under experimental conditions (Bryne *et al.*, 1987). A reduction in serum concentration of thyroid hormones was demonstrated in seals (*Phoca vitulina*) that had been fed with fish contaminated with PCBs (Brouwer *et al.*, 1989). In addition, PCB contamination has also been associated with interstitial fibrosis in thyroid glands from seals (Schumacher *et al.*, 1993).

Toxicological studies revealed that tissues from Icelandic seals contained much lower levels of chlorinated hydrocarbons compared with animals from the North Sea (Luckas *et al.*, 1990). Therefore the aim of this study was to investigate the thyroid glands of harbour porpoises from German, Icelandic, and Norwegian waters for possible pathological changes.

MATERIALS AND METHODS Post mortem examinations (Kuiken and Hartmann, 1993) of 36 harbour porpoises from German, Icelandic, and Norwegian waters were performed between 1998-2000. Thyroid glands of 12 stranded or by-caught harbour porpoises from each of these waters were collected at necropsy. Of the investigated animals, 12 were males and 24 females. Age classification was based on the body weight and sex organ size. There were two neonates, 19 sub-adults and 15 adults. For histological examinations, sections were stained by Haematoxylin and Eosin (HE) as routine stains, and with the van Gieson stain for detection of collagen. Furthermore, thyroid glands were examined immuno-histologically using a standard avidin-biotin-peroxidase technique (Baumgärtner *et al.*, 1989) and a polyclonal rabbit anti-human thyreoglobulin antibody (Code No. A 0251, DAKO Corporation, Glostrup, Denmark). Ten randomly selected fields of the thyroid gland were semi-quantitatively evaluated using follicle size and estimation of degree of solid and follicular tissue areas and degree of connective tissue as criteria (0-5%, 6-25%, 26-50%, 51-75% and 76-100%).

RESULTS With respect to number and size of follicles, differences were observed in all three groups. The analysis of thyroid glands of harbour porpoises from German (Figs 1a, 2a, and 3a) and Norwegian waters resulted in a relatively low number of follicles for varying size (harbour porpoises from German waters: 1.6 small-, 1.9 medium-, 1.7 large- and 1.1 high-sized follicles; harbour porpoises from Norwegian waters: 5.4 small-, 0.8 medium-, 0.4 large- and 0.3 high-sized follicles; Fig. 4). Whereas the follicles in samples from German animals were rather uniformly distributed over all size classes, the samples from Norwegian animals showed a high number of small-sized follicles. The thyroid glands from Icelandic animals (Figs. 1b, 2b, and 3b) were dominated by small-sized follicles, and high-sized follicles were not found (harbour porpoises from Icelandic waters: 18.7 small-, 1.4 medium-, 0.2 large- and no high-sized follicles; Fig. 4).

The analysis of interfollicular collagen revealed comparable findings for animals from German and Norwegian waters (German and Norwegian waters: 25.5% and 24.8% of the thyroid gland is represented by collagen, respectively; Fig. 5). Correspondingly, only a relatively low percentage of solid tissue was observed (German waters: 53.0%; Norwegian waters: 52.5%). By contrast, the thyroid glands from Icelandic animals exhibited a very low percentage of collagen (3.5%) whilst a high percentage of solid tissue samples (73.8%) was observed. The degree of severity of fibrosis between the three groups was significant (Kruskal-Wallis test; p=0,001). The distribution of follicles in the thyroid glands was uniform for harbour porpoises from all three areas (German waters: 6.2%; Icelandic waters: 4.8%; and Norwegian waters: 3.6%).

DISCUSSION Only minimal interfollicular fibrosis was observed in the thyroid glands from Icelandic animals, whereas thyroid glands from Norwegian and German harbour porpoises showed a moderate to severe interfollicular fibrosis. Additionally, thyroid glands with increased fibrosis exhibited a loss of follicles. The present study allows no final statement to be made about the cause or the mechanisms that are responsible for the increased fibrosis in thyroid glands of harbour porpoises from German and Norwegian waters. Previous studies showed that PCBs cause changes in thyroid function and morphology, such as decreased thyroid hormone production and interstitial fibrosis (Bryne *et al.*, 1987; Brouwer *et al.*, 1989; Schumacher *et al.*, 1993). In conjunction with toxicological investigations, the present findings suggest that thyroid glands of harbour porpoises may be adversely affected by chemical endocrine disruptors. Although it remains speculative at present, the adverse effects of pollutants on the thyroid glands may cause interfollicular fibrosis, and the loss of follicles in thyroid glands of harbour porpoises from German and Norwegian waters.

ACKNOWLEDGEMENTS The study is generously funded by the German Federal Environmental Agency (UBA). We are greatly indebted to all fishermen, seal hunters, and environmental organisations for supplying the Institute with carcasses. Furthermore, we would like to thank our Icelandic, Norwegian, and Danish colleagues for their assistance in sampling harbour porpoises.

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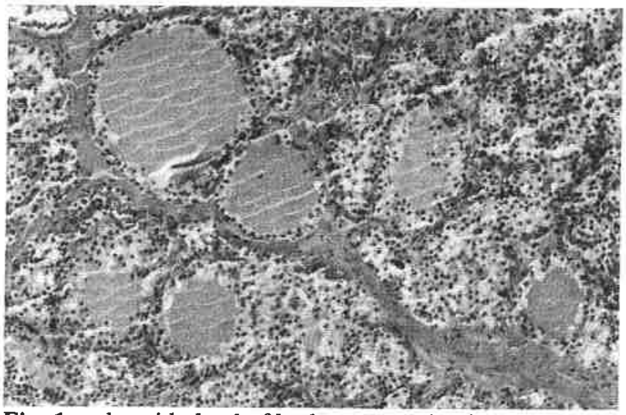
Fig. 1a: thyroid gland of harbour porpoise from German waters, H.E.

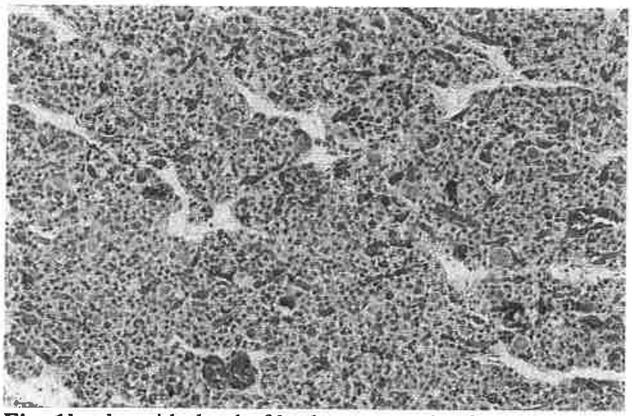
Fig. 1b: thyroid gland of harbour porpoise from Icelandic waters, H.E.

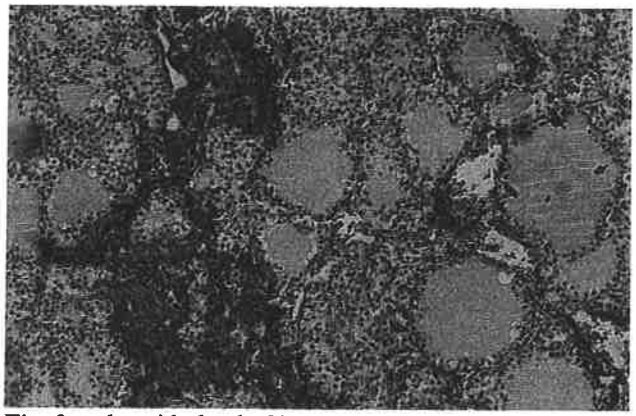
Fig. 2a: thyroid gland of harbour porpoise from German waters, *van Gieson*

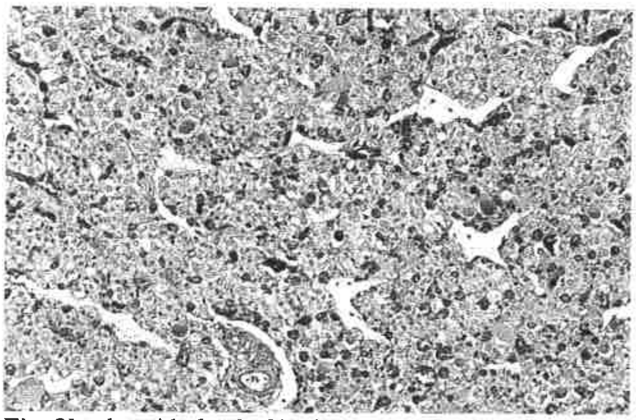
Fig. 2b: thyroid gland of harbour porpoise from Icelandic waters, *van Gieson*

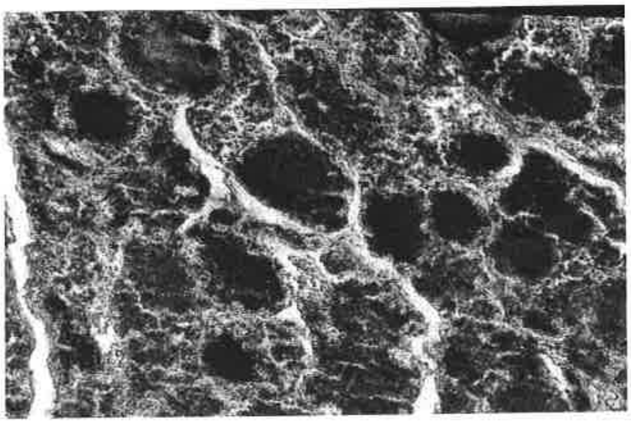

Fig. 3a: thyroid gland of harbour porpoise from German waters, avidin-biotin-peroxidase technique

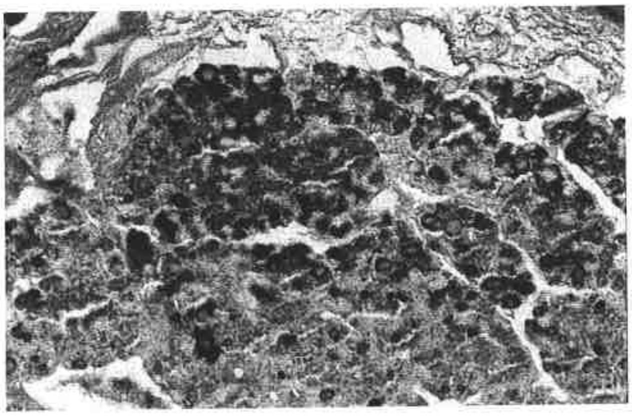

Fig. 3b: thyroid gland of harbour porpoise from Icelandic waters, avidin-biotin-peroxidase technique

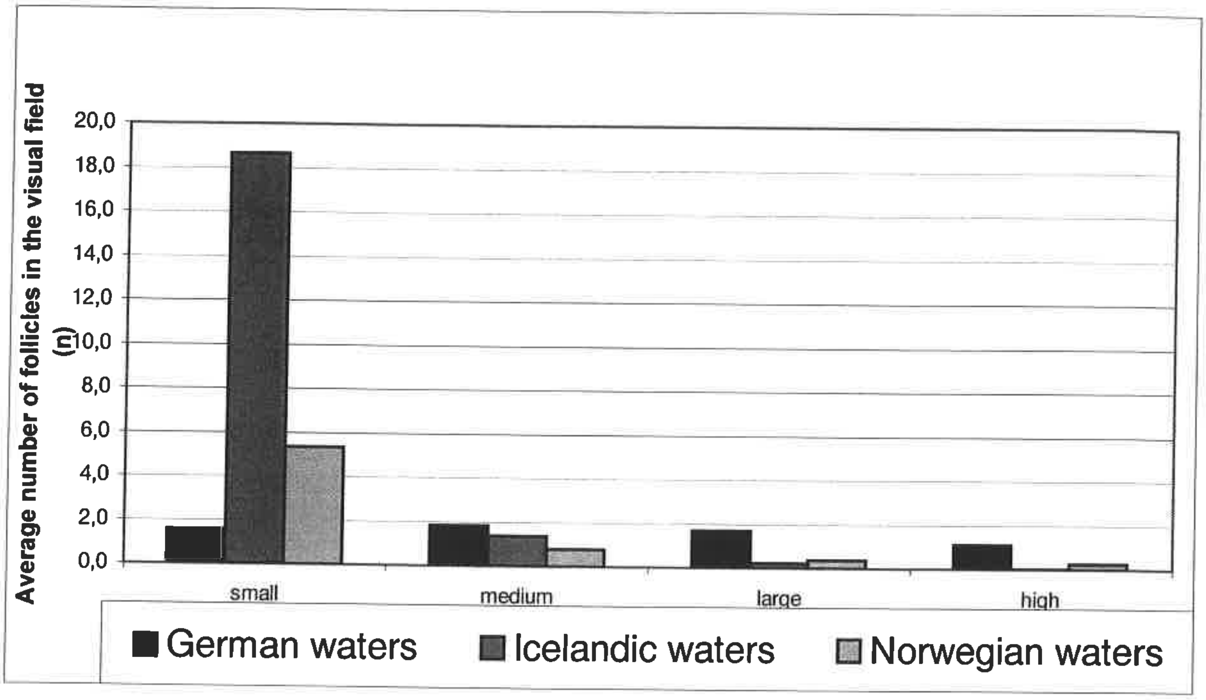

Fig. 4: Follicle Analysis

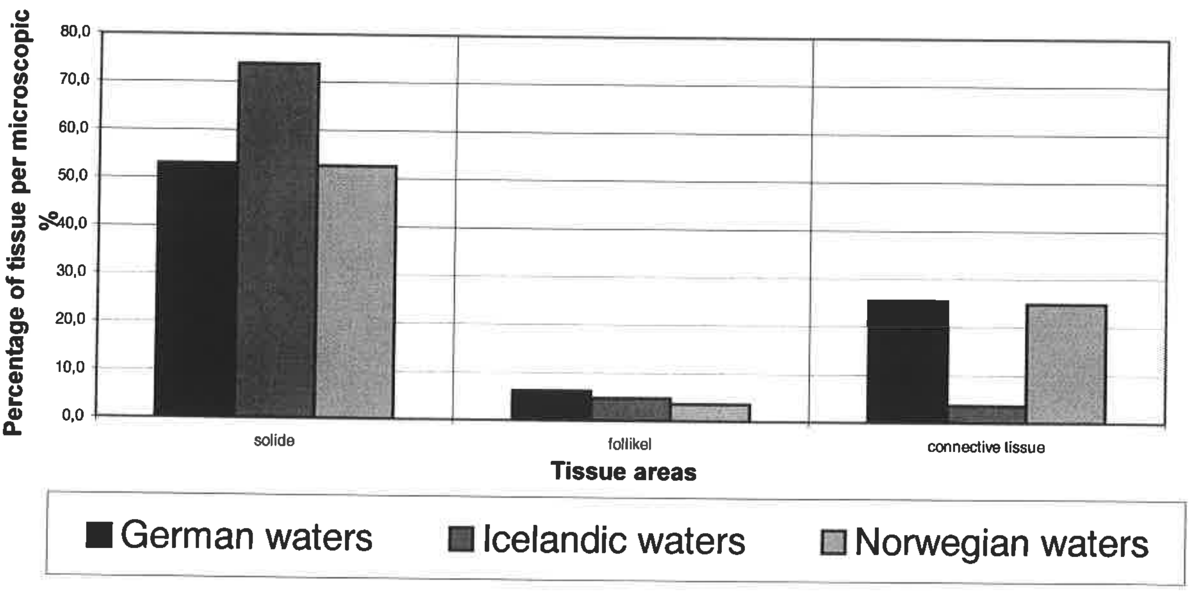

Fig. 5: Tissue Analysis

ACOUSTIC DEFICIENCY AND MORTALITY IN FREE-LIVING DOLPHINS

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Any etiological agent that could influence in a negative way the use of the biosonar of free-living dolphins is an important factor that can bring about the death of the animal. Given the anatomical features of the dolphin head, the anatomical areas most affected by etiological agents that cause hearing deficiency are likely to be the nasal/auricolar sinus and the mandible (by parasites and traumatic injuries respectively).

Three clinical cases regarding two mandibular fractures in bottlenose dolphins (*Tursiops truncatus*), and one parasitic infection in a Risso's dolphin (*Grampus griseus*) in which the echolocation deficiency might have been one of the main causes of death in these animals stranded along the Italian coasts, are examined.

NEW TECHNIQUES

SHORT-BEAKED COMMON DOLPHIN PREY SPECIES IN THE EASTERN IONIAN SEA: INSIGHT FROM FISH SCALES SAMPLED DURING SURFACE FORAGING

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INTRODUCTION A short-beaked common dolphin (*Delphinus delphis*) community has been the subject of a long-term study conducted in eastern Ionian Sea coastal waters since 1993 (see Bruno *et al.* and Politi and Bearzi, this volume).

In this area, common dolphins engage in activities involving feeding rushes and high-speed fish pursuits at the water-air interface for approximately 5% of their total time budget (based on >12,500 behavioural 3-min samples collected in 1996-2000).

Evidence of actual feeding other than surface "events" (*sensu* Bearzi *et al.*, 1999), performed by the dolphins, included observations of dolphins biting or carrying prey in their mouths, fish scales drifting in the water following surface-feeding events, and frantic gathering of marine birds in the area.

When visible from the surface, prey targets were mostly schooling fish, 5-15cm long, the taxa of which could not be visually identified. To gain insight into common dolphin feeding ecology, this study focused on drifting scales collected immediately after individual predatory events.

MATERIALS AND METHODS The fieldwork was carried out between 1997-2000, from May to October. The study area is located in the eastern Ionian Sea, in the waters surrounding the island of Kalamos, Greece. Observations were conducted from 4.7 m inflatable craft with fibreglass keels, powered by outboard engines. The scales lost by fish during predatory events were sampled by means of a snare (mesh size=0.4 mm, diameter=20 cm) mounted on top of a 1.5 m wooden pole.

The snare was handled from aboard the boat, in sampling spots where surface-feeding events were observed ("feeding spots"). Drifting fish scales could be visually detected up to a depth of a few metres, due to their reflective properties in the sunlight. Due to the rapid sinking of the scales, their recovery from aboard the boat was only possible soon after a predatory event occurred in a feeding spot. The scales collected with the snare were preserved in 80% ethanol and stored into labelled vials.

A total of 57 fish scale "catches", each catch relating to one predatory event in a given feeding spot, were collected in 35 different days across the 4-year study period (Table 1). Fish scales were stored in separate vials (one vial per catch). The number of scales included in a vial ranged between 1-20 (mean=5.6, SD=4.67, N=57).

One scale was randomly extracted from a vial for fish species identification. Scales were hydrated with distilled water for approximately 5 h, placed in a 10% potassium hydroxide solution for 30 min, gently brushed, then mounted between two microscope slides, and photographed with a Leica DM RB polarising-light microscope (x 1.6 lens).

The photographs of scales sampled, following common dolphin feeding events, were then compared with an atlas of scale photographs obtained from known local fish species. Since morphological variability exists among scales from different body parts of the same individual, the atlas included photographs of scales collected from four different body parts, for fishes of various sizes.

RESULTS The analysis showed that all the scales sampled, following common dolphin feeding events, were Clupeiformes (Table 2). In particular, 50.9% (N=29) were found to be scales from either sardines *(Sardina pilchardus)* or gilt sardines (*Sardinella aurita*). These species could not be reliably discriminated based on photos included in the atlas (Fig. 1). The remaining 49.1% (N=28) were anchovy scales (*Engraulis encrasicholus*).

DISCUSSION This study suggested that Clupeiformes were the main prey target of surface-feeding common dolphins in the area; and that the collection and analysis of drifting fish scales represents a useful tool to gain insight into the poorly-known food habits of Mediterranean common dolphins.

ACKNOWLEDGEMENTS The help provided by Anna Maria Bolzern and Umberto Fascio (Department of Biology, University of Milan) was essential. We are grateful to Sebastiano Bruno and Ada Natoli for contributing to field data collection. The Milan Aquarium and Hydrobiological Station and the Venice Natural History Museum provided logistic support.

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Table 1. Number of fish scale "catches" and individual scales sampled during this study.

Year	N of "catches"	N of scales
1997	10	59
1998	32	190
1999	3	15
2000	12	57
Total	57	321

Table 2. Number and proportion of sampled scales of gilt sardines and sardines (combined), and anchovies.

	Sardina pilchardus *Sardinella aurita*		*Engraulis encrasicholus*	
Year	N	%	N	%
1997	5	50.0	5	50.0
1998	12	37.5	20	62.5
1999	1	33.3	2	66.6
2000	11	91.6	1	8.3
Total	29	50.9	28	49.1

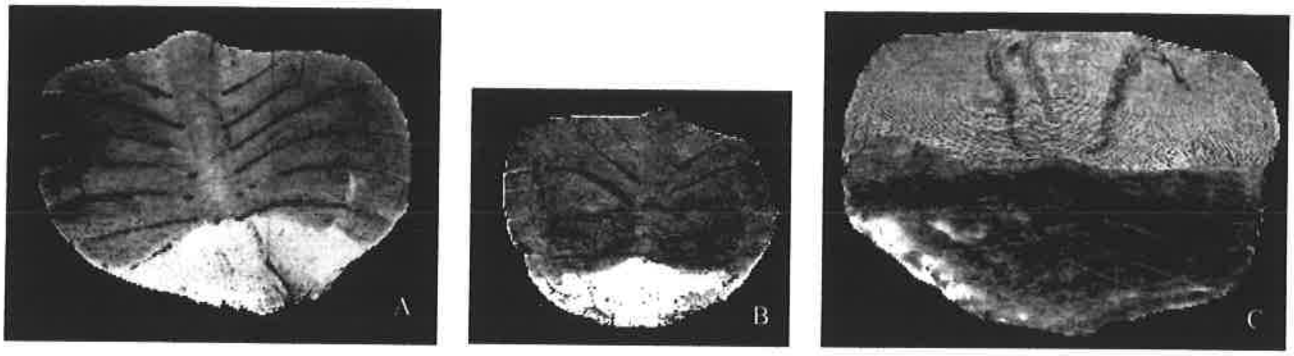

Fig. 1 Scales of sardine (A), gilt sardine (B), and anchovy (C).

PYTHAGORAS: A COMPUTER-BASED SYSTEM FOR THEODOLITE TRACKING

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Theodolites represent a non-invasive tool for obtaining cetacean movement, habitat use, and behavioural disturbance data from shore. Although the technique has been used for about 30 years, and despite the recent increase in digital theodolite use for cetacean behaviour studies, there are no truly user-friendly computer programs available for gathering and basic analysis of data in real-time.

We developed a computer-based program, dubbed "*Pythagoras*", to aid researchers in collecting, managing, and analysing data for theodolite-based cetacean observation. *Pythagoras* provides location of user-defined fix types (e.g. whales, dolphins, boats, etc.) and a dynamic interface, which can be customised to fit the researcher's needs. Additional information, such as behaviour, group size, and environmental conditions can be stored with each theodolite fix.

Tracking data are immediately available in the form of real-time graphic representation. Data are stored in Microsoft Access and can be exported as Microsoft Excel, Arc Info, Surfer, Mat Lab, text, or comma-separated file formats. The program also includes an analysis module to calculate linearity, reorientation rate, and leg speed for each track and distance and orientation between two or more track-lines. Behavioural data are analysed for frequency, time intervals (i.e. blow interval), interval between two behaviours (i.e. first surface – dive = surface time), and rate (number of times per minute) of particular behaviours.

A comparison of several computer-based theodolite systems is provided to evaluate potential benefits of each program, and provide a basis for future developments. *Pythagoras* provides researchers with a tool for efficiently collecting and managing theodolite-obtained cetacean movement data in the field.

PASSIVE TRACKING AND TIMING OF RESPIRATION AS A METHODOLOGY TO DETERMINE REACTIONS OF MEDITERRANEAN FIN WHALES IN RESPONSE TO DIFFERENT SOURCES OF POSSIBLE DISTURBANCE

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INTRODUCTON Nineteen individual fin whales (*Balaenoptera physalus*) were studied in their Ligurian Sea feeding grounds between 1995 and 2000, to describe and measure short-term responses to:
a) close approaches by a fast-moving inflatable craft; and
b) anthropogenic noise sources.

MATERIALS AND METHODS Passive tracking was performed with a technique based on the simultaneous determination of:
1) position of the observation vessel;
2) distance between the target animal and the observation vessel;
3) angle of the target animal with respect to the observation vessel.

Target animals were tracked by means of a Leica Vector laser range-finder (1500 DAES 7x42 class 1) connected to a portable PC with dedicated software (HighWhale), which combined tracking data with synchronously-timed surfacing intervals (Fig. 1).

RESULTS AND DISCUSSION **Approaching by a small inflatable** Two distinctive swimming-surfacing patterns were observed: one supposedly related to feeding, and one to travelling (Fig. 2A, B). "Feeding" whales reacted to disturbance by changing their behaviour to travelling. During the disturbance phase, swimming and respiratory parameters (mean-of-the-sample values) changed between the three experimental phases (Table 1; ANOVA, repeated measures, $n=18$, $P<0.05$, *post hoc* comparisons were significant for pre-approach *vs* approach, and pre-approach *vs* post-approach phases).

Independent of behavioural patterns, two kinds of avoidance reactions were simultaneously performed by the whales: travel at increased speed (+23%), and reduction of the time spent at the surface (-7.3%). After the disturbance ceased, the surfacing activity never completely reverted to pre-disturbance conditions, based on one hour of post-exposure control. Supposed feeding behaviour appeared to be disrupted.

Anthropogenic noise sources In a preliminary test, conducted in collaboration with Saclant Undersea Research Centre, the same technique was employed to evaluate fin whale reactions to potential acoustic disturbance represented by low-power, low-frequency sonar transmissions (1-8 kHz, SL 160-180 dB), and concurrent background noise. During a test performed on two associated fin whales, differences were measured between pre-exposure and post-exposure phases in travel speed (increasing by 27%), and mean dive time (increasing by 129%).

CONCLUSIONS This method of passive tracking represents a useful tool to assess fin whale reactions to different kinds of human-caused interference. Concerning sonar noise, more samples will be needed to compare the possible reaction with the response to known causes of disturbance.

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Table 1. Comparison between the mean values of the three experimental phases

		Pre-approach phase mean (±SD)	**Approach phase** mean (±SD)	**Post-approach phase** mean (±SD)
Index of linearity	p<0.05	0.5 (±0.3)	0.65 (±0.2)	0.70 (±0.2)
Velocity (m/sec)	p<0.05	1.3 (±0.5)	1.6 (±0.6)	1.6 (±0.6)
Dive time (sec)	ns	227.5 (±133.3)	215.1 (±89.4)	253.1 (±127.8)
Surface time (sec)	p<0.05	90.0 (±34.6)	56.4 (±17.2)	75.2 (±29.6)

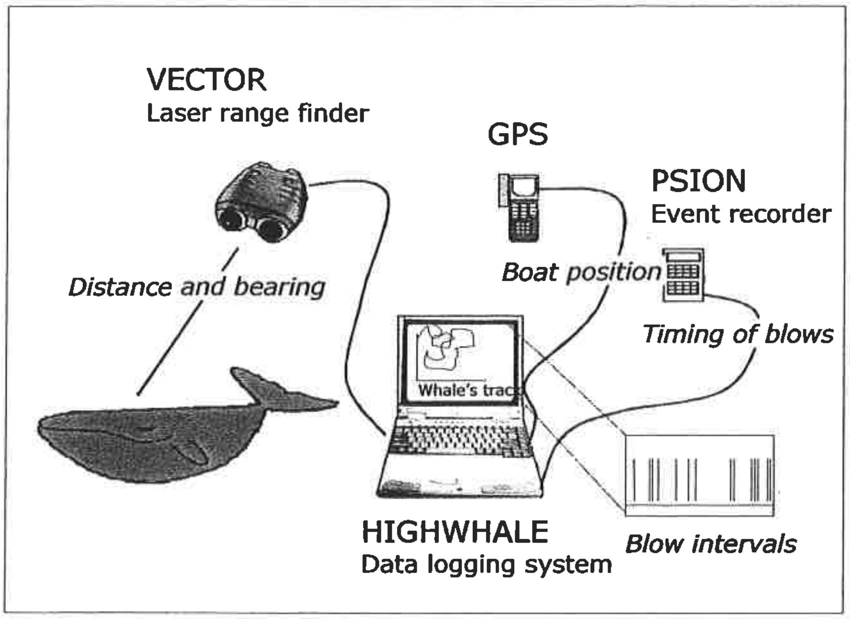

Fig. 1 Laser range-finder based passive tracking

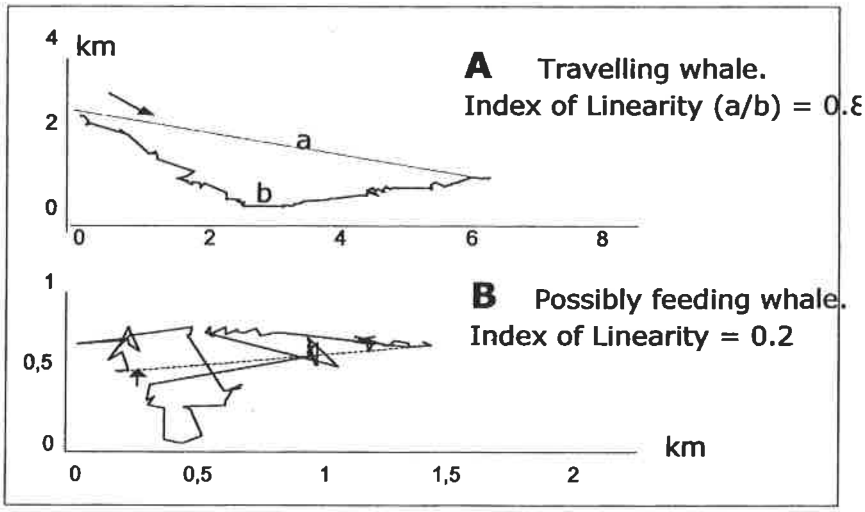

Fig. 2. Two different swimming patterns as observed from the surface

GEOGRAPHICAL INFORMATION SYSTEM ON BLACK SEA CETACEANS: PRESENT STAGE OF DEVELOPMENT

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Rather numerous data on Black Sea cetaceans (*Phocoena phocoena*, *Tursiops truncatus* and *Delphinus delphis*) have been accumulated by BREMA Lab during the last 12 years (1989-2000) from Black Sea waters off the Crimean Peninsula, and also from the Sea of Azov and Kerch Strait. It therefore became reasonable to collate and analyse the set of multifarious information using interdisciplinary principles and an advanced digital approach. To date, the idea of a Black Sea Cetacean Geographical Information System (BSC GIS) is partly realised by the creation of four databases (MS Excel) entitled "Strandings" (919 cases), "By-catches" (144 cases), "Sightings" (548 primary records), and "Library" (about 400 references).

Each case/record contains common (species, date, time, place, co-ordinates) and specific data, in accordance with each type of observation technique and methodological approaches undertaken in the research. In particular, sightings records include notes on observation effort and platforms, weather conditions, size of animal groups, their behaviour, and individual markers. Stranding and by-catch records consist of information on animal viability (if dolphins and porpoises were found alive), stage of carcass degradation, results of sex and age determination, body measurements, tooth formulae, stomach contents, features of reproductive organs, pathological findings, and various laboratory analyses (histological, microbiological, serological, parasitological, toxicological, etc.).

BSC GIS is supplied with mapping capabilities. Convenient interfaces and navigation aids are foreseen as well as subsidiary digital archives of photo- and video documents. Preparation of two additional databases "Habitats" and "Captivity" should be future directions of BSC GIS development.

USE OF A MULTI-SENSOR ACOUSTIC TAG TO ASSEESS RISK FACTORS ASSOCIATED WITH COLLISIONS BETWEEN SHIPS AND RIGHT WHALES

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To assess the circumstances surrounding collisions between ships and northern right whales, *Eubalaena glacialis*, we have conducted experiments combining the use of a new digital acoustic recording tag (DTAG) with traditional behavioural observations and controlled sound exposures. The DTAG is a multi-sensor archival tag that records the acoustic environment (Fs = 16 kHz) as well the behaviour of the whale using a suite of sensors (Fs = 23.5 Hz) that includes: 3-axis accelerometers, compass, pressure sensor, and thermistor. The whale's pitch, roll, and heading as well as water depth and temperature are recorded simultaneously with acoustic data. The tag, encased in a polyethylene faring, is attached to a whale non-invasively with suction cups. During 1999 and 2000, in the Bay of Fundy, Canada, we deployed 11 tags, and we conducted four playback experiments to tagged whales in 2000. With this package, we can continuously record a whale's motor and acoustic behaviour at or below the water's surface. The pitch data, for example, contain a signal resulting from the animal's undulation as it swims, so we know when a whale is stroking, and the stroke rate. While the playback experiments testing right whales' response to ship noise/approaches are to date incomplete, we have found behaviour that might increase the risk of whales being struck. During 95 presumed foraging dives, right whales glided for 15-60% of their ascents. Passive locomotion reduces their ability to effectively manoeuvre, thereby diminishing their ability to respond to an approaching ship even if they interpret it as a threat. In addition to swimming/diving behaviour, the DTAGs recorded the sounds of 108 passing boats. Ongoing analyses of the whales' motor behaviour surrounding these events, and further experimental sound exposures, will hopefully provide insight into how whales respond in these potentially high-risk situations.

MONITORING ECHO-LOCATION ACTIVITY OF PORPOISES AROUND SET GILL NETS

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Monitoring by-catch rates and their distribution in space and time generally requires the uses of observers and is costly. We investigated the possible utility of self-contained porpoise echo-location click loggers as a surrogate for such observations. Click loggers were deployed by fishermen using bottom set gill nets in the Celtic Sea. The logger monitors an area of approximately diameter. No loggers were deployed at sites not being fished. Data on fish catch and porpoise bycatch were also collected, either by observers or through a voluntary reporting scheme by the fishers. 3,804 hours were monitored and approximately 300,000 clicks were logged.

A net of 500 m length in this study on average caught one porpoise in 83 days. During that time, a logger on average detected porpoise activity in 10,500 intervals of 30-secs duration in the course of 'encounters' that mostly last only a few minutes.

No significant relationship was found between click rate per day and porpoise by-catch on that day by the boat deploying the logger. The surprisingly high frequency of encounters indicates that entanglement must be a rare outcome of a porpoise encountering a net.

PHYSIOLOGY AND ANATOMY

INDICATORS OF REPRODUCTIVE STATUS IN TEETH OF FEMALE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE KATTEGAT AND SKAGERRAK SEAS

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Indicators of reproductive status and reproductive history were investigated in teeth of female harbour porpoises (*Phocoena phocoena*) in the Kattegat and Skagerrak Seas. Previous studies of teeth from dolphins have shown an association between dark stained layers (DSLs) in tooth dentine and numbers of calving events. The formation of DSLs is possibly explained by calcium fluctuations associated with the reproductive cycle of the female.

In the present study, two methods were applied to investigate reproductive status and reproductive history in teeth of female harbour porpoises; examination of DSLs in decalcified and stained teeth and analysis of calcium content in polished teeth. Prior to the examination, it was established that females and their foetuses deposit the same layer at the same time, and that the opaque layer was deposited during lactation. The opaque layer was used to locate DSLs and subsequently sampled for calcium analysis. Furthermore, the neonatal line was found to be formed prior to birth based on the result that four foetuses had already formed a completely neonatal line.

The result of the examination of decalcified, sectioned and stained teeth showed that the formation of DSLs is associated with the reproductive biology in female harbour porpoises. However, it did not provide supportive evidence for the hypothesis that DSLs indicate either age at sexual mortality, ovulation, or calving events represented by lactation. The calcium analysis showed a larger variation within the opaque layers than between layers, and this indicates that there were no calcium fluctuations due to lactation or to age.

CORTISOL LEVELS IN CAPTIVE AND WILD HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) AND EFFECT OF HANDLING METHODS

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INTRODUCTION In recent years, as a result of increased concerns for improving the well being of odontocetes held for research, display, rehabilitation, or handled in tagging projects, more effort has been put into assessing stress, and comparing the effect of various handling methods.

Cortisol levels have been accepted as a sensitive indicator of acute stress in cetaceans, especially in relation to capture and handling (Thomson and Geraci, 1983, 1986; Parker and Schroeder, 1987; Orlov *et al.*, 1989, 1991; Copland and Needham, 1992; Aubin *et al.*, 1996).

In harbour porpoises, cortisol levels have only been reported as point data for porpoises by-caught in herring weirs and taken onboard a vessel to be tagged before release (Koopman *et al.*, 1995).

This study provides the first longitudinal monitoring of cortisol levels in harbour porpoises, and compares the influence of different handling methods on these levels.

MATERIALS AND METHODS **The captive animals:** three porpoises (Table 1) were kept together outdoors in a semi-natural enclosure of about 9600 m^3, spanned by nets on two sides, and were thus exposed to natural environmental conditions regarding water quality, tidal currents, temperature, light, and variation in flora and fauna.

The wild animals: six males (93-142 cm long) and six females (91–166 cm long), which were by-caught in pound nets in Danish waters, and equipped with satellite tags:

On this occasion, a medical check and sampling similar to the one on the captive animals was performed. In most cases, porpoises were trapped in the pound nets for less than 24 hours.

Blood sampling procedures:

- The captive animals came voluntarily into a holding pool, they were removed from the water by a trainer, and transported on a stretcher to an investigation table nearby. Blood was taken between 10-30 mins after the animals had been removed from the water. The procedure was repeated one to four times a month.
- Blood has been collected from Freja at the pool-side by voluntary husbandry behaviour since July 1999.
- In the wild porpoises, blood was collecting before tagging, i.e. between 10 and 20 mins after removal from the water, and in most cases less than one hour after the boat initially entered the pound net.
- Blood was taken from the dorsal side of the flukes. Within the next few days, serum cortisol was measured by radio-immuno assay following standard techniques, in a commercial laboratory in Germany.

RESULTS **Cortisol levels in captive and wild porpoises: (Table 2)** Nuka, the youngest porpoise, exhibited higher cortisol levels than the older captive porpoises, but the difference was only significant in the male (two-sided t-test, $p<0.05$). Average levels of cortisol were significantly higher in the wild porpoises than in the captive ones (two-sided t-test, $p<0.001$).

Difference in cortisol level between on-land sampling and pool-side sampling in Freja: (Table 3)
Average cortisol level was three times higher when blood was collected after Freja had been removed from the water compared with when blood was collected at the pool-side, for the same time period (two-sided t-test, $p<0.001$). This occurred although the handling procedure had been known to the female for 2.5 years.

Long-term variation in captive porpoises:(Figs. 1, 2, 3)
Tendencies in the long-term profile of cortisol levels were examined using a reduced data set (data points connected by the line in the Figures), that did not include:

- Data from the first month of acclimatisation at the centre;
- Values which were typically outside the normal range shown by each animal; and
- Values corresponding to sampling at the pool-side for Freja.

The two adult porpoises did not exhibit a significant decrease in cortisol level in almost four years that they have been in human care. Comparatively high values are still observed from time to time (Figs. 1 & 2).

The youngest porpoise, Nuka, showed a significant decrease in cortisol levels over the eight months that she remained in human care, the higher cortisol values which she exhibited on arrival (>100 μg/l) decreasing to a level similar to that found in the other two porpoises (c. 70 μg/l) (Fig. 3).

CONCLUSIONS The cortisol obtained after removing the porpoises from the water does not represent baseline cortisol levels for harbour porpoises, since the animals have been handled prior to collection. The level observed in the mature female when blood was taken at the pool-side is likely to be closer to cortisol resting values for porpoises.

Based on cortisol levels, the captive porpoises did not get habituated to a bi-monthly handling procedure over a four-year period, although the procedure has been kept similar, and the same core people have been involved - the dentist syndrome!

Even after three years in human care, restraining and removing from the water elicited a three-fold increase in cortisol levels compared with cortisol levels obtained at the pool-side under voluntary husbandry behaviour. Values in wild porpoises were about nine times higher than values obtained at the pool-side.

The sensitivity to capture and confinement shown by porpoises, points dramatically to the advantage of voluntary husbandry behaviour for limiting stress in human care; and the moral obligation of stress awareness and prevention, when working with wild porpoises.

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Table 1. Biological characteristics of the three harbour porpoises

		Beginning of study	End of study
Freja	Female	07/04/97: 127 cm, 40 kg, 2-3 yrs	31/01/01: 150 cm, 59 kg, 6-7 yrs
Eigil	Male	07/04/97: 130 cm, 37 kg, 2-3 yrs	31/01/01: 141 cm, 43 kg, 6-7 yrs
Nuka	Female	19/04/99: 115 cm, 31 kg, < 1 yr	22/02/00: 124 cm, 37kg, 1.5 yrs

Table 2. Average cortisol levels in wild and captive harbour porpoises

Cortisol, μg/l	No.	min	max	mean	sd
Freja (on-land sampling)	33	11.8	216.0	71.0	33.5
Eigil ** (on-land sampling)	43	14.9	274.0	65.1	51.1
Nuka (on-land sampling)	9	54.3	166.0	96.4	34.6
Wild females	6	96.0	295.0	174.3	68.4
Wild males	6	69.3	303.0	168.5	96.4

** Two extreme values were not included in these tables, 3 μg/l (210497) and 793 μg/l (140597), both from the time that Eigil was still in the initial temporary pool.

Table 3. Average cortisol levels from on-land sampling and pool-side sampling in Freja from June 1999 - July 2000

Cortisol, μg/l	No.	min	max	mean	sd
On-land sampling	7	48.4	77.1	60.6	10.1
Pool-side sampling	7	7.5	61.7	18.7	19.4

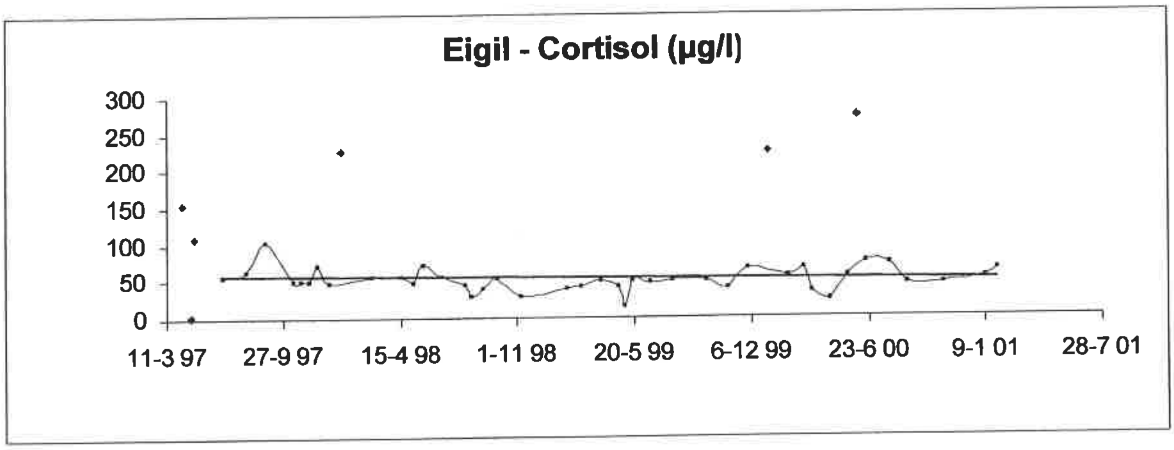

Fig. 1. Cortisol values taken from Eigil in the period 07-04-97 - 31-01-01. Tendencies in long-term profile of cortisol levels were examined using a reduced set (data points connected by the line in the Figures), which does not include data from the first three months of acclimatisation at the centre. Values which are typically outside the normal range.

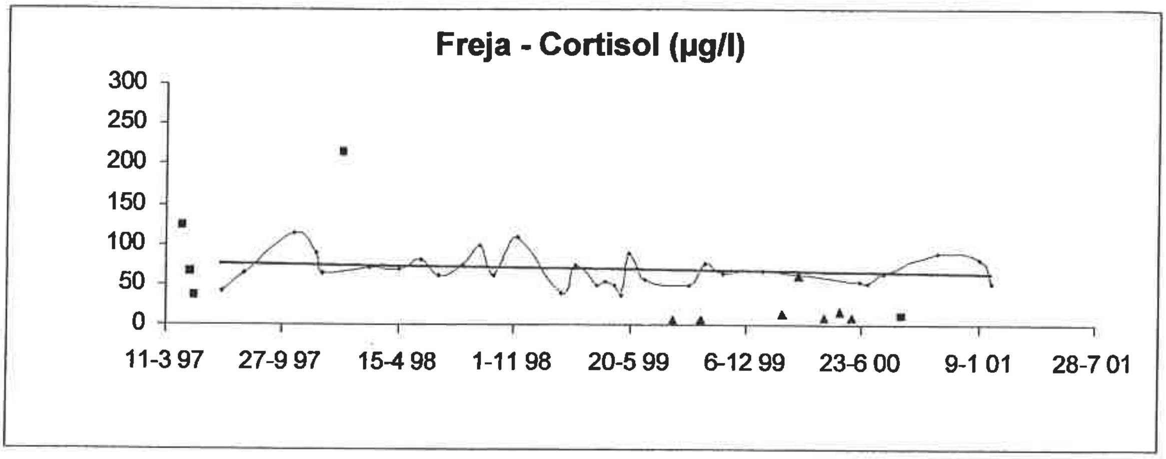

Fig. 2. Cortisol values taken from Freja in the period 07-04-97 - 31-01-01. Tendencies in long-term profile of cortisol levels were examined using a reduced set (data points connected by the line in the figures), which does not include: data form the first three months of acclimatisation at the centre, values which are typically outside the normal range, and values corresponding to sampling at pool side for Freja.

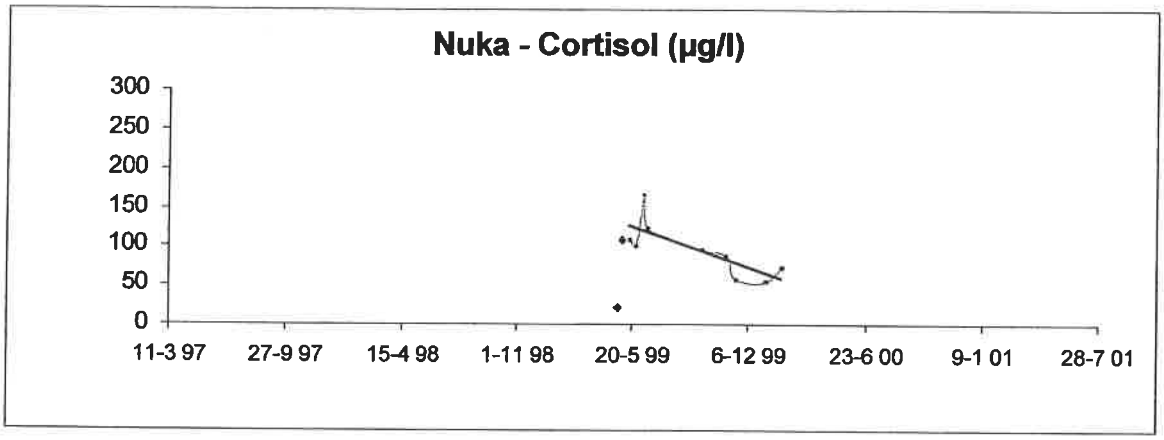

Fig. 3. Cortisol values taken from Nuka in the period 19-04-99 - 22-02-00. Tendencies in long-term profile of cortisol levels were examined using a reduced set (data points connected by the line in the figures), which does not include data form the first three months of acclimatisation at the centre, and values which are typically outside the normal range.

A COMPARATIVE MORPHOMETRIC ANALYSIS OF THE OPTIC NERVE IN TWO CETACEAN SPECIES, THE STRIPED DOLPHIN (*STENELLA COERULEOALBA*) AND FIN WHALE (*BALAENOPTERA PHYSALUS*)

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Despite the wealth of data on the importance of vision in regulating cetacean behaviour, current knowledge of the cetacean visual system is rather limited. In particular, very few studies are available on the anatomical organisation of the visual pathway in mysticetes. Here, we have undertaken a study aimed at comparing the anatomical organisation of the optic nerve in one mysticete (the fin whale, *Balaenoptera physalus*) and one odontocete species (the striped dolphin, *Stenella coeruleoalba*). We have analysed semi-thin cross-sections of the optic nerve examining various morphometric parameters such as total fibre count, fibre density and fibre diameter spectrum. Sections were also reacted with antibodies directed against neurofilaments, β-tubulin, myelin basic protein, and glial-fibrillary acidic protein to stain selectively both neural and glial components of the nerve.

We found that the two cetacean nerves share a number of specialisations that distinguish them from the optic nerve of terrestrial mammals. Fibre density is approximately two-fold lower than in land mammals. A corresponding increase in the cross-sectional area occupied by astrocytes is observed. A population of "giant" (up to 15 μm in diameter) optic axons is present in both *B. physalus* and *S. coeruleoalba*. Nerve and ganglion cells of "giant" dimensions are evident in their retinae. It is argued that these features probably reflect common adaptations to the constraints imposed by the aquatic environment. "Giant" optic axons might ensure short-latency detection of prey and other targets during navigation, while the increased astroglial content might be related to the maintenance of neuronal function during periods of anaerobic metabolism underwater. In addition, the conservation of these peculiarities in both baleen and toothed whales suggests that these characteristics constitute a common pleiomorphic character of the cetacean structural plan that emerged at very early times during their evolutionary history.

HISTOLOGICAL AND ANATOMICAL EXAMINATIONS ON THE NASAL AIR SAC SYSTEM IN THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

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In toothed whales, air sacs are part of the respiratory tract. They vary greatly in size and arrangement between species. Although a number of studies deal with the complex anatomy, little is known about their function. Even less is known about the histology of the inner lining of these sacs and their direct surroundings, i.e. consistency of the epithelium and corium. For this study, air sac samples were taken from three harbour porpoises to examine their histology.

In all air sacs, stratified squamous epithelium and a stratum germinative were found. A stratum granulosum was found in the vestibular sacs, but not in the premaxillary sacs. In the caudal sacs and the anterior and posterior nasofrontal sacs, a distinctive stratum granulosum could not be identified. No stratum lucidum has been detected. The degree of keratinisation varies within the nasal sacs, but no area showed complete hornification. All diverticula are surrounded by tight and fibrous connective tissue with a high content of collagenous fibres. Vestibular sacs, caudal sacs, and both nasofrontal sacs have areas with tight and straightened fibrous connective tissue. Elastic fibres were found around all diverticula. Reticular fibres solely were found around both nasofrontal sacs and premaxillary sacs. The lamina propria of all diverticula is characterised by elasticity and also compactness to a high degree. This could be a hint to the function of sound production of the nasal air sac system. In addition to histological examinations a 3-dimensional reconstruction technique, based on a synthetic resin, was developed to illustrate the dimensional aspects of the anatomy of the nasal air sac system. The material used is an acrylic polymeric based on methylmethacrylate. Casts of the diverticula of two heads of harbour porpoises were made.

FUNCTIONAL ANATOMY OF THE SPERM WHALE EYE

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In connection with a mass stranding of sperm whales on the Danish North Sea coast, fresh material for an investigation of the sperm whale eye was obtained. The eyes were investigated macro- and microscopically. Although it is the largest eye among the odontocetes, the sperm whale eye is very small in relation to body size and small compared to mysticete whales of similar size. Characteristic features were: 1) a thick, bowel shaped sclera surrounding the bulbus; 2) a large, vascularised rete ophthalmica surrounding the optic nerve; and 3) a massive musculus retractor bulbi. Other features were a spherical lens, weakly developed or absent ciliary muscles, weakly developed or absent muscles for moving the eye (except for the retractor muscle), giant ganglion cells in the retina, and a fibrous tapetum. These features corresponded well with what is reported for other species of odontocetes, as well as previous reports on the sperm whale eye.

It is suggested that the function of the three most prominent structures, the massive sclera, the rete, and the large retractor muscle, can be explained by an ability of the whale to retract its eye when closing it. The eye is retracted into the orbit by the retractor muscle, and space for the eye is provided by drainage of the rete for blood. Refilling the rete will cause the eyeball to protrude and open the eye. The proposed function is presumed to be general for cetaceans, and this ability was documented in a harbour porpoise (*Phocoena phocoena*), where retraction and protrusion was readily visible during both voluntary and provoked opening and closing of the eye.

BONE DENSITY IN THE STRIPED DOLPHIN'S THORACIC LIMB: A TOOL FOR DEVELOPMENT AND AGE DEFINITION

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Age determinaton in the striped dolphin (*Stenella coeruleoalba*) is currently defined by use of dentine layers in sections of the teeth. Additional means of age determination include degrees of ossification of the sternum, gonadal maturation, and length of the specimen. A few recent papers (Calzada *et al.*, 1997; DiGiancamillo *et al.*, 1998) have pointed out the usefulness of radiological examination for field determination of age in stranded animals. We recently started a new investigation on the density of bone in the thoracic limbs of *Stenella coeruleoalba* using samples recovered from strandings occurring along Italian coasts.

We used a bone densitometer (Hologic QDR-1000, Hologic Inc., Waltham, MA) to acquire data on mineral deposition and density, and compared the results with what was already known of the biology of those specimens. To standardise our findings, we centred our investigation on the humerus and proximal segment of the radius. Data acquired included bone mineral content (BMC) and bone mineral density (BMD).

Preliminary findings indicate that mineral deposition and density in the arm and forearm of striped dolphins are positively correlated with age and bone development including maturation of the ossification centers of the thoracic limb. We believe that radiological examination of the thoracic limbs of stranded dolphins can be used as a reliable and practical tool for age determination of dolphins of unknown origin. A detailed study of bone deposition further improves our understanding of the biology of stranded specimens, and indicates the value of data on bone biology, consumption and calcium reabsorption.

STOCK IDENTITY AND DISTRIBUTION

ONGOING STUDIES ON BELUGA WHALE TEETH: PRELIMINARY RESULTS

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An attempt was made to study beluga teeth (*Delphinapterus leucas*) in more detail, and to compare their morphometry and ultrastructure between animals from different localities. 115 specimens were acquired from north-western (Upernavik) and south-western (Sisimiut) Greenland. Teeth were first selected mainly from the middle of the jaw where wear at the crown was least. Teeth also vary in size depending on the position in the jaw, so it is important to use only comparable teeth. All specimens provided both untreated sections as well as decalcified and stained sections for study (IWC Special Issue 3; eds. W.F. Perrin & Myrick Jr., 1980). Morphometrics and ultrastructural characteristics were studied, as these had proven useful in other species (short-finned pilot whale, Lockyer, 1993; harbour porpoise, Lockyer, 1995,1999).

Beluga teeth are robust, with a thick layer of cement surrounding the dentinal column. There are obvious differences with the teeth of other species, such as pilot whales or bottlenose dolphins. Characteristics defined in these species may therefore not be immediately useful when applied to beluga whale teeth.

Results from morphometric studies indicate that there is a difference in overall proportions between animals from southern and northern Greenland. It appears that females from Sisimiut have smaller teeth when compared to either males from Sisimiut, or males and females from Upernavik. At this stage, we can only hypothesise why, but it may have something to do with feeding ecology of the Sisimiut females. The amount and type of sediment ingested influences the shape and condition of the teeth. When looking at the number of GLGs in several sets of teeth, the front teeth turned out to have lost at least 5 GLGs when compared with teeth further back. It is imperative that this be considered when selecting teeth for ageing purposes.

FIRST RESULTS ON THE DISTRIBUTION OF WINTERING HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) IN FRENCH POLYNESIA, 1997-2000

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INTRODUCTION Southern humpback whales (*Megaptera novaeangliae*) are known to feed around Antarctica during the austral summer, and to winter in tropical latitudes from July to December (Winn and Reichley, 1985; Dawbin, 1997). Until very recently, little was known about southern humpback whales wintering in the central Pacific, notably in the waters of French Polynesia where they are commonly seen from July to November (Poole, 1993; Gannier and Gannier, 1999). This study summarises distribution results obtained during surveys in the Society, Australes, and Marquesas Islands in the 1997-2000 period. Humpback whale presence in the Tuamotus and Gambier Islands is also discussed.

MATERIALS AND METHODS

Data Collection Surveys were undertaken from two types of vessels (Table 1). These included a) opportunistic surveys on the 85 m research vessel "L'Atalante" (used as a platform of opportunity during the programme *Zepolyf 2*) adopting a passing mode survey at 18.5 km/h in conditions with winds less than Beaufort 5, and with one observer searching with the naked eye from the upper deck, 15 m above the sea surface (although species identification was confirmed using 12x50 binoculars); and b) dedicated surveys aboard a 12 m auxiliary sloop with the same protocol used in all three surveys: random tracks covered at 10 km/h using diesel propulsion, in conditions with winds less than Beaufort 5, and three observers searching the frontal sector with the naked eye, 3 m above the sea surface. Additionally, acoustic sampling was systematically performed every 2.8 km.

Data Processing Data were processed with *Oedipe* software for mapping and effort calculations (Massé and Cadiou, 1994). *Distance 2.2* (Laake *et al.*, 1994) was used to quantify the presence of whales, taking the daily effort as the unit sample. An index of relative abundance (RAI) was estimated for both surveys, as the average number of animals sighted per kilometre of effective effort:

$$\mathbf{RAI = n \times S / L}$$

where **n** is the number of on-effort sightings
S is the mean school size
L is the effective sampling effort

Effective search width was assumed to be consistent for each platform. Since wind in excess of Beaufort 4 can have adverse effects on the detection of cetaceans (Hiby and Hammond, 1989; Buckland *et al.*, 1993), only primary sightings obtained with sea state of Beaufort 4 or less were retained. Confidence intervals were estimated on the basis of a log-normal distribution of the relative abundance index. Acoustic data were mapped, and a simple "singing rare" was computed to quantify the whale acoustic activity.

$$\mathbf{T\% = 100 \times (P / N + P)}$$

where **P** is the number of positive listenings (i.e. when a whale song is heard during the listening)
N is the number of negative listenings
T% is calculated for each year.

RESULTS **Effort and sightings (opportunistic survey):** A total of 4438 km was covered on-effort, with 17 groups of whales observed, comprising an estimated total of 200 individuals. The area surveyed was mostly offshore and not random, since the geophysical survey was focusing upon certain sea areas. The surroundings of three islands were sampled with good weather as well as some shallow banks. Whales were observed close to Rimatara and Rurutu; sightings were also obtained close to sea mounts; two sightings were recorded some 200 km south of Tahiti. Number of sightings and effective effort resulted in an RAI index of 1.25 whales/100 km (CV = 30.4%).

Effort and sightings (dedicated survey): a total of 6668 km were covered on effort, and 84 groups of whales observed. The summary is as follows:

- in 1997: 1056 km, 17 samples, 11 sightings (22 individuals)
- in 1998: 894 km, 18 samples, 15 sightings (28 individuals)
- in 1999: 1349 km, 24 samples, 29 sightings (44 individuals)
- in 2000: 3370 km, 39 samples, 22 sightings (42 individuals)

In the Australes Archipelago, a total of 712 km was covered on effort around Taivavae, Tubuai, and Rurutu. All Maequesas Islands were sampled in 2000 with 2555 km of effort.

In 1997, humpbacks seemed to be less frequent around Raiatea-Tahaa than around islands located more to the east. In 1999, 23 sightings were made in Society Islands, generally very close to the reef barrier, and six in the Australes; in 2000, there were 12 and 10 sightings respectively in the Society and Australes Islands, and none in the Marquesas.

Humpback whales were often observed in groups of 1-3 animals: 51% of sightings were of single animals, 31% of pairs, and 10% of groups of three whales. There were five on-effort sightings of four animals, and one of a group of six whales. Nine sightings included a mother with a yearling (individual 7-8 m long), mostly in September; in five cases, the mother was escorted by one (three sightings) or two large-sized animals. We obtained nine sightings of mother-newborn calf pairs in October and November, and on three occasions a singing male was escorting the pair.

Relative abundance index: The sighting rate varied from 1.04 group/100 km (CV=35%) in 1997 (Society Islands), to 2.68 groups/100 km (CV=34%) in 1999 (Australes Islands), and 3.07 groups/100 km (CV=29%) in 2000 (Windward Islands) (Table 1). Mean school size was higher in the Society Islands, with a maximum of 2.4 in 2000, resulting in higher and increasing RAI estimates for the Windward surveys between 1997 and 2000 (Table 1). For 1998 and 1999, the RAI estimates in the Windward Islands were similar with 3.13 whales/100 km and 3.18 whales/100 km, respectively, although mean school size decreased from 1.87 to 1.61 (Table 1). High estimates were obtained in the Australes Islands in 1999 and 2000 although high CV (37% and 45%) and lower sample sizes must be accounted for. In the Marquesas, the RAI estimate was zero.

Acoustic results (Table 3): In 1997, small islands such as Moorea and Huahine appeared to be more attractive to singers than large islands such as Tahiti or Traiatea-Tahoa.

DISCUSSION

Winter distribution range: Results presented by Winn and Reichley (1985), showing that individuals seen in the Cook Islands had previously been marked in Area V, did not mention French Polynesia. The humpback whale population wintering in the central Pacific (east of the Cook Islands) is assumed to belong to Antarctic Area VI "stock" – and to feed east of 170° W (Hauser *et al.*, 1999; Reeves *et al.*, 1999). To date, the population identity of humpback whales wintering in French Polynesia remains unclear. The possibility of animals from Area I, known to winter usually of western South America (Florez-Gonzalez, 1991), wandering into the central tropical Pacific should not be discarded.

- In the Marquesas (northernmost archipelago, about 140° W and 9° S), humpbacks were observed by local people in 1998, 1999, and 2000 (Curvat, Taiohae, Nuka Hiva, October 2000, *pers. observ.*). If their winter presence has been marginal in the past (Reeves *et al.*, 1999), their occurrence may be increasing in recent years.
- In the Gambier (archipelago located far south-east at 136° W and 23° S), we were told that humpback whales are seen every year on a few occasions in July-August, but rarely in September-October (Sanford, Rikitea, Gambier, Dec 1999, *pers. observ.*).
- In the Tuamotus (70 islands), the presence of humpbacks is poorly and only qualitatively documented.

The opportunistic survey results showed that whales were distributed over a wide area early in the wintering season, in agreement with Dawbin (1997) for the northbound migration. However, we may not exclude several offshore shallow banks to be used for wintering. For the southbound migration, records off Tahiti occurred on 12 December 1999 (sighting of two individuals, Castel, Eleuthera Plongée, Punaauia, Tahiti, *pers. observ.*); and on 13 January 2000 (sighting of a juvenile, Follin, Punaauia, Tahiti, *pers. observ.*). These late records are in agreement with results of Patterson (1991), off eastern Australia. However, it is apparent from our small boat surveys that sighting frequency decreased from the end of October, with the exception of mother-calf pairs, regularly seen until November. The late presence of calving females in wintering areas is mentioned in the literature (Dawbin, 1997).

Influence of environmental factors: Water temperatures of about 25° C are reported to be favourable to humpback whale calving (Winn and Reichley, 1985). From hydrological results, we know that SST at latitude 23° S (Gambier, southern Australes) may vary between 22.5° C and 25° C depending on the "ENSO" phenomenon (Rancher and Rougerie, 1993), when variations are less considerable at latitude 17° S (Society Islands). Hence, during colder years, mother-newborn calf pairs might spend a shorter time in the coldest places of French Polynesia, and favour warmer waters found northwards, in the Society and Tuamotus Islands. This is supported by recent data on the presence of newborn calves in Rurutu (E. Leborgne, *pers. comm.*).

CONCLUSIONS The present study has brought a significant increase of knowledge about humpback whale distribution in French Polynesia, consistent survey methods delivering effort-corrected results. However, a wide area in the Tuamotus Islands remains to be studied before the humpback whale distributional range in French Polynesia can be totally described.

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Table 1. Sampled area by year and archipelago

Opportunistic survey :	**Archipelago**	**Dedicated survey :**
	Leeward Islands	1997 (September-October)
	Windward Islands	1997 / 1998 / 1999 / 2000 (November)
1999 (7 July to 5 August 1999)	Australes Islands	1999 / 2000 (September)
	Marquesas Islands	2000 (October)

Table 2. Sighting rates et Relative Abundance Index for Small boar surveys.

Year	1997	1998	1999	2000	1999	2000
Area	Windward-Leeward	Windward	Windward	Windward	Australes	Australes
sighting rate n/L	0.104 E-01	0.168 E-01	0.197 E-01	0.302 E-01	0.268 E-01	0.164 E-01
(CV%)	(35.4)	(25.3)	(23.5)	(18.0)	(34.0)	(41.2)
School size	2.0	1.87	1.61	2.40	1.16	1.62
(CV%)	(11.7)	(14.7)	(11.5)	(22.6)	(14.3)	(16.2)
RAI	2.08	3.13	3.18	7.24	3.13	2.66
ind./100km	(37.2)	(29.2)	(26.2)	(28.9)	(36.8)	(44.8)

Table 3. Singing rates and Relative Abundance Index for small boat surveys

	Society Islands	**Windward Islands**		**Australes Islands**		**Marquesas Islands**	
Year	Average	Singing rate	Nbr. of samples	Singing rate	Nbr. of samples	Singing rate	Nbr. of samples
1997	29,9%	32,0%	309	-	-	-	-
1998		36,4%	214	-	-	-	-
1999		35,8%	344	22,6%	47	-	-
2000	-	-	-		84	0,0%	271
Total			**867**				**271**

THE FIRST CETACEAN SIGHTINGS NETWORK IN SPAIN: RESULTS OF A CO-OPERATION WITHIN THE SPANISH CETACEAN SOCIETY

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INTRODUCTION In 1999, the Spanish Cetacean Society (SEC) was created in order to co-ordinate the activities of different organisations and research groups in Spain, and to provide assistance to regional and national authorities in issues related to the conservation of the marine environment. In July 1999, the Spanish Ministry for the Environment appointed to the SEC the custody of a national database of strandings and sightings of cetaceans in order to standardise the methodology used by all groups involved in these activities, and to facilitate the exchange of information among researchers. The Sightings Working Group of the SEC has been, since then, developing and updating the cetacean sightings database with the participation of most research and conservation groups working in Spain. This is the first time in Spain that most groups put together their information creating a National Sightings Network and giving a fairly complete vision of cetacean distribution throughout the whole country, showing the importance of co-ordinated co-operation in the context of conservation.

METHODOLOGY A common database for sightings was created in 1999 in order to collect and standardise the records of all sightings of cetaceans made in Spain by groups integrated in the Spanish Cetacean Society. This database was developed within the project "Collection, analysis and development of protocols on sightings, strandings and recovery of marine mammals and sea turtles in Spanish waters" of the SEC, funded by the Spanish Ministry for the Environment in the context of ACCOBAMS, and has the following fields:

1. key (XXX-9999, where XXX is three letters identifying the group or person donating the data, and 9999 is the number of sighting of that group or person)
2. platform (helicopter, aircraft, land base, ferry, research ship, fishing ship, whale-watching, inflatable, others)
3. species
4. date (only month and year)
5. area (ATN = north Atlantic coast, ATS = Atlantic waters of Andalucia, CAN = Canary Islands, ALB = Alboran Sea, GIB = Strait of Gibraltar, MUR = Murcia, VAL = Valencia, BAL = Balearic Islands and CAT = Catalonia)
6. behavioural data (yes/no)
7. oceanographical data (yes/no)
8. social structure data (yes/no)
9. photographs (yes/no)
10. video (yes/no)
11. acoustics (yes/no)
12. samples (yes/no)
13. type of samples (if field 12 is yes, specify type of samples: skin, blubber, faeces, etc.)

The main objective of this database is to provide a useful tool to all people involved in research based on sightings at sea, in order to facilitate and improve the effectiveness of exchange of information and collaboration among groups. In this way, a national network for sightings has been created, as an important step towards the better knowledge of the Spanish cetofauna.

RESULTS Up to now, 8,003 sightings of 20 species of cetaceans (including at least three species of beaked whales pooled here as "Ziphidae") have been collected by the authors from all around the Spanish peninsula, Canary Islands, and Balearic Islands, including 18 years of data from dedicated surveys and from opportunistic sightings. None of these data was obtained from published papers or reports of third persons in the respective areas. Only sightings made by the authors or by other persons (mainly opportunistic sightings, only those completely reliable) and reported directly to the authors are being considered. The dedicated surveys total more than 72,000 nautical miles (more than 133,000 km) on effort. The distribution of records by groups is shown in Table 1. Combining the records collected by the authors, Table 2 shows the different areas and the respective proportions of sightings of all species of cetaceans.

DISCUSSION There is an important diversity of species of cetacean in Spanish waters (28 species have been recorded from strandings and sightings). In the data presented here, 20 species were recorded, including three beaked whales: *Mesoplodon densirostris, Ziphius cavirostris* and *Hiperodoon ampullatus*, the first one in the Canary Islands and the last two both in the Mediterranean and the Canary Islands. Of all areas, the Canary Islands presented the highest diversity, followed by Andalucia, in the westernmost Mediterranean. It is clearly observed in Table 2 that distribution was not homogeneous across the different areas. In the Canary Islands, the most frequently observed species was the short-finned pilot whale (*Globicephala macrorhyncus*), which has not been recorded in any other area. Other species abundant in the archipelago were the bottlenose dolphin (*Tursiops truncatus*) and the Atlantic spotted dolphin (*Stenella frontalis*). The last one is an interesting case because it represents an oceanic type which in the NE Atlantic only shares distribution with Azores, Madeira, and Cabo Verde.

In general, the three most abundant species in all peninsular areas and the Balearic Islands were the bottlenose dolphin, striped dolphin (*Stenella coeruleoalba*), and common dolphin (*Delphinus delphis*). The bottlenose dolphin, one of the most endangered species in Europe (Annex II of the Habitat Directive of the European Union), was the most frequently recorded species in Galicia (NW Spain), Valencia, and the Balearic Islands, occupying third or fourth place in number of records in the rest of the areas. The striped dolphin was also a very frequently observed species in all Mediterranean areas. The common dolphin showed a negative gradient towards the north in the Mediterranean region. It was, together with the striped dolphin, the most common recorded species in Andalucia, and started decreasing quickly towards the north. The long-finned pilot whale (*Globicephala melas*) was a frequently encountered species in the area of Andalucia. The rest of the species can be considered as relatively less important from a quantitative point of view than the previous ones.

Since the creation of this sighting network along the Spanish coast and its common database in 1999, a common protocol for the collection of data of sightings at sea has been developed, with the consensus of all groups, and it is already being used by several research groups. These protocols are available for all those people or groups willing to take data on sightings of cetaceans at sea in Spain, through the web site of the Spanish Cetacean Society (www.cetaceos.com).

CONCLUSIONS Hence, the most important results of this network and common database are that:

a) it is the first time that a real co-ordination for the investigation of cetaceans at sea is established in Spain,
b) it has the enormous potential of a joint analysis of data from different areas, allowing the achievement of a global view of the situation of the cetacean populations in Spain,
c) it will allow, among other things, the follow-up and comparative study of similar problems faced by cetacean populations in different areas (whale-watching, fast-ferries, etc.), and thus,
d) it will allow a more effective monitoring and management of the cetacean populations and their habitats in Spain through a more understandable and coherent presentation of results to the local and national administrations.

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Table 1. Distribution of records by group. Species: DDE = *Delphinus delphis*, TTR = *Tursiops truncatus*, SCO = *Stenella coeruleoalba*, GGR = *Grampus griseus*, GME = *Globicephala melas*, PPH = *Phocoena phocoena*, BPH = *Balaenoptera physalus*, PMA = *Physeter macrocephalus*, ZIPH = family Ziphiidae, PCR = *Pseudorca crassidens*, OOR = *Orcinus orca*, BAC = *Balaenoptera acutorostrata*, EGL = *Eubalaena glacialis*, BED = *Balaenoptera edeni*, KBR = *Kogia breviceps*, SFR = *Stenella frontalis*, SBR = *Steno bredanensis*, GMA= *Globicephala macrorhyncus*, MISUN = unidentified misticete, DELUN = unidentified dolphin

Group	DDE	TTR	SCO	GGR	GME	PPH	BPH	PMA	ZIPH	PCR	OOR	BAC	EGL	BED	KBR	SFR	SBR	GMA	MISUN	DELUN	TOTAL
CEMMA - IIM	423	1901	3	47	160	76	3	0	0	0	4	1	1	0	0	0	0	0	15	95	**2,729**
SECAC	23	58	6	12	0	0	1	10	4	1	1	0	1	1	1	46	12	276	0	0	**453**
CEMU	66	29	49	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	**151**
CIRCE	221	217	207	0	352	0	17	55	0	0	12	0	0	0	0	0	0	0	3	0	**1,084**
BITÁCORA	143	7	87	2	5	2	4	2	0	0	1	0	0	0	0	0	0	0	0	0	**253**
ALNITAK	535	258	791	82	279	0	61	26	33	1	1	0	0	0	0	0	0	0	0	179	**2,246**
ESPARTE	38	5	20	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**67**
SEC	109	19	43	0	9	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	**183**
ANSE	21	9	19	6	11	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	**76**
UN. VALENCIA	15	29	37	3	14	0	6	4	0	0	0	0	0	0	0	0	0	0	4	22	**134**
GREENPEACE	11	198	188	37	7	0	38	15	2	0	0	0	0	0	0	0	0	0	0	5	**501**
GREC-CRC	22	6	57	8	3	0	14	13	3	0	0	0	0	0	0	0	0	0	0	0	**126**
TOTAL	**1,627**	**2,736**	**1,507**	**200**	**844**	**78**	**148**	**127**	**42**	**2**	**19**	**1**	**2**	**1**	**1**	**46**	**12**	**276**	**22**	**312**	**8,003**

Table 2. Distribution of records by area (percentages of records by species per area). Species: DDE = *Delphinus delphis*, TTR = *Tursiops truncatus*, SCO = *Stenella coeruleoalba*, GGR = *Grampus griseus*, GME = *Globicephala melas*, PPH = *Phocoena phocoena*, BPH = *Balaenoptera physalus*, PMA = *Physeter macrocephalus*, ZIPH = family Ziphiidae, PCR = *Pseudorca crassidens*, OOR = *Orcinus orca*, BAC = *Balaenoptera acutorostrata*, EGL = *Eubalaena glacialis*, BED = *Balaenoptera edeni*, KBR = *Kogia breviceps*, SFR = *Stenella frontalis*, SBR = *Steno bredanensis*, GMA= *Globicephala macrorhyncus*, MISUN = unidentified mysticete, DELUN = unidentified dolphin

AREA	TOTAL SIGHT.	DDE	TTR	SCO	GGR	GME	PPH	BPH	PMA	ZIPH	PCR	OOR	BAC	EGL	BED	KBR	SFR	SBR	GMA	MISUN	DELUN	TOTAL
Provenza	**88**	0.0	0.0	53.4	1.1	2.3	0.0	36.4	5.7	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**100 %**
Catalonia	**78**	5.1	6.4	61.5	5.1	3.8	0.0	9.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	**100 %**
Balearic Islands	**500**	2.0	49.4	30.4	7.4	1.2	0.0	3.2	4.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.6	**100 %**
Valencia	**97**	7.2	32.0	27.8	5.2	3.1	0.0	8.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	12.4	**100 %**
Murcia	**339**	20.9	10.6	38.6	5.6	10.0	0.0	3.2	2.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	**100 %**
Andalucia	**3710**	29.3	12.3	29.4	1.9	17.1	0.1	1.9	2.0	0.9	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.5	**100 %**
African coast	**9**	11.1	0.0	22.2	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**100 %**
Galicia	**2729**	15.5	69.7	0.1	1.7	5.9	2.8	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.5	**100 %**
Canary Islands	**453**	5.1	12.8	1.3	2.6	0.0	0.0	0.2	2.2	0.9	0.2	0.2	0.0	0.2	0.2	0.2	10.2	2.6	60.9	0.0	0.0	**100 %**
TOTAL	**8003**	**20.3**	**34.2**	**18.8**	**2.5**	**10.5**	**1.0**	**1.8**	**1.6**	**0.5**	**0.0**	**0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**0.1**	**3.4**	**0.3**	**3.9**	**100 %**

ARE GREY SEALS (*HALICHOERUS GRYPUS*) COLONISING THE NORTHERN COAST OF SPAIN?

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The temporal distribution of juvenile grey seals in the northern Spain, during the winter months, has been well documented since the beginning of the twentieth century. There is no historical evidence for the presence of colonies of pinniped species in this area. The origin of the grey seals arriving on the north coast of Spain has been demonstrated in recent years, by recaptures of tagged seals from Ireland.

Until now, observations and strandings of this species were considered as "sporadic" on Spanish coasts, and this temporal presence confirmed the post-natal dispersion described for the species. But the increase in the grey seal population in the British Isles and France occurring in the last few years, seems to have produced an increase in the arrival of individuals to the north coast of Spain.

From winter 1998, a clear increase of juveniles of this species has been noticed in this area, raising the total number in these three years, to 56 seals. Of those, 34% were observed alive, 21% live-stranded, 32% stranded dead, and 13% were by-caught. Before winter 1998, all the observations and strandings of grey seals had been recorded between the months of December and March, and the total lengths of animals ranged between 90 and 115 cm. Jointly with the clear increase in records of seals, the total length (and consequently, the age) of the animals has also been increasing, four adult males of this species being observed in 1999 and 2000. On the other hand, the observation of healthy animals is more frequent year by year, and the period of permanence has clearly enlarged from December to May.

All these facts make us believe that if northern Spain is experiencing a process of colonisation by this species, it probably occurred earlier in other geographically adjacent areas.

FIN WHALE *(BALAENOPTERA PHYSALUS)* MIGRATION THROUGH THE STRAIT OF GIBRALTAR?

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INTRODUCTION Research effort on the fin whale has been relatively important in the northern part of the Western Mediterranean basin. The region of the Liguro-Provençal basin has been highlighted as being an important feeding ground for this species in the Mediterranean Sea, especially during the summer months (Zanardelli *et al.*, 1992; Forcada *et al.*, 1993; Forcada *et al.*, 1996; Gannier, 1997). The decline of the fin whale population in Liguria during the winter gives rise to the question of where these whales go, which has focused the attention of researchers during the last decade (Marini *et al.*, 1995). Nevertheless, very little is known about possible migration patterns of this species in the Mediterranean Sea, and about the wintering grounds. The only passage for possible migrations between the Mediterranean and the Atlantic Sea is the Strait of Gibraltar. To test this hypothesis, research on this species started in 1999 by researchers of CIRCE in co-operation with ESPARTE and ALNITAK which has been recording sightings of fin whales in the eastern section of the Alboran Sea since 1994.

METHODOLOGY

Shipboard surveys:

Ship-board surveys have been conducted in waters around the Strait of Gibraltar and the eastern Alboran Sea. Seven thousand six hundred and thirty-six nautical miles (14,141 km) have been sailed in the Gibraltar region and contiguous Atlantic region onboard a ten metre motor-boat in 1999 and 2000, whilst 18,478 nm (34,221 km) have been sailed in the central and eastern Alboran Sea region from 1992 to 2000. Data were recorded on number of individuals sighted, estimated size, initial cue and activity, contact position, depth, climatic parameters, sea state, associated species, and human activities.

Interviews and information from fishermen, yachtsmen and authorities.

For several years, some fishermen, yachts, and especially customs and police ships and planes, have been sending sighting sheets to ALNITAK, CIRCE and ESPARTE. Interviews were held also by the different platform crew members with selected fishermen, maritime authorities and yachtsmen in all ports along the coastline of the research region throughout the research years. Only interviews and sighting sheets of fishermen, yachtsmen, whale-watching boats and authorities considered most reliable and with most experience were taken into account, and only data verified either by photographs or by a very good and trustworthy description have been considered.

RESULTS Between 106 and 109 fin whales were sighted in a total of 74 sightings in the entire area. Seventy-four percent of these sightings were made between 1994 and 2000 in the central and eastern part of the Alboran Sea, and the other 26% were made between April-October of 1999 and 2000 in the Strait of Gibraltar (Fig. 1).

In 83.8% of the sightings, the behaviour of these animals was recorded, totalling 2,479 minutes of observation. In 82.3% of the encounters, the animals were sighted travelling westbound towards or into the Atlantic; in 16.1% of encounters, the animals were feeding; and, finally, in 1.6% of the sightings, the animals were milling. (Figs. 2 & 3).

DISCUSSION AND CONCLUSIONS The new data reveal that possibly a large number of fin whales tend to go to the Atlantic Ocean during summer (82% of the sightings were made during July, August, and September).

Another interesting fact is that the data confirm that the central part of the Alboran Sea could be a feeding ground. This area is considered as one of the most productive areas of the Mediterranean Sea, as a result of the upwellings of Estepona and Malaga (Garcia Lafuente *et al*, 1998) . In the remaining areas, on only one occasion, in the Bay of Algeciras, were the animals sighted feeding. This sighting was made in conjunction with a bloom of euphausiids in the bay.

Research from now will concentrate upon answering the question of whether these whales come back to the Mediterranean and, if so, when.

AKNOWLEDGEMENTS First of all, thanks go to Patricia Gozalbes for collaboration and comments, and to Anne Collet for her suggestions. Our special thanks go to the captains who patiently supported us in the campaigns we carried out, in particular to Antonio, Andres, Juan, Miguel and Kiko. We thank all the staff members of the different whale-watching platforms, particularly Walti, Keti, and all the volunteers of the firm España.

Last but not least, we thank the "Torre de Salvamento Marítimo de Tarifa Tráfico", and all the fishermen that took part in our research programme.

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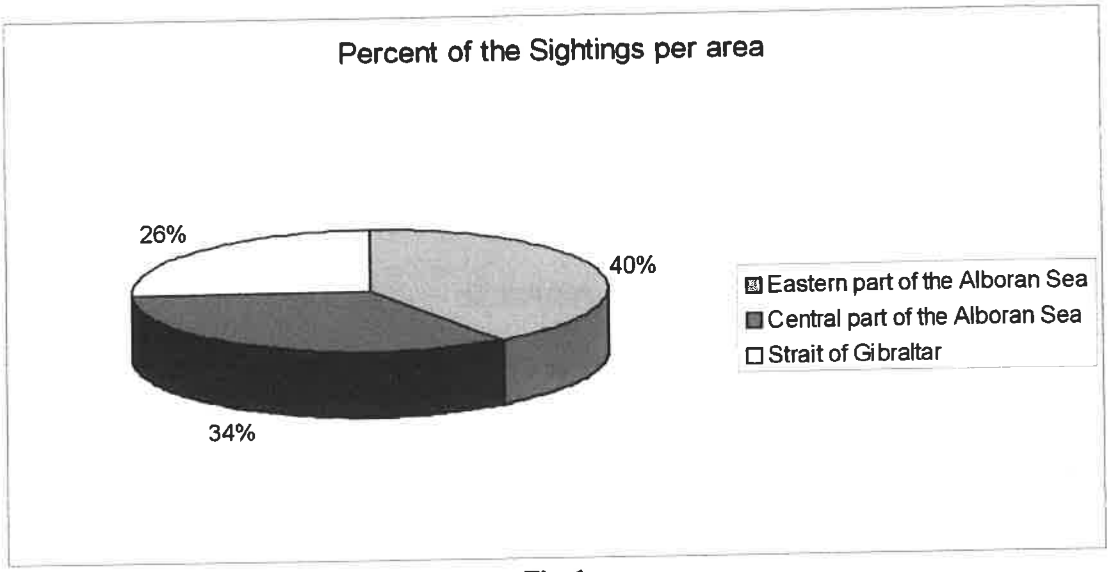
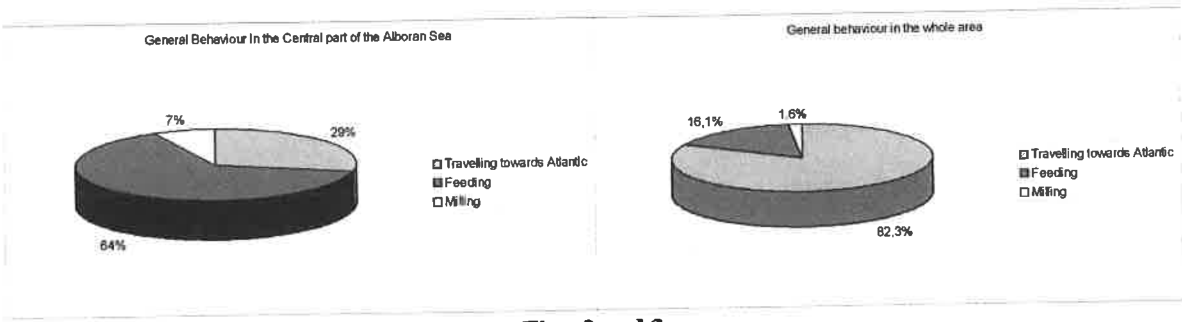


Fig. 1



Figs. 2 and 3

SUMMER DISTRIBUTION OF FIN WHALES IN THE MEDITERRANEAN SEA

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Baleen whales generally assemble in high productivity areas during the summer feeding period. During that season, the Mediterranean Sea features two mesotrophic regions, the Alboran Sea and the north-western basin, other pelagic areas being oligotrophic. A four-year summer study was conducted in 1997-2000 to determine regional cetacean populations from Gibraltar (5°W) to Rhodes Island (29°E), at latitudes in the 35°-44° range. A consistent linear transect protocol was adopted during the period (six knots, four observers) and the same vessel was used (a 12-metre 80 hp motor sailing vessel); the six-observer team included three permanent researchers. Pre-determined zig-zag tracks offshore totalled 12,489 km of effective effort (Beaufort 3 or less) distributed in the Alboran Sea (941 km), south-western (1957 km), and north-western (4361 km) basins, northern (619 km) and southern (1585 km) Tyrrhenian Sea, Ionian Sea (2448 km) and Levantine basin (578 km).

From 78 on-effort sightings obtained on fin whale groups, numbering one to five individuals, only seven were recorded south of 41°N, two south of 40°N and none east of Sicily (eastern Mediterranean), or west of Ibiza. Sighting frequencies were low in the south-western basin (2.0 sightings/1000 km) and southern Tyrrhenian Sea (1.9 sightings/1000 km), but high in the northern Tyrrhenian Sea (16.1 sightings/1000 km) and north-western basin (14.0 sightings/1000 km).

Relative abundance indices were calculated with Distance 2.2 software: 4.0 and 4.4 individuals/1000 km were estimated in the south-western basin and southern Tyrrhenian Sea respectively, against 25.8 individuals/1000 km in the northern Tyrrhenian Sea and 23.3 individuals/1000 km in the north-western basin.

These results suggest that large-scale fin whale distribution generally follows superficial primary biomass patterns, as observed by satellite imagery, with the noticeable exception of Alboran Sea where high productivity occurs, and no whales were sighted, underlining the specificity of this sub-region. Previous results had been restricted to the western basin.

ACKNOWLEDGEMENTS We thank the Ministère de l'Environnement and the Conseil Régional de Provence Alpes Cote d'Azur for having contributed to this study.

DISTRIBUTION AND SCHOOL-SIZE PATTERNS OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN NORTHERN SPANISH MEDITERRANEAN WATERS

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INTRODUCTION The bottlenose dolphin (*Tursiops truncatus*) is considered to be the most endangered cetacean species in the western Mediterranean. The Red Book of Spanish Vertebrates catalogues its Mediterranean population as Vulnerable and the Habitats Directive (EU) and Bern Convention consider it in need of protection. This species is believed to occupy only coastal waters in the western Mediterranean, and for this reason many of the existing coastal marine protected areas include the conservation of this cetacean amongst their main aims. This study provides new data on the coastal habits of the species, its distribution, and school-size patterns emerging from a long-term study on sightings of the species, as well as highlighting the potential significance of the offshore population component.

With this aim, we analysed 227 sightings (Fig.1) from the database of the GRUMM (University of Barcelona) which comprised sightings recorded during the last fifteen years in northern Spanish Mediterranean waters, including the Balearic Islands. We examined patterns of distribution, water depth, group size, presence or absence of calves, and distance from the coast, to better understand the actual situation of the species in the area and establish baselines for identification of protected areas.

RESULTS

Depth range

36% of sightings were made in waters less than 50 m deep, 54% in waters between 50-200 m deep, and 10% in waters over 200 m deep. (Fig. 2).

Group size

18% of the total of sightings recorded (n=227) consisted of only one individual, 70% comprised five or fewer individuals, and only 1.3% of the sightings were of more than 30 individuals. (Fig. 3).

The average number of dolphins per sighting decreased with time during the study; a significant reduction ($p<0.005$) in group size occurring from 1991 (0=8.9) to 2000 (0=3.9) (Fig. 4).

Thus, whereas in 1991, groups larger than 10 individuals represented 41% of sightings, in 2000, the same category reduced to 3%. On the other hand, during those ten years, the proportion of sightings of groups with few animals (less than four) has increased from 39% in 1991, to 66% in 2000. (Fig.5).

Distance to the coastline

The minimum distance to the coast was determined for the 28 sightings recorded along the peninsular coastline only. This was not done for sightings around the Balearic Islands, because inter-island distances confused such determination. 46% of sightings were recorded within 5 nm of the shore, 25% between 5-20 nm, and 29% more than 20 nm from the shore. Schools sighted between 10-20 nm from the coast were larger than the others, with a group size of 14 to18 individuals. The median size of schools sighted in the first 5 nm was one dolphin (Fig. 6).

Schools with calves

74% of the total number of sightings (n=168) contained information on presence or absence of calves: 44 (26%) of these contained calves. Most of the groups with calves were found in the depth range of 40 to 150 m. Within waters deeper than 150 metres, only about 15% of the groups sighted included calves (Fig. 7).

The number of sightings with calves in relation to the number of sightings without calves decreased from 1998 to year 2000, the value for 2000 being the lowest of the past decade (Fig. 8). The average size of schools with calves (0=10.7) was significantly ($p<0.005$) larger than those without (0= 5.05).

CONCLUSIONS In the area studied, bottlenose dolphins are mainly coastal, and are often found within the first 5 nm of the coast, and within the first 200 m depth. However, 54% of the sightings occurred between 5 and 30 miles from the coast and some individuals were also found in waters deeper than 500 m. While groups of only one individual are often in the first 5 nm, the larger schools of bottlenose are found in the range 10-40 nm from the shore. This information should be taken into account when designing marine protected areas, which in most cases are restricted to only the very coastal waters. The percentage of groups containing calves outside the continental shelf is low.

In the decade 1991-2000, the occurrence of large groups of dolphins has decreased while groups of few individuals have become more frequent. The number of schools with calves has also decreased. This is indicative of a declining trend in species abundance.

ACKNOWLEDGEMENTS Thanks are due to all the persons, groups, and institutions who supplied sightings data. The Ministry of the Environment of Spain (General Directorate for Nature Conservation) funded this study.

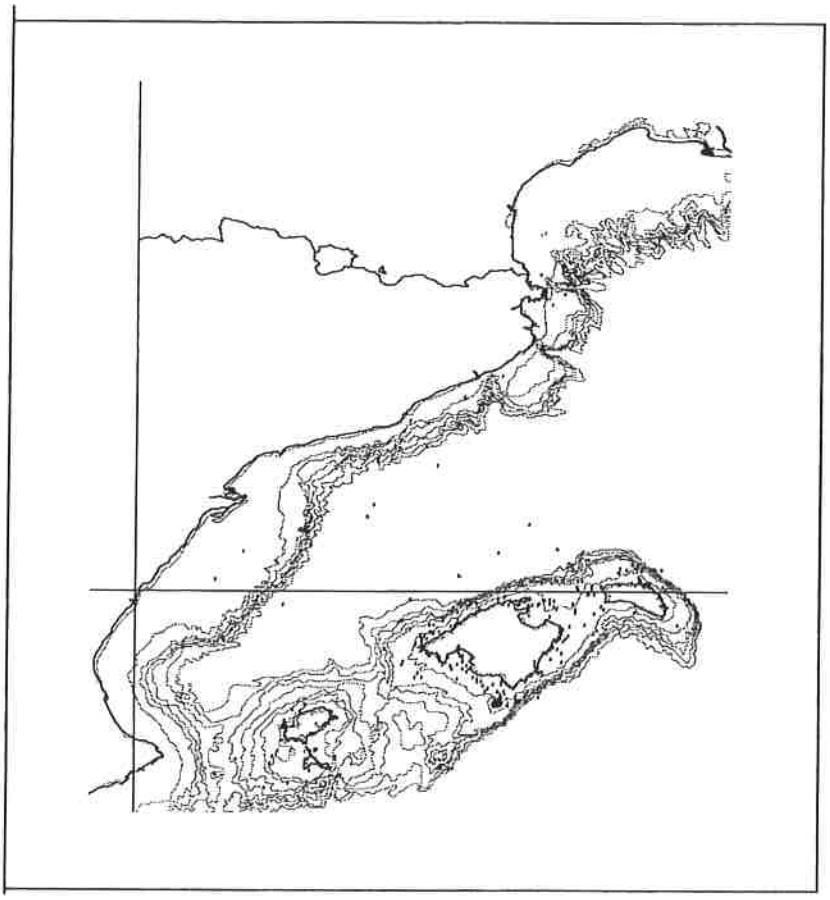

Fig.1 Study area showing all sightings of *T. Truncatus* recored

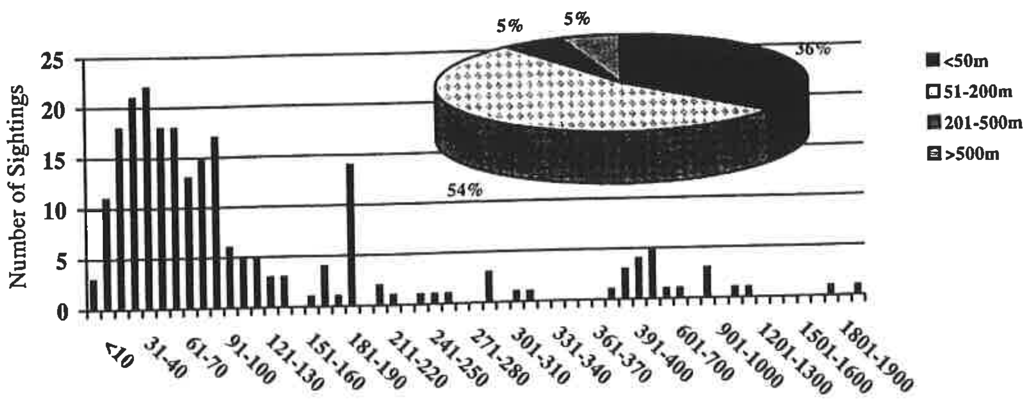

Fig. 2 Number and % of sightings recorded for each depth range.

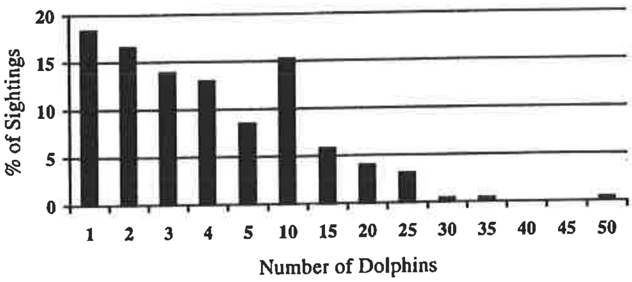

Fig. 3. % of sightings with a given group size.

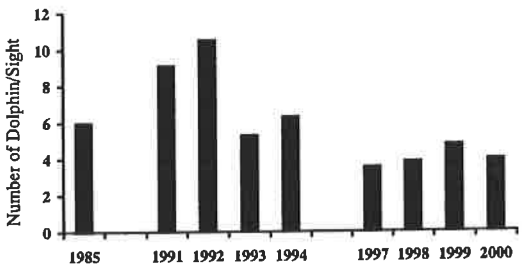

Fig. 4. Average group size for each group.

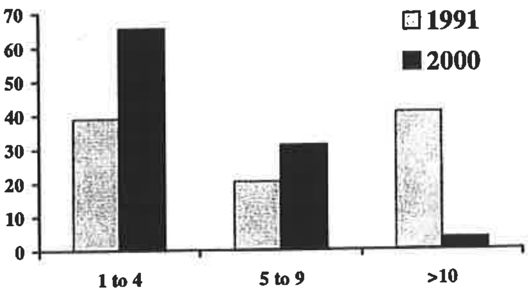

Fig. 5. % of sightings of each group size category for years 1991 and 2000.

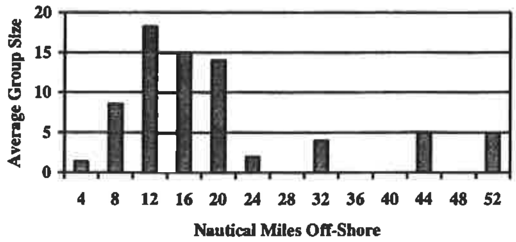

Fig. 6. Distance from coast and dolphin's group size.

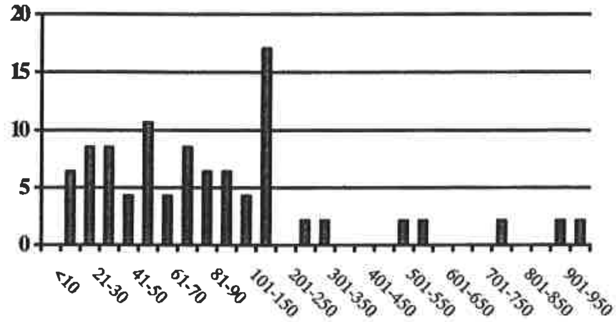

Fig. 7. % of sightings with calves and the depth range where they were observed

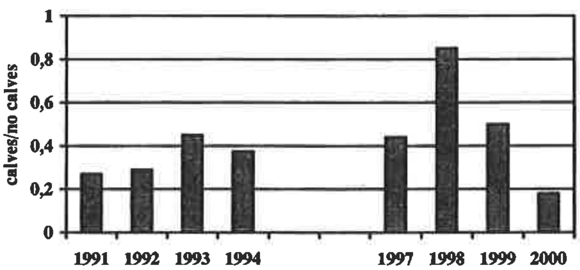

Fig. 8. Proportion of sightings with calves/ sightings without calves for each year.

CONTRASTING SPATIO-TEMPORAL HABITAT USE BY BOTTLENOSE DOLPHINS: CONSERVATION AND MANAGEMENT IMPLICATIONS

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Bottlenose dolphin distribution off western Europe is heterogeneous in both space and time. In some areas, dolphins are rare or seasonal, whilst in others they occur year-round. This study aims to improve our understanding of the factors that promote these patterns by comparing habitat use in three coastal areas off western Europe: (1) Mer d'Iroise off Brittany, France, (2) Cardigan Bay, west Wales and (3) eastern Scotland. Data were derived from standard boat and photo-identification surveys. Around 70 dolphins were estimated to inhabit the French area and numbers exceeding 110 occur off Wales and Scotland. When compared, the ranging patterns were conspicuously different. Animals off France were comparatively sedentary. Individuals around Sein Island, for example, had an annual linear range of less than 10 km. Animals off Wales and Scotland were more mobile, often making daily movements of 30 km or more, and some having annual linear ranges in excess of 200 km. Furthermore, off Scotland there is evidence for a gradual expansion in total population range. Whilst the environmental factors responsible for these differences remain unknown, the results are important for management. Special Areas of Conservation have been specifically designated for protection of bottlenose dolphins in Wales and Scotland with each including the believed core of the populations' range. However, due to the differing ranging patterns of individuals, not all animals will gain equal protection. Information on movements is therefore crucial to determine what proportion of each population is actually under management. Furthermore, because of suspected change in range, the boundaries of these protected areas must not be permanent. In France, instead of an SAC, a Marine National Park has been planned and will encompass the dolphins' entire spatial ranges.

SEI NO MORE? FIRST EUROPEAN RECORD OF THE BRYDE'S WHALE (*BALAENOPTERA EDENI*) FROM THE ISEFJORD, DENMARK, AND REVIEW OF EUROPEAN SEI WHALE RECORDS

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On 1 September 2000, a 7 m balaenopterid whale stranded in the Isefjord, Sealand, Denmark. External features, the dimensions of the baleens, as well as osteological features, identified the animal as a Bryde's whale (*Balenoptera edeni*). A DNA analysis conducted concurred with the morphological species determination. This is the first record of the species from European waters.

A review of European sei whale records was conducted, challenging the original species assignment of several smaller specimens. Unfortunately, the sei whale record along the southern European coast is incomplete and some material collected has subsequently been lost.

CETACEAN SIGHTINGS AND STRANDINGS IN THE SEA OF AZOV

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There are no exact data on cetacean distribution in the Sea of Azov. It is known only that during warm periods, harbour porpoises come from the Black Sea and return back by the winter. In 1990-99, we collected information on 13 direct sightings (62 harbour porpoises) and 303 strandings (89% *Phocoena phocoena*, 1% *Tursiops truncates*, and 10% unidentified carcasses) of cetaceans in the Azov Sea. Those data were complemented by interviews (>60) of fishermen and local inhabitants along the Ukrainian and Russian coasts. As a result, the modern boundaries of harbour porpoise distribution were specified. These cetaceans are common annually in the southern and western parts of the sea, but they are absent (at least, during the last five years) in the more freshwater bays of the north-eastern part. Nevertheless, stranded porpoises were sometimes found in Taganrog Gulf. The greatest number of cetacean carcasses was found in the area of intensive bottom-set gill net fisheries in the southern and western parts of the sea. Net-marks and amputated flukes indicated by-catches.

OBERVATIONS OF THE BRYDE'S WHALE (*BALAENOPTERA EDENI*) IN THE CANARIAN ARCHIPELAGO

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The Bryde's whale, *B. edeni*, is distributed worldwide across temperate and tropical waters, usually below 30° latitude in both hemispheres. There is virtually no information about the species in the north-eastern Atlantic. In the Canary Islands, there is a strong seasonal presence of Bryde's whale, the species being mainly found between June and October, when it is the most abundant member of the family Balaenopteridae.

While carrying out a study on bottlenose dolphins at the island of Gran Canaria during 1999 and 2000, Bryde's whale was observed 58 times in a depth range from 94 and 1450 m (n = 52, mean = 498.5 m and SD = 287.5 m). Most of the sightings were lone adult animals, with a maximun group size of three individuals. The animals were photographed, filmed, and eight biopsy samples were taken for genetic analysis. Most of the times, the species displayed active behaviour, probably asociated with feeding, with the presence of Cory's shearwater (*Calonectris diomedea borealis*), but occasionally it also showed an interest for the research vessel. Canarian tuna fishermen use this species as a biological indicator due its association with some tuna species, specially the skipjack tuna (*Katsuwonus pelamis*).

The Canaries may constitute a feeding ground for Bryde's whale – the analysis of the stomach contents of a stranded individual reinforces this hypothesis, – and probably also a mating ground. Concerning the genetic analysis of the eight biopsy samples, 363 bp of the mtDNA control region were sequenced and the gender of the animals was determined by amplifying the SRY gene. These sequences are the first ones for the Bryde's whale in the eastern North Atlantic. Only one haplotype was found, and this differs from one found in the Eastern Indian Ocean by only one base pair. This difference is a characteristic for the samples taken from the Canarian population. From the eight individuals, 50% were males.

HABITAT UTILISATION, OCCURRENCE AND SIGHTING PATTERN OF BRYDE'S WHALES IN MARGARITA ISLAND AND THE NORTH-EAST COAST OF VENEZUELA

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No research effort had been made in Margarita Island and the north-east coast of Venezuela to assess the local population of Bryde's whale *Balaenoptera edeni* since 1977, when Hubbs Sea World Research Institute determined a possible occurrence pattern of Bryde's whale, among other cetacean species, on a jetfoil craft route from the continental coast to the southern portion of the island. The objectives of this study is to establish in a preliminary way the spatial distribution of the species in the study area including the east coast of Margarita Island, making comparisons with other parts of Venezuela's west and central coastal ranges, also, to determine a preliminary sighting index and abundance, and the ecological implication of the specie's distribution in a fast developing coast.

Observations were made in 1999-2000, from cliff-based stations and sightings cruises from several boats including ferry and oceanographic research boats. Sightings were then plotted on a map using GIS software, and the spatial distribution analysed taking into consideration the topography of the area. Sightings and abundance indices were calculated in relation to the observation time effort.

Bryde's whale is the most common baleen whale in the region, although humpback whales and possibly fin whales have also been sighted. The distribution pattern extends to the east coast of Margarita Island, as proposed by Evans *et al* (1977), where females with calves have been recorded. Bryde's whale is present all along the coast of Venezuela, with the highest sighting records on the north-east coast, where there is a risk of habitat degradation with the increase of the tourist industry in the region. This is the first field effort made by a Venezuelan institution and Venezuelan researchers, to assess and produce information on the local population of cetaceans.

FIRST SUMMER POPULATION ESTIMATE OF BOTTLENOSE DOLPHINS ALONG THE NORTH-WESTERN COASTS OF THE OCCIDENTAL MEDITERRANEAN BASIN

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INTRODUCTION Bottlenose dolphin numbers are thought to have dramatically decreased in the north-west Mediterranean Basin during the second part of the 20th Century. To assess the present status of this species in the area, a systematic survey focusing on population estimates was conducted during summer 2000.

METHODS Surveys were made from three research motor-sailing ships, with three permanent observers on each, using different methods adapted to previous knowledge of the area-specific biology of bottlenose dolphin, and to the coastal bathymetry.

From 15th July to 16th August, systematic effort of the boat dedicated to Corsican coasts has been concentrated in depths of <200 metres, totalling 1100 nautical miles (nm), whereas the boat devoted to the Italian coasts travelled 715 nm until La Spezia, from the shore to a distance of 15 nm. Using a line-transect method in depths generally lower than 1000 metres, the third boat surveyed 1100 nm during the same period, covering the entire continental French coast from the Spanish to Italian frontiers.

Sightings from two other surveys, made by EPHE between 13th July and 28th September, are also taken into account, for their complementary results.

Photo-identification of individuals has been made, as accurately as possible, for all encounters and, in some cases, visual estimation of the numbers was completed by an under-water observation.

RESULTS Taking into account visual sightings and photo-identification results, the total number of dolphins seen during the total period ranged between 424-515 individuals from 27 to 31 groups, mainly around Corsica (198-242 individuals) and in the Gulf of Lions (200-209 individuals).

Two areas with higher abundances of bottlenose dolphins were found: the first was along the western coasts of Corsica, and mainly near the Désert des Agriates in its north-western part, and the second in the south and eastern parts of the Gulf of Lions.

Around Corsica and in the Gulf of Genova, bottlenose dolphins do not spread far from the shore, and they are more often seen over depths of 50 to 70 metres. On the other hand, individuals in the Gulf of Lions more readily frequent the lower part of the continental shelf, above depths of 90 to 120 m.

These surveys show that there are no bottlenose dolphins living along the Côte d'Azur, from west of the Hyères Archipelago to the Italian frontier, which is consistent with past studies. They also indicate that the species is not very abundant in the Gulf of Genova (less than fifty), and that individuals are mainly concentrated in its eastern part, between Portofino and La Spezia.

Proportions of calves by groups found around Corsica Island are similar to those observed during previous studies made since 1993 by the GECEM (3.8-3.9%), indicating that this population seems to be stable. Otherwise, calf proportions are higher in the Gulf of Lions (5.0-5.2%) than in Corsica, and could reflect the return of the species, and the population increase noted in this area since the second part of the 1980s.

Mean group size is more than twice as large in the Gulf of Lions, as in Corsica or the Gulf of Genova. Photo-ID matches show that individual movements could have large ranges encompassing all of the Gulf of Lions or Gulf of Genova, and from Corsica to continental France. With regard to sire fidelity during one season, 73% of the animals identified in mid-July on the coast of Agriates (N-W Corsica) were re-sighted, and practically all at the same place, during one second survey in mid-August. There, the dolphins seem to exploit a rather restricted sector. In the Gulf of Lions, on the other hand, certain individuals identified in the south of the zone in mid-July (including one with a completely truncated dorsal fin) had been found one week later in the north-east, after having crossed almost all the Gulf, had then returned at the end of September close to the point of the first observation. As for the dolphins living along the Italian coasts, it is probable (but this remains to be confirmed) that they may range as far as those of the Gulf of Lions.

A aimilar site fidelity of certain dolphins, but on a different time scale, has also been noted by a partial examination of the files collected over several years. Thus, in Corsica, and always off the Désert des Agriates, an animal located in summer 2000 proved to be the very first individual identified in the area in 1993, and it has been re-sighted there each year since then, but in four different groups, often with a young, as was the case in 2000. In addition, it seems that there is just one animal (Ag34) known in the sector Agriates - Cap Corse to have, until now, been re-sighted in summer outside the zone. That implies that those individuals meeting in this area are quite site faithful there, at least during the summer period.

With regard to site fidelity from one year to the next, it should be noted that the dolphin without a dorsal fin that had traversed a large part of the Gulf of Lions this summer, had already been seen the previous year, but to a greater extent inside the Gulf: only a few nautical miles from Port la Nouvelle (*pers. obs.*). It thus appears that the "territories" exploited by individuals can be extremely variable depending upon the region.

Lastly, it is clear that bottlenose dolphins are capable of making extended movements in the north-western Mediterranean. The phenomenon had been shown in 1997, following the re-sightin on 5th September in the islands of Hyères of the Ag34 individual photographed close to Saint Florent on 17th July of the same year (Dhermain *et al.* 1999). However, as shown for the first time by project TURSIOPS-2000, the same animal was re-sighted on 16th August, 2000 in Macinaggio (Cap Corse), thus showing the return of an individual bottlenose dolphin between Corsica and the continent.

CONCLUSIONS In the north-western Mediterranean, a first partial census of bottlenose dolphins around Corsica had already taken place from 14th to 27th August, 1993 (Bompar and Ripoll, 1993). Later on, and parallel to the follow-up of the groups observed over the coasts of Provence (Dhermain, 1996, 1997 and 1998), three other surveys (Ripoll and Dilliere, 1995; Ripoll, 1998) were devoted to behaviour studies and the follow-up by photo-identification of the subpopulation of the Gulf of Saint-Florent. Particular dolphins have been recorded for five years now in the photo-identification catalogue.

By largely extending the geographical framework of our work, it is clear that project TURSIOPS-2000 of the Cape Ligures Program has brought information of very great interest on the bottlenose dolphin populations inhabiting the area. Those efforts should be renewed, and extended, since we have as a result a more sound basic knowledge of this local population, which it is advisable to develop for a better understanding of the factors affecting dolphin movements and as a result, improved conservation of the species and its habitats. In particular, it would be helpful that such a work should lead to the establishment of a catalogue of photo-identified bottlenose dolphins for the entire north-western Mediterranean, including the whole of the French Mediterranean, Sardinian, and north Tyrrhenian waters, from which it would be useful to compare with individuals photographed in the Balearic Islands, and the southern Tyrrhenian Sea.

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Table 1. Synthesis of main parameters, by region, of groups of *Tursiops* encountered during the campaign TURSIOPS 2000

Region	Gulf of Lions	Hyères archipelago	Gulf of Genova	Corsica	TOTAL
Number of sightings	8	2	7	32	49
Total number of individuals	**200 - 209**	**16**	**10 - 48**	**198 - 242**	**424 - 515**
Mean group size *(range)*	18.5 *(3 - 58)*	8 *(7 - 9)*	7.1 *(1 - 10)*	9.2 *(1 - 25)*	*1 - 58*
Number of newborn	13	0	2 - 6	12	27 - 31
Percentage of newborn	**5.0 - 5.2%**	**0%**	**11.5%**	**3.8 - 3.9%**	
Mean distance to the coast (nm)	16.4 *(5.9 - 25)*	0.1	*(0.8 - 5)*	2.2 *(0.4 - 5.8)*	
Mean depth (m)	117 *(σ = 35)*	55	91 *(σ = 52)*	82 *(σ = 94.7)*	

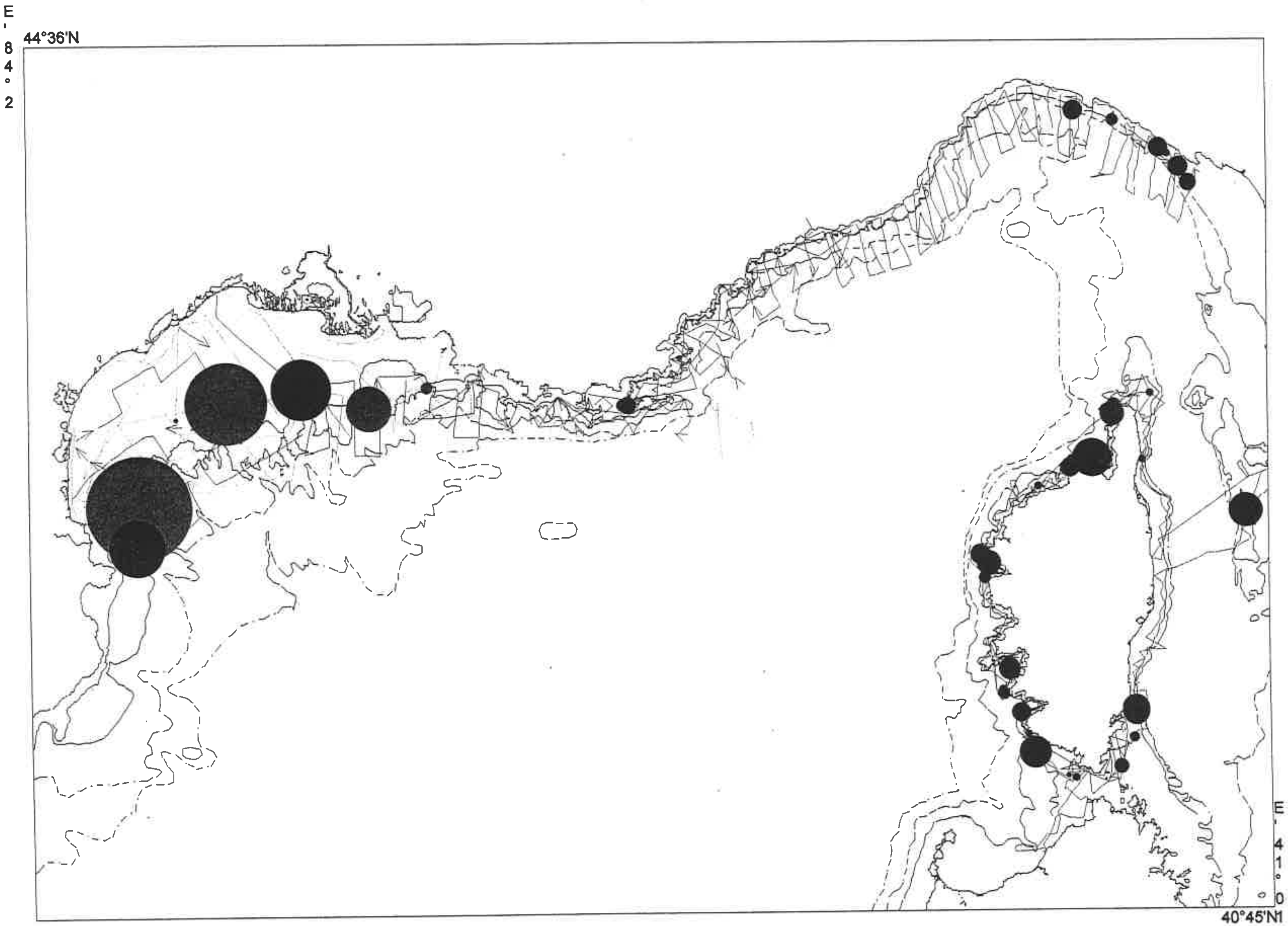

Fig. 1. Distribution of sightings of bottlenose dolphins from July to September 2000, in the north Occidental basin of the Mediterranean

ATLANCETUS NETWORK: MARINE MAMMAL STRANDINGS IN THE NORTH-EASTERN ATLANTIC DURING 1999

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Relevant information can be gathered through regular and standardised monitoring of marine mammal strandings. The Atlancetus network has been collecting data on mortality and by-catches of whales, dolphins, porpoises and seals according to established standard protocols since 1996. Information on dead or live-stranded animals, animals seen floating, or animals entangled in fishing gear is compiled on a database created for this purpose, and published on a regular basis.

Nine zones were defined in the Atlantic Iberian Peninsula and North Atlantic archipelagos, encompassing a large area with a relative extensive coastline that includes both offshore and inshore habitats. The Atlancetus study area covers a significant number of strandings on the Atlantic coasts of Europe, recording an average of about four hundred events per year. The present work describes data on marine mammals stranded and by-caught during 1999 in the study area described. Species occurrence, seasonal and geographical distribution, and fishing gear interactions results are discussed. Data collected in the last four years are also analysed. Recommendations for the adequate collection of strandings data, and benefits gained from this type of international multi-institutional collaboration are presented.

BOTTLENOSE DOLPHINS IN WEST SCOTLAND

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Bottlenose dolphins are listed under Appendix II of the EU Habitats Directive and, as such, the UK Government has an obligation to designate Special Areas of Conservation for key bottlenose dolphin habitats. Several groups of bottlenose dolphins have been reported in West Scotland. However, the occurrence of bottlenose dolphins on the West Coast of Scotland is frequently overlooked by statutory bodies.

In 2000, a number of sightings of bottlenose dolphin groups were reported in West Scotland from a variety of sources (including members of the public, local naturalists, wildlife tour operators and marine scientists). There are five main areas where sightings have been reported.

1) Sightings were recorded year-round, from the area around the Isle of Mull, with groups ranging in size from 1 to 23 individuals (mean size = 7).

2) Groups of 4-10 animals were also reported year-round from Loch Indaal, the Isle of Islay (mean size = 6).

3) On the Kintyre peninsula, groups of 2-20 dolphins were sighted near Campbeltown, and also near the Isle of Arran (mean group size = 11).

4) In the coastal waters of the Isle of Skye, sightings were made of a small bottlenose dolphin group (1-6 animals; mean group size= 4).

5) Several sightings were also reported from the area north of the Isle of Jura (1-12 animals; mean group size = 5).

Regular sightings have also been received from the Western Isles, particularly the coastal waters of Barra and in Loch Maddy, North Uist.

A research programme funded by the Worldwide Fund for Nature was started in December 2000 to investigate patterns of habitat use and residency, and population dynamics and sizes, through photo-ID and focal animal studies. These investigations will be important to determine whether a Special Area for Conservation for West Scotland's bottlenose dolphins is warranted or feasible.

FIRST REPORT OF MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*) IN GREEK WATERS

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On 23 May, 2000, a dead cetacean was found floating by the north-eastern coasts of Skiathos island (NW Aegean Sea, approx. 23° 31' E, 39° 11' N), Northern Sporades, Greece. The carcass condition, in relation to the relative high ambient temperature of this season, indicated that the animal had been dead for no longer than 2-3 days. The specimen was examined externally and was identified as a male minke whale (*Balaenoptera acutorostrata*), having the characteristic of the species - broad white bands on its flippers. The calf was 4.16 m length.

A corroded fishing hook (of the type used normally in Greece for sword-fish fishing long lines) was found attached on the animal's body. In addition, the lower body had a number of deep (approx. 2cm), sharp cuts (not bleeding) which it was speculated could have being caused by nylon fishing line used for sword-fish fishing (normally of diameter 1.5 mm). Such material itself has not been found attached on the carcass.

The above findings indicate that possibly the animal had been entangled in abandoned fishing long lines. However, a necropsy could not verify this as the cause of death. Measurements and photographs of the dead animal were taken and are presented. This is the first report of a minke whale in Greek waters.

DISTRIBUTION OF CETACEAN STRANDINGS IN GREECE BASED ON AN INFORMATION NETWORK

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Up to 1990, our knowledge on the presence of cetaceans in Greek waters was based on sporadic reports of incidental sightings or on museum specimens. Following the appearance of the dolphin morbillivirus (DMV) epidemic in Hellenic waters in 1991, a National Rescue and Information Network has been established throughout island and coastal Greece in order to collect sighting reports for marine mammals in Greek waters. The present study is based on data collected during the period 1991-2000 through this network.

From a total of 346 stranded cetaceans recorded throughout Greece, eight species have been identified. These are in order of decreasing frequency: striped dolphin *Stenella coeruleoalba*, Cuvier's beaked whale *Ziphius cavirostris*, bottlenose dolphin *Tursiops truncatus*, short-beaked common dolphin *Delphinus delphis*, Risso's dolphin *Grampus griseus*, harbour porpoise *Phocoena phocoena*, sperm whale *Physeter macrocephalus*, and fin whale *Balaenoptera physalus*.

The recorded stranding events provide evidence concerning the geographical distribution of each of these cetacean species in Greek waters. In addition, results obtained through autopsy and/or necropsy in relation to the cause of death indicate that the main threats to cetaceans in Greek waters are deliberate killing, entanglement in nets, and collision with boats.

SURVEYS AND ABUNDANCE

CETACEAN STRANDINGS IN DOÑANA LITTORAL, SOUTH-WEST OF IBERIAN PENINSULA

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INTRODUCTION The littoral zone of Doñana, a 60-km coastline from the Guadalquivir river mouth to the estuary of the Odiel river, is located in the Gulf of Cadiz. This area seems to be an obligatory migratory route for a number of cetaceans. However, very little is known about their occurrence in the area. From the begining of 2000, a Cetacean Stranding Monitoring Programme has been conducted along the coast of Doñana. The aim of this programme is to obtain as much data as possible of each cetacean stranding event through identification, measurement and collection of biological samples. This paper presents the data about the distribution and abundance of stranded cetaceans in this area. Additionally, we evaluated the importance of the interactions with fisheries and some preliminary results on diet.

METHODS The strandings have been detected by a coastal control network in which several local institutions and conservation groups in the area have participated. Whenever possible, at each stranding event, date, place, species, sex, and age were recorded, and individuals were examined to determine the most probable causes of death. Biometric measurements were taken, according to Norris (1961). Also, biological samples were collected when possible, for toxicological, pathological and diet analyses.

RESULTS During 2000, a total of sixteen cetacean strandings have been recorded: 15 odontocetes and one mysticete. All were single stranding events. On only one occasion was the animal alive: a neonate fin whale which was returned to the sea. We identified six different species: six bottlenose dolphins (*Tursiops truncatus*), two common dolphin (*Delphinus delphis*), one striped dolphin (*Stenella coeruleoalba*), one harbour porpoise (*Phocoena phocoena*), one long-finned pilot whale (*Globicephala melas*), and one fin whale (*Balaenoptera physalus*). Four unidentified odontocetes were also recorded. The general characteristics of the cetacean strandings are shown in Table 1.

Abundance of stranding species Previous authors (Fernández-Casado *et al.*, 1999; Máñez et al., 1999) found also that bottlenose dolphin was the most frequently recorded cetacean in the area (Fig. 1). Common dolphin and striped dolphin are regular species in the littoral of Doñana (Fernández-Casado *et al.*, 1999; Máñez *et al.*, 1999; and own data). The harbour porpoise is not a rare species in the area when considering the recorded stranding from this year and the five records of Mañez *et al.* (1999). The ecological characteristics of the coast (shallow sea with estuaries) form a suitable habitat for this cetacean. Our record of the long-finned pilot whale is the second for the study area, and this species is probably rare. The presence of fin whales seems to be regular in the area, although only a few stranding records exist. Mañez *et al.* (1999) recorded two fin whales along the beach of Doñana National Park, to which we can add the stranding of this year in Matalascañas and another in Punta Umbria, close to the coast of Doñana.

Temporal distribution of strandings Strandings seem to increase during the spring and summer (Figs. 2 and 3); between March and July, 81% of all events were recorded, with a maximum in July (31%). From this month to November, no strandings took place. This situation could be related to seasonal feeding movements, migrations between the Atlantic and the Mediterranean, or with the dominant marine currents. The remaining strandings (19%) occurred during autumn-winter. Although bottlenose dolphin strandings are concentrated in the spring-summer period, some are recorded during autumn. That might indicate a sedentary population in the Gulf of Cadiz.

Age and Sex Of the sixteen strandings recorded, the age was determined in thirteen cases, and the sex in nine cases. Figs. 4 and 5 show the proportions of ages and sex found

Interactions with fisheries Of the fourteen examined specimens, 36% of the mortality events were caused by fisheries.

Preliminary diet data In bottlenose dolphins, we found a mixed range of prey, with a main type formed by littoral schooling fishes such a scad (horse mackerel), sardine (pilchard), breams, etc, and a less frequent group which are associated with sandy or muddy shallow bottoms. We found also several mimetic small squids and octopus, and a small shrimp that normally lives buried in the substrate. The presence of sand and shell remains of bivalves reinforces the idea that some bottlenose dolphins in the area have learned to complete their diet with prey from bottom. Striped and common dolphins have a preference for pelagic areas, specially the striped dolphin. In those species, we found bones of a small mesopelagic light fish, jawbones of two squid, and one oceanic pota. In the common dolphin, we found pelagic *Macroramphosus* and two squid species.

CONCLUSIONS The sixteen strandings recorded during 2000 in the littoral zone of Doñana suggest an increase in numbers of strandings compared with previous years. Fernández-Casado *et al.* (1999) refer to 34 strandings on the coast of Huelva (larger than the studied area) in a period of three years (1996-98). This increase is probably associated with a larger effort in the detection of strandings.

The bottlenose dolphin is the most frequent cetacean species amongst strandings. The temporal distribution of the strandings occurs mainly in spring and summer, and to a smaller extent in autumn. There is possibly a resident population of bottlenose dolphins in the area since strandings have occurred in most parts of the year.

Interactions with fisheries are at least as high as 36% of the events indicated.

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Table 1. General characteristics of the cetacean strandings during 2000 in the littoral of Doñana: TTR - *Tursiops truncatus*, DDE - *Delphinus delphis*, SCO - *Stenella coeruleoalba*, PPH - *Phocoena phocoena*, GME - *Globicephala melas*, BPH - *Balaenoptera physalus*, UOD - Unidentified odontocet, CS - Body conservation state, TL - Total length

Species	Date	Sex	Age	CS	TL(cm)
TTR1	16-03-00	M	Adult	3	302
TTR2	29-05-00	F	Young	3	203
TTR3	26-06-00	M	Young	4	216
TTR4	13-07-00	F	Calf	3	129
TTR5	23-07-00	–	–	–	–
TTR6	23-11-00	M	Young	3	170
DDE1	19-04-00	M	Adult	4	180
DDE2	10-05-00	M	Young	3	113
SCO1	11-04-00	M	Young	3	152
GME1	18-05-00	–	Young	4	270
PPH1	07-07-00	M	Adult	2	153
BPH1	21-11-00	–	Calf	1	612
UOD1	24-03-00	–	–	–	–
UOD2	05-06-00	–	–	–	–
UOD3	03-07-00	–	Calf	3	93
UOD4	12-07-00	–	–	–	–

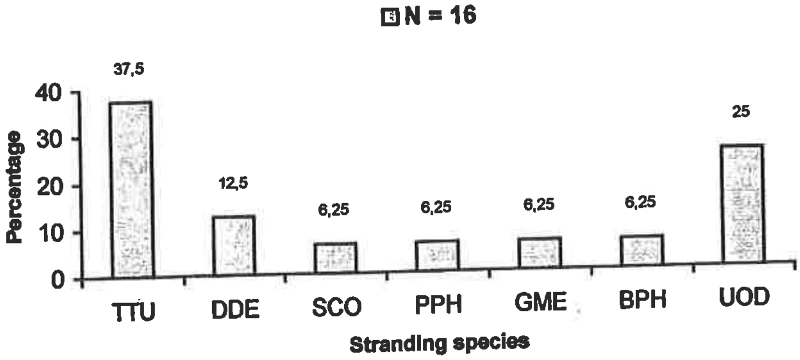

Fig. 1 - Stranding species

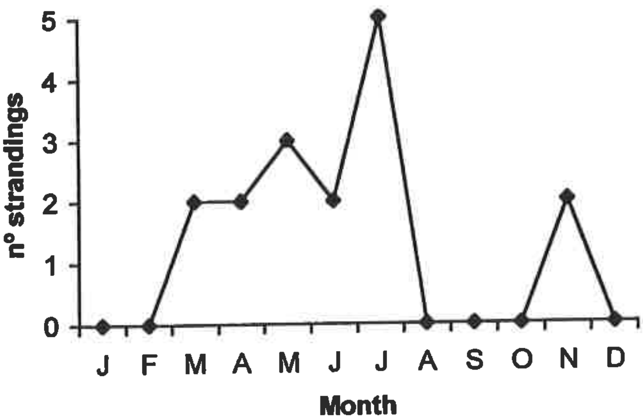

Fig. 2 - Annual distribution of the strandings

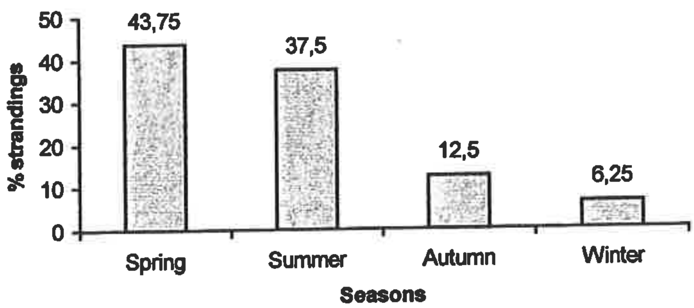

Fig. 3 - Seasonal distribution of the strandings

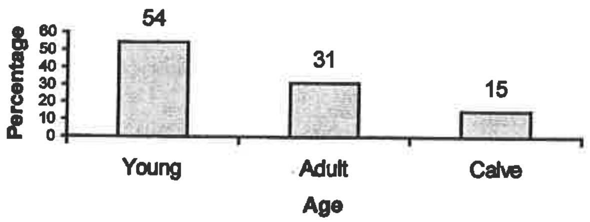

Fig. 4 - Rate of age

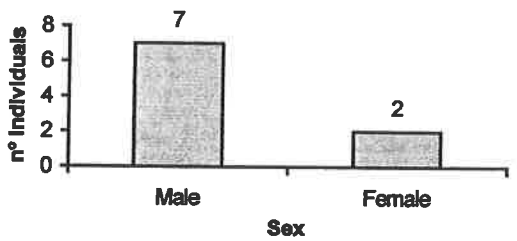

Fig. 5 - Rate of sex

MARINE MAMMAL ABUNDANCE AND ECOLOGICAL ROLE IN THE MARGINAL ICE ZONE OF FRAM STRAIT

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Polar oceans are characterised by the absence of large predatory fishes like sharks and tunas. In contrast, marine mammals and seabirds play an important role as top predators. During August 2000, the abundance of marine mammals was studied in the marginal ice zone of Fram Strait between Greenland and Svalbard. Seals were counted in strip transects along the cruise track of the ice-breaker "Polarstern", and during three helicopter flights with a total transect length of >460 km.

The most abundant marine mammal in the marginal ice zone was the ringed seal. Occurring with an average abundance of 0.2 and 0.6 individuals km^{-2} according to the airborne and vessel-based surveys, respectively, the ringed seal population may consume a substantial portion of the secondary production of its main prey, polar cod and the amphipod *Themisto libellula*. Hooded and bearded seals occurred along the continental rise and over the East Greenland Shelf..

"Polarstern" was also used as a "platform of opportunity" to record cetacean sightings during the cruise. A total of 12 sightings, comprising at least 28 individuals, were recorded. Minke whales were most abundant, occurring right into the pack ice. In contrast, fin whales did not enter the ice, but were sighted several times along the ice edge. At 79°N 6°E, the ice edge coincided with the western boundary of the West Spitsbergen Current, characterised by a strong eastward increase in sea surface temperature, typical of a pelagic front. In this region, two minke whales, five fin whales, seals and >60 juvenile Brünnich's guillemots were observed. The increased nutrient availability and the concentration of prey at pelagic fronts offer an enhanced food supply for marine mammals and seabirds. Thus, permanent or predictable fronts may provide important feeding areas for marine mammals and should be included in Marine Protected Area concepts.

OCCURRENCE, DISTRIBUTION, AND MOVEMENTS OF OUTER COASTLINE BOTTLENOSE DOLPHINS OFF GALVESTON, TEXAS

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Several studies have been conducted on bottlenose dolphins (*Tursiops truncatus*) in the Galveston Bay area, but no detailed studies have extended to outside Gulf of Mexico waters. Bottlenose dolphins are top predators of this area and can thus serve as bio-indicators of the system. The bottlenose dolphins that inhabit the Gulf of Mexico adjacent to Galveston Island were studied from June 1999 to July 2000, providing the first detailed description of the dolphins inhabiting this area. Data were collected from two different platforms: from shore-based observation points to gather information on occurrence patterns, and from a small boat for photo-identification, to describe movement patterns of individuals.

Dolphins were observed in the coastal waters off Galveston Island during all months of the year, spanning the entire length of the island. More dolphin groups were present when shrimp boats were present, and those groups were significantly larger than groups seen in the absence of shrimpers. 601 individuals were photographically identified with relatively few re-sightings, indicating that the study area is only part of the home range of these individuals. Comparison with existing photos for Galveston Bay animals show that some animals were frequently sighted in both areas, while some were only sighted in one of the areas. One possible explanation is that individuals or groups may exhibit habitat preference when engaged in specific behaviours; groups from the bay or from deeper water may utilize the coastal area for play or socialising. Further study of this and all areas of Galveston Bay are recommended, as long-term monitoring of these identified individuals will allow for descriptions of patterns of habitat use

BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) BECAME PREVALENT CETACEAN SPECIES IN BLACK SEA COASTAL WATERS OFF THE CRIMEA

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During the past century, the abundance ratio between two inshore species of Black Sea cetaceans has been considered as an axiom: the harbour porpoise (*Phocoena phocoena*) is a predominant form while the bottlenose dolphin (*Tursiops truncatus*) represents a minority. The last two surveys confirming this maxim were conducted in the USSR and Turkey fourteen years ago (1987); thus, their results have become out of date.

In 1990-99, we collected 397 primary records of cetacean sightings in the coastal (20-60 km wide) Black Sea area surrounding the Crimean peninsula from Karkinitsky Bay to Kerch Strait. Special observations were carried out in June 1995, June 1997, June-July and September 1998, by means of sailing and motor yachts which covered distances from 255 to 934 km (10371 km in total).

It was shown that in 1997 and 1998 there was prominent growth (by more than five times) in the bottlenose dolphin abundance index by comparison with 1995. Meantime, the level of harbour porpose presence demonstrated an obvious decline in 1998 following a peak in 1997. So, the ratio between bottlenose dolphin and harbour porpoise abundance indices showed a trend towards a prevalence of bottlenose dolphins: 1995 – 0.8; 1997 – 0.9; June-July 1998 – 6.8; September 1998 – 12.9. The difference between the last two figures could be explained by annual autumn accumulation of bottlenose dolphins in the waters closed to the southern extremity of the Crimea (Cape Fiolent – Cape Sarych). Almost daily patrolling in that area in September – October 1997, and August – December 1998, confirmed the undoubted predominance (by 7-26 times) of bottlenose dolphin abundance in comparison with harbour porpoises. Bottlenose dolphin groups numbering hundreds of animals migrate every autumn to this relatively small area from the eastern and, probably, other parts of the Black Sea. Mass incidental mortality in bottom-set gill nets is the most obvious cause of the marked decrease in harbour porpoise abundance.

ON THE PRESENCE OF THE HUMPBACK DOLPHIN (*SOUSA PLUMBEA*) IN ZANZIBAR

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INTRODUCTION Several cetacean species have been reported in the waters surrounding Zanzibar (Stensland *et al.*, 1998; Tocchetti *et al.*, 2001). Nevertheless, very little information is presently available regarding occurrence, distribution, and abundance. On February 1999, one of the authors (A. Bortolotto) went to Zanzibar for a general review of the area; then, in co-operation with the Institute of Marine Sciences in Zanzibar, it was decided to start a research project (October 1999) aimed at studying the occurrence of cetaceans in these waters, as well as the influence of human activities on their presence (Tocchetti *et al.*, 2001), with particular reference to the Indian Ocean humpback dolphin (*Sousa plumbea*).

The archipelago of Zanzibar (Indian Ocean) is situated off the coast of Tanzania from which it is separated by a relatively shallow channel (36 km at its nearest point with a maximum depth of 70 m and around 45 m as an average). It consists of two main islands, Pemba and Unguja (Zanzibar) as well as a number of smaller islands (Chumbe, Bawe, Changuu, Kibandiko and Chapwani, in our study area) (Fig. 1). Unguja is the biggest island in the Archipelago (85 km x 39 km) and the seat of its main town (Stone Town). The western part of the island is characterised by the presence of mangroves sometimes interrupted by sandy or rocky beaches. The small islands facing this coastline share its features; additionally there are a few sandbanks (such as Pange), emerging only during the low tide in areas slightly southward and westward of Stone Town. The tidal range varies from about 1.5 to 3 m; and in a few areas there are coral reef formations, but generally speaking it is very limited in this part of the island. By contrast, on the southern, northern, and especially eastern part of Unguja, the depth increases markedly and coral reefs are more consistent, therefore showing slightly different coastal features with only a single big mangrove area in the middle of the eastern coast (Chwaka Bay). After several considerations, we decided to focus our efforts on the area around Stone Town, from Kama promontory (in the north) to Chukwani (in the south). Occasionally we also monitored the area around Kizimkazi, to the south-west of the island, where bottlenose dolphins (*Tursiops* spp.) are exposed to a massive uncontrolled "dolphin-tour" activity, as well as in the area around Matemwe, to the north-east, where several cetacean sightings are reported, mainly of spinner dolphins (*Stenella longirostris*) and humpback whales (*Megaptera novaeangliae*) (Fig. 1).

MATERIALS AND METHODS All our surveys were made on 10 m wooden boats powered by a 15 HP engine. Occasionally we carried out also shore-based observations, mainly to the north of Stone Town. In the period between October and November 1999, a total of 13 exploratory surveys were made; with 43 pre-defined ones in summer 2000. During the 2000 surveys, we used two different methods: 'single line transects' (SLT) and 'ecological surveys' (ES), whilst in 1999, we made random surveys.

Single line transects In order to estimate the occurrence of cetaceans, we drew up five different linear routes for regular coverage. A speed of 10 km/h was maintained while looking forward and on both sides in a stretch of approximately 200 m (on each side). Each transect was 12 km long, weather permitting (Fig.1). Whenever we made a positive sighting, we also noted down the estimated distance from the boat and the angle formed with the boat direction.

Ecological surveys We followed pre-planned routes (Fig. 1) in areas where the environmental conditions best suited the habitat of humpback dolphins (i.e. within depths of 25 m, according to the literature); during each ES, we tried to maintain a distance of about 250 m from the shore wherever possible.

All of the above mentioned surveys (both types) have been carried out in three different time periods: morning, midday, and afternoon. During these surveys, several data were constantly monitored: water temperature, cloud cover, and type of clouds, sea conditions (Beaufort scale: 3 as upper limit), wind direction, visibility, boat speed, and GPS position, as well as the presence of other species and human activities. In case of positive contact with cetaceans, we also noted group size, behavioural budget (travelling, activity, and inactivity), and breathing rates. Wherever possible, pictures were also taken for our photo-ID programme. We used Nikon F60 cameras equipped with Tamron 80-300 mm zoom lenses and 400 ISO films for both colour slides and B/W prints; furthermore, we also used a video camera in order to record complex behavioural sequences.

RESULTS All cetaceans sighted during the coastal ES were humpback dolphins. No other species was sighted during these coastal surveys. The only exceptions are the bottlenose dolphin in Fig 2, presumably of an *aduncus* type (genetic analyses are presently being conducted), found dead entangled in the nets near Changuu Island, as well as sighting of two dolphins (presumably *Tursiops* sp.) on 14th September, 2001 near Pange (in the only ES conducted relatively offshore, the one we called 'islands'). On the other hand, only one humpback dolphin, a large-sized adult heading offshore, has been sighted during the SLT routes (on 23rd August, 2000), 2.4 km from the Island of Bawe - c.a. 6 km from Stone Town. This case is similar to the one described by Corkeron (1990), and cited in Karczmarski *et al.* (2000). Therefore, this is one of the few reports of humpback dolphins occurring several kilometres from the shore. As in the case previously cited, our sighting occurred in a relatively shallow area (<30 m). Nevertheless, most of our sightings took place predominantly inshore as expected.

The humpback dolphins observed during this survey clearly belong to the "Indian Ocean form" *Sousa plumbea*, based on dorsal fin structure, according to what has been previously described (Ross *et al.*, 1994), the dorsal fin of the animals that we observed being quite elongated and thickened basally, as shown below, and according to Rice (1998) (Fig. 3).

The schools that have been sighted during our 1999 surveys, ranged from three to about eight dolphins (n = 6). On all the occasions, we noticed the presence of one or two calves. This was always in association with groups containing more than one adult, as previously described (Saayman and Tayler, 1979). During 2000, the groups ranged from 1 to 8 individuals (n = 19); only one calf has been sighted (5th Aug) in association with four other individuals, less than 100 m from the shore to the south of Stone Town. As previously described (Saayman and Tayler, 1979), the humpback dolphins that we observed usually swam quite slowly although on one particular occasion (October 1999), we noticed a general increase in the overall school's activity, possibly due to what appeared to be a socio-sexual interaction between two individuals (apparently adults) involved in courtship-like behaviour. The animals were isolated from other members of their group, and showed vigorous activity with 'helical interchanging of their relative position' as previously described in a long-term study in Algoa Bay, South Africa (Karczmarski *et al.*, 1997).

During this preliminary study, several pictures have been taken in order to document the presence of the species, as well as to start a catalogue for future photo-identification studies. Previous researchers have pointed out the difficulty in identifying humpback dolphins given the dorsal fin features of this species, and have suggested the use of alternative techniques such as matrix photo-identification (Karczmarski and Cockcroft, 1998) versus a more traditional approach (Defran *et al.*, 1990). All the pictures are presently being examined by different researchers. So far, we managed to successfully identify only one individual. Although many others have exhibited distinct markings, the main problems is the difficulty of obtaining good quality pictures, mainly due to the attitude of the animals, and the extreme light conditions. Nevertheless, given the importance of photo-identification to shed some light on the ecology of this poorly known species, we will continue to focus our attention on this method, with dedicated surveys on summer 2001.

Several authors have described a characteristic avoidance reaction to boats, rarely permitting close approaches. Nevertheless, during both our 3-week period (1999), and the three months spent in 2000, we never experienced such a tendency. On the contrary, the animals appeared to be quite interested in our boat, often approaching it directly and following our path, independently of the presence of a calf (1999). On a few occasions, they came really close to the research boat (only a few metres from our cameras) and spent a considerable amount of time with us. As a matter of fact, on several occasions it has been our choice to interrupt the contact because of poor visibility due to the late hour. In our study, humpback dolphins were often seen in areas heavily used by inshore traffic (i.e.: around the Port of Stone Town) in February 1999, October 1999, and in 2000; this is in contrast with what has been observed by Karczmarski (1996) in the area around Port Elizabeth, South Africa, and more in general in Algoa Bay, South Africa, where animals appear to be particularly disturbed by power boats (Karczmarski *et al.*, 1997).

If harrassed by a boat, humpback dolphins in our study area tended to perform avoidance behaviours, normally making longer dives, changing their direction and swimming underwater for a long distance before surfacing. An interesting fact that we noticed during 2000 was the tendency of humpback dolphins to be attracted by jet skis. This tendency was clearly seen on several occasions both from the shore and from our research boat.

On one particular occasion, we were observing the animals from our boat floating adrift when a jet ski passed by, causing all the animals to change their behaviour and actively approach it at a close distance. Humpback dolphin surface breathing patterns hve been described as fairly stereotyped (Karczmarski *et al.*, 1997); as a general tendency, in our study area also, they exposed their beaks on surfacing, arching the back strongly (Fig. 4), and sometimes raising the flukes on diving (Fig. 5). During our surveys, aerial behaviour was relatively infrequent in according to the literature (Karczmarski *et al.*, 1997); nevertheless, on a few occasions full vertical leaps, porpoising, and breaching were noted in both 1999 and 2000. During October 1999, aerial behaviours were performed only by calves, while in 2000 we noticed a large adult performing a full vertical leap.

CONCLUSIONS In conclusion, the typically restricted inshore occurrence facilitates the implementation of sea- and land-based observation. During both seasons, we noticed the tendency of the animals to follow a definite pattern southward and northward at different times of the day. This tendency is still under evalutation, and will be more extensively studied in the future. Furthermore, as pointed out in previous studies, there is the need to examine also their nocturnal behaviour and their response to boat traffic. For these reasons, in summer 2001 we are planning to start observations from the land, as well as acoustic surveys of the study area, along with the Italian CIBRA, University of Pavia. Furthermore, an official co-operation with the Milano Museum of Natural History is being established in order to support the activities of the Beit-el-Ameni, the Natural History Museum in Zanzibar.

ACKNOWLEDGEMENTS We kindly acknowledge Mario Mariani, vice-consul of Italy in Tanzania, for his support and friendship, Omar Ali Amir for his support and help, Claudia Fachinetti, Roberto Induni, Cristina Pilenga from the University of Pavia for their help, Laura Bonomi for reviewing this presentation and for photo-ID analysis, and finally Fondo per la Terra / Earth Fund for partially supporting this project at its beginning.

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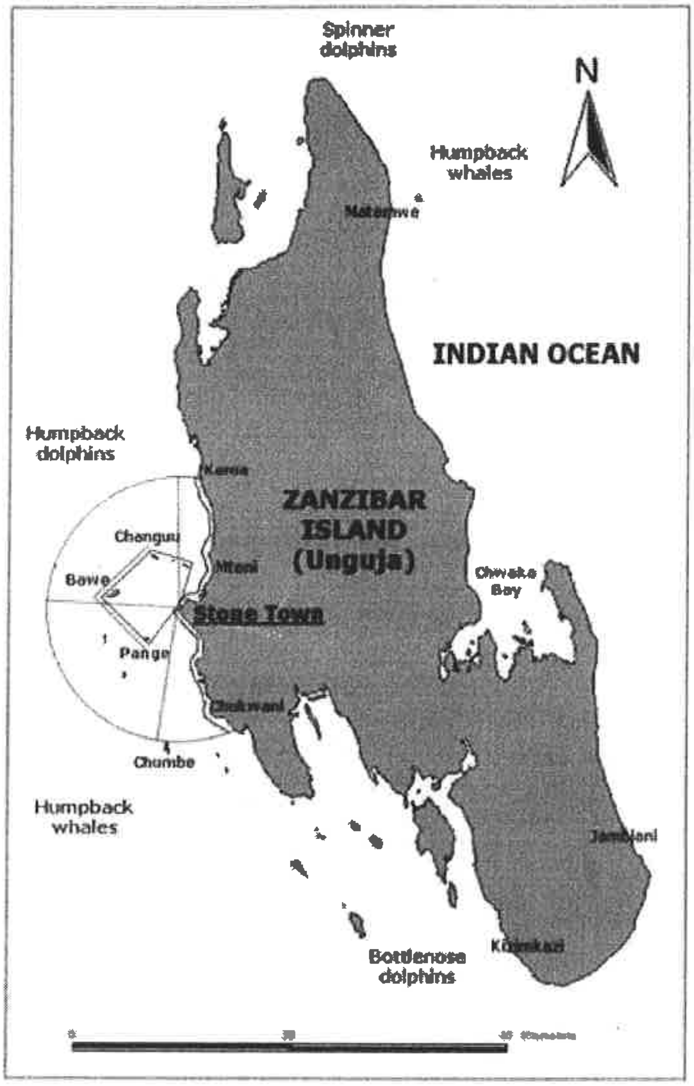

Fig. 1. The study area

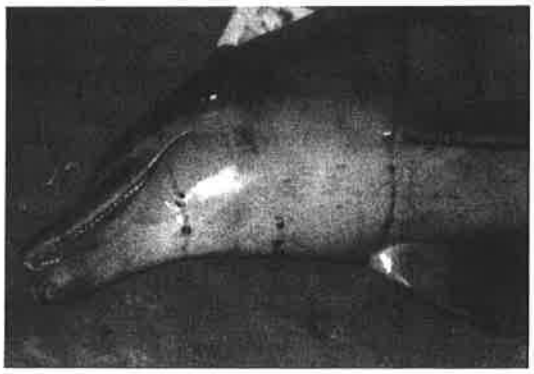

Fig. 2. A male bottlenose dolphin found dead entangled in the nets near Changuu Island.

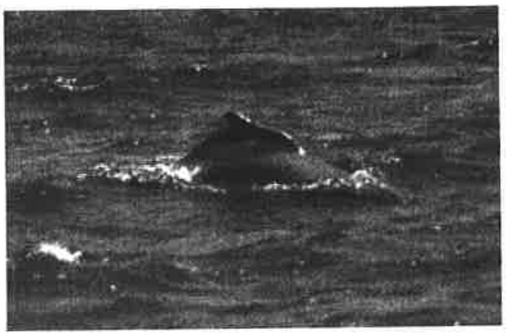

Fig. 3. The typical appearance of Zanzibar humpback dolphins.

Fig. 4. A strong arch before the dive.

Fig. 5. Fluke up.

BRAVING THE ELEMENTS: WINTER CETACEAN SURVEYS IN THE BAY OF BISCAY, 1995-2000, THEIR VALUE AND CONSERVATION SIGNIFICANCE

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The majority of dedicated cetacean surveys in temperate waters are carried out in a narrow window of opportunity during the summer months, when sightings rates are at their highest, and weather conditions are most suitable. Few systematic surveys have been made during winter months (November to February), especially in offshore areas, and the seasonal status of many species over this period is poorly known. This paper describes the distribution and abundance of cetacean species in the eastern Bay of Biscay during the winter, recorded through Biscay Dolphin Research Programme (BDRP) surveys between November 1995 and December 2000. Under the sponsorship of P&O Portsmouth, BDRP undertakes monthly effort-based surveys along a fixed route through the Bay of Biscay onboard the Pride of Bilbao. Standard survey methods developed for ferries and other 'platforms of opportunity' are employed.

Over the survey period, fifteen winter trips were made, with more than 6000 km of search effort completed in ten International Council for the Exploration of the Sea (ICES) grid cells off France and Spain. Surveys were made in all weathers, some in extreme conditions, pushing observers to the very limits of physical tolerance. In spite of this, a wealth of data has been generated, in no small part due to the resilience of observers and the extraordinarily good viewing platform provided by the research vessel.

Eleven cetacean species have been recorded including, of conservation significance: (1) large numbers of common dolphin *Delphinus delphis* in the northern Bay of Biscay; (2) regular sightings of bottlenose dolphin *Tursiops truncatus*, and long-finned pilot whale *Globicephala melas*; and (3) occasional sightings of little-studied species such as Cuvier's beaked whale *Ziphius cavirostris*, Sowerby's beaked whale *Mesoplodon bidens*, and northern bottlenose whale *Hyperoodon ampulatus*. These and other species have undoubtedly been under-recorded due to the challenging, but ultimately rewarding, viewing

LOW-COST LINE-TRANSECT SURVEYS FOR HECTOR'S DOLPHIN.

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Abundance data are usually required before threatened species receive management action. Surveys to estimate abundance robustly are usually expensive, and in many cases unaffordable. Additionally, coastal rather than oceanic species are those most in need of conservation. A significant challenge, then, is to design robust surveys for inshore cetaceans using cost-effective platforms. Hector's dolphins (*Cephalorhynchus hectori*) occur only in inshore waters of New Zealand (mainly in South Island waters). A population decline due to gillnet bycatch has resulted in an IUCN listing of "Endangered" for this species, and underscores the need for robust abundance data.

We adapted a 15.3 m sailing catamaran for line-transect surveys by installing larger engines, a raised sighting platform for three observers with binoculars, and a GPS-interfaced data-recording system. On open coasts, transects were placed at 45° to the coast to minimise variance due to dolphins moving along shore or inshore-offshore. Within harbours, transects were placed at 45° to an imaginary line running down the centre of the harbour. With each stratum, the location of the first transect was chosen randomly; thereafter, they were regularly spaced (1, 2, 4 or 8 nm apart) according to pre-existing data on dolphin density. We have covered the south, east, and north coasts of New Zealand's South Island. Total transect length was 2060 km, of which 18% was in harbours and bays, 68% on open coasts to 4 nm offshore, and 14% from 4 to 10 nm offshore. At Banks Peninsula, we conducted simultaneous boat/helicopter surveys to measure the combined effect of dolphins being attracted to the survey vessel and observers missing sightings. Analysis of these data show that uncorrected estimates are inflated by a factor of two. The total estimate for the south, east, and north coasts (Farewell Spit to Long Point) is 1,882 dolphins (CV = 21%).

EVIDENCE OF SITE FIDELITY IN THE STRAITS OF GIBRALTAR FOR SPERM WHALES (*PHYSETER MACROCEPHALUS*)

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INTRODUCTION. The presence of sperm whales *(Physeter macrocephalus)* in the area of the Straits of Gibraltar has long been reported (Cabrera, 1925; Bayed and Beaubrun, 1987, Notarbartolo di Sciara and Demma 1994, Cañadas *et al.*, 2000). However, because very little is still known about the abundance, distribution, social structure, and migration patterns of this species in the region, data for this species were collected from April to October in 1999 and 2000, from whale-watching trips with experienced observers onboard.

In 2001, CIRCE started an interdisciplinary research project combining genetic and bio-acoustic approaches for greater precision. This programme focuses on the foraging ecology and the breeding status and stock identity of sperm whales encountered in the Straits of Gibraltar on a year-round basis. In this study, previous results of photo-identification analysis of the present season, in 2001, are shown.

METHODS From April to October of 1999 and 2000, 582 whale-watching trips were carried out in the region of the Straits of Gibraltar, totalling 1181 hours spent at the sea, and 7,444 nm sailed, covering most of the Straits area, but not Moroccan waters. No trip was made when wind force was stronger than 15-16 knots. Three different boats between 9 and 12 m length were used on these trips, always with one or two experienced observers aboard, with an observation height of 2.8-3.2 m. For all cetacean sightings during these whale-watching trips, a variety of parameters were recorded: weather conditions, position, associated species, group structure, and behaviour patterns. Here, only the data collected at the moment of contact with sperm whales, when onboard the whale-watching boats, have been considered for the analyses. In encounters with sperm whales, the approximate size of the animals was calculated, as well as other data such as social structure, breathing and diving patterns. Besides this, in 26 of the sightings of sperm whales, a total of fifty pictures of the flukes were taken for photo-identification studies. Photo-identification was conducted using a 35 mm reflex camera, a 300 mm telephoto lens, and 100 ASA colour slide films. In addition, sloughed skin samples were opportunistically collected for genetic analysis.

On the other hand, from February to April 2001, CIRCÉ started to work with another methodology, based on research trips. A total of nine of these trips had already been carried out in the same study area, using a motor boat of 11 m length with an observation height of 2.9 m. Eleven sightings of sperm whales were recorded. Some of the previous results of the analysis of the 19 pictures used for photo-identification are shown below.

RESULTS .In 36 of the whale-watching trips (6.18 % of the total), each with an average duration of 2 hrs 25 mins, 54 sightings of sperm whales (4.76 % of the total) were obtained, totalling 60 individuals.

Table 1 and Fig. 1 show the number of sightings by month in 1999 and 2000, according to time spent at sea. Fig. 2 shows the distribution of sperm whale sightings in the study area.

During encounters with sperm whales aboard the whale-watching boats, social structure was recorded. Fig. 3 shows that 86.5% of the cases were lone individuals, 11.5% were groups of two individuals, and 1.9% of the sightings were groups of three individuals.

Finally, the analysis of the fifty pictures obtained in 1999 and 2000, and used for photo-identification, shows that five individuals were photographed during 1999, and four in 2000. Three of the individuals photographed in 2000 were also photographed in 1999.

The preliminary results of the analysis, shown in Table 2, of identified individuals in the first nine research trips carried out by CIRCÉ in 2001, show that one individual was sighted again (*Champi*), while other one (*Curro*) was observed for first time.

DISCUSSION AND CONCLUSIONS The data show that the sperm whale is frequently observed in the study area, the Straits of Gibraltar. There is a peak in sightings during the summer months due to the higher number of whale-watching trips in those months. However, when correcting for seasonal variation in sightings effort, these preliminary data suggest that sperm whales are more abundant in spring, and that their numbers decrease in summer, with a possible increase in sighting rates in autumn, but more work should be conducted in winter to verify the occurrence and movement of sperm whales around the Straits at that time.

The photo-identification techniques reveal that at least three individuals were observed in this area in different years, indicating that some individuals may be seasonally resident in the area. Exchange of data collected by CIRCÉ within the Straits of Gibraltar with other research groups and associations working elsewhere in the Mediterranean Sea should help us to better determine the status of the species within the Mediterranean Sea. However, these preliminary results emphasise the importance of this region as a study area to investigate these topics.

ACKNOWLEDGEMENTS Our special thanks go to the captains who patiently supported us in the campaigns we carried out, in particular to Antonio, Andres, Juan, Miguel and Kiko, and to all the staff members of the different whale-watching platforms, in particular to FIRMM España (Foundation for Information and Research on Marine Mammals). Last but not least, we thank the "Torre de Salvamento Marítimo de Tarifa Tráfico", and all the fisherman that have taken part in our research programme.

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Table 1. Distribution of sightings of sperm whales in seasons 1999 and 2000, according to time spent at the sea

Month	Hours at the sea	Nautical miles	Number of trips	Sightings per trip (%)
April	42	268	21	38.1
May	56	358	28	32.1
June	85	537	42	14.3
July	284	1790	140	13.6
August	387	2443	191	3.7
September	213	1343	105	0.0
October	111	703	55	9.1
Total	1178	7442	582	9.3

Table 2. Individuals sighted in the different seasons 1999, 2000 and 2001

NAME	APR 99	MAY 99	JUN 99	JUL 99	AUG 99	SEP 99	OCT 99	APR 00	MAY 00	JUN 00	JUL 00	AUG 00	SEP 00	OCT 00	FEB 01	MAR 01	APR 01
Zeus II					■												
Walti				■													
Champi			■					■	■					■	■		
Amanita				■						■							
Papillon				■				■									
Gitano								■	■						■	■	■
Curro																	

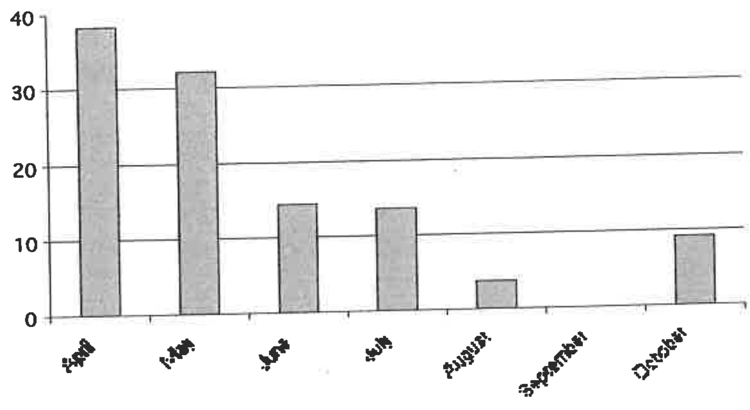

Fig. 1. Distribution of sightings of sperm whales in seasons 1999 and 2000, according to time spent at the sea.

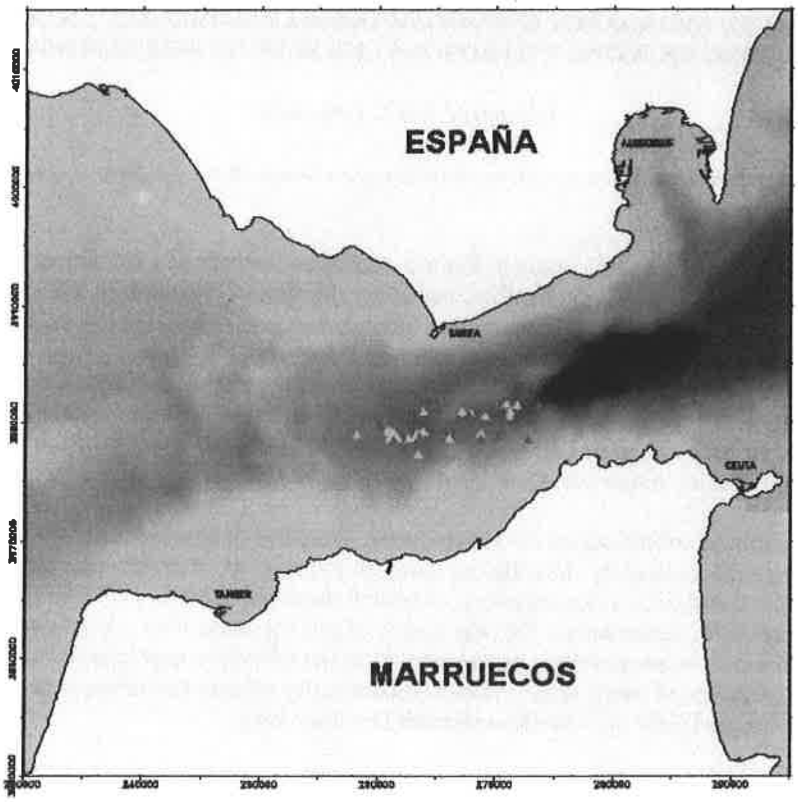

Fig. 2. Map of the study area with the recordings of sightings of sperm whales

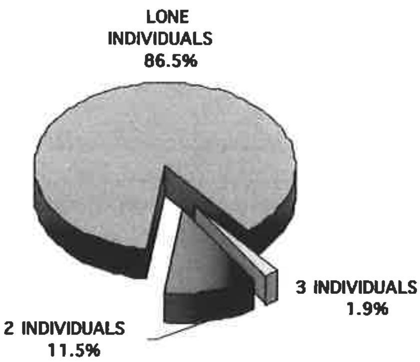

Fig. 3. Composition of the observed groups of sperm whale

IMPROVED ABUNDANCE ESTIMATES FROM LINE-TRANSECT SURVEYS: MODELLING SIGHTING CONDITIONS AND SCHOOL SIZE DISTRIBUTION

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Estimation of the probability of detecting animals forms a critical component of a line-transect analysis. In cetacean surveys, several factors may affect this probability, including the sighting conditions, the type of survey platform used, and the actual size of each school. Conventional line-transect analyses cannot provide unbiased and precise abundance estimates when these factors have a severe effect on the detection process.

Data collected on dolphin stocks in the eastern tropical Pacific Ocean (ETP) from dedicated shipboard surveys between 1998-2000 have been analysed using conventional techniques, but these produce highly variable annual abundance estimates, and making inferences about trends over time is difficult.

By incorporating the sighting conditions as covariates in the detection function model, we model heterogeneity in detectability of dolphin schools directly. In addition, since dolphins in the ETP are encountered in highly variable school sizes (from single individuals to aggregations of several thousand animals), we formulate a simple model for the school size distribution, to better reflect the true nature of this variation than a single estimate of mean school size. In particular, the model we use provides an adequate fit to the tail of the true school size distribution, since any failure to model the presence of these large schools substantially affects the abundance estimates. Our results indicate a reduction in bias and yield less variable estimates between years.

STATUS AND CONSERVATION OF THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) POPULATION IN THE MADDALENA ARCHIPELAGO NATIONAL PARK

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The present study is an assessment of the status and conservation needs of the bottlenose dolphin (*Tursiops truncatus*) population in the Maddalena Archipelago National Park. Preliminary data were collected through boat surveys and photo-identification during summers 1999 and 2000. This research is promoted by the Nature Conservation Department of CTS "Bottlenose Dolphin Project".

Mean school size was 4.7 (range 1-12): four females with a calf were observed, eight out of the 14 individuals regularly observed throughout the archipelago were successfully photo-identified. Most encounters occurred in areas with similar topographic features - relatively shallow sea-beds with *Posidonia oceanica* meadows. Observations varied according to time of day: During the day, the encounters were more frequent when the boat traffic was lower. However, the highest number of encounters coincided with the peak tourist season and the most intense boat traffic. In terms of conservation, there is a need to investigate the potential limiting factors on this species- i.e. to assess the impact of fishing activities, boat tourism, and marine pollution, and to determine factors important for its survival. For instance, the presence of cargo ships carrying hazardous substances travelling through the Straiit of Bonifacio constitutes a potentially great threat, and the species is reliant on the conservation of the sea-grass meadows which it uses as feeding grounds. Because of the increasing interest in whale/dolphin-watching activities, a regulation of such activities within the Park is urged to minimise the impact on dolphins.

Overall, there is a need to increase knowledge on the ecology of this population through regular and long-term monitoring, and to run effective public awareness programmes. The recent set-up of a Dolphin Research Centre by the Nature Conservation Department of CTS in the area, provides a solid basis for a constant effort in research and conservation of this species.

CETACEAN FAUNA OF THE GREEK SEAS: UNEXPECTEDLY HIGH SPECIES DIVERSITY

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INTRODUCTION The oligotrophic eastern Mediterranean Sea has always been considered poor regarding its cetacean fauna. Until recently, very little was known concerning the cetaceans that inhabit its northern part, i.e. the Greek Seas: east Ionian, Aegean, and north Libyan Seas (Frantzis, 1997). This paper reveals that the Greek Seas present an unexpectedly high diversity in cetacean species, and discusses preliminary information regarding their distribution and relative abundance.

METHODS During the last eleven years, data from dedicated surveys, strandings, opportunistic sightings, and published or unpublished photographic and video documents have been systematically gathered in a database, accounting for 519 sightings and 558 strandings. Sightings from an older published work regarding the cetaceans of the Aegean Sea (Carpentieri *et al.*, 1999), and all confirmed sightings found in the literature, have also been included in the database.

From 1991 to 2000, dedicated surveys up to three months long have been organised every year in the summer and autumn. Surveys covered the north and south Ionian Sea, the sea area off south-west Crete, the Corinthian Gulf, and to a lesser degree, the sea area between the Northern Sporades Islands and the Chalkidiki Peninsula (Fig. 1). Ferries with standard routes in the Aegean Sea have been used as platforms of opportunity for the surveys of Carpentieri *et al.* (1999). Consequently, the distribution of sightings is seriously biased in favour of the above areas and routes (Fig. 1). Conventional visual methods for detecting cetaceans have been used in all survey areas except off south-west Crete, south-west Ionian Sea, and Northern Sporades – Chalkidiki area, where joint acoustic and visual methods have been used. Opportunistic sightings recorded up to the end of April 2001 in any other part of the Greek Seas, have also been included in the database.

Stranding data were obtained mainly through a national network organised and co-ordinated by the National Centre for Marine Research and the Pelagos Cetacean Research Institute. The network's data cover the period September 1991 – April 2001 (Fig. 2), and derive from standardised forms sent in by local port-police authorities. This network cannot be considered complete since the number of unreported strandings (known through sources other than the network) is not negligible. After being meticulously checked, stranding reports were discarded (classified as "unidentified") if not accompanied by photos that could definitely allow unbiased species identification. For mass strandings, and strandings of infrequent cetacean species, additional information was gathered by contacting people who saw and photographed the stranded cetacean and/or by going to the stranding site itself. Only 44.3% of the total strandings were retained by those methods. Thirty old stranding records from the period 1840-1990 were also included in the database since they were accompanied by photos or were cited in scientific references. All stranding data refer to individuals and not to stranding events (mass strandings were rare and concerned only Cuvier's beaked whales).

RESULTS Our study revealed that twelve cetacean species have been recorded in the Greek Seas (Table 1). Seven of these are resident and commonly observed in one or more of the Greek Seas: fin whale, sperm whale, Cuvier's beaked whale, Risso's dolphin, bottlenose dolphin, striped dolphin and common dolphin (Fig. 3A and 3B). In addition, the harbour porpoise, that was once considered absent from the entire Mediterranean, is definitely present locally in the North Aegean Sea, although its exact range and degree of residency have to be assessed (Frantzis *et al.*, 2001). The false killer whale is an occasional species; the humpback whale has been sighted exceptionally once; the Sowerby's beaked whale and minke whale have been found floating dead only once (Fig. 3B). Four other species (beluga, Blainville's beaked whale, pilot whale and killer whale) had been erroneously included in the Greek cetacean fauna in the past, due to a wrong assumption, two false identifications, and lack of irrefutable evidence, respectively (Cebrian and Papaconstantinou, 1992; Androukaki and Tounta, 1994). Pilot and killer whales are resident and occasionally present in the western Mediterranean, respectively. Although their occasional occurrence in the Greek Seas cannot be refuted, their presence should still be regarded as unconfirmed.

DISCUSSION The numbers of recorded sightings and strandings (Table 1) cannot be used as an index of relative abundance. Sightings are biased in favour of species on which more effort has been dedicated during some surveys (e.g. sperm whales off south-west Crete). Similarly, strandings are biased towards species that are easily identifiable (Cuvier's beaked whales and large whales) or species that draw the attention of people and press (sperm and fin whales). If we consider the Greek Seas as a whole, there is no doubt that striped dolphins are the most abundant species in pelagic waters, followed by bottlenose dolphins in coastal waters. Both species can be encountered almost everywhere in Greece. Common dolphins are abundant locally, in a few areas (coastal, internal Ionian Sea and north Aegean Sea), but become rare or absent as one moves southwards in both seas. Although Risso's dolphins are less frequent than the other dolphin species, they have been recorded in all geographical areas of the Greek Seas. Both sightings and strandings indicate that Cuvier's beaked whales and sperm whales occur commonly all along the Aegean Arc (the end of the continental shelf around the Aegean and Greek Ionian Sea). Both species are also present in the north and south Aegean Sea, mainly over deep basins. Finally, the fin whale is common in the pelagic waters of the Ionian Sea, but rarely seems to enter the Aegean Sea.

CONCLUSIONS Although still not complete, the existing image of the Greek cetacean fauna is now close to the real situation. General, opportunistic surveys cannot offer a lot to our knowledge anymore. Future effort has to be dedicated to large-scale surveys able to give abundance estimates for the different species populations and/or local, long-term projects focusing upon vulnerable Mediterranean cetacean species, in well-defined, critical areas.

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Table 1: Sightings and strandings recorded in the Greek Seas (1840-2001)

No	SPECIES	SIGHTINGS	STRANDINGS
1	*Balaenoptera physalus*	23	6
2	*Physeter macrocephalus*	133	14
3	*Ziphius cavirostris*	46	84
4	*Grampus griseus*	18	23
5	*Tursiops truncatus*	94	71
6	*Stenella coeruleoalba*	155	49
7	*Delphinus delphis*	47	11
8	*Phocoena phocoena*	1	3
9	*Pseudorca crassidens*	1	1
10	*Megaptera novaeangliae*	1	-
11	*Balaenoptera acutorostrata*	-	1
12	*Mesoplodon bidens*	-	1
13	Unidentified cetaceans		294
	Total	519	558

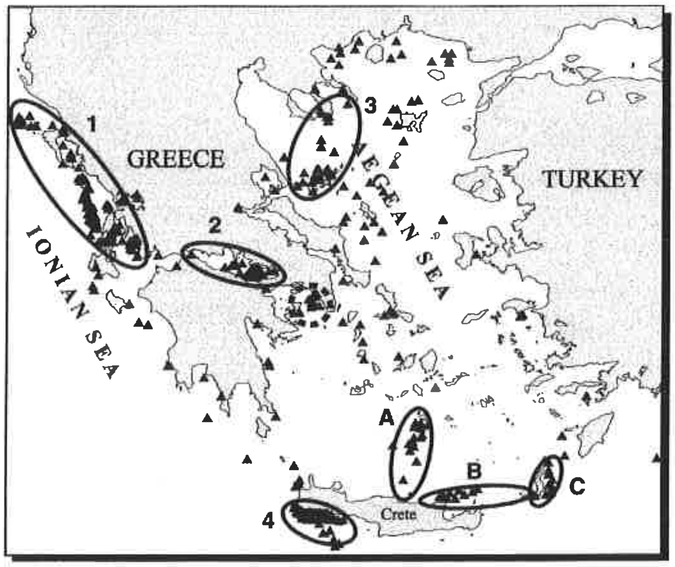

Fig. 1: Distribution of all cetacean sightings recorded in the Greek Seas (triangles). Areas circled with solid lines have been surveyed more intensively either by long-term, dedicated projects (1: North Ionian Sea, 2: Gulf of Corinth, 3: Northern Sporades-Chalkidiki, 4: SW Crete), or while using ferries as platforms of opportunity (A: Santorini-Heraclion, B and C: Heraclion-Karpathos). Almost all sightings within the dashed circle are due to the exceptional presence of fin whales in the Saronic Gulf for 3 months in 1998.

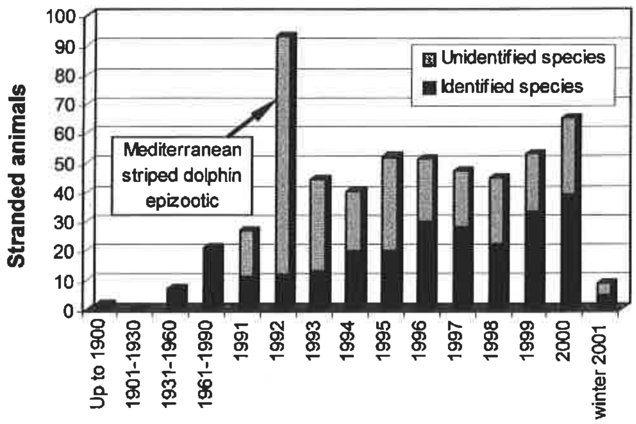

Fig. 2: Distribution of the 558 stranded cetaceans along the Greek coasts in time. Strandings have been recorded more systematically only since September 1991. Numbers of stranded animals are underestimated for all periods, since they represent only the data included in the national database (see methods).

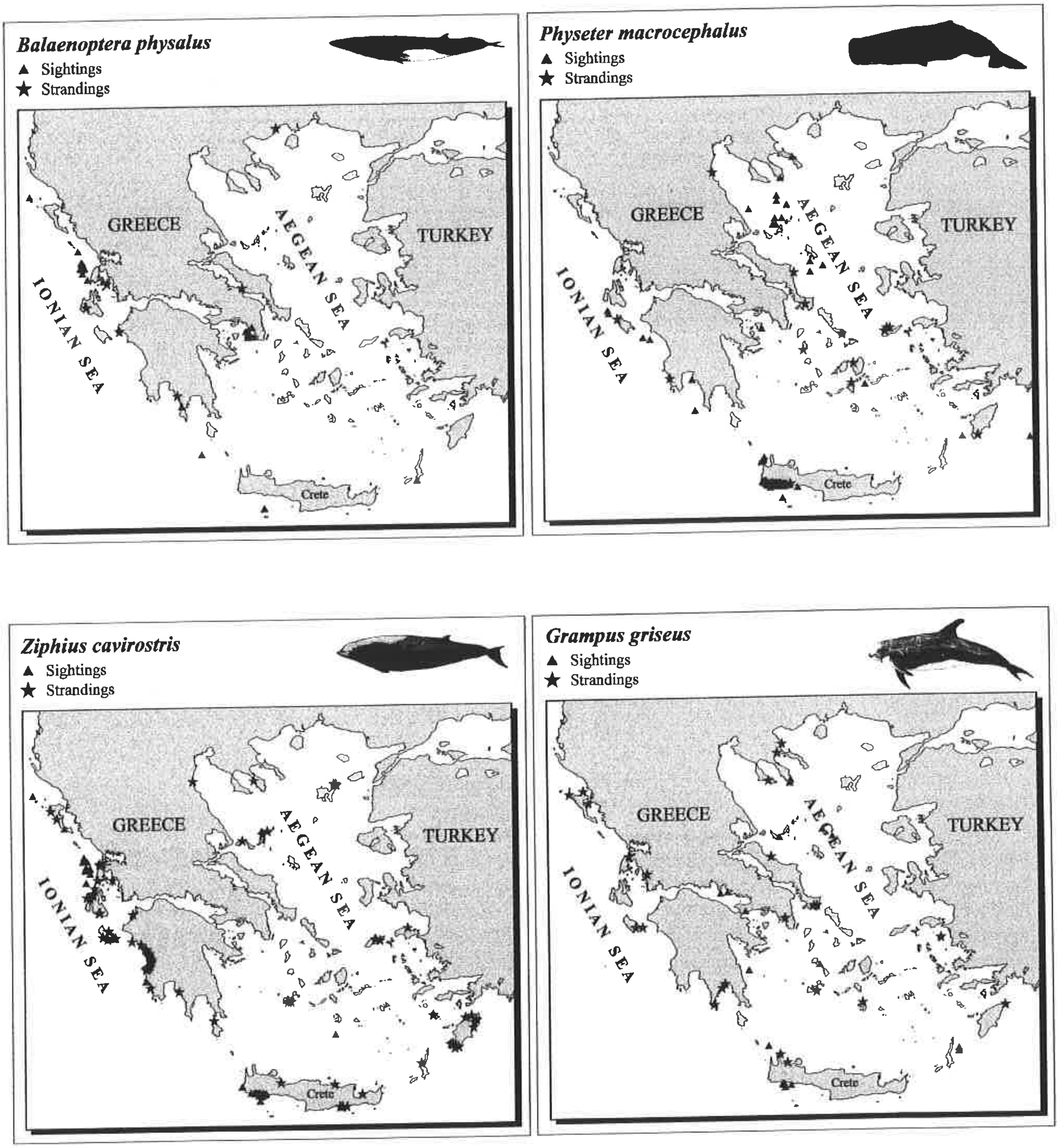

Fig. 3A: Distribution of all known sightings (triangles) and strandings (asterisks) in the Greek Seas, for fin whales, sperm whales, Cuvier's beaked whales and Risso's dolphins respectively. Stranding data represent mainly the period September 1991-April 2001, although all known older strandings since 1840 have also been included. Numbers of stranded animals are underestimated, since they represent only the data included in the national database and sighting distribution is biased in favour of areas surveyed more intensively (see methods and Fig. 1).

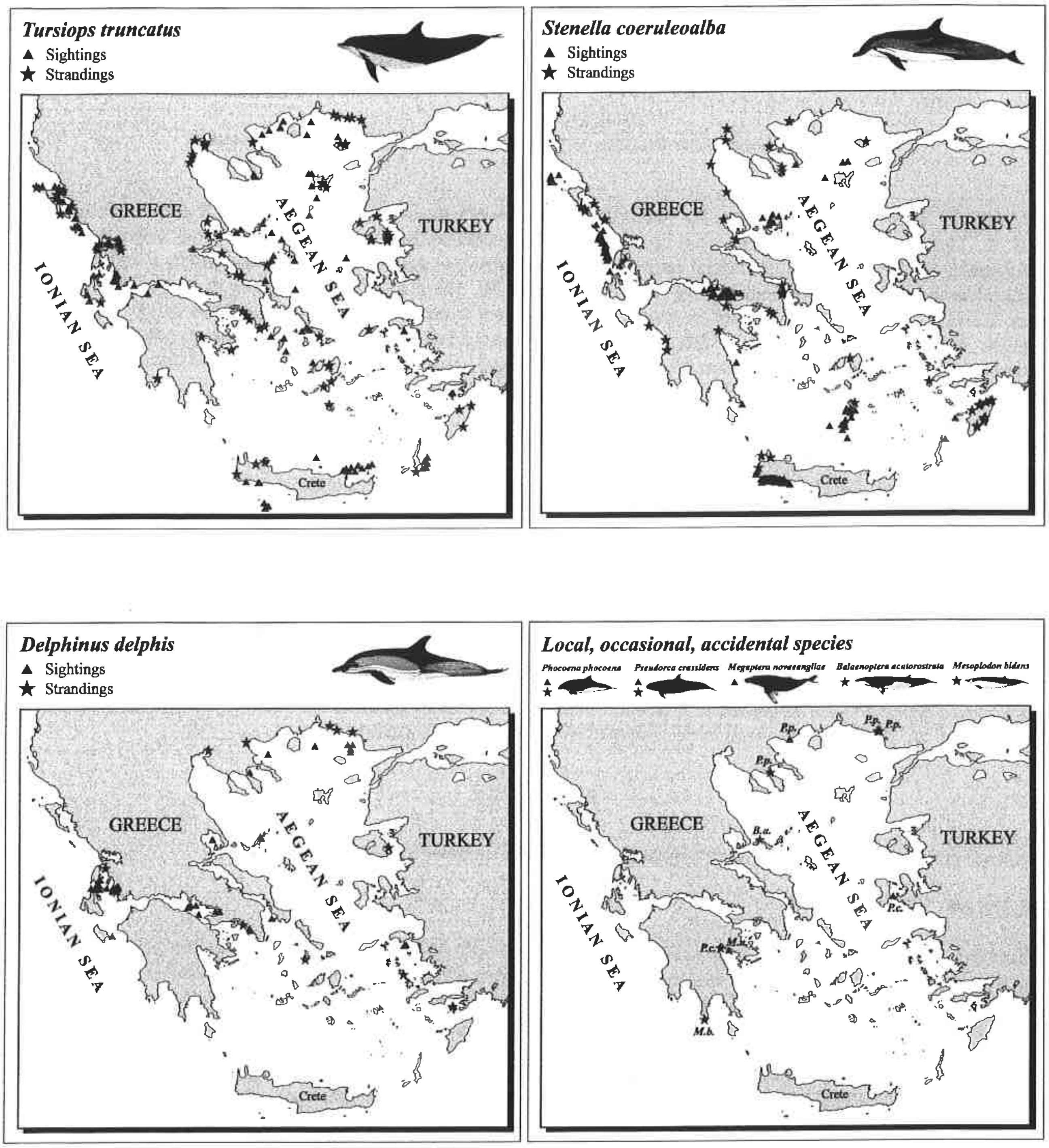

Fig. 3B: Distribution of all known sightings (triangles) and strandings (asterisks) in the Greek Seas, for bottlenose dolphins, striped dolphins, common dolphins and cetacean species that are local (harbour porpoise), occasional (false killer whale) or accidental (humpback whale, minke whale and Sowerby's beaked whale) respectively. Stranding data represent mainly the period September 1991-April 2001, although all known older strandings since 1840 have also been included. Numbers of stranded animals are underestimated, since they represent only the data included in the national database, and sighting distribution is biased in favour of areas surveyed more intensively (see methods and Fig. 1). *P.p.*: harbour porpoise, *P.c.*: false killer whale, *M.n.*: humpback whale, *B.a.*: minke whale, *M.b.*: Sowerby's beaked whale.

DISTRIBUTION OF CETACEANS IN THE MARQUESAS ISLANDS (FRENCH POLYNESIA)

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INTRODUCTION The Marquesas Archipelago is located between 7°30' S and 10°30' S at a longitude of 140° W. These islands are not surrounded by a coral reef, contrary to most other islands of French Polynesia. No information on the local distribution of cetaceans was available for the Marquesas Islands before a survey was undertaken in December 1998 and January 1999 (Gannier, 1999). The marine environment is poorly known in this area. However, local primary production enhancement is known from direct observation and the interpretation of satellite imagery (Signorini *et al.*, 1999). The aim of our study was to assess the cetacean population in the Marquesas at the end of the cold season (October), and to compare new results with those obtained during the warm season.

MATERIALS AND METHODS Between 29 September and 2 November 2000, we conducted surveys in the entire archipelago of Marquesas. During sampling, the ship, a 14-m catamaran, was cruising at an average speed of six knots and at least three observers were on watch using their naked eyes (Gannier, 1999, 2000). Position (by GPS) and environmental parameters (sea state, wind, cloud cover, etc) were recorded every half-hour, and a listening session was conducted with a towed hydrophone. For each sighting, school size, species, activity pattern, and presence of newborn calves were recorded, as well as other information.

Results were plotted with OEDIPE IFREMER software (Massé and Cadiou, 1994). The diversity was expressed as the relative frequency, ***Fi***, ratio of the number of observed individuals belonging to the species *I* on the total number of cetaceans sighted on-effort; the Shannon-weaver index was also used to describe the diversity. We determined a relative abundance index, ***R***, only in inshore areas (within five miles of the coast) and from visual sampling obtained with good sighting conditions (Beaufort 3 or less). This index was obtained from the line-transect density estimator (Buckland *et al.*, 1993), and estimates were computed with Distance 2.2 software (Laake *et al.*, 1994).

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

Variance and confidence intervals were estimated with the delta method (Buckland *et al.*, 1993).

RESULTS

Sampling and sighting results: A total of 2,555 km was covered on-effort, most of which (2,105 km) were with good sighting conditions (Beaufort 4 or less) inc luding 924 km with less than Beaufort 3. A total of 63 sightings were recorded, 57 being on-effort sightings including one unidentified dolphin school. Only delphinids belonging to seven different species were sighted: pantropical spotted dolphin (*Stenella attenuata*, 23 sightings), spinner dolphin (*Stenella longirostris*, 17 sightings), bottlenose dolphin (*Tursiops truncatus*, 6 sightings), rough-toothed dolphin (*Steno bredanensis*, 4 sightings), melon-headed whale (*Peponocephala electra*, 3 sightings), short-finned pilot-whale (*Globicephala. macrorhynchus*, 2 sightings), and pygmy killer whale (*Feresa attenuata*, 1 sighting). Results show the dominance of spotted and spinner dolphins, with 40% and 30% of sightings respectively (Table 1).

Mean school size varied according to the species (Table 1): melon-headed whale was always observed in large schools (30-120); spotted dolphin and spinner dolphin showed mean school sizes of 31.9 and 29.8 respectively; and bottlenose dolphin and rough-toothed dolphin schools were more limited, with mean sizes of 11.8 and 8.0 individuals respectively.

When proportions of individuals were considered, pantropical spotted and spinner dolphins were also dominant, with 44.4% and 30.6% respectively. However, melon-headed whales assume some importance (16% of the total). Due to their smaller school sizes, the three other species were less represented. We obtained a Shannon diversity index of 1.91.

Acoustic sampling: Out of 265 acoustic samples made during the transects, 28 gave positive results and showed delphinid presence, from which only six were synchronised with visual sightings.

Species associations: On nine occasions, schools of different species were recorded simultaneously. The most frequent association inshore was pantropical spotted dolphin – spinner dolphin (five times); a mixed school of 200 animals was also observed 45 km offshore. Pantropical spotted dolphins were also observed twice with bottlenose dolphins, and once with short-finned pilot whales. Spinner dolphins were also seen with melon-headed whales.

We noted calves on 35% of pantropical spotted dolphin sightings, 53% of spinner dolphin sightings, and 100% of melon-headed whale sightings.

Bathymetric affinity: 53 sightings of six species were represented within three bottom depth ranges: neritic area (coastline to 100 m depth), slope area (101-2000 m depth), and oceanic area (>2000 m depth).

Spinner dolphins showed a significant preference for neritic areas (80% of all spinner dolphins sighted), as did melon-headed whales (100%) and bottlenose dolphins (88%). In contrast, pilot whales and rough-toothed dolphins showed a preference for slope areas (28% of rough-toothed dolphins) and for oceanic areas. The spotted dolphin was the only species to be found over all three zones, with a preference for slope areas (47%).

Relative abundance: For analysis, an effective search half-width of 600 m was arbitrarily adopted. From a total of 993 km on 23 transect segments, 37 sightings resulted in a mean group size of 29.9 individuals, a detection rate of 0.037 individuals per kilometer (CV=16.5%), and a relative abundance index of 0.93 delphinids per kilometre (CV=24.6%).

DISCUSSION Comparison with previous surveys was possible because both crew followed a similar protocol (Table 2), and three observers participated in both programmes. To minimize the effect of sampling biases, we have compared only inshore sightings for both years, with 65 sightings for 1998-99 and 39 for 2000, on five different species. Sightings frequency ranks were conserved for all species. We noted that three additional species were observed on single occasions in the previous study: the Risso's dolphin, killer whale, and false killer whale. Proportions of individuals F_i showed some variation between years (Fig. 2), mainly because the proportion of melon-headed whale sightings decreased from 52% to 24.6%, and spinner dolphins increased from 7.8% to 24.6% of delphinids sighted between 1998-99 and 2000. Thus, a seasonal variation in their presence is apparent between October and December-January, when melon-headed whales are most frequent. This might be caused by onset of reproductive activity or a change in trophic conditions.

A Mann-Witney Test on the four main species revealed no significant differences between the two years for school sizes of bottlenose dolphin (p=0.7630), spotted dolphin (p=0.3609), and melon-headed whale (p=0.4835), but there was a significant difference for spinner dolphins (p=0.0015).

Results on relative abundance inshore were slightly lower for 2000, with 0.93 delphinids per kilometre, compared with a mean value of 1.2 obtained in 1998-99. This could result from the lower presence of melon-headed whales. However, the relative abundance is still much higher than elsewhere in French Polynesia: Gannier (2000) obtained a relative abundance estimate of 0.28 dolphins per kilometer in the inshore area of the Society archipelago. The higher delphinid abundance in the Marquesas is clearly related to mesotropic conditions (Signorini *et al.*, 1999). No sperm whales and no humpback whales were sighted during this cold season survey (Bourreau and Gannier, 2001).

Bathymetric affinity (for all sightings: inshore and offshore) were conserved for the six common species: 1) spinner dolphin, melon-headed whale, and bottlenose dolphin were always neritic species; 2) pilot whale and rough-toothed dolphin were deep-water species, and 3) spotted dolphins were present in the three habitats. This distribution is certainly due to ecological factors (reproduction, prey distribution, etc) because anthropogenic impacts are negligible.

CONCLUSIONS This 35-day survey in the Marquesas allowed us to confirm results of the first study (Gannier, 1999), notably on cetacean diversity and abundance: 1) the Archipelago features a high diversity; 2) large species such as sperm whale or humpback whale are apparently rare; and 3) relative abundance is higher than in other areas in French Polynesia.

This area is ecologically complex, and unfortunately not well-known. Complementary studies using other methodologies such as hydrology and satellite imagery will be necessary to understand this ecosystem.

ACKNOWLEDGEMENTS We thank Dufour Boat Charter, C. and J. Gallé for their contribution, and all the volunteers who have participated in this programme (Stéphane B., Guy C., Céline C., Violaine D., Odile G., Michel G., Guillaume P. and Guido R.).

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Table 1. Results of sightings in for 6 species (take in account the school of 12 pygmy killer whales).

Species	*S. attenuata*	*S. longirostris*	*P. electra*	*T. truncatus*	*S. bredanensis*	*G. macrorhynchus*
Number of sightings (and %)	23 (*40.4%*)	17 (*29.8%*)	3 (*5.3%*)	6 (*10.5%*)	4 (*7%*)	2 (*3.5%*)
Mean school size *	31.9	29.8	90	11.8	8	11.5
School size range *	2-150	2-100	30-120	1-35	5-12	9-14
CV(%)	23.8	19.3	33.3	43.8	19.8	-
Total * (and F_i in %)	**733** (*44.4%*)	**506** (*30.6%*)	**270** (*16.3%*)	**71**(*4.3%*)	**32** (*1.9%*)	**23** (*1.4%*)

*: in individuals

Table 2. Main characteristics of both field studies in Marquesas islands: 1998-99 et 2000.

	1998-99	2000
Plateform	ketch 15m	catamaran 14m
Period of year and duration (in days)	December-January / 52	October / 35
Duration of effective sampling (h.)	118,5	205
Sampling (km) with Beaufort < 4	2791	2105
Beaufort < 3	1928	924
Total of sightings (on-effort)	101	57
Number of common species	7	
Relative abundance (delphinid per kilometre)	1.2	0.93

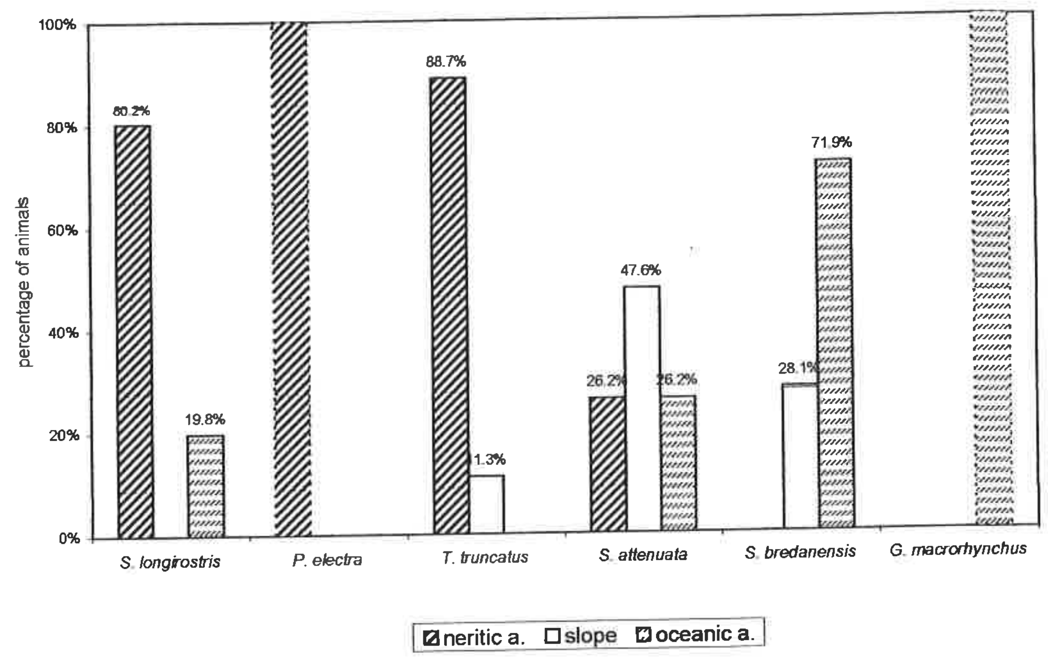

Fig. 1. Distribution of animals (by species) on 3 bathymetric classes.

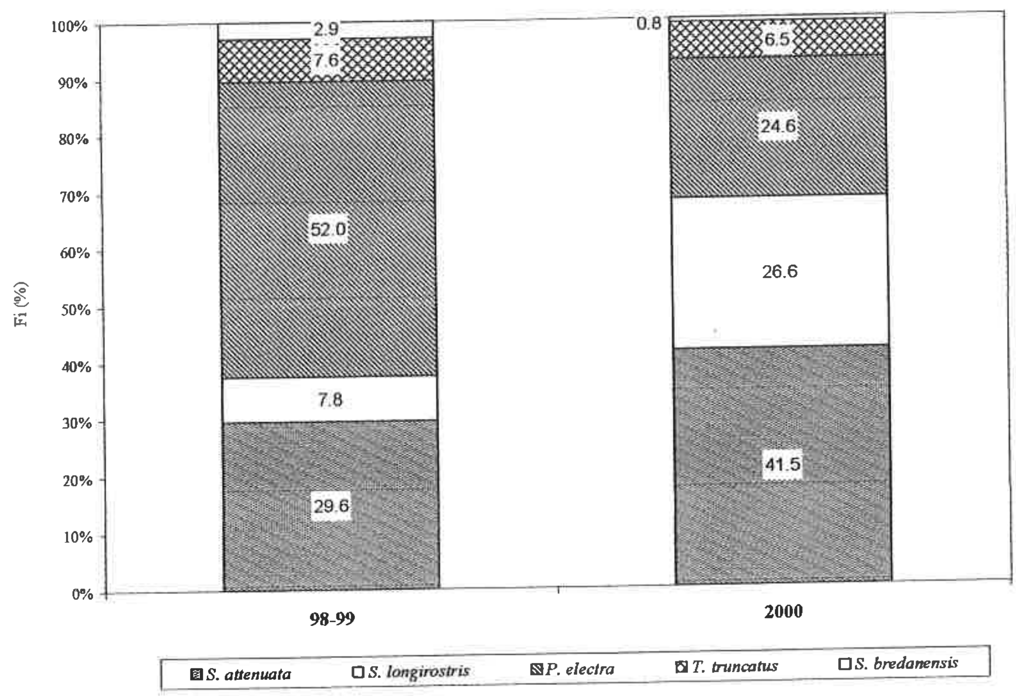

Fig. 2. Percentage of inshore cetaceans sightings for both periods (within 5 milles from coast).

CAPTURE-RECAPTURE METHOD TO ASSESS POPULATION SIZE: THE BOTTLENOSE DOLPHINS OF THE MOLENE ARCHIPELAGO

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Generally speaking, the use of photo-identification results in a partial census of a cetacean population. In order to assess its size, capture-recapture methods are commonly applied. The coastal bottlenose dolphin population of the Molène archipelago, in France, was the subject of a 5-year photo-identification study from 1994 to 1998. Only 24 animals were identified, a number that was actually under-estimated regarding the real population size. Analysis based upon capture-recapture method is required, taking into account the encounter history of each identified dolphin. The application program "capture" is used, considering that the Molène archipelago population is geographically and demographically closed during the 5-year period. The models proposed by "capture" allow for three types of variation in capture probability: inter-individual heterogeneity (M_h), behavioural response (Mb), and time changes (M_t). An equal individual catchability model (M_0) is also proposed, although this assumption does not suit the bottlenose dolphin population studied. In the same way, capture probability does not vary with behaviour. M_t, M_h and the combination M_{th} only remain.

Dolphin capture probabilities of the archipelago vary with time and with individuals. Photo-identification data are analysed at two temporal scales: monthly and yearly captures. Results do not change whatever the time interval chosen. The three models result in a similar assessment of the bottlenose dolphin population size, which on average, comprises 25 individuals. This value is only based upon animals with long-lasting marks, and thus must integrate those that do not present such marks. In the end, we assessed the whole population to be between 45 and 47 dolphins.

In order to protect and conserve the population, it is essential to know the number of dolphins living within a restricted area, like the Molène archipelago. The study contributes to the project of the Marine National Park of Iroise Sea, which includes this dolphin population

OBSERVATIONS OF BEAKED WHALES OFF PICO ISLAND, AZORES

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INTRODUCTION The Azores islands make op a volcanic archipelago situated in the mid-Atlantic Ocean between 37° - 40° N and 25° - 31° W, with its nine main islands spread throughout 2352 km^2, about 900 miles off the coast of Portugal.

The beaked whales are one of the least known families of mammals and, due to their preference for oceanic habitats and generally boat-shy behaviour, it is likely to remain this way in the near future. Several species of beaked whales, mostly of the genus *Mesoplodon* have yet to be seen alive, and it is unclear whether all species are already known to science (McLeod, 2000).

Four species of ziphiids (*Hyperoodon ampullatus*, *Mesoplodon bidens*, *Mesoplodon europaeus*, and *Ziphius cavirostris*), have been recorded in the waters of Azores (Reiner, 1990; Reiner *et al.*, 1993), but almost all the available information comes from occasional sightings or stranded animals.

The south coast of Pico island was once one of the most important areas for land-based whaling operations. Whale-watching operators nowadays use the old watchtowers situated on strategic spots on land and used in whaling times. Last summer, we used one of these watchtowers to observe and obtain data on the movements and behaviour of these animals.

METHODS The study area was the south coast of Pico island and the watchtower we used was located at 38° 23' 094" N, 28° 14' 418" W, at an altitude of 75 m. The distance covered was almost 20 nm offshore.

Observations started early June 2000 and ended in the beginning of October 2000, completing 18 weeks but with some interruptions. The observation effort was 572 hours, distributed in periods from 09:00 h to 13:00 h, and from 14:00 h to 18:00 h. 10 x 50 Olympus binoculars were used, and with the help of an experienced look- out from the whaling times, we took records of all sightings.

Records from these sightings included species or genus identity, position and depth, hour, sea state (Beaufort scale), wind direction, visibility, swimming direction, size of groups, presence of calves, and predominant activity.

Observations were conducted in conjunction with the whale-watching boat crews, who wee able to confirm some of the data obtained from shore. In all cases, care was taken to reduce the possibility that the same group was scored in consecutive records.

RESULTS This observation effort resulted in 147 sightings of ziphiids, of which 12 were northern bottlenose whales. Of the remaining 135 sightings of *Mesoplodon* groups, 12 were further identified by closer observation from whale-watching boats as Sowerby's beaked whales (*Mesoplodon bidens*).

Positions of sightings for both groups are presented in Figs. 3 and 4. These occurred in all directions covered from the watchtower. Average group size was 4.3 (S.D. = 2.4), for *Mesoplodon* and 5.3 for *Hyperoodon* (see group size distribution in Figs. 5 and 6). For *Mesoplodon*, a weak negative correlation was found between group size and distance from shore (highly related also to depth): Spearman correlation coefficient $r_s = -0.25$, $p < 0.004$, $N = 135$.

No calves were observed in any of the groups. Other data, concerning monthly variation in sightings, morning-afternoon variation in sightings, swimming direction, and predominant activities are presented in Figs. 7-12.

DISCUSSION This study provides some useful information concerning the occurrence of beaked and bottlenose whales off Pico Island during summer months. It shows that much data can be obtained by shore-based observations, although clearly these could be much improved by permanent communication between the watchtower and the boat crews. A consistent general swimming direction was not detected; our data therefore do not suggest that ziphiid movements near Pico Island during this time of the year are part of any particular migratory pattern.

Group size showed a slight tendency to increase with proximity to shore, which might be related to feeding activities. The fact that no calves were spotted does not allow us to identify any calving season or peak.

ACKNOWLEDGEMENTS We would like to thank Espaço Talassa and all the team that work there for the support in this study. Thanks are due also to Sr. João, Sr. Sidónio and Sr. Antero for teaching us so much, and to Prof. Joaquim Luís for providing the Pico Island map.

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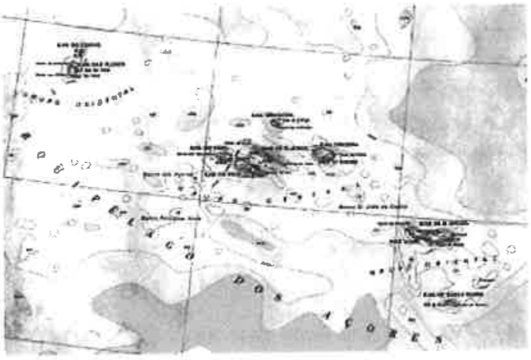

Fig. 1-Azores

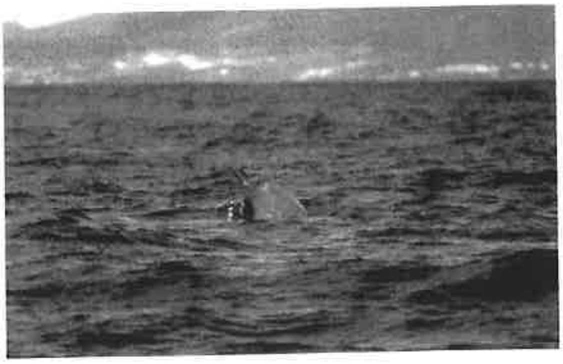

Fig. 2. *Hyperoodon ampullatus*.

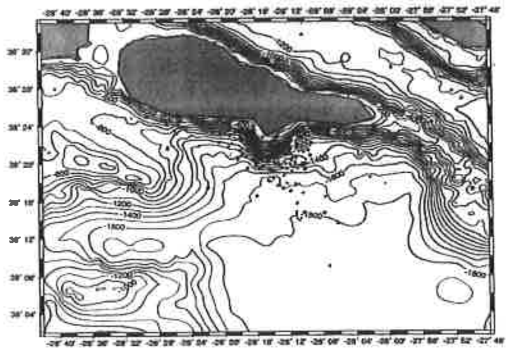

Fig.4- Sightings of *Mesoplodon sp.*

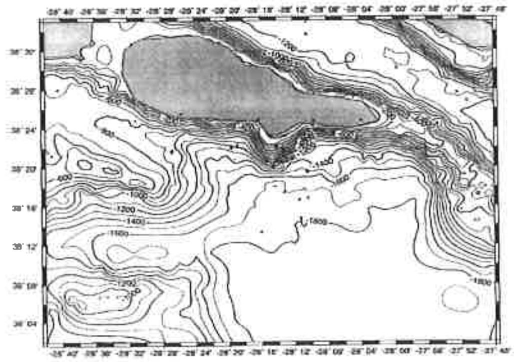

Fig.3- Sightings of bottlenose whales (*H. Ampullatus*)

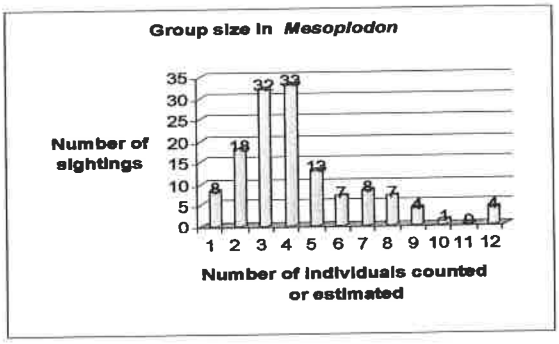

Fig. 5

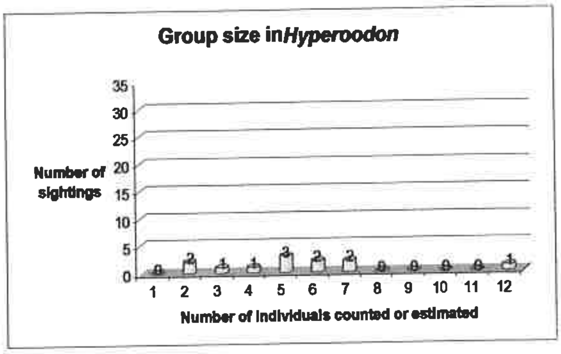

Fig. 6

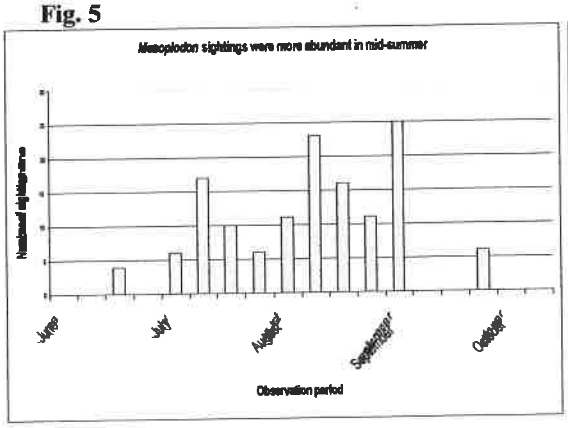

Fig. 7

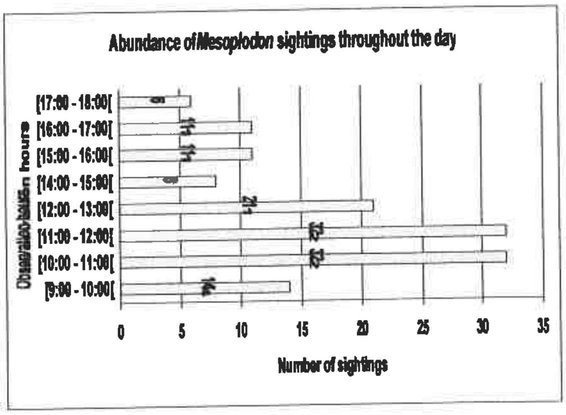

Fig. 8

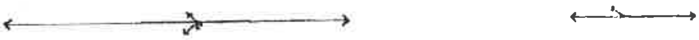

Fig.9- Predominant swimming directions for *Mesoplodon sp.*

ESTIMATES OF RELATIVE ABUNDANCE OF SMALL CETACEANS IN GALICIAN WATERS

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INTRODUCTION The Galician coast has a length of 1,195 km, with an approximate total shelf area of 20,000 km^2 (0-1,000 m depth). It has the highest stranding rate of the Atlantic coast of the Iberian Peninsula (annual average: 1 stranding / 6.1 km) (ATLANCETUS, 2000).

METHODOLOGY During 1998 and 1999, observers onboard fishing boats covered a total of 111 days along the Galician shelf. For each trip, sightings and auxiliary data were collected (time and location of each group of animals, species, minimum and maximum estimates of group size, presence of calves, direction of travel, and behaviour, location, effective visible track width, and whether the boat was fishing or travelling) (Buckland, 1990). The area surveyed during each trip was estimated from the track length and visible track width.

RESULTS Over two years, there were 891 hours of observations, 49.6% in 1988, and 50.4% in 1999. During this period, 132 sightings of cetacean groups were recorded: common dolphin *Delphinus delphis* (71.1%), bottlenose dolphin *Tursiops truncatus* (15.5%), harbour porpoise *Phocoena phocoena* (2.2%), long-finned pilot whale *Globicephala melas* (5.3%), Risso's dolphin *Grampus griseus* (0.7%), unidentified delphinids (3.7%), and mysticetes (1.5%).

In order to derive density estimates, a bootstrap re-sampling procedure was used. This provides 95% confidence limits for the number of animals present. Since it is not possible to quantify the proportion of animals present on the survey track that were recorded by observers, these estimates are strictly speaking relative abundance estimates.

CONCLUSIONS The population size estimates for small cetaceans in Galician waters were: *ca.* 8,100 common dolphins, 700 bottlenose dolphins and 400 long-finned pilot whales (Table 1). There were few sightings of harbour porpoise and Risso's dolphin.

The common dolphin is the most abundant species, with a wide distribution along the continental shelf. Other species are certainly less abundant and probably have more restricted distributions. The small size of porpoises in particular, probably means that numbers were under-estimated. Some species recorded from strandings, e.g. striped dolphin *Stenella coeruleoalba*, were not sighted during boat-based surveys.

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Table 1. Numbers of cetaceans seen during surveys (minimum, median, maximum counts), along with stratified and unstratified population estimates

Species	N° of groups	Min count	Med count	Max count	Unstratified	Stratified, with 95%CL
Balaenoptera physalus	1	1	2	3	4	4 (0-11)
Delphinus delphis	98	3081	3497	3913	7245	8137 (4388-13678)
Grampus griseus	1	1	1	1	2	2 (0-7)
Globicephala melas	7	80	86	91	178	385 (13-1131)
Unidentified delphinid	4	30	35	40	73	91 (5-323)
Unidentified mysticete	1	1	1	1	2	(0-5)
Phocoena phocoena	3	8	9	10	19	7 (0-16)
Tursiops truncatus	21	268	291	313	603	664 (251-1226)
All	**136**	**3470**	**3921**	**4372**	**8123**	**9305 (5368-14823)**

FEATURES OF CETACEAN GROUPS OBSERVED IN THE ADRIATIC SEA FROM 1988 TO 2000

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INTRODUCTION The Adriatic Sea is inhabited by three species of dolphins: bottlenose dolphins (*Tursiops truncatus*), striped dolphins (*Stenella coeruloalba*), and common dolphins (*Delphinus delphis*). Cetacean sightings collected in the Adriatic Sea since 1988 (Manoukian *et al.*, 2001) have allowed to assess the occurrence of dolphins in this sea area, and to collect a significant amount of data concerning group sizes that range from one single individual to more than one hundred specimens belonging to the family Delphinidae. The analysis of these data enable us to study the "group behaviour" of each species, giving also an entropic meaning. According to these three different species, geographical distribution, group size, and seasonal variation of group size, it has been possible to study spatial and temporal patterns. Moreover, the geographical and temporal distribution of sightings referred to cetacean species that sporadically frequent the Adriatic Sea have also been indicated, and are included in this study.

MATERIALS AND METHODS Marine mammals have been monitored visually by trained personnel, from the R/V Salvatore Lo Bianco, which has covered the western part of the Adriatic Sea with a zigzag grid (Fig. 1) during two acoustic surveys conducted from July to October each year since 1988, and from the vessels of the Shipping Company "Adriatica", along the commercial routes followed regularly all year around (Fig. 1). Two types of data have been systematically stored and processed (Orsi Relini *et al.*, 1992): spatial data and temporal data. The analysis of the data has been divided into three parts. First, general observations on those species belonging to the family Delphinidae have been conducted. The temporal data are represented in the form of a time series from 1988 to 2000, measured either all year round or seasonally, while spatial data are shown on raster maps, consisting of an array of grid cells (each elementary cell is one square mile in dimensions), forming square blocks of 10 x 10 elementary cells. Second, specific investigation of delphinid group characteristics has been performed. For each single species, the following features are calculated on a yearly and seasonally (cold and warm seasons) basis:

- the frequency distribution of group size: $f_i = g_i/G$, where G is the total number of groups and g_i is the size of the group i;
- the entropy of grouping: $H = -\Sigma f_i ln f_i$, as defined by Okubo (1986). The entropy H is a reasonable measure of disorder in grouping; the principle of maximum entropy states that the maximum value of H is obtained when the frequency distribution is geometric or exponential;
- the geographic barycentre of the groups: $x_0 = (\Sigma g_i x_i/G)$, $y_0 = (\Sigma g_i y_i/G)$;
- the "central moment of inertia" (J_ξ, J_η) and the uncertainty ellipse for the group distribution: $\rho_\xi = (J_\xi/G)^{1/2}$, $\rho_\eta = (J_\eta/G)^{1/2}$.

Finally, a general view of rare species observed in the Adriatic Sea has been developed. The analysis regards the whole Adriatic Sea.

RESULTS AND DISCUSSION The number of groups of the three populations, as a whole, has been affected by drastic and unpredictable changes from 1988 to 2000, both on a yearly and seasonal scale. The highest yearly (Fig. 2a) and summer peak of groups was detected in 1995, while the highest winter peak was found in 1996. By contrast, although the trend in species composition shows a slight difference year by year (Fig. 2b), the percent of groups per species has remained almost stable: groups of bottlenose dolphins are around 80% of the total, those of striped dolphins about 16%, and those of common dolphins about 4% (Fig. 2c). Therefore, fluctuations in the number of dolphin groups cannot be attributed to interactions between species.

Bottlenose dolphins form larger groups in the cold season (19.54) than in the warm season (14.80) (Table 1); likewise, groups of striped dolphins are more numerous in the cold season (9.75) than in the warm season (7.96). By contrast, common dolphins form smaller groups in the cold season (5.00) than in the warm season (9.74). The mean distance from the coast of bottlenose dolphins (15.47 nm) and striped dolphins (17.63 nm) are very close. However, striped dolphins choose areas that are about twice as deep as those chosen by bottlenose dolphins. Common dolphins live in the deepest habitats of Adriatic Sea. Therefore, it seems that there is no mixing or only a small amount of mixing among the three species of dolphins.

The centres of gravity and central moments of inertia in the spatial distributions of the three species are depicted in Figure 4. For the bottlenose dolphin (Fig. 4a) the barycentre is around the bathymetric of 100 m: the population, as a whole, moves from the deep waters of the south (winter) into the shallow waters of north (summer), over a distance of about 45 nm. On the other hand, during the same seasonal change, the striped dolphin population (Fig. 4b) moves from north to south over an average distance of 25 nm. The barycentre remains all the year above 100 m. The direction of movement is the same for common dolphins (Fig. 4c): the barycentre moves from north (close to the Croatian coast) to south (close to the mid-line), over an average distance of 100 nm. The spatial dispersions of bottlenose and striped dolphins do not vary significantly during the year, while common dolphin spatial dispersion is strongly affected by change of season.

The frequency distributions and the entropic analysis of herds of the three species observed are shown in Figure 5. In general, pairs or single animals prevail (except for common dolphins). Somewhat surprisingly, the yearly frequency distributions of bottlenose and striped dolphins are well represented by a geometric distribution. This maximises the entropy of grouping (Jaynes, 1979) under the only constraint that the mean number of animals per group is equal to g_i/G. Assuming that the entropy is a measure of disorder in grouping, common dolphin groups correspond to the highest state of order.

Table 2 shows the number of sightings and individuals of cetacean species that sporadically frequent the Adriatic Sea. The majority of sightings have been during the summer period and indicate a preponderance of Risso's dolphins (42%), compared with sperm whale (29%), and fin whale (29%).

CONCLUSIONS There is no evidence for competition between the three delphinid species. Their composition in percentage remains almost stable over the years, as well as seasonally. Nevertheless, the total group size changes considerably.

The three species inhabit different areas of the Adriatic Sea, with very little overlap. The entropy of dolphin group frequency distributions indicates that common dolphins have a state of order higher than the other two species.

The "herding behaviour" as well as the spatial distribution and seasonal migration patterns are sharply different between bottlenose dolphins and common dolphins, while striped dolphins appear to be intermediate.

ACKNOWLEDGEMENTS The authors would like to thank "ADRIATICA" Shipping Company for their assistance in the collection of data on cetaceans.

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Table 1 – Mean number of cetaceans per herds, mean distance from the coast and mean depth per species and per period of year

Species	Yearly												
	Herd number	Herd features				Depth (metres)				Off the coast (nautical miles)			
		N° (max)	N° (mean)	St. Dev	Total individuals	Max	Min	Mean	St. Dev	Max	Min	Mean	St. Dev
Bottlenose dolphins	218 (68,56%)	155	15,28	23,03	3333	1210	9	143,81	260,98	47,06	0,79	15,47	10,14
Striped dolphins	79 (24,84%)	50	8,51	9,14	672	1200	9	244,05	377,61	48,41	0,01	17,63	14,19
Common dolphins	21 (6,60%)	25	8,38	6,81	176	1190	12	534,29	478,36	47,4	2,21	24,71	13,65
TOTAL	318 (100,00%)				4181								

Species	During summer period (May-October)					During winter period (November-April)				
	Herd number	Herd features				Herd number	Herd features			
		N° (max)	N° (mean)	St. Dev	Total individuals		N° (max)	N° (mean)	St. Dev	Total individuals
Bottlenose dolphins	168 (70,59%)	100	14,02	20,34	2356	50 (62,50%)	155	19,54	30,35	977
Striped dolphins	55 (23,11%)	50	7,96	9,29	438	24 (30,00%)	30	9,75	8,86	234
Common dolphins	15 (6,30%)	25	9,74	6,32	146	6 (7,50%)	20	5,00	7,38	30
TOTAL	238 (100,00%)				2940	80 (100,00%)				1241

Table 2 – Number of sightings and individuals for each rare species observed in the Adriatic Sea during the entire period of study

Species	Yearly		During summer period (May-October)		During winter period (November-April)	
	Sightings	Individuals	Sightings	Individuals	Sightings	Individuals
Risso's dolphin	9	24	7	21	2	3
Fin whale	4	16	2	14	2	2
Sperm whale	4	16	3	15	1	1
TOTAL	17	56	12	50	5	6

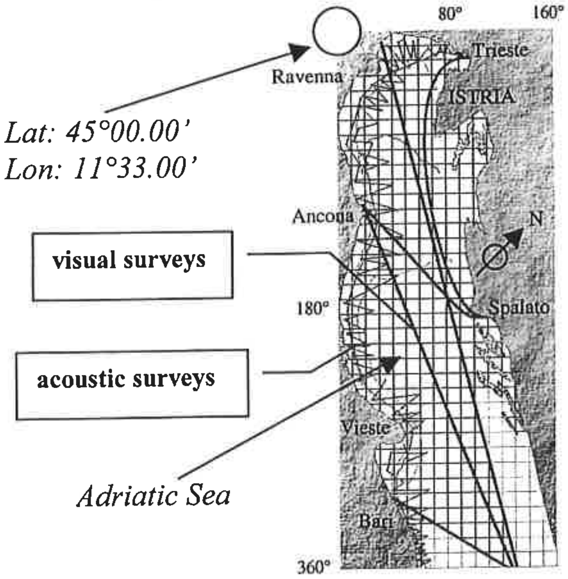

Fig. 1- Tracks of acoustic (zig-zag grid) and visual (linear drawing) surveys

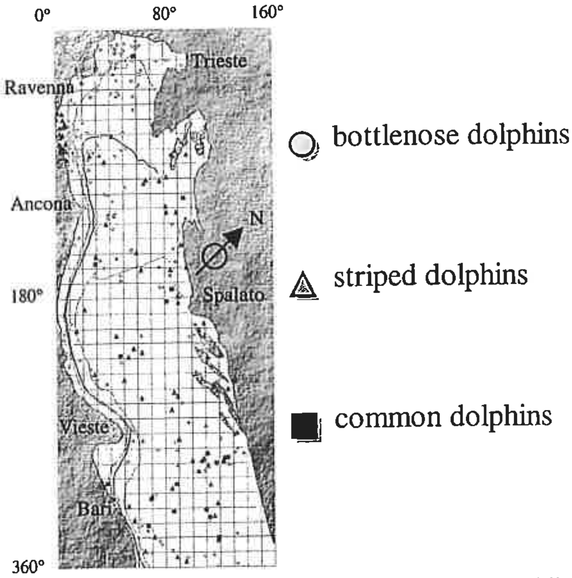

Fig. 2 - Geographical distribution of delphinidi from 1988 to 2000

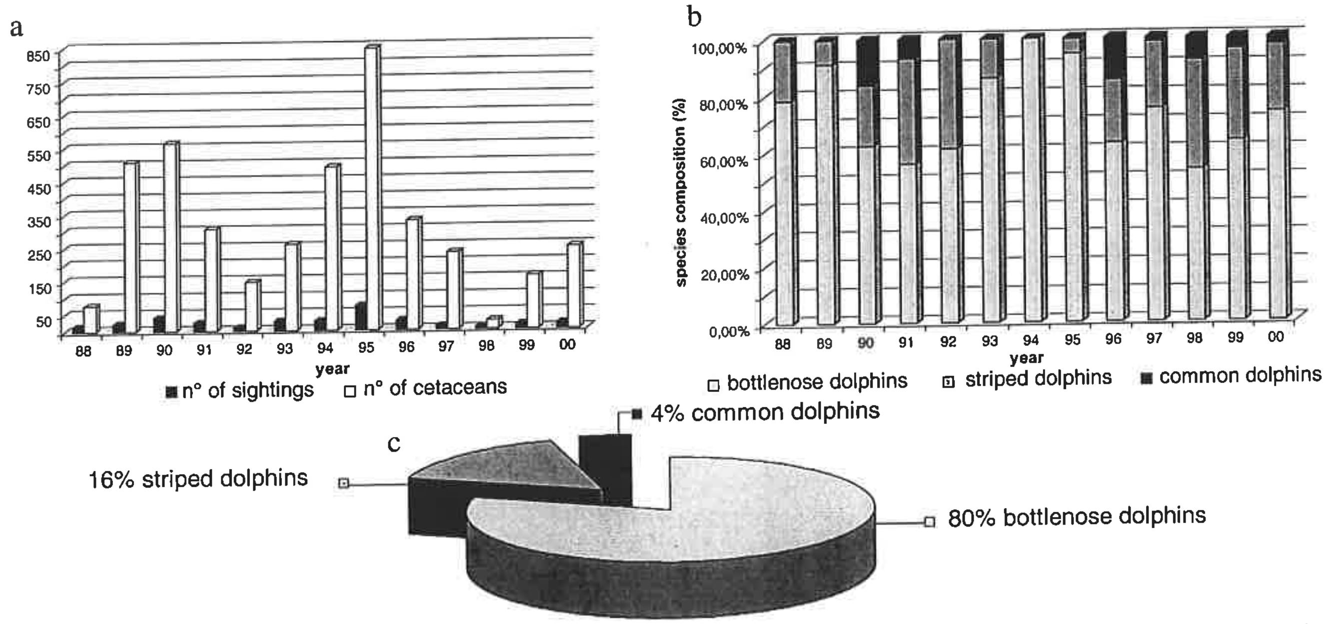

Fig. 3 – (a) Time trend of sightings and delphinidi numbers visually surveyed. (b) Trend of species composition. (c) Global species composition observed during the twelve years of study.

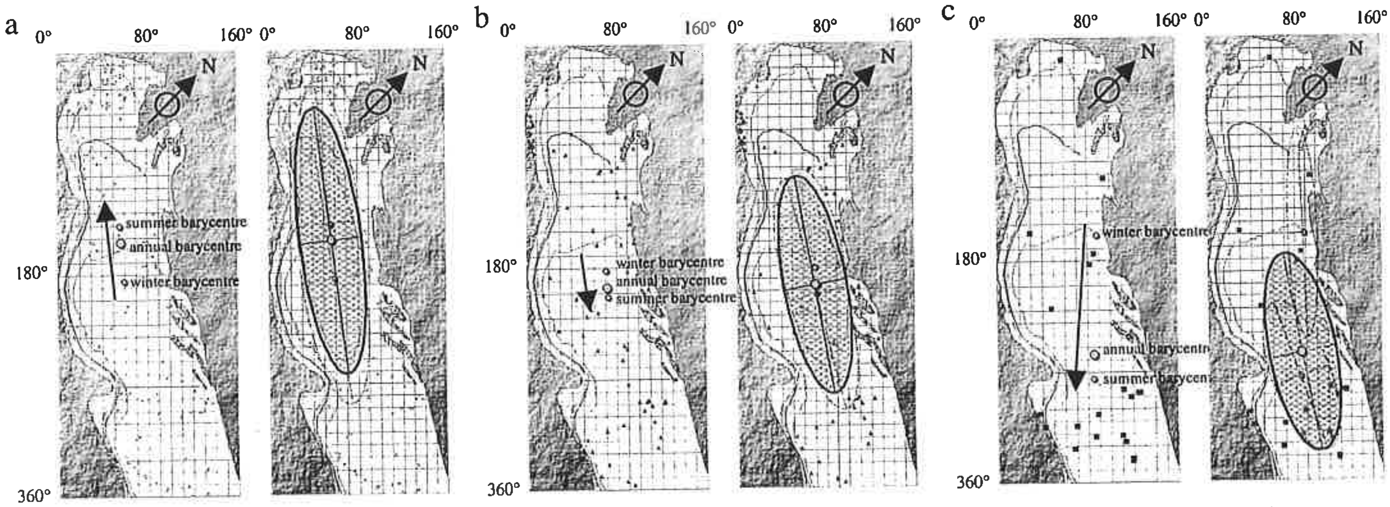

Fig. 4 – Seasonal and annual barycentres and standard deviations of bottlenose dolphins (a), striped dolphins (b) and common dolphins (c) spatial distribution. The black arrows indicate the direction of migration of three cetacean species.

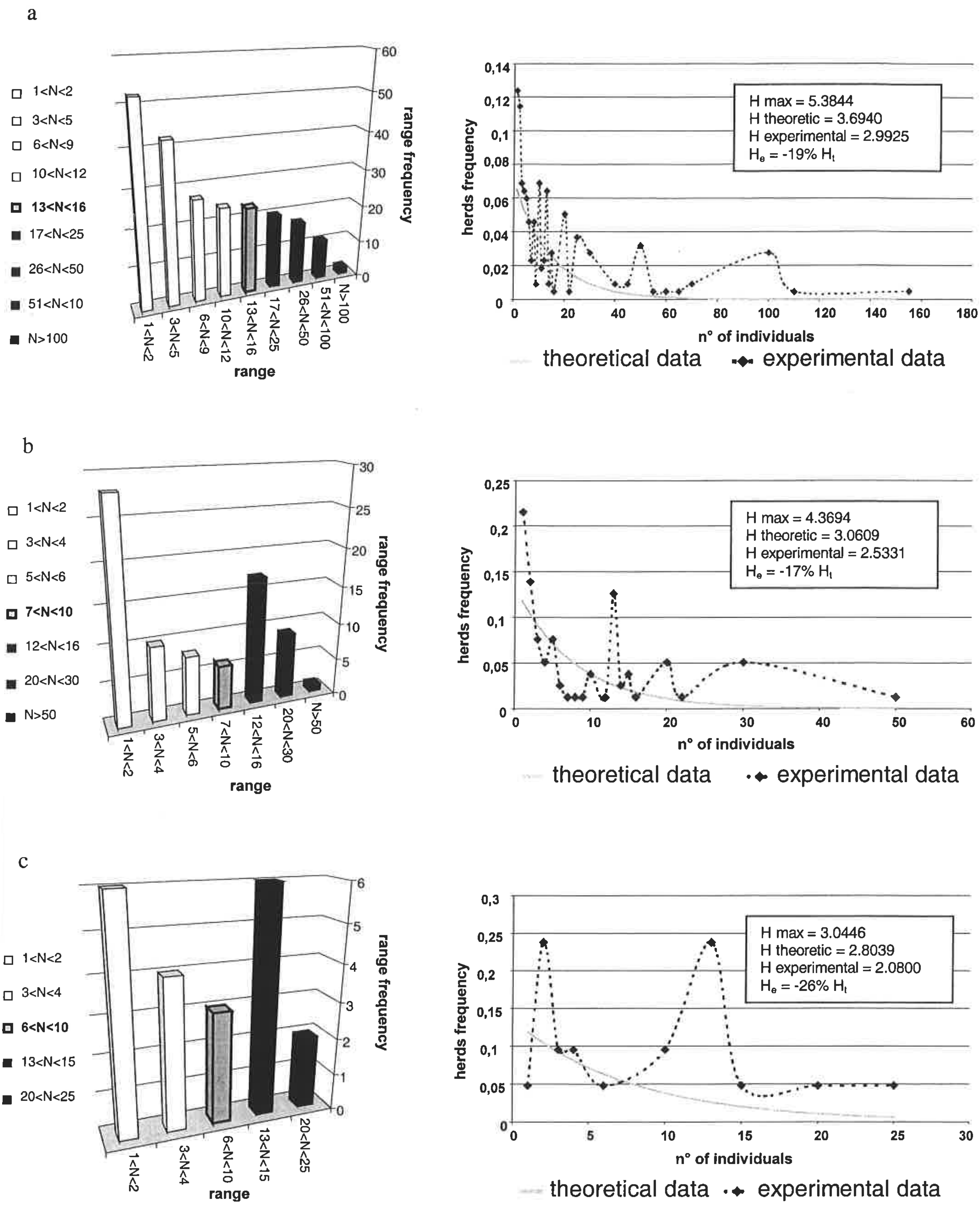

Fig. 5 - Frequency of particular herd sizes' occurrence (on the right) and entropic analysis of the herd size frequency's distribution (on the left) of bottlenose dolphins (a), striped dolphins (b) and common dolphins (c)

VARIATION IN DETECTION RATES OF HARBOUR PORPOISE WITH STATE-OF-TIDE AND TIME-OF-DAY IN PART OF THE BAY OF FUNDY, CANADA, AS ASSESSED BY ACOUSTIC SURVEY

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INTRODUCTION Harbour porpoises (*Phocoena phocoena*) reside in the Bay of Fundy, Canada, between late spring and early autumn. In the summer of 1999, a small-scale acoustic survey was carried out off Grand Manan Island, an area of known high porpoise density (Gaskin, 1977; Palka, 1995). The purpose of the study was (a) to compare the spatial pattern of porpoise detections with prior knowledge based on visual observations, and (b) to investigate the relationship between porpoise detections, and the state-of-tide and time-of-day.

Porpoise distributions have previously been related to oceanic variables such as temperature and fish density (Palka, 1995). The activities of small odontocetes have also been related to tidal and diurnal cycles in several studies, including wild harbour porpoises in Cardigan Bay, Wales (Pierpoint *et al.*, 1999). The underlying processes may be the activities and movements of prey species (e.g. Hoese, 1971; Saayman and Tayler, 1979; Pierpoint *et al.*, 1999; Gordon *et al.*, 2000), or an increase in echolocation activity as light levels decrease (e.g. Goold, 2000). The variation may have a social or biorhythmic origin. Strong currents may also effect movements into sheltered waters.

METHODS Harbour porpoises make ultrasonic sounds at ~115-145 kHz, which may be detected using special equipment (Fig. 1). A high frequency hydrophone (30-150 kHz bandwidth) was towed on 100 m cable linked to an ultrasonic click detector (Chappell *et al.*, 1996; Gillespie and Chappell, *submitted*) and a laptop computer. Porpoise clicks were distinguished from other impulsive sounds by using their amplitudes in three frequency bands (115 to 145 kHz, 71 kHz and 50 kHz).

The research vessel *Song of the Whale* towed the hydrophone repeatedly along a 12 nm strip at approximately six knots between Grand Manan Island and East Quoddy Light (Fig. 2). Because it was anticipated that the number of legs of the survey would be relatively low, a design was chosen which would keep spatial variation low. In this way, the variance of the detections was reduced allowing the effect of time and tide to be examined.

A 'leg' is defined here as a passage along the strip (north- or southbound). Thirty-six legs (72 hours) were completed between 14th July and 2nd September, 1999. For statistical comparisons, time-of-day was reduced to four categories: 0-6, 6-12, 12-18, 18-24 hours (Canadian Atlantic Time); and state-of-tide to four categories: high (1.5 hours either side of high water), falling (1.5 – 4.5 hours after high water), low, and rising (similarly defined). As far as logistically possible, legs were attempted which would be uniformly distributed with time and tide (Table 1). The survey area was further divided into two habitats, termed 'region A' and 'region B' (Fig. 2). Grand Manan Island obstructs the flow of water in and out of the Bay of Fundy, so it was anticipated that the currents would differ between these two areas, and consequently that porpoise distribution or behaviour might also differ.

The detection rate used was the proportion x/n, where x is the number of three-second samples with porpoise detections, and n is the total number of three-second samples. The proportions from each leg were arcsine ($\sqrt{x}$) transformed in order to make the distributions more approximately normal (Zar, 1996), and the rates on survey legs were compared for equality of means with time and tide using ANOVA. The part of the survey area near Grand Manan is well known to local researchers as an area of high porpoise use based on visual observations, and the spatial pattern of detection rates within the survey area was also compared with this prior knowledge.

RESULTS Figure 3 shows the distribution of vocal activity versus latitude for the survey area, with a smooth regression line (6th order spline). The rate is clearly higher in region A, with a peak at a latitude of about 44.80°N, at the northern tip of Grand Manan Island.

Figure 4 shows plots of the rate as a function of time and tide, in regions A and B. Table 2 shows the results of ANOVAs, comparing these rates after transformation. The data were significantly different at the 5% level with time in region A but not region B (region A: $F=6.64$, $P<0.01$; region B: $F=1.90$, $P=0.15$). The data were not significantly different with tide in either region (region A: $F= 1.14$, $P=0.35$; region B: $F= 2.10$, $P=0.11$).

DISCUSSION The acoustic detection rate was clearly higher in region A, near Grand Manan, corresponding with prior knowledge based on visual observations. This result testifies that acoustic techniques can be used reliably to measure either vocal activity or as an index of abundance. However, these two possible causes are difficult to distinguish in an acoustic data set.

No differences were found in detection rates in region B with time of day or tide. Detection rates in region B were low: if porpoises make little use of this area for feeding, then this may explain the lack of temporal variation. In region A, a significant difference was found with time, with a peak in detection rate evident at 18-24 hours. Pierpoint *et al.* (1999) similarly reported a higher detection rate at night. However, no differences were detected in region A with tide. This latter result is unexpected. The Bay of Fundy experiences the highest tidal range in the world (17 m), and associated strong currents. Depending on the direction of the tide, porpoises might be expected to either utilise the region near the island for feeding on current-swept prey, or to avoid or occupy the area when currents are very high. There are suggestions in Fig. 4 that differences not detected here may exist between high or falling and low or rising tides in region A. Pierpoint *et al.* (1999) recorded a significantly higher detection rate during the high or falling tide.

The survey design ensured that the variance of the detections was not inflated further by spatial variation. This was necessary to allow the investigation of time and tide with relatively few samples from a small-scale survey. This approach has drawbacks, however: firstly, the results only represent the patterns within the small survey area, and a larger, randomised, or systematic survey over a wider region would be required to confirm any patterns more generally. Secondly, the results cannot distinguish between changes in vocal activity and changes in porpoise abundance. A large-scale survey could conceivably distinguish between a population vocalising at an even rate with a shifting distribution versus an evenly distributed population with time-varying vocal activity.

ACKNOWLEDGEMENTS The team would like to extend thanks to members of the Grand Manan Whale and Seabird Research Station, and also to Dave Johnson, Oliver Boisseau, Vicky Quayle, and Mandar Trevedi for additional help with fieldwork. Thanks also to colleagues in IFAW for their support of the team's work.

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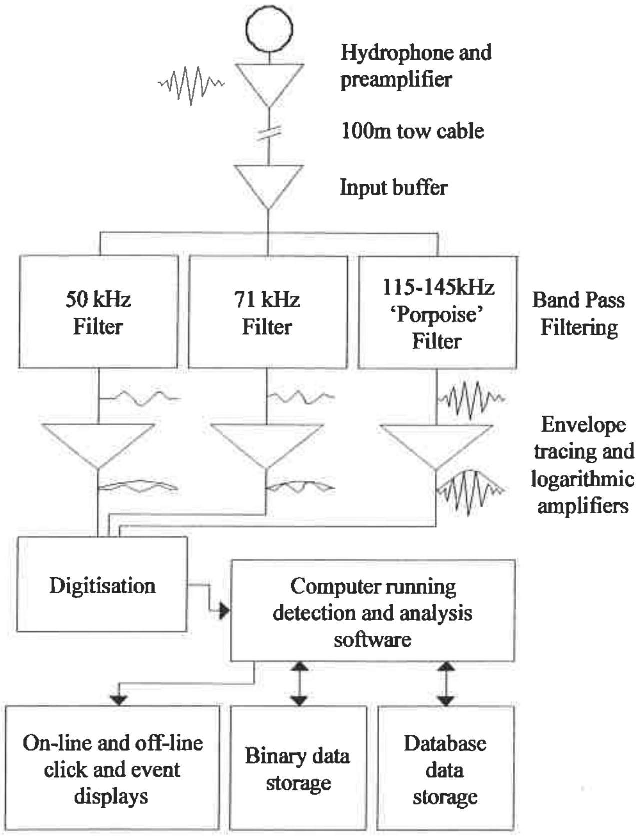

Fig. 1. Schematic of porpoise detection process

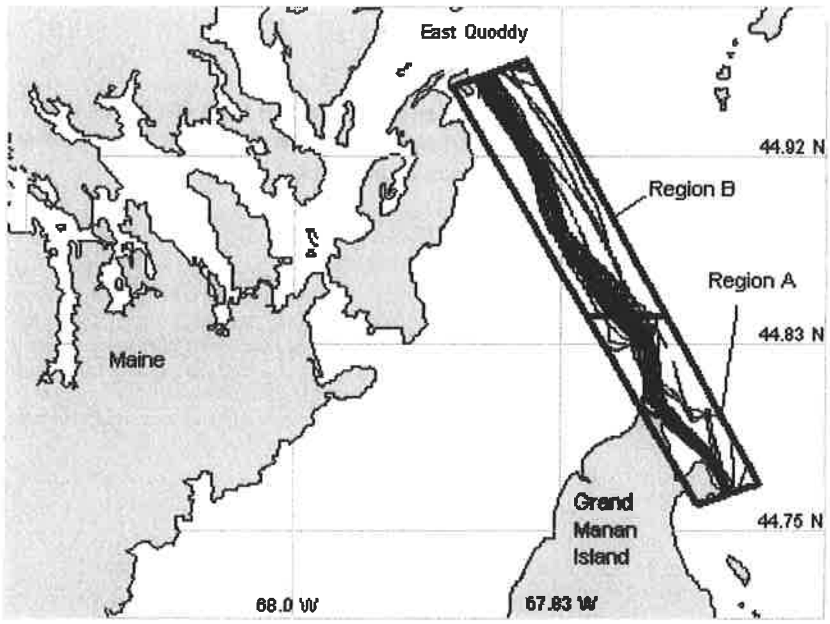

Fig. 2. Map of survey area (black box) in the Bay of Fundy, Canada.
The area was divided into two regions between which currents were expected to differ

Table 1. Number of legs completed with time-of-day and state-of-tide.

	0-6	6-12	12-18	18-24	Total
High	1	1	4	2	8
Falling	4	3	3	5	11
Low	0	3	2	2	11
Rising	2	3	1	0	6
Total	7	10	10	9	36

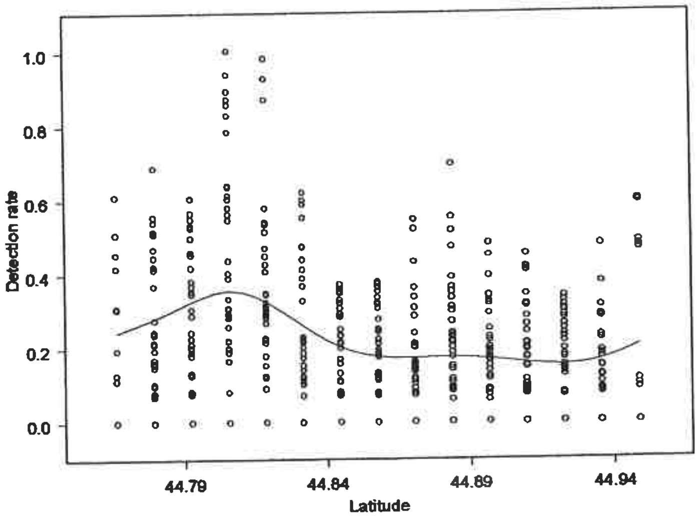

Figure 3. Detection rate against latitude. Points represent the detection rate on a small section (0.8 NM) of a leg, and the smoothed line is a 6th–order spline regression fit. The detection rate is the proportion of three-second samples with porpoise clicks after arcsine transformation. More detections were made in region A, near Grand Manan Island.

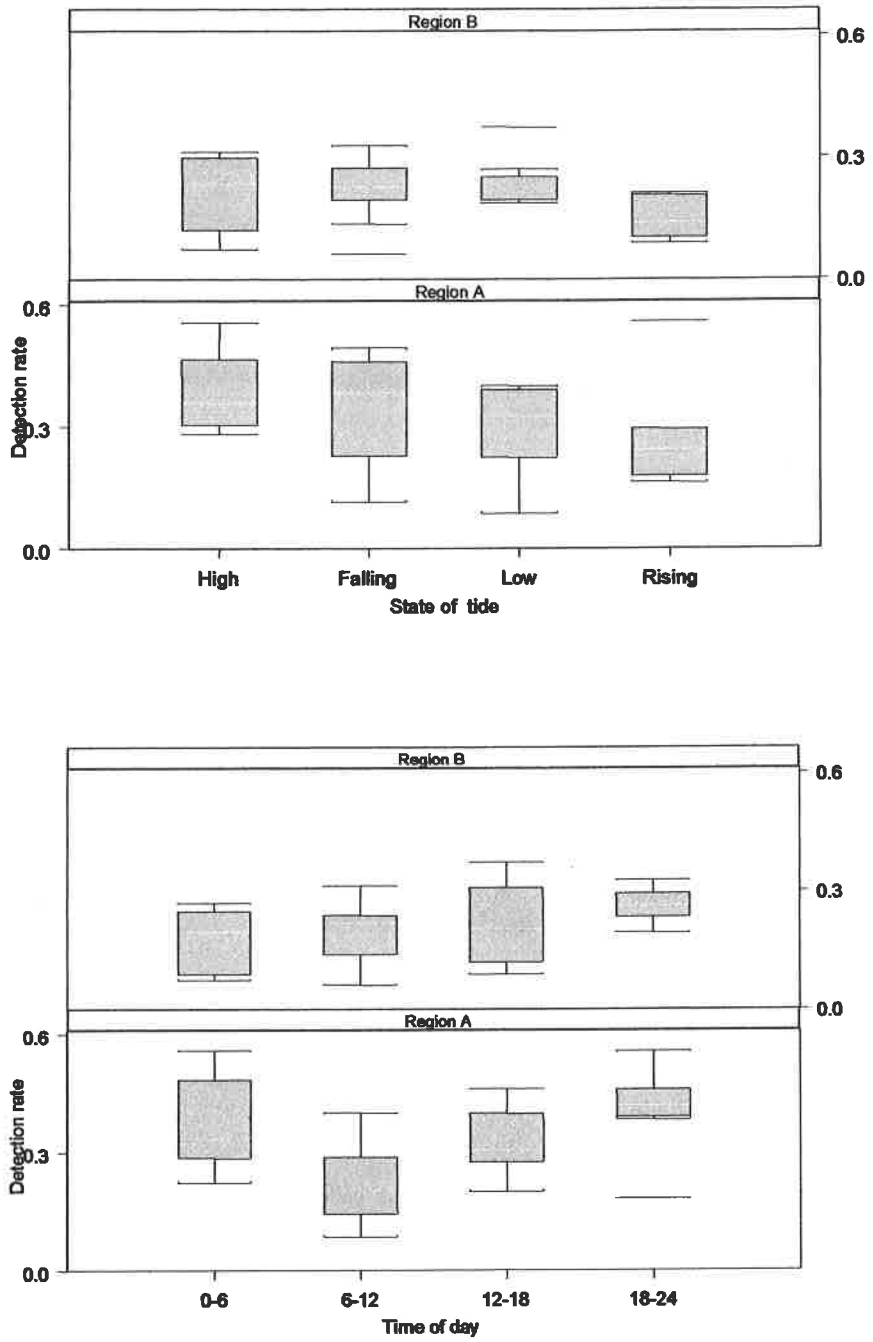

Figure 4. Boxplots of detection rate against time-of-day and against state of tide, for regions A and B. The detection rate is the proportion of three-second samples with porpoise clicks after arcsine transformation.

PRELIMINARY DATA ON THE OCCURRENCE, DISTRIBUTION, AND FEEDING BEHAVIOUR OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN A SOUTHERN LOCATION OF THE "INTERNATIONAL SANCTUARY FOR MEDITERRANEAN CETACEANS"

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The occurrence, distribution and feeding behaviour of a school of bottlenose dolphins (*Tursiops truncatus*) was observed from 1997 to 2000, in the nearshore waters off the Tuscany coast. The study area is situated between two islands, Tino (SP) and Gorgona (LI), encompassing an area of approximately 850-km^2, about 20 km away from the mainland. The study area is included within the waters of the International Sanctuary for Mediterranean cetaceans, as well as within the waters of the National Park of the Tuscan Archipelago. Bottlenose dolphin presence in this area has never been investigated before.

Observations were conducted by boat every week and these highlighted the recurrent presence of the species. Photo-identification studies based on nicks or marks present on their dorsal fins has allowed us to identify twenty individuals of the group. Echo-sounder recordings conducted during the sightings indicate a correlation between dolphin presence and prey presence. Moreover, the presence or absence of fishing boats appears to influence the hunting behaviour of the dolphins, which consequently manifest particular hunting strategies. The sighting of newborns observed during each of the study years indicates that this area appears relevant for nursing and calf-rearing activities. The results represent the starting point for future projects aimed at defining cetacean distribution and behaviour within the broader range area of the Tuscan Archipelago.

DISTRIBUTION & ABUNDANCE OF CETACEANS IN WESTERN IRISH WATERS AND THE ROCKALL TROUGH

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An intensive shipboard sightings survey was conducted from 30 July to 22 August, 2000, to provide precise estimates and to investigate the summer distribution of various cetacean species in western Irish waters. Methods employed in this SIAR survey mirrored closely those used in the 1994 SCANS survey, including the use of a double-platform method, the estimation of g(0), and the assessment of animal movement in response to the survey vessel. The survey area measured approximately 62,400 km^2 and included a significant portion of the central and eastern Rockall Trough. Thus *ca.* 50% of the study area comprised the deep-water basin >1000 m depth, while the remainder comprised continental slope and shelf waters. Due to good weather conditions, over 96% of the target area was surveyed using the double platform method, with the remainder surveyed using a single observer platform.

A total of 126 cetacean sightings were made during the survey, ten of which occurred during off-effort periods. The most commonly sighted species by far were common and Atlantic white-sided dolphins, while among the larger species, sperm whales, fin whales, and minke whales were most frequently encountered. Among the rarer species encountered were groups of Cuvier's beaked and Sowerby's beaked whales, northern bottlenose whales, and a single humpback whale. Common and white-sided dolphins were seen throughout the study area, while sperm whales were sighted exclusively along the northern margin of the Rockall Trough. Estimates of abundance were possible only for common and white-sided dolphins due to their significantly greater sighting frequencies.

EVIDENCE OF DECLINE FOR A COASTAL COMMON DOLPHIN COMMUNITY IN THE EASTERN IONIAN SEA

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INTRODUCTION Once widely distributed in the whole Mediterranean Sea, the short-beaked common dolphin (*Delphinus delphis*) has faced a dramatic decline in numbers in recent years (Notarbartolo di Sciara and Demma, 1994; IUCN/CSG In prep.)

The common dolphin community described in this paper has been consistently studied between 1993-99 in eastern Ionian Sea coastal waters (Politi *et al.*, 1994, 1998), and reportedly represents a relic sub-population in need of strong conservation measures. Largely based on the presence of common dolphins, in 1995 the study area qualified as Site of Community Importance under the EU Habitats Directive *Natura 2000* (Frantzis, 1996). As this measure alone may not grant appropriate resource management and protection for this endangered species, interdisciplinary research and focused conservation strategies are urgently needed – particularly in the light of recent findings.

MATERIALS AND METHODS Research was conducted in 1993-94 from a 15 m sailing vessel, in 1995-96 from a 4.7 m inflatable craft with pneumatic keel powered by a 40 HP outboard engine, and in 1997-99 from a 4.7 m inflatable craft with rigid keel powered by a 50 HP four-stroke outboard engine.

Dolphins were photo-identified during *ad libitum* surveys conducted in a study area of approximately 500 km^2 (between 38°48'N - 38°30'N of latitude and 20°43'E - 21°02'E of longitude). Individual photo-identification was based on long-term natural marks on the dolphins' dorsal fins, such as nicks on the trailing edge (Würsig and Jefferson, 1990) and the pigmentation pattern of "white patches" on both sides of the fins.

Search routes were opportunistically chosen to cover homogeneously all parts of the study area. The search effort is outlined in Table 1. Sighting conditions were considered "positive" when the sea state was less than Beaufort 3, and at least one observer was scanning the sea surface, following Bearzi *et al.* (1997). Sighting frequencies were then computed based on 10km-long searching bouts.

RESULTS During 267 photo-identification surveys, 696 groups were observed and 66 adults with long-term natural marks on their dorsal fins were catalogued. The rate at which the 66 individual dolphins were identified during the study (Fig. 1) shows that an asymptote was reached by 1998, indicating that most of the potentially identifiable individuals were catalogued by that time.

Individual frequency of re-sightings ranged from 1 to 54 different days (mean=16.7, SD=11.4, SE=1.4, n=66). Five individuals were sighted only once.

Mean relative sighting frequencies in 1993-99 ranged between 0.8-2.0 sightings every 100 km surveyed ($mean_{1993-99}$=1.6 sightings/100 km, SE=0.0011, SD=0.04, n=1321). No significant differences in relative sighting frequencies were found for these years (Kruskal-Wallis H=10.99, $p>0.05$). There was no correlation between relative sighting frequency and group size (Spearman's r=0.11, $p>0.05$), indicating that the capability of detecting dolphins in the study area was independent of the number of individuals composing a group.

The mean group size was 7.9 (median=6.0, SD=6.07, SE=0.23, n=696). Group sizes showed significant differences among years (F=17.13, df=6, $p<0.001$). Similar group sizes were recorded between 1993-96 and 1997-99, but a significant decrease occurred after 1996 (Tuckey's test HSD $p<0.001$): the mean group size was 11.7 in 1993-96 (median=9.0, SD=9.08, SE=0.72, n=157, range 1-40) and this declined to 6.8 in 1997-99 (median=6.0, SD=4.26, SE=0.18, n=539, range 1-32; Fig. 2).

To evaluate relative trends of dolphin abundance, a "yearly encounter ratio" was obtained by dividing the yearly number of photo-identified individuals observed in the study area by the cumulative number of individuals catalogued until the same year (Table 1). Although 99% of the individuals were catalogued by 1997, and 100% by 1998, the yearly encounter ratio decreased constantly, as shown in Fig. 3 (the low figure in 1995 reflects poor research effort).

DISCUSSION The study suggests high levels of site fidelity for this common dolphin community, based on high individual re-sighting rates, and low percentage of dolphins sighted only once. The rate at which dolphins were identified decreased after 1996, and the discovery curve reached an asymptote in 1998. This indicates that most community members carrying natural marks suitable for photo-identification were identified by 1998.

The decrease in the total number of photo-identified individuals observed in the study area every year, combined with the smaller mean group sizes observed after 1996, indicated that this common dolphin community faced a decline (less animals, smaller groups) during the research period.

Group fragmentation and smaller group sizes represent a typical behavioural strategy when food resources are distributed in small and low-density patches (Chapman and Chapman, 2000). Although dolphin declines may result from a number of environmental changes, the observed patterns are consistent with the hypothesis of decreased food prey availability and/or density in the study area.

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Table 1. Individuals photo-identified and catalogued in years 1993-1999.

Year	1993	1994	1995	1996	1997	1998	1999
Survey effort (days)	*11*	*23*	*10*	*31*	*75*	*70*	*47*
Number of photo-identified individuals observed in the study area	*34*	*43*	*33*	*53*	*49*	*44*	*35*
Cumulative number of catalogued individuals	*34*	*49*	*52*	*63*	*65*	*66*	*66*

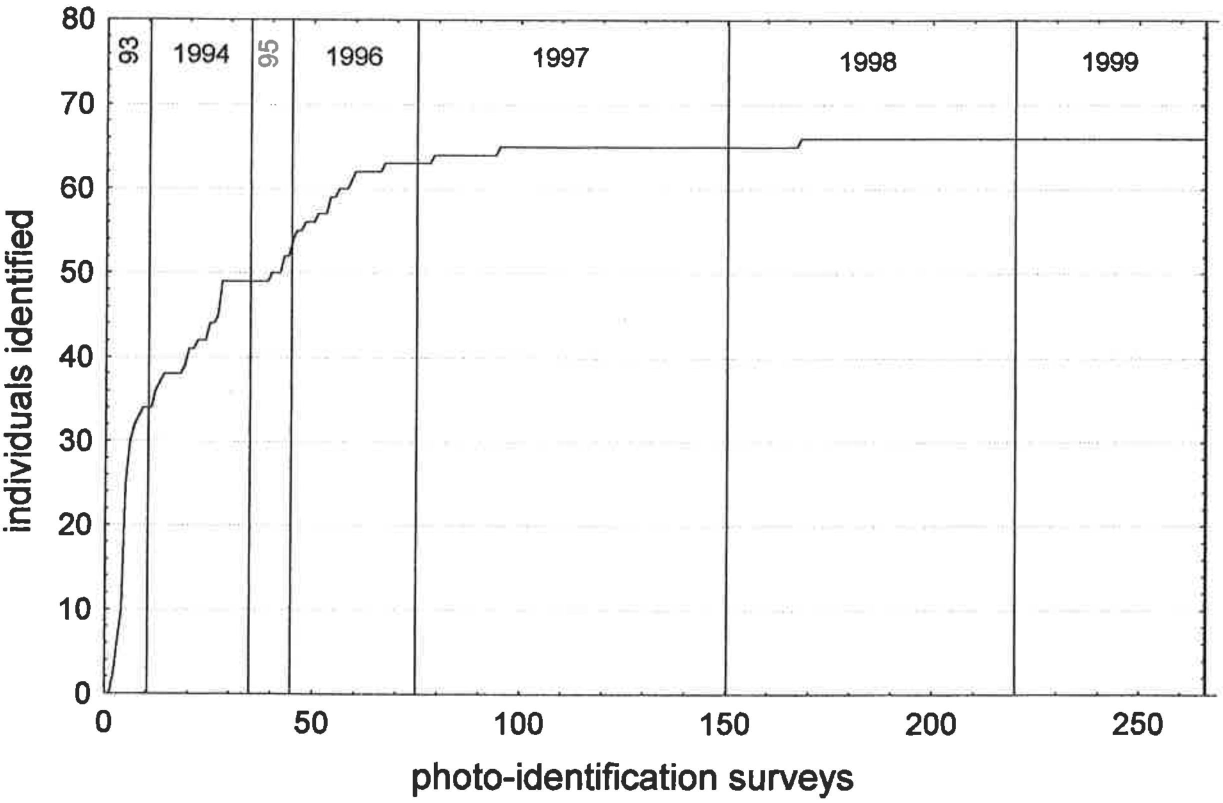

Fig. 1. Rate of discovery curve.

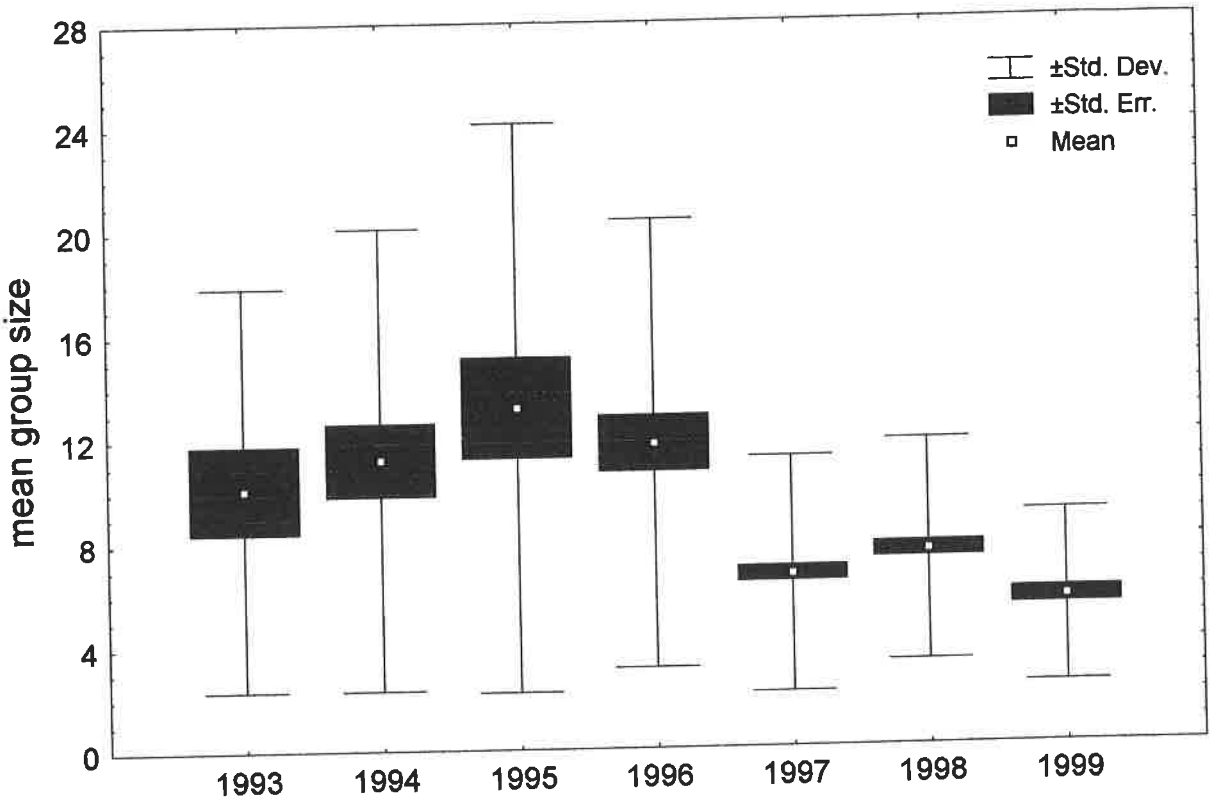

Fig. 2. Group size variations among years.

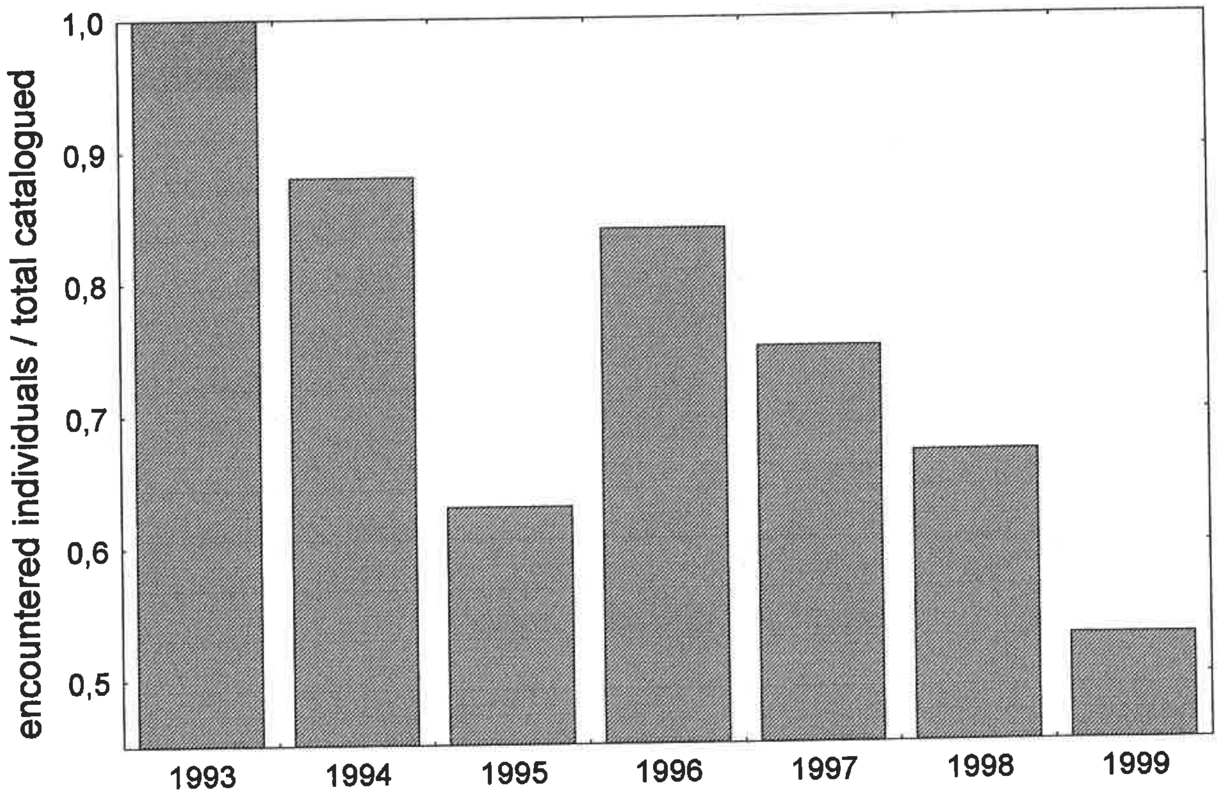

Fig. 3. "Yearly encounter ratios" in different years.

DISTRIBUTION, HABITAT USE AND BEHAVIOUR OF BOTTLENOSE DOLPHINS AT LAMPEDUSA ISLAND (ITALY): RESULTS OF FIVE YEARS OF SURVEY

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INTRODUCTION Since 1996, a population study has been conducted at Lampedusa Island (Mediterranean Sea, Italy), whose objectives were: a) to assess the eventual degree of residency of bottlenose dolphins (*Tursiops truncatus*) around the island; b) to estimate the population size; c) to study habitat use and d) to examine the dolphins' behaviour.

MATERIALS AND METHODS Land- and boat-based surveys, and photo-identification technique were used to derive the population estimate, and to examine distribution and movements of individuals over a three-month summer period (July-September each year, from 1996 to 2000). Land-based observations each lasting three hours were made from the two island's higher places (Albero Sole, NW; and Capo Grecale, NE) at fixed times, both during the morning (07:00-10:00 hrs) and during the afternoon (17:00-20:00 hrs).

Dolphin number, position, estimated behaviour, and direction of movement were recorded onto data sheets. Using a 4.5 m inflatable powered outboard, boat-based surveys were made, trying to cover all the four zones into which we divided the area around the island within six miles of the coast. However, the northern part was rarely accessible due to the bad sea conditions.

35 mm cameras equipped with 35-80 mm, 70-210 mm and 60-300 mm lens were used for photo-identification purposes.

Focal group and *ad libitum* sampling methods (Altmann, 1974) were applied to assess the dolphins' behavioural activity, using both a video camera and a tape voice recorder. The behavioural categories considered were: travelling, feeding, feeding in association with trawlers, searching, socialising, playing, milling, resting, and mixed behaviours (Bel'kovich *et al.*, 1991; Shane, 1990; Pace *et al.*, 1999).

Data were analysed by mixed-model factorial ANOVA, and principal components analysis (PCA).

RESULTS A total number of 281 sightings (188 boat-based and 53 land-based) were recorded during the study (see Fig. 1 for details). Bottlenose dolphins have been documented in all parts of the study area, with some locations having a concentration of sightings. In particular, due to the presence of a submerged fish farm at Cala Calandra, zone 1 holds about 30% of the total number of sightings, since the animals were always seen in association with this structure. Zones 2 and 3, situated in the southern part of the island, reaches 27% and 28% respectively, while zone 4 covers the remaining 15% of sightings.

Group size ranged from single animals to 16 individuals (mean=3.8; S.D.=2.2; mode=1). A total of 140 recognisable individuals were catalogued, and many of these identified dolphins (n=85, corresponding to 60% of the total) were re-sighted over the five-year study period, indicating a high degree of residency of the population (Fig. 2). However, the number of animals (n=55) solely identified on single occasions may demonstrate that Lampedusa's waters could only represent part of the home range for many members of the population, possibly distributed in the entire Pelagie's Archipelago, even if the movements of the animals beyond the three islands of the archipelago are as yet unknown.

The recruitment of individuals to the photo-identification catalogue decreased throughout the study (Fig. 3). However, the continuing additions to the end of the study show that unknown animals were still being encountered, suggesting a larger population than the photo-ID catalogue.

Total age class composition of the group was: 883 adults (82%), 139 juveniles (13%) and 55 newborns (5%). An unusual distribution of sightings, as well as a difference between each year of study relating to the presence of newborns, was seen. In fact, two-way ANOVA reveals that mother-calf pairs prefer zone 4 ($F=2.98$; $df=3$; $p=0.04$) and that years 1998 and 2000 were higher than the others for the mean number of newborns observed ($F=4.25$; $df=4$; $p=0.01$). The preference for zone 4, particularly near to Albero Sole, was probably due to the fact that this area is relatively quiet in terms of boat traffic and human disturbance, allowing mother-calf pairs to remain in a safer environment.

To explore the relationship between behavioural categories and animals' age, principal components analysis (PCA) was conducted (60% of the total variance). Based on the PCA pattern (Fig. 4), the category related to social behaviour appeared to be the only one mainly associated with juvenile and newborn individuals. Furthermore, social behaviour was found to be significantly associated with zone 3 ($F=3.8$; $df=3$; $p=0.04$), the area where more numerous and structured groups were observed. Other relationships between the different zones and behavioural categories were revealed by observation. In fact, RESTING was found primarily in zone 1, while feeding in association with trawlers occurred mainly in zone 2.

CONCLUSIONS Other authors have already reported that dolphins follow fishing boats, adapting their behaviour to take advantage of human activity (Norris and Prescott, 1961; Leatherwood, 1975; Würsig, 1986; Corkeron *et al*., 1990; Shane, 1990). Moreover, the presence of trawling boats or fish farms seemed to influence the dolphins' foraging strategy. In fact, dolphins close to the boat or to the fish farm, obtained easy access to feeding resources.

The other results suggested a presence of a resident population of bottlenose dolphins at Lampedusa Island, consisting of about 85 individuals, and the existence of variable habitat use in relation to behavioural categories and mother-calf pairs.

While this study has provided a baseline data set relating to the Lampedusa Island population, it is important to maintain scientific monitoring of bottlenose dolphins in the area, in order to accumulate significant information to be used for conservation management of the species in other coastal zones in Italy.

ACKNOWLEDGEMENTS We would like to thank all the volunteers and people (A..d'Esposito, and A..Aquilano) who participated in the fieldwork. We also thank CTS-Environmental Department and Informa S.r.L. for their grant support.

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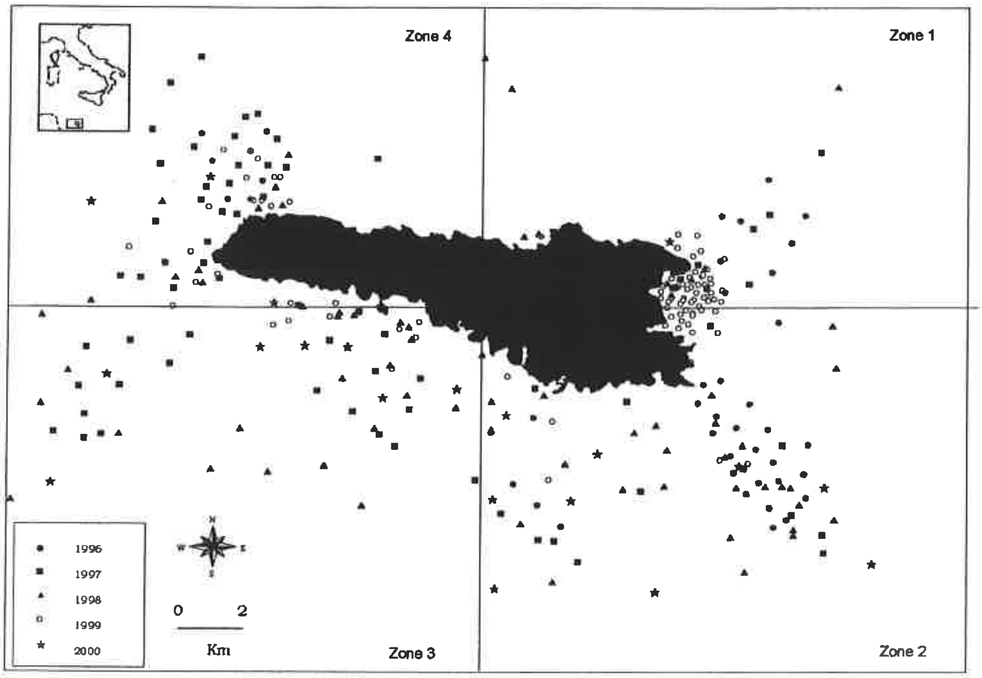

Fig. 1. Plot of sightings around Lampudesa Island, 1996-2000

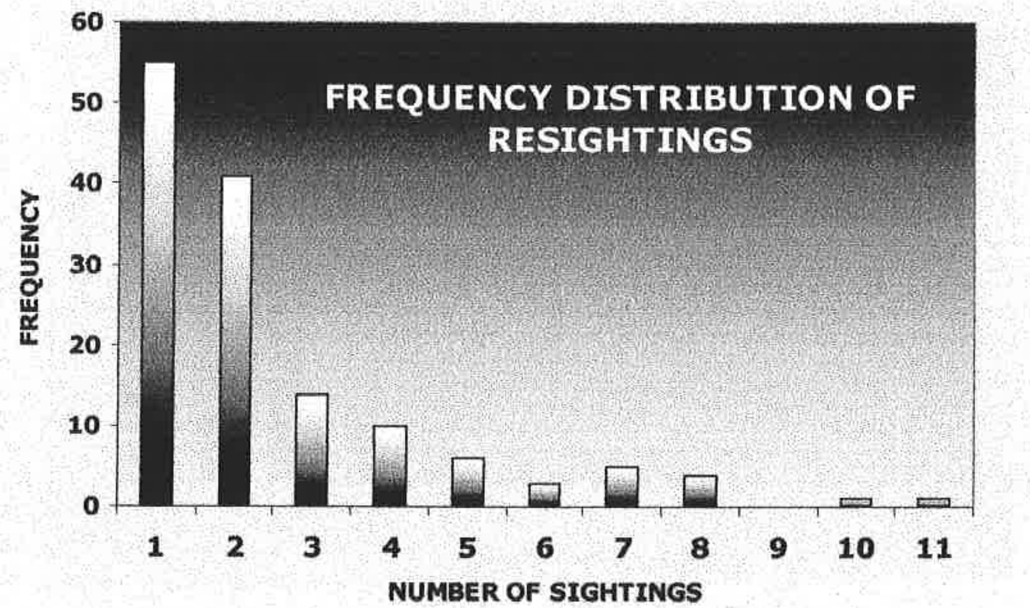

Fig. 2. Frequency distribution of bottlenose dolphin sightings

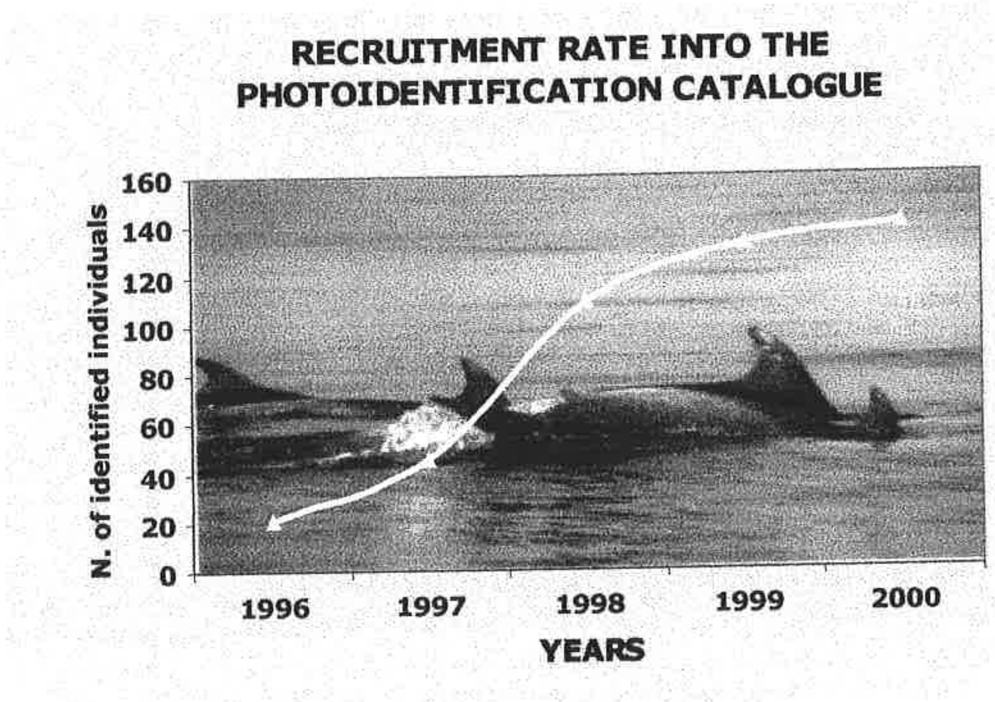

Fig. 3. Recruitment rate into the photo-identification catalogue

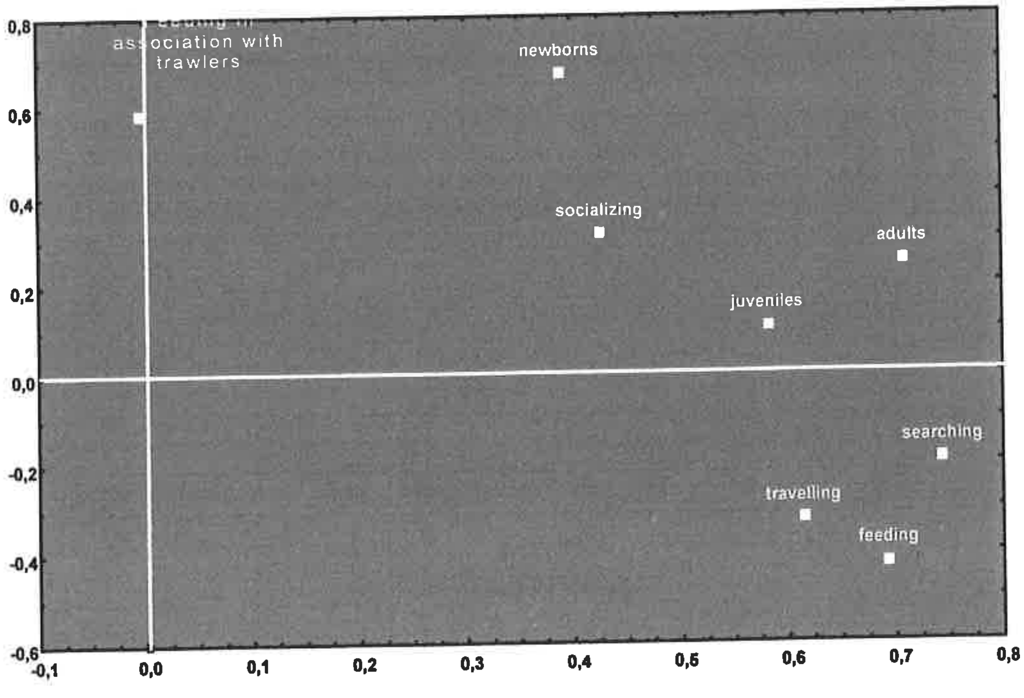

Fig. 4. Principal Components Analysis of behavioural categories and age structure

MONITORING THE SEASONAL MEDITERRANEAN FIN WHALE, *BALAENOPTERA PHYSALUS*, PASSAGE THROUGH THE STRAIT OF MESSINA (IONIAN SEA) USING GIS TECHNIQUES

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INTRODUCTION A seasonal presence of the Mediterranean fin whale, *Balaenoptera physalus*, along the North-Eastern Sicilian Coast was observed, beginning from 1995.

The fin whales sighted along the coast showed a behaviour that was connected to feeding. This hypothesis strengthens conclusions from different studies that show a remarkable primary production and the presence of the Mediterranean krill, *Meganictyphanes norvegica*, along this part of Ionic coast. This trophic richness is due to the hydrodynamic characteristics of the straits which produce upwelling areas and strong tidal currents.

The data collected also show that the fin whales pass through the Strait of Messina from June to October, with a clear alteration of their course between the summer and the autumn months.

MATERIALS AND METHODS The study area is located between Capo S.Alessio and Messina along the Ionian Sicilian coast. This area is called Strait of Messina, and is characterised by:

1) harmonic tidal movements due to the opposite phases of the Ionian and the Tyrrhenian basins;
2) whirlpools caused by upwelling;
3) water mixing between the warm and superficial Tyrrhenian waters and the cold and intermediate Ionian waters;
4) water refluxing southward along the Sicilian coast.

During this study, sightings were made from boat and coastal surveys. For each sighting, the coordinates of the start and end point of the whale observation were recorded from a boat using a GPS-38 Garmin, and from the coast using theodolite tracking (Wursig and Würsig, 1979; Würsig *et al.*, 1991). All the coordinates with the corresponding fin whale's direction of movement and the number of sightings of individuals were implemented in a GIS using ArcView software. On several occasions, it was also possible to get near the animals to take photos for photo-identification, using 35-mm cameras equipped with power-winders, 80-200 mm/f.2.8 zoom lenses, and ISO 400 black & white print, or Kodak Ektachrome ISO 100 colour slide film. All photographs were later compared manually using the procedures developed previously by Gannier and Gannier (1997), and Agler (1990, 1992).

RESULTS Sightings of fin whales along the coast of eastern Sicily have occurred during the summer period (Giordano *et al.*, 1995; Tringali *et al.*, 1999), and, in particular, the data collected during this study show a fin whale passage through the Strait of Messina from June to October.

During the last five years, 75 fin whale sightings were made, and 79 individuals were recorded. Most sightings were of single individuals, but there were 16 cases of groups of 2-3 individuals. Five individuals were photo-identified, and young individuals were recorded seven times (Fig. 1).

The fin whales were observed to go along the coast and when they stopped for more than 30 minutes (Fig. 2), their behaviour was found to be related to feeding. This finding strengthens conclusions from different studies that show a remarkable primary production for this area, and the presence of the Mediterranean krill, *Meganictyphanes norvegica*, along the Ionian coast (Guglielmo, 1995). This trophic richness is due to the hydrodynamic characteristics of the straits which produce upwelling areas and strong tidal currents.

A clear alteration of course was found between the summer and autumn months: in June, July and August, sightings were characterised by a north, north-east and easterly direction, whereas the September and October sightings were characterised by a south and south-westerly direction (Fig.3). This change may be connected to a north-south fin whale migration within the Mediterranean Basin.

CONCLUSIONS Fin whales are seasonally present in the western Ionian Sea during late spring and summer, but little has been reported concerning their seasonal abundance and habitat use in the area. Their periodical return along the Ionian coast of Sicily points out the importance of this area as a feeding ground for fin whales within the Mediterranean Sea, and it has been suggested that their presence could be a feature of a migration within the Mediterranean Sea (Marini *et al.*, 1995).

This paper is a small contribution on this subject, but the GIS approach that was chosen will help the future monitoring and study of the links between their presence and the environmental parameters.

ACKONWLEDGEMENTS The authors wish to thank the Coast Guard of Messina, and Captain F. Lichi of the SIREMAR company.

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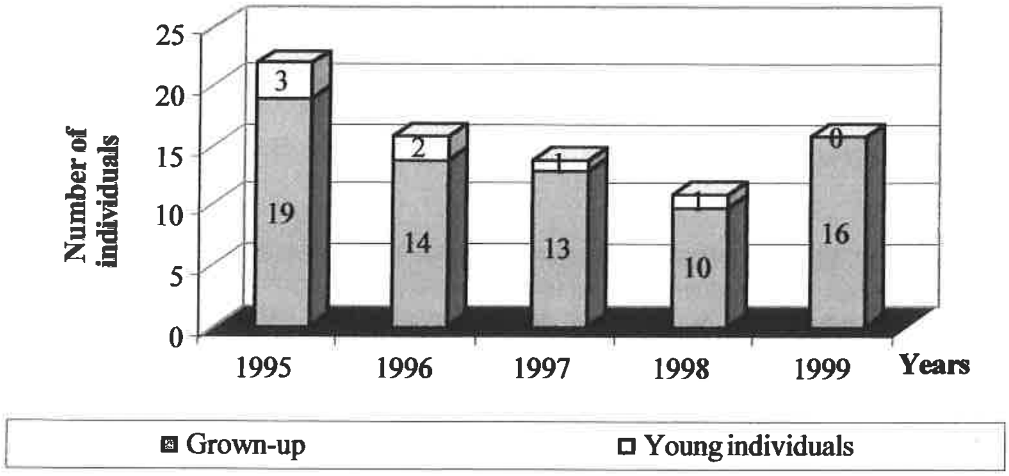

Fig. 1. Number of young and grown-up individuals

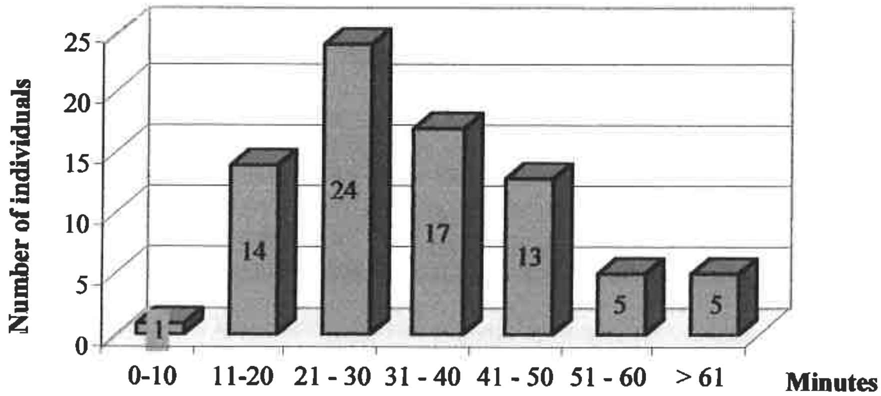

Fig. 2. Time of whale sightings

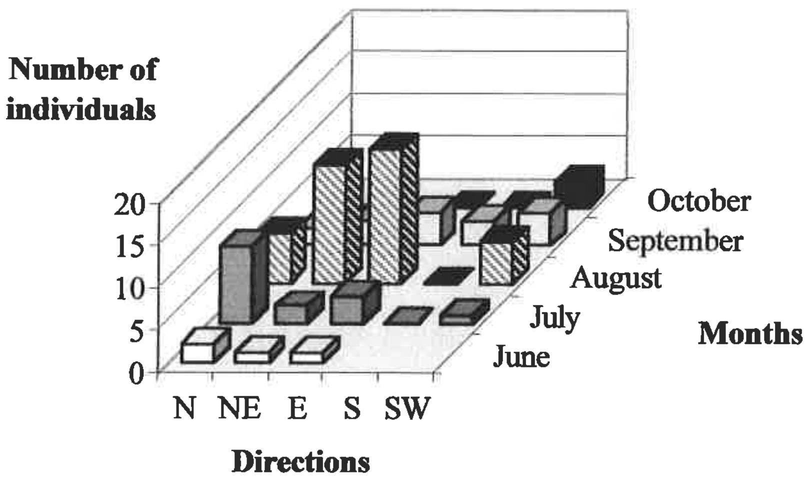

Fig. 3. Monthly direction of the whales

CETACEAN DISTRIBUTION IN THE LIGURIAN SEA DURING LATE SUMMER 1999 AND 2000 AS MEASURED ON SIRENA CRUISES

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INTRODUCTION NATO SACLANT Undersea Research Centre (SACLANTCEN) is sponsoring a multi-year programme to collect an integrated oceanographic, biological and hydrographic data set with the goal of explaining how these parameters may affect the distribution of marine mammals. The ultimate goal of the SACLANTCEN programme entitled Sound, Oceanography and Living MArine Resources (SOLMAR) is the development of reliable methods for the prediction of cetacean presence to support the Centre's Acoustic Risk Mitigation Policy. Two SOLMAR sea trials, entitled 'Sirena', were conducted in the Ligurian Sea in late summer 1999 and 2000.

MATERIALS AND METHODS Sirena 1999 (Sirena '99) and Sirena 2000 (Sirena '00) were conducted in the Ligurian Sea during the time periods of 3-13 August 1999 and 21 August – 15 September 2000, respectively. The operational area covers about 31,000 km^2. Two ships were deployed in the basin during the same time period. The NATO research vessel, NRV Alliance, an acoustically silent ship, provided a stable platform for visual observations and acoustic measurements. Visual observations were made while the ship was transiting at six knots (D'Amico *et al.*, 1999). The acoustic monitoring was made using a towed horizontal line array with real-time passive beam forming capability (D'Amico *et al.*, 2000). The Italian Navy's Hydrographic Office research vessel, ITS Magnaghi, performed oceanographic, lower and middle trophic level measurements, and cetacean visual observations. The ITS Magnaghi's primary objective was to collect vertical oceanographic measurements at fixed stations spaced along a 12-nm grid throughout the study area, to build up a three-dimensional picture of the oceanography of the area. Visual observations were made on station and between stations while the ship was transiting at six knots. Measurements of temperature, salinity, fluorescence as a proxy for chlorophyll, and dissolved oxygen (only for Sirena '00) were conducted at each station. Table 1 summarises the visual and acoustic monitoring efforts during both trials, and Figure 1 reports the tracks of the cruises for the two ships.

During Sirena '99 and Sirena '00, remotely sensed data from the SeaWIFS (Sea-Viewing Wide Field of View Sensor) ocean colour and AVHRR (Advanced Very High Resolution Radiometer) sea surface temperature sensors were collected and processed at SACLANTCEN. These data were used to determine mesoscale physical and biological oceanographic patterns in the Ligurian Sea during the field trials. (Data courtesy of Dr. Farid Askari - SACLANTCEN authorised NASA/SEAWIFS Research Ground Station). *In-situ* vertical profiling provides subsurface biological and hydrographic feature resolution that cannot be detailed with satellite imagery. The *in-situ* data are compared to the remotely sensed values and the cetacean visual sightings, to determine if there is a correlation between the oceanographic features and animal presence.

All data collected are plotted using ESRI ArcView Geographic Information System (GIS) Version 3.1 on a Mercator projection. To visualise frequency maps of sightings and acoustic detection, a geo-referenced grid that covers the entire operational area is generated. This grid consists of cells of 0.1 degrees, which corresponds to 6 x 4.37 nm. Habitat score was estimated, for every cell, by species, on the basis of the following formula (Azzellino *et al.*, 2001).

$$\textbf{Habitat score} = \frac{\dfrac{\mathrm{N}^{\circ}\textit{animal}}{\mathrm{MAX}\ \textit{animal}} \times \dfrac{\mathrm{N}^{\circ}\textit{sighting}}{\mathrm{MAX}\ \textit{sighting}}}{\dfrac{\textit{minutes}_{\mathrm{cell}}}{\mathrm{MAX}\ \textit{minutes}_{\mathrm{cell}}}}$$

Figure 2 shows fin whale habitat scores during Sirena '99 and Sirena '00 cruises separately. All data are from NRV Alliance, visual sightings only.

RESULTS Visual observations made from the NRV Alliance and ITS Magnaghi during Sirena '99 and '00 are shown in Figure 3. As the plots indicate, during the late summer time frame, fin whales (*Balaenoptera physalus*) were sighted primarily in the deeper portion of the basin, in water depths of 2000 metres or greater. However, during Sirena '99, the ITS Magnaghi observed fin whales much further to the east compared to Sirena '00. The western edge of the basin was also the primary area for visual and acoustic observations of sperm whales (*Physeter* *macrocephalus*). In Sirena '99, although no sperm whale visual observations were made from either vessel, some acoustic detection was made from the NRV Alliance in the western portion of the basin. As with fin whales, the predominant locations of the sperm whales were in the deeper western portion of the basin (Gordon *et al.*, 2000).

Figures 4a and 4b show the satellite sea surface temperature for the operation area in comparison with the depth of the 13.8 °C isotherm, the deep diving whale locations, and the bathymetry of the Ligurian Sea for Sirena '99 and Sirena '00 respectively. In Sirena '00, the sperm whale distribution indicates an apparent correlation with the colder surface water and a shallow thermocline, as shown by the overlying plot of the visual sightings. There were no sperm whale visual sightings in 1999, when the doming of the cold subsurface water was not as strong, and the measurement area was further to the east. This suggests that sperm whales prefer colder, deeper regions, as seen in 2000.

Figures 5a and 5b show the satellite ocean colour compared with the maximum chlorophyll values, fin whale sightings, and the depth of the maximum values of chlorophyll again for Sirena '99 and Sirena '00 respectively. During both trials, the fin whales were located in the centre of the basin, consistent with the regions of higher chlorophyll, and indicating regions of high biological productivity (Dubroca *et al.*, 2000).

Visual observations of Cuvier's beaked whale (*Ziphius cavirostris*) for both years occurred only in the canyon area offshore of Genoa. Although little is known about Cuvier's beaked whale distribution in the Mediterranean Sea, it has been suggested that they prefer regions of steep bathymetry, and possibly where there is a frontal zone that produces an enrichment of biomass. While no definitive characterisation of beaked whale habitats exists, their occurrence in the vicinity of the same submarine canyon for two successive years is significant (McLeod, 1998). Sightings were made from the NRV Alliance only in Sirena '99, and from both vessels in Sirena '00.

CONCLUSIONS It is essential to learn how ocean dynamics affect the distribution and behaviour of whales and the organisms forming the prey upon which the whales feed. Data from the Sirena sea trials provide a multi-year, integrated data set to explain why several species of cetaceans were found in specific locations based on oceanographic, biological and hydrographical parameters. In late summer, cooler sea surface temperature data appear to correlate with high levels of chlorophyll production, as seen by remotely sensed images and *in-situ* measurements. Coincident sightings of three species of marine mammals indicated that fin and sperm whales generally preferred the deep, nutrient rich portion of the basin, and the Cuvier's beaked whales preferred a submarine canyon where there was a frontal influence.

The Sirena sea trials have demonstrated the methodology to fuse physical and biological oceanographic parameters together with cetacean sightings. By determining regions of high and low cetacean density, a paradigm can be established for monitoring and conservation of marine species.

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Table 1. Visual and acoustic monitoring effort

		Sirena '99	Sirena '00 - Phase 1	Sirena '00 - Phase 2
Research Vessel	NRV Alliance	3-13 Aug 1999	22 - 29 Aug 2000	29 Aug - 7 Sep 2000
	ITS Magnaghi	3-13 Aug 1999	22 Aug - 6 Sep 2000	6 - 15 Sep 2000
NRV Alliance	Length of Track (nm, daylight)	736	648	524
	Hours of visual observations	154	112	126
	Length of Track with towed array deployed(nm)	668	1061	179
	Hours of passive acoustic monitoring	148	192	32
ITS Magnaghi	Length of Track (nm, daylight)	375	552	249
	Hours of visual observations	140	224	//

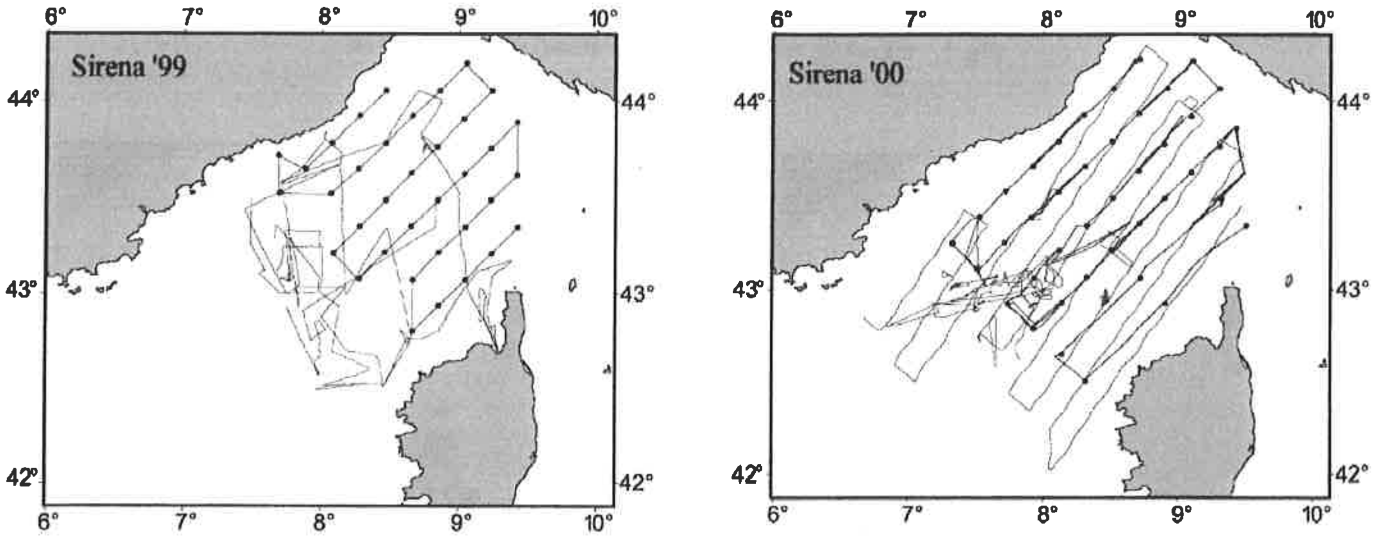


Fig. 1. NRV Alliance and ITS Magnaghi tracks during both trials

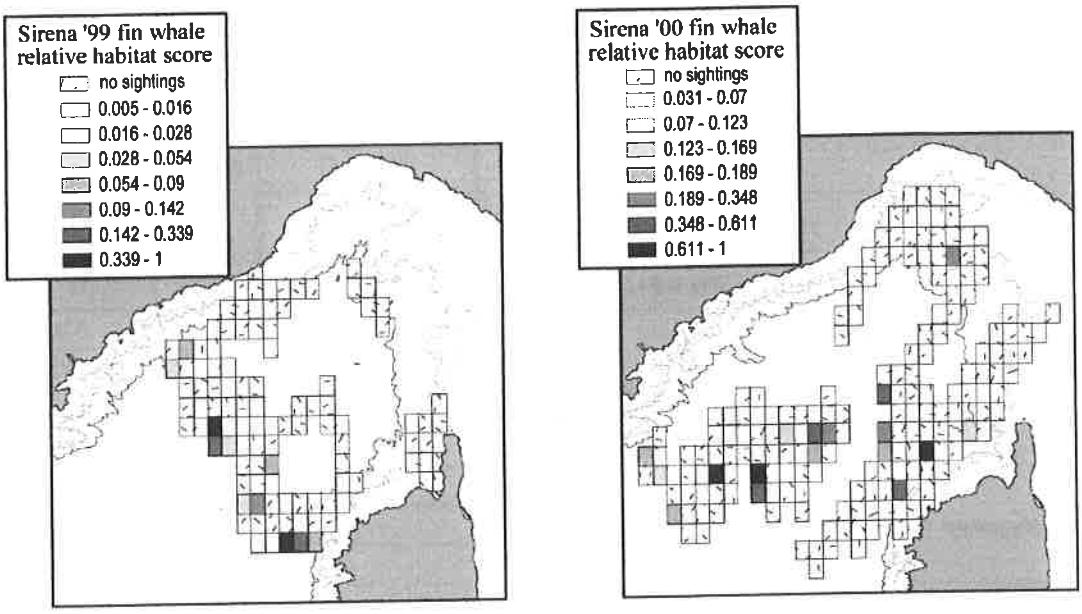


Fig. 2. Fin whale habitat score (normalised) during both trials

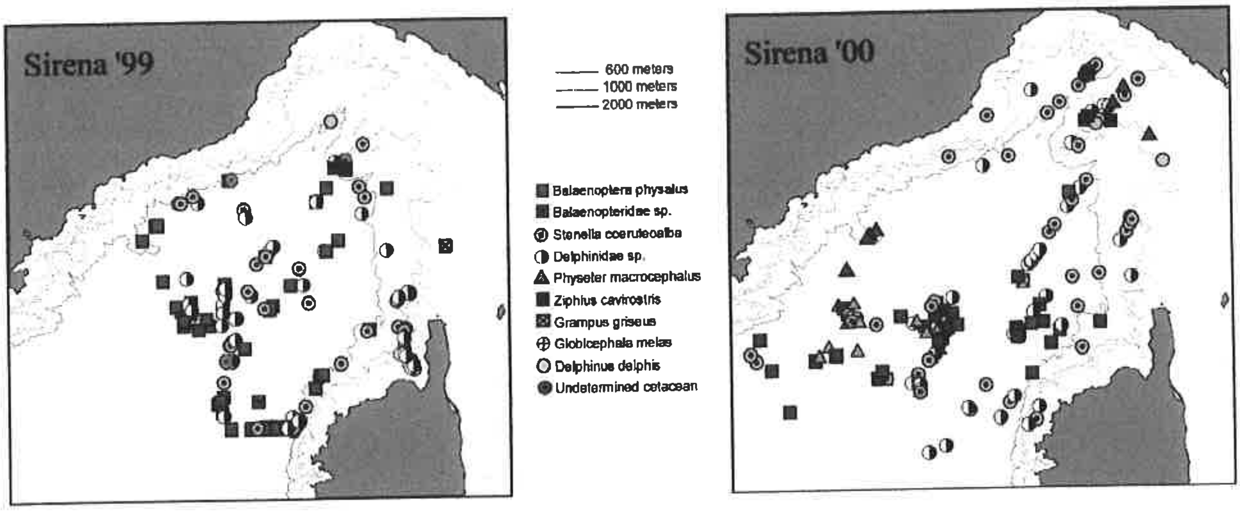
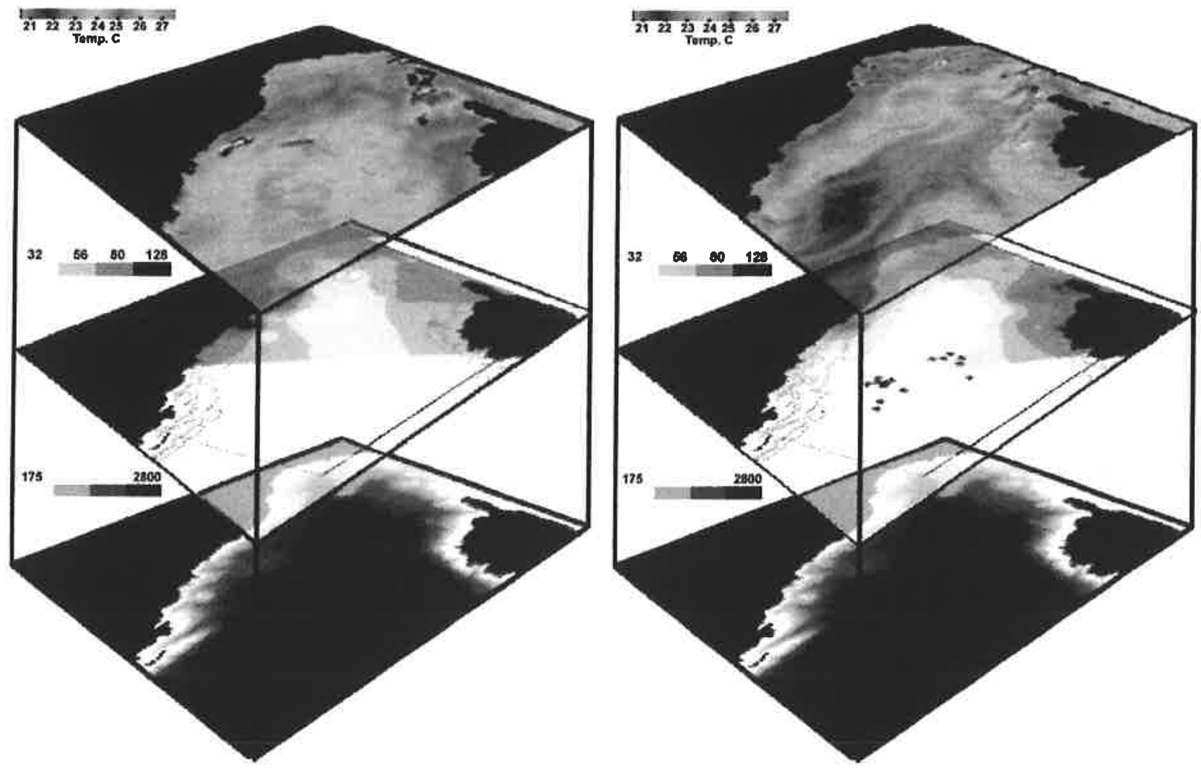
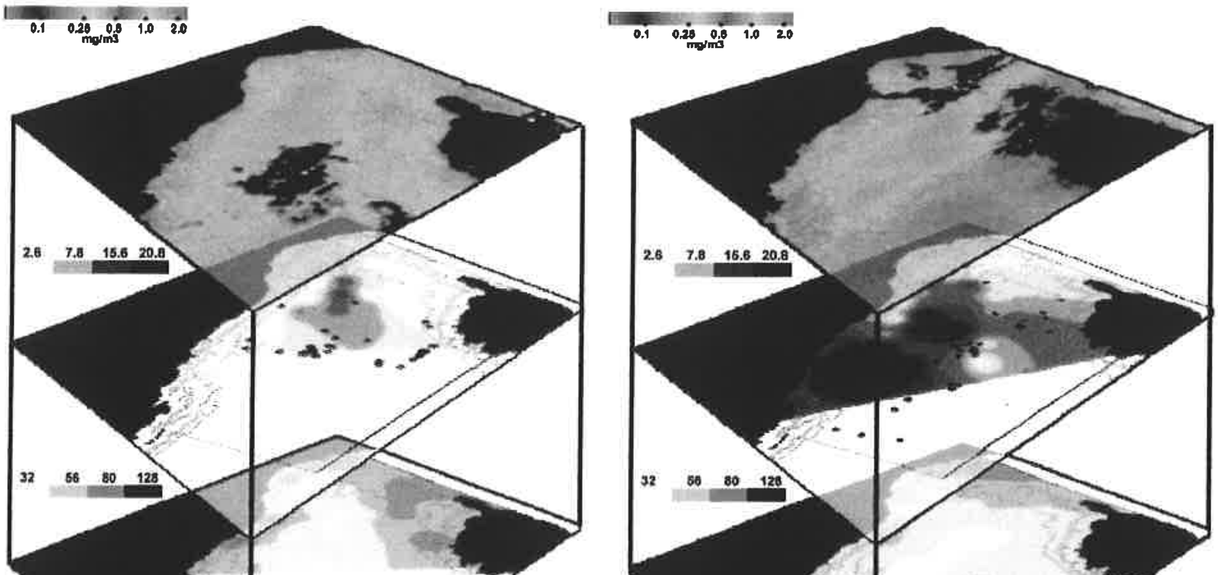


Fig. 3. Visual sightings from NRV Alliance and ITS Magnaghi during both trials



Figs. 4a and 4b. Sirena '99 and Sirena '00 AVHRR sea surface temperature (°C) (upper layer), depth (m) of the 13.8°C isotherm with deep-diving whale visual sightings (middle layer), and basin bathymetry (lower layer)



Figs. 5a and 5b. Sirena '99 and Sirena '00 SeaWIFS chlorophyll "a "(mg/m^3) (upper layer), chlorophyll "a" maximum values (mg/m^3) (middle layer) with fin whale visual sightings, and the depth of the maximum values of chlorophyll "a" (lower layer)

FOURTEENTH ANNUAL REPORT OF EUROPEAN CETACEAN SOCIETY: 2000

Paid-up members of the European Cetacean Society for the year 2000 numbered 409. The highest representation came from United Kingdom (98), Germany (47), Italy (47), Spain (41), France (29), Ireland (21), Denmark (16), USA (15), Portugal (13), Switzerland (13), Sweden (10), the Netherlands (8), Belgium (7), Australia (6), Norway (6), and Greece (5).

Countries with three members or less include Algeria, Austria, Bermuda, Canada, China, Croatia, the Czech Republic, Ecuador, Finland, Greece, Hungary, Iceland, Israel, Japan, Malta, Malaysia, Monaco, New Zealand, Poland, Slovenia, Turkey, and Ukraine.

The membership list of the Society continues to be run from the German Museum for Marine Research and Fishery in Stralsund, which also takes care of the mailing of material including Proceedings. The Society is very grateful to its director Harald Benke, and to Ines Westphal who is responsible for these tasks.

The European Cetacean Society Annual Conference in 2000 was held in University College Cork in Ireland, and was attended by 300 people. The theme was 'Cetaceans in the Ecosystem: Defining Critical Habitat'.

The conference was organised by Emer Rogan. Abstracts were reviewed by a team of reviewers organised by Greg Donovan. Awards were judged by a team lead by Jaume Forcada.

A total of 134 talks and 416 posters were presented at the conference; there was a student meeting and four workshops: Irish Whale and Dolphin Sanctuary, Stock Identity, Tagging, Rare Seals, and a Student Workshop on presentation of research results

The major task of putting together the Proceedings has once again been undertaken by Peter Evans, with help from Rebecca Pitt-Aitken and Emer Rogan.

The European Seminar on Marine Mammals: Biology and Conservation, was again held in September at Universidad Internacional Menéndez Pelayo in Valencia, Spain, organised by Toni Raga, with help from Peter Evans. A book entitled "Marine Mammals: biology and conservation", based on contributions to this course will be published by Plenum Press/Kluwer Academic.

Two newsletters were produced during the year, with recent research and news items in Europe and elsewhere in the world, conservation issues, cetacean meetings and publications, and Society business.

The Society web page has been further developed by Jan Willem Broekema.

In accordance with the AGM decisions, a statement on cetacean bycatch in pelagic trawls was sent to relevant EU representatives of member states; a letter was sent to ASCOBANS expressing the society's concern over inaction; and a letter was sent to the Government of the Canary Islands on the issue of fast ferry collisions. The Society has also written to the government of Mexico regarding conservation action for the vaquita.

The Society has continued to provide information or advice to government departments and non-governmental organisations in European countries, with representation at ASCOBANS.

The Society is grateful to members and others who have assisted with conferences and in other ways. Particular thanks are due to Peter Evans for his work on the Proceedings and in many other areas, to Roland Lick for his solid work on the finances of the Society, and to Greg Donovan for his valuable work on the submission of abstracts.

Nick Tregenza
Secretary

FINANCIAL REPORT FOR THE YEAR UP TO 1 MAY 2001

	Irish account IEP	German account DM	British account GBP
Balance as of 1 April 2000	0.00	59,023.91	917.86
INCOME			
ECS account savings from 2000		59,023.91	917.86
Membership fee during the year 2000/2001		23,531.49	30.50
Profit, Conference Cork	17,000.42	5,013.54	
Other payments (Sale of Proceedings, T-Shirts, etc)		840.00	
Interest on Savings account, 2000		962.36	11.42
Total Income		**89,371.30**	**959..78**

EXPENSES		German account DM	British account GBP
Travel expenses board meeting 2000		4,326.14	180.00
ECS Newsletters (printing)		2,100.53	
ECS Proceedings Valencia (printing, typing, etc)		9,079.16	468.12
Secretarial Expenses		399.00	
Postage (Newsletters, Proceedings, E-mail subscribtion, etc)		3,229.19	215.54
Bank account and credit card expenses		2,747.35	
Computer Support Group		0.00	
Total Expenses		**21,881.37**	**863.66**
Balance as of 1 May 2001	**17,000.42**	**67,489.93**	**96.12**
	Overall balance	**DM** **(EURO**	**110,006.61** **56,245.48)**

Roland Lick
Treasurer

The **European Cetacean Society** was formed in January 1987 at a meeting of eighty cetologists from ten European countries. A need was felt for a society that brought together people from European countries studying cetaceans in the wild, allowing collaborative projects with international funding.

AIMS (1) to promote and co-ordinate the scientific study and conservation of cetaceans;
(2) to gather and disseminate information to members of the society and the general public.

ACTIVITIES The Society set up seven international working groups concerned with the following subject areas: sightings schemes; strandings schemes; cetacean pathology; bycatches of cetaceans in fishing gear; computer data bases that are compatible between countries; the harbour porpoise (a species in apparent decline in Europe, and at present causing serious concern); and a regional agreement for the protection of small cetaceans in Europe (in co-operation with the United Nations Environment Program/Convention on the Conservation of Migratory Species of Wild Animals, Secretariat in Bonn, Germany). Some of these have been disbanded now, having served their purpose, and other groups (such as one specifically addressing seals) have been established. The names and addresses of contact persons for all working groups are given at the end.

Contact persons have been set up in each European member country, where appropriate, to facilitate the dissemination of ECS material to members, sometimes carrying out translations into the language of that country. Their names & addresses are given below.

Special issues of a newsletter are produced at intervals for members. Otherwise, news regarding conservation issues, notable cetacean information from Europe, information on legislation & regional agreements, and reports and notices from Council are posted on ECS e-mailing llists and, where appropriate, the ECS website as topics arise.

There is an annual conference with talks and posters, and at which the annual general meeting is held. The results are published as annual proceedings, under the title *European Research on Cetaceans.* Besides the present volume, others have been published for conferences held in Hirtshals (Denmark) in 1987, Tróia (Portugal) in 1988, La Rochelle (France) in 1989, Palma de Mallorca (Spain) in 1990, Sandefjord (Norway) in 1991; San Remo (Italy) in 1992, Inverness (Scotland) in 1993, Montpellier (France) in 1994; Lugano (Switzerland) in 1995, Lisbon (Portugal) in 1996, Stralsund (Germany) in 1997, Monaco in 1998 (in conjunction with the Society of Marine Mammalogy, as the 1st World Marine Mammal Science Conference); Valencia (Spain) in 1999, and Cork (Ireland) in 2000.

At intervals, workshops are held on particular topics, and the results published as special newsletter issues: no. 6 - a workshop on the harbour porpoise, held in Cambridge (England), 1988; no. 10 - a sightings workshop held in Palma de Mallorca (Spain), 1990; no. 17 - a workshop to standardise techniques used in pathology of cetaceans held in Leiden (Netherlands), 1991; no. 23 - a workshop to review methods for the field study of bottlenose dolphins held in Montpellier (France), 1994; no. 26 - a workshop for the diagnosis of by-catches in cetaceans held in Lugano (Switzerland), 1995; no. 37 – a workshop on Lung Pathology held in Lisbon (Portugal), 1996; and no. 40 – a workshop on collisions between cetaceans and vessels, held in Rome (Italy), 2001.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **DM 75** (=39 Euros) for full members; **DM 150** (= 77 Euro) for institutional members and **DM 45** (= 23 Euro) for student members. For members outside of Europe, an additional **DM 30** (= 15 Euro) will be charged for higher postage costs. Payment may be made at the Annual Conference in Euro or the currency of the host country. During the year, membership fees can be paid by **credit card** or **transferred directly** to the following ECS-account: Dr Roland Lick, ECS, Postbank Hamburg, Germany, *national bank transfer*: Account No. 789584-205, Bank Code 200 100 20, *international bank transfer*: Account-No.: IBAN DE21 2001 0020 0789 5842 05, BIC (SWIFT-Code): PBNKDEFF (giving your name and calendar year for membership fee.) Payment in excess of the membership fee will be gratefully received as a donation to the Society.

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To: jiscmail@jiscmail.ac.uk
Subj:
Text: join ecs-talk firstname(s) lastname stop

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INSTRUCTIONS FOR CONTRIBUTORS TO ECS PROCEEDINGS

Members of the European Cetacean Society are invited to submit summaries of their talk or poster for publication in the Society's Conference Proceedings. They can be half-page abstracts as submitted before the conference, or fuller papers up to five pages in length. These are reviewed by two independent persons. Please use the format given below.

(1) Keep the text, references, and figures/tables to a total of no more than five pages (single-spaced). For those to whom English is not their native language, please ask an English speaker to check the entire text. Unless stated otherwise below, please use Times New Roman font, size 10 throughout.

(2) Prepare all tables and figures in their final form (in black and white NOT colour), and provide the originals for camera-ready printing. Number every table and figure for cross-reference to the text. Place tables, then figures, in chronological order, separate from the text. DO NOT INCLUDE THEM WITHIN THE MAIN BODY OF THE TEXT. Re-size so they occupy as little space as possible whilst still being legible. Place Figure captions underneath each figure, and Table captions above each Table, with Fig. 1, Table 1, etc. in bold type, lower case, and the caption itself in ordinary type, lower case and centred.

(3) Centre the title of your contribution, in capitals and bold type (latin names in the title should be in capitals and italics); one line below place a list of authors in lower case ordinary type (with their initials/first names BEFORE the surname, and a space between initials); one line under this, use ascending numbers (Times New Roman font size 10, at 5-point position superscript) for the addresses of the respective authors.

(4) Place the main text two lines below the authors' addresses. Do not indent the first line but include one line space between paragraphs. Please use double-spacing for two of the three hard copies of the text.

(5) Use common (vernacular) names of species in preference to Latin names, but on the first occasion only, please use both. All Latin names should be in italics and in parentheses. References in the text should be written as follows: (Capelli *et al.*, 1979; Di Sciara, 1982). Note the commas between name and year.

(6) Sub-headings such as **INTRODUCTION**, **MATERIALS AND METHODS**, **RESULTS**, **CONCLUSIONS**, and **ACKNOWLEDGEMENTS** should be in the body of the text, at the left edge, but **REFERENCES** should be centred above. There is no need for an abstract of any five-page contribution.

(7) Check references carefully to ensure they are complete, including full title and page numbers. Place in ordinary type (except for book titles which go in italics), in Times New Roman font, size 9 pt, as follows:

Aguilar, A. and Jover, L. 1982. DDT and PCB residues in the fin whale, *Balaenoptera physalus*, of the North Atlantic. *Rep. int. Whal. Commn*, 32: 299-301.

Sequeira, M.L. 1990. On the occurrence of Ziphiidae in Portuguese waters. Pp. 91-93. In: *European Research on Cetaceans - 4*. Proc. 4th Ann. Conf. ECS, Mallorca, 2-4 March, 1990 (Eds. P.G.H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, England. 140pp.

Stewart, B.S. and Leatherwood, S. 1985. Minke whale *Balaenoptera acutorostrata* Lacépède, 1804. Pp. 91-136. In *Handbook of marine mammals*, vol. 3. (Eds. S.H. Ridgway and R.J. Harrison). Academic Press, London. 430pp.

(8) Please provide either half-page abstracts or longer five-page contributions both as hard copies and on CD, using Microsoft Word, and Times New Roman font, size 10 throughout (except references which are size 9 pt). **Do not send by e-mail.** Include three copies of the longer contributions (two of which will go to independent referees).

PLEASE ENSURE THAT YOU FOLLOW THE ABOVE INSTRUCTIONS AND SEND TO THE EDITOR BY 30TH JUNE. IF YOU DO NOT COMPLY WITH INSTRUCTIONS, OR ARE LATE, YOUR PAPER MAY NOT BE INCLUDED.

Dr Peter Evans, Sea Watch Foundation, 11 Jersey Road, Oxford 0X4 4RT, UK (Tel. 44-1865-717276; e-mail peter.evans@zoology.ox.ac.uk).

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