EUROPEAN RESEARCH ON CETACEANS - 13

PROCEEDINGS OF THE THIRTEENTH ANNUAL CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY,

VALENCIA, SPAIN

5-8 APRIL 1999

EDITORS: P.G.H. EVANS, J. CRUZ AND J.A. RAGA

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INTRODUCTION

The Thirteenth Annual Conference of the European Cetacean Society was held at the Palau de la Musica in Valencia, Spain between 5th and 8th April, 1999. It was attended by 325 persons from 29 countries. The Society is very grateful to Juan Antonio Raga and his Organising Committee - Celia Agustí, Pascual Asensi, Francisco Javier Aznar, Francisco Javier Badillo, Carmen Blanco, Mercedes Fernández, Patricia Gozálbez, M^{a} Victoria Herreras, Iván López, Francisco Esteban Montero, M^{a} Angeles Raduán, and Jesús Tomás, for making this such an enjoyable and successful conference.

A Conference Scientific Committee was chaired by Juan Antonio Balbuena and also comprised Anne Collet, Greg Donovan, Peter Evans, Jaume Forcada, Christina Lockyer, and Emer Rogan. The following persons have reviewed abstracts: Alex Aguilar, Robin Baird, Juan Antonio Balbuena, Giovanni Bearzi, Simon Berrow, Arne Bjørge, Anne Collet, Jim Boran, Jim Darling, Greg Donovan, Manuel dos Santos, Geneviève Desportes, Peter Evans, Jaume Forcada, Jonathan Gordon, Cristophe Guinet, Phil Hammond, Rus Hoelzel, Vincent Janik, Paul Jepson, Claude Joiris, Céline Liret, Christina Lockyer, Simon Northridge, Bayram Özturk, Graham Pierce, Juan Antonio Raga, Vincent Ridoux, Emer Rogan, Marina Sequeira, Ursula Siebert, Tiu Simila, and Mark Tasker. To all these we owe a debt of thanks for the time they gave up for this important task.

We also gratefully acknowledge the contribution to the conference made by the following organisations: Universität de València; Ministerio de Educación y Cultura; Ministerio de Medio Ambiente; Conselleria de Medio Ambiente and Conselleria de Cultura, Educación y Ciencia, Generalitat Valenciana; Ajuntament de València; Ciutat de les Arts i de les Ciències, Generalitat Valenciana; Caja de Ahorros del Mediterráneo; Civis Project Management; and Air Iberia.

The theme of the conference this year was "Marine mammal conservation for the new millenium". Key lectures on this theme were invited from Greg Donovan (UK), Aleta Hohn (USA), and Bernd Würsig (USA). To all three we offer our very grateful thanks.

Contributions have been arranged broadly by subject, and within subjects, they are arranged alphabetically. All abstracts were subject to a review process and represent all those submissions which 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 very carefully. It is worth noting that only about five percent of contributors closely follow the guidelines at present.

An enormous amount of effort has gone into the editing and production of these Proceedings. In this connection, I should like to thank my co-editors Joana Cruz and Toni Raga for their invaluable help at all stages of its production. Joana did an enormous amount in re-formatting contributions and helping with the editing; Toni, besides organising the conference in the first place, prepared the short abstracts and organised the printing of Proceedings in Valencia.

Support for the publication of this book was provided by the Foundation "Centro de Estudio y Conservación de la Biodiversidad" of the Spanish Ministry of the Environment.

Peter G.H. Evans

ACOUSTICS

RHYTHMIC PATTERN OF ECHOLOCATION CLICK TRAINS OF ODONTOCETES: THE *RIME* (RHYTHMIC IDENTITY MEASUREMENT) HYPOTHESIS

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A frequency representation by means of a Fourier time series analysis is used to unveil a rhythmic dimension in the click repetition pattern of odontocetes. By this analysis a hitherto unnoticed longitudinal modulation emerges from the apparent irregular succession of clicks in the click train. To further unravel the presence of deterministic aspects out of the click repetition pattern, the latter is conceived as a probabilistic point process. This is described by the so-called intensity function or expectation density, which predicts the occurrence of a click at a certain time. Next, a geometric analysis of the pulse repetition frequency (PRF) pattern is presented which enhances the linear dependence (correlation) between the nth inter-click interval and the next (n+1) th interval in the sequence. We have called RIME (Rhythmic Identity Measurement), the individual longitudinal modulations found in the series of click trains.

The RIME hypothesis demonstrates that the identity of a particular animal is permanently available to the rest of the group through its vocalisations. It further shows that the information received during the echolocation process come from the echo reflection of the whole series of clicks within a click train and not from the addition of single echoes processed one by one. This latter point allows the animal to distinguish rhythmically its own echoes against the background of other click trains. Examples are given for the PRF patterns of *Physeter macrocephalus*, *Inia geoffrensis*, *Orcaella brevirostris*, and *Tursiops truncatus*.

THE ROLE OF ECHOLOCATION IN SOCIAL BEHAVIOUR OF DOLPHINS

M. Azzali[1], S. Catacchio[1], C. Farchi[1], P. Garbati[1], A. Impetuoso[1], M. Jones[2], M. Luna[1], F. Mantovani[1] and R. Tizzi[3]

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INTRODUCTION Current opinion is that sonar signals are used by dolphins to perceive the environment. However, it has been suggested that sonar pulses emitted by dolphins have characteristics that identify both the individual dolphin and its group (Azzali *et al.*, 1998). If this is so, the features of the sonar signals emitted by a dolphin can potentially be affected by the vicissitudes of its life and of its group.

In this paper, the sonar signals emitted freely by the dolphins of four communities (Rimini, Gardaland, Cattolica I, Cattolica II) have been analysed for a significant period of time and within meaningful social circumstances. The aim was to demonstrate that the acoustic behaviour of these animals is significantly influenced by the social context in which they live. If this assumption is correct, the characteristics of each dolphin's sonar pulses might evolve and considerably change as a consequence of the social changes occurring during its life.

MATERIALS AND METHODS Measurements of the echolocation signals were carried out in one-hour sessions, conducted on a two-week basis in three Dolphinaria: Cattolica I (October 1992 - February 1993), Rimini (June 1997 - December 1998), Gardaland (June 1997 - February 1999), and Cattolica II (April - May 1998).

Biographic data of the studied dolphins (*Tursiops truncatus*) are reported in Table I. Sounds were recorded from dolphins of the four communities using a Bruel & Kjaer 8105 Hydrophone, positioned at least 1 m below the water surface, a Bruel & Kjaer charge amplifier 2635, and an analogic wide band recorder (10Hz-300 kHz). Sonar signals were monitored with a digital oscilloscope HP 54520A. All the dolphins were accustomed to the presence of the hydrophone and the experimenters. Behavioural observations were registered by an operator onto both the audio channel of the wide band recorder and the audio channel of a video-recorder, on which the images of dolphins were recorded with a sub water camera, tracking the dolphins. Immediately after each session, sonar pulses were digitised at an effective sampling rate of 5.12 sample per 1 ms, much higher than Nyquist sampling rate. Using the comments and the images, each pulse was attributed to a dolphin. Pulses of uncertain origin were discarded. None of the free-swimming animals were stimulated to use their own sonar, except in the sessions conducted on the community in Cattolica II (Table 1). There, each session was divided into two blocks of 30 min: in the first block the dolphins were not stimulated whereas in the second block, targets with different shapes were presented to them (Mantovani, 1998). The number of sonar pulses collected during each session ranged from a few hundred for some subjects to a few dozen for other subjects. A predetermined number of sonar pulses emitted by each dolphin were chosen at random from the sessions held in a selected period to have equal, unbiased acoustic sampling of all individuals. Afterwards, these sonar pulses were processed in the laboratory. The feature extractor and the classifier of each set of clicks of each dolphin were developed using MATLAB m-file language. The six adimensional parameters used in this study were extracted from the statistical moments (two parameters), the time moments (two parameters), and the frequency moments (two parameters), as described in Azzali *et al.* (1998). Therefore, we can imagine a dolphin as a point in a space with six dimensions.

The clustering process was based on the hierarchical method (Gower and Ross, 1968), particularly useful when the number of points, n, is small. Initially, every point (i.e. dolphin) in the data set of n points (n = number of dolphins) is considered as a separate cluster. The matrix of the euclidean distances is calculated (no. of distances = n(n-1)/2). In the next stage, the two most similar (nearest) points are combined to form one cluster. A new matrix of distances is calculated. This merging process is continued in the consecutive stages of the cluster analysis thus reducing by one the number of clusters at each step. The clustering procedure, that can be represented with a dendrogram, ends when all the points are assigned to one cluster.

RESULTS Rimini community: The study began with the birth of a calf (Blue, June 1997), that probably determined the considerable changes of the acoustic and social behaviour of the community, described below. The matrices of inter-dolphin similarity distances and the relative dendrograms were calculated once a month (Farchi, 1999) in order to follow the development of the calf's sonar signals and the acoustic situation of the other members of the group at the same time. In this paper we report the matrices and the dendrograms that refer to significant periods (July 1997 and February 1998) in which important events took place.

The first dendrogram (Fig. 1 A) shows the acoustic similarity within the members of the group while the newborn calf is hardly able to utter, though it was very interested in the sonar pulses emitted by its mother. In this period (July 1997) the adults acoustically closest to the three calves were Beta, Blue's mother, and the other female Alfa. Speedy (the dominant member), remained distant from the group of young dolphins and two females (88.5). The situation completely changed in February 1998. In this period, Blue emitted the greatest number of sonar pulses and became a complete member of the acoustic community. The dendrogram (Fig. 1 B) shows that Alfa and Beta, the two adult females, are rather distant from the youngest calves (Blue and Luna), whereas Speedy is acoustically close to both. In this particular period, the members of the community were separated into different clusters. Finally, we report the matrix and relative dendrogram (Fig. 1 C) where the mean distances, calculated for the 19 month period of study, are represented. The dendrogram shows clearly that the community of six dolphins forms, on average, an acoustic group in which the three calves and the three adults are separated by a considerable distance. In particular Blue and Luna, the youngest calves, both females and born in captivity, are also acoustically the closest to each other in the community.

Gardaland community: Our study began in June 1997, when an adult female (Betty) became a new member of the group and an adult male (Romeo), the dominant member, died. These events probably affected the acoustic and social behaviour of the small developing community until October 1998 (Impetuoso, 1998). Until then, the three dolphins alternated between periods of no vocalisation at all, episodes of little click production. In particular, Violetta had difficult social and acoustic relationships with the other two dolphins. She spent most of the time swimming alone and showed substantial acoustic distance from both Robin (835) and Betty (491). During this period, a brief program was also inserted in order to stimulate the use of the sonar by all the dolphins in the community. This particular acoustic situation in which the inter-dolphin distances were very high and the animals were unable to form an acoustic group is shown in Figure 2 A. Unexpectedly, in November 1998, the three dolphins greatly increased the quantity of sonar signals emitted and the inter-dolphin similarity distances decreased by about five times. (Fig. 2 B). The dolphins began to form a real acoustic community. This positive situation lasted until December 1998.

In January 1999, the arrival of a new adult female (Amada), contrary to all expectations, did not give rise to a relative disorder within the community. The distances in the matrix of inter-dolphin similarities (Fig. 2 C) reduced further by about two times. Only Violetta seemed to withdraw from the acoustic group as she did with Betty's arrival, without reaching, however, the great distance from the group observed during the first period of study.

Essentially, the inter-dolphin distances decreased about twenty times from the first to the third period of the study, meaning that the animals had slowly organised themselves as an acoustically well-established group.

Cattolica I community: The community in Cattolica was studied between two events: the birth (September 1992) and the death (February 1993) of Daphne, the calf of Bonnie and Clyde (Table I). During this period, Cattolica's community was characterised by the difficult relationship between the couple Bonnie and Clyde, and Misha. This hard conflict lasted until Misha was completely separated from them by a net. However, this did not prevent Misha from quarrelling acoustically with the couple through the net. As we can see from the dendrogram, and the matrix reported in Figure 3, Misha was also acoustically very distant (366.1) from the other members of the community and, in particular, from Bonnie and Clyde, which on the contrary were very close to each other (15.1) and formed a separate cluster. This particular acoustic and social situation probably also affected the relationship between Bonnie and Daphne (her calf). In fact Daphne shows a considerable distance from both Bonnie and Clyde (258.3), whereas Blue, the calf in Rimini's community, was acoustically much closer to its parents than Daphne. The features of Daphne's clicks are not distant from the ones emitted by Blue (74.6) and by Luna (77.6), the calves housed in the Rimini pool (Azzali *et al.*, 1998). This similarity suggests that calves have their own typical sonar inflexion, probably due to the physiological development of the organs involved in sound emission.

Cattolica II community: The second period of study in Cattolica's Aquarium took place in April-May 1998. In this period, the pool was used as a real nursery (Table 1), housing two adult females (Candy and Isa) and their calves (Ulisse and Silver). The research aimed at comparing the sonar pulses emitted by the animals in two different situations: with the presence or absence of targets (Mantovani, 1998). When not stimulated by targets (Fig. 4 A), the animals formed a tight acoustic group where the two furthest neighbours were the two calves, Silver and Ulisse (29.6), while the two nearest neighbours were unexpectedly Candy (mother of Ulisse) and Silver (3.3). Isa (the dominant member) seems to act as a kind of acoustic bridge between Ulisse and the other two dolphins.

When the animals were stimulated by targets (Fig. 4 B), the acoustic distances calculated among the members of the group are on average lower than in the situation described above (Fig. 4 A). However, the community split into two clusters: the two adult females (Candy and Isa), and the two calves (Ulisse and Silver). Probably the two clusters relate to the different ability of adults and calves to analyse the targets using their own sonar.

CONCLUSIONS The results indicate that:

1. The inter-dolphin distances calculated in the 19-month period of study in Rimini's pool show that the community forms a well organised acoustic group (Fig. 1 C). However, the dendrograms that refer to particular periods, such as Blue's sonar developing (Fig. 1 A) and its entering into the acoustic group (Fig. 1 B), indicate that particular social events can produce significant changes in the average acoustic behaviour of the community.
2. The high acoustic distances (Fig. 2 A) and the scarce click production observed during the first period of study in Gardaland's community may be due to some particular events and to the lack of a dominant member. In this period, the dolphins formed neither an acoustic nor a social group. However, the dolphins were probably organising themselves, since unexpectedly after 16 months they started using the sonar and to behave as an acoustic group (Fig. 2 B). This process of group forming was not altered by the arrival of a new dolphin (Fig. 3 C).
3. The first community of dolphins in Cattolica was characterised by episodes of intense conflicts between the couple Bonnie and Clyde and Misha. The high acoustic distance between Misha and the two dolphins, as well as the pretty large distance between

Daphne and her parents (Fig. 3), reflect the difficult social context in which the animals lived.
4. The second community in Cattolica, made up of two adult females and their own calves, formed a very close acoustic group where the highest distance observed is definitely lower than in the other pools. When stimulated by targets, however, the sonar signals produced by the two calves were rather different from their mothers'.

It seems that the features of the dolphin's sonar pulses reflect the social context in which they live and that their acoustic behaviour can be used to highlight their social behaviour.

ACKNOWLEDGEMENTS This research was performed with financial assistance from Gardaland. The authors acknowledge the support and interest provided by the assistance of Gardaland, Cattolica and Rimini delphinaria. We are especially grateful to Dr. Allyson Seacat of Cattolica delphinarium for her helpful suggestions.

REFERENCES

Azzali, M., Garbati, P. and Impetuoso, A. 1998. Similarity among sonar signals collected from small communities of dolphins (*Tursiops truncatus*). Pp. 247-255. In *Proceedings of the Fourth European Conference on Underwater Acoustics* (Eds. A. Alippi and G.B. Cannelli). Vol. I CNR-IDAC, Rome, Italy. 533pp.

Farchi, C. 1999. *Sviluppo dei segnali sonar in Tursiops truncatus (Montagu, 1821) nei primi 18 mesi di vita in cattività. Interazioni acustiche con gli altri membri del gruppo.* Tesi di Laurea 1997/98. Università degli studi di Ancona. 138pp.

Gower, J. C. and Ross, G. J. S. 1968. Minimum spanning tree and single-linkage cluster analysis. *Appl. Statist.,* 18, 54-64.

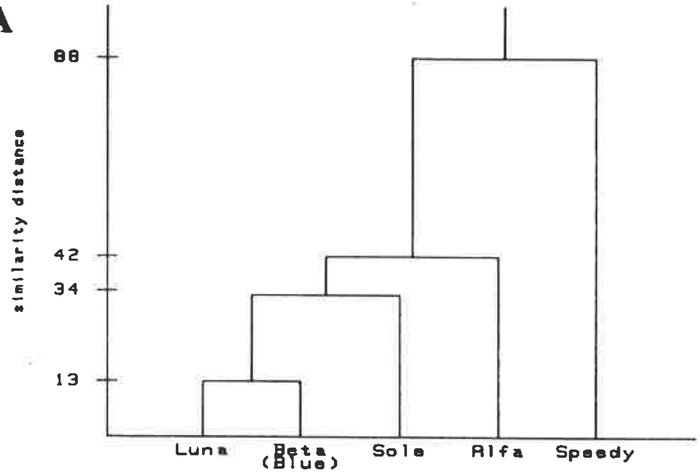
Impetuoso, A., 1998. *Identificazione delle caratteristiche individuali e di gruppo nei segnali sonar registrati in piccole comunità di delfini Tursiops truncatus (Montagu, 1821) in cattività.* Tesi di Laurea 1997/98. Università degli studi di Torino. 298pp.

Mantovani, F. 1998. *Reazioni acustiche di Tursiopi (Tursiops truncatus) alla presentazione di oggetti sconosciuti.* Tesi di Laurea 1997/98. Università degli studi di Bologna. 210pp.

Table 1 - Dolphin's biographic data (referred to the period of study)

POOL	DOLPHINS	SEX	PROVENIENCE	AGE	RESIDENCE IN CAPTIVITY	DEMOGRAPHIC EVENTS
RIMINI	Speedy	M	Adriatic Sea	28 y. (adult)	17 years	father of Sole, Luna, Blue
	Alfa	F	Caribbean Sea	19 y.(adult)	11 years	mother of Sole and Luna
	Beta	F	Caribbean Sea	17 y. (adult)	11 years	mother of Blue
	Sole	M	born in captivity	4-5 y. (juvenile)		
	Luna	F	born in captivity	2-3 y. (juvenile)		
	Blue	F	born in captivity	1-18 months (calf)		
GARDALAND	Violetta	F	Caribbean Sea	15 y. (adult)	8 years	
	Robin	M	Caribbean Sea	18 y. (adult)	9 years	
	Betty	F	Florida Sea	17 y. (adult)	9 years	
	Amada	F	Florida Sea	26 y. (adult)	15 years	
CATTOLICA I	Bonnie	F	Caribbean Sea	18 y. (adult)	15 years	mother of Daphne
	Clyde	M	Adriatic Sea	20 y. (adult)	15 years	father of Daphne
	Misha	M	Caribbean Sea	5 y. (juvenile)	3 years	
	Daphne	F	born in captivity	1-5 months (calf)		
CATTOLICA II	Candy	F	Rockport Sea	20y. (adult)	17 years	mother of Ulisse
	Isa	F	Cuba Sea	12 y. (adult)	9 years	mother of Silver
	Ulisse	M	born in captivity	7 months (calf)		
	Silver	M	born in captivity	10 months (calf)		

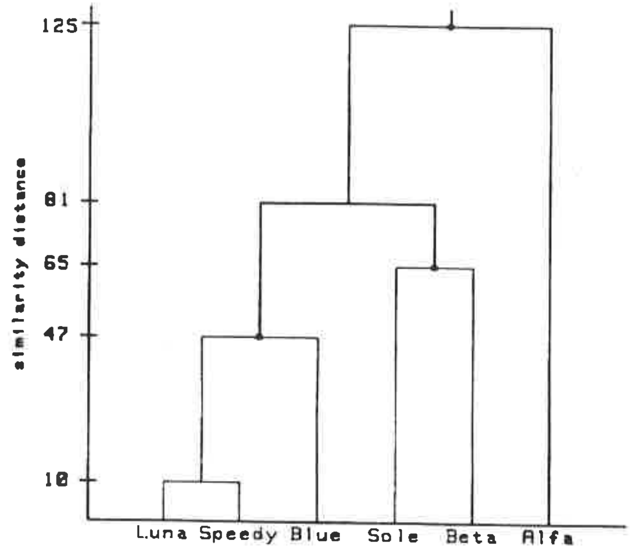
A



JULY '97

	Sole	Beta	Speedy	Luna	Alfa
Sole	0	33.5	108.8	67.1	150.9
Beta		0	108.2	13.4	64.7
Speedy			0	88.5	149.5
Luna				0	41.9
Alfa					0

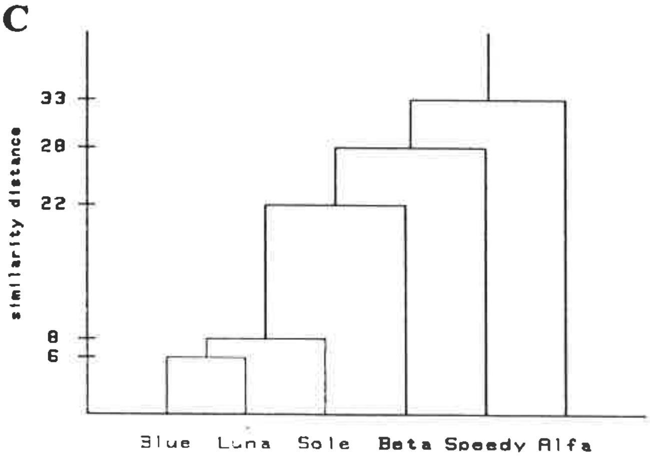
B



FEBRUARY '98

	Sole	Beta	Blue	Speedy	Luna	Alfa
Sole	0	65.4	167.1	83.3	94.7	125.7
Beta		0	220.5	83.2	81.3	196.9
Blue			0	47.4	68.3	403.1
Speedy				0	10.4	299.5
Luna					0	249.5
Alfa						0

C

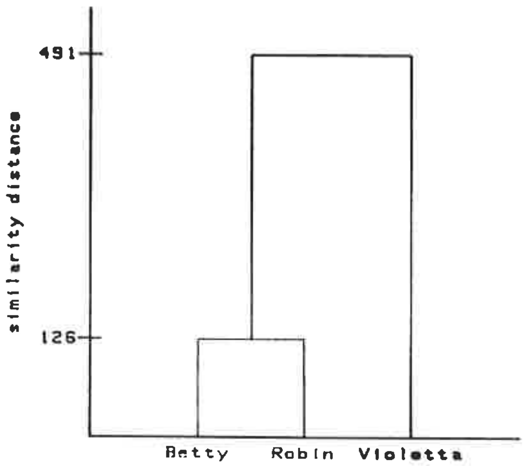


AVERAGE FROM JUNE '97-DECEMBER '98

	Sole	Beta	Blue	Speedy	Luna	Alfa
Sole	0	23.2	20.8	47.4	8.2	41.6
Beta		0	64	73.2	37.9	33.7
Blue			0	28.6	6	118.7
Speedy				0	42.1	151.9
Luna					0	80.1
Alfa						0

Fig.1 - Matrices of inter-dolphin similarity distances and dendograms for dolphins resident in Rimini pool

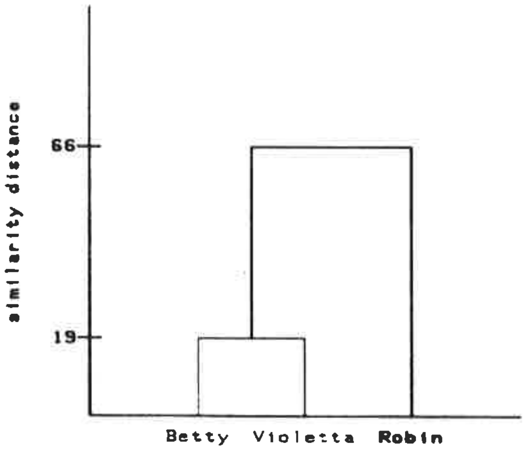
A



JUNE '97-OCTOBER '98

	Betty	Robin	Violetta
Betty	0	126	491
Robin		0	835
Violetta			0

B



NOVEMBER '98-DECEMBER '98

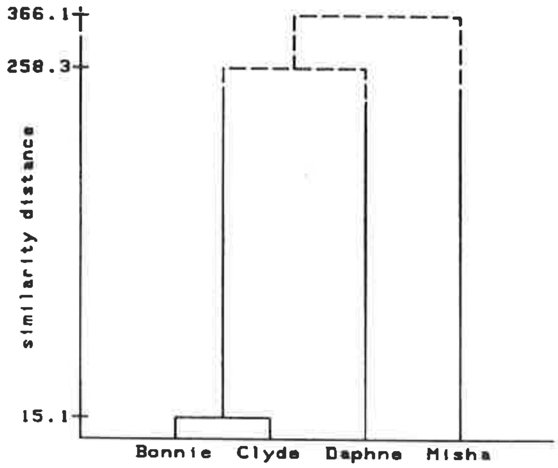
	Betty	Robin	Violetta
Betty	0	150	19
Robin		0	66
Violetta			0

C

JANUARY '99-FEBRUARY '99

	Betty	Robin	Violetta	Amada
Betty	0	9.7	24.9	6.18
Robin		0	63.79	24.05
Violetta			0	24.06
Amada				0

Fig.2 - Matrices of inter-dolphin similarity distances and dendograms for dolphins resident in Gardaland pool

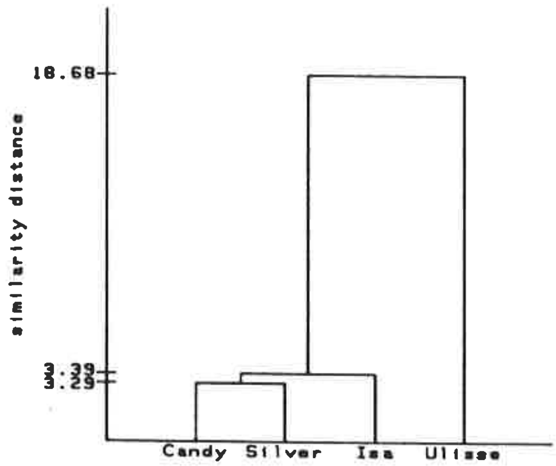


OCTOBER '92-FEBRUARY '93

	Bonnie	Clyde	Daphne	Misha
Bonnie	0	15.1	258.3	466.8
Clyde		0	357.6	366.1
Daphne			0	716.2
Misha				0

Fig.3 - Matrix of inter-dolphin similarity distances and dendrogram for dolphins resident in Cattolica pool

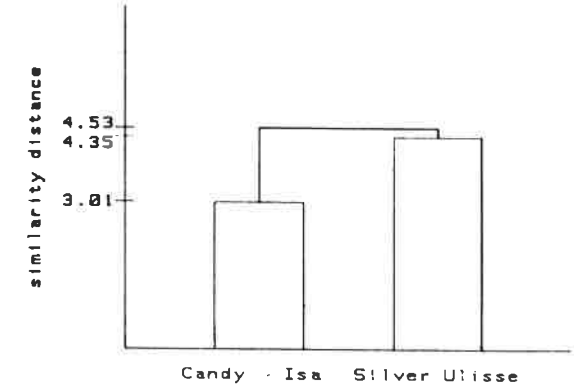
A



APRIL '98-MAY '98
Without targets

	Candy	Isa	Silver	Ulisse
Candy	0	3.5	3.3	23.8
Isa		0	3.4	18.7
Silver			0	29.6
Ulisse				0

B



APRIL '98-MAY '98
With targets

	Candy	Isa	Silver	Ulisse
Candy	0	3,01	21,97	10.24
Isa		0	11.18	4.53
Silver			0	4.35
Ulisse				0

Fig.4 - Matrices of inter-dolphin similarity distances and dendrograms for dolphins resident in Cattolica pool

A BIOACOUSTICAL OCEANOGRAPHY LABORATORY FOR ASSESSING NOISE AND INTERACTIONS WITH CETACEAN ECOLOGY IN MARINE PROTECTED AREAS

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Activities at ICRAM, the Italian Central Institute for Applied Marine Research, are devoted, among other things, to assessing marine protected areas (MPAs). Particular attention is given to the underwater acoustic environment.

A laboratory of bioacoustical oceanography was created in 1998. Available skills include: (a) passive acoustics: single and multiple-sensor recording, and classification, analysis and computer-based storage/retrieval of underwater biological & anthropogenic sounds; (b) active acoustics: conduction of small-scale echosurveys with scientific echosounders and multiple-frequency transducers, data analysis and evaluation; (c) data telemetry/radio-tagging: radio-tagging of large cetaceans with non-invasive attachments, radio-tracking and remote data retrieval; (d) GIS-rendering and evaluation of collected data.

A project for assessing presence, distribution and underwater activities of fin and sperm whales within the Ligurian Sea International Cetacean Sanctuary was started in summer 1998. Techniques for studying small scale prey-predator relationships betweeen fin whales and the Mediterranean krill *Meganyctiphanes norvegica* were tested successfully.

ANALYSIS OF THE SOUND EMISSIONS OF CAPTIVE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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Bottlenose dolphins (*Tursiops truncatus*) produce a great variety of sounds, including whistles, echolocation clicks, and other pulsed sounds. The behaviour and the sound emissions of eight bottlenose dolphins were studied in a dolphinarium (Zoomarine, Albufeira, Portugal).

Acoustic recordings were made with a B&K 8103 hydrophone and a Sony TCD-D10 Pro DAT recorder. Systematic behavioural observations were conducted (including show behaviours) simultaneously with acoustic recordings.

Whistles were the most abundant signal type (n=4,238) and several frequency modulation profiles were found to be repeatedly produced. Echolocation click trains and other pulsed signals were also produced. Whistle production throughout the day showed statistical concordance among four days of systematic sampling. Highest levels of whistle production occurred in interactions among the dolphins, and in interactions between the dolphins and their trainers. The clicks and other pulsed sounds, more frequent in resting and swimming, showed a similar occurrence cycle throughout the day. Performances of conditioned behaviours (during shows) were associated with decreased levels of whistles and increased levels of click trains and other pulsed sounds.

OBJECTIVITY IN THE STUDY OF MARINE MAMMAL VOCALISATIONS: A WAVELET APPROACH

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INTRODUCTION Sounds produced by marine mammals generally have a non-stationary behaviour, ranging from short transients to long tonals, with a huge variety of chirp-like intermediates. Analysis of these sounds needs adapted tools in order to characterise the signals efficiently in both time and frequency dimensions. In numerous studies and for well-known reasons, the spectrogram has been used as the interface between sound and feature extraction.

The spectrogram popularity in our type of study stems from at least three reasons: firstly, a spectrogram is a two-dimensional picture displaying sounds along two physical dimensions (time and frequency) which are familiar to our auditory system. Little training is needed to recreate an approximate sound image out of a spectrogram and vice-versa. Secondly, real-time implementation can now be performed on off-the-shelf platforms thanks to software availability and the Fast-Fourier-Transform (FFT), which greatly reduces the computational load. Thirdly, since a spectrogram is the squared modulus of a Short-Time-Fourier-Transform (STFT), the underlying parameters, such as the window size, the amount of overlapping, and window shape, are the only parameters affecting the result. The user interface is therefore very simple and little mathematical background is necessary to handle it. For example, Figs. 1 and 2 show significant differences when parameters are changed. If more frequency resolution is needed, the window must be longer. As time resolution is lower when long windows are used, a higher overlap is needed in order to attenuate the blocking effect in time-domain. Choosing the window type is more subtle: a higher contrast is obtained with a simple rectangular window but spectral high energy peaks tend to spread over the whole bandwidth (side lobes). The use of smoother windows gives lower contrast but attenuates these side-lobe artefacts.

Nevertheless, in many applications, such as in behavioural and communication studies, the spectrogram does not provide enough freedom to the user. When the interest is to obtain a "brain picture" of the sound that a marine mammal actually hears, it is indispensable to be able to implement and account for a maximum number of parameters, which describe its auditory perception. Hearing sensitivity and frequency discrimination capabilities are two additional parameters we decided to consider in order to create a new representation. Though hearing sensitivity is straightforwardly computed, frequency discrimination is not. When a system has more resolution in frequency, it has less in time, and vice-versa; this principle is known as the Heisenberg uncertainty principle. Here we introduce a method based on a wavelet approach, which respects this principle and still provides a spectrogram-like representation of the signal. Moreover, unlike STFT, the transform is orthogonal, so that extraction of coefficients (e.g. whistle time-frequency pattern) allows perfect reconstruction of the corresponding information in the temporal domain.

METHOD To develop the idea introduced above, sounds from a bottlenose dolphin *Tursiops truncatus* were used, since some information is available for both hearing sensitivity and frequency discrimination (Au, 1993). Fig. 3 and 4 show that this information is frequency dependent, implying that the processing method must be performed in the frequency domain. Meyer wavelet sub-band filtering is an efficient tool for frequency domain processing because frequency windows of arbitrary size can be chosen (Mallat, 1998).

The processing is performed in the frequency domain: hence, given a signal s(t) (length: power of 2), and a Meyer wavelet transform operator W adapted to the data in Fig. 4, the procedure is quite simple:

1) The spectrum S(f) is calculated by Fast-Fourier-Transform (FFT)
2) W(S(f)) is computed to separate frequency windows. The result is a matrix of N vectors, each representing the spectral content of a given frequency bin. The use of Meyer wavelets ensures that no redundancy occurs, a consequence of orthogonality.
3) spectral information from these frequency bins is inverse-FFT to reconstruct the temporal information.
4) a 2D representation is built out of each (temporal information-frequency range) pair.

RESULTS Unfortunately, the signals used for the experiment were sampled at 48 kHz, limiting the spectral representation at 24 kHz, a bandwidth where no really interesting phenomenon occurs in the dolphin auditory system. However, a substantial change in the representation can be observed in Fig 5., where two types of vocalisations are expanded. The signal includes whistles and echolocation clicks. The most striking change is a tremendous loss in the low frequency part, where hardly any information remains compared with the upper part. Another interesting phenomenon is the fact that clicks seem to take a "drop" shape, with very low time resolution in the low frequencies. Globally, the representation is far less resolved in time than the upper spectrogram. Although the new representation is far less attractive in terms of perceptual pattern extraction, it gives a more precise picture of what the animal experiences. Moreover, extraction of shapes to reconstruct the corresponding signals in the temporal domain is not only possible but also more adapted, which is of major interest in communication and behaviour studies.

CONCLUSION A new method to represent marine mammal vocalisations with an insight in their auditory system parameters has been introduced. It is believed that this adapted decomposition will be useful for scientists who want to study intra-specific behaviour and communication. Certainly also an efficient tool for an intuitive insight in sonar capabilities, this wavelet approach will hopefully open new perspectives in the study of marine mammal vocalisations.

REFERENCES

Au, W. W. 1993. Characteristics of the receiving system for simple signals. Pp. 32-58. In: *The Sonar of Dolphins*, Springer-Verlag, New York.

Delgutte, B. 1996. Physiological models for basic auditory percepts. Pp. 157-220, In: *Auditory Computation* (Eds. H. L. Hawkins, T. A. McMullen, A. N. Popper & R. R. Fay). Springer-Verlag, New York.

Mallat, S. 1998, *A Wavelet Tour of Signal Processing*. Academic Press, New York.

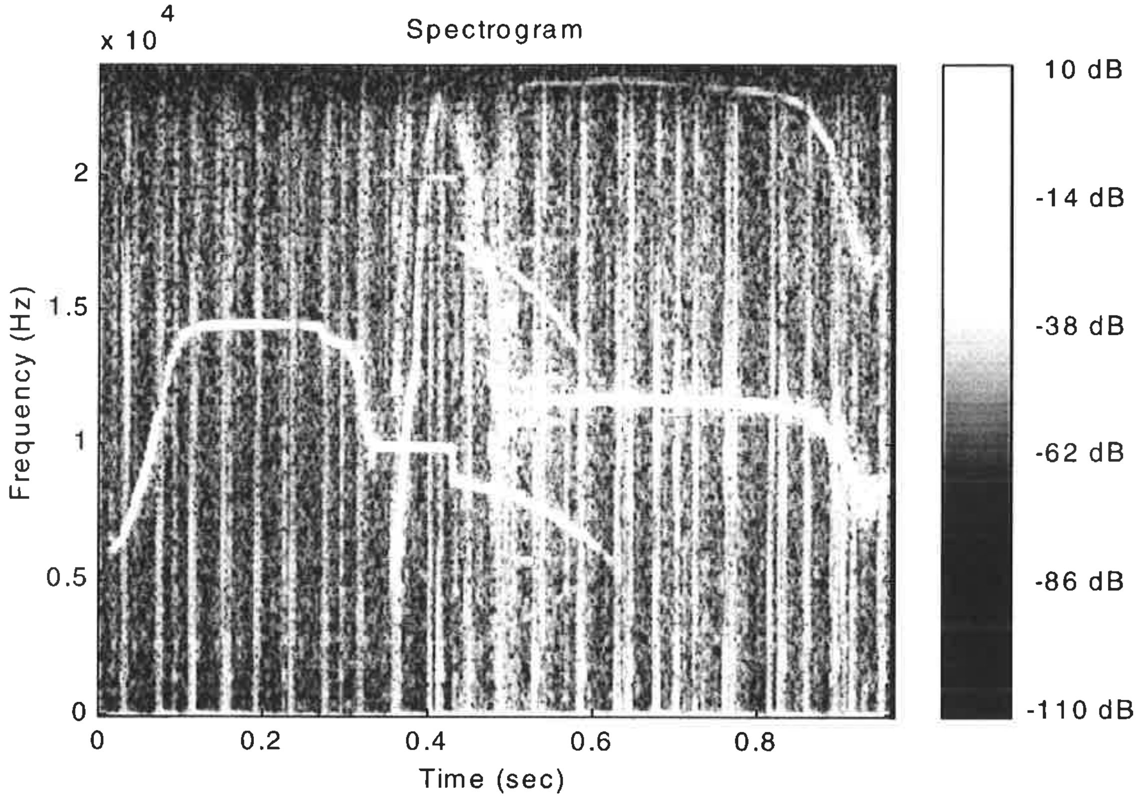


Fig.1 Spectrogram of *Tursiops truncatus* sounds (whistles and echolocation clicks), using a Kaiser window size of 512 samples, with 80% overlap.

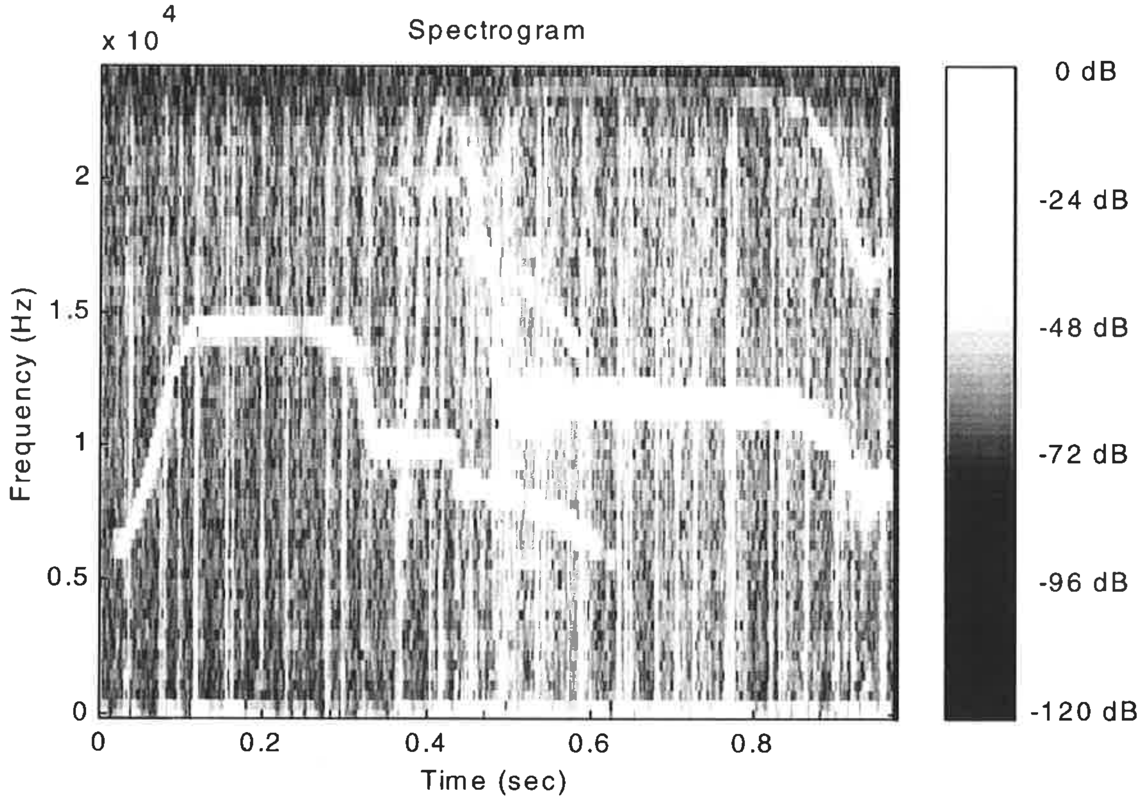


Fig.2 Same sound as above, using a Hamming window size of 128 samples, with 50 % overlap. The representation is less redundant, but the result is far less attractive.

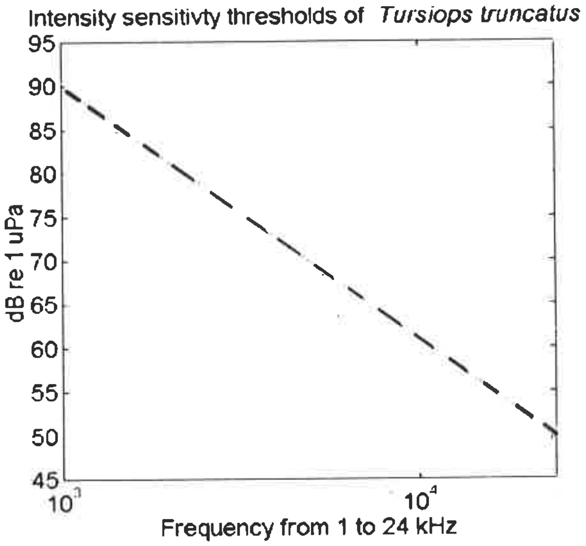


Fig. 3 Linear interpolation of hearing sensitivity for *Tursiops truncatus* between 1 and 24 kHz.

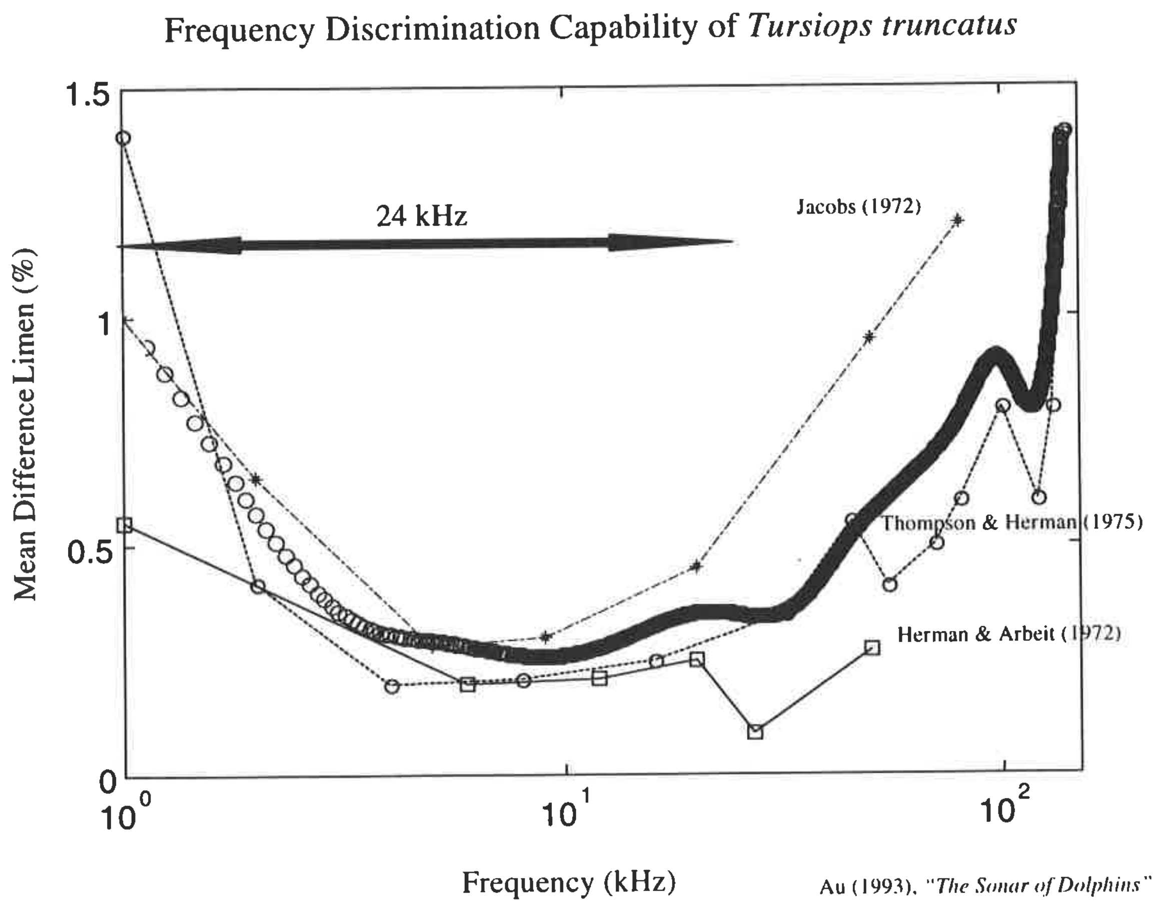
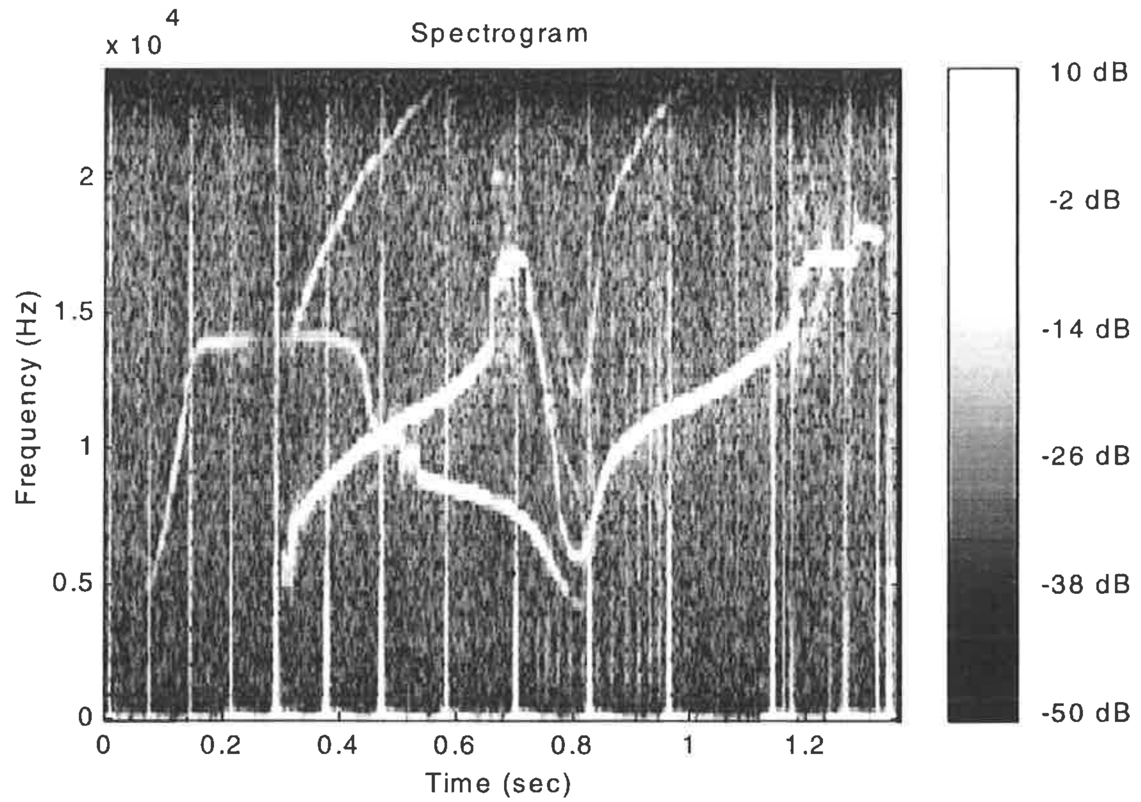


Fig. 4 Interpolation (circles) of frequency discrimination capability data for *Tursiops truncatus* . Difference limen is the ratio between frequency window size and central frequency. In the current study, only the 24 kHz bandwidth information was used.



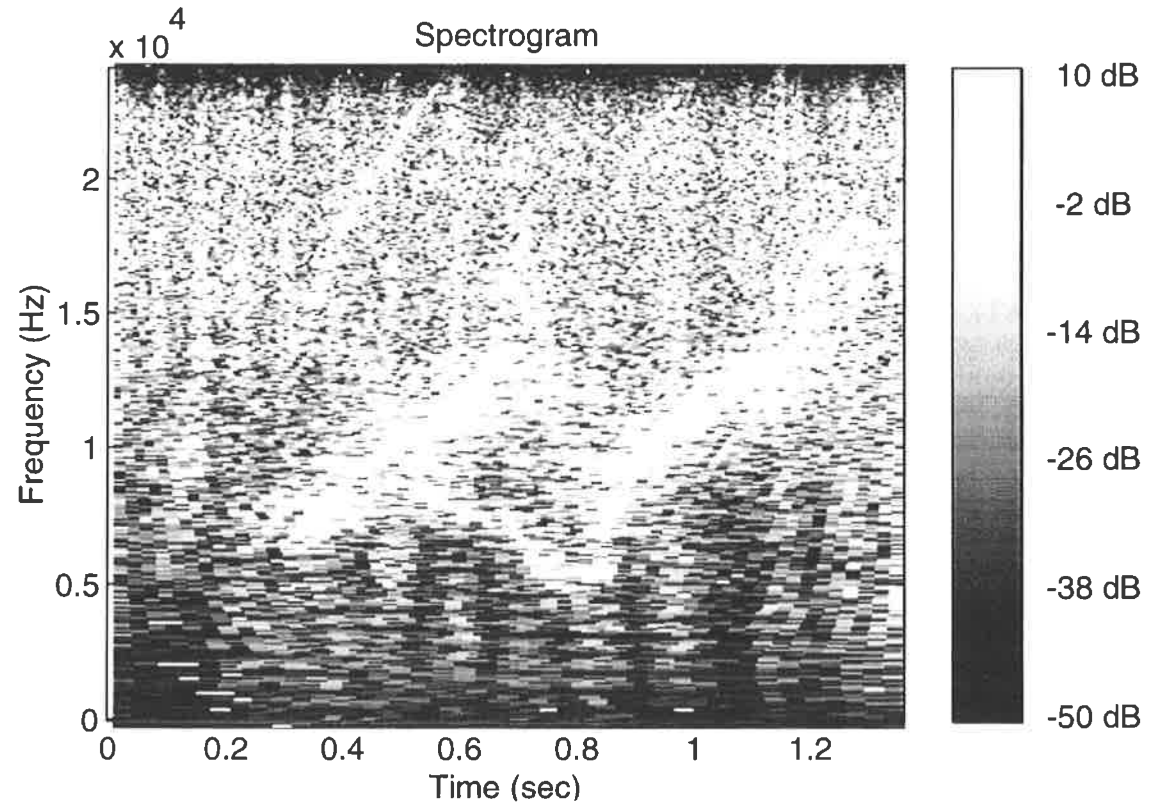


Fig 5. Top: Spectrogram of a set of whistles and echolocation clicks from *Tursiops truncatus*, using a 256 point hamming window and 50% overlap. Bottom, representation obtained considering the auditory system sensitivity and frequency discrimination

NEW SPERM WHALE VOCALISATIONS RECORDED IN THE MEDITERRANEAN SEA

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INTRODUCTION Sperm whales are vocal animals primarily known for their clicks vocalisations (Backus and Schevill, 1966; Watkins, 1980). Diverse categories of sound have been recognised to date according to the pattern and number of the clicks emitted: namely 'usual clicks', 'creaks', 'rapid clicks', 'chirrups' and 'codas' (Gordon, 1987) and they seems to be related to the activity of the whales. 'Codas' are distinctive and repetitive pattern of clicks (Watkins and Schevill, 1977), and 'chirrups' are brief rapid trills of clicks (Gordon, 1987). Both are generally heard from whales forming large and tight group at the surface and are believed to be 'social sounds' (Gordon, 1987). To date, only one coda pattern has been described in the Mediterranean Sea (Borsani and Pavan, 1994), although some variation within this pattern has been obtained (Pavan *et al*, 1996). During a dedicated sperm whale survey in the Tyrrhenian and Ionian Seas (Gannier and Drouot, 1999), numerous codas were recorded from nursery schools. The diverse coda patterns recognised are presented below.

MATERIAL AND METHODS The platform was a 12 metre motor-sailer with a 80HP diesel engine. A mono hydrophone was used, towed behind the boat by a 60 m cable. Its sensitivity was about 89.10^6 mV per Pa and its frequency response was linear from 200 Hz to 25 kHz. A multiple setting high-pass analog filter was added to reduce the ambient noise and thus improve the recording. The recording equipment consisted of a Sony WMD6 analog recorder (used in the Tyrrhenian Sea) and a TCD-7 DAT recorder (used in the Ionian Sea). Recordings were performed during the observation of two nursery schools: one in the Tyrrhenian Sea including 5 individuals (one calf, one juvenile and 3 females) and one in the Ionian Sea including 7 individuals (one calf, 2 juveniles and 4 females). The distance of the animals from the boat was less than 100 m, when recordings were undertaken. The best quality recordings were copied on to Digital Audio Tape (DAT), resulting in 17 min. recordings from the Tyrrhenian Sea group and 45 min. recordings from the Ionian Sea group. Recordings of the different vocalisations were sampled onto a computer hard disk using a Cambridge Electronic Design (CED) 1410 laboratory interface. The sampling frequency was 45.5 kHz and a high-pass filter of 2kHz was used. The analysis of the vocalisation was performed using CED Spike 2 software V.4.70. The codas were distinguished in the recording sequence from their specific and repetitive pattern of clicks. They were categorised according to the number and timing of the clicks they included. The click pattern of each coda type was described by measuring the Inter-Click Interval (ICI), defined by the time interval (in ms) between consecutive clicks. The chirrups were distinguished aurally by the characteristic burst of clicks. They were numerous in the recording of both groups. A representative sample of 38 'chirrups' was randomly selected and analysed. The analysis consisted of measuring the ICI, the total length, the click number, and the click rate of each 'chirrup' retained for analysis.

RESULTS Three coda types were identified in the recordings from the Ionian sea: 4-click codas, 5-click codas and 7-click codas. They all started with 3 regular clicks, at approximately equal intervals and were followed by 1, 2 or 4 clicks, for the 4-click, 5-click and 7-click coda respectively. The 4-click coda (Table 1) consisted of 3 rapid and evenly spaced clicks followed by a 4th click after a long interval of four times the first ICI, i.e: [/// /]. The 5-click coda (Table 2) included 3 rapid and evenly spaced clicks followed by a 4th and 5th clicks with doubling of the ICI, i.e: [/// / /]. The 7-click coda (Table 3) consisted of 3 rapid and evenly spaced clicks followed by 4 evenly spaced clicks (at about four times the first ICI), i.e: [/// / / / /].

Three other coda types were identified in the Tyrrhenian sea recordings (July 1998): A [/ / / /] 4-click coda type (Table 4) (3 rapid and evenly spaced clicks followed by a 4th click after an interval of twice the first ICI); a [/ // /] 4-click coda type (Table 5), with a central pair of rapid clicks; and a [/ / /] 3-click coda type (Table 6), with the final interval twice the first ICI.

DISCUSSION During our study, codas were heard only from nursery schools at the surface, which is consistent with the results of Weilgart and Whitehead (1992). Six distinct coda patterns were recognised, 3 in the Ionian Sea and 3 in the Tyrrhenian Sea. Sperm whales in the Mediterranean produce more than one coda pattern, as in other studied populations. Only the (3+1) pattern was recognised to date. A (3+1) type coda was found in the recordings from both the Ionian and the Tyrrhenian seas. This (3+1) pattern was similar to the codas already described in the Mediterranean Sea (Borsani and Pavan, 1994). However, considerable variations in both the total duration and the click timing within this (3+1) pattern are evident between the two regions. In the Tyrrhenian sea, the (3+1) coda is similar to the 'short codas' previously recorded there by Pavan *et al.* (1996) in the same region. In contrast, the (3+1) pattern from the Ionian Sea had considerably shorter duration and shorter ICI between the initial 3 clicks. Thus our recordings provide further evidence of variations in the (3+1) pattern within the Mediterranean basin. These variations could represent regional differences, since it has been suggested by several authors that codas could vary geographically (Gordon, 1987). Some new coda patterns were found in our recordings. The 3 coda patterns described in the Ionian Sea all started with 3 rapid clicks. This observation is consistent with the finding of Weilgart and Whitehead (1992), who observed that sperm whales off the Galapagos Islands produced different codas by the addition of clicks to a 'root' pattern.

CONCLUSIONS This study resulted in new findings concerning the acoustic activity of sperm whales in the Mediterranean. This included the identification and description of several new coda types, not only in a region never subjected to acoustic survey such as the Ionian Sea, but also in the Tyrrhenian Sea, previously investigated.

ACKNOWLEDGEMENTS We are particularly grateful to Dr J.Goold, University of Wales, for providing help and equipment for the laboratory analysis of the vocalisations. We thank Marineland (Antibes) and the Conseil Regional de Provence-Alpes-Côte d'Azur for having provided fund for this research.

REFERENCES

Backus, R. H. and Schevill, W. E. 1966. *Physeter* clicks. p. 510-528. In: *Whales, dolphins and porpoises*. (Ed. K. S. Norris) University of California Press, Berkeley, CA. 789pp.

Borsani, J. F. and Pavan, G. 1994. Acoustic aspects of Sperm whale behaviour and ecology in the Mediterranean Sea. *Boll. Zool. Suppl.*, 79: 26-35.

Goold, J. C. (in press). Behaviour and acoustic observations of sperm whales in Scapa Flow, Orkney Islands. *J. Mar. Biol. Ass. U. K.*

Gordon, J. C. D. 1987. *The behaviour and ecology of sperm whales off Sri Lanka.* PhD thesis. University of Cambridge, Cambridge, UK.

Pavan, G., Nascetti, D., Manghi, M., Priano, M., Fossati, C. and Borsani, J. F. 1996. Bioacoustic research on sperm whales in cooperation with the Italian Navy. Pp. 82-85. In: *European Research on Cetaceans - 10.* Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Watkins, W. A. 1980. Acoustics and the behaviour of sperm whales. Pp. 283-290. In: *Animal sonar systems*. (Eds. R. G. Busnel and J. F. Fish). Plenum, New York and London. 1,135pp.

Watkins, W. A. and Schevill, W. E. 1977. Sperm whale codas. *J. Acoust. Soc. Am.*, 62: 1485-1490.

Weilgart, L. and Whitehead, H. 1992. Coda communication by sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. *Can. J. Zool.*, 71: 744-752.

Table 1 - Interclick Interval (ICI) and total duration of the 4-click [/// /]codas (N=54) recorded in the Ionian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	28.7	0.4	24.4	37.4
t3-t2	32.6	0.7	25.1	51.4
t4-t3	181.3	8.9	58.3	300.5
Total duration	242.7	9.0	117.2	375.9

Table 2 - Interclick Interval (ICI) and total duration of the 5-click [/// / /] codas (N=12) recorded in the Ionian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	32.2	0.6	28.7	35.7
t3-t2	35.9	1.0	31.6	43.1
t4-t3	61.4	2.8	43.4	82.4
t5-t4	120.1	11.1	66.2	188
Total duration	249.7	9.6	181.6	330.7

Table 3 - Interclick Interval (ICI) and total duration of the [/// / / / /] 7-click codas (N=5) recorded in the Ionian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	28.7	2.6	22.1	37.9
t3-t2	55.2	4.5	42.2	66.2
t4-t3	152	25.5	91.2	243.1
t5-t4	176.1	7.27	151.4	193.0
t6-t5	165.9	28.3	62.9	216.6
t7-t6	190.3	20.9	152.3	245.9
Total duration	768.2	36.6	704.1	897.7

Table 4 - Interclick Interval (ICI) and total duration of the [/ / / /] 4-click codas (N=5) recorded in the Tyrrhenian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	153.8	5.5	137.1	171.7
t3-t2	109.7	3.1	100	117.6
t4-t3	285.6	6.6	268.5	308.4
Total duration	549.2	12.2	523.2	594.3

Table 5 - Interclick Interval (ICI) and total duration of the [/ // /] 4-click codas (N=4) recorded in the Tyrrhenian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	150.1	9.1	137.6	176.9
t3-t2	25.5	2.4	19.8	31.0
t4-t3	241.3	4.7	229.2	251.5
Total duration	416.9	7.73	397.1	433.9

Table 6 - Interclick Interval (ICI) and total duration of the [/ / /] 3-click codas (N=6) recorded in the Tyrrhenian Sea

ICI (in ms)	Mean	SE	Min	Max
t2-t1	144.1	3.4	136.1	154.3
t3-t2	253.8	3.5	240.8	264.8
Total duration	397.8	5.5	376.8	414.3

SOURCE LEVELS AND THE ACTIVE SPACE OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) WHISTLES

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Bottlenose dolphins (*Tursiops truncatus*) live in large fission-fusion societies. Despite the lack of prominent landmarks for orientation, each individual is very mobile, and ranges over wide areas each day. To maintain group cohesion under such conditions, dolphins use individually specific signature whistles. In this study, I measured sound pressure levels of whistles of wild bottlenose dolphins in the Moray Firth, Scotland, and calculated the active space, i.e. the distance at which another dolphin can perceive the whistle of a conspecific. Whistling dolphins were localised with a dispersed microphone array by comparing differences in the times of arrival of a whistle at different transducers. The maximum source level found was 169 dB re 1 mPa.

The active space of these whistles was calculated considering transmission loss, ambient noise, the critical ratios, and the auditory sensitivity of this species. In a homogeneous environment (depth: 10 m) whistles between 2 and 10 kHz could easily be heard over more than 5 km. These results suggest that group cohesion can be maintained over large distances but also that dolphins, considered to belong to separate groups, might be in acoustic contact as part of a communication network.

WHISTLE USAGE IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*): SIGNATURE WHISTLES AS CONTACT CALLS

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The signature whistle hypothesis assumes that bottlenose dolphins use signature whistles for individual recognition and to maintain group cohesion. This assumption is based on the fact that isolated individuals produce stereotyped whistles. To date, no study has tried to compare call usage in group and isolation contexts to investigate functional aspects of dolphin whistles.

In this study whistle type usage in a group of four captive bottlenose dolphins was compared in two contexts. Individuals were recorded while they were separate from the group and while they all swam in the same pool. Separations occurred spontaneously when one animal swam into another pool. No partitionings were used. Calling animals were identified by an amplitude comparison of the same sound in the two different pools. To avoid observer bias, whistles were classified into types independently by five different observers.

Each individual produced its own stereotyped signature whistle when it was separated from the group. The remaining dolphins also produced primarily their signature whistles if one animal was in a separation like that. However, if all animals swam in the same pool, whistling rates were the same as in separation but only non-signature whistles were used. Whistle copying was rare and did not initiate reunions or specific vocal responses. No aggressive interactions were observed prior to separations. These results strongly support the hypothesis that signature whistles are contact calls that are used in individual recognition and the maintenance of group cohesion.

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PASSIVE ACOUSTIC SURVEY OF CETACEAN DISTRIBUTIONS NORTHWEST OF THE HEBRIDES, WINTER 1997-1998

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The NE Atlantic is currently subject to seismic survey activity that may result in the development of offshore oil fields in the future. The area is important for at least 22 species of cetaceans and is subject to a programme of visual surveys by JNCC's Seabirds and Cetaceans Team. Visual surveys in this open ocean area, especially in the winter, can be severely constrained by daylight hours and sea-state combined with the poor sightablity of certain species. To complement the visual survey, and to make more efficient use of the survey vessel, a passive acoustic survey was carried out by HWDT for Conoco UK, in collaboration with JNCC, from the same platform.

The survey was conducted in an area to the NW of the Hebrides. Medium frequency acoustic data was recorded at regular intervals (usually every 3 minutes) using a towed stereo hydrophone. High frequency signals were logged continuously from a second hydrophone using automated *Porpoise* detection hardware and software. Data sets were analysed for cetacean vocalisation and noise levels.

The passive acoustic survey was conducted 24 hours a day, in all sea-states, and was able to detect and identify species which were otherwise difficult to observe (especially sperm whales because of their long dive times, and harbour porpoises because of their size and elusive nature). The acoustic survey did not interfere with the visual survey. Over 2,334 nautical miles of transect were surveyed acoustically, compared with 1,367 nautical miles visually.

Sperm whales, pilot whales, killer whales and delphinid species were heard at 25%, 1%, <1%, and 21% of acoustic stations respectively. Charts of their relative abundance are presented. For some species, at least, acoustic detection rates were substantially higher than for the visual survey. For example, sperm whales were detected at 1,398 stations representing 55 *encounters*, compared with three sightings, while there were 280 acoustic *encounters* of porpoises compared with five sightings.

The combination of acoustic and visual surveys maximises survey data for a relatively minor additional expense. Further processing of sperm whale recordings and porpoise detection files will give estimates of absolute abundance for these species in the area.

A REVIEW OF BEAKED WHALE ACOUSTICS, WITH INFERENCES ON POTENTIAL INTERACTIONS WITH MILITARY ACTIVITIES

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INTRODUCTION The family Ziphiidae, or beaked whales, are an enigmatic group of oceanic cetaceans. Despite accounting for around one-quarter of all cetacean species, little is known about most beaked whale species. In particular, little is known about interactions between beaked whales and human activities. In the 1990's, two reports have linked mass strandings of beaked whales with the presence of military activities in the local areas (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998). These reports documented the stranding of a total of 58 individuals in four separate events. The main species involved was Cuvier's beaked whale (*Ziphius cavirostris*); however, specimens of dense beaked whales (*Mesoplodon densirostris*), Gervais beaked whale (*Mesoplodon europaeus*), and a northern bottlenose whale (*Hyperoodon ampullatus*) were also involved. Mass strandings of beaked whales are relatively uncommon events, particularly those consisting of more than one species. It is therefore important to examine possible reasons for such events.

Frantzis (1998), who reported on the stranding of twelve *Z. cavirostris* in Greece in 1996, linked the strandings to tests of an active sonar system in the local vicinity. However, at present the evidence to support this hypothesis is somewhat limited. This current lack of evidence does not mean that such possible links should be ignored; instead, the possible impacts of military activities on beaked whales should be investigated further. Since noise pollution was implicated by Frantzis in the Greek stranding event, this paper will concentrate on the potential effects of noise pollution on beaked whales.

The potential impact of noise-producing military activities on beaked whales will depend on their biology. In particular, the acoustic abilities of beaked whales (sound production and hearing) are of major importance in relation to the understanding of interactions between them and anthropogenic noise production. For example, if a sound is not perceived by an animal, it is unlikely that the sound will have a directly negative impact. This paper reviews the current knowledge of beaked whale acoustics and relates this knowledge to the possible effects of military activities on the family Ziphiidae.

Review of the acoustical abilities of beaked whales

Sound production: At present, information on sound production is only available for four species of beaked whale (see Table 1). These are *H. ampullatus*, *Mesoplodon carlhubbsi* (Hubb's beaked whale), *M. densirostris*, *Berardius arnuxii* (Arnoux's beaked whale), and *Berardius bairdii* (Baird's beaked whale). The recordings from both *Mesoplodon* species come from individual stranded animals, and the recordings of *H. ampullatus*, *B. arnuxii*, and *B. bairdii* come from small number of locations and, presumably, from a limited number of individuals. In addition, there is a recording made in the wild of an unidentified *Mesoplodon* species (possibly *Mesoplodon hectori* - Hector's beaked whale). Sounds produced can be divided into two categories: pulsed and unpulsed. Pulsed sounds presumably function in echolocation, as found in other odontocetes, while unpulsed sounds probably function for social communication. These recordings suggest that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between two and 10 kHz, and possibly up to 16 kHz, for social communication.

Hearing ability: Hearing is one of the most important aspects of biology which will determine how beaked whales are affected by anthropogenic noise production, since only sounds which can be detected can have directly negative impacts on the species involved.

At present, no audiograms are available for any species of beaked whale. As a result, no direct information is available on their exact hearing abilities. Anatomical examination of the auditory structures of beaked whales indicate that their ears are predominantly ultrasonic adapted (Ketten, 1998). This fits well with what is known about the sound-producing abilities (particularly pulsed sounds) as sounds produced are presumably within the hearing range of the whales which produced them. However, Ketten (1998) noted that beaked whales have well developed semi-circular canals in comparison with other cetaceans. As a result, beaked whales may be more sensitive than other cetaceans to low frequency sounds, but as yet there is no neurological evidence to support this idea, and it is possible that the semi-circular canals may serve another function in Ziphiidae.

DISCUSSION At present, there is little information available on the acoustic abilities of beaked whales. Sound production has only been recorded from five species, and currently there is no direct information on hearing ability of any species of beaked whale (although inferences from anatomical data are available). In addition, the number of occasions where sound production has been recorded is very small and in some cases limited to a single individual of a particular species. However, from these limited observations, it appears that beaked whales produce pulsed sounds (presumably used for echolocation) over a wide range of frequencies from 300 Hz to 129 kHz and unpulsed sounds (probably used in social communication) in a much narrower range of frequencies from 2-10 kHz, and possibly as high as 16 kHz in *H. ampullatus*. Hearing is presumably sensitive to these frequencies. However, hearing abilities may extend beyond these ranges. Anatomical evidence supports the idea of sensitivity to the higher frequencies which beaked whales produce, but indicate that there may also be some sensitivity to intense low frequency sounds.

If the potential impacts of noise production from military activities, and indeed other human activities, on beaked whales are to be properly assessed, and suitable mitigating steps taken if required, it is clear that further information needs to be gathered on their acoustic abilities. When the opportunities arise, every effort should be made to obtain recordings of sounds produced by beaked whales, even by those not directly associated with beaked whale research. The frequencies outlined above will provide a general guide as to what can be expected. However, it should be noted that other species may not conform to what is currently known. In addition, as strandings of beaked whales are rare, auditory anatomy of beaked whales should be investigated whenever possible, and if any animals strand alive, the possibility of producing an audiogram should be considered.

Despite the limited current knowledge, care should be taken when undertaking activities which produce sounds in areas where beaked whales may be present, particularly if intended outputs are within frequency ranges known to be produced by beaked whales. Not only are beaked whales likely to be sensitive to these frequencies, but biologically important sounds may be masked by such anthropogenic noises. This may result in loss of social cohesion and separation of individuals, navigational errors leading to stranding, noise-induced panic and/or reduced foraging efficiency. Areas where beaked whales may be present are waters of 200 m. or more depth, and particularly areas of complex seabed topography such as sea-mounts, gullies, and the shelf edge (e.g. MacLeod, 1998).

In addition, beaked whales are some of the deepest and longest diving species of marine mammal. Evidence from time-depth recorders attached to *H. ampullatus* indicate that beaked whales may routinely dive for up to 70 minutes and to depths of over 1,000 metres (Hooker and Baird, 1999). Evidence from stomach contents analysis and from these time depth recorders indicates that during these dives, beaked whales may spend a large percentage of the dive at or close to the bottom (Read, 1996; Hooker and Baird, 1999). During this time they would be expected to produce pulsed sounds (echolocation) to aid in prey location, and possibly unpulsed sounds to aid with group cohesion. As a result, beaked whales may be particularly sensitive to masking of natural sounds by anthropogenic sounds, or other negative impacts, during such deep dives. Therefore, it is important not only to consider the effect of anthropogenic sound production on animals at or near the surface, but also to consider the effects on animals at or near the bottom where sound propagation and effects on animals may differ from surface waters. It is therefore important to gather further information on dive profiles of beaked whales at every opportunity to allow a more accurate assessment of surface sound production on beaked whales during long dives.

CONCLUSIONS

1. Information on sound production is only known from a limited range of beaked whale species and almost nothing is known about hearing abilities other than data gathered from auditory anatomy.
2. Beaked whales appear to use frequencies between 300 Hz and 129 kHz for echolocation and 2-10 kHz for social communication.
3. More information is needed, particularly on sound production, auditory anatomy, and dive profiles, if potential interactions between beaked whales and noise producing human activities are to be assessed and potential impacts prevented. Therefore, every effort should be made to record sounds produced by beaked whales when the opportunity arises
4. Military activities which produce sounds within those frequencies used by beaked whales may have a greater impact than those which produce sounds out with these frequencies, although anatomical data suggests beaked whales may also be sensitive to intense, low frequency sounds.

ACKNOWLEDGEMENTS I would like to thank the Defence Research Agency of the U.K. for encouraging the undertaking of, and providing funding for, this research. In addition I would like to thank Ed Harland for his comments, and Sascha Hooker for providing me with information from her research.

REFERENCES

Caldwell, D. K. and Caldwell, M. C. 1971. Sounds produced by two rare cetaceans stranded in Florida. *Cetology*, 4: 1-6.

Dawson, S., Barlow, J. and Ljundberg, D. 1998. Sounds recorded from Baird's beaked whale, *Berardius bairdii*. *Marine Mammal Science*, 14: 335-344.

Frantzis, A. 1998. Does acoustic testing strand whales? *Nature*, Lond., 392: 29.

Hooker, S. K. and Baird, R. W. 1999. Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacea: Ziphiidae). *Proceedings of the Royal Society, London*, Series B, 266.

Ketten, D. R. 1998. Marine mammal hearing and acoustic trauma: Basic mechanisms, marine adaptions, and beaked whale anomalies. Pp. 2.63-2.75. In: Summary Record, SACLANTCEN Bioactoustical Panel, La Spezia, Italy, 15-17 June 1998.

Lynn, S. K. and Reiss, D. L. 1992. Pulse sequence and whistle production by two captive beaked whales, *Mesoplodon carlhubbsi*. *Marine Mammal Science*, 8: 299-305.

MacLeod, C.D. 1998. *Habitat requirements of dense beaked whales, Mesoplodon densirostris, off the island of Abaco, The Bahamas*. Unpubl. Report to the Society for Marine Mammalogy.

Read, A. J. 1996. Incidental catches of small cetaceans. Pp. 109-128. In: *The conservation of whales and dolphins: science and practice* (Eds M. P. Simmonds and J. D. Hutchinson). John Wiley & Sons, Chichester & New York. 476pp.

Rogers, T. L. and Brown, S. M. 1999. Acoustic observations of Arnoux's beaked whales (*Berardius arnuxii*) off Kemp Island, Antartica. *Marine Mammal Science*, 15: 192-198.

Simmonds, M. P. and Lopez-Jurado, L.F. 1991. Whales and the military. *Nature*, 351: 448.

Winn, H. E., Perkins, P. J. and Winn, L. 1970. Sounds and behavior of the northern bottlenose whale. *Abstracts, Seventh Annual Conference on the Biolological Sonar of Diving Mammals*. Pp. 53-59.

Table 1 - Summary of Known Sound-producing Abilities of Beaked Whales

Species	**Frequencies Recorded**	**Sound Type**	**Response Range of Equipment Used**	**Reference**
H. ampullatus	5 - 25 kHz.	Pulsed	25 Hz - 35 kHz	Hooker pers. comm
H. ampullatus	Below 500 Hz to above 26 kHz. 3 - 16 kHz.	Pulsed Unpulsed	Flat response between 500 Hz and 14 kHz.	Winn *et al.* 1970
B. bairdii	up to 129 kHz. 4 - 8 kHz.	Pulsed Unpulsed	30 Hz - 180 kHz 20 Hz - 20 kHz	Dawson *et al.* 1998
B. arnuxii	1 - 10.9 kHz Approx. 2 - 6 kHz	Pulsed Unpulsed	40 Hz - 16.5 kHz	Rogers and Brown 1999
Mesoplodon sp.	Ultra-sonic clicks	-	up to 32 kHz	Ljungblad unpubl. in Dawson *et al.* 1998
M. densirostris	Slightly less than 1 kHz to almost 6 kHz.	Pulsed and Unpulsed	40 Hz - 20 kHz	Caldwell and Caldwell 1971
M. carlhubbsi	300 Hz to over 40 kHz. 2.6 - 10.7 kHz.	Pulsed Unpulsed	70 Hz - 40 kHz	Lynn and Reiss 1992

CUVIER'S BEAKED WHALES IN THE IONIAN SEA: FIRST RECORDINGS OF THEIR SOUNDS

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INTRODUCTION In order to study the vocalisations of Cuvier's beaked whales (*Ziphius cavirostris*, G. Cuvier 1823), a large dolphin whose acoustic behaviour is unknown (Heyning, 1989; McLeod, 1998; Notarbartolo di Sciara & Demma, 1994) a "Ziphius project" started in late spring, 1998.

The research was programmed and carried out in an area placed along the continental slope out of Corfù, Paxos and Lefkada islands (Greece), where sightings of this species were reported, during the preceding years, by other authors (Pulcini, Angradi, 1994) and by the skipper of the research ship himself.

This region is about 200 km north of the beaches where, in 1996, an extraordinary stranding of 12 beaked whales occurred (Frantzis, 1998).

MATERIALS AND METHODS A 16-metre sailing vessel covered the area, under optimal weather conditions, during seven days (and 350 nautical miles), devoted to this task, out of an ordinary summertime whale-watching activity.

The researchers carried out both visual observation and acoustic sampling. Underwater acoustic recordings were taken both following a fixed schedule (five minutes were unconditionally recorded every thirty minutes) and during sightings. The hydrophone was an omnidirectional "Cetacean Research Technology C300", and was connected to a double-speed double-bandwidth DAT recorder (frequency range of the whole system was up to 44 kHz).

RESULTS Three pairs of beaked whales were sighted (August 3rd, August 16th, and October 1st) (see Fig. 1). Two pairs of whales were slowly approached, and photographs, videos, and underwater sound recordings were taken. Beaked whales, known to be elusive deep divers, appeared to take notice of the presence of the boat. While swimming together when sighted, they separated when approached, remained at 40/60 m. from the boat and then, after a few minutes, simultaneously dived and disappeared.

Underwater acoustic recordings, following a sighting, were successful twice, resulting in the first tapes of this species that we have knowledge of. No dolphins were sighted during the hours preceding or following the reported encounters, nor any other sounds recorded during the same periods. This makes one confident that the peculiar sounds recorded were indeed of this species. Later, the laboratory analysis of the tapes taken with "fixed scheduled sampling" resulted in the discovery of another sequence of whistles with the same characteristics as those recorded during beaked whales' sightings. This tape was taken in the same area on October 18th (see Fig. 1).

CONCLUSIONS A few whistles but no clicks at all were recorded. The sounds appear as weak modulated whistles, as shown in the spectrograms (see Fig. 2), with minimum variability among them. Sounds did not emerge much from the background noise; this is probably related both to distance between the hydrophone and the whales, and to a low-intensity emission by the whale.

ACKNOWLEDGEMENTS We wish to thank all the patient people that were on board during that long summer; without them this research would have not been possible. In particular we thank Carla Benoldi, Barbara Bonsignori, Pucci Chiofalo, Sabrina Djavidnia, and Marilena Quero; those were important days.

REFERENCES

Frantzis, A. 1998. Does acoustic testing strand whales? *Nature*, Lond., 392: 29.

Heyning, J. E. 1989. Cuvier's Beaked Whale *Ziphius cavirostris* G. Cuvier, 1893. Pp. 289-308. In: *Handbook of Marine Mammals* Volume 4: River Dolphins and the Larger Toothed Whales. (Eds. S. H. Ridgway & R. Harrison). Academic Press, London & San Diego. 442pp.

McLeod, C. 1998. Summary of the present knowledge of beaked whales. Report of the Bioacoustics Panel convened at Saclant, 15-17 June 1998 (Eds. A. D'Amico and V.C. Verboom): 9-15.

Notarbartolo di Sciara, G. and Demma, M. 1994. *Guida dei mammiferi marini del Mediterraneo*. Ed. Muzzio, Italy. 262pp.

Pulcini, M. and Angradi, A. M. 1994. Observations of Cuvier's beaked whale *Ziphius cavirostris* in the Jonian islands of Greece. Pp. 116-119. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

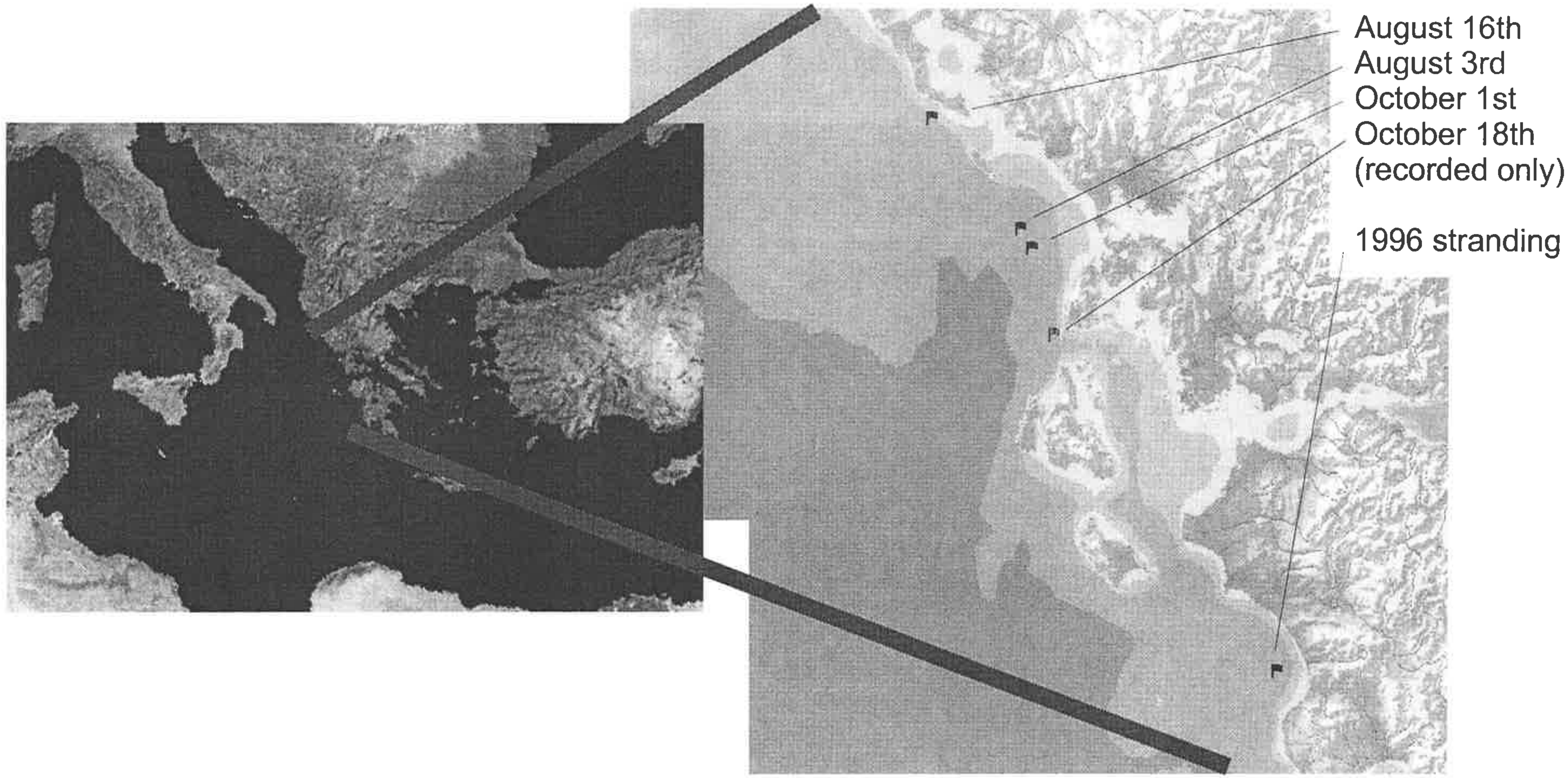

Figure 1. These maps show the Jonian sea, our sigthings, the recording and the 1996 mass stranding.

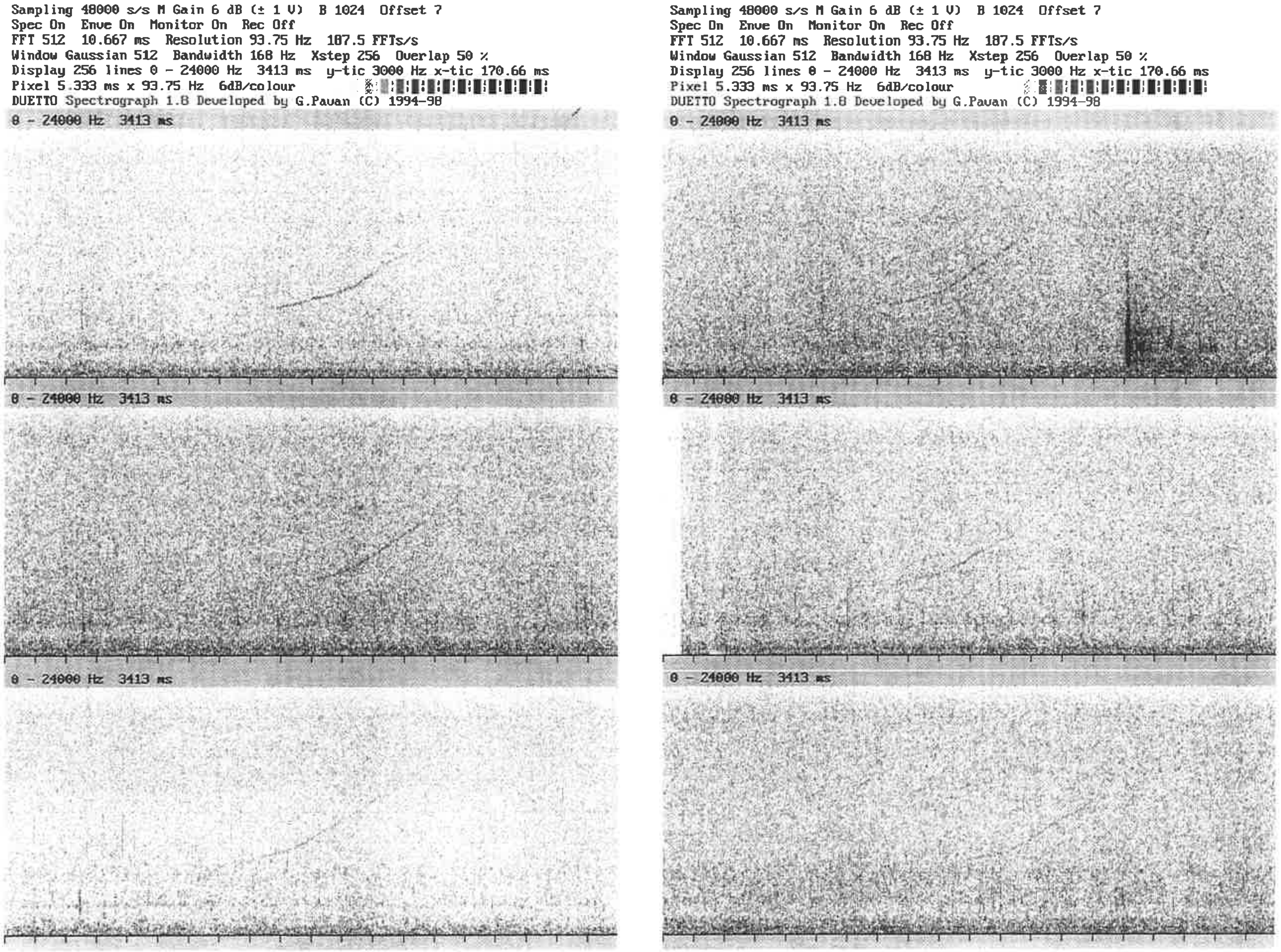

Figure 2. Spectrograms of the largest part of the recorded whistles. The whistles range from about 8000Hz up to more than 12 KHz, with a constant sweep up. The measurable lenght of the whistles is about one second.

THE SOUNDS AND CALCULATED SOURCE LEVELS FROM THE WHITE-BEAKED DOLPHIN RECORDED IN ICELANDIC WATERS

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INTRODUCTION The white beaked dolphin, *Lagenorhynchus albirostris* (Gray 1846), has a robust body with a short thick gray, white or brown beak. The adult dolphins weigh between 220 and 350 kg and are between 220 and 280 cm in length. They are found in the North Atlantic where they can be seen in groups along the coast of Iceland in summer. The dolphins are very curious and will often swim near boats and bow ride. Sometimes they exhibit various aerial displays like tail walking, jumping, back splashing, tail lobbing and twisting in the air. The main purpose of this study was to measure source levels of their echolocation signals using a 4-hydrophone array.

MATERIALS AND METHODS The recordings were made in Icelandic waters not far from Keflavik (64°00.49' N, 22°33.37′ W) between 22 and 26 August 1998 (see Fig. 1). We used a symmetrical four hydrophone array developed by W. W. L. Au with omni directional ITC 1094 hydrophones having a flat frequency response up to 160 kHz. The accuracy for calculating ranges extends up to 30 m. A small underwater video camera was attached 10 cm above the centre hydrophone. The hydrophone cables were connected to a multi-channel amplifier and to a portable computer on board. The hydrophone array was mounted on a long pole that was lowered to a depth of about two meters from the side of a 30 foot motor boat. The dolphins' signals were continuously digitised and stored in memory until the amplitude of a signal on the centre hydrophone exceeded a pre-set trigger level. Up to 80 consecutive clicks could be stored in one data file at a time. The clock time of the computer was synchronised with the video, and a time stamp for each triggering was stored in a companion file.

Data were analysed using a program written by W. W. L. Au. The program used the click with the highest amplitude for estimating sound pressure level (SPL). The relative time differences between the four channels were used to calculate the range to the dolphin. Ranges were then used to calculate source levels (SPL in dB (peak-to-peak) re. 1 μPa at 1 m.), taking into account the loss in intensity due to spherical spreading, but not the loss frequency dependent attenuation because of the short distances. Click number, SPL, range, source level and interclick interval (ICI) were stored in data-files, which could be opened in a spreadsheet for analysis. Since the ICI can be very long for numerous reasons, intervals longer than 100 ms were arbitrarily discarded in our analyses.

RESULTS A total of 1,648 clicks were analysed in 79 files. The average calculated source level was 204 dB (SD = 6 dB). The maximum source level was 219 dB measured at a range of 22 m. and the minimum source level was 189 dB measured at a distance of 1.5 m.

Figure 2 shows that the source level increases with the log of range, giving a correlation coefficient of 0.65, which is significant (n = 1,648, one-way Anova, $p < 0.01$).

Figure 3 shows interclick interval (ICI) as function of range. The ICI is distributed between 36 and 100 ms (average = 51 ms, SD = 12 ms) and the regression line has a correlation coefficient of 0.05, which is significant (n = 1,366, one-way Anova, $p < 0.01$). The regression line does not follow the line for two-way-travel time, that is the time for sound to travel from the dolphin to the target and back.

Figure 4 shows an example where one dolphin is looking straight towards the video camera during one second. The source levels remain fairly constant at 204 to 206 dB at ranges of 3.5 to 6.5 metres, but the source level decreases to less than 200 dB at about a range of 2.7 metres. The results from this individual reflect the calculated source levels from all recordings shown in Fig. 2.

DISCUSSION The source levels from white-beaked dolphins are similar to those reported for the bottlenose dolphin (*Tursiops truncatus*, Montagu 1821) in open waters (Au, 1993). The source level for the bottlenose dolphin varied from 208 dB (peak-to-peak) re. 1 mPa at a range of 6 m to a maximum of 230 dB (peak-to-peak) re. 1 mPa at a range of 77.7 m. The source level was 214 dB (peak-to-peak) re. 1μPa at a range of 20 m. Thus the source levels increased with target range for the bottlenose dolphin. We calculated the source levels of 208 dB at a range of 6 m. (n = 20, SD = 2) and 214 dB a range of 20 m. (n = 20, SD = 2) from free-ranging white-beaked dolphins. Thus the source levels are essentially identical for these two species at the same target distance, and they increase with the log of range for the white-beaked dolphin.

The interclick intervals are higher than expected from the two-way travel time, and the interval is never smaller than 36 msec even at close range. Au (1993) reported click intervals between 100 and 160 ms at a range of 55 and 73 m, but at a closer range (6 m) the click interval varied between 10 and 55 ms (Au, 1980). We expected the white-beaked dolphin to shorten the interclick interval as it approached the array. However, there is a poor correlation between distance to the array and the interclick interval.

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REFERENCES

Au, W. W. L. 1980. Echolocation signals of the Atlantic bottlenose dolphin (*Tursiops truncatus*) in open waters. Pp. 251-282. In: *Animal Sonar Systems* (Eds. R. G. Busnel and J. F. Fish). Plenum, New York and London. 1,135pp.

Au, W. W. L. 1993. *The sonar of dolphins*. Springer Verlag. New York. 277pp.

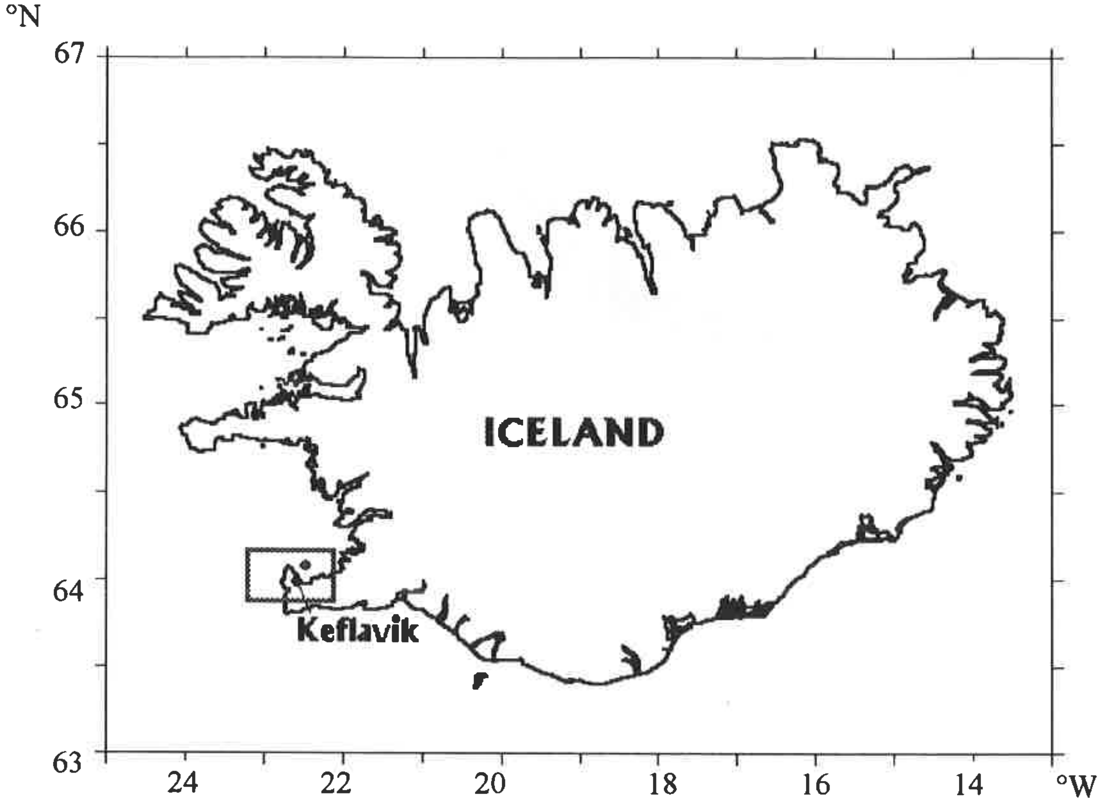

Fig 1. Study site near Keflavik in Iceland

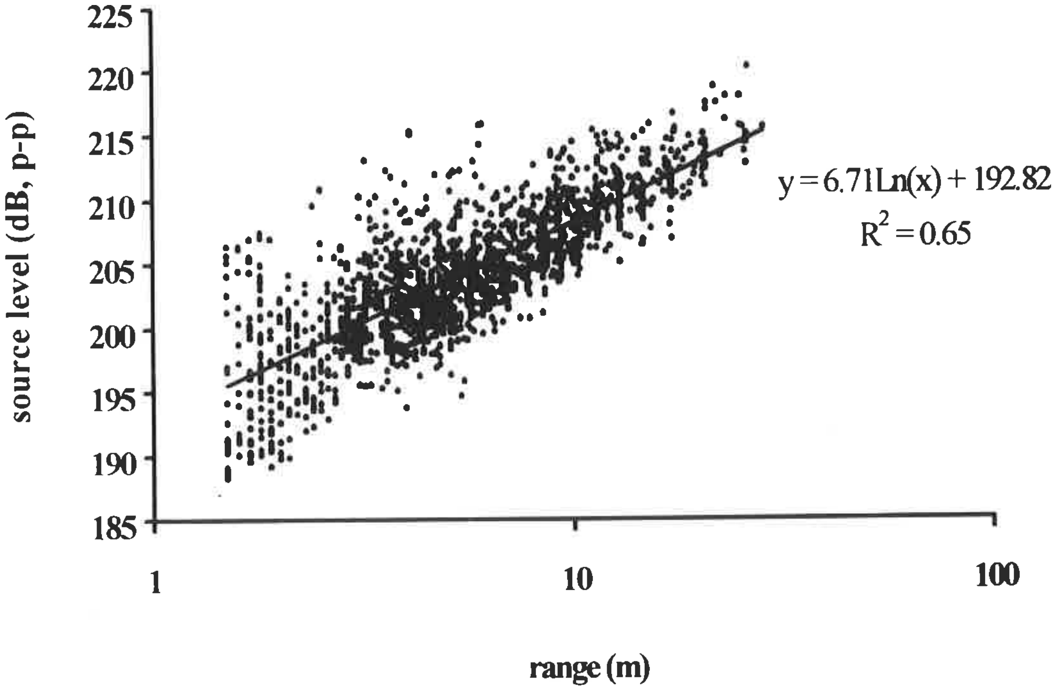

Fig 2. The figure shows that source levels increase with the log of range.

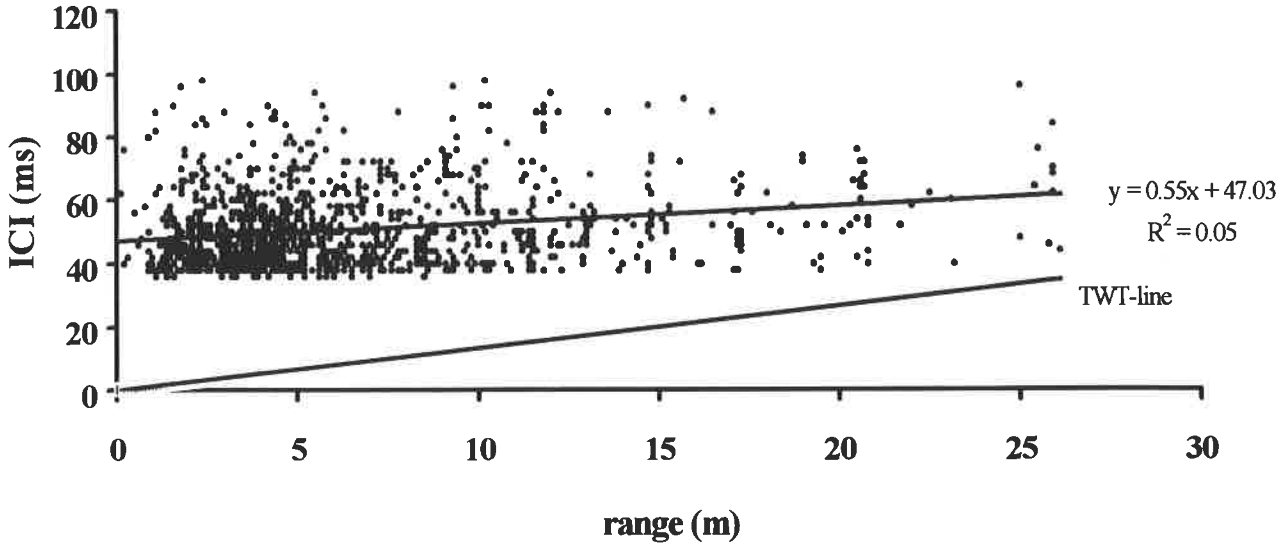

Fig. 3. The interclick interval (ICI) as function of range. The ICI is always greater than the two-way travel time (TWT). The ICI appears not to be related to range.

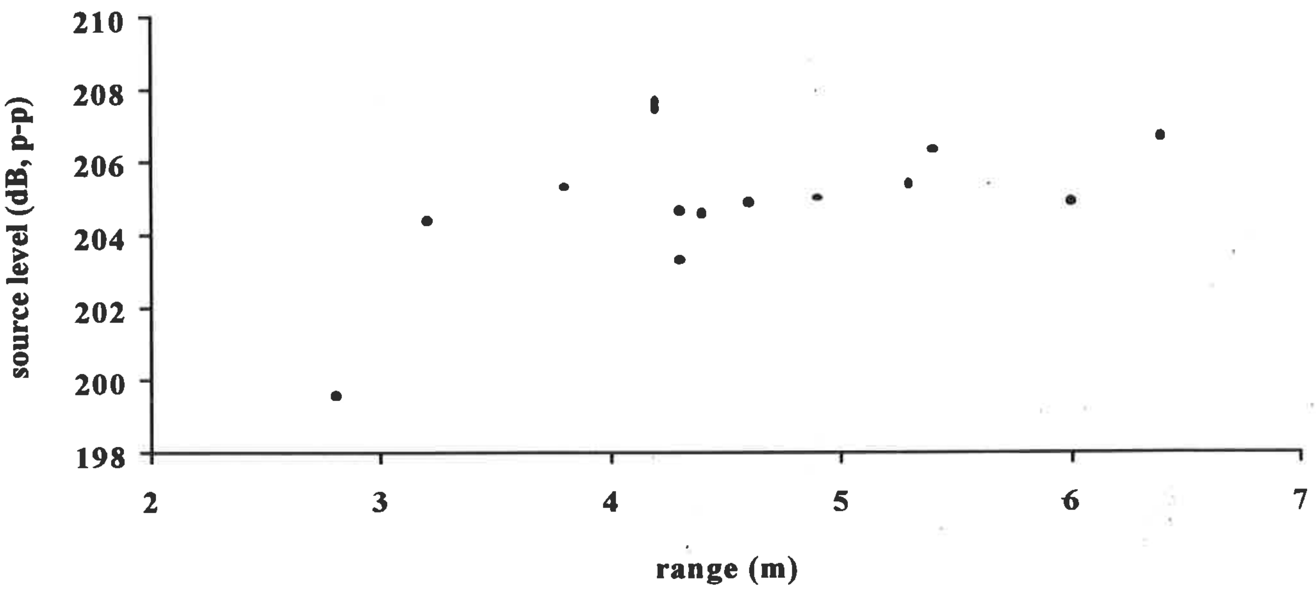

Fig. 4. An example from one file, where one dolphin is looking straight towards the underwater video camera during one second.

BEHAVIOUR

INVESTIGATION ON THE ABILITY OF *TURSIOPS TRUNCATUS* TO DISCRIMINATE, RECOGNISE AND CLASSIFY GEOMETRIC SHAPES USING VISUAL AND/OR ACOUSTIC PERCEPTION

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INTRODUCTION This paper presents the results of three experiments in which a dolphin, free swimming and using both visual and echolocation perceptions, was requested to discriminate (first experiment), to recognise (second experiment) and to classify (third experiment) differently shaped objects. Visual and echolocation perceptions rely on different phenomenologies to detect/recognise objects (sonar is capable of transmitting and receiving from objects sound energy with a variety of waveforms; sight is capable of receiving light energy reflected from the objects). Thus the scene perceived by the two senses concerns two different domains, with an overlapping area. Let us assume, for example (Fig.1a), that the set of targets present in the detection space is: {A, B, C}. One sense can perceive only the subset {A, B} and the other sense only the subset {B, C}, depending on the phenomenology used to detect targets. In the overlapping area, the two senses interact and the level of evidence is increased. The domains of echolocation and sight can be represented by Venn diagrams, that depend on the distance of the dolphin from the objects (the area of overlap increases with decreasing range), on the background and noise. For the objects used in these experiments, the potential detection space of sight and echolocation of a dolphin is shown in Figure 1. Moreover, the two senses may have different confidence levels: dolphins may rely more on acoustic than visual perception or vice versa, depending on their distance from the objects, on environmental conditions, and on their physiological state.

Acoustic and visual processing is quite complex and involves many issues. This work addresses the problem of the levels (automatic, selective, cognitive) at which a dolphin is able to process visual and/or acoustic perception.

a) In the first experiment, (automatic-level processing) the dolphin was requested to discriminate an object, identical to the sample and translucent to light (detectable acoustically), from other two alternative objects opaque to both light and sound (detectable visually and acoustically) (Fig. 1b). Most of this task can be performed automatically, comparing the gross characteristics of the objects, generated from the visual and echolocation phenomenologies, without necessarily implying object recognition.

b) In the second block of experiments (selective – level processing), the dolphin was requested to discriminate two objects, translucent to light from another alternative object opaque to both light and sound (Fig. 1c), and to recognise in the total information received from the two translucent objects, differing only in shape, the specific features of the object that matched the sample. This task involves, besides the capacity to discriminate, an ability to select the echo features of specific targets, to recall them from memory, and the ability to compare the present sonar echoes with those already stored in memory (Au, 1992 and 1993). However, this task can be performed without necessarily implicating the ability to represent objects symbolically.

c) In the third block of experiments (cognitive – level processing), the dolphin was requested to discriminate two objects translucent to light from an object opaque to light and sound, as above, and to recognise between them the object that matched the shape of the sample but differed in size from it (Fig. 1d). This task deals with cognitive symbols, rather than with echo features. It implies the ability of fusing the similarities (edges, lines, angles, symmetry), abstracting the differences produced by the change of size, and comparing the spatial relations between the sample and the objects.

These experiments give us ways of "looking into" the dolphin's knowledge of the world.

METHODS **Subject:** The subject was an adult female bottlenose dolphin (*Tursiops truncatus*) named Alpha. She was born free in the Caribbean Sea and was about 18 years old at the time of study (February 1997 - March 1998). Alpha had no previous experience in any type of experiment.

Materials: A set of spheres (S_i), cylinders (C_i) and rectangular prisms (P_i) were used as targets/samples (see Table 1 for details). They were made of Plexiglas (PMMA), a material which is translucent to light (optical reflectivity 8%) but with a good acoustic reflectivity (37%). A set of alternative objects (O_i) was casually chosen (a green plate, a red skittle, a buoy, a plastic clothes-hook etc.) and used for training and experiments. They were well detectable both echoically and visually (optical and acoustic reflectivity >50%).

Procedures: The training and three different experiments, (292 trials) took place between February 1997 and March 1998 in the Rimini Dolphinarium (Fig. 2a). During the training the dolphin was familiarised with the Delayed Matching-To-Sample procedure (DMTS) (Roitblat *et al.*, 1990), which was carried out with the alternative objects (O_i) only. Each trial began at a start station with the dolphin facing out of the pool towards the trainer, who presented her the sample, suspended on a string about 1 m underwater. A few seconds before the sample was removed, a frame with a set of three objects (including a copy of the sample), suspended on strings and randomly ordered, was gently lowered into the water at a depth of 2 m. and about 20 m. away from the station. Upon a sign from the trainer, Alpha swam towards the scene and could use as much time as she liked to examine it. She indicated her choice by touching the object with her rostrum and standing in front of it for at least 5 seconds. If the answer was correct, she was called back with a whistle and rewarded with fish. If the choice was incorrect, she was called back with a low frequency signal and the trial was not repeated. The number of trials was limited (10-20) to prevent the dolphin from learning through the reward mechanism.

Experiments: Experiment 1 concerned the discrimination task; experiment 2, formed by two blocks 2a and 2b, concerned the recognition task; and experiment 3, formed by two blocks 3a and 3b, concerned the classification task.

In the experiments 1, 2a and 3a, the sample was exposed both to vision and echolocation, while in the experiments 2b and 3b, it was presented to the dolphin only through echoes. For this purpose, the sample together with an hydrophone Brüel & Kjær 8105 was hidden inside a hollow fibreglass sphere (Ø 40 cm), almost transparent to ultrasounds (Fig. 2b). The clicks of the dolphin were monitored and recorded respectively on a HP Digital Oscilloscope 54520 and a Wide Band Recorder (10 Hz-300 kHz). The recorded sonar pulses were processed using MATLAB m-file language, and the procedure described in Azzali *et al.* (1998).

In the experiments 3a and 3b, the sample presented to the dolphin by the trainer differed in size (but not in material and shape) from the match that the dolphin had to choose.

Measurements on acoustic characteristics (longitudinal and transversal velocity) of the Plexiglas, on the scattered radiation patterns, and the acoustic images of the targets, were carried out in laboratory at a frequency of 200 kHz to check if it were possible to recognise shapes using up-to-date sonar systems.

RESULTS The results of all the experiments are reported in Table 2 and in Fig. 3. In the six sessions (73 trials) of experiment 1, Alpha's choice accuracy was significantly higher (correct responses ranged between 90% and 100%) than a random choice ($G>25$, $df=1$, $P<0.001$, G Test) for all the three samples (S_1, C_1, P_1).

In the six sessions (85 trials) of experiment 2a, the dolphin's performance was statistically significant for the sphere and the cylinder ($G>12$, $df=1$, $P<0.001$) but not for the prism ($G=0.04$, $df=1$, P=NS). The comparison between her choice accuracy in these two experiments did not result in any significant dfferences for the sphere and the cylinder ($G=2.05$ and $G=2.69$, $df=1$, P=NS respectively) but was significant for the prism ($G=17.96$, $df=1$, $P<0.001$) because she did not recognise it although she was able to discriminate it. Her choice accuracy did not change in function for the higher level of difficulty. In experiment 2b (44 trials), the visual perception of the sample was precluded and Alpha's recognition performance was significantly higher than a random choice for all the three geometric shapes (including the prism) ($G=5.59$, $df=1$, $0.01<P<0.02$ for sphere and prism; $G=18.74$, $df=1$, $P<0.001$ for cylinder). However, Alpha chose the "negation" instead of "affirmation" to indicate the prism (she could easily identify it, but she touched the other target). A similar behaviour has been reported in literature (Helweg *et al.*, 1996). The analysis of the clicks used by Alpha in this experiment shows that the signals employed to recognise the cylinder and the sphere are similar to each other, but distant from the ones used for the prism (Fig. 4a).

In experiment 3a (48 trials), the classification performance of the dolphin was statistically significant for the sphere and the prism ($G>20$, $df=1$, $P<0.001$), even if again Alpha chose the "negation" to indicate the sphere. However, the dolphin was unable to classify the cylinder ($G=0.22$, $df=1$, P=NS). In experiment 3b (46 trials), the classification accuracy of Alpha, impeded from seeing the sample, did not differ significantly from experiment 3a ($G=1.11$, $df=1$, P=NS for spheres; $G=0.02$, $df=1$, P=NS for cylinders; $G=0.95$, $df=1$, P=NS for prisms). Again, the dolphin was unable to classify the cylinder ($G=0.06$, $df=1$, P=NS), but in contrast to the previous case, she significantly confused it with the prism only ($P=0.035$, $df=1$, Binomial Test). The results of click analysis show that sonar pulses used to ensonify prisms and cylinders are more similar than the ones used for the spheres (Fig. 4b).

Laboratory experiments on the targets presented to Alpha indicated that the scattered radiation patterns contain too little information to recognise the shapes, while the acoustic images contain information too complex for humans to process it in detail (Ruggini, 1998).

CONCLUSIONS The results of the three experiments can be summarised as follows:

1. The performances of Alpha in discriminating the objects were excellent (experiment 1).
2. Alpha showed difficulty in recognising the prism when the sample was exposed to both echolocation and sight (experiment 2a). However, when the sample was exposed only to echolocation, the dolphin's capability to recognise prisms, besides cylinders and spheres, was good (experiment 2b). Perhaps the dolphin relied more on sight than on echolocation in experiment 2a.
3. There are several ways to classify the shapes, that can be separated into two or more categories depending on which shape property one looks for. Alpha was able to classify the spheres (a smooth shape) and the prisms (an edged shape), abstracting the differences produced by the changes in size. However, she showed great difficulty in classifying cylinders (a smooth shape but with contours), resulting in her confusion in experiment 3a sometimes with spheres and sometimes with prisms, but in the acoustic experiment 3b, this was only with prisms.
4. It seems that the dolphin classifies shapes into two categories: smooth surfaces versus edged surfacesm and has difficulties in classifying shapes which are intermediate between them.
5. Alpha seems to change the features of her sonar pulses as a function of the stimulus object and/or of the difficulty to perform the task.
6. Alpha's choice accuracy in the trials where the sample was exposed only to her echolocation, was equal or better (experiment 2) than in the trials in which it was exposed to both her vision and echolocation. This result seems to contrast with

previous studies (Pack *et al.*, 1995; Harley *et al.*, 1996). However the material translucent to light, used for targets, allowed the two senses to interact and to participate in the decision only when the dolphin was very close to the scene. It seems that Alpha, dealing with this type of material, was most successful when she could rely only on the acoustic perception to select the features of the sample.

ACKNOWLEDGEMENTS We are grateful to all the Rimini Dolphinarium staff and especially to Paolo Bettini for providing assistance during data collection. Special thanks also to Sergio Catacchio for his precious technical support.

REFERENCES

Au, W. W. L. 1992. Target sonar discrimination cues. Pp. 357-377. In: *Marine Mammals Sensory* (Eds. J. Thomas, R. Kastelein & A. Supin). Plenum Press, New York. 773pp.

Au, W. W. L. 1993. *The Sonar of Dolphins*. Springer-Verlag, New York. 277pp.

Azzali, M., Garbati, P., and Impetuoso, A. 1998. Similarity among sonar signals collected from small communities of Dolphins (Tursiops truncatus). Pp. 247-254. In: *Proc. of the 4th European Conference on Underwater Acoustics Vol. I* (Eds. A. Alippi , and G.B. Cannelli). CNR-IDAC Rome, Italy. 533pp.

Harley, H. E., Roitblat, H. L., and Nachtigall, P. E. 1996. Object representation in the bottlenose dolphin (*Tursiops truncatus*): integration of visual and echoic information. *J. Exper. Psychol.-Anim. Behav. Processes*, 22, 2: 164-174.

Helweg, D. A., Roitblat, H. L., Nachtigall, P. E., and Hautus, M. J. 1996. Recognition of aspect-dependent three-dimensional objects by an echolocating Atlantic bottlenose dolphin. *J. Exper. Psychol.-Animal Behav. Processes*, 22, 1: 19-31.

Pack, A. and Herman, L. 1995. Sensory integration in the bottlenosed dolphin: immediate recognition of complex shapes across the senses of echolocation and vision. *J. Acoust. Soc. Am.*, 98, 2: 722-733.

Roitblat, H. L., Penner, R. H., and Nachtigall, P. E. 1990. Matching-to-sample by an echolocating dolphin (*Tursiops truncatus*). *J. Exper. Psychol.-Animal Behavior Processes*, 16, 1: 85-95.

Roitblat, H. L. and Von Fersen, L. 1992. Comparative cognition: representations and processes in learning and memory. *Ann. Rev. Psychol.*, 43: 671-710.

Ruggini, C. 1998. *Capacità di riconoscimento e classificazione di forme geometriche da parte di Tursiops truncatus (Montagù, 1821).* Tesi di Laurea in Scienze Biologiche 1996/ '97. Università degli Studi di Firenze. 109pp.

Table 1 - Stimulus object characteristics

(a)

	SPHERE	CYLINDER	PRISM
DIMENSIONS (mm)	S1 (Δ58) S2 (Δ72)	C1 (Δ50x50) C2 (Δ50x100) C3 (Δ50x200) C4 (Δ70x220)	P1 (40x40x60) P2 (40x40x122) P3 (40x40x245) P4 (40x40x163.5)
EDGES	0	2	12
VERTICES	0	0	8
HORIZONTAL SYMMETRY PLANS	1	1	1
VERTICAL SYMMETRY PLANS	•	•	4

(b)

	P1, C1, S1	P2, C2, S2	P3, P4, C3	C4
VOLUME (mm^3)	9.700 ca	196.000 ca	392.000 ca	846.000 ca

(c)

	REFLECTIVITY		DENSITY	SOUND VELOCITY (10^3 m/s)		ACOUSTIC IMPEDANCE (r = 10^6 Kg/m^2*s)	
	ACOUSTIC	OPTICAL	(r = 10^3 Kg/m^3)	Vl	Vt	r x Vl	r x Vt
PLEXIGLASS (PMMA)	37%	8%	1.18 - 1.19	2.73	1.43	3.2	1.7

Table 2. FIVE EXPERIMENTS RESULTS (S_i= sphere; C_i= cylinder; P_i= prism; O_i= alternative object; V=visual perception; E=echolocation).

	SPHERE				CYLINDER				PRISM			
	Scene	**Trials**	**Correct Responeses (%)**	**Statistical Significance**	**Scene**	**Trials**	**Correct Responeses (%)**	**Statistical Significance**	**Scene**	**Trials**	**Correct Responeses (%)**	**Statistical Significance**
EXPERIMENT 1 - DISCRIMINATION - (V/E - V/E)	$S1 \rightarrow S1 \wedge O1 \wedge O2$	10	90	N=25 df=1 G=25.745 $P<0.001$ (G test)	$C1 \rightarrow C1 \wedge O1 \wedge O2$	11	91	N=26 df=1 G=27.046 $P<0.001$ (G test)	$P1 \rightarrow P1 \wedge O1 \wedge O2$	10	100	N=22 df=1 G=29.821 $P<0.001$ (G test)
	$S1 \rightarrow S1 \wedge O1 \wedge O2$	15	100		$C1 \rightarrow C1 \wedge O1 \wedge O2$	15	100		$P1 \rightarrow P1 \wedge O1 \wedge O2$	12	100	
EXPERIMENT 2a - RECOGNITION - (V/E - V/E)	$S1 \rightarrow S1 \wedge P2 \wedge O$	12	100	N=32 df=1 G=16.368 $P<0.001$ (G test)	$C2 \rightarrow C2 \wedge (S2 \vee P2) \wedge O$	13	85	N=28 df=1 G=12.320 $P<0.001$ (G test)	$P2 \rightarrow P2 \wedge (S1 \vee C2) \wedge O$	9	33	N=25 df=1 G=0.039 P=NS (G test)
	$S1 \rightarrow S1 \wedge (P1 \vee C1 \vee C2) \wedge O$	20	75		$C2 \rightarrow C2 \wedge (S1 \vee P2) \wedge O$	15	100		$P2 \rightarrow P2 \wedge C2 \wedge O$	16	62.5	
EXPERIMENT 2b - RECOGNITION - (E - V/E)	$S1 \rightarrow S1 \wedge (C1 \vee P1) \wedge O$	15	80	N=15 df=1 G=5.596 $0.01<P<0.02$ (G test)	$C1 \rightarrow C1 \wedge (S1 \vee P1) \wedge O$	14	100	N=14 df=1 G=18.739 $P<0.001$ (G test)	$P1 \rightarrow P1 \wedge (S1 \vee C1) \wedge O$	15	20	N=15 df=1 G=5.596 $0.01<P<0.02$ (G test)
EXPERIMENT 3a - CLASSIFICATION - (V/E - V/E)	$S1 \rightarrow S \wedge (C2 \vee P2) \wedge O$	15	0	N=15 df=1 G=20.124 $P<0.001$ (G test)	$C2 \rightarrow C \wedge (S1 \vee P2) \wedge O$	18	44	N=18 df=1 G=0.217 P=NS (G test)	$P2 \rightarrow P \wedge (S1 \vee C2) \wedge O$	15	93	N=15 df=1 G=24.521 $P<0.001$ (G test)
EXPERIMENT 3b - CLASSIFICATION - (E - V/E)	$S1 \rightarrow S \wedge (C2 \vee P2) \wedge O$	12	8	N=12 df=1 G=9.361 $0.001<P<0.01$ (G test)	$C2 \rightarrow C \wedge (S2 \vee P2) \wedge O$	15	47	N=15 df=1 G=0.065 P=NS (G test)	$P2 \rightarrow P \wedge (S1 \vee C2) \wedge O$	15	100	N=15 df=1 G=20.124 $P<0.001$ (G test)

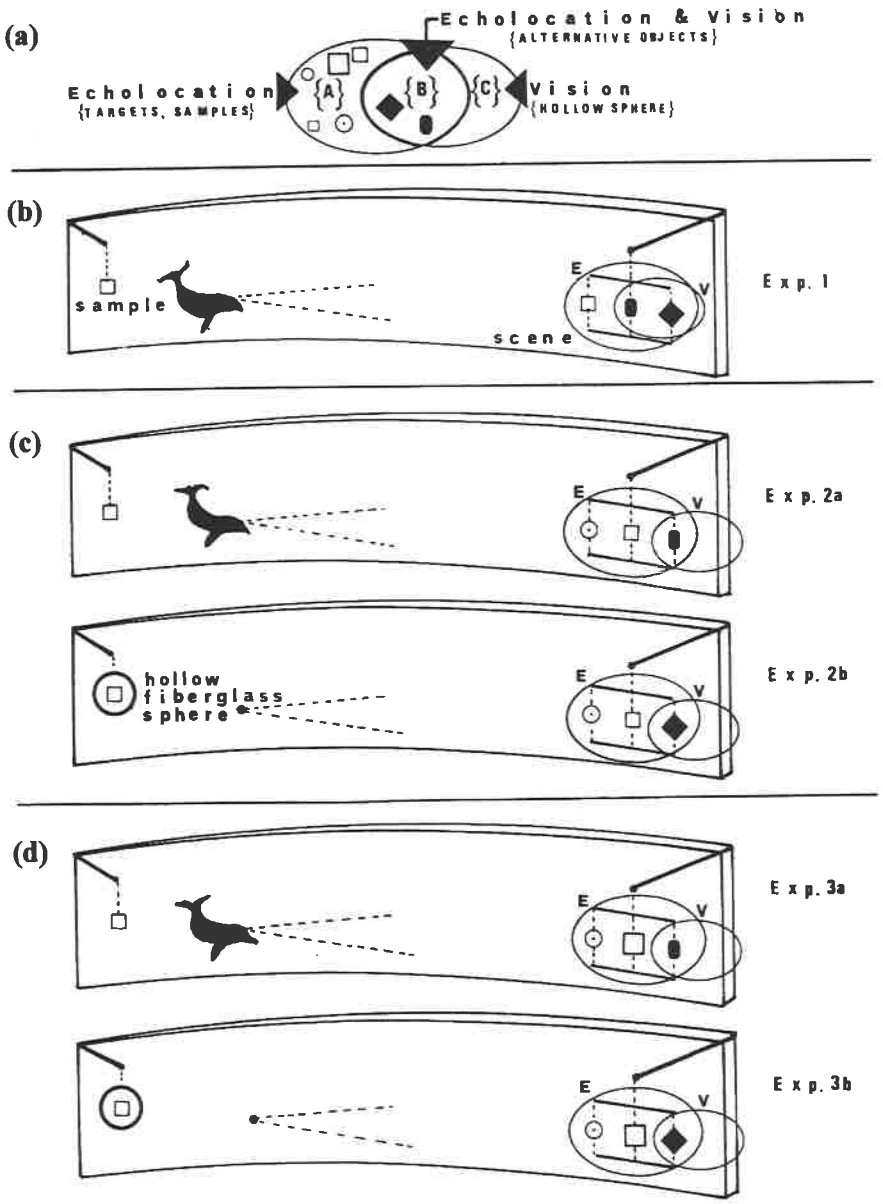


Fig.1 Representation of the objects used in the experiments by Venn diagrams (**a**), and of the experiments carried out in the Rimini dolphinarium (**b**), (**c**), (**d**).

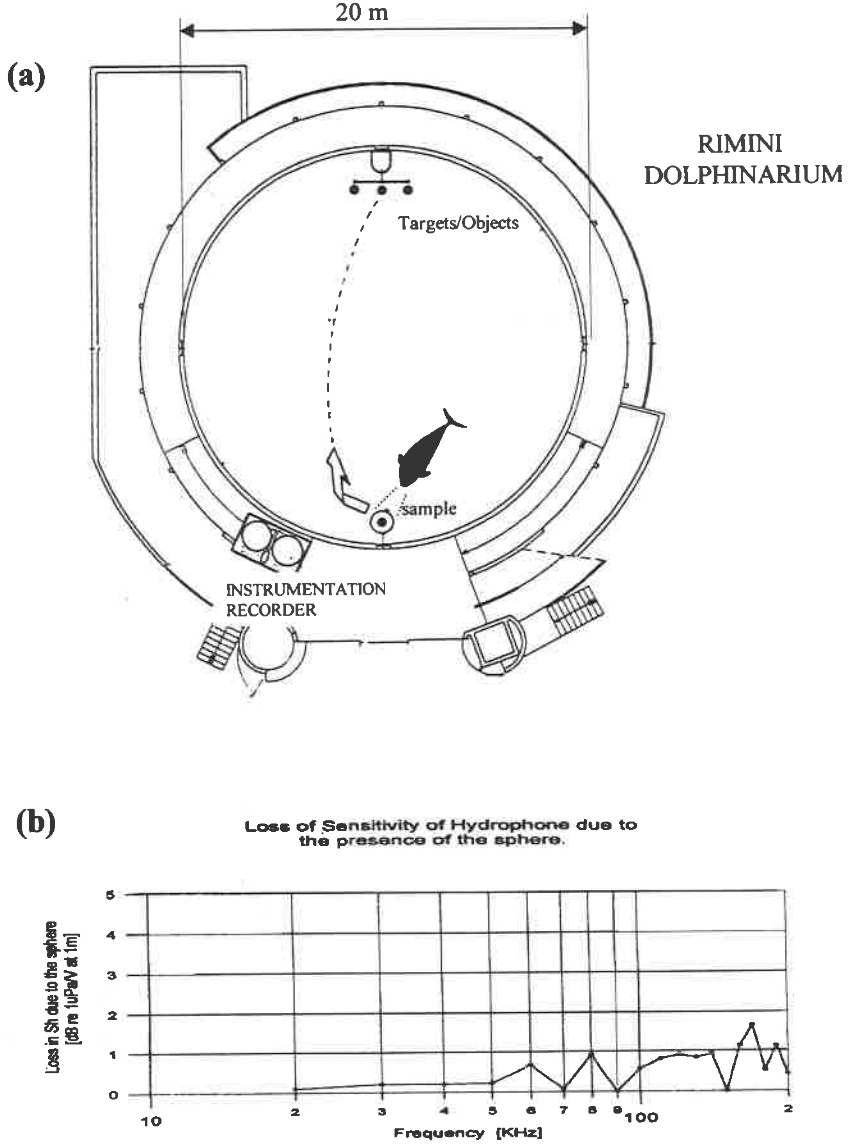
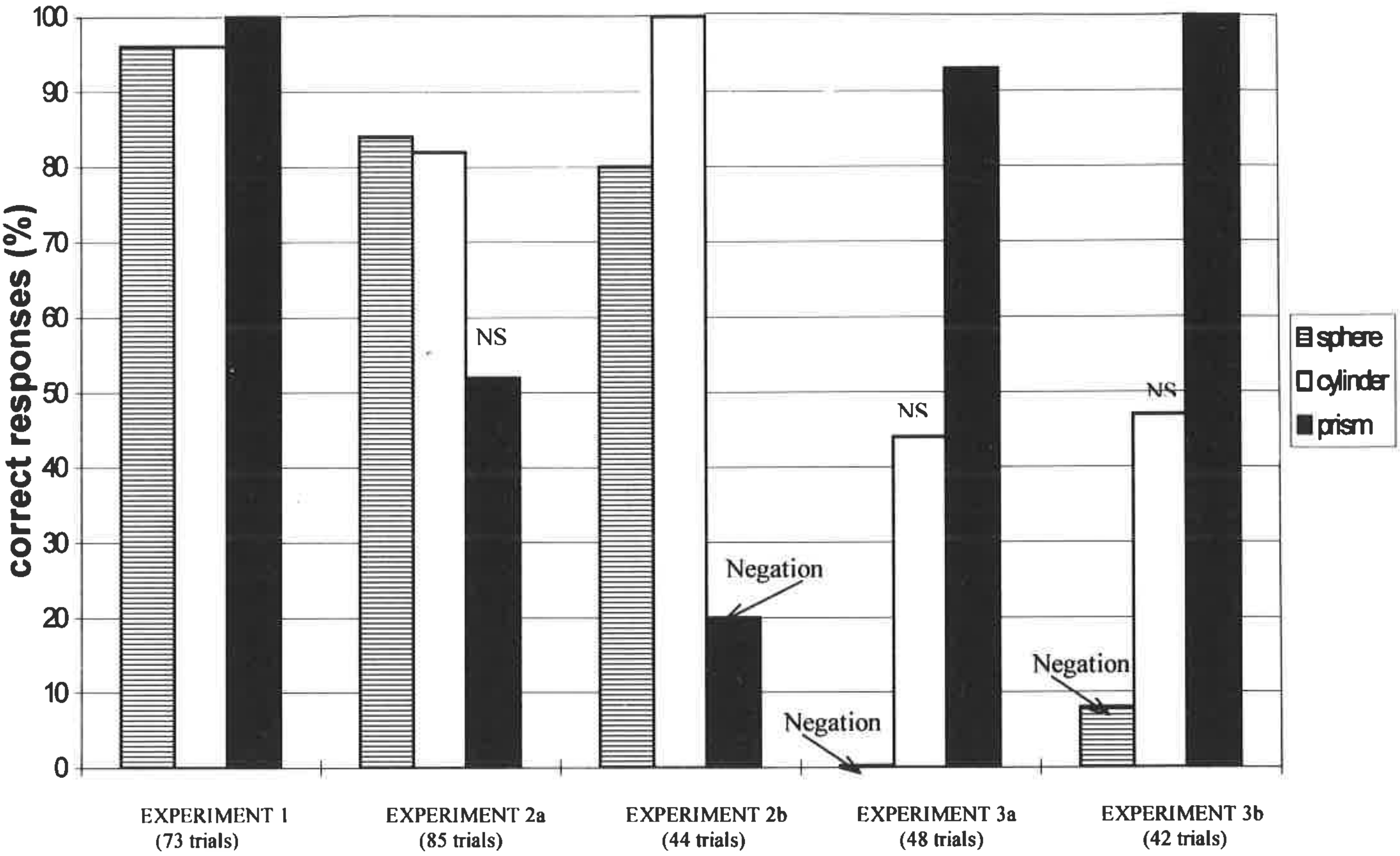


Fig.2 (**a**) Experimental set-up showing the dimension of the pool, the position of the targets/objects and of the sample, hidden inside a hollow sphere transparent to ultrasounds. (**b**)Transparence of the sphere to ultrasounds.

(a)

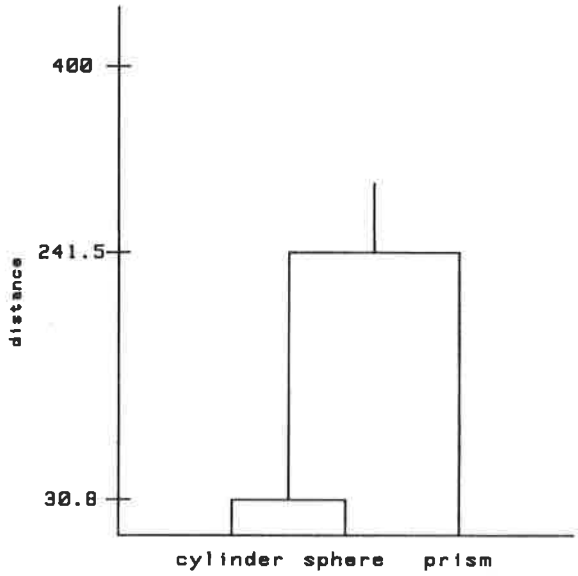


(b)

	SPHERE	CYLINDER	PRISM
EXP. 1 versus EXP. 2a	N = 57, df = 1 G = 2.049, P = NS (G test)	N = 54, df = 1 G = 2.692, P = NS (G test)	N = 47, df = 1 G = 17.966, P < 0.001 (G test)
EXP. 2a versus EXP. 2b	N = 47, df = 1 G =0.126, P = NS (G test)	N = 42, df = 1 G =3.921, 0.02 < P < 0.05 (G test)	N = 40 df = 1 G =4.037, 0.02 < P < 0.05 (G test)
EXP. 3a versus EXP. 3b	N = 27, df = 1 G =1.107, P = NS (G test)	N = 33, df = 1 G =0.016, P = NS (G test)	N = 30, df = 1 G =0.947, P = NS (G test)

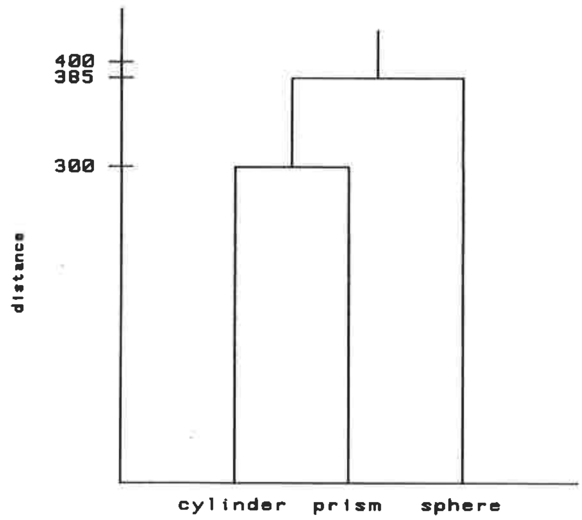
Fig. 3 (a) Proportion of correct responses in percentage(**a**), and comparison of choice accuracy in the five experiments(**b**).

(a)



	Sphere	Cylinder	Prism
Sphere	0	1172	385.5
Cylinder		0	300.8
Prism			0

(b)



	Sphere	Cylinder	Prism
Sphere	0	30.8	241.5
Cylinder		0	249.1
Prism			0

Fig.4 Inter-target similarity distances (matrices and dendrograms) of the sonar pulses used by Alpha (**a**) in the experiment 2b, and (**b**) in the experiment 3b.

HOW MATRILINEAL ARE SPERM WHALE SOCIAL UNITS?

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Previous genetic analyses have suggested matrilineal relatedness within groups of female and juvenile sperm whales. However, photo-ID studies in the Eastern Tropical Pacific have shown that groups are typically not permanent entities, but consist of multiple separate social units, which associate together only briefly. Once analysis of long-term photo-ID records facilitated the delineation of social unit membership, it became possible to assess the genetic structure of sperm whale social units.

In this study, we used a combination of molecular techniques (sexing, mitochondrial DNA sequencing and multi-locus microsatellite typing), on sloughed skin samples. The coefficient of relatedness (r), between pairs of individuals, was estimated using 'Relatedness' software (Queller & Goodnight 1989). Monte Carlo simulation models were constructed for several genetic unit structures, based on age-specific demographic parameters: fecundity, mortality, male dispersal. The data for two known units were compared with those for the simulated units for two measures of genetic structure: r and number of putative parent-offspring pairs (ppo).

A number of factors were indicative of deviations from strict matrilineality: the presence of unrelated individuals, and of different haplotypes within units, low numbers of ppo, and low within-unit r. Although measures of genetic structure within units were significantly greater than for simulated unrelated individuals, they were significantly lower than for pure matrilines.

Deviations from matrilineality could be an artifact of past whaling; however, if this is not the case, then our results raise new questions about the structure of sperm whale society, and the factors which promote social unit membership.

SOME OBSERVATIONS OF MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*) FEEDING BEHAVIOUR AND ASSOCIATIONS WITH SEABIRDS IN THE COASTAL WATERS OF THE ISLE OF MULL, SCOTLAND

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INTRODUCTION The Hebridean Whale and Dolphin Trust and Sea Life Surveys, a commercial whale watching business, have been conducting research in the coastal waters of the Isle of Mull, on the west coast of Scotland, since 1990. The main focus of the research is the minke whale (*Balaenoptera acutorostrata*), and data collection has involved recording sightings, photo-identification, and noting behaviour. The main behaviour noted is feeding behaviour, in particular lunge feeding, often in association with many seabirds.

Most survey effort is dedicated to the photo-identification project which concentrates on obtaining close-up photographs of the whale. However, occasionally sequences of photographs are taken of feeding behaviour, in particular, lunge feeding. Data on seabird species in the vicinity of encountered whales were recorded for the summers of 1992-95.

The aim of this study is to make some general comments on feeding behaviour from the photographs, and to analyse the data collected on associated seabird species.

MATERIALS AND METHODS Surveys were conducted from May to October each year, covering the inshore waters of Northwest Mull, Coll, Tiree, and part of the Small Isles (Rum, Eigg and Muck). When a minke whale was encountered, details of this sighting were logged on a laptop computer on the boat, using the LOGGER program (Leaper *et al.*, 1997). The general behaviour of the whale was recorded as actively feeding, milling, travelling, or breaching. The presence of any birds in the vicinity of the whale was noted. If birds were present, an estimate of the numbers and species were recorded (only available for 1992-95). Bird species were divided up into auks (razorbills and guillemots), gulls (kittiwakes, herring gulls, lesser black-backed and great black-backed gulls), Manx shearwaters, gannets, common terns and great skuas.

Bird data were analysed to determine the number of encounters in which birds were present, the relative proportion of each species of birds by month, and the associated behaviour of the whales. Photographs from 1992-98 were analysed to investigate which bird species showed the greatest degree of association with the whales. Photographed sequences of feeding behaviour were studied to determine the different type of lunges observed.

RESULTS Bird Association: A total of 654 minke whale sightings between 1992 and 1995 were recorded, and birds were present in the vicinity of the whale(s) during 223 (34%) of these sightings. The species of birds recorded were Manx shearwaters *Puffinus puffinus*, herring gulls *Larus argentatus*, great black-backed gulls *Larus marinus*, lesser black-backed gulls *Larus fuscus*, kittiwakes *Rissa tridactyla*, gannets *Sula bassana*, great skuas *Stercorarius skua*, common terns *Sterna hirundo*, guillemots *Uria aalge*, and razorbills *Alca torda*. Figure 1 shows the percentage sightings where birds were present by month. This shows that sightings during September and October show the highest presence of birds.

The total number of birds recorded during the 223 sightings of whales when birds were present was 38,629. The number of birds per whale sighting by month is shown in

Figure 2, which demonstrates that the greatest number of birds per whale sighting occurs during the month of August.

Figure 3 shows the relative proportion of each species of bird by month, and demonstrates that Manx shearwaters predominate during the months of June, July and August, and gulls predominate in numbers during the months of May, September and October.

Figure 4a summarises the behaviour of the whales when birds were present compared with sightings when they were absent (Fig. 4b). This shows that when birds were present, the whales were mainly feeding and milling. When birds were absent, the whales were milling and travelling.

By studying photographs which reveal the bird species in very close proximity to the whales, and from personal observations in the field, two types of association were apparent.

Manx shearwaters tended to hover over whales, following their surfacings very closely, and this was seen during July and August. Gulls (mainly herring gulls and juvenile gulls) tended to clump and form feeding groups on the surface of the water, often numbering hundreds of birds. In this case, it was the whale that approached these groups, lunging up through the birds. This type of association was seen more often during the months of September and October.

Feeding Behaviour Photographed: The following lunges could be described from the photographs.

Dorsal/ventral lunges: The whale lunged from the water in the dorsal/ventral plane. The angle that the head left the water varied, sometimes the whole head emerged with throat grooves and baleen showing. On other occasions, only part of the upper lip and rostrum showed. Water was often seen spilling from each side of the mouth.

Lateral or side lunges: The whale lunged out of the water with the axis of its body at right angles to the horizontal plane. The degree to which the whale left the water again varied and on occasions the throat grooves, one flipper, and the tail flukes could be observed. On other occasions, only splashing could be seen, with just the tip of one fluke exposed.

Twisting lunges: The whale initially lunged out of the water in the dorsal/ventral plane and then twisted its body so that it leant to the right or left. Then at the same time that its dorsal fin was showing, one tip of the tail fluke was exposed.

DISCUSSION The inshore waters of the Hebrides are rich in marine life, and many top marine predators inhabit the area in the summer months to feed. Minke whales and many species of birds are likely to be exploiting the same prey species, in particular, shoaling fish such as herring (*Clupea harengus*), sprat (*Sprattus sprattus*) and sandeels (Ammodytidae) (see review by Evans, 1982). Whales may pursue fish to the surface waters making them more accessible to birds that feed only from the surface or just below. In this study, Manx shearwaters were observed following the whales movements and so must benefit from this association. Whales approaching groups of feeding gulls may be an indirect association in that the whales are pursuing fish that the birds have already grouped over. This suggests that shoaling fish are already concentrated at the surface, perhaps by predatory fish, which the whales and birds then exploit.

More dedicated studies of feeding behaviour and assòciating birds, in relation to fish abundance and distribution, should be conducted in future to provide some valuable insights into the local ecosystem. Concurrent photo-identification studies may reveal the feeding strategies of individual whales.

ACKNOWLEDGEMENTS Many thanks to the International Fund for Animal Welfare, World Wide Fund for Nature, and Richard Evans (Royal Society for the Protection of Birds) who have provided support and advice for this project.

REFERENCES

Evans, P. G. H. 1982. Associations between Seabirds and Cetaceans - a review. *Mammal Review*, 12: 187-206.

Leaper, R., Fairbairns, R., Gordon, J., Hiby, A., Lovell, P. and Papastavrou, V. 1997. Analysis of data collected from a whalewatching operation to assess relative abundance and distribution of the Minke whale (*Balaenoptera acutorostrata*) around the Isle of Mull, Scotland. *Rep. Intern. Whal. Commn.*, 47: 505-511.

Fig 1. The percentage of whale sightings that birds were present by month

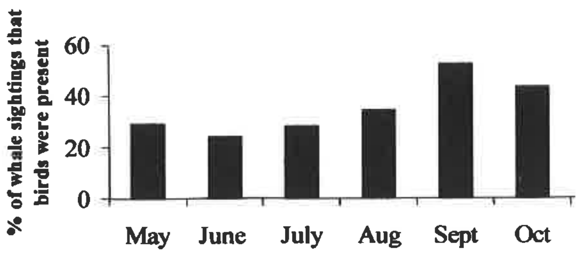


Fig 2. The number of birds per whale sighting by month

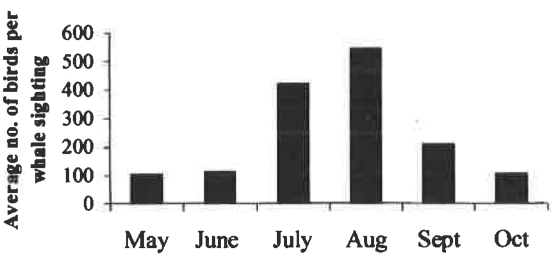


Figure 3. The percentage frequency of each bird species by month

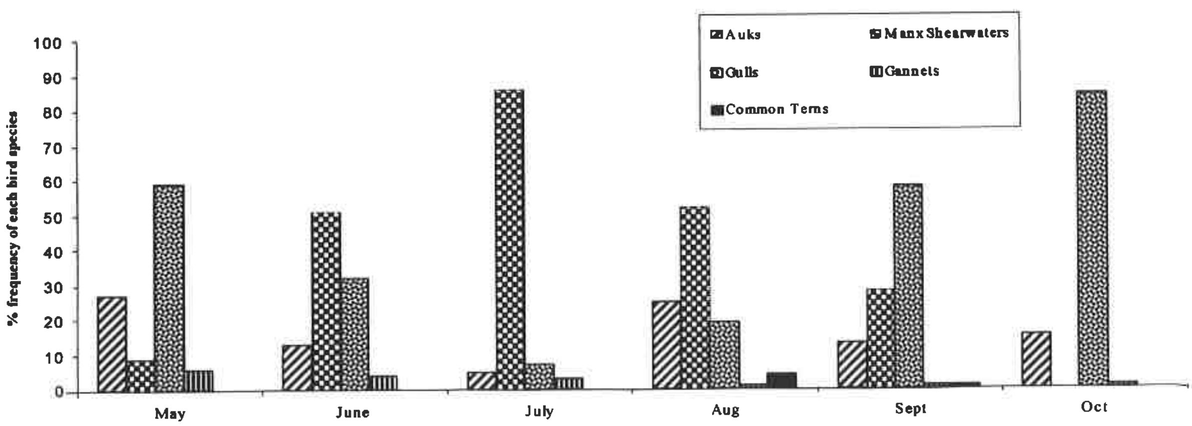


Fig. 4a. Whale behaviour in the presence of birds

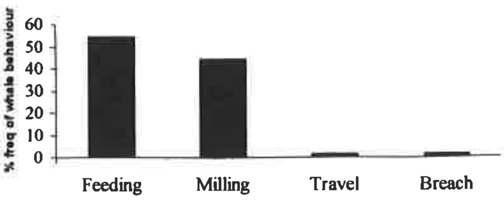
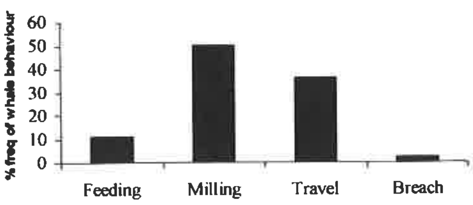


Fig. 4b. Whale behaviour in the absence of birds



POSSIBLE EVIDENCE OF CHIRALITY OR 'HANDEDNESS' IN BOTTLENOSE DOLPHIN BEHAVIOUR, DETECTED BY EXAMINING DORSAL FIN LESIONS FROM PHOTOGRAPHIC DATA

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Photographic data were collected during a twenty-six month study of resident bottlenose dolphins in the Shannon Estuary, Ireland. Individuals were identified by examining naturally occurring nicks, rakes and lesions on their dorsal fins.

Amongst the types of lesion recorded were pale patches on the leading edge of the dorsal fin, possibly caused by abrasion. The quality of photographs was measured by scoring each photograph on a scale of one to four (one being the highest quality, four being the lowest). High quality photographs (with a score from one - three) of 117 individually identified dolphins, photographed during the study, were examined and scored for the presence or absence of this abrasion lesion type. The results showed that a significantly higher proportion of fins identified from the right side of the animal had this abrasion when compared with fins identified from the left (*X*2, df=1, P<0.001).

This right/left bias in the occurrence of abrasions may be caused by a behavioural trait within the population. Possible causes for such a bias are discussed in the context of existing examples of 'handedness' in cetaceans, and social learning.

THE ROLE OF CETACEANS IN THE DIET OF THE PORTUGUESE DOGFISH, *CENTROSCYMNUS COELOLEPIS*

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The Portuguese dogfish *Centrocymnus coelolepis* Bocage and Capello, 1864, is a small demersal-pelagic shark belonging to the Squalidae family with a maximum size of 114 cm. During a study on the biology of the species in the Canary Archipelago, 208 specimens were caught with long lines at various locations of the islands, at depths ranging between 600 and 2,500 m.

The stomach of the specimens was examined systematically, and cetacean remains were found amongst cephalopods, fish and crustaceans which constitute the normal diet of the species. The cetacean remains were mainly chunks of fat and connective tissue, although some muscles and guts were also present, in addition to plerocedoids of the cestoda *Phyllobothrium* cf. *delphini*. The latter showed a higher prevalence of captured animals on the south-west coast of Tenerife. In this area, populations of short finned pilot whales *Globicephala macrorhynchus* and bottlenose dolphins *Tursiops truncatus* are present all the year round. Although it is likely that the Portuguese dogfish predates on cetacean carcasses which fall to the seabed from the surface, it is also possible that this species bites bottom-dwellers cetaceans. Thus, numerous pilot whales with scars likely to be caused by this shark, have been observed.

Other species which were examined in this study were the false catshark *Pseudotriakis microdon* Capello, 1868, the smooth lanternshark *Etmopterus princeps* Collet, 1904, the shortnose velvet dogfish, *Centroscymnus cryptacanthus* Regan, 1906, the arrowhead dogfish *Daenia profundorum* (Smith & Radcliffe, 1912), the rough longnose dogfish, *D.histricosa* Garman, 1906, the kitefin shark *Dalatias licha* (Bonnaterre, 1788), the leafscale gulper shark *Centrophorus squamosus* (Bonnaterre, 1788) the gulper shark *C.granulosus* (Bloch & Schenier, 1801), and the lowfin gulper shark *C.lusitanicus* (Bocage & Capello, 1864) with cetacean remains found only in the latter species.

SURFACE INTERACTION BETWEEN THREE SPERM WHALES (*PHYSETER MACROCEPHALUS*) AND A MEGAMOUTH SHARK (*MEGACHASMA PELAGIOS*)

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INTRODUCTION During spring to summer, 1998, a preliminary census of cetacean species was started in the area of Manado Bay and Bunaken Archipelago, North Sulawesi, Indonesia.

This project is sponsored by WWF Italia and supported by volunteers. Boat surveys took place daily covering a deep sea area where it is possible to meet pelagic species not far from the coast.

Sperm whales (*Physeter macrocephalus*) were encountered seven different times over a period of about four months.

Photo-ID and acoustic recordings will be used on a longterm basis to verify their abundance, distribution, dimension and growth rate.

A unique encounter: On 30th August, 1998 at 10:00 hrs, not far from Nain Island (124°50'3"N, 1°46'W) where sea depth is about 1,000 m., an interaction between three sperm whales and a c. 5 m. long megamouth shark (*Megachasma pelagios*) was observed near the surface.

One of the sperm whales was taking the shark in its mouth during what appeared like an unusual predation contest. At the same time, another sperm whale of the group pointed towards the observers' boat swimming very fast at the surface and, with its mouth open, clearly showed the white part of its lower jaw. The animal passed below the boat, showing an apparent interest in who had disturbed the action that was going on.

In the end, the ten-twelve metre long sperm whales swam off together and the megamouth shark remained at the surface still rather bewildered, swimming slowly without an evident direction. Its dorsal fin and gills showed signs of whale attack. After a few minutes, the shark slowly dived and disappeared in the deep blue sea.

DISCUSSION Megamouth sharks are plankton eating deep sea animals (taking euphausiids, copepods and even jellyfish - Berra and Hutchins, 1991). They have a large head in proportion to their body, white marks on tips of their fins, and a dark triangular mark under the throat. The upper lobe of the caudal fin is very large. It is very rare to meet and observe them near the surface where they usually come only at night, following small crustacean prey. Knowledge about their biology mainly comes from net captured specimens or stranded animals.

Until now, there have been just 13 confirmed reports of megamouth shark sightings world-wide and none of sperm whale predation on them (Florida Museum of Natural History Ichthyology Homepage University of Florida). Table 1 shows world-wide sightings of megamouth sharks.

Most of the studies have shown that sperm whales are mainly benthic or bathypelagic feeders (Berzin, 1971; Leatherwood and Reeves, 1985); nevertheless, some of the prey are captured in mid-water and some may be taken near the sea surface at night. A lot of buoyant objects found in their stomachs demonstrate, in fact, that sperm whales sometimes eat at the surface. Sperm whales are usually considered squid or bone fish feeders, but there are some observations of the presence of *Lamniformes* sharks in their diet (Martin and Clarke, 1986). Megamouth sharks belong to the Order *Lamniformes* (Table 2).

Hypothesis: Is it possible that sperm whales, being huge bathypelagic predators, could recognise megamouth sharks as a prey, being bathypelagic as well?

Is it possible that the three sperm whales observed found the megamouth and moved it from depth to the surface?

Why did we see the megamouth at surface during the day?

Do sick animals come to the surface?

Was it an attack, playfulness, or just curiosity that attracted sperm whales to the megamouth shark?

Hypotheses and questions on what happened are many, but answers are scarce.

CONCLUSIONS This megamouth shark sighting is one of the few reported in open sea compared with a greater number of stranded individuals or caught in fishing nets.

This encounter is also a significant event for studies on the relationship between whales and sharks. The first record of a cetacean attacking a shark occurred in California in Octorber 1997, when killer whales attacked a white shark.

REFERENCES

Berra, T. M. and Hutchins, J. B. 1990. A specimen of Megamouth shark, *Megachasma pelagios* (*Megachasmidae*) from Western Australia. *Rec. West. Aust. Mus.*, 14, 4: 651-656.

Berra, T. M. and Hutchins, J. B. 1991. Natural history notes on the Megamouth Shark, *Megachasma pelagios*, from Western Australia. *The Western Australian Naturalist*, Vol. 18, No. 8.

Berzin, A. 1971. *The Sperm Whale.* Translated from Russian. Israel Program for Scientific Translation, Jerusalem.

Compagno, L. J. V. 1984. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part. 1- *Hexanchiformes* to *Lamniformes*. FAO species catalogue. Vol. 4. Food. Agric. Org. United Nations; FAO Fisheries Synopsis 125, Vol. 4, Pt. 1, 249pp.

Leatherwood, S. and Reeves, R. R. 1985. *The Sierra Club Handbook on Cetaceans*. Sierra Club, San Francisco. 302pp.

Martin, A. R. and Clarke, M. R. 1986. The diet of sperm whales (*Physeter macrocephalus*) captured between Iceland and Greenland. *J. Mar. Biol. Ass.* U.K., 66: 779-790.

Table 1 - World-wide sightings of megamouth sharks

Sighting n°	Location	Date	Sex	Total length
1	Ohau (Hawaii)	15/11/76	M	446cm
2	Catalina Island (California)	29/11/84	M	449cm
3	Mandurah (Australia)	18/08/88	M	515cm
4	Hamamatsu City (Japan)	23/01/89	M	400cm+
5	Suruga Bay (Japan)	06/89	?	490cm
6	Dana Point (California)	21/10/90	M	494cm
7	Hakata Bay (Japan)	29/11/94	F	471cm
8	Dakar (Senegal)	04/05/95	?	180cm?
9	Southern Brazil	18/09/95	M	190cm
10	Toba (Japan)	01/05/97	F	500cm+
11	Cagayan de Oro (Philippines)	21/02/98	?	549cm ca.
12	Atawa, Mie (Japan)	23/04/98	F	549cm
13	Manado, Sulawesi (Indonesia)	30/08/98	?	500cm ca.

Table 2 - Megamouth shark classification

Order	*Lamniformes*
Family	*Odontaspidae* (Sand tiger sharks)
	Mitsukurinidae (Goblin sharks)
	Pseudocarchariidae (Crocodile sharks)
	Megachasmidae (Megamouth shark)
	Alopiidae (Tresher sharks)
	Cetorhinidae (Basking shark)
	Lamnidae (Mackerel sharks)

NIGHT-LIFE OF THE HARBOUR PORPOISE

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INTRODUCTION Results are presented of field trials carried out on the Welsh coast using the POD (an automated, acoustic data logger). The aim of these trials was to assess the feasibility of using this device to monitor habitat use by harbour porpoises.

The study site, Newport Bay, is a shallow bay (<25m deep) on the south-west coast of Wales. Coastal habitats in this region are known to be important for porpoises (Pierpoint *et al*, 1998). Bottlenose dolphins are also reported from Newport Bay.

The POD was deployed on seven occasions from August and December 1998, during which data were collected for continuous periods of up to 90 hrs. The POD logged the number of harbour porpoise echolocation clicks detected in successive 60 sec. periods. POD data were used to describe patterns of porpoise activity at the site, and to generate indices of habitat use, which serve as a baseline for future monitoring.

Diurnal – Nocturnal Activity Patterns Recorded levels of porpoise activity during each trial were consistently higher at night than during the day. To test this observation statistically, data were first extracted as a series of complete 24-hr samples. Twenty 24-hr samples were available (28,797 minutes). Four time-of-day groups (Day, Night, Sunrise, Sunset) were compared using Friedman's test (non-parametric ANOVA for repeated measures). Each group was ranked within successive 24-hr samples, by the proportion of minutes in which porpoises were detected.

The results of the test indicated that there were significant differences between the mean ranks of each group (Friedman's $Chi^2 = 20.08$, 3 df, $p < 0.001$). Six pair-wise comparisons were made to determine between which groups significant differences occurred. Significant differences at the 5% level (Tukey test) were found between Night & Day, Night & Sunrise, and Night & Sunset.

Tidal Influence - Using all data pooled, detection rates were then calculated for successive 0.5 hr periods after high water. Levels of porpoise activity appeared to fall into two periods of relatively high (A) and low (B) activity respectively, approximately consistent with complex changes in the direction of tidal flow at the study site. Porpoises were detected during 12% of 1min samples in Period A, and 3% in Period B.

We compared detection rates for these tidal periods during day and night. The level of porpoise activity during Period A at night consistently ranked higher than at other times. The proportion of minutes with detections were ranked and compared across four groups. Significant differences were found between groups (Friedman's $Chi^2=30.4$, 3 df, $p<0.001$). Tukey multiple comparisons between the six possible pairs of groups showed significant differences at the 5% level between A(night) and B(night), B(day) and A(day). Corresponding significant results were also found when these analyses were repeated using the mean number of porpoise clicks detected per minute.

We concluded that porpoise activity in Newport Bay was significantly affected by both time of day and state of tide. Significantly greater activity was recorded at night and during the ebb tide than at other times.

Monitoring habitat use by porpoises Overall, porpoises were recorded at the study site in 8% of 1 min. periods, during 568 hrs of acoustic monitoring effort. Two hundred and sixty-one discrete encounters were documented (delimited by periods of 10 min. without detections). Several encounters were of more than 2 hrs duration, the longest over 4 hrs.

As most porpoise activity apparently occurs at night in Newport Bay, existing visual data provide poor indices of site use. We calculated daily and monthly detection rates from POD data. Interestingly, trends in habitat use during the present trials did not follow the consistent seasonal trends recorded by visual observation at better known sites on the Welsh coast. Highest activity was recorded in early December, when porpoises were detected in approximately 22% of successive 1-min. periods. At other sites, levels of habitat use and the number of porpoises present peak in late summer, and decline later in the year. Howeve, it should be borne in mind that acoustic monitoring was only conducted in the last five months of the year.

Interactions between Harbour Porpoise and Bottlenose Dolphin During one field trial, bottlenose dolphins were observed foraging at the study site close to groups of harbour porpoises. With dolphins present, the POD detected non-porpoise clicks with significant energy at 50 kHz and 90 kHz, characteristics consistent with dolphin biosonar. During the days which followed, dolphin type clicks were detected during periods when porpoises were also present. Patterns of porpoise activity followed those observed on other occasions, although more daytime activity was recorded than in most other trials.

The striking periodicity and long duration of porpoise encounters, as well as data from visual observations, suggest that porpoises visit this site regularly to feed. The coincidence of bottlenose dolphin and harbour porpoise detections in this case, may reflect exploitation of a common food resource - local fishermen reported the annual arrival of shoals of spawning herring in the bay during this field trial. During this study, a dead adult porpoise was found in the vicinity of the POD, which *post mortem* examination indicated had been killed by bottlenose dolphins (J. Baker, *pers. comm.*). We hypothesise that such fatal interactions may sometimes occur during bouts of competitive foraging.

REFERENCES

Pierpoint, C., Baines, M., and Earl, S. 1998. *The Harbour Porpoise (Phocoena phocoena) in West Wales.* A briefing report to The Joint Marine Partnership of The Wildlife Trusts and WWF-UK, in support of a Special Area of Conservation for harbour porpoises. 34pp.

SHORT-TERM BEHAVIOURAL REACTIONS OF HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) TO THE PRESENCE OF WHALE-WATCHING VESSELS

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From June to September 1998, a study to investigate the influence of commercial whale watching vessels on a population of humpback whales (*Megaptera novaeangliae*) on the coast of Ecuador was carried out. The Isla de la Plata, an island situated 40 km. off the coast in the Machalilla National Park, was used as a platform to observe behaviour of whales and whale watching vessels. Positions of boats and whales were taken with a theodolite from a 95 m. high cliff. Additionally simultanous observations were made from three points situated in the corners of the triangular island. The theodolite data is analysed with respect to swimming speed of whales and boats, group size of whales, distance between whales and boats, and changes in group composition.

Observations of one group of animals was carried out before, during, and after an interaction with whale-watching vessels. The simultanous observations are analysed with respect to the habitat use of humpback whales when whale-watching vessels were present or not.

The humpback whales show short-term reactions to the presence of whale-watching vessels, as the splitting of a group when boats approach, and a subsequent reunion once the boats have left the whales. The data also indicate that the use of the area around the Isla de la Plata changes with the increase of whale-watching vessels.

PHOTO-IDENTIFICATION AS A TOOL TO APPROACH THE BEHAVIOUR AND CONSERVATION OF THE RIVER DOLPHIN *INIA GEOFFRENSIS* IN COLOMBIA

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Over a period of six years, photo-identification has been used in a long-term research study with river dolphins in the Amazon and Orinoco basins in Colombia. Up to now, 307 *Inia geoffrensis* have been identified: 123 in the Amazon river, 28 in the Caqueta river, 86 in the Arauca river, and 68 in the Orinoco-Meta-Bita rivers. Photographs were taken with reflex cameras using a 70-210 mm lens and Fujichrome film 100 ASA pushed to 200. The identification criteria were notches, scars, pigmentation patterns, and, most recently, snout abnormalities. Over 6,000 hours were spent watching dolphins in the study areas from boats and from land observation points. Focal animal samples and *ad libitum* observations were the main methods for recording behaviour. Residence patterns, especially in lakes in the case of the Amazon and in the confluence of tributaries in the Orinoco and Arauca, were recorded. Long distance movements in less than 24 hours were also recorded.

Mating behaviour was described in detail, taking into account identified dolphins in the Orinoco and Arauca rivers, confirming the polygyny of this species. Aggressive interactions were also recorded. Conservation strategies were developed, involving local children with names being given to identified dolphins. Catalogues with pictures of some of these were given to tourist agencies in the Amazon.

CONSERVATION

STATUS AND CONSERVATION THREATS OF SMALL CETACEANS IN SPANISH WATERS

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The results of a survey conducted during 1992-97 show that small cetaceans suffer a variety of adverse human impacts in Spanish waters.

In the Mediterranean Sea, tissue pollutant concentrations, particularly of organochlorine compounds, exceed the threshold levels above which effects on reproduction, growth, and the immune function have been demonstrated to occur in other mammals.

Moreover, fishing continues to be the main source of mortality for a number of populations, with kills of several hundred individuals occurring every year: driftnets, purse seines and some artisanal gillnet operations appear to be the most conflictive activities. Consequently, the populations of common, bottlenose and striped dolphins have all suffered severe declines during the last two decades, and populations are now either fragmented or greatly reduced in their overall distribution range.

In Atlantic waters, purse seines, pair trawling, and deliberate kills for human consumption appear to be the main threats. The species most affected are common dolphins, bottlenose dolphins and harbour porpoises, the latter having been reduced to very small populations that barely survive along the northwestern coast.

The research was funded by the General Direction for the Conservation of Nature, Ministry of the Environment.

POTENTIAL LIMITS TO ANTHROPOGENIC MORTALITY FOR HARBOUR PORPOISES IN THE BALTIC REGION

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We calculated potential limits to anthropogenic mortality for harbour porpoises in the Baltic region, using the conservation objectives set by the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) to investigate whether reported minimum by-catch levels are too high.

According to ASCOBANS: "Populations should be kept at or restored to 80% of their carrying capacity". Mortality limits (ML) were calculated as the product of three terms: $ML = N_{min}\ \Omega R_{max}\ CF$, where N_{min} is a minimum abundance estimate (defined as the 20th percentile of a log-normal distribution), ΩR_{max} is half of an estimated maximum rate of increase, and CF is a conservation factor less than 1.0. A value of 0.04 was used for R_{max}. N_{min} was calculated from SCANS and other abundance surveys conducted in the region. If anthropogenic mortality is less than a mortality limit calculated using this definition of N_{min}, in combination with CF=0.4, a population should not be depleted to less than 80% of its carrying capacity. However, this is only true if unbiased estimates of abundance, mortality, and R_{max} are available, and if stock structure is known well enough so that there is no possibility that multiple populations are treated as a single population. To account for the uncertainties in available estimates of these parameters, the CF was reduced by 50% to CF=0.2.

We defined the Baltic region to include the Skagerrak, Kattegat and the Great and Little Belt Seas, the Kiel and Mecklenburg Bights, and the Baltic Sea and performed the calculations for different hypotheses regarding stock structure among these areas. Data on minimum by-catches per year for these areas were obtained from the published literature. Minimum number of by-catches exceeded the calculated mortality limits for all the stock structure hypotheses tested, indicating that these catches will cause depletion.

The presented results are a serious cause for concern for the harbour porpoise in this region, whose status is already threatened. We suggest that immediate management actions are necessary to reduce the magnitude of by-catches to meet the ASCOBANS conservation objectives.

TOUR BOATS AND DOLPHINS: QUANTIFYING THE ACTIVITIES OF DOLPHIN WATCHING VESSELS IN THE SHANNON ESTUARY

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INTRODUCTION The Shannon estuary, on the western seaboard of Ireland, is home to the only known resident group of bottlenose dolphins (*Tursiops truncatus*) in Ireland (Berrow *et al.*, 1996). Commercial whalewatching began in the estuary in 1993 from Carrigaholt but expanded to Kilrush in 1994. Prior to this study there were no data available on the extent and operation of whalewatching in the estuary. In order to develop a sustainable industry, that does not degrade the habitat for dolphins, a thorough understanding of both the industry and the ecology of the dolphins are required. In this study of tour boats, we address a number of questions, important for the proper management and conservation of bottlenose dolphins in the estuary including: where do operators search for, and locate, dolphins? How many and which individual dolphins are watched? And is this consistent with time?

METHODS Commercial whalewatching trips were accompanied from two ports, Carrigaholt and Kilrush in County Clare on the western seaboard of Ireland (Fig. 1), from 5-11 July 1997 and 10-20 July 1998. Additional trips were sampled outside this intensive study period, two in 1997 and five in 1998. The position of the tour boat in the estuary was recorded from the vessels GPS every 10 minutes together with prevailing weather (wind direction and strength, precipitation, and cloud cover) and sea-state. Trips were chosen in order to carry out simultaneous observations on different vessels from the two ports. The time taken to first observe dolphins on each trip and the total number of dolphins in each group was recorded. A group was described as "one or more dolphins in apparent association" and behaviour categorised from Berrow *et al.* (1996). Whenever possible all dolphins were photographed and analysed using standard photo-ID techniques.

RESULTS **Dolphin-watching industry** Since 1993 and 1994, the number of commercial trips has increased to around 200 per annum (Table 1) involving 2,431 passengers (1997) at a mean rate of 6.3 passengers per trip. During 1998, only 117 trips were carried out, an overall decline of 42% on 1997 as the weather from late July to September 1998 was unfavourable for boat based whalewatching. The present season is very short, with most trips (78%) carried out in July (37%) and August (41%). The mean number of passengers per trip from Carrigaholt has increased from 7.0 in 1995, 8.9 in 1996, to 10.0 in 1997 suggesting the carrying capacity of present operators, during peak season, may soon be reached. A total of 36 trips were sampled during this study, 10% of the total carried out from both ports in 1997 and 14% of those in 1998.

Location and duration of whalewatching trips Such was the consistency in which dolphins were searched for and located in both 1997 and 1998 from the two ports, that individual tracks have not been presented but zoned (Fig. 1). Vessels operating out of each port rarely had contact with each other either visually or via radio during any trips in this study. The mean length of each trip from Carrigaholt in July 1997 was 129 mins and 131 mins in July 1998 (Table 2). Trips from Kilrush were significantly longer (Mann Whitney, $U = 51.0$, $P < 0.01$) in 1997 but not in 1998 ($U = 29.5$, $P = 0.33$). Time to locate dolphins was significantly longer from Kilrush compared with Carrigaholt in 1997 ($U = 26.0$, $P < 0.05$) but not in 1998 ($U = 33.6$, $P = 0.38$). No significant relationship was found in 1997 between time taken to locate dolphins and hours referenced to HW from either Carrigaholt (ANOVA, $F_{1,11} = 0.08$, $P = 0.79$) or Kilrush ($F_{1,3} = 0.44$, $P = 0.56$). Mean trip length of trip and time to locate dolphins was greater from Carrigaholt but shorter from Kilrush at other times of the year, but none of these differences were significant compared to July (Mann-Whitney U-test, $P > 0.05$).

Number of dolphins observed on dolphin-watching trips Single groups were observed on eight trips in 1997 (44%) and five (45%) in 1998. Only one group, on average, was observed per trip in 1998 from Carrigaholt, half that recorded in 1997, but the number of groups observed from Kilrush vessels increased by 30% from 1.2 groups in 1997 to 1.7 in 1998. Though not significantly different (Mann Whitney, $U = 305$, $P = 0.12$) fewer dolphins were seen from both ports in 1998 compared with 1997 (Table 2). Juvenile dolphins were recorded on 13 trips (72%) in 1997 and five (45%) in 1998, with up to four in a group in each year from both ports, showing that breeding groups were being observed. Most groups observed in both years were described as travelling (62 and 58%) or foraging (28 and 34%).

Monitoring of individual dolphins During 1997, 24 individual dolphins could be individually identified using photo-ID and 18 during 1998. In 1997, 21 dolphins were recorded from Carrigaholt and eight from Kilrush, at rates of 3.2 and 2.8 identifiable dolphins per trip, but this was not significantly different (P21 = 1.08, NS). Of the dolphins recorded from Carrigaholt in 1997, 21% were also recorded from Kilrush and three individuals only from Kilrush. Only two dolphins (9%) were recorded from both ports in 1998 but there were only four dolphins (22%) recorded on three or more occasions in 1998 so results should be treated with caution. Of the five dolphins common to both ports in 1997, three were seen from Kilrush a day after they were seen from Carrigaholt, one, two days later and only one individual on the same day. In 1998, the same dolphin was never seen at both sites during the study period nor were any seen on consecutive trips on the same day. On four occasions in 1997, the same dolphins were seen on consecutive trips on the same day from the same port indicating that this was the same group located by the tour boat on each trip. Of the 24 dolphins identified in 1997, six (25%) were also present in 1998. Two animals were observed only from Carrigaholt in 1997 and only from Kilrush in 1998, and two animals from both ports in 1997 but only from Kilrush in 1998. One dolphin was observed in both years only from Kilrush and one observed only from Carrigaholt in 1997 but from both ports in 1998. This dolphin was recorded from Carrigaholt on 14 July and from Kilrush on 15 July suggesting it had moved up river during these dates. Six of the dolphins identified in this study were also recorded in the Shannon estuary in 1993 by Berrow *et al.*, (1996). Thus, at least 16% of the identified population, or 26% if only those dolphins recorded from Carrigaholt are considered, have been using the estuary, at least during the summer, since 1993.

CONCLUSIONS Since 1993, the whalewatching industry in the Shannon estuary has grown to around 200 trips per annum. At present, the season is short and strongly influenced, especially in the outer estuary, by the prevailing weather. Dolphins were found in predictable areas enabling tour boats to largely follow fixed routes when searching for dolphins. Operators were very successful (97% of trips sampled) in locating dolphins. Operators from different ports in the estuary tended to have largely exclusive areas within which they search for, and watch, dolphins. Over the short summer sampling period, the dolphin groups which each operator watched were also largely exclusive. However, although operators watched different dolphin groups between sites, they often watched the same groups on consecutive days and between years. Despite changes in the distribution of dolphins between years, some groups are still subjected to whalewatching, and any adverse effects of tour boats on their behaviour could be intensified. Tour boats are mainly locating travelling groups of dolphins which may limit potential disturbance since this activity is probably less susceptible to the presence of tour boats than activities such as foraging or resting. However, tour boats are also frequently watching groups with calves but this subject warrants further study. The areas searched by tour boats to locate dolphins in relation to individual dolphins' home range needs to be quantified as do the areas in which dolphins carry out maintenance and other activities. There is evidence that the carrying capacity of present operators may soon be reached, and, given the potential increase in whalewatching in the future, these should be investigated now to prevent possible conflict between operators and dolphins in the future.

This study presents the first quantified data on commercial whalewatching in the Shannon estuary, and provides a baseline from which to monitor the development of the industry and assess the impacts on the dolphins.

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REFERENCES

Berrow, S. D., Holmes, B. and Kiely, O. 1996. Distribution and abundance of Bottle-nosed dolphins *Tursiops truncatus* (Montagu) in the Shannon estuary. Biology and Environment. *Proc. R. Ir. Acad.*, 96B:1-9.

Table 1. Number of commercial whalewatching trips carried out in the Shannon estuary, Ireland from 1993 to 1998

	1993	1994	1995	1996	1997	1998	% of total[1]
MV Fiona David	NA	NA	162	145	118	63	59
MV Deva	-	8	28	33	36	18	18
MV St Senan II	-	-	-	36	38	28	19
MV Cariad	-	-	-	5	8	8	4
MV Karen Ann	-	-	2	6	-	-	-
Others	c10	-	-	-	-	-	-
TOTAL	**10+**	**8+**	**192**	**225**	**200**	**117**	

[1] of 1997 figures

NA - Not available

Table 2. Mean (± SE) time to locate dolphins and the number of groups and individual dolphins located (range in parentheses) per trip from Carrigaholt and Kilrush during July

Season	Port	No. of trips	Time to locate dolphins (mins)	Number of dolphin groups	Total number of dolphins
1997	Carrigaholt	13	19 ± 2 (10 - 30)	2.0 ± 0.3 (1 - 4)	11.6 ± 1.5 (5 - 22)
	Kilrush	5	39 ± 7 (19 - 60)	1.2 ± 0.2 (1 - 2)	12.0 ± 3.2 (5 - 20)
1998	Carrigaholt	4	25 ± 12 (10 - 60)	1.0 ± 0.2 (1 - 1)	9.1 ± 3.7 (3 - 20)
	Kilrush	7	45 ± 7 (19 - 60)	1.7 ± 0.4 (0 - 3)	9.6 ± 4.4 (0 - 30)

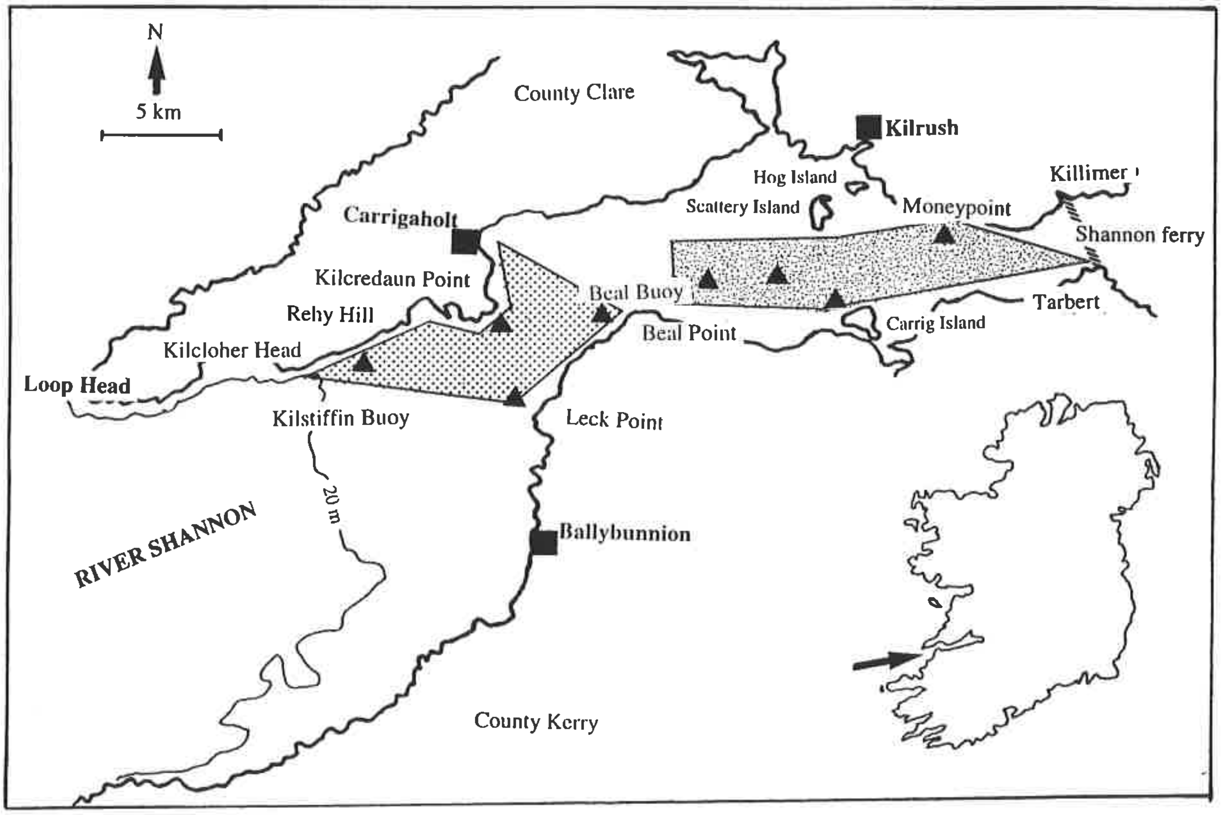

Fig. 1. Map of the Shannon estuary, Ireland showing location of whalewatching ports and landmarks. Areas searched for dolphins by tour boats from Carrigaholt is indicated by dotted area and Kilrush by stippled area. Triangles indicate main dolphin encounter zones.

CETACEAN BY-CATCHES AND STRANDINGS ALONG THE NORTH, WEST, AND EAST COASTS OF THE BLACK SEA IN 1997-1998

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Between January 1997 and November 1998, 261 dead cetaceans were recorded along Ukrainian (188 cases), Bulgarian (39) and Georgian (34) coasts of the Black Sea. The identified animals (238) were presented by harbour porpoises *Phocoena phocoena* (81%), bottlenose dolphins *Tursiops truncatus* (14%) and common dolphins *Delphinus delphis* (5%). Precisely known by-catches (151) were predominant in comparison with strandings (108) which also included suspected by-catches. Incidental catch in bottom-set gill nets was determined as the main cause of death, especially for harbour porpoises (140 carcasses). Standard post-mortem examination was carried out on 124 animals. The samples were taken for histopathological, parasitological, bacteriological, immuno-histochemical and toxicological analyses, and for age determination.

The pathological findings included different types of pneumonia, bronchitis, lymphadenitis, splenitis, gastritis, enteritis, cholangitis/pericholangitis, focal encephalitis, arteriosclerosis, and dermatitis. No morbillivirus antigen was detected in lung, brain and spleen of any of the animals investigated.

Lung lesions caused by nematodes (*Halocercus ponticus*, *H.taurica*, *Stenurus ovatus*) were complicated probably by non-specific pyrogenic bacteria and yeasts. Nematodes *Stenurus minor* and *Crassicauda sp.* were found in cranial air sinuses, trematodes *Pholeter gastrophilus*, and cestodes *Diphyllobothrium stemmacephalum* - in the gastro-intestinal tract.

This work, supported by EC Inco-Copernicus, is currently in the final stage of sample collecting, processing, and data analysis.

THE MONACO AGREEMENT ON THE CONSERVATION OF CETACEANS OF THE BLACK SEA, MEDITERRANEAN SEA AND CONTIGUOUS ATLANTIC AREA

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The preparatory works for the adoption of an Agreement on the Conservation of Cetaceans of the Black Sea and the Mediterranean Sea started in September 1991. On this date, the Third Meeting of the Conference of State Parties to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 23 June 1979) was held at Geneva. During this Third Meeting, State Parties to the Bonn Convention asked for the collaboration of all States of the range area to adopt a multilateral agreement on the conservation of small cetaceans of the Black Sea and the Mediterranean Sea, an agreement pursuant to Article IV, paragraph 4, of the Bonn Convention.

Accordingly, a First Intergovernmental Meeting took place at Monaco, from 26 to 30 September, 1995, in which a very advanced draft agreement was adopted (Document CMS/CET/Doc.4(Rev.1)). A Final Negotiation Meeting was also held at Monaco, from 19 to 24 November, 1996, in which the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area was adopted (Document CMS/CET-II/Doc.6 and Document CMS, 24 November 1996).

The Monaco Agreement pursues two main objectives. Firstly, to achieve and maintain a favourable conservation status for cetaceans for all its geographical scope of application, including both marine areas subject to the sovereignty or jurisdiction of State Parties to this Agreement, and the high seas. To this end, State Parties to this Agreement shall prohibit and take all necessary co-ordinated measures to eliminate, where this is not already done, any deliberate taking of cetaceans, and shall co-operate to create and maintain a network of Special Protected Areas to conserve cetaceans. However, concerning the prohibition of deliberate takings of cetaceans, Article II-2 must also be taken into account. This provision stipulates that any State Party to this Agreement may grant an exception to this prohibition only in emergency situations (see infra) or, after having obtained the advice of the Scientific Committee, for the purpose of non-lethal *in situ* research aimed at maintaining a favourable conservation status for cetaceans.

The Monaco Agreement stipulates that the duty to co-operate in the conservation of cetaceans is not confined only to small cetaceans, as was originally asked for at the Third Meeting of the Conference of State Parties to the Bonn Convention, but applies to all cetaceans that have a range which lies entirely or partly within the Monaco Agreement Area or that accidentally or occasionally frequent the Monaco Agreement Area, an indicative list of which is contained in its Annex 1 (Article I.-2) (see Table 1). As it is stated in other international treaties, for the purposes of the Monaco Agreement, "range" means all areas of water that a cetacean inhabits, stays in temporarily, or crosses at any time on its normal migration route within the Agreement Area (Article I.-3(f)). However, an original characteristic of the Monaco Agreement consists of the definition of Range State, that comprises not only "any State that exercises sovereignty and/or jurisdiction over any part of the range of a cetacean population covered by this Agreement", but also any "State, flag vessels of which are engaged in activities in the Agreement Area which may affect the conservation of cetaceans" (Article I.-3(g)), which is an expression broader than the concept of coastal States of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area. It is also worth noting that the expression "activities which may affect the conservation of cetaceans" is broader than fisheries activities. Moreover, Annex 1 of the Monaco Agreement expressly states that this Agreement shall also apply to any other cetaceans not already listed in this Annex, but which may frequent the Monaco Agreement Area accidentally or occasionally. Therefore, the conclusion is that the Monaco Agreement applies to all kinds of cetaceans that can be found in the Black Sea, in the Mediterranean Sea, and in the Contiguous Atlantic Area, which is bounded to the west by the line joining the lighthouses of Cape St. Vicente (Portugal) and Casablanca (Morocco).

However, the Monaco Agreement, as many other international conventions, neither stipulates any particular co-operative conservation measure different from the prohibition of their deliberate taking, nor establishes any particular Special Protected Area for the conservation of cetaceans. It confines itself to provide the procedures and the institutions (the Meeting of the Parties, the Secretariat, the Subregional Co-ordination Units, the Bureau and the Scientific Committee) that, in the future, will be charged with the duty to adopt these decisions.

Nevertheless, the Monaco Agreement pretends that the decisions to be adopted will be effectively applied in practice. Accordingly, Article XI provides that the provisions of this Agreement shall not affect the right of any State Party to this Agreement to maintain or adopt more stringent measures for the conservation of cetaceans and their habitats, nor the rights or obligations of any State Party to this Agreement deriving from any existing Treaty, Convention or Agreement to which it is also a Party, except where the exercise of those rights and obligations would threaten the conservation of cetaceans. This provision means that the decisions adopted in the future for the implementation of the Monaco Agreement will be considered as a minimum environmental standard for the conservation of cetaceans, that could be either individually or jointly elevated, but never reduced.

The second objective of the Monaco Agreement consists of the undertaking of its State Parties to apply, within the limits of their sovereignty and/or jurisdiction and outside these waters in respect to any vessel under their flag or registered within their territory, and in accordance with their international obligations, the conservation, research and management measures prescribed in Annex 2 to the Monaco Agreement. These measures shall be adopted by State Parties to the Monaco Agreement, to the maximum extent of their economic, technical, and scientific capacities. In implementing these measures, State Parties to the Monaco Agreement must give priority to conserving those species or populations identified by the Scientific Committee as having the least favourable conservation status; must apply the precautionary principle, by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation; and must undertake research in areas or for species for which there is a paucity of data.

The measures prescribed in Annex 2 to the Monaco Agreement address six different matters. Firstly, the adoption and enforcement of national legislation. In general, these national legislations must include all measures needed to give full protection to cetaceans. In particular, they must implement measures to: (a) minimise adverse effects of fisheries on the conservation status of cetaceans, such as limiting the use of drift nets; (b) prevent fishing gear from being discarded or left adrift at sea and require the immediate release of cetaceans caught incidentally in fishing gear; (c) require impact assessments to be carried out; (d) regulate the discharge at sea of pollutants believed to have adverse effects on cetaceans; and (e) strengthen or create national institutions with a view to furthering implementation of the Monaco Agreement.

Among all these legal measures, the most relevant one is the undertaking of State Parties to the Monaco Agreement to develop and implement the necessary legislative, regulatory, or administrative measures to minimise the adverse effects of fisheries on the conservation status of cetaceans. In particular, no vessel shall be allowed to keep on board, or use for fishing, one or more driftnets whose individual or total length is larger than 2.5 kilometres. This length was proposed by the European Community, who adopted a very conservative attitude by defending the maximum length already allowed for driftnets by the European Law and, in particular, by the EEC Regulation No. 345/92, of 27 January 1992. Some non-Community States, but also some Member States of the

European Community (Spain and Greece) were in favour of banning all use of driftnets. However, the delegations of France and Italy backed the European Commission's proposal, arguing that the European Community, and not its Member States, enjoys the exclusive competence on fisheries; that the adoption of this proposal does not prevent the possibility, after the entering into force of the Monaco Agreement, of adopting a measure containing a full ban on driftnets; and that nothing impedes to maintain a full ban on driftnets by those States that had already forbidden their use in their domestic laws, as is in fact the case, for instance, with Spanish domestic law.

Secondly, the assessment and management of human-cetacean interactions. In order to apply measures towards this aim, State Parties to the Monaco Agreement shall, in co-operation with relevant international organisations, collect and analyse data on direct and indirect interactions between humans and cetaceans in relation to *inter alia* fishing, industrial, and touristic activities, and land-based and maritime pollution. But a weak point of the Monaco Agreement relates to its establishment where for this purpose and when necessary, State Parties shall take appropriate remedial measures. The appropriate remedial measures provided for by the Monaco Agreement are the developing of guidelines and/or codes of conduct to regulate or manage such activities. But both guidelines and codes of conduct are instruments that do not have a mandatory character. Therefore, national or regional legal measures concerning this topic will also be needed.

Thirdly, habitat protection. The Monaco Agreement lays down the understanding of State Parties to the Monaco Agreement to establish and manage Special Protected Areas for cetaceans corresponding to the areas which serve as the habitats of cetaceans and/or which provide important food resources for them. In order to elude the problem of co-ordination with other international legal instruments, it is recommended that such Special Protected Areas should be established within the framework of the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution and its relevant protocol, that is, the 1995 Protocol concerning Special Protected Areas and Biological Diversity in the Mediterranean (Bou and Badenes, 1997), or within the framework of other appropriate instruments. But, so far as the Black Sea is concerned, it must be underlined that there is no appropriate legal regional instrument on the establishment of specially protected areas and, therefore, their establishment in the Black Sea remains as uncertain as it was before the adoption of the Monaco Agreement (Öztürk, 1996; Zaitsev and Mamaev, 1997).

Fourthly, research and monitoring. On this matter, State Parties to the Monaco Agreement undertake to co-ordinate concerted research on cetaceans and to facilitate the development of new techniques to enhance their conservation. The Monaco Agreement promotes, in particular, the following five fields for research and monitoring: (a) monitor the status and trends of cetaceans, especially those in poorly known areas, or species for which little data are available, in order to facilitate the elaboration of conservation measures; (b) co-operate to determine the migration routes and the breeding and feeding areas of cetaceans in order to define areas where human activities may need to be regulated as a consequence; (c) evaluate the feeding requirements of cetaceans and adapt fishing regulations and techniques accordingly; (d) develop systematic research programmes on dead, stranded, wounded or sick animals to determine the main interactions with human activities, and to identify present and potential threats; and (e) facilitate the development of passive acoustic techniques to monitor cetacean populations. It is worth noting that the Meeting of the Parties may establish a supplementary conservation fund from voluntary contributions of State Parties or from any other source in order to increase the funds available for monitoring, research, training and projects relating to the conservation of cetaceans (Article IX.3). Hence, until the optional establishment of such a supplementary fund, the implementation of measures on this topic depends exclusively on the individual will of each State Party.

The fifth matter for which Annex 2 prescribes measures deals with capacity building, collection and dissemination of information, training and education. Annex 2 establishes that State Parties shall give priority to capacity building in order to develop the necessary expertise for the implementation of the Monaco Agreement. But this is not an absolute undertaking, because the differing needs and the developmental stages of the Range States will be taken into account when implementing their own capacity building. Moreover, State Parties to the Monaco Agreement shall co-operate to develop common tools for the collection and dissemination of information about cetaceans and to organise training courses and education programmes. A positive aspect of the Monaco Agreement, which is not usual in international treaties, consists in the fact that it has solidified this general duty to co-operate. Hence, the Monaco Agreement stipulates that, in particular, State Parties shall co-operate to: (a) develop systems for collecting data on observations, incidental catches, strandings, epizootics and other phenomena related to cetaceans; (b) prepare lists of national authorities, research and rescue centres, scientists and non-governmental organisations concerned with cetaceans; (c) prepare a directory of existing protected or managed areas which could benefit the conservation of cetaceans and of marine areas of potentially importance for the conservation of cetaceans; (d) prepare a directory of national and international legislation concerning cetaceans; (e) establish, as appropriate, a subregional or regional data bank for the storage of information collected under the above paragraphs; (f) prepare a subregional or regional information bulletin on cetacean conservation activities or contribute to an existing publication serving the same purpose; (g) prepare information, awareness and identification guides for distribution to users of the sea; (h) prepare a regional synthesis of veterinary recommendations for the rescue of cetaceans; and (i) develop and implement training programmes on conservation techniques, in particular, on observation, release, transport and first aid techniques, and responses to emergency situations.

Lastly, but not least, the sixth matter for which Annex 2 prescribes measures concerns responses to emergency situations. Emergency situations are described as situations where exceptionally unfavourable or endangering conditions for cetaceans occur, such as major pollution events, important strandings or epizootics, with the effect of deteriorating the conservation status of one or more cetaceans populations. State Parties shall prepare, in co-operation with each other and in collaboration with competent bodies, emergency plans to be implemented in case of threats to cetaceans; evaluate capacities necessary for rescue operations for wounded or sick cetaceans; and prepare a code of conduct governing the function of centres or laboratories involved in this work.

REFERENCES

Document CMS/CET/Doc.4 (Rev.1): *(Draft) Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea (and Contiguous Atlantic Area).* 17pp.

Document CMS/CET-II/Doc.6: Convention on the Conservation of Migratory Species of Wild Animals, Final Negotiation Meeting. *Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area. 19-24 November 1996, Monaco.* 12pp.

Document CMS, 24 November 1996, *Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area. 24 November 1996.* 18pp.

Bou Franch, V. and Badenes Casino, M. 1997, La protección internacional de zonas y especies en la región mediterránea. *Anuario de Derecho Internacional*, 13: 33-130.

Öztürk, B. 1996, *Proceedings of the First International Symposium on the Marine Mammals of the Black Sea (27-30 June 1994 Istanbul, Turkey)*, Istanbul. 120pp.

Zaitsev, U. and Mamaev, V. 1997, *Biological Diversity in the Black Sea. A Study of Change and Decline*, New York. 208pp.

Tab. 1 - Indicative List of Cetaceans to which the Monaco Agreement applies

INDICATIVE LIST OF CETACEANS OF THE BLACK SEA TO WHICH THE MONACO AGREEMENT APPLIES		
	PHOCOENIDAE	
Phocoena phocoena		Harbour porpoise
	DELPHINIDAE	
Tursiops truncatus		Bottlenose dolphin
Delphinus delphis		Common dolphin
INDICATIVE LIST OF CETACEANS OF THE MEDITERRANEAN SEA AND THE CONTIGUOUS ATLANTIC AREA TO WHICH THE MONACO AGREEMENT APPLIES		
	PHOCOENIDAE	
Phocoena phocoena		Harbour porpoise
	DELPHINIDAE	
Steno bredanensis		Rough-toothed dolphin
Grampus griseus		Risso's dolphin
Tursiops truncatus		Bottlenose dolphin
Stenella coeruleoalba		Striped dolphin
Delphinus delphis		Common dolphin
Pseudorca crassidens		False killer whale
Orcinus orca		Killer whale
Globicephala melas		Long-finned pilot whale
	ZIPHIIDAE	
Mesoplodon densirostris		Blainville's beaked whale
Ziphius cavirostris		Cuvier's beaked whale
	PHYSETERIDAE	
Physeter macrocephalus		Sperm whale
	KOGIIDAE	
Kogia simus		Dwarf sperm whale
	BALAENIDAE	
Eubalaena glacialis		Northern right whale
	BALAENOPTERIDAE	
Balaenoptera acutorostrata		Minke whale
Balaenoptera borealis		Sei whale
Balaenoptera physalus		Fin whale
Megaptera novaeangliae		Humpback whale

THE MEDITERRANEAN SANCTUARY FOR THE PROTECTION OF MARINE MAMMALS

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The marine area between Sardinia (Italy), Corsica (France), Liguria (Italy) and Provence (France, Monaco), with an extension of 73,000 km^2, constitutes an ecological identity of an exceptional importance due to its geographical and climatic features and, above all, because of its hydrological dynamics. It is an ecosystem that includes different specific habitats, characterised by a large biological diversity but with a reduced biomass, that it is in fact very sensitive to any phenomenon of deterioration by pollutants and to a human impact such as overfishing.

This marine area is one of the most important zones of the Mediterranean due to the existence of large concentrations of nutrients in the euphotic layer that leads to the abundance of euphausiid shrimps (*Meganyctiphanes norvegica*). Hence, it has been possible to record in this marine area twelve species of cetaceans, and at least seven of them concentrate themselves regularly in this area. Some of these species, such as fin whales (*Balaenoptera physalus*), striped dolphins (*Stenella coeruleoalba*), long-finned pilot whales (*Globicephala melas*) have denser populations or at least denser seasonal aggregations in this marine area than in any other Mediterranean Sea area. Moreover, tuna (*Scrombidae*), swordfish (*Xiphias gladius*) and other fisheries resources must also be numbered among the species recorded in this area.

At the end of the 1980's, the United Nations General Assembly, taking into account that the use of driftnets in international fisheries is highly indiscriminate and wasteful, attempted to implement an absolute interdiction of these particular nets. For instance, the United Nations General Assembly Resolution 44/225 of 22nd December 1989, recommended a moratorium on all large-scale pelagic driftnet fishing on the high seas by 30th June 1992. Hence, it was expressly recognised that the use of lengthy driftnets implies constant accidental captures of protected species, particularly of some species of marine mammals. At the same time that this world-wide trend against driftnet fishing was initiated, several non-governmental organisations began to claim the prohibition on the use and detention of driftnets for fishing pelagic species in the Mediterranean, particularly in those areas where larger concentrations of marine mammals can be found. Some of these non-governmental organisations drafted different proposals towards this aim, foreseeing the notion of a Mediterranean Sanctuary for the Protection of Marine Mammals. It is worth noting, for instance, that in 1989, the Tethys Institute drafted a proposal in order to establish a biosphere reserve in the basin existing between Corsica, Liguria and Provence. In 1992, the 1st International Conference for the Protection of Marine Mammals in the Western Mediterranean proposed the establishment of a protected ecological area, which should be a common area for all the Western Mediterranean Coastal States, in which all of them should proceed jointly towards an ecological management of living marine resources.

These non-governmental proposals were formulated simultaneously to the development of individual action on this matter by the closest Mediterranean coastal States to this special area. Thus, it is worth noting an Italian Decree of 22nd May 1991, modified by a Decree of 19th June 1991, by which the Italian Ministry for the Merchant Marine established a "biological protected area" ("Sanctuary" for the protection of cetaceans) in the area of the Ligurian Sea between the Mesco crest, the cape Corso and the cape Antibes", delimited by three points fixed by the Italian Decree and the coastline. Inside this Sanctuary, the use of driftnets was forbidden.

The similar individual action followed by these three States paved the way for the subsequent adoption of a Joint Declaration by the same three States, establishing a Sanctuary for the Protection of Marine Mammals in the Mediterranean. The Ministry of the Environment of France, the Minister of the Environment, and the Minister of Merchant Marine of Italy, and the State Minister of Monaco signed at Brussels this Joint Declaration on 22nd March 1993.

This 1993 Joint Declaration represents a further step towards a fruitful international co-operation for the protection of marine mammals in the area of the Mediterranean Sea where they concentrate most of their time. It has the form of a statement of principles that must be implemented by the domestic law of the three concerned States. In its preamble, the three State Parties to the 1993 Joint Declaration acknowledged the serious threats existing for marine mammals and their habitats in the Mediterranean, as well as the fact that the waters existing among Corsica, Liguria and Provence are an important area of distribution of these species.

Therefore, the State Parties to the 1993 Joint Declaration established an international marine Sanctuary in the waters between Corsica (France), Liguria (Italy) and Provence (France, Monaco) with the objective of protecting all species of marine mammals. The 1993 Joint Declaration expressly states that the Sanctuary includes the marine internal waters and the territorial seas of the three States, as well as areas of the high seas, being its geographical scope of application very precisely delimited (see Fig. 1). However, the limits of the Sanctuary may be extended by the State Parties to the 1993 Joint Declaration, unless an objection to this extension is made by any one of them.

The three State Parties to the 1993 Joint Declaration undertake, on the one hand, to adopt all measures which are necessary to ensure a favourable state of conservation of marine mammals, in order to protect them and their habitats from all direct and indirect negative impacts. Their state of conservation will be considered favourable when the knowledge of the populations shows that the marine mammals in the region constitute a vital element of the ecosystems to which they belong. For reaching this aim, they establish an international Authority which has the competence of co-ordinating the management of the Sanctuary. The three concerned States will promote, under the co-ordination of the Authority, the carrying out of research programmes aiming at the implementation of the measures adopted pursuant to the 1993 Joint Declaration. These programmes will be implemented at the national, European, and international levels. On the other hand, they also undertake to promote campaigns for the information of the public.

Moreover, the 1993 Joint Declaration establishes a set of concrete measures adopted for reaching these aims. Thus, the three State Parties prohibit any deliberate catch or harassment of marine mammals in the Sanctuary. All ships are prohibited from the use and possession of driftnets for fishing pelagic species. Research activities requiring the catching of marine mammals are permitted only if they comply with the objectives of the 1993 Joint Declaration, and are subject to authorisation by the national competent authorities. The three State Parties to the 1993 Joint Declaration also undertake to regulate fishing methods which could, after the pertinent scientific assessment is carried out, lead to the catching of marine mammals and affect their food reserves, taking into account the risk of fishing engines being lost or discarded at sea. But this last duty applies only to ships flying their flags. Moreover, offshore races and marine mammal watching for tourist purposes are to be regulated and, if appropriate, prohibited.

Among these measures, the most important one is, without any doubt, the absolute prohibition on the use and possession on board of driftnets. In the Mediterranean, both targeted species of fishes (mostly highly migratory species, such as tuna and swordfish) and non-targeted species (such as marine mammals, birds and turtles) become entangled in pelagic driftnets. Therefore, it is specially interesting to point out the novelty of an absolute prohibition of driftnets, as it is embodied in the 1993 Joint Declaration, particularly if compared with partial prohibitions of this kind of non-selective nets, as stipulated, for instance, in the European Economic Community Regulation No. 345/92 of

22nd January 1992, or in the Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and Contiguous Atlantic Area (Monaco, 24th November 1996). Firstly, the 1993 Joint Declaration implies that it is forbidden to use or keep on board any kind of driftnets, whatever their individual or total length may be, while both the 1992 European Regulation and the 1996 Monaco Agreement only prohibit the use of driftnets with an individual or total length larger than 2.5 km. Secondly, on the one hand the prohibition provided for by the 1993 Joint Declaration is intended to apply to all ships, whatever their flag may be, including the ships flying the flag of a non-State Party to it, and without taking into account whether they are sailing in the internal waters, territorial seas, or in the high seas area existing inside the Sanctuary. On the other hand, the 1992 European Regulation applies in the Mediterranean Sea to all ships flying the flag of whatever State, but only if these ships are sailing in the territorial seas of any of its Mediterranean Member States (France, Greece, Italy and Spain); in the Mediterranean high seas, the 1992 European Regulation only applies to ships flying the flag of whatever of the fifteen Member States, but it does not apply to any other ship flying the flag of a different State. Similarly, the 1996 Monaco Agreement only applies in the high seas of the Mediterranean and Black seas to ships flying the flag of any of its State Parties.

In addition to these measures, the State Parties to the 1993 Joint Declaration also undertake to strengthen monitoring in the Sanctuary and to increase the fight against pollution resulting from any source which may have a direct or indirect impact on the state of conservation of marine mammals. The compliance with the provisions of the 1993 Joint Declaration and their control is ensured by the national agencies in charge of maritime surveillance. The three State Parties to it will facilitate each other, by, if needed, the reciprocal use of ports and airports through simplified procedures.

The signatory ministers of the 1993 Joint Declaration invited the competent authorities of other Mediterranean States to act in a compatible way with the provisions of the 1993 Joint Declaration. This invitation conforms the Achilles' heel of this original international legal instrument. It is the first time that an international instrument creates a specially protected area lying partly and to a large extent in the high seas and managed by an international Authority. But in the high seas area existing inside the Sanctuary, the measures either provided for by the 1993 Joint Declaration, or adopted in the future by its international Authority, are only legally binding for the three State Parties to this 1993 Joint Declaration. It is not possible to create international duties for third States either by an international treaty setting forth protective measures for marine mammals, or by the measures adopted in the future by an international Authority, unless third States consent voluntarily to accept these measures that restrict high seas fisheries freedom. An international treaty negotiated exclusively among three States cannot, in the high seas, protect marine mammals against activities carried out by ships flying the flag of a State that is not a State Party to the international treaty concerned.

This last assertion means that, in order to provide an effective protection for marine mammals inside the Mediterranean Sanctuary against activities carried out by third States, another legal approach is needed.

In principle, the objective of providing an absolute protection for marine mammals inside the Mediterranean Sanctuary could be reached if France, Italy, and Monaco establish economic exclusive zones in the Mediterranean Sea. It must be pointed out that the United Nations Convention on the Law of the Sea allows coastal States or the competent international organisation, to prohibit, limit or regulate the exploitation of marine mammals more strictly than other marine living species in their 200-mile economic exclusive zones and that the waters of the Mediterranean Sanctuary are not found that far. However, until now, there is a tacit agreement among the Mediterranean coastal States on the non establishment of economic exclusive zones in this semi-enclosed sea (Bou, 1998). Therefore, the possibility of establishing these marine zones must be abandoned, despite the fact that the protective measures thereafter adopted, would be legally binding even for third States.

Another legal possibility that would produce a similar result, apparently easier to reach in the short term, consists of converting the Mediterranean Sanctuary for the protection of marine mammals into one of the Special Protected Areas of Mediterranean Importance (SPAMI) that are scheduled in the Protocol concerning Special Protected Areas and Biological Diversity in the Mediterranean (Barcelona, 10th June 1995). If, in the framework of the 1995 Barcelona Protocol, the Sanctuary is included in the SPAMI List, then the protective measures adopted for the marine mammals would be legally binding for all State Parties to the 1995 Barcelona Protocol. It must be underlined that, although the 1995 Barcelona Protocol is not legally binding for third States, it contains different provisions aimed at ensuring that no one, even third States, engage in any activity contrary to its principles and purposes (Bou, 1995).

Taking these facts into account, it is worth noting that, on 17th November 1995, the Fourth International Conference for the Protection of Marine Mammals in the Western Mediterranean (RIMMO), held in Antibes (France), adopted a Proposal on a future designation of the waters located between Corsica, Liguria, and Provence as a SPAMI, according to the 1995 Barcelona Protocol.

The RIMMO Proposal is a very well structured text. It was drafted in conformity with the Annex to the 1995 Barcelona Protocol containing the Common Criteria for the Choice of Protected Marine and Coastal Areas that Could Be Included in the SPAMI List. But in order to be successful, this initiative of a non-governmental organisation must solve several obstacles. The first obstacle arises from the fact that the 1995 Barcelona Protocol has not yet entered into force.

Once the 1995 Barcelona Protocol enters into force, the proposal for inclusion in the SPAMI List of an area situated, partly or wholly, on the high seas or in areas where the limits of national sovereignty or jurisdiction have not yet been defined, as it is the case with the Mediterranean Sanctuary, it must be presented jointly by the neighbouring State Parties concerned. This requirement means that a non-governmental organisation, such as RIMMO, is not entitled to officially present a proposal for inclusion of an area in the SPAMI List, although it may promote a similar action taken by States that are State Parties to the 1995 Barcelona Protocol. Thus, if it is to be successful, the RIMMO initiative needs, on the one hand, that the 1995 Barcelona Protocol enters into force, with France, Italy and Monaco being State Parties to it and, on the other hand, that these three States support the RIMMO Proposal or another one with similar contents. If this is the case, and after checking that the proposal is consistent with the Common Criteria for the Choice of Protected Marine and Coastal Areas that Could Be Included in the SPAMI List, then the decision to include the Mediterranean Sanctuary in this List shall be taken by consensus by all the State Parties to the 1995 Barcelona Protocol.

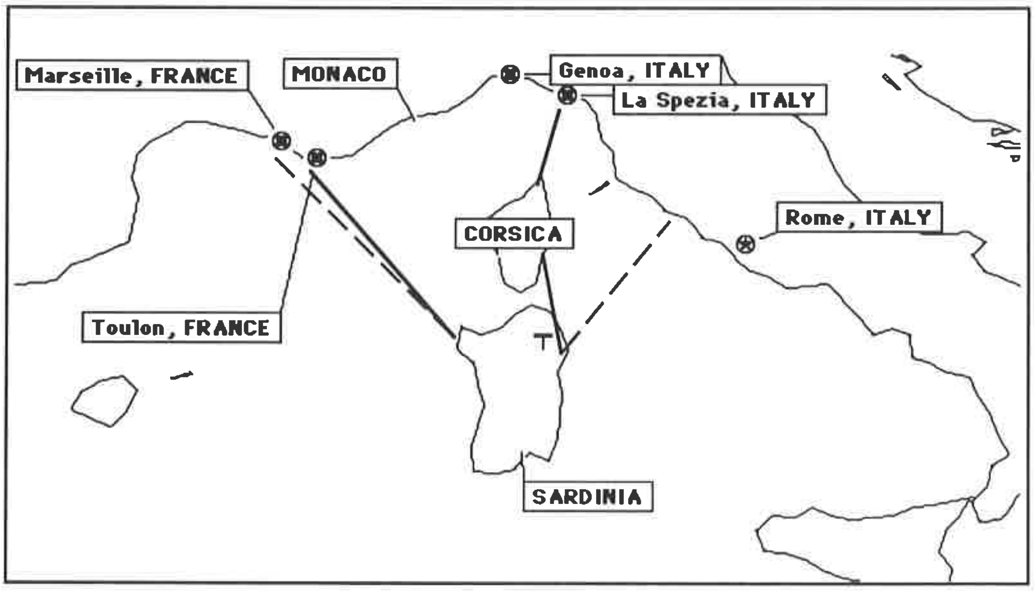
Fortunately, some recent developments show that this is what is going to happen. The 1995 Barcelona Protocol has not yet entered into force, but it has been already ratified by Spain, Monaco, and Tunis. Other Mediterranean States, and among them France and Italy, will probably ratify it soon, so it is expected that the 1995 Barcelona Protocol will enter into force during 1999. Moreover, on 29th September 1998, Italy prepared a draft Agreement concerning the establishment in the Mediterranean of a Sanctuary for marine mammals (Ministero dell'Ambiente, 1998). The 1998 Italian draft Agreement, that must be negotiated with France, Monaco and the European Community, strengthens the protective measures already included in the 1993 Joint Declaration and broadens its geographical scope of application (see Fig. 1). Pursuant to the Italian draft Agreement, when the 1995 Barcelona Protocol enters into force, the State Parties to the draft Agreement undertake to present the proposal for inclusion of the Sanctuary in the SPAMI List.

REFERENCES

Ministero dell'Ambiente, 1998. *Proposta dell'Italia per un Acordo relativo all'istituzione nel Mediterraneo di un Santuario per i mammiferi marini.* 20pp.

Bou, V., 1995. Protected Areas and Species: The Mediterranean Basin. Pp. 671-696. In: *Proceedings of The Second International Conference on the Mediterranean Coastal Environment*, vol. 2. (Ed. E. Özan).

Bou, V., 1998. La protección de los mamíferos marinos en el Mar Mediterráneo. *Anuario de Derecho Internacional*, 14: 3-51.



——— Limits of the Sanctuary pursuant to the 1993 Joint Declaration

– – - Limits of the Sanctuary pursuant to the 1998 Italian draft Agreement

Fig. 1 - The Mediterranean Sanctuary for the Protection of Marine Mammals

1993 Limits: To the West, a line from Point Escampobarion (the western point of Giens Peninsula: 43°01'40"N, 06°06'00"E) to Cape Falcone (40°58'30"N, 08°11'50"E), located at the western extremity of the Asinara Gulf (northern Sardinia). To the East, a line from Cape Corso (43°00'45"N, 09°25'05"E) to point bianca (esatern point of the La Spezia Gulf: 44°09'25"N, 09°58'35"E). To the South, a line from Cape Ferro in Sardinia (41°09'25"N, 09°32'00"E) to Point Chiappa in Corsica (41°35'00"N, 09°22'00"E).

1998 Limits: To the West, a line joining the mouth of the river Rhone (43°20'00"N, 04°50'30"E) and Cape Falcone, located at the western coast of Sardinia (40°58'00"N, 08°12'00"E). To the East, a line joining Cape Ferro, located in the north-eastern coast of Sardinia (41°09'018"N, 09°31'18"E) and Fosso Chiarone, located in the western coast of Italy (42°21'24"N, 11°31'00"E).

ARE BOTTLENOSE DOLPHINS DISTURBED BY FAST FERRIES?

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INTRODUCTION The fast ferry industry is growing more rapidly than any other sector of the world transport market (Baird, *pers. comm.*). Fast ferry services now operate in many areas of known cetacean abundance, and there is anecdotal evidence of conflict. Fast ferries are known to be noisy, but research has tended to focus on airborne noise pollution in the human environment. This paper, which follows a preliminary analysis (Browning *et al.*, 1997), presents results from the first study to consider potential acoustic disturbance of cetaceans by fast ferry services in UK. The subjects of the study were the UK's fastest passenger ferry - CONDOR EXPRESS - and a group of free-ranging bottlenose dolphins (*Tursiops truncatus*) off the Dorset coast. Our study sought to answer two questions:

1. Does the CONDOR EXPRESS fast ferry have the potential to cause acoustic disturbance of bottlenose dolphins?

2. Is there any evidence of disturbance/displacement of the local dolphins?

The ferry - Condor Express is the UK's fastest ferry (Fig. 1). The ferry is a wave-piercing catamaran made by INCAT of Tasmania. In March 1997, CONDOR EXPRESS was transferred to a new, twice daily, service from Poole to the Channel Islands. Her specifications are as follows (Moore, 1998):

• Length overall	86.27 m
• Beam overall	26.00 m
• Draft	3.507 m when planing
• Deepest draft	3.900 m
• No. passengers	775
• Vehicle capacity	175 cars
• Top speed	41 knots
• Propulsion system	4 water jets powered by diesel engine, cycling 24 tonnes water per second at top speed.

The dolphins: The Durlston Marine Research Area (Fig. 2) is the site of a long-running study of bottlenose dolphins. Since 1988, when a systematic cetacean watch was initiated, the study has grown to encompass cetacean behaviour, acoustics, and photo-identification (Browning, 1997; Harland *et al.*, 1996a, 1996b). Five animals have been identified as the only regular visitors to the Marine Research Area, and these are the subject of ongoing studies (Browning, 1999).

METHODS Acoustics: The acoustic signature of the ferry was measured using two separate monitoring systems: 1) the 'boat hydrophone: a ball hydrophone and preamplifier suspended 2 m. below a small fishing boat. The boat was drifting in 18 m. of water outside Swanage Bay, approximately 1 km west of the track of the ferry (closest point of approach 900 m.); 2) the 'tripod hydrophone': a fixed ball hydrophone (on a tripod) suspended 1.2 m. above the seabed in 11 m. of water in Durlston Bay. This hydrophone lies approximately 3.5 km west of the ferry's track. Both signals were recorded on DAT, and replayed into an Advantest R9211C analyser to obtain spectra.

Dolphin sightings: Our assessment of dolphin disturbance relied upon the simplest possible parameter: the frequency of sightings in the study area. Dolphin sightings data from the Durlston Dolphin Watch were combined with sightings from casual observers to provide enough data to compare levels of dolphin activity before and since the commencement of the fast ferry service. Two questions were considered:

- Has there been a change in the frequency of dolphin sightings since the ferry started operating?

- Has there been a change in the time of day at which sightings occur at Durlston, which may be related to the timing of the ferry crossings?

Both of these analyses used sightings records from casual observers as well as the systematic Dolphin Watch. In order to ascertain whether the casual sightings are a reliable indicator of dolphin presence, the correlation between casual sightings and Dolphin Watch sightings (effort-related) was examined. Using 1997/8 sightings data, the correlation coefficient was calculated as 0.72, indicating a strong positive correlation between sightings from casual observers and the Dolphin Watch team. This supports the use of both data sets for the above analyses.

RESULTS Acoustics: Typical spectra are shown in Figures 3 and 4. For the 1 kHz spectrum, the measurement bandwidth is 1.2 Hz, and for the 20 kHz spectrum, it is 25 Hz. Each spectrum is averaged from 16 input spectra. The dominant sound sources within the 100 Hz to 20 kHZ frequency range are the two strong lines around 500 Hz, caused by machinery. In addition to these discrete lines, machinery also produces a continuous spectrum across the range 100 Hz to above 5 kHz, though the contribution above 1 kHz is relatively small. Above 10 kHz the sound energy increases again, due to displaced water impacting the sea surface. Measurements from both hydrophones indicate that the 500 Hz contribution is directional, and is strongest when the ship is approaching the hydrophone. This effect, caused by the ship's design, has also been noted in air (Odegaard *et al.*, 1997).

Dolphin sightings: Figure 5 shows the year by year analysis of all dolphin sightings within the Durlston Marine Research Area, allowing comparison of the first year following the commencement of the ferry service with the six previous years. Data collected prior to 1991 have not been included, as the sightings programme was in its infancy at this stage, and data may not be of a comparable quality. In 1997/98, dolphin sightings were reported on 70 days. Although this is considerably lower than the previous year, the figure is within 0.11 standard deviations of the mean for the six previous years (mean = 73.3, SD = 31.1). Figure 6 shows an analysis of the proportion of all sightings days on which sightings occurred between 14:00 hrs and 17:00 hrs, this being a period when the ferry passes through the study area twice. In 1997/98, sightings occurred between 14:00 hrs and 17:00 hrs on 36% of all sightings days, an identical figure to the mean for the six previous years.

DISCUSSION What is a fast ferry? The number of fast ferries operating in the UK has doubled in the last five years (Condor Ferries, *pers. comm.*). This trend has been mirrored worldwide, with 150% growth in 1996-97 alone (Anon. 1998). Fast ferries are defined in various ways, from specific performance ratios (for example, Arriaga *et al.*, 1997) to general description. Blunden (1998) uses the definition: 'a vessel operated commercially that is capable of carrying at least 50 passengers at a minimum service speed of 25 knots. Over the last few decades, several distinct designs of fast ferry have been manufactured, from hovercraft to hydrofoil, but at present the market is strongly dominated by wavepiercing catamarans. Between 1995 and 1997, catamarans accounted for 78% of deliveries. Fast ferry technology continues to develop rapidly, with the emphasis on passenger and vehicle ferries with ever larger capacities.

Environmental impacts: The potential environmental impacts of fast ferries have been considered by several authors. Of particular concern are the effects of the waves produced by fast ferries, which are quite different from those produced by conventional ferries. The waves from fast ferries tend to be long, low, swell-like waves, which, in shallow water, increase in height due to shoaling (Kofoed-Hansen and Mikkelsen, 1997). The implications of this for beach recreation, coastal erosion, and bird nesting sites are discussed by Lankester (1997). Waves also propagate downwards from fast ferries, causing seabed disturbance (and potentially, habitat damage) at depths of up to 100m (Jørgensen, 1996).

Noise pollution: Noise is another recognised problem. In air, waterjet fast ferries produce a distinctive, low frequency 'hum', and in Denmark thousands of complaints lead to the introduction of tight noise exposure limits specifically related to fast ferries operating in residential areas (Odegaard *et al.*, 1997). In water, far less is known. There have been several reports of whale collisions with fast ferries (Clark, *pers. comm.*) but it is not known whether these were related to noise pollution.

Our study found the key elements of the fast ferry's acoustic signature to be a strong machinery sound at around 500 Hz (possibly produced by the turbo blowers on the propulsion engines) and considerable high frequency noise from the impact of displaced water on the sea surface. It is likely that in deeper water, the impeller blade rate of 30-40 Hz would also be important.

Is this significant for bottlenose dolphins? Figure 7 shows an audiogram for the bottlenose dolphin (adapted from Richardson *et al.*, 1995). The dominant 500 Hz feature of the fast ferry's acoustic signature falls within a relatively insensitive part of the hearing range. Whether this means that the dolphin is unlikely to be disturbed by the sound is debatable. The level of the 500 Hz lines compared with wideband levels is typically only 3 dB above total noise power in the region 300 Hz to 1 kHz. The ferry's higher frequency element falls in a region of much greater auditory sensitivity. It is conceivable that the increase in wideband noise caused by the ferry might reduce the range over which the dolphins' vocalisations are effective, especially in the 10-20 kHz range typical of tonal communication. Potentially, therefore, fast ferries may be a cause of disturbance for bottlenose dolphins. Of course, acoustic disturbance might not be the only impact which fast ferries have on cetaceans: other aspects such as the 'startle factor' of such fast craft, or the production of temporary 'bubble barriers' underwater might also be important.

Is this significant for the Durlston dolphins? The CONDOR EXPRESS ferry briefly traverses the Durlston Marine Research Area four times in 24 hours. During these passages, the ferry increases the ambient noise level across the spectrum, with a strong contribution at 500 Hz. Ambient noise in the area is typically high, and the ferry's wide band contribution has a comparable effect to that of sediment transport and flow noise during a peak spring tide or storm, though much more fleeting. The Durlston dolphins are quite wide ranging, and seem to be unusual in the rarity of their observed use of tonal communication. We feel that the ferry is unlikely to disturb the Durlston dolphins for the following reasons:

- encounters with the ferry will be infrequent, as the animals have a large range, and the ferry only crosses four times a day;

- the ferry's high frequency noise, though potentially significant, is comparable to those produced regularly by certain sea conditions;

- the 500 Hz contribution is less likely to be significant, especially when combined with the brevity and infrequency of encounters.

Are there signs of disturbance in the Durlston dolphins? The sightings analyses showed no signs of disturbance: although there was a marked drop in sightings in the first year of the ferry service, when compared with the previous six years' data, the analysis was unable to detect any significant change in the annual frequency of sightings days.

No change was detected in the time of day at which sightings occurred, suggesting that dolphin are not avoiding the ferry. The latter analysis is weakened by the fact that the ferry was experiencing punctuality problems during the survey, and did not always pass through the study area between 14:00 and 17:00 hours as assumed. Condor Ferries estimated that 80% of crossings ran to schedule. On several occasions, dolphins have been observed as the ferry passes, with no noticeable change in their behaviour. Condor Ferries report that bottlenose dolphins occasionally approach and bow-ride the ferry as it approaches the Channel islands at reduced speed. Both of these observations support the sightings analysis. However, it should be noted that the analysis relies upon sightings data from a large number of observers, over a long period of time, and as such are subject to various unquantifiable factors such as: growing public awareness of dolphin presence and of the need to report sightings; increasing skill of the Dolphin Watch team; and increasing use of the hydrophone to indicate dolphin presence and precipitate sightings. As such, the sightings analysis should be taken only as a rough indicator of gross activity patterns.

Limitations: We acknowledge that our study was limited by the following factors: the short duration of study; the highly variable quality of data, combining dolphin sightings from trained and casual observers; the unreliable timing of ferry crossing (see above); a lack of knowledge of the behavioural implications of acoustic disturbance; and a lack of knowledge of the behavioural response to different frequencies, sound levels, and duration of noises.

CONCLUSIONS We feel that, in our particular set of circumstances, the fast ferry is unlikely to cause acoustic disturbance of bottlenose dolphins, and, indeed, no signs of disturbance were detected, albeit from a rather crude analysis. However, we feel that in a different acoustic environment, disturbance may be more likely. For instance, 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. Moreover, it should be noted that fast ferry designs are very diverse, and we only studied one model. Other designs might have very different acoustic signatures. In addition, cetacean species other than bottlenose dolphins - especially larger species - may be more susceptible to acoustic disturbance. Given the rapid expansion of the fast ferry industry, we urge researchers to look into this as a matter of urgent conservation importance. As well as researching acoustic impacts, it is important to consider other factors, for example the 'startle factor' of a fast vessel and its possible implication in collisions between fast ferries and cetaceans.

ACKNOWLEDGEMENTS We would like to thank the Durlston Dolphin Watch team and the Durlston Marine Project partners (WWF-UK, Dorset County Council, the National Trust, Dorset Wildlife Trust and the Friends of Durlston). Thanks also to Alan Lander (Swanage Fishermen's Association) and Peter Moore, Nick Dobbs, and Tracy Franklin (Condor Ferries).

REFERENCES

Anon, 1998. *The World Fast Ferry Market* (2nd Edition). Baird Publications.

Arriaga, A., Berry, S., Cooper, I., Liddington, P., Meunier, M. and Potter, P. 1997. *Purbeck Integrated Transport Scheme - Feasibility study of ferry links* - Main Report. University of Southampton Department of Aeronautics and Astronautics and Department of Ship Science.

Blunden, A. 1998. *Fast ferries - from 70 seats to 1,500 seats + 375 cars in 40 years.* Fast Ferry International internet homepage October 1998. http://www.fastferry.co.uk/history.html.

Browning, L. J. 1997. *Durlston Marine Research Area - a status report on the physical environment, wildlife and human use.* Durlston Coastwatch. 24pp.

Browning, L. J. 1999. *Durlston Marine Research Area - a Research Action Plan.* Durlston Marine Project. In press.

Browning, L. J., Williams, A. D., and Harland, E. 1997. Cetacean disturbance by high speed ferries: a preliminary assessment. In: *Proceedings of the Institute of Acoustics,* vol *19:9*, pp. 85-95.

Harland, E., Plowman, R., and Turnbull, M. 1996. Deployment of a sea-bed mounted hydrophone for cetacean monitoring. Pp 69-71. In: *European Research on Cetaceans - 9,* Proc.9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb 1995, (Eds. P. G. H. Evans & H. Nice), European Cetacean Society, Kiel, Germany. 302pp.

Harland, E., Turnbull, M., Williams, R., and Copley, V. 1996. The Durlston Cetacean Monitoring Project. Pp 89-91. In: *European Research on Cetaceans - 9,* Proc.9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 February 1995, (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Jørgensen, H. M. 1996. The Danish Society for Nature conservation demands immerdiate regulation of high speed ferry traffic in Danish waters. *Danish Society for Nature Conservation,* Press Release.

Kofoed-Hansen, H., and Mikkelsen, A. C. 1997. Wake wash from fast ferries in Denmark. Pp 471-478. In *Proceedings Fourth International Conference on Fast Sea Transportation,* Sydney, Australia, July 21-23 1997, Baird Publications, Australia.

Lankester, R. 1997 *High speed ships - technical success, environmental failure.* North Sea Monitor, June 1997, pp. 16-17.

Moore, P. M. 1998. 35 Years of Fast Ferries in the Channel Islands - a taster from the forthcoming book. Condor Ferries internet website October 1998. http://www.condorferries.co.uk/history.html.

Odegaard, J., Nielsen, O. W. and Gosling, A. 1997. External noise from fast ferries. Pp 479-484. In: *Proceedings Fourth International Conference on Fast Sea Transportation, Sydney,* Australia, July 21-23 1997, Baird Publications, Australia.

Richardson. W. J., Greene, C. R., Malme, C. I. and Thompson, D. H. 1995. *Marine Mammals and Noise.* Academic Press, San Diego.

Williams, A. D and Browning, L. J., 1999. Analysis of sightings, photo-identification and acoustic data from a small group of bottlenose dolphins in central Southern England: moving towards an integrated approach., Pp. 196-201. In: *European Research on Cetaceans - 12.* (Eds. P. G. H. Evans & E. C. M. Parsons). Proc. 12th Ann. Conf. ECS, Monaco, 20-24 January 1998. European Cetacean Society, Valencia, Spain. 436pp.

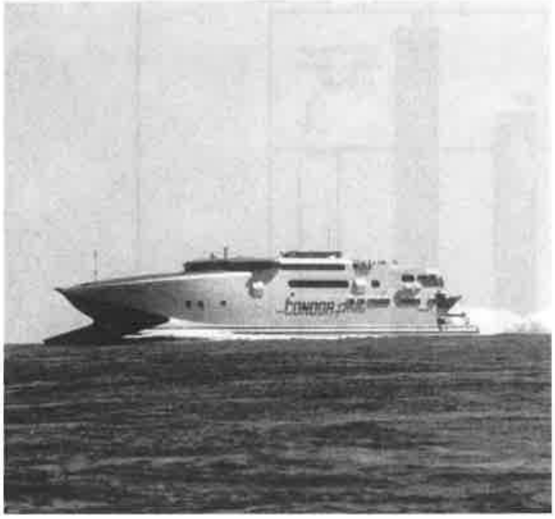

Fig. 1 - *CONDOR EXPRESS*
(Photo by Lisa Browning)

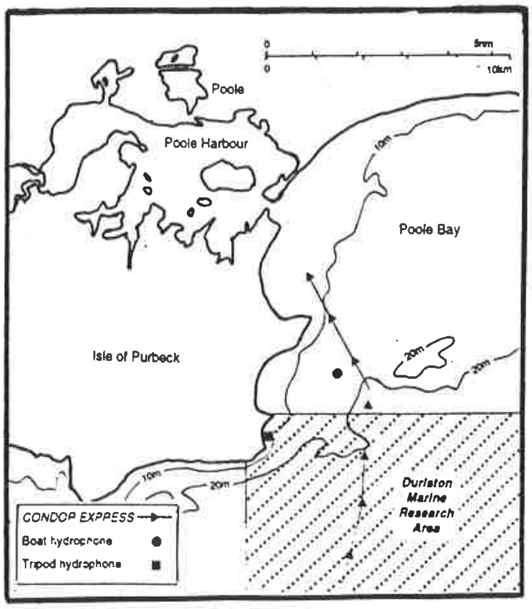

Fig. 2 - The study site. (N.B. The Durlston Marine Research Area has since been enlarged to cover most of the sea area of the map)

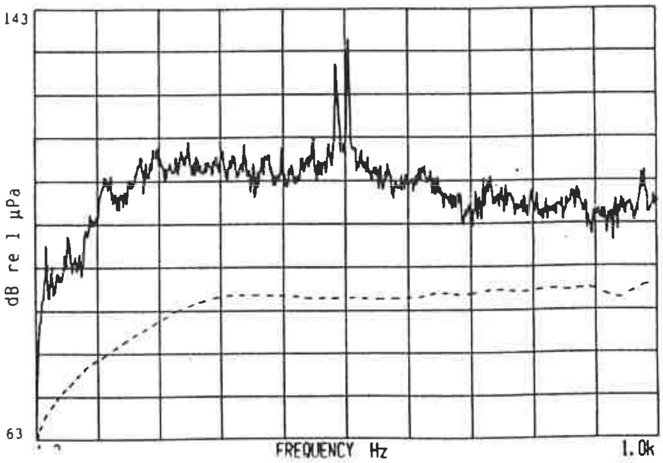

Fig. 3 - Boat hydrophone output up to 1 kHz, closest point of approach (900 m)

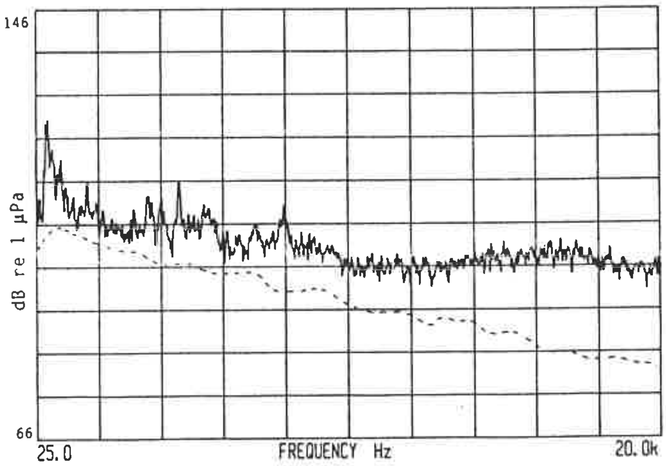

Fig. 4 - Tripod hydrophone output up to 25 kHz, closest point of approach (3.5 km)

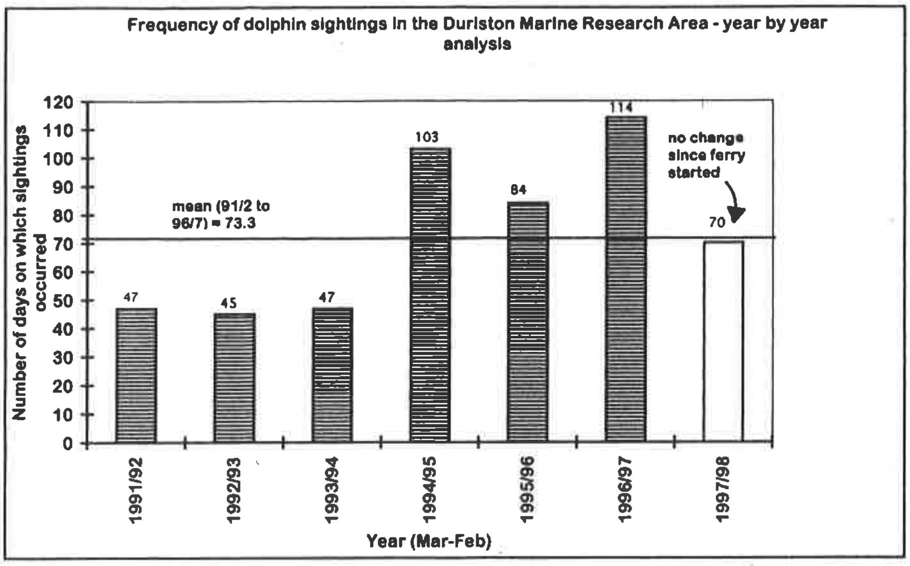

Fig. 5 - Dolphin sightings days per year, 1991/92 to 1997/98

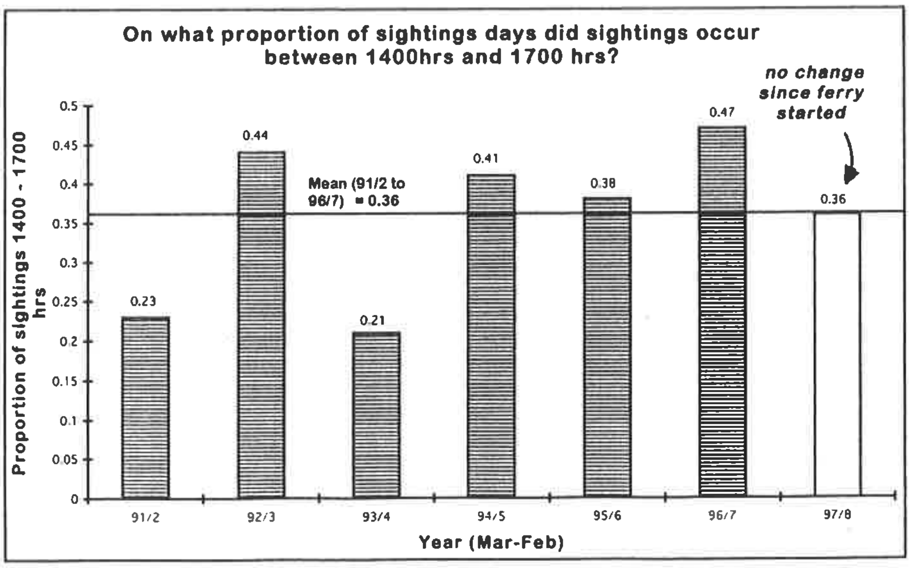

Fig. 6 - Proportion of dolphin sightings occurring between 14:00 and 17:00, 1991/92 - 1997/98

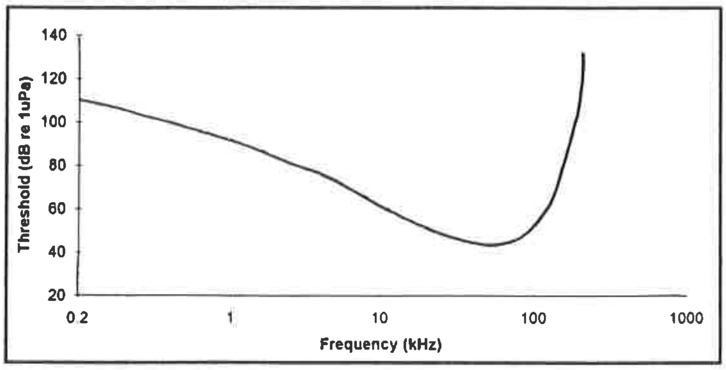

Fig. 7 - Bottlenose dolphin audiogram (adapted from Richardson *et al.*, 1995)

MORTALITY OF LA PLATA RIVER DOLPHIN, *PONTOPORIA BLAINVILLEI*, IN SOUTHERN BUENOS AIRES PROVINCE, ARGENTINA (1998): BIG CHANGES THAT CHANGE NOTHING

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The La Plata River dolphin, an endemic small cetacean of the Southwest Atlantic coast, is threatened all along its distribution by a sustained high level of incidental mortality in artisanal fisheries.

Previous surveys showed that in the Buenos Aires Province alone there may be c. 500 dolphins killed every year (Corcuera *et al.*, 1998). Here we assess the incidental capture levels in four fishing harbours/camps where a high mortality was detected in the past: Puerto Quequén, Claromecó, Puerto Rosales, and Ingeniero White.

By means of personal interviews with fishermen and on-board observations, we estimated the annual Mortality (M), the Fishing Effort and the Catch per Unit of Effort (CPUE) in each locality. A preliminary comparison with data obtained in 1993 shows some significant differences. While in Puerto Quequén, mortality is still low (M= 12.8; 95% CI= 6.56-21.60), the CPUE is 10 times higher than the one previously estimated. This may be caused by a reduction in the fishing depths of the operating vessels. Claromecó used to be a threatening fishing locality, but now seems not to be a high risk area, due to the extinction of the shark fishery that caused its high mortality level in the early 1990's. In Puerto Rosales, M is very low (M= 6.0; 95% CI= 2.20-13.10), while in Ingeniero White it is as high as the one previously calculated, though the vessel fleet has doubled.

Overall, the data show that, although fishing gear changed dramatically (the main cause of M is now the shrimp gear, not the gillnet, given the collapse of the latter) at the end of this decade, artisanal fishing still proves to be a potential threat to the conservation of this small dolphin. Trends in M need therefore to be periodically monitored. An abundance estimation of the species is urgent in Argentina.

This project was founded by Yaqu-Pacha (Germany) and MACN (Argentina).

PRELIMINARY SURVEY ON THE INTERACTIONS BETWEEN LOCAL POPULATIONS OF *DELPHINUS DELPHIS* AND *TURSIOPS TRUNCATUS* AND COASTAL FISHERY IN NORTH-EASTERN AEGEAN SEA

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During the summer of 1998, some observations and interviews with the fishermen of Macedonia and Thracia (Greece) were undertaken to determine the presence of dolphins and their interaction with the coastal fisheries activities.

This preliminary survey was conducted in order to trial a future more intensive study which would attempt a possible management proposal. The study area is in the Thracian Sea delimited by the co-ordinates 40° 39' N - 23° 42' E and 40° 58' N - 25° 13' E. In this area are located the main fishing ports of North Greece.

After three months spent in the study area to interview fishermen, about 50% of them reported interaction with dolphins. Between these interactions, 75% operated over all the fishing period, and in 38% of all interactions were reported damage to the nets and an estimated significant decrease in fish catch. The dolphins normally appeared in numbers of 2-4 individuals. The species involved in the interactions are: common dolphin *Delphinus delphis* and bottlenose dolphin *Tursiops truncatus*. Further investigations should be carried out in the near future, including a census of the populations, recording of dolphin behaviour, recording of dolphin presence at the nets, interviews with fishermen, quantification of net damage, stomach content analysis of stranded individuals.

INFLUENCE OF BOAT TRAFFIC ON THE AMAZON RIVER DOLPHIN (*INIA GEOFFRENSIS*) IN AMAZONIAN ECUADOR

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Due to the commercial development of the Amazon basin, motorised canoes are becoming increasingly frequent as the main means of transport. Dolphins react differently on boat traffic: some avoid boats, others are attracted and go bow-riding.

In the present study, the surfacing positions of Amazon river dolphins were observed in relation to a dugout canoe travelling with a 25 HP outboard engine. One observer watched the river at the bow and another observer surveyed behind the canoe. The distance of the dolphin to the canoe was estimated for the first sighting. The group size and composition was then determined while floating. Many sightings were made at the front as well as behind the canoe although, within a 50m range, dolphins surfaced more frequently behind the canoe than in front. Dolphins which were first seen further away than 50 m were sighted more often in front of the canoe. This behaviour was highly significant for all sightings ($Chi^2 = 18.6$; FG: 3; p<1%), and in the presence of calves ($Chi^2 = 11.2$; FG: 3; p<5%). The surfacing position did not depend on the size of the group.

These results lead one to the assumption that Amazon river dolphins make long dives and come up behind the canoe, and this may be part of avoidance behaviour.

HUMAN-INDUCED PROBLEMS IN CETACEAN CONSERVATION: CAN WE MANAGE TO REDUCE THEM?

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Human-related problems in cetacean conservation are reviewed from a management perspective, i.e. at the population rather than the individual animal level. Two categories are considered: those that result in almost instantaneous direct deaths (e.g. direct hunting; incidental capture; ship strikes); and those that affect the overall 'fitness' of the population (e.g. via environmental degradation such as pollution in its many forms).

Our ability to manage these effectively is considered. It is perhaps easier to address problems in the former category. However, problems in the latter category may become of more importance in the next millenium. The history of the management of direct exploitation is examined for general lessons that may be applicable to management problems associated with the general fitness of cetacean populations. Some general principles are identified that are important in attempts to manage anthropogenic impacts on cetaceans. These include the need to take uncertainty into account, identify data requirements that are achievable, identify and prioritise objectives, and for continual monitoring even when a solution appears to have been found. Simulation modelling is valuable both for prioritising the various problems and attempting to identify solutions. Cetacean conservation problems must be viewed in a broader context.

Work currently being undertaken by relevant international bodies is reviewed and a number of case-studies are considered.

THE ROLE OF PROTECTED AREAS FOR CETACEANS

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Although terrestrial sites have long been set aside to protect animal and plant biodiversity, marine organisms have never received the same level of attention. In Europe, the EU Habitats & Species Directive (1992) has served to establish a network of protected areas (known as the Natura 2000 series), but the criteria used also are aimed primarily at terrestrial wildlife. The designation of marine Special Areas of Conservation (SACs) has tended to focus upon special habitats such as lagoons, reefs, estuaries, shallow inlets and bays with emphasis upon sedentary animal and plant communities. Very mobile species like cetaceans are rarely catered for in this network. Indeed, only three sites in the European Union have been put forward as candidates with cetaceans specially in mind: Cardigan Bay (West Wales) and the Moray Firth (North-east Scotland) for bottlenose dolphins, and Sylte (North Germany) for harbour porpoise. In no way would these alone ensure the longterm favourable conservation status for those species.

Four main issues are addressed: (1) What is meant by a protected area? At present, marine sanctuaries, reserves, national parks, and special areas of conservation all aim to provide some level of protection but each means something different, and the definition may vary between countries; (2) What are protected areas designed to do? - are they to prevent direct killing, minimise the impact of a particular activity, or preserve in the longterm some area of high biological richness? Carefully defined objectives need to be set. (3) What criteria should be used in their selection? - should it be on the basis that a certain portion of a restricted population lives there, or because it contains important habitat for breeding, calf rearing and feeding for a particular species? (4) How do we manage protected areas? - who does this? How do we enforce rules & regulations? How do we monitor impacts and ensure that our objectives are achieved?

Marine protected areas in Europe are reviewed to see the extent to which they meet particular objectives, drawing upon recent developments in conservation biology theory. The establishment of Cardigan Bay as a marine SAC is used as a case example to test the efficacy of a number of clearly defined objectives.

EFFECTS OF WHALE WATCHING ON SPERM WHALE *(PHYSETER MACROCEPHALUS)* BEHAVIOUR OFF ANDØYA, NORWAY

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INTRODUCTION The area outside the island of Andøya in Norway has been subjected to whale watching since 1988. In 1997, over 11,000 tourists were taken to see the whales, and up to seven boat trips a day were arranged by four different whale watching companies (personal communication: E. Fulterer, Whale Safari Ltd., 8480 Andenes, Norway). The whale watching is under no management program.

The unique diving behaviour of the sperm whale makes it an excellent target for whale watching. The sperm whale dives deep, staying submerged for 15-40 minutes. Between dives it spends 5-15 minutes at the surface resting (Papastavrou *et al.*, 1989; Whitehead *et al.*, 1992; Jaquet *et al.*, 1998; Sarvas 1999). When resting, the whale usually lies still or swims slowly, and is easy to approach.

At high latitudes such as the Norwegian waters, the sperm whale population consists of only males, mostly solitary or in small groups. The males are usually engaged in feeding (Gordon, 1987). There is estimated to be several thousand individuals in the Norwegian Sea (Christensen *et al.*, 1992).

For practical reasons, research on possible disturbance of the whales by boats must be restricted to short term effects. However, it is possible to make predictions on how short term reactions may affect the whales in the long run. Avoiding the boat by spending less time at the surface, for instance, may cause the whale to dive shorter dives and thus spend less time foraging. Time spent avoiding the boat by shallow dives is also time taken away from feeding. A decrease in the blow interval is caused by higher respiration, indicating excitement or stress, which in turn may have long term consequences.

MATERIALS, METHODS AND STUDY AREA The study area was about 200 km^2 large and extended from 69°22' to 69°31 N and from 15°30' to 15°55' E. Surface behaviour data were collected between June 7th and September 1st, 1997, during 34 whale watching trips. Identification pictures of the whales were taken throughout the season from May 25th to September 9th, 1997, for a total of 68 days.

The whale watching vessel used in the study has a wooden hull of approximately 30 metres and has a size of 150 gross registered tonnes. The main engine is a Cummins 6 cylinder diesel motor with 470 horse power and the auxiliary engine is an Isuzu 4 cylinder diesel motor with 47 horse power. The travel speed is 9 knots at 1,600 rpm. The minimum rounds when the motor is connected is 600 rpm.

The surface behaviour of the whales was followed from the crow's nest of the whale watching vessel. The surface encounters were divided into two groups: those approached whales that ended up being 300 metres or closer to the boat were the study group, and the unapproached whales at over 1,500 metres from the nearest boat served as a control group. The approached whales were also examined at different distances from the boat. The analysed surface behaviour included the mean surface time, the mean standardised blow interval, and the frequency of shallow dives in the presence of the boat. In order to eliminate the effect of surface time on the blow interval, the blow intervals were standardised according to their order in relation to the last blow before fluking.

Identification pictures of the whales were taken from the deck of the boat, and the pictures were developed and analysed later. The location of the boat was recorded by GPS on a Logger program onboard (Fleming, 1999).

RESULTS The surface time was measured for 114 encounters in the close group and 48 encounters in the far group (Table 1, Fig. 1). There was no statistically significant difference between the mean values of the two groups. However, there seemed to be a tendency towards more unusually short surfacings in the close group. In the close group, 46% of these unusually short surfacings ended without a fluke up. In the early season, the mean surface time was shorter for the close group than for the far group, and this difference was statistically significant. There was no significant difference in the means in the late season. When comparing the mean surface times of the individuals seen most often in the presence of the boat (ID2 and ID3) and the others, no significant difference was detected. It is worth mentioning, however, that ID2 and ID3 had no extremely short surface times.

Altogether 2,128 blow intervals in the close group and 825 blow intervals in the far group were analysed (Fig. 2). The mean blow intervals for the close group and the far group tended to grow as the surface time proceeded; only during the last two or three blows did the interval decrease. For the far group the changes were distinct, while the changes in the close group were more discrete. The mean standardised blow interval was slightly lower for the close group than for the far group (Table 2, Fig. 3). The mean value for the close group was lower than for the far group both in the beginning of the season and later on. The mean value for ID2 and ID3 was slightly higher than for the other individuals.

When observing the standardised blow intervals at different distances from the boat (Fig. 4), it was discovered that these scarcely decreased as the boat approached ($R_S = 0.06$, $p<0.01$). The decrease was pronounced in the two closest categories (0-50 m. and 51-100 m.), decreasing from 13.6 to 12.9 secs within a short distance. When comparing the means of these categories, separately, it was discovered that they were significantly different ($p<0.01$). Of the 135 encounters diving within 1,000 m. of the boat, 96 dived with a fluke-up and 35 made a shallow dive. Thus the rate of diving without fluking was 29% for approached whales. The rate of diving was 34% in the early season and 24% in the late season. The number of dives ending with and without a fluke-up were measured for six distance categories (Fig. 4). Most of the fluke-ups were observed at a distance of 0-100 m. from the boat. Diving without fluking was most common at a distance of 50-250 m. from the boat.

DISCUSSION **Effects of the presence of the boat:** The whales' respiration was slightly more intense in the presence of the boat than in its absence. The fact that the blow interval of the whales did not increase during surface time in the close group as it did in the far group suggests that the recovery from the dive is not as fast when the boat is present. It is possible that the boat causes stress, excitement, or an increase in activity, and this would result in higher respiration.

The presence of the boat did not seem to affect the mean surface time of the whales, but proportionally more short surface times among the whales close to the boat were observed. This might be caused by some individuals diving prematurely because of the approaching boat.

In the present study, the proportion of dives ending without fluking for approached encounters was higher than for undisturbed animals in other studies (Gordon *et al.*, 1992, Jaquet *et al.*, 1998), yet not alarmingly high. It is also likely that shallow diving was not the usual reaction to the boats, and that it was characteristic of certain individuals or situations. Since the boat never pursued a shallow diving individual consistently (personal observation), it can be assumed that its foraging was not interfered with for very long.

Estimating critical distances from the approaching boat: The extent of diving without fluking at different distances can be used to estimate the flight distance of the whales. Thus one can estimate that the flight distance in situations where the whales avoid the boat is mostly between 50-250 metres.

The fact that the blow interval decreased drastically when the boat approached closer than 50 metres from the whale suggests that value to be a minimum disturbance distance. This supports the estimation made in the Workshop on the Special Aspects of Watching Sperm Whales in order to provide guidelines for boats (Anonymous, 1997).

Changes in the reactions as the season proceeds: The fact that early in the season the surface times of the whales were affected by the boats, and that the rate of shallow diving was higher than in the late season, suggests that the whales avoided the boats less as the season proceeded. It is likely that the whales became accustomed to whale watching during the season. It is also possible that the individuals that were disturbed by the boats moved away from the area early in the season, leaving only the less wary ones in the whale watching area.

Individual differences in reactions to the boats: It seems that the whales ID2 and ID3 are more habituated to boats than other individuals. However, there is no indication that a long residence time would have necessarily caused the habituation; Although ID3 has been seen during several seasons, ID2 was not spotted until 1995 (personal communication: E. Lettevall, University of Gothenberg, Sweden).

Comparisons to earlier studies done in the area: In 1989, the rate of diving without fluking within 500 metres from the boat was 78% (Eberhardt, 1993), which is extremely high. Since then, the proportion of shallow dives has decreased significantly. This may be a result of habituation; whale watching had only been in operation in the area for one year by 1989. It may also be a result of the boat captains becoming more skilled in approaching the whales.

REFERENCES

Anonymous. 1997. *Report of the international workshop on the special aspects of watching sperm whales. 8th-11th January 1996, Roseau, Commonwealth of Dominica, East Caribbean.* Report from International Fund of Animal Welfare, East Sussex, UK. 36pp.

Christensen, I., Haug, T. and Øien, N. 1992. Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. *ICES J. Mar. Sci.*, 49: 341-355.

Eberhardt, F. 1993. *Surface behavior of sperm whales Physeter macrocephalus under the impact of whale-watching vessels off Andenes, Norway.* Master's thesis in aquatic ecology, Dept. of Zoology, Stockholm University. 24pp.

Fleming, V. 1999. *Effects of whale watching on sperm whale (Physeter macrocephalus) behaviour off Andøya, Norway.* Master's thesis, Dept. of Ecology and Systematics, University of Helsinki. 53pp.

Gordon, J. C. D., 1987. *Behaviour and ecology of sperm whales off Sri Lanka.* PhD. thesis, University of Cambridge, UK. 347pp.

Gordon, J., Leaper, R., Hartley, F. G. and Chappell, O. 1992. Effects of whale-watching vessels on the surface and underwater acoustic behaviour of sperm whales off Kaikoura, New Zealand. *Science and research series*, 52: 1-63. Dept. of Conservation, Wellington, New Zealand.

Jaquet, N., Dawson, S. and Slooten, E. 1998. Diving behaviour of male sperm whales: foraging implications. *Rep. Int. Whal. Commn.* SC/SO/CAWS 38: 1-26.

Papastavrou, V., Smith, S. C. and Whitehead, H. 1989. Diving behaviour of the sperm whale, *Physeter macrocephalus*, off the Galapagos Islands. *Can. J. Zool.*, 67: 839-846.

Sarvas, T. H. 1999. The effects of the deep scattering layer on the diving behavior of sperm whales off Andøya, Norway. Master's thesis, Dept. of Ecology and Systematics, University of Helsinki. 36pp.

Whitehead, H., Brennan, S. and Grover, D. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. *Can. J. Zool.*, 70: 912-918.

Table 1 - Times spent at the surface

Study period	Whole summer		Period 1		Period 2		Whole summer	
Group	Close	Far	Close	Far	Close	Far	id2 & id3	Others
Sample size (enc)	114	48	57	24	57	24	9	82
Mean (min)	5:44	6:03	5:09	6:20	6:19	5:46	7:18	6:07
Minimum (min)	0:12	1:49	0:46	2:43	0:12	1:49	0:46	5:28
Maximum (min)	10:51	9:59	9:42	3:19	10:50	9:00	10:27	10:50
Standard error (min)	0:13	0:19	0:16	0:24	0:21	0:30	0:17	0:37
Student's p(t≤T)	0.4		0.02		0.3		-	
Mann-Whitney p(t≤T)	-		-		-		0.2	

Table 2 - Standardised blow intervals

Study period	Whole summer		Period 1		Period 2		Whole summer	
Group	Close	Far	Close	Far	Close	Far	Ind. 2&3	Others
Sample size (blows)	2128	866	911	427	1217	439	194	1934
Mean (s)	13.8	14.7	14.0	14.9	13.5	14.5	14.1	13.7
Minimum (s)	4	5	5	6	4	5	7	4
Maximum (s)	43	43	43	43	41	43	34	43
Standard error (s)	0.09	0.13	0.14	0.17	0.10	0.21	0.25	0.09
Mann-Whitney p(t≤T)	<0.01		<0.01		<0.01		0.04	

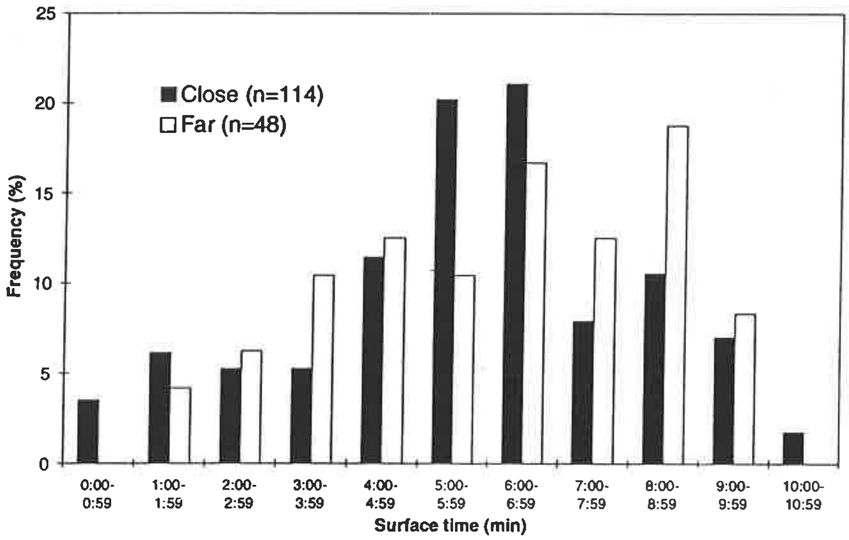

Fig. 1 - Frequency distribution of surface times for the close group and the far group

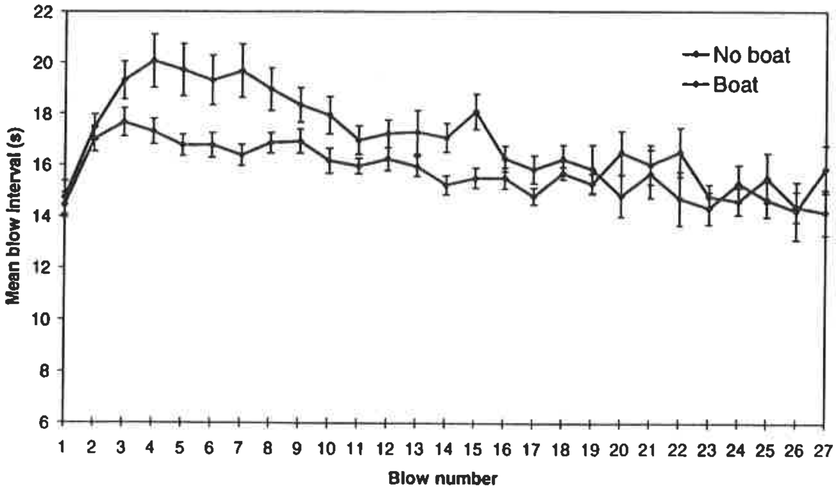

Fig. 2 - Mean blow interval and standard error of the mean plotted against blow numbers for the close group and the far group. The blow number is given starting from the last blow interval before diving (number 1) toward earlier blow intervals. Thus the second last blow interval before diving is number 2, etc

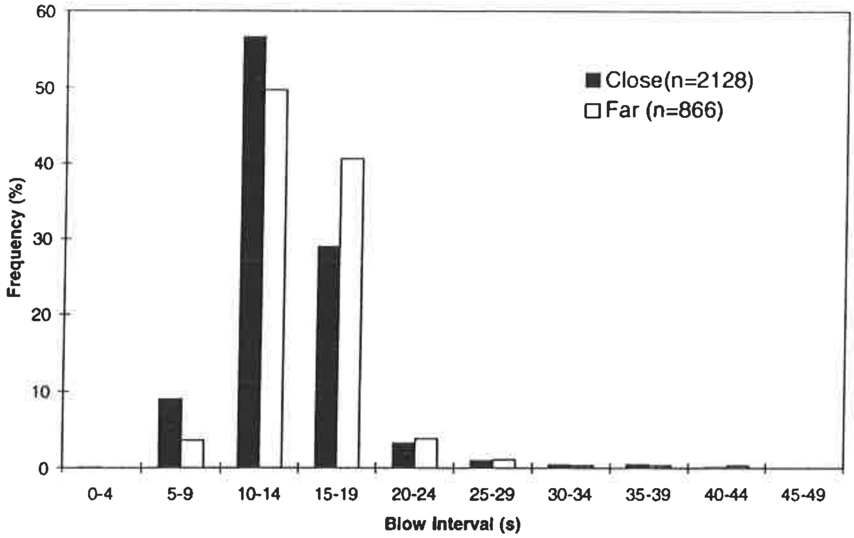

Fig. 3 - Frequency distribution of the standardised blow interval for the close group and the far group

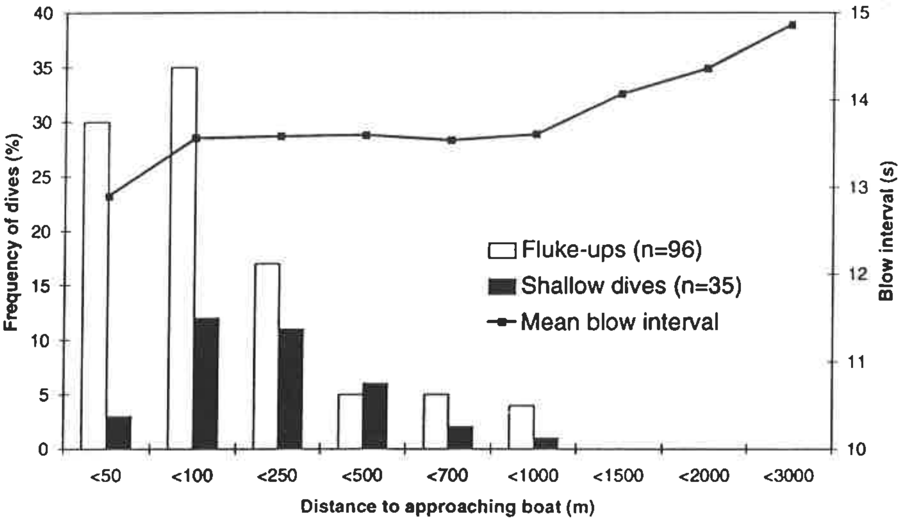

Fig. 4 - Mean blow intervals, shallow dives and fluke-up dives plotted against different distance categories to the approaching boat

INVESTIGATING THE EFFECTS OF AIRGUN ARRAY NOISE ON PORPOISES

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The effects that the intense blasts of sound produced by airgun arrays during seismic surveys might have on marine mammals with sensitive hearing has been a matter of increasing concern in recent years.

The harbour porpoise (*Phocoena phocoena*) is the commonest cetacean species in many of the areas in which seismic surveys are being conducted in the Northern Hemisphere, and this EC MAST funded project set out to investigate the effects of seismic surveys on this species. Being small elusive animals that are hard to see, harbour porpoises can be difficult to study using conventional visual methods. For this work, passive acoustic monitoring techniques, using automated detection and logging equipment, were used to investigate changes in behaviour and distribution in response to airgun noise.

Two approaches were employed: a small airgun array, under the field team's control, was deployed in inshore waters; and observations were made from a guard vessel during full-scale seismic surveys in offshore waters. The inshore work was conducted in two bays in Orkney. A 10 m. vessel conducted surveys within the study area continuously, following exactly the same (approx. "figure of eight") survey tracks. After collecting some two hours of baseline data, the gun array slowly approached the bay from a range of three miles while firing, entered the bay, and then left. A further two hours of data were collected after the boat departed. During offshore work, the acoustic equipment monitored continuously for porpoises from a vessel approximately one mile ahead of the airgun array.

Comparisons were made between detection rates during periods when guns were on, and other periods (during turns for example) when they were off. After modelling for the effects of time of day, tidal height, and position within the bay, no changes in detection rates resulting from gun activity or range to guns could be detected in the Orkney data. There were no significant differences in detection rates between periods when guns were on and off in the data from the full-scale survey. The relatively poor sensitivity of porpoise hearing to low frequency sounds may explain this study's lack of evidence for any response. However, it should be noted that the inshore work reported here used a very small array, while the offshore observations were made at ranges of around a mile from a full-scale array and effects may occur at shorter range.

ENDANGERED MARINE MAMMAL SPECIES: THEIR LIKELY FUTURE AND A PROPOSED CONSERVATION STRATEGY

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In the latter half of the 20[th] century, conservation measures to protect marine mammals have largely focused on straightforward causes and direct effects. Mortalities due to intentional removals such as entanglement in fishing gear or ship strikes are monitored and safe levels of removals are investigated. It is now widely recognised that these factors may be significant in some places for the conservation of marine mammals and other species. Those direct sources of mortality or detriment 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 interest of a population. Understanding or predicting these "domino effects" often requires more knowledge of ecosystem structure and function than has been available. We provide two examples of such unintended consequences and discuss conservation strategies in the context of such consequences.

Ecosystem Linkages: In 1998, Jim Estes and his colleagues reported on a sudden and significant decline in sea otter (*Enhydra lutris*) abundance in the western Bering Sea, particularly in the Aleutian Islands. As a result of decades of careful and comprehensive research on sea otters in that region, they were able to determine that the cause of the decline was not due to redistribution or reduced fecundity. Increased mortality then became the likely cause of the decline. Again, they were able to rule out disease, toxins, or starvation as the responsible agents. But the team had noted predation by killer whales (*Orcinus orca*) for the first time in 1991. Estimates of attack rates in the 1990's and energetic requirements of killer whales confirmed that this new source of predation on sea otters could be the cause of the decline. Why this sudden and significant predation by killer whales? The primary prey of killer whales in that area had been Steller sea lions (*Eumetopias jubatus*) and harbour seals (*Phoca vitulina*). Western Steller sea lions have declined sharply, with the population in 1994 estimated to be down to a fifth of its size in 1965; Bering Sea harbour seals are thought to be declining as well (Hill *et al.*, 1997). With their primary prey populations declining, the killer whales apparently turned to sea otters as prey (Estes *et al.*, 1998).

The Bering Sea is a well-studied ecosystem (see National Research Council, 1996). As a result, it is possible to track changes in the ecosystem that occurred due to actions taken long ago. The declines in mammal and bird species have been attributed to declines in their preferred prey species, such as ocean perch (*Sebastes alutus*) and herring (*Clupea harangus*). Populations of these fishes have declined due to overfishing and to increases in abundance of pollock (*Theragra chalcogramma*). Pollock have lower nutritional value and as adults are competitors of the marine mammals and birds. The pollock population is thought to have increased, beginning in the 1800's when the depletion of whale stocks reduced competition for food (euphausiids and calanoid copepods) for juvenile pollock. Merrick (1995) suggested that the current significant trophic shift began in the mid-1960's as a direct result of the dietary overlap between whales, fish, and pinnipeds. He estimated that the "the reduction of fin whales, Pacific herring, and Pacific Ocean Perch in the Bering Sea and Aleutian Islands could have released 1.36 to 2.81 million mt of zooplankton prey a year, which would be sufficient to feed 4.3 to 8.9 billion age-1 pollock for a year.". In addition, the decline in northern fur seals (*Callorhinus ursinus*) removed predation pressure from juvenile salmon.

Recent modelling of the Bering Sea ecosystem trophic changes confirms that whaling in the 1950's began a cascading effect, accounting for most of the changes that have occurred (Trites *et al.*, 1999). However, they found that whaling alone could not account fully for the trophic shift and huge increases in pollock biomass. Merrick (1995) and others (see National Research Council, 1998) have discussed the climate regime shift in the North Pacific Ocean beginning in 1976-77. Since that time, preferred prey items have begun to decline, one species after another. So, superimposed on human activities, are large-scale oceanographic events over which we have little or no control and little understanding.

Estes *et al.* then attempted to anticipate the potential changes in the coastal ecosystem that might ensue with a decline in the sea otter populations. Sea otters are the keystone species of the kelp ecosystem. Removing sea otters means that kelp predators, such as sea urchins, are likely to eliminate kelp and local kelp ecosystems. These ecosystems are important for numerous species of fish, seabirds, and invertebrates. So, in a long chain of events, depletion of pelagic whale populations decades ago could trigger future devastation of coastal kelp beds. Further consequences still remain to be seen; however, these trends do not seem reversible.

The realisation that it is important to understand the role of species in ecosystems and maintain species at levels that retain that function is becoming more prevalent. This example provides support for maintaining ecosystem structure and function and not taking actions that would jeopardise it, particularly when we do not yet have a sufficient knowledge base to predict short-term and long-term consequences.

Defining Stocks: Unintended consequences may also occur when an action meant to be in the interests of a population has detrimental effects instead, such as when stocks are improperly delineated. Advances in approaches to defining stocks follows advances in our understanding of how different types of error in decision-making affects outcomes. The traditional scientific approach is to avoid accepting a hypothesis (or more accurately, rejecting the null hypothesis). In the case of attempting to discern whether one is dealing with either one population or more than one, the null hypothesis is that there is only one panmictic population. With this approach, one would only subdivide this unit if there were significant statistical differences at the 0.05 level that would allow one to reject the null hypothesis. Normally, we make it difficult to reject the null hypothesis and focus on the alpha level because we do not wish to fall into the Type-I error of accepting as truth that multiple population units are indeed present.

The alternative approach of a conservation biologist or population manager to the question defining population boundaries has been well-articulated by Taylor (1997). Population managers often have to make decisions based on imperfect information; the kind that would make an academic throw up her/his hands and say "More data!". Living with uncertainty for the population manager, however, is a fact of life. If the Precautionary Principle is followed when confronted with uncertainty, then one would opt for decisions that are risk-adverse to the population. Increasingly, statistics takes the form of a power analysis, which focuses on the beta level, or the Type-II error of incorrectly maintaining the null hypothesis (Gerrodette, 1987; Taylor and Gerrodette, 1993). Ignoring the Type-II error is a risky policy when applied to the management of a population; particularly so when the population is endangered.

An example of a situation in which the approach used to define stocks may be critical can be found in bottlenose dolphins (*Tursiops truncatus*) along the Atlantic coast of the United States. The species ranges coastally from southern New York in the north to Florida in the south and then along the Gulf of Mexico coast of the United States. But it is found north of North Carolina only from about May through October, so at least some component is migratory. In 1987-88, an epizootic event affected bottlenose dolphins that range from New Jersey to central Florida on the Atlantic coast. The event began off North Carolina in the summer, progressed northward throughout the summer and fall, then began moving southward throughout the later fall and winter (Scott *et al.*, 1988) as though a single infected population was moving along the coast. During this time, there was a 10-fold increase in strandings and it was estimated that over half the bottlenose dolphins along the coast died (Scott *et al.*, 1988). On the basis of the pattern and magnitude of strandings, therefore, one coastal migratory stock was defined and then listed as "depleted" with the goal of offering it additional protection under the U.S. Marine Mammal Protection Act (see summary in Hohn, 1997). This listing specifically excluded bottlenose dolphins found in estuarine waters along the coast, as well as the larger offshore form of bottlenose dolphin.

Bottlenose dolphins along the U.S. Atlantic coast are also exposed to various kinds of fishing gear and deleterious human activities. Incidental mortality in fishing gear is particularly a concern along the North Carolina and Virginia coasts, one of the areas where the most strandings occurred during the epizootic. So, if more than one stock of bottlenose dolphins exists, then a northern stock may be more compromised than other stocks.

Under the more traditional approach of emphasis on Type-I error, the Atlantic coast bottlenose dolphin population would be considered as a single population until we "proved" otherwise. The population size would be considered the abundance estimate from the entire coastline. The problem with this approach is that most of the known mortality is limited to a fraction of the area. This approach could lead one to believe that the mortality is relatively small compared to the population size of the entire coastline, and thus is sustainable. But if the population in the high-mortality area has a very low dispersal rate with other populations or is in fact genetically isolated, the effective population would be much lower, and the threat to the population much greater, than this approach would lead us to believe.

Using the more-precautionary approach that takes into consideration Type-II error, one would focus on the area where the mortality is occurring. One risk-adverse strategy in the absence of data would be to simply assume that the area impacted by the fishery is a separate population, and manage it on that basis. With more information, one could set up alternative hypotheses that focus on specific questions such as: Given the population size and the estimated mortality, how much immigration from other areas would be required for the take to be sustainable, and how does this compare with estimated dispersal rates? How many surveys over what period of time would be required to detect trends in the population?

In 1997, a multi-year project to delineate stock structure of the coastal bottlenose dolphins was initiated (Hohn, 1997). It was assumed that if multiple stocks occur, then separating these stocks would be complicated and, therefore, best achieved by simultaneous use of various methods, including genetics, stable isotope ratios, contaminants, morphometrics, life history, telemetry, and photo-identification. Previous photo-identification studies at various sites, mostly in the southern end of the range, indicate resident groups of dolphins in estuaries with transient bottlenose dolphins along the coastal zone in the same area. They also indicate migratory-type movements in that transient dolphin abundance is highly seasonal, and the season of high abundance varies at various geographic locations. Whether it is one group migrating between sites is not known. In the multi-year, multi-method study, preliminary results from telemetry, stable isotope ratios, and photo-identification already suggest that there is more than stock. Some of the results also indicate that the coastal and estuarine "populations" are not independent throughout the range of bottlenose dolphins.

CONCLUSIONS It is axiomatic that we manage animal populations for various human purposes, ranging from exploitation to conservation to preservation. We typically manage on the basis of imperfect, and often scanty, information, about the populations, their ecosystem, and the effects of human activities. Fishery and wildlife biologists have to make management decisions on the basis of "best available information" – all too often a mix of data, assumptions, and extrapolations. Often, the baseline data have been collected over the short term on just a single species without an understanding of long-term impacts. We need to more thoroughly understand why specific human actions are sometimes so detrimental to marine mammal populations even when we are trying to help.

From the "perspective" of the populations or species of concern, what aspects of their life histories or habitat requirements result in their susceptibility to human intervention? Are we too frequently taking management actions with too few data or applying too many assumptions that are incorrect at the expense of the populations we are trying to conserve? How can we learn from past mistakes to better conserve endangered populations? Better yet, can we gain enough knowledge about the populations and their ecosystems to ensure that we maintain each species role in that ecosystem? It is difficult enough to attempt to manage more straightforward events such as direct removals, and it is probably still beyond our understanding to accurately predict the broad spectrum of effects of our actions on the ecosystem. Anticipating such consequences will be one of our more pressing challenges for the next millennium.

REFERENCES

Estes, J. A., Tinker, M. T., Williams, T. M., and Doak, D. F. 1998. Killer whales predation on sea otters linking oceanic and nearshore ecosystems. *Science*, 282: 473-476.

Gerrodette, T. 1987. A power analysis for detecting trends. *Ecology*, 68: 1364-1372.

Hill, P. S., DeMaster, D. P., and Small, R. J. 1997. Alaska marine mammal stock assessments, 1996. NOAA Technological Memorandum NMFS-AFSC-78. 150pp.

Hohn, A. A. 1997. Design for a multiple-method approach to determine stock structure of of bottlenose dolphins in the mid-Atlantic. NOAA Technical Memorandum NMFS-SEFSC-401. 22pp.

Merrick, R. L. 1995. *The relationship of the foraging ecology of Steller sea llions (Eumetopias jubatus) to their population decline in Alaska*. Ph.D. dissertation, University of Washington, Seattle. 171pp.

Merrick, R. L., Loughlin, T. R., and Calkins, D. G. 1987. Decline in abundance of the northern sea lion *(Eumetopias jubatus)* in Alaska, 1956-86. *Fishery Bulletin U.S.* 85: 351-365.

National Research Council. 1996. *The Bering Sea ecosystem*. National Academy Press, Washington, DC. 320pp.

Scott, G. D., Burn, D. M., and Hansen, L. J. 1988. The dolphin die-off: long-term effects and recovery of the population. Proceedings of the Oceans '88 Conference: 819-823.

Taylor, B. L. 1997. Defining "population" to meet management objectives for marine mammals. Pp. 49-65. In *Molecular genetics of marine mammals*. (Eds. A. E. Dizon, S. J. Chivers, and W. F. Perrin). Society for Marine Mammalogy Special Publication, 3. 388pp.

Taylor, B. L., and Gerrodette, T., 1993. The uses of statistical power in conservation biology: The vaquita and northern spotted owl. *Conservation Biology*, 7: 489-500.

Trites, A. W., Livingston, M. C., Vasconcellos, M. C., Mackinson, S., Springer, A. M., and Pauly, D. (In press). Ecosystem change and the decline of marine mammals in the Eastern Bering Sea: testing the ecosystem shift and commercial whaling hypotheses. *Fisheries Centre Research Reports* 1999, Vol. 7.

IMPLEMENTING THE CONSERVATION STRATEGY FOR THE MEDITERRANEAN MONK SEAL IN GREECE

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The fact that in Greece lives and breeds the largest Mediterranean monk seal population, dictates the concentration of conservation efforts within the country. Recognising the need of a longterm conservation plan, a National Strategy for the Conservation of the Mediterranean Monk Seal in Greece has been formulated, taking into account the main threats to the species.

MOm, in collaboration with the Hellenic Ministry of Environment, is implementing this Strategy through the National Action Plan for the Conservation of the Monk Seal, with the following actions:

- Monitoring of the monk seal population in the National Marine Park of Alonnissos, North Sporades (NMPANS);
- Monitoring of the status of the marine environment in the NMPANS;
- Surveillance and safeguarding of the NMPANS;
- Public awareness and sensitisation of the NMPANS visitors;
- Operation of the Biological Station in Gerakas, Alonnissos;
- Establishment of a SAC Network for the species;
- Operation of a National Information Network (RINT);
- Operation of a National Rescue and Rehabilitation programme;
- Operation of Environmental Education programmes.

Information will be presented on the goals, progress, and up to date results of the above activities, giving special emphasis on the recent efforts for the establishment of a network of conservation areas within the country.

THE ROLE OF CETACEANS IN THE ZONING PROPOSAL OF MARINE PROTECTED AREAS: THE CASE OF THE ASINARA ISLAND MPA

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In 1998, the Italian Ministry of the Environment conferred the study assignment on the management and zonation measures for the establishment of two new MPAs (as indicated in the Italian Framework Law 394/91 for MPAs) to the Italian Central Institute for Applied Marine Research (ICRAM). The areas interested are the Asinara Island (NW Sardinia) (Fig. 1) and the Archipelago of the Maddalena (NE Sardinia).

Both the ecological and socioeconomic aspects must be taken into consideration in the zonation process to characterise the area and the local realities (Diviacco and Tunesi, 1996). There is, however, no standard procedure regarding the elements to consider in order to conduct a zonation process. The present MPAs do not take into account the presence of cetaceans in the management of the area because of the difficulty of placing these very mobile animals, with often offshore habits, into a process that has the goal of protecting mainly coastal habitats. There are several international conventions and agreements that designate MPAs as the most suitable tools for the protection of marine environment and biodiversity. The most important of these documents are:

1. **Barcelona Convention** (1976). The Convention for the Protection of the Mediterranean Sea against Pollution provides, through the Protocol for Special Protected Areas and Mediterranean Biological Diversity (1995), special protection for endangered Mediterranean species and habitats essential for their conservation (Annex II includes 19 marine mammal species);

2. **Bern Convention** (1979). This convention underlines the importance of protecting the natural habitats of the species, in particular those listed in Appendix I and II (Appendix II of the fauna strictly protects 29 species of cetaceans);

3. **Habitats Directive** (1992). The fundamental purpose of this directive is to establish a network of protected areas with the goal of maintaining the widest distribution of threatened habitats and species, amongst which are the bottlenose dolphin and the harbour porpoise;

4. **ACCOBAMS** (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 pays special attention to the creation of MPAs to achieve this.

The MPA of the Asinara Island is the first case in the Mediterranean Sea in which the presence and distribution of cetacean species were considered for the purpose of global zonation of a MPA.

The cetaceans were considered important for two different reasons:

1. Bottlenose dolphins are present at least during the summer months (the only period for which we have data) in the coastal waters around the Asinara Island. Because of their coastal distribution, these dolphins potentially are most affected by human presence and activity. In fact, the bottlenose dolphin is listed in the IUCN's 'Red Data Book' among the species whose conservation status is poorly known.

2. Cetacean presence can give rise to commercial and scientific whalewhatching that can constitute, if appropriately managed, a significant portion of economic development, thus contributing to the local economy and to the management of the MPA.

Furthermore, the whalewatching activities can be important for the education and increasing awareness of the public to the problems of the marine environment.

Therefore the following research was undertaken to assess the presence and distribution of cetaceans in the MPA so as to determine the necessary zonation requirements dictated by the species involved:

a) a review of the available bibliographical information on Cetaceans in the area was undertaken (Lauriano & Notarbartolo di Sciara, 1995; Lauriano, 1997a, b);
b) a line transect boat survey of 42 days was conducted between July 20th and August 30th, 1998, in the waters surrounding the Asinara island.

Analysis of the data from the literature and the 1998 survey indicate a total of 150 cetacean sightings of the following five species: fin whale, bottlenose dolphin, striped dolphin, common dolphin, and Risso's dolphin (Fig. 2). Figures 3 and 4 show the distance from the nearest coast (in terms of mean and range), and the sighting frequency (sightings/hours X 100) for each species encountered. All the sighting points were put in a GIS ArcView database, together with the other ecological and socioeconomical aspects (Table 1) that were considered to be important for the zonation of the Asinara Island MPA. The actual zonation process was based on a Multi-Criteria Analysis (MCA) which allowed the joint consideration of aspects as different as social preferences, development needs, and conservation requirements (Alphonce, 1997; Nijkamp *et al.*, 1990; Villa *et al.*, 1996; Voogd, 1993).

The indications deduced from the regular cetacean presence, the co-existence of coastal and pelagic species, and the relative ease in obtaining sightings (as expressed in the short distances from the coast) have allowed the cetacean presence to be a strategic factor in the process of the MPA zonation. The areas of interest for the whalewatching activities and for the biological cycle of coastal cetaceans are shown in Figs. 5 and 6.

REFERENCES

Alphonce, C. B. 1997. Application of the analytic hierarchy process in agriculture in developing countries. *Agricultural Systems*, 53: 97-112.

Diviacco, G. and Tunesi, L. (In Press). Analisi dell'ambiente naturale e antropico finalizzata alla gestione della fascia costiera della Provincia di Savona (Mar Ligure). Atti del convegno CONISMA – Unimar "*La ricerca scientifica e tecnologica per lo sviluppo compatibile della pesca e della maricultura*", Fano, 1996.

Lauriano, G. and Notarbartolo di Sciara, G. 1995. The distribution of cetaceans off Northwestern Sardinia. Pp. 104-106. In: *European Research on Cetaceans - 9*, Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P.G.H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Lauriano, G. 1997a. Preliminary observations of fin whales (*Balaenoptera physalus*) off Northwestern Sardinia. Pp 122-124. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Lauriano, G. 1997b. Distribution of bottlenose dolphins around the island of Asinara (north-western Sardinia). Pp. 153-155. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Nijkamp, P., Rietveld P. and Voogd, H. 1990. *Multicriteria evaluation in phisical planning*, Holland Publishers, The Netherlands.

Villa, F., Ceroni, M. and Mazza, A. 1996. A GIS based method for multiobjective evaluation of park vegetation. *Landscape and Urban Planning*, 35: 203-212.

Voogd, H. 1983. *Multicriteria evaluation for urban and regional planning*. Pion Ltd., Amsterdam, The Netherlands.

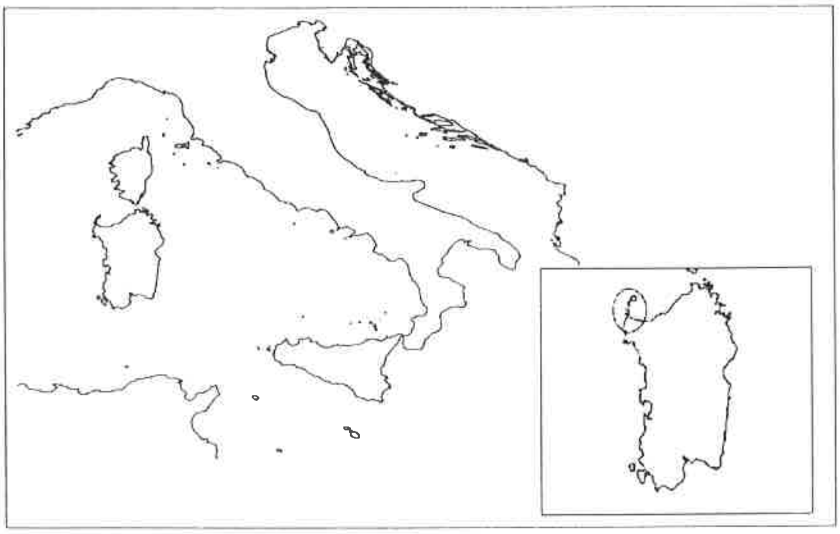

Fig. 1 - Study area

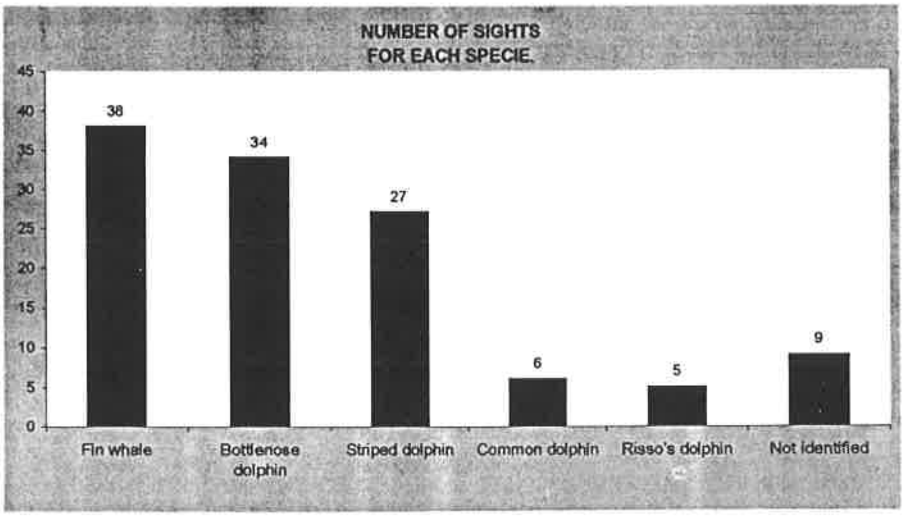

Fig. 2 - Number of sightings for each species

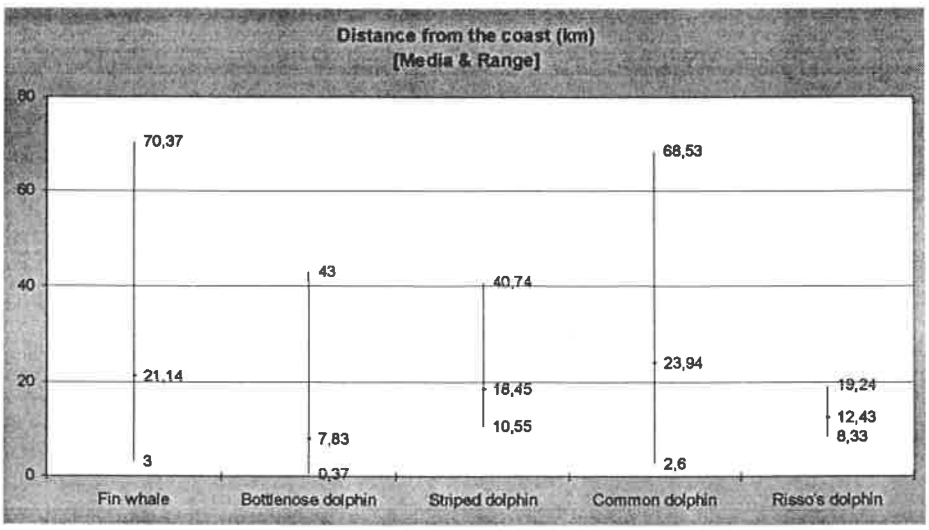

Fig. 3 - Distance from the nearest coast expressed in terms of medians and range

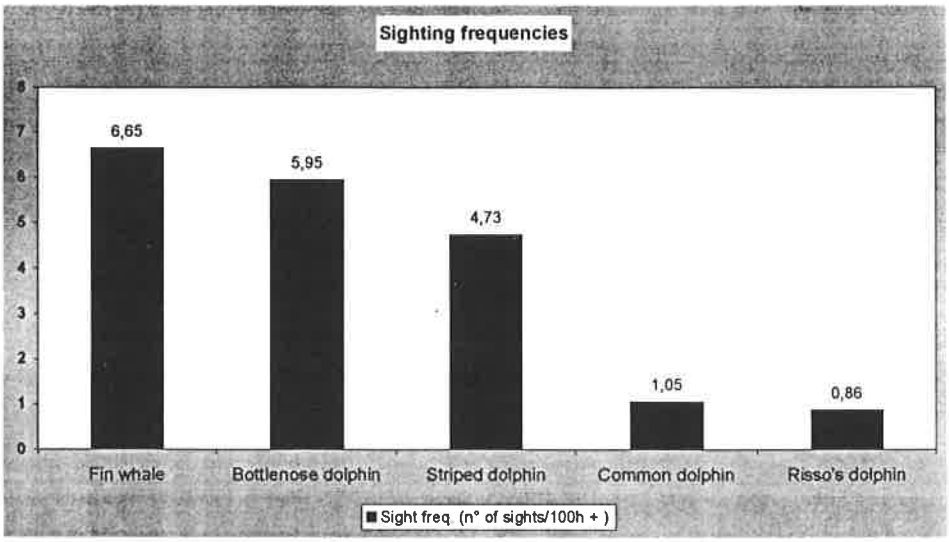

Fig. 4 - Sighting frequencies for each species

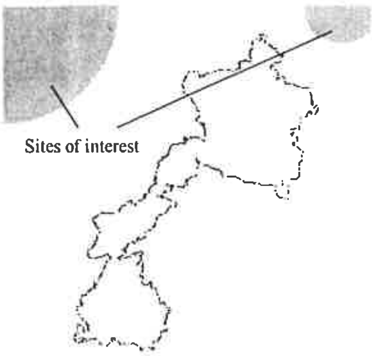

Fig. 5 - Site of potential interest for whalewatching activities

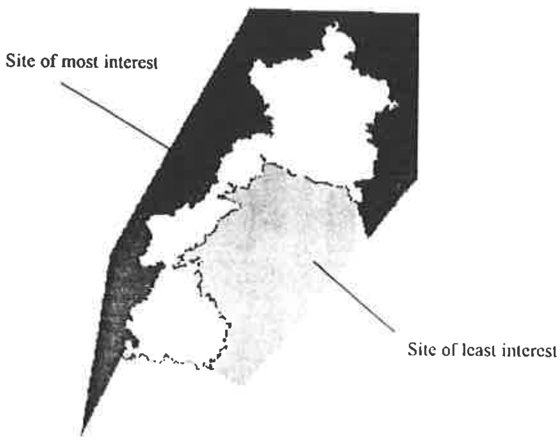

Fig. 6 - Sites of interest for the biological cycle of coastal cetaceans

SPERM WHALES AND DRIFTING NETS IN THE MEDITERRANEAN SEA: THE EXAMPLE OF THE BALEARIC ISLANDS

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The sperm whale *Physeter macrocephalus* Linnaeus, 1758 is a relatively frequent species in the eastern Mediterranean, which is present all year round. However, knowledge of its biology, distribution and status within the area is scarce. Since 1991, when the International Whaling Commission and several conservation associations called attention to the interaction of this species with the drifting nets used by the Italian drift gillnet fishery for swordfish, several dead specimens of sperm whales have been found on the Mediterranean coast with clear signs of having been victims of such nets. Up to date, the real scope of the mortality caused by this fishery as well as its effect on the more than likely reduction of the population of this species in the Mediterranean is unknown. The IUCN (1991) had already pointed out the potential vulnerability of this species and urged for the need for related research.

Between 1993 and 1998, 24 strandings of sperm whales have been recorded along the coastline of the island of Mallorca and its surroundings, fifteen of them in connection with drifting nets (4 alive and succesfully liberated). The present work offers information on the spatial and temporal distribution of these strandings, as well as of the condition, sex and age class of the affected animals.

PROPOSITION OF MANAGEMENT CRITERIA FROM BOTTLENOSE DOLPHIN STUDY

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INTRODUCTION In the last few years, the increasing interest in natural patrimony, terrestrial and marine, has led to strong conservation and management efforts developing in order to maintain a high degree of biodiversity. In this context, a Marine National Park is proposed for the Iroise sea (west of Brittany). Coastal bottlenose dolphins (*Tursiops truncatus*) are present in this zone, some of them around *île de Sein* and some others in the *Molène* archipelago. These two resident groups have been studied for several years and the results obtained show a patchy distribution of the animals with preferential sites changing with their activity in time and space (Liret and Ridoux, 1999). Descriptive criteria of management such as their home range and their spatial distribution have been first suggested in the framework of a Marine National Park (Liret *et al.*, 1996). But such an approach is limited by the temporal and spatial variation in dolphin distribution. Now, effort is made to define rigid criteria from habitat studies well suited for long-term conservation. This preliminary work makes use of data from *île de Sein* 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 dolphins.

Spatial distribution of dolphins: Data from the bottlenose dolphins of *île de Sein* were collected from 1994 to 1997. Field sessions were performed once every two months. The location, group size and activity of dolphins were noted every five minutes. Locations were mapped using 200 m cell-sized grids within the study area. Data were counterbalanced by group size in order to correct observations of few animals. Activity was divided into three categories: foraging, resting, and travelling. The result is a quantitative mapping of the dolphins' presence by taking into account the number of samplings in each cell (Fig.1). Such a map can be made for each activity. All year round, dolphin groups remained very close to the inhabited island within an annual home range of about 5 km^2 (Liret and Ridoux, 1999). Three preferential sites are highlighted: the two western ones are mainly used for foraging, from October to April; and the eastern site is a resting zone during summer.

Environmental parameters of coastal habitat: The environmental parameters taken into account for this work were depth, slope orientation, and percent slope. They were calculated within the study area, delimited by the 10 m depth contour surrounding the inhabited island. The morphometric variables were obtained from bathymetric soundings collected every 50 m at sea by the Hydrographic and Oceanographic Service of the Marine. These data give us a Digital Elevation Model (DEM), which is used to describe the submarine topography from depth, slope orientation and percent slope (Fig.2 a, b, c). Moreover, the presence of emerged land (rocks and island) within the study area is taken into account.

Analysis between habitat and dolphins: The first stage of the analysis is to combine dolphin data and the morphometric variables within the study area. The GIS procedure used results in a unique file putting together all the information. For each cell of the study area showing relative use by dolphins (total and by activity), we calculate surface percentages of different categories of depth, slope orientation, and percent slope. Moreover, the percentage of emerged land is estimated in each cell.

Next, dolphin observations are compared with each category of morphometric variable by using single-factor analysis of variance (ANOVA). The results obtained show significant parameters ($P<0.05$) different for total observations and activities (Table 1). The dolphins mainly use intertidal zones and those between 6-8 m depth. However, considering their activities, they prefer intertidal and 0-2 m zones to forage, and sites of 6-8 m depth to rest. Travelling occurs at depth of 4-8 m. Concerning slope orientation, dolphins are present in zones oriented north and west corresponding respectively to travelling and resting. The orientation has no major influence on the foraging distribution. Whatever their activities, bottlenose dolphins are located in zones where the percent slope exceeds 10%. Moreover, they use low slope areas to forage. The presence of rocks has a major influence on dolphin distribution. The analysis of variance give us the habitat characteristics preferred by the species.

Predicting dolphin distribution: The significant habitat variables held in the analysis are introduced in the Geographical Information Database, except for the emerged land. Two maps are produced showing predicted areas for resting and foraging, activities of major interest for the bottlenose dolphins (Fig. 3). We identify very favourable areas corresponding to the significant habitat features highlighted by the analysis of variance, and favourable areas determined by morphometric variables with ANOVA results of between 0.05 and 0.5. Of course, this large interval has no statistical mean but it allows us to test in which order the model increases the range according to the choice of *alpha*. The predicted zones by the model correspond in part to the preferential sites used by dolphins to forage and to rest. For these two activities, the resulting ranges are much more extensive than those obtained by the field study. However, the preferential sites are included in the predicted distribution areas. These results suggest that there may be a significant relationship between environmental characteristics and dolphin distribution. But the analysis has now to take into account more spatial and temporal environmental variables (current, rock vicinity, substrate type,...) in the aim to perform dolphin habitat modelling. Such a project involves testing modelling results in other Atlantic sites where bottlenose dolphin distribution is being studied. The relation between coastal bottlenose dolphin distribution with preferential sites and the topographic features has already been highlighted in different sites: Moray Firth, Scotland (Wilson, 1997); Gulf of California, Mexico (Ballance, 1992); etc.

CONCLUSIONS Such a spatial and temporal multidisciplinary approach will contribute to conservation management based on habitat features more than spatial distribution (Wiens, 1996). These preliminary results constitute a first approach to define management criteria for bottlenose dolphins of the Iroise Sea in term of habitat features. Once modelling has been performed, they will be incorporated into the management plan of the future Marine National park. GIS is a powerful tool to study cetaceans in relation to their marine environment. It allows us to identify the biological and physical characteristics, and to predict areas of cetacean habitat (Moses and Finn, 1997).

ACKNOWLEDGEMENTS Many thanks to Vincent Ridoux, Jean-Marc Ménégaz, Pol Creton, and Sami Hassani for their help. We acknowledge the Hydrographic and Oceanographic Service of the Marine for their contribution to this work and Emmanuel Giraudet (Géosystèmes laboratory) for mapping.

REFERENCES

Ballance, L. T. 1992. Habitat use patterns and ranges of the bottlenose dolphin in the Gulf of California, Mexico. *Mar. Mamm. Sci.*, 8, 3: 262-274.

Liret, C.; Creton, P.; Le Moal, G. and Ridoux, V. 1996. Dolphin home range and reserve zonation: do we need field studies to define management policy? Pp. 15-19. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Liret, C. and Ridoux, V. 1999. Spatio-temporal variations in habitat use and activity patterns of coastal bottlenose dolphins. *J. Zool.* London. Submitted.

Moses, E. and Finn, J. T. 1997. Using Geographic Information Systems to predict North Atlantic right whale (*Eubalaena glacialis*) habitat. *J. Northw. Atl. Fish. Sci.*, 22: 37-46.

Wiens, J. A. 1996. Wildlife in patchy environments: metapopulations, mosaics and management. Pp. 53-84. In *Metapopulations and wildlife conservation* (Eds D. R. McCullough). Island Press, Washington, 429pp.

Wilson, B., Thompson, P. M. and Hammond, P. S. 1997. Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. *J. Appl. Ecol.*, 34: 1365-1374.

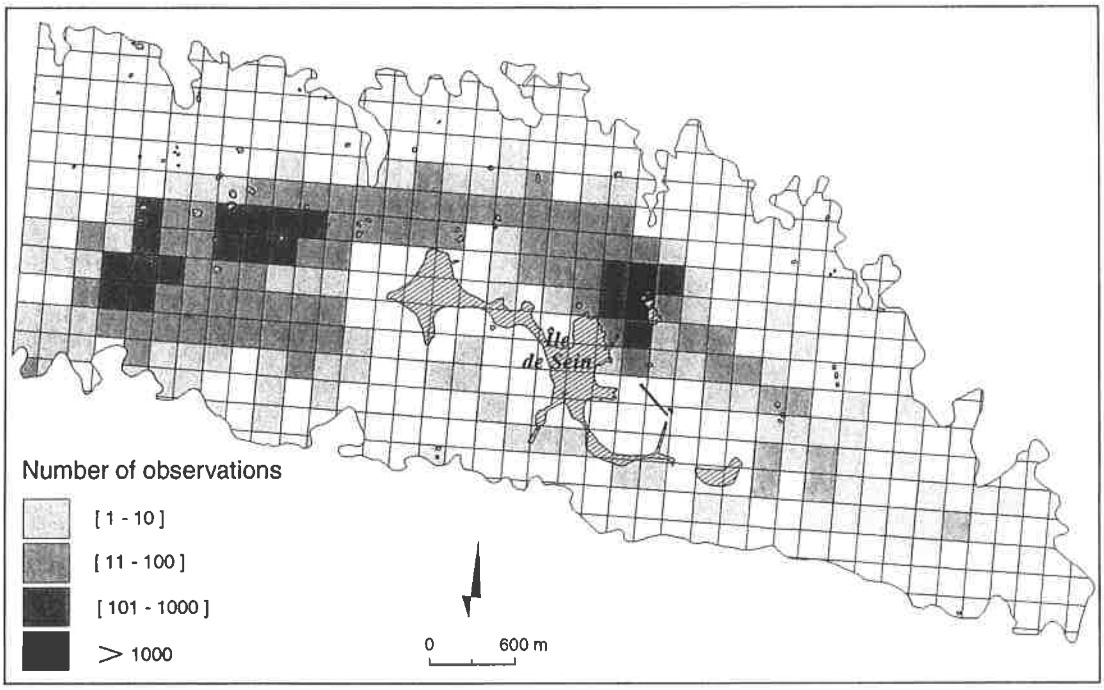

Figure 1 - Spatial repartition of coastal bottlenose dolphin group around *île de Sein* from 1994 to 1997.

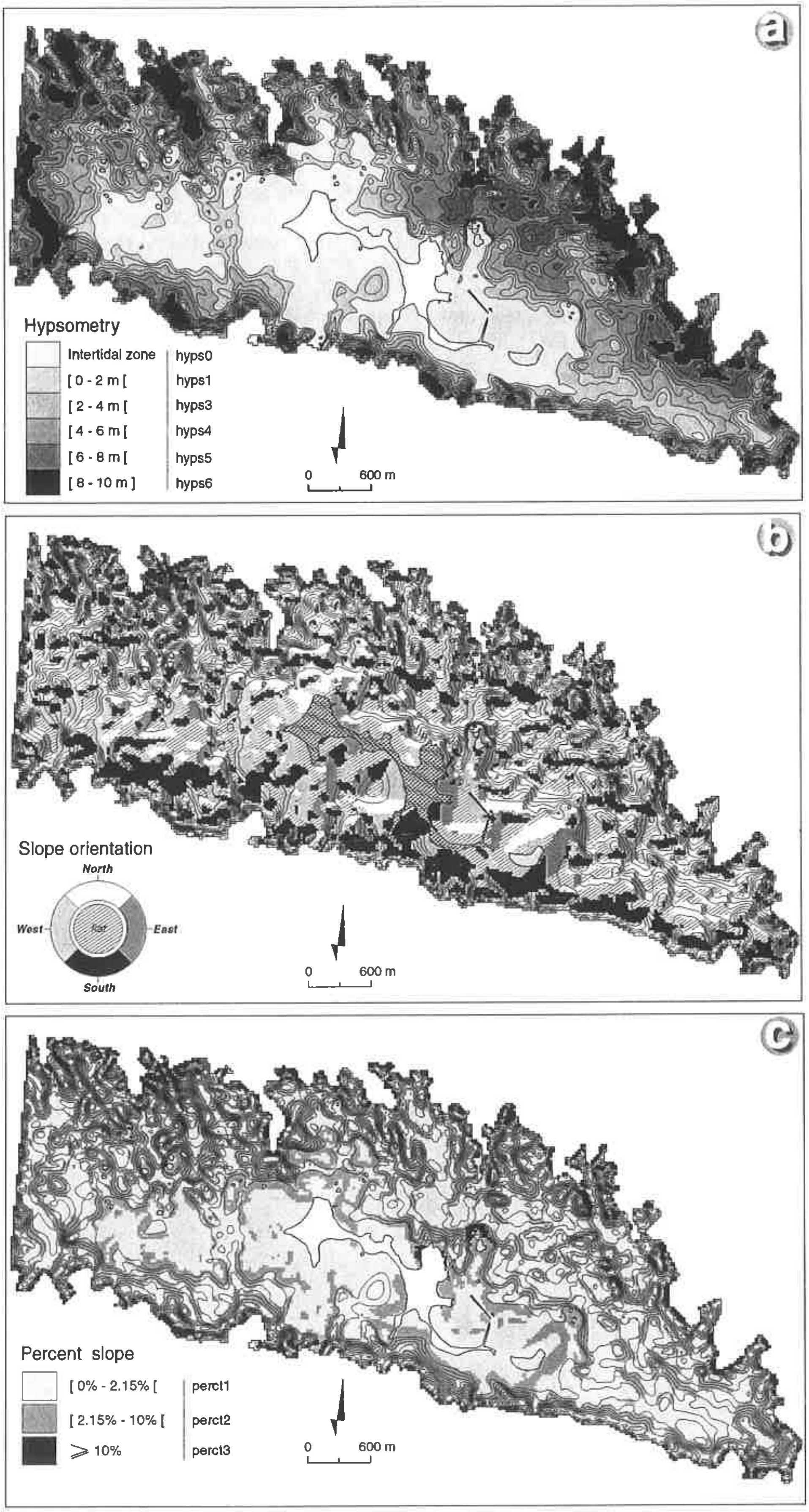

Figure 2 - Parameters resulted from the Digital Elevation Model. (a) Hypsometry is divided in 6 categories ; (b) Slope orientation corresponds to flat surface and 4 main directions of 90°: North (315°-45°), East (45°-135°), South (135°-225°) and West (225°-315°) ; (c) Percent slope is divided in 3 categories: low (0-2.15%), medium (2.15-10%) and high (>10%).

Table 1 - Single-factor analysis of variance (ANOVA) between dolphins' observations (total and per activity) and environmental parameters (hypsometry, orientation and percent slope). Significative P values (alpha = 0.05) are in bold and P values between 0.05 and 0.5 are in italics.

	Total observations	Resting	Foraging	Travelling
hyps0	*0.0748*	*0.2651*	**0.0041**	0.0713
hyps1	0.7015	0.9380	**0.0252**	0.7704
hyps2	0.8003	0.8326	0.7106	0.8032
hyps3	0.7572	0.8011	0.7695	**0.0227**
hyps4	**0.0033**	**0.0000**	0.6927	**0.0026**
hyps5	0.9455	0.9986	0.9581	*0.4402*
Flat	0.9418	0.8350	0.9792	0.8601
North	**0.0490**	*0.4300*	*0.0619*	**0.0298**
East	0.8407	0.8803	0.9194	*0.2755*
South	0.8486	0.8397	0.8777	0.9150
West	**0.0117**	**0.0013**	*0.1043*	*0.3399*
Perct1	0.5401	0.7493	**0.0462**	0.6383
Perct2	*0.1691*	*0.1287*	*0.1818*	*0.3425*
Perct3	**0.0000**	**0.0000**	**0.0042**	**0.0000**
Rocks	**0.0003**	**0.0055**	**0.0013**	**0.0169**

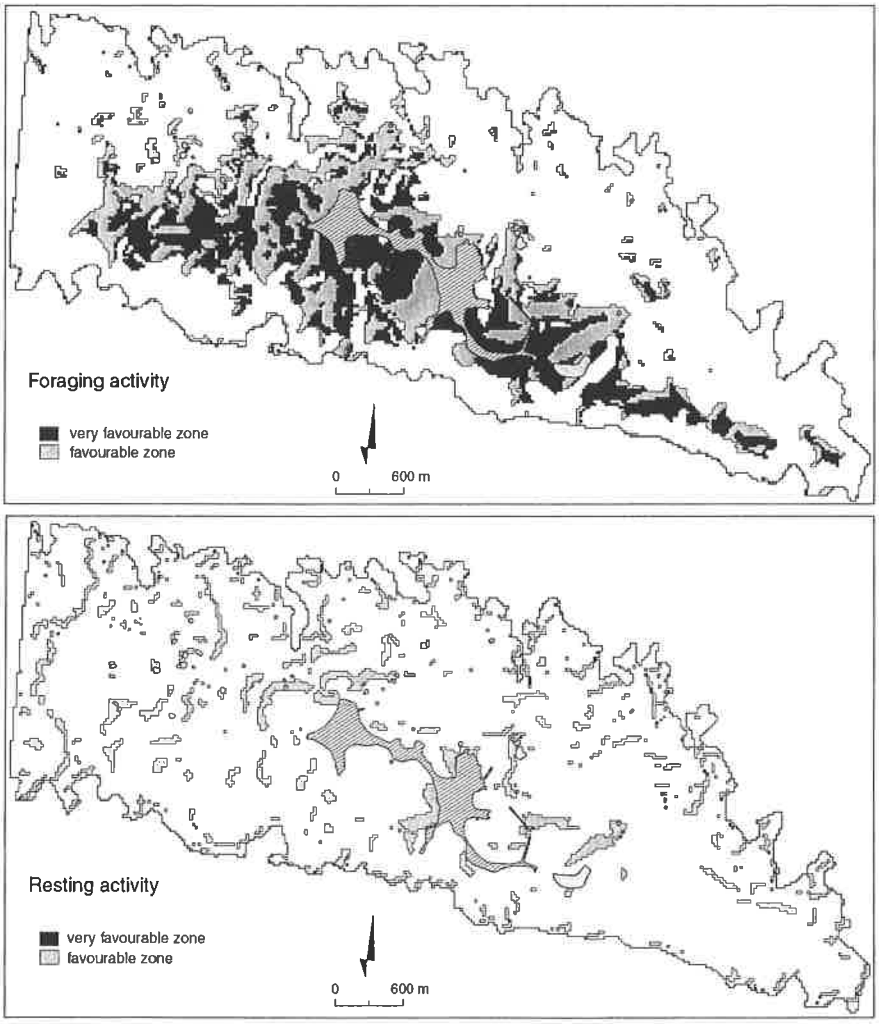

Figure 3 - Predicted bottlenose dolphin distribution areas for foraging and resting activities around *île de Sein*. Very favourable areas are determined by significative categories of hypsometry, slope orientation and percent slope (P<0.05) and favourable sites by morphometric variables with P values between 0.05 and 0.5.

IMPACT OF WHALE WATCHING VESSELS ON SPERM WHALE (*PHYSETER MACROCEPHALUS* ACTIVITIES IN WATERS SOUTH OF PICO AND FAIAL ISLANDS, AZORES

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INTRODUCTION The Azorean archipelago is a naturally good area for whalewatching. Besides harbouring several different species that might be resident, it is also on the route of some migrating species. It is considered one of the areas in the North Atlantic with the highest concentration of sperm whales (*Physeter macrocephalus*), being also a mating and nursery ground (Berzin, 1972; Evans, 1987).

The area south of Pico Island is one of the places where whalewatching is rapidly increasing, probably due to the same reasons that formerly made this area one of the most prosperous Azorean sperm whaling grounds. The whalewatching season usually starts in May and lasts until September. The main fleet operates with small inflatable boats powered with one or two out-board engines, although a sailing boat and a big game fishing boat are currently in use. The aim of the present study is to assess the effects of whalewatching vessels in the diurnal activities of the sperm whale, in order to contribute to a scientific basis to the management of this activity.

MATERIALS AND METHODS Land-based observations were carried out from fixed vantage points (whaling look-outs), within the period from 6th June to 23th September, 1998. Research was mainly based in the south of Pico ("Vigia da Queimada") and occasionally in Southwest Faial ("Vigia dos Capelinhos"). Searching and tracking of whales was made using 15x80 Steiner binoculars with a compass mounted on a tripod.

Distance to shore, velocity, group size, and individual size were estimated with the aid of a former experienced whaling look-out, who was present for the majority of the observational periods. Additional information on heading, surface behaviour, diving patterns, and aerial displays was taken and grouped into main activities. Differences between behavioural patterns in the absence and presence of vessels (<450 m) were analysed. Individual size was categorised in three classes: small (up to c. 6 m), medium (c. 7-12 m) and large (more than c. 14 m), corresponding respectively to calves, mature females and immature individuals, and males (Best, 1968). Calves observed alone for less than 45 min. (mean duration dive for larger individuals) were assumed to belong to a female group. If a group was seen to split, or join up with another group during tracking, only one of them was considered for details, and registered as a new sighting (Best *et al.*, 1995). Whenever possible, ventilation cycles were recorded.

RESULTS Land-based observations were conducted during 39 days, totalling 184.5 hrs of observation, of which 84.5% were in South Pico. A total of 216 sightings of nine different cetacean species were recorded (Fig.1). Only sightings up to ten miles offshore (N=64) are investigated here, of which 73% occurred up to five miles (Fig. 2). The percentage of group types registered is shown in Fig. 3. On five of the 14 sightings, calves were observed alone, always at intervals shorter than 45 min. Maximum number of individuals per group was five, with an average of 3.1 (±0.3 SE) individuals. In 67% of the sightings, sperm whales were reported in feeding activities, and in 5% in socialising/resting (Fig. 4). Whalewatching vessels were present in 59% of all sightings. During the study period, no changes in apparent activity were ever registered, despite the presence of whalewatching boats. Although frequency of disruption in the normal pattern of direction, spatial arrangement and diving was higher in the presence of boats, these differences were not statistically significant (Fisher exact test, N=4) (Fig.5).

Gender was found to have a significant effect on the mean blow intervals of 32 sperm whales. Moreover, a significant interaction between the presence of boats and gender of the whale suggests that the two factors are not independent (Two-way ANOVA, gender: $F_{(1,766)}$ = 171.6051, P<0.0005, boat: $F_{(1,766)}$ = 1.0783, P<0.5, interaction: $F_{(1,766)}$ = 5,6209, P<0.05) (Table 1). Mean blow interval of females was significantly higher in the presence of boats (Mann-Whitney U test, U=3466.1, P<0.05). However, the same difference was not detected among males (U=3529, P<0.5).

DISCUSSION AND CONCLUSIONS Feeding was the predominant activity in which sperm whales were engaged, being found in average groups of 3.1 individuals. This is in accordance with other studies which describe that when feeding, groups spread out (into clusters of one to three individuals) for several hundred metres of ocean, and calves swim from cluster to cluster as the larger whales dive (Whitehead, 1996; Gordon, 1987). In fact, in this study, calves were never observed alone for more than 45 min. The predominance of feeding over other activities may suggest that this area is an important feeding ground for sperm whales. In addition, the occurrence of deep waters so near to shore, especially for females with calves, reinforces the idea that this area may be of great importance for this kind of study.

Although disruption of sperm whale activities or behavioural patterns does not seem to occur in the presence of boats, a relationship was found between the latter and female mean blow intervals. Results described in this study (Table 1) are comparable to those of Gordon & Steiner (1992), who found a mean blow interval for females and immature males of 12.7 sec., and 19.3 sec. for adult males. Some authors suggested that blow rates could be useful in characterising different behavioural states, and therefore to assess the effects of disturbance on whales (Würsig *et al.*, 1986). In this context, and despite the absence of an obvious relationship between apparently disturbed females and the presence of calves, it is strongly recommended that future research should take into account this particular aspect.

ACKNOWLEDGEMENTS We could not finish without acknowledging: at the look-outs, Mr. João Vigia and Sidónio Bettencourt, for sharing their experience with such a strange thing as a 'look-out girl'; in the field, the whalewatching enterprises Espaço Talassa, Norbert Diver, and Aquaçores for their support and friendship; and for help with the data, Pedro Afonso and Alexandre Silva. This work was partly funded by the EU Project LIFE98NAT/P/5275 and the Azorean Regional Tourism Directorate.

REFERENCES

Berzin, A. A. 1972. *The Sperm Whale*. Published by The National Marine Fisheries Service & The National Science Foundation (H. Mills, Eds.), Israel Program for Scientific Translations, Ltd. 394pp.

Best, P. B. 1968. The sperm whale (*Physeter catodon*) off the west coast of South Africa - 2. Reproduction in the female. *Div. sea fish. investig. report no. 66*, Dep. of Industries. S. Africa. 32pp.

Best, P. B., Sekiguchi, K. and Findlay, K. P. 1995. A suspended migration of humpback whales *Megaptera novaeangliae* on the west coast of South Africa. *Mar. Ecol. Prog. Ser.*, 118: 1-12.

Evans, P. G. H. 1987. *The Natural History of Whales & Dolphins*. Christopher Helm, London. 343pp.

Gordon, J. C. D. 1987. Sperm whale groups and social behaviour observed off Sri Lanka (SC/38/Sp7). *Rep. Int. Whal. Commn*, 37: 205-217.

Gordon, J. and Steiner, L. 1992. Ventilation and dive patterns in sperm whales, *Physeter macrocephalus*, in the Azores (SC/42/Sp7). *Rep. Int. Whal. Commn*, 42: 561-5.

Whitehead, H. 1996. Babysitting, dive synchrony and indications of alloparental care in sperm whales. *Behav. Ecol. Sociobiol.*, 38: 237-244.

Würsig, B., Wells, R. S. and Croll, D. A. 1986. Behaviour of gray whales summering near St. Lawrence Island, Bering Sea. *Can. J. Zool.*, 64: 611-21.

Table 1 - Number, average and standard error of blow intervals of 32 female sperm whales in the presence and absence of boats

Blow interval (s)	Females		Males		Total
	Boats absent	Boats present	Boats absent	Boats present	
N. of blow intervals	375	213	114	68	770
Average	12,4	13	18,6	17,2	13,9
SE	0,2	0,2	0,7	0,7	0,2

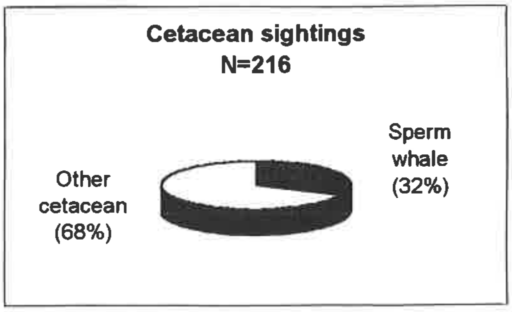


Fig. 1 - Percentage of total cetacean sightings

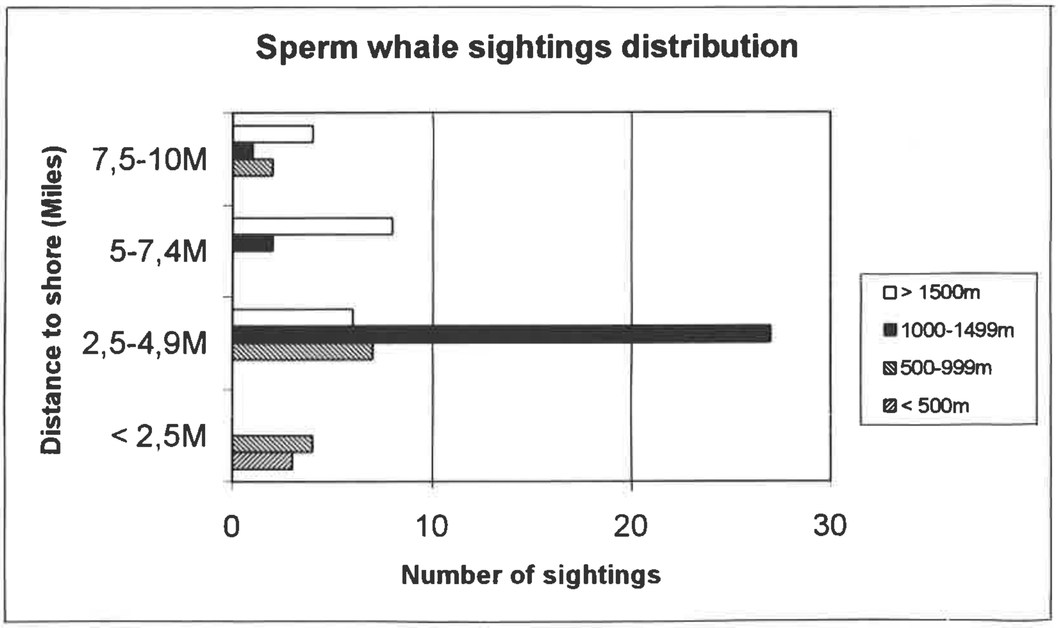


Fig. 2 - Frequency distribution of sperm whales in relation to distance to shore (miles) and water depth (m.)

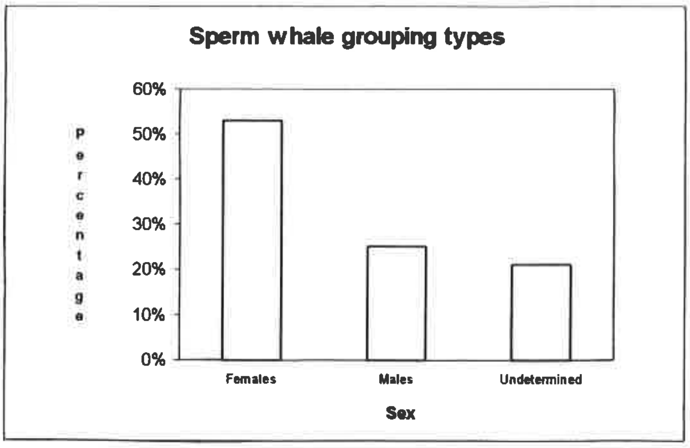


Fig. 3 - Percentage of sperm whale group types

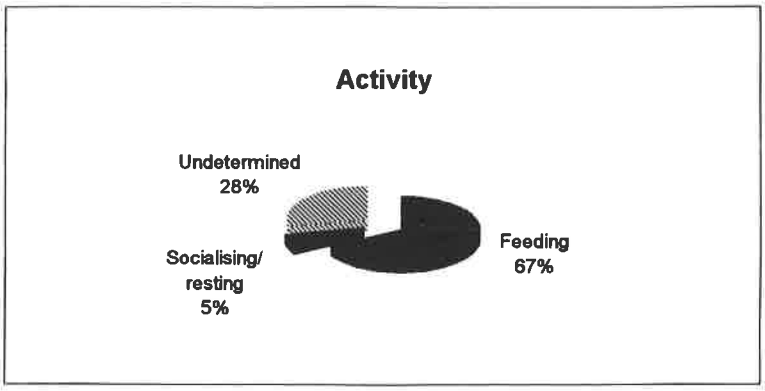
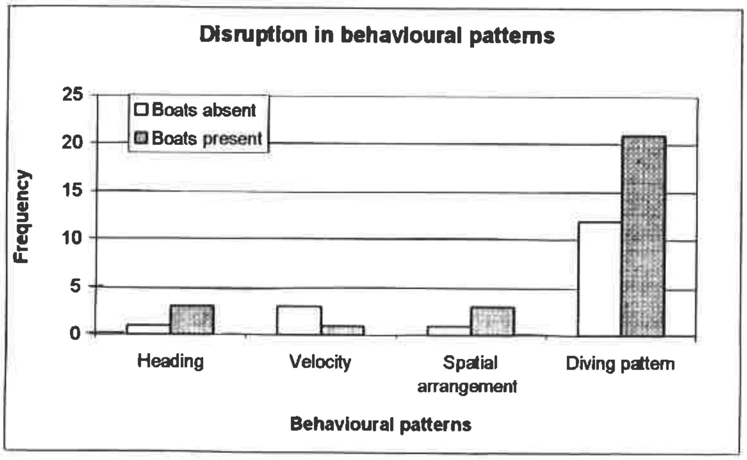


Fig. 4 - Percentage of activities in which sperm whales were engaged



Fisher exact Test: P=0.4616 P=0.1790 P=0.4616 P=0.3223

Fig. 5 - Frequency of disruption in behavioural patterns of sperm whales in the presence and absence of boats

CETACEAN CONSERVATION IN NORTHWEST SCOTLAND: PERCEIVED THREATS TO CETACEANS

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INTRODUCTION The west coast of Scotland has an abundant and diverse population of cetaceans: to date, twenty-four cetacean species have been reported from this region, making it one of the most important habitats for cetaceans in Europe (Evans, in press).

PERCEIVED THREATS TO CETACEANS IN NORTHWEST SCOTLAND

Directed takes Commercial whaling occurred in West Scotland (from Loch Tarbet, Harris) from 1904-28 and briefly re-opened between 1950-51. The whaling station predominantly caught fin, sei and blue whales (1,538, 378 and 316 animals, respectively) with some catches of northern right, sperm, northern bottlenose and humpback whales (94, 77, 1, and 19 whales, respectively) (Thompson, 1928; Brown, 1976). At present, Norwegian commercial whaling operations are being undertaken in waters adjacent to Scotland; the target species being North Atlantic minke whales. At present, there is little information on the movements or migratory patterns of minke whales, but it is feasible that these could take them from Scottish waters into current or future whaling grounds for part of the year.

Incidental takes Gillnet fisheries are known to be a major problem for small cetacean populations (e.g. Tregenza *et al.*, 1997). Northridge and Hammond (1999) presented preliminary data collected by observers on a small number of gillnet boats operating in the waters to the west of the Outer Hebrides. This study demonstrated that by-catch of harbour porpoises does occur in this area. This region is also exploited by Spanish fishing vessels operating within and immediately adjacent to Scottish waters. The level of cetacean by-catch inflicted by these foreign vessels is unknown.

In 1986, the use of monofilament gillnets was banned for Scottish inshore fisheries; however, the ban was repealed in 1996. After this repeal, there was concern from some environmental groups that the return of monofilament gillnets may lead to high levels of harbour porpoise by-catch in the inshore waters of Northwest Scotland. However, the amount of gillnet fishing effort in this region is very low, which is mainly due to the fact that gillnetting is currently unprofitable compared with other types of fishing (Gill, 1999). However, the fishing industry is very dynamic and the level of gillnet fishing effort could increase in the future.

Pollution

Organochlorines There is only limited information about the levels of anthropogenic contaminants in cetaceans from Northwest Scotland. Published data on concentrations of organochlorines are summarised in Table 1. Several of the levels of organochlorines summarised in Table 2 are of a magnitude equal to those which have been reported to cause reproductive (e.g., Subramanian *et al.*, 1987) and immune system (e.g. Lahvis *et al.*, 1995) changes in other species of small cetacean. However, in general, the organochlorine concentrations reported upon are relatively low.

Trace elements Published information on trace element concentrations in cetaceans from Northwest Scotland is summarised in Table 2. Concentrations of mercury and cadmium are reasonably high (up to 71 and 99 ppm, respectively), particularly in long-finned pilot whales and striped dolphins. Both of these species forage upon cephalopods, and the fact that these two species have accumulated elevated levels of cadmium and mercury suggests elevated concentrations in their prey species.

PAHs A neonate harbour porpoise, stranded on the Isle of Islay, is the only cetacean from the west coast of Scotland which has been examined for the presence of PAHs (polycyclic aromatic hydrocarbons). The PAHs are a carcinogenic group of contaminants which are primarily derived from the combustion of fossil fuels and oil-related industry. The porpoise had detectable levels of PAHs despite being a neonate (Ekofisk equivalents: 1.0 ppm; Chrysene equivalents: 0.23 ppm, wet weight; Law and Whinnett, 1992). It would be expected that adults from the region would accumulate greater concentrations of this class of pollutant. Considering the potential for PAH contamination in Northwest Scotland, the analysis of cetacean tissues for PAHs warrants further research.

Hydrocarbons The most obvious hydrocarbon pollutant is crude oil, whether it is released into the environment deliberately (as the result of sluicing out the tanks of oil tankers after offloading) or unintentionally (accidental discharges and oil spills). Due to the close proximity of oil fields to the coast of Northwest Scotland, there is a considerable volume of oil-related shipping traffic which passes through the area, and there are several oil-related installations, particularly in the northern Outer Hebrides. In addition, discharges have occurred of fuel oil, frequently the result of leaking vessels and sometimes the result of shipping accidents. The hydrocarbons contained in fuel oil may not have the physical impact on the marine biota that crude oil has (e.g. covering seabirds in a tarry hydrocarbon film), but nonetheless they may have a toxicological impact.

Butyltins Butyltins (BTs) have been described from several species of cetacean in recent years and there is concern about the possible toxicological implications for BT pollution on cetacean populations (Iwata *et al.*, 1994, 1995). Butyltins are primarily used as anti-fouling treatments upon ship hulls and marine structures, such as fish farm cages. Davies *et al.* (1987) reported that BT contamination was elevated in sea lochs, the result of contamination from fish farms, coupled with an enclosed water system. In 1986, the use of tributyltin on boats less than 25 m was banned in Scotland. However, Ambrose (1994) noted that around 69% of ships are still being painted with BT anti-fouling paints. Therefore, it would be expected that coastal species frequenting sealochs and harbours, such as bottlenose dolphins and harbour porpoises, would be exposed to elevated levels of BT contamination. As yet, there have been no studies upon the level of BT contamination in cetacean species from western Scotland, and this issue needs attention.

Sewage There are few sewage plants in this region of Scotland and most domestic discharges are small scale from septic tanks, although there are some areas where untreated discharges may cause localised pockets of sewage pollution. Sewage pollution resulting from untreated industrial discharges (from the wool, leather, distilling and seafood industries) is probably more problematic. Fish-farms are the greatest source of untreated sewage pollution in the coastal waters of West Scotland.

Fish-farm-related pollutants Fish-farms produce a variety of pollutants, the monitoring of which is the responsibility of the fish-farm operators. These pollutants include butyltins, which are used as anti-foulants on cages, and faecal matter. The amount of sewage pollution produced by fish-farms in Northwest Scotland is greater than the total marine sewage discharge of the region's human population. This faecal matter is entirely untreated and this waste gathers in high concentrations underneath fish-farm cages together with unconsumed fish food to form a dense mat of decaying organic matter. As fish-farms are typically situated in sealochs and sheltered areas, these enclosed water systems result in the accumulation of the organic detritus, with an accompanying increase in anoxic conditions and sewage-related pathogens. In addition, the aquacultured fish are treated with various chemicals such as neurotoxic organophosphates and cypromethrin, to combat fish lice. The cultured fish are also fed with hormonal growth promoters and antibiotics to improve fish yields. These chemicals could have biological impacts on populations of cetaceans inhabiting adjacent areas by altering reproductive development, and causing a reduction in their natural resistance to pathogens.

Fish-farms are probably the largest contributor to anthropogenic pollution in the coastal waters of Northwest Scotland, yet the impacts of these pollutants upon coastal and sealoch-dwelling cetaceans (such as harbour porpoises and bottlenose dolphins) has, as yet, been unstudied. An investigation of these impacts should be considered a research priority.

HABITAT DEGRADATION AND DISTURBANCE

Prey depletion The north-west of Scotland holds many important fishing grounds and many commercially important fish species caught in the regions are also important prey species for cetaceans - such as herring and mackerel. There is currently a fisheries quota system in operation in Scotland, with takes being calculated to alleviate the problem of over-fishing. However, the quotas are based upon the amount of fish landed at recognised ports. The quotas do not take into account fish which are discarded at sea, transferred to other ships offshore, or landed illegally. Due to a combination of these factors, fisheries quotas are being greatly exceeded and stocks of fish are being diminished.

Fisheries Another impact of Scottish fisheries upon the marine ecosystem are trawl and scallop dredging fisheries. Swathes of seabed are obliterated by the gear used in these fisheries. One of the problems with these fisheries, particularly in coastal areas, is that the seabed is not left to recover before being trawled again. If coastal waters were managed by local fishing organisations, which allowed seabed recovery before re-trawling, it would not only maximise the yields of fishermen, but also allow some habitat and prey protection for cetaceans. This is currently not possible, however, as trawlers frequently come into coastal waters from outside areas, with no knowledge of previous fishing effort in the trawl sites.

Oil exploration In addition to the potential risk from oil-related pollution, as mentioned above, the oil industry also poses a threat to cetaceans with respect to the degradation of their habitats. Several oil companies are currently conducting a series of seismic surveys off the coast of the Outer Hebrides in a search for new oil fields. The area in which these seismic surveys are being conducted is known to be inhabited by several species of cetacean, in particular, beaked, bottlenose, sperm, fin, sei, and pilot whales, and Atlantic white-sided dolphins (Stone, 1997, 1998; Hughes *et al.*, 1998; Lewis *et al.*, 1998). In a recent study off the Outer Hebrides, Swift (1997) monitored the acoustic behaviour of delphinids and sperm whales before, during, and after seismic surveys and noted significant behavioural changes. The UK Government has recently issued the oil industry with a code of practice to attempt to mitigate the impacts of seismic surveys upon cetaceans. This code of practice should prevent the lethal and sub-lethal effects of seismic testing (e.g. auditory damage) but the issue of habitat degradation and disturbance of cetaceans within breeding and resting grounds as the result of oil exploration, still remains.

Fish-farms The fish-farm industry has already been highlighted above as a major source of pollution and degradation within cetacean habitats. Another area in which fish-farms cause an impact on coastal cetaceans is the use of acoustic harassment devices to scare seals away from fish farm cages ("seal scrammers"). The acoustic devices would not only deter seals from fish farm sites, but could also exclude cetacean species such as harbour porpoise from breeding, feeding or resting sites.

Shipping The north-west of Scotland is an important maritime area with a substantial volume of commercial and recreational shipping activity. Shipping can impact cetacean populations in two ways. Firstly, collisions with shipping may injure or kill cetaceans. As yet, this has not been reported to have occurred in Northwest Scotland. Secondly, the noise produced by shipping may cause disturbance, stress and degradation of the habitats of cetaceans (Richardson, 1995; Evans, 1996). A code of conduct for boat-users in the vicinity of cetaceans has been drafted for and distributed in Northwest Scotland (HWDT, 1999), which will hopefully help minimise some of the disturbance caused by marine shipping.

Military Activities The north-west of Scotland is the site of many military exercises, in particular, submarine exercise areas occupy most waters in the region. The extensive use of sonar and a high density of submarine activity could disturb a variety of cetacean species. The Ministry of Defence's British Underwater Test and Evaluation Centre is situated near the Kyle of Lochalsh, with the adjacent area being used as a torpedo testing range: some 130 square miles of the Sound of Raasay are considered to be a danger area to shipping because of the use of explosives in this region. This area is also an important habitat for cetaceans, notably the harbour porpoise and, on occasions, northern bottlenose whale. In addition, a missile firing range is situated on the island of South Uist, which fires ordinance westwards out into an area of high cetacean abundance. Finally, joint forces training exercises are conducted three times a year in Northwest Scotland. Concern has been voiced from wildlife tour operators that this exercise coincides with a period of abnormally low local cetacean (minke whale & harbour porpoise) abundance.

The amount of military activity in Northwest Scotland is considerable, as is the potential for lethal and sub-lethal impacts upon cetacean populations in this region. This issue, therefore, needs investigation.

REFERENCES

Ambrose, P. 1994. Anti-fouling news. *Mar. Pollut. Bull.*, 28: 134.

Brown, S. G. 1976. Modern whaling in Britain and the north-east Atlantic Ocean. *Mamm. Rev.*, 6: 25-36.

Davies, I. M., Bailey, S. K. and Moore, D. C. 1987. Tributyltin in Scottish sealochs, as indicated by degree of imposex in the dogwhelk *Nucella lapillus* (L.). *Mar. Pollut. Bull.*, 18: 400-404.

Evans, P. G. H. 1996. Human disturbance of cetaceans. Pp. 376-394. In *The Exploitation of Mammals - principles and problems underlying their sustainable use.* (Eds. N. Dunstone & V. Taylor). Cambridge University Press. 415pp.

Evans, P. G. H. (in press). Whales, dolphins and porpoises. Chapter 5.15. In *Coasts and Seas of the United Kingdom. Region 15 - The Outer Hebrides.* (Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska & J.P. Doody). Joint Nature Conservation Committee, Peterborough.

Gill, A. 1999. *Study to investigate the extent and nature of the fixed-net fishery in Hebridean waters and possible conflicts with harbour porpoise (*Phocoena phocoena*) populations.* Hebridean Whale and Dolphin Trust, Tobermory, UK. 36pp.

HWDT (Hebridean Whale & Dolphin Trust) 1999. *Code of conduct.* Hebridean Whale and Dolphin Trust, Oban. 2pp.

Hughes, K., Arnold, H., De Boer, M., Irish, R., Mackins, C., Murray, E., Norris, K., Pert, J., Simmonds, M. and Stanley, M. 1998. Results of the Greenpeace/WDCS cetacean survey of the Atlantic Frontier; July-August 1998. Pp 18-36. In *The Atlantic Frontier, Britain's Last Wilderness* (Eds. E. Murray and M. Simmonds). Whale and Dolphin Conservation Society & Greenpeace, London.

Iwata, H., Tanabe, S., Miyazaki, N. and Tatsukawa, R. 1994. Detection of butyltin compound residues in the blubber of marine mammals. *Mar. Pollut. Bull.*, 28: 607-612.

Iwata, H., Tanabe, S., Mizuno, T. and Tatsukawa, R. 1995. High accumulation of toxic butyltins in marine mammals from Japanese coastal waters. *Environ. Sci. Technol.*, 29: 2959-2962.

Lahvis, G. P., Wells, R. S., Kuehi, D. W., Stewart, J. L., Rhinehart, H. L. and Via, C.S. 1995. Decreased lymphocyte responses in free-ranging bottlenose dolphins (*Tursiops truncatus*) are associated with increased concentrations of PCBs and DDT in peripheral blood. *Environ. Health Persp.*, 103: 67-72.

Law, R. J. and Whinnett, J. A. 1992. Polycyclic aromatic hydrocarbons in muscle tissue of harbour porpoises (*Phocoena phocoena*) from UK waters. *Mar. Pollut. Bull.*, 24: 550-553.

Law, R. J., Fileman, C. F., Hopkins, A. D., Baker, J. R., Harwood, J., Jackson, D. B., Kennedy, S., Martin, A. R. and Morris R. J. 1991. Concentrations of trace metals in the livers of marine mammals (seals, porpoises and dolphins) from waters around the British Isles. *Mar. Pollut. Bull.*, 22: 183-191.

Lewis, T. P., Swift, R., Gozalbes, P., Butler, J. and Gordon J. 1998. *Report on passive acoustic monitoring of cetacean distribution north-west of the Hebrides 1997-1998.* Hebridean Whale and Dolphin Trust, Mull. 52pp.

McKenzie, C. 1999. *Concentrations and patterns of environmental contaminants in marine mammals and their diets.* Ph.D. thesis. Robert Gordon University, Aberdeen.

McKenzie, C., Rogan, E., Reid, R. J. and Wells, D.E. 1997. Concentrations and patterns of organic contaminants in Atlantic white-sided dolphins (*Lagenorhynchus acutus*) from Irish and Scottish coastal waters. *Environ. Pollut.*, 98: 15-27.

Northridge, S. and Hammond P. S. 1999. Estimation of porpoise mortality in UK gill and tangle-net fisheries in the North Sea and west of Scotland. Paper presented to the Scientific Committee at the 51st Meeting of the International Whaling Commission, Grenada, 1999. SC/51/SM42.

Richardson, W. J. 1995. Documented disturbance reactions. Pp. 241-324. In *Marine Mammals and Noise* (Ed. W.J. Richardson, C.R. Greene, C.I. Malme and D.H. Thomson). Academic Press, London.

Stone, C. J. 1997. Cetacean observations during seismic surveys in 1996. JNCC Report No. 228. Joint Nature Conservation Committee, Aberdeen. 67pp.

Stone, C. J. 1998. Cetacean observations during seismic surveys in 1997. JNCC Report No. 278. Joint Nature Conservation Committee, Aberdeen. 85pp

Subramanian, A. N., Tanabe, S., Tatsukawa, R., Saito, S. and Miyazaki, N. 1987. Reduction in testosterone levels by PCBs and DDE in Dall's porpoises of the north-western north Pacific. *Mar. Pollut. Bull.,* 18: 643-646.

Swift, R. 1997. *The effects of array noise on cetacean distribution and behaviour.* M.Sc. thesis, University of Southampton. 163pp.

Thompson, D'A. W. 1928. On whales landed at the Scottish whaling stations during the years 1908-1914 and 1920-1927. *Sci. Invest. Fish. Bd. Scotland* 1928, 3: 1-40.

Tregenza, N. J. C., Berrow, S. D., Hammond, P. S. and Leaper, R. 1997. Harbour porpoise (*Phocoena phocoena* L.) by-catch in set gill nets in the Celtic Sea. *ICES J. Mar. Sci.*, 54: 896-904.

Wells, D. E. and Echarri, I. 1992. Determination of individual chlorobiphenyls (CBs), including non-ortho, and mono-ortho chloro substituted CBs in marine mammals from Scottish waters. *Intern. J. Environ. Anal. Chem.,* 47: 75-97.

Table 1 - Concentrations of organochlorine pollutants in the blubber tissue of cetaceans from Northwest Scotland (concentrations are expressed as parts per million, wet weight)

Area	Species	n	PCB	Dieldrin	HCB	Chlordane	DDT	Reference
Ayr	*Phocoena phocoena*	1	10.0	2.21	-	2.01	7.34	McKenzie, 1999
Oban	*Lagenorhynchus acutus*	1	33.1	4.74	0.76	12.4	45.7	McKenzie *et al.*, 1997
Islay	*Stenella coeruleoalba*	2	5.63-7.25	0.51-0.84	0.22-0.26	1.62-2.21	5.46-6.98	McKenzie, 1999
Coll	*Grampus griseus*	1	9.54	0.69	0.07	1.09	7.51	McKenzie, 1999
Mull	*Physeter macrocephalus*	1	0.71	-	-	-	-	Wells and Echarri, 1992
Skye	*P. macrocephalus*	2	2.62-2.90	0.13-0.15	0.17-0.18	0.42-0.52	3.61-4.32	McKenzie, 1999
	Stenella coeruleoalba	1	6.37	1.48	0.19	4.49	10.2	McKenzie, 1999
	Mesoplodon bidens	1	3.12	0.02	0.09	0.12	1.89	McKenzie, 1999
N.Uist	*L. acutus*	1	30.2	4.60	1.10	11.9	54.6	McKenzie *et al.*, 1997, McKenzie, 1999
	L. acutus	1	3.57	0.95	0.66	2.09	7.20	
Lewis	*Phocoena phocoena*	1	4.08	0.23	0.23	0.23	1.96	McKenzie, 1999
	Globicephala melas	4	6.16-10.3	0.37-1.15	0.16-0.26	1.71-4.51	7.83-14.1	McKenzie, 1999
	Grampus griseus	1	4.32	0.55	0.08	0.83	1.85	McKenzie, 1999
	Mesoplodon bidens	3	3.10-3.33	0.07-0.09	0.07-0.11	0.27-0.54	2.00-2.82	McKenzie, 1999

Table 2 - Concentrations of trace element pollutants in the tissues of cetaceans from Northwest Scotland (concentrations are expressed as parts per million, wet weight)

Area	Species	n	Tissue	Cd	Hg	Pb	Sn	Zn	Reference
Islay	*Phocoena phocoena*	1	Liver	<0.07	0.7	<0.07	-	49	Law *et al.*, 1991
	Stenella coeruleoalba	2	Liver	5.5-10.3	16.7-20	b.d.	0.13-0.28	46-87	McKenzie, 1999
Skye	*Stenella coeruleoalba*	1	Liver	5.5	15.9	b.d.	0.13	30.5	McKenzie, 1999
Benbecula	*Stenella coeruleoalba*	2	Liver	4.5-8.0	2.09-4.89	b.d.-0.12	0.15-0.17	44-83	McKenzie, 1999
			Kidney	33.2-33	0.88-3.38	b.d.-0.03	0.07-0.10	33-36	
N.Uist	*Lagenorhynchus acutus*	1	Liver	0.3	0.89	b.d.	0.09	70	McKenzie, 1999
			Kidney	0.26	0.33	b.d.	0.06	23	
Lewis	*Globicephala melas*	4	Liver	2.1-37.2	1.99-71	b.d.-0.28	0.07-0.20	13.8-53	McKenzie, 1999
			Kidney	47-99	1.58-7.26	b.d.-0.21	0.05-0.13	22-40	
	Grampus griseus	1	Liver	8.70	1.47	0.10	0.10	27	McKenzie, 1999
			Kidney	3.34	7.97	0.41	0.16	27	
	Mesoplodon bidens	3	Liver	0.40-6.7	0.97-1.05	b.d.	0.14-0.86	28-35	McKenzie, 1999

b.d.: below detection limits

GREY SEALS AND FISHERIES INTERACTIONS ON THE EAST AND SOUTH-EAST COASTS OF IRELAND

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The grey seal (*Halichoerus grypus*) is one of two seal species found around the coast of Ireland. Interactions between seals and fisheries in Ireland have been reported since the 1970's; however, the question is still hotly debated today. This study attempted to look at the question of seals and fisheries interactions by examining both direct and indirect interactions. Direct interactions were examined through a five-month study of the tangle net fishery for monkfish (*Lophius* spp.) along the south-east coast. This involved assessing the damage to the catch directly through sea trips (n=20), and indirectly by fishermen landing their damaged catch. In total, 308 damaged fish were measured and the original weights estimated, giving a weight of 667 kg of damaged monkfish. From the "at sea" trips (10% of the total) a damage level of 10.8% of the catch was attributed to seals. The relative merits of both types of approach and the results achieved are discussed.

Indirect interactions between seals and fisheries were studied through diet analysis from by-caught animals collected during the fishery, and faecal samples collected on haul out sites within the study area. Little is known about the diet of grey seals in Ireland. There are no published results from studies carried out in the past. This study represents the first on the diet of grey seals in this part of Ireland. The diet analysis of both the stomach and faecal samples showed that the most common components were whiting and *Trisopterus* spp.

CETACEAN BYCATCH IN THE WESTERN COAST OF THE TURKISH BLACK SEA IN 1993-1997

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The Black Sea has a very fragile ecosystem because it is semi-enclosed and has the largest anoxic water mass on the planet. Eutrophication, heavy pollution, over-fishing, invasion of alien species and coastal erosion are the main threats for the Black Sea biodiversity. Cetaceans, as top predators of this marine ecosystem, are also subjected to these dangers. Nonetheless, bycatch is probably the biggest threat for those living in the coastal waters.

The cetacean bycatch was studied in 1993-97 on the western coast of the Turkish Black Sea, from the Bulgarian border to Istanbul. A total of 63 specimens were examined. Except one specimen of bottlenoise dolphin *Tursiops truncatus*, all specimens were harbour porpoise *Phocoena phocoena*. These two species inhabit the coastal waters while the common dolphin *Delphinus delphis*, the other component of cetacean fauna of the Black Sea, was not found as its habitat is generally more offshore than the other two species. Most specimens were immature animals, with a body length less than 130 cm.

Bycatches occurred in bottom gill nets for turbot fisheries from April to June. The mesh size of the turbot net is 22 cm and the length is 150 m. Maximum depth of the setting of the net is about 80 m. There is an urgent need to regulate the turbot fishery so that the cetacean bycatch can be reduced.

CETACEAN BY-CATCH IN A DRIFTNET FISHERY FOR ALBACORE TUNA IN THE CELTIC SEA

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An observer programme to assess cetacean by-catch in a drift gillnet fishery for albacore tuna (*Thunnus alalunga*) was conducted from July to October 1996. Twenty-one trips with 125 hauls were observed, representing over 50% of the fishing effort for the Irish fleet.

A total of 256 individuals were observed by-caught, comprising a minimum of eight different species. These included common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), long-finned pilot whale (*Globicephala melas*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), minke whale (*Balaenoptera acutorostrata*), and sperm whale (*Physeter macrocephalus*). Of the cetaceans caught, 13 were released alive.

Bycatch of all cetaceans ranged from 0–13 per haul, with the distribution of animals per haul over-dispersed, with a variance of 6.5. The mean bycatch rate was 2.05 animals per haul with common dolphins (66.4%) and striped dolphins (25.4%) the most commonly caught. In general, striped dolphins had a more southerly distribution, although some were by-caught as far north as 52°N. Common dolphins had a more northerly distribution, with the majority of catches occurring between 51° and 52°N. Common dolphins ranged in size from 93–231 cm and from <1–21 years age. Striped dolphins ranged in size from 106–228 cm and from <1–25 years age. Bycatch per haul was not found to be significantly correlated with the number of tuna caught, or with sea-state.

The estimated total bycatch of all cetaceans in the Irish fishery in 1996 was calculated and compared with abundance estimates for common dolphins and striped dolphins in the region, derived from project MICA and the SCANS survey.

THE EFFECTS OF SEISMIC AIRGUN ARRAYS ON THE ACOUSTIC BEHAVIOUR AND DISTRIBUTION OF SPERM WHALE AND OTHER CETACEANS IN THE N.E. ATLANTIC/ATLANTIC FRONTIER

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The effects of high energy seismic sounds on marine mammals are poorly understood. We present results of passive acoustic surveys to monitor sperm whale (*Physeter macrocephalus*) vocal behaviour, and distribution before, during, and after 2D seismic surveys over the Rockall Bank and Rockall Trough, North-east Atlantic.

Surveys were conducted from the survey's guard vessel during the summer and autumn of 1997. Acoustic methods allowed round the clock monitoring, in conditions that typically prohibit visual surveys. Transects were designed to give a uniform coverage of the survey area before and after seismic surveys. However, requirements to monitor one nm ahead of the seismic vessel dictated how effort was distributed during seismic activity. Acoustic data (0.2-22 kHz) was collected at monitoring stations every two minutes (0.18 nm) along transects from a stereo, towed hydrophone array. Data were scored for vocalisation type & strength, airgun activity, and various forms of noise. The effects of depth, environmental co-variates, and time of day on detection were removed by modelling. Runs of positive stations were considered to be single independent encounters with a group of whales. An encounter with a new group was assumed when detections were separated by an interval without detection >30 minutes.

Encounter rates were highest during the initial phases of seismic activity and during post surveys, suggesting that sperm whales were not excluded from the area by the survey. Encounter duration was shorter during seismic activity but this difference was not significant. Detection rates at the start and end of lines, 60 minutes either side of *guns-on* (line start) and *guns-off* (line end) were compared using a matched pairs analysis. These were not found to be significantly different.

The results, which reveal few if any effects of airgun noise on sperm whales, are surprising in light of the dramatic responses by sperm whale to distant airgun noise reported in the literature. Possible explanations include: a history of seismic activity in the area over the last 30 years could have resulted in habituation, and/or responses may have been occurring at scales to which this research was not sensitive. These results are discussed, as are their implications for future studies.

THE FIRST EXPERIENCE OF A DAILY WHALEWATCHING ACTIVITY TO COLLECT DATA AND TO INFORM PEOPLE ABOUT CETACEAN BIOLOGY AND ECOLOGY CARRIED OUT BY WWF - LIGURIA

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INTRODUCTION In the last year, political attention has focused on the problem of cetacean protection, thanks to the efforts of scientific researchers and environmental associations to increase the public awareness of conservation problems and degradation of the marine ecosystem. Several studies have highlighted the importance of the Corso Ligurian Basin, one of the most productive areas of the Mediterranean Sea. That is why in 1998, proclaimed by UN, the "Year of the Oceans", a new marine reserve "Alto Mar Tirreno-Mar Ligure", was established. WWF thinks that a concrete way to protect marine mammals and their ecosystem is to start with a public awareness campaign. In this context, WWF carried out a project on whalewatching.

The project: Eight surveys were held, all with the same route and method: leaving at 09:30 hrs from the port of Genoa, navigating along the coastline up to Varazze, going into the open sea as far as 20-25 miles from the coast, and then returning.

Sightings were successfully made on all daily trips except for the one where the weather conditions were not favourable. Most of the sightings were characterised by groups of striped dolphins (*Stenella coeruleoalba*) ten miles off the coast in front of Varazze.

There were further sightings of the same species just out of Genoa's port: probably the dolphins were attracted by fishing boats. During the sightings, the animals did not seem to be scared. The fin whale (*Balaenoptera physalus*) was seen twice, and the rare false killer whale (*Pseudorca crassidens*) once.

CONCLUSIONS On board, the participants can not only improve their knowledge about cetaceans, but they can also learn the best way to behave with marine mammals in their environment. It is to be hoped that most of the participants understood that laws are not sufficient to protect cetaceans and their fragile environment without everybody's efforts.

WHALE WATCHING, PILOT WHALES AND BOTTLENOSE DOLPHINS IN THE CANARY ISLANDS: A SUSTAINABLE ACTIVITY?

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INTRODUCTION Whalewatching is an expanding tourist industry worldwide, and the Canary Islands are fully aware of this situation. From the 40,000 tourists of 1991 to 700,000 in 1996 (Montero Arechavaleta, 1997), the increase in whalewatching activities is such that during 1998, a total of 1 million visitors were expected. The Canaries therefore take second place in the world in the number of whalewatchers, following USA. This activity significantly contributes to the economy of the islands (particularly Tenerife), since the revenue coming only from the tickets sold on the boat excursions has already exceeded $1.428.000.

The activity began in the SW of Tenerife, and, since then, other sites have been incorporated such as the south of La Gomera and, more recently, the south of Gran Canaria. In any case, the area between the west coast of Tenerife and the south coast of La Gomera, is the best and most unique site for these purposes. Characteristics such as an almost lacking continental shelf between the islands which favours the approach of oceanic species, and the influence of the so called 'island mass effect', result in the presence of a great diversity of cetaceans within a small area (20 species have been recorded out of the 25 that have been described for the Canary Islands) and it sustains communities of resident, semi-resident, and transient short-finned pilot whales and bottlenose dolphins.

Additional factors have been added to the above characteristics which have made the south of Tenerife a particularly attractive site to carry out whalewatching activities. The key to this success is probably due to the fact that it can be carried out all year round, thanks to the good climatic conditions of the islands; in addition, a permanent community of short-finned pilot whales is present, with its main distribution area in a site of easy access for most vessels. With the aim of preserving these animals from possible damage, in 1995 the Canary Government approved a whalewatching regulation and, since then, a patrol boat has been operating in the area almost daily.

The present study involves the analysis of the whalewatching industry and its associated problems, both from a socio-economic and biological viewpoint, and presents possible solutions for making it sustainable.

METHODS We analysed the development of the activity in the west of Tenerife thanks to data gathered from the environmental department of the Canary Government in order to authorise and control the whalewatching activities. From data on species and boat sightings, our study area (250 km^2 in the SSW of Tenerife) is the one most visited, supporting 83% of the total activity. The data were taken from the control boat "Calderón", and the parameters recorded were date, time, and position of the boats and date, time, position, species, number of individuals, behaviour, and route of the cetaceans.

RESULTS - Analysis of the situation:

About cetacean sightings: Taking into account the data collected by the patrol boat, the species which are most frequently seen are the short-finned pilot whale (*Globicephala macrorhynchus*), with an average of 7.4 sightings per effort day (1996 to 1998), and the bottlenose dolphin (*Tursiops truncatus*), with a 0.4 effort day average of sightings, both being present all year round.

A total of 13 species were recorded from the control boat "Calderón" between 1996 and 1999, including various baleen whale species, sperm whales, killer whales, common, spotted, rough-toothed and Risso´s dolphins. Another seven species were recorded in the Channel by several researchers, including the endangered right whale and blue whale (Table 1)

About the Whalewatching Industry – factors and data:

1. Whalewatching in the Canaries is an unstoppable tourist activity which is conducted all year round with little fluctuation in intensity.
2. During 1996 and 1997, 86% of days were suitable for this activity (based on the weather conditions), resulting in only 50 "bad days" per year.
3. The whalewatching area is close to a very important tourist destination (with more than 4 million tourists in 1997). And 83% of the activity is concentrated within a relatively small area of 250 km^2 located at the south-west of Tenerife in a site of easy access for most vessels.
4. The presence of a resident community of short-finned pilot whales close to the marinas (less than 30 minutes away) determines a high degree of success.
5. Pilot whales can be seen at all times during the day all the year round. The frequency of cetacean sightings in the area varies little during the year, which means that the objective of visitors is almost guaranteed.
6. Since it is still a young activity in the Canaries but has a great potential, it is estimated that in 1998 approximately 1 million people visited the whales and dolphins in the south-west of Tenerife.
7. Pilot whales were seen on 95% of the effort days (data were taken at sea for at least 3 hours). On the remaining 5% of days, other species such as common or spotted dolphins were seen.
8. Species sighted: see Fig. 1.
9. Marinas, boats and enterprises: see Tables 1, Figs.1 and 2.

Marinas, boats and enterprises (Table 2):

a) Four marinas, located within 40 km from the coast, have 51 whalewatching boats belonging to 27 enterprises, with capacity for 2,423 passengers.
b) From the 48 registered tourist vessels during 1996, an average of 17 visited the south area within the same day, encountering a maximum of 29 boats within the same day, especially during July and August. In 1997, 50 were registered whalewatching boats but 42 were considered active. The mean value increased up to 19 boats per day with a maximum of 27 during July. In addition, a maximum of 34 different boats per month were seen carrying out the activity in such area, in contrast to 37 boats in the previous year. For 1998, the average of boats per day was 18, and the maximum 25 in October. This show that the average of boats per day did not vary much in these years, the maximum no. of boats per day actually decreasing. It should be noted that each vessel carries out 2, 3 and up to 4 trips per day.
c) Within one year, the decrease in the no. of whalewatching enterprises was evident (from 33 in 1996 to 27 in 1997). It is assumed that if several operators normally manage more than one boat (sometimes even four) the trend is to concentrate the boats into fewer hands. The most stable and strong capital enterprises are the ones which are growing.

The number of vessels involved in this activity since the beginning to the present is a good indicator of the development of the industry. The number of vessels in the early 1990's was ten, but, by 1997, there were already fifty (Fig. 2). Over the last couple of years, the stabilisation of the number of vessels does not imply that there have been no changes; on the contrary, some vessels have been replaced by larger ones which have increased their capacity as a response to this strong tourist demand. Thus, 10% of the vessels that were functioning in 1996 have stopped doing so, being replaced by new ones which have been specially built for these excursions. This boat "swapping" seems to be mainly the result of a lack of docking facilities in the marinas of SW Tenerife.

Along the SSW coast of Tenerife, a variety of boats can be found, ranging from small sailing boats to large catamarans with submarine windows; these depart at different times of the day. Following an analysis of the progression of the activity in the southern area, it is noticeable that catamarans have become the preferred vessel to carry out the activity and, although their numbers are hardly higher than the others, their capacity is greater than the rest, accounting for 50% of the total, the remaining percentage comprising both sailing boats and other boats in equal proportions. Amongst catamarans, those with a submarine view stand out, since the existing ones (only four) account for 36% of the activity.(Fig. 1).

Conservation Issues: Whalewatching could be a threat for the cetacean conservation if it is not developed in the correct way. Other potential conservation threats in the area include heavy traffic from sport vessels, regular vessel routes, the alteration of the coastline through the construction of artificial beaches and housing estates, and marine pollution from various outfalls.

The three main objectives to pursue would be:

1) Conservation of the resident populations of bottlenose dolphins and of short-finned pilot whales, through the development of actions geared towards the reduction of threats.

2) Creation of a Programme for the Management of Natural Resources in the Channel located between the islands of Tenerife and La Gomera, and location of areas which are likely to fall under a natural protected scheme.

3) Analysis and assessment of the importance, fragility, distribution, etc, of other cetacean populations, especially those which are quite unique on a worldwide basis, such as the genera *Ziphius*.

From the above, it can be seen that there is a need to unite efforts in order to achieve a high degree of efficiency in cetacean conservation. The co-ordination of all the programmes, activities and projects related to these animals would achieve better results and, besides benefiting the cetaceans, this would also be beneficial for society overall.

About the Investigation: In the Canaries, both cetacean research as well as the activities surrounding them, started with Jim Heimlich-Boran's PhD thesis on the social structure of the short-finned pilot whale (1989-92), which was followed by the "Study of impacts caused by vessels in the short-finned pilot whale resident population in the SW waters of Tenerife" (Martín and Montero, 1993). Subsequently, the Dept. of Tourism and Transport, through the company Saturno, created the "Cetacean Institute of the Canaries", which during its existence (1995-97), produced the following documents: "The Observation of Cetaceans in the Canaries as a Tourist Activity for the Canaries. 1996-1997. Description and diagnosis", and "Impact of the vessels on the population of short-finned pilot whales (Montero and Arechavaleta, 1997), both unpublished reports. In addition, a German research group, called "Project Context" developed during summer 1996 a study on the acoustics of short-finned pilot whales and their relationship with vessels.

In 1993, the "Society for the Study of the Cetaceans in the Canary Archipelago" (SECAC) was created as a non-profit organisation, unique in the Canaries, geared towards the research, conservation and dissemination of information on cetaceans within the Canary Archipelago, although most of its work has been concentrated on the SSW coast of Tenerife, specially in connection with acoustic studies of the short-finned pilot whales and studies on bottlenose dolphins. Finally, it is worth noting that the two Universities from the Canaries intend to become involved in the study of the bottlenose dolphin and the short-finned pilot whale, within the framework of a project financed by the European programme LIFE, and the Advisory Office for Territorial Policy.

CONCLUSIONS Whalewatching in the Canaries is an unstoppable tourist activity with great impact on the economy of the islands, as well as for the cetacean populations on which this activity is based. A target that needs to be pursued without delay is to integrate the use of a natural resource with socio-economic benefits for the population, with the maintenance in a favourable state of cetacean populations and their habitats, since the balance is fragile and unstable. It is for this reason that now, more than ever, this development should be carried out in a sustainable manner, taking into account its socio-economic aspects but giving priority to habitat and species conservation. The contribution to education and scientific knowledge should not be forgotten.

Management Recommendations: The work undertaken by the control boat, which has the support of the environmental agents and the co-operation of the Civil Guards, is essential for a good management of the area. Furthermore, the control that they keep on the activity is vital in order to achieve the objectives that are being pursued, that is, for this tourist activity to be compatible with the conservation of cetacean populations and their habitats. It is therefore important to keep this support and improve it further.

There are still many areas remaining for improvement in order to achieve an effective management of this activity, and it is therefore important to revise the existing regulations in order to replace the deficiencies observed during the three years of application of the decree. However, the main thing is to apply the rules efficiently and find the required support to achieve this aim. It is quite obvious that a more global approach is required in order to address the problems that surround this activity. Managers, researchers, and operators need to work as a team to find solutions that will ensure that whalewatching will not increase the survival risk of resident populations or of their environment and, therefore, does not alter the basic population parameters nor the usual pattern of use of such habitats. On the other hand, it should be possible to develop and maintain activities for the observation of cetaceans which are viable and responsible.

It is surprising to see that the control of the activity is more based on the availability of moorings for vessels in the marinas of the area rather than on a suitable policy to manage the communities of resident cetacean species of the area. For this reason, it is necessary to make an approximate estimate of the maximum number of vessels that could be used for the activity without causing a significant impact. Other measures to undertake would be diversify to other areas and towards other type of activities less intense and more educational, as well as maintaining an effort to have an efficient control and promote educational and research tasks in the medium and long term.

Scientific and Research Recommendations: From a scientific viewpoint, it is essential to know the biology of the species observed, understand the characteristics of the operations and of the vessels, and have an estimate, at least on a preliminary basis, of what is the sustainable capacity of this industry. Knowledge of population parameters and habitat use by cetaceans is essential. Although some research on the impact of whalewatching on pilot whales has been undertaken, information regarding basic aspects such as population size, behaviour, and habitat use remains scarce. Since 1996, no further scientific monitoring of these species has been undertaken.

Educational Recommendations: It should not be forgotten that whalewatching not only has a recreational/tourist use but can also be a means to develop educational, scientific and cultural activities in the marine and coastal environment. It is essential to develop an awareness campaign which covers not only the operators and tourists of the SSW Tenerife but also the others, not forgetting the people of the Canaries, and paying attention to encompass marine biodiversity conservation in school studies. On the other hand, the preparation of guides who must be onboard the whale watching boats must be sufficient and rigorous.

Now is the time to make an effort in order to ensure the protection of these animals through effective regulation, and to control whale watching activities, taking into account research upon these activities, and the need for adequate education and awareness.

REFERENCES

B.O.C. (Canarias Oficial Bulletin) nº de 20 de noviembre de 1995. Decreto 320/1995 por el que se regula la observación de cetáceos en Canarias.

Heimlich-Boran, J. 1993. *Social organisation of the short finned pilot-whale, with special reference to the comparative social ecology of delphinids*. PhD. Thesis. University of Cambridge. 235pp.

Heimlich-Boran, S and Heimlich-Boran, J. R. 1990. Ocurrence and group structure of short-finned pilot whales *Globicephala macrorhynchus* off the western coast of Tenerife, Canary Islands. Pp. 102-104. In: *European Research on Cetacean - 4*. Proc. 4th Ann. Conf. ECS, Palma de Mallorca, Spain, 2-4 March, 1990.(Eds. P. G. H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, England. 140pp.

Hernández-León, S. 1986. *Efecto de masa de isla en aguas del Archipiélago Canario según estudios de biomasa y actividad de sistema de transporte de electrones en el mesozooplancton*. Tesis doctoral de la facultad de Biología de la Universidad de La Laguna. 402pp.

Hoaggland, P. and Meeks, A. E. 1997. *The demand for Whale watching at Stellwagen Bank National Marine Sanctuary*. (Draft Report).

Hoyt, E. 1995. *The Worldwide Value and Extent of Whale Watching: 1995*. Whale and dolphin Conservation Society, Bath, UK. 36pp.

IFAW, Tethys Research Institute and Europe Conservation.1995. *Scientific aspects of managing whale watching*. Montecastelo workshop report, 30 March - 4 April 1995. (Edited by IFAW). 40pp

Martín, V., Montero, R., Heimlich-Boran, J. R. 1992. Preliminary observations of the cetacean of the Canary Islands. Pp 61-65. In *European Research on Cetacean - 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb., 1992.(Eds. P. G. H. Evans). European Cetacean Society, Cambridge, UK. 254pp.

Martín, V. and Montero, R. 1993. *Estudio de impacto que provocan las embarcaciones en la pobación de calderones residentes en las aguas del SO de Tenerife*. Unpubl. report.

Martín, V. 1996. Diurnal activity patterns and behaviour in the short-finned pilot whale *(Globicephala macrorhynchus)* of the SW coast Tenerife, Canary Islands. P. 199. In: *European Research on Cetacean - 10*. Proc. 10th Ann. Conf. ECS, Lisboa, Portugal, 11-13 March 1996.(Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 302pp.

Montero, R. and Arechavaleta, M. 1997. *La Observación de cetáceos de Canarias como actividad turística en Canarias. 1996-1997. Descripción y diagnóstico & Impacto de las embarcaciones sobre la población de calderón tropical*. Unpubl. report.

Urquiola, E. 1996. Cetáceos en Canarias: Normas para su observación. *Revista de Medio Ambiente* Nº 10.

Urquiola, E. 1998. Observación de cetáceos en Canarias: Conservación, problemática y evolución (II). *Revista de Medio Ambiente* Nº 11.

Urquiola, E. and Sevilla, J. 1998. Observación de cetáceos en Canarias. Situación actual (I). *Revista de Medio Ambiente* Nº 10.

Urquiola, E., Sevilla, J. and Iani, V. 1998. The evolution of whale watching in the Canaries after the regulation of 1995: a year of study. Pp. 62-66. In *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund,.Germany, 10-12 March 1997. (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Vonk, R. and Martín, V. 1988. First list of odontocetes from the Canary Islands. Pp. 31-35. In: *European Research on Cetaceans - 2* Proc. 2nd Ann. Conf. ECS, Troía, Portugal, 5-7 Feb, 1988. (Eds. P. G. H. Evans). European Cetacean Society, Lisboa, Portugal. 119pp.

Table 1 - Species observed in the Canary Islands

SPECIES	YEARS		
	1996	1997	1998
Globicephala macrorrhynchus	1447	2155	1000
Tursiops truncatus	111	79	58
Delphinus delphis	25	43	19
Stenella frontalis	14	21	4
Physeter macrocephalus	11	3	6
Steno bredanensis	7	2	-
Pseudorca crascidens	3	1	-
Balaenoptera edeni	2	3	-
Balaenoptera borealis	-	8	-
Balaenoptera sp.	-	2	1
Stenella coeruleoalba	-	3	-
Grampus grisseus	-	1	-
Ziphius cavirostris	-	1	-
Orcinus orca	-	2	-
Unknown	4		-
Effort days	225	263	132
Pilot whale Av. Sight./effort day	6.4	8.2	7.6
Bottlenose dolphin Av. Sight./effort day	0.5	0.3	0.4

Table 2 - Evolution of the number and capacity of the boats and its associated enterprises before and after the 320/1995 regulation

MARINAS		1994	1995	1996		1997	
		Without Decree		Auth.	Active	Auth.	Active
PUERTO	Nº of boats	17	20	25	24	27	23
COLON	Capacity	447	725	901	889	905	829
	Enterprises	11	13	15	15	11	10
LOS	Nº of boats	12	15	15	13	15	11
CRISTIANOS	Capacity	728	999	1179	1143	1295	1026
	Enterprises	9	11	12	11	11	9
TOTAL Southwest	**Nº of boats**	**29**	**35**	**40**	**37**	**42**	**34**
	Capacity	**1175**	**1724**	**2080**	**2032**	**2202**	**1855**
	Enterprises	**20**	**24**	**27**	**26**	**22**	**19**
LOS GIGANTES-SAN JUAN (west)	Nº of boats	7	9	8	8	8	8
	Capacity	323	407	313	353	335	323
	Enterprises	6	7	6	8	6	6
TOTAL TENERIFE	**Nº of boats**	**36**	**44**	**48**	**45**	**50**	**42**
	Capacity	**1498**	**2131**	**2393**	**2385**	**2537**	**2178**
	Enterprises	**26**	**31**	**33**	**34**	**27**	**24**

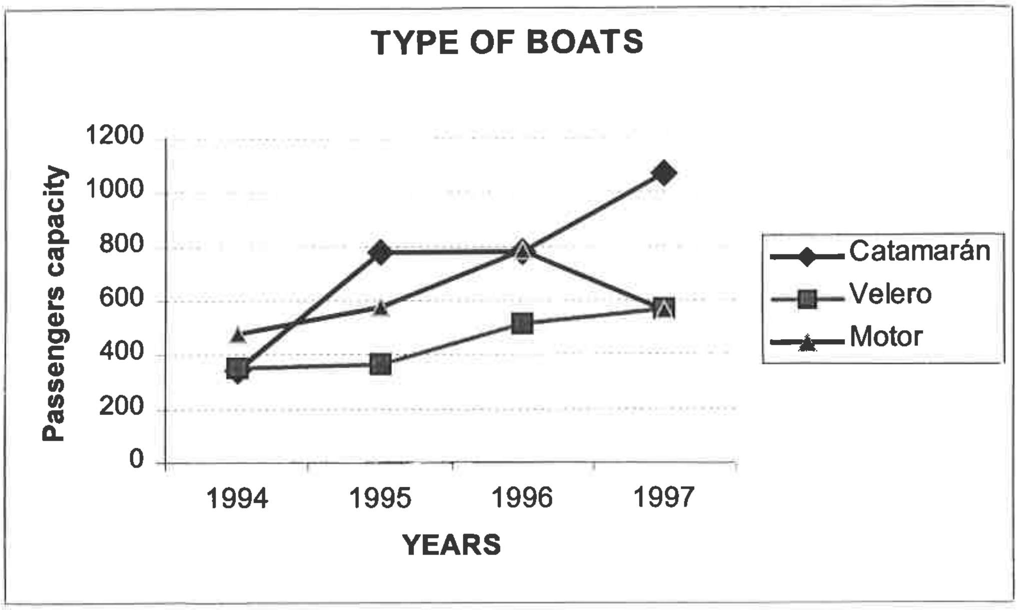

Fig. 1 - Evolution of the global passengers capacity of the whale watching boats

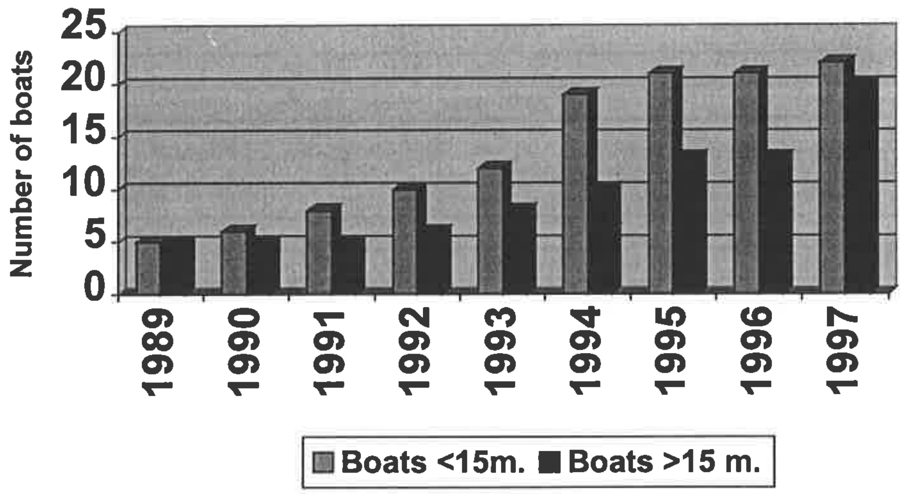

Fig. 2 - Evolution of the number of whale watching boats

THE BISCAY DOLPHIN RESEARCH PROGRAMME – WHERE SCIENCE AND EDUCATION WORK SIDE-BY-SIDE

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Since 1995, a monthly transect survey has been carried out across the Bay of Biscay aboard the P&O European ferry the MV "Pride of Bilbao". An important part of the project's mission is to raise public awareness of cetaceans - the variety of species that occur in local waters, and the reasons why the transect survey is so important. Using a passenger ferry as a research platform offers a unique opportunity to reach a captive audience from all walks of life. Education projects have been undertaken that have brought direct feedback from the scientific work to hundreds of thousands of passengers during the first three years of the programme.

A combination of crew participation, interpretation panels, a guide book, video and special passenger events (bridge visits and themed cruises) have served to aid passengers in seeing their first wild cetaceans in the context of scientific research for conservation. The project has now established its own web site so that passengers can follow-up any queries once at home, and can view some of the latest images photographed by the research team at sea.

A unique blend of education and research has been achieved where the quality of each is not compromised by the other.

DISTRIBUTION & SURVEYS

THE CANARY ISLANDS CETACEAN SIGHTING NET. II

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INTRODUCTION The Cetacean Sighting Net (CSN) is working from autumn 1996 in the Channels Tenerife - La Gomera and Tenerife - Gran Canaria (Canary Islands). Results from the longterm sightings database can be of great value for studying abundance shifts in the populations, which may be possible to interpret later in relation to different factors such as oceanographic parameters, fishery statistics, and the conservation state of the habitat.

METHODS The CSN uses Fred. Olsen ferry lines as research platforms for studying the spatial and temporal distribution of cetacean sightings in two channels between the islands. This is possible because the ferry lines operate as constant transects all year round. Volunteers are trained at the department for recording environmental and sighting details during the trips. The sightings made by volunteers are directly checked by the researcher and recorded in Dbase IV. The distribution of the results is corrected by unit of effort (nº of trips), and analysed with the statistical package SPSS. The 275 crew sightings are recorded and analysed separately because they cannot be corrected for effort. Species groups according to size are used to classify sightings (small <4m, medium <9m, large >10m). Environmental and oceanographic conditions are analysed in relation to the number of sightings and influence on cetacean behaviour. Sea surface temperature deviations are provided courtesy of the Spanish Oceanographic Institute in Tenerife.

RESULTS The 187 trips and 126 sightings made by volunteers from autumn 1996 to spring 1998 for the S/C de Tenerife (Tenerife) - Agaete (Gran Canaria) transect, are analysed here. The transect is divided into 16 stations around two nautical miles long, from Agaete to Tenerife (Fig. 1).

Stations 1 to 3: Gran Canaria continental shelf.
Station 4 to 5: continental slope
Stations 6 to 12 more than 2,000 m medium depth, with few changes in depth profiles.
Stations 13-15: continental slope
Station 16: Tenerife continental shelf.

The sea state (Douglas scale) is statistically different for different seasons of the year (Kolmogorov-Smirnov, $p = <0.05$) and it is not for the 16 spatial stations (K-S, $p = 0.773$). The number of sightings shows significant differences between those of sea state above 4 and those of 4 or less (Mann Witney U, $p = <0.05$). Average sea state during the period of study was 2.86 (spring), 4.01 (summer), 2.78 (autumn) and 3.53 (winter).

Species sighted have included: *Tursiops truncatus*, *Delphinus delphis*, *Stenella frontalis*, *Stenella coeruleoalba*, *Grampus griseus*, *Globicephala macrorhynchus*, *Orcinus orca*, *Pseudorca crassidens*, *Ziphius cavirostris*, Family Ziphiidae, *Physeter macrocephalus*, *Balaenoptera acutorostrata*, Family Balaenopteridae, *and Eubalaena glacialis.*

Spatial Distribution: There are statistical differences in the total number of sightings among the 16 stations (K-S, $p = 0.001$), mainly due to significant differences in bottlenose and common dolphin sightings (K-S, $p = <0.05$ for both), concentrated between two and seven nautical miles from Agaete (up to station nº. 4). *Tursiops truncatus* is more common in the first four miles from Agaete (highest frequencies at est. nº. 2), where the depth does not exceed 250 m. The main sighting area for *Delphinus delphis* extends to 1,100 m depth (mainly est. nº. 3).

Central area of the channel: few sightings - mainly oceanic dolphins in winter/spring, including common dolphins; short-finned pilot whales in summer/autumn; and large and medium sized animals from the families Ziphiidae & Balaenopteridae, and unidentified ones.

West area: Volunteer data show no significant differences in short-finned pilot whale distribution, but according to Fig. 2, data from crew sightings do show a higher number of sightings near Tenerife in the autumn (K-S, p = 0.013). Sperm whale sightings are relatively high in this area.

Temporal Distribution: There are no statistical differences for the total number of sightings between the seven seasons analysed (K-S, p = 0.066), nor for the "large cetacean" category. But there are for short-finned pilot whales (K-S, p = 0.004), with peak frequencies in autumn. And for the "small cetacean" category (K-S, p = 0.0032), caused by unidentified dolphins. When comparing sightings only at the stations 1 to 4, bottlenose dolphins show no significant differences between seasons (K-S. p = 0,065), in contrast to common dolphins (K-S. p = 0.025).

Summer is the season with least sightings, which may be related to a significantly higher sea state, or to seasonal shifts in cetacean distributions, which need further study.

There are two periods that can be distinguished: a) autumn 1996 to spring 1997; and b) autumn 1997 to spring 1998, which are separated by the lowest period of sightings: summer (Fig.3). There are statistical differences between them in dolphin frequency (Mann Witney U, p = 0.002), which is not caused by changes in the distribution of typically oceanic dolphins such as spotted dolphin (*Stenella frontalis*) or striped dolphin (*S. coeruleoalba*) (Mann-Witney U, p = 1), but by coastal dolphin sightings. Differences are clear inside that area which has a high density of sightings (stations 1 to 4) for common dolphin (Mann-Witney U, p = 0.044) and mainly for bottlenose dolphin (Mann-Witney U, p = 0.002)

DISCUSSION Results suggest that there may be a resident population of bottenose dolphins from Agaete to around 4-5 nm from the coast, the species being present at least all year round (there is an important need to study resident individuals) and a seasonally resident population of common dolphins whose main area overlaps partially with the bottlenose dolphin area, but it reaches the continental slope. This fact is reinforced by the statistical differences in the spatial distribution of bottlenose dolphins, and the lack of any seasonal changes in distribution when tested statistically. This population may be the same as that studied a few miles south of the Gran Canaria coast, with its still unknown pattern of mobility.

Talud areas of both islands have high number of sightings, sperm whales showing a shift to station 13. The importance of talud areas for birds and cetaceans has already been demonstrated (Heimlich-Boran, *et al*, 1998, Weimerskirch, 1993)

Shhort-finned pilot whales have a higher abundance in summer and mainly in autumn, when sea water is warmer, and this fits well with their tropical distribution. The concentration around the continental slope of Tenerife can be related to the high cephalopod abundance in the area during autumn, cephalopods being the only prey found in studies of pilot whale stomach contents in the Canary Islands (Hernández-García and Martín, 1994). Their distribution still requires a more detailed study.

Oceanographic Parameters: The significantly lower bottlenose and common dolphin sighting frequencies during period B (autumn 1997 - spring 1998) when compared with period A (autumn 1996 - spring 1997), coinciding with abnormalities in surface water temperature of up to one degree centigrade over the previous year's average in the Canaries. This fact has strongly influenced the abundance of small fish epipelagic schools, typical prey of dolphins and tuna, whose fishery was poor in the same period.

This fact may be related to the El Niño phenomenon. It shows the high vulnerability of coastal populations to different environmental factors, one reason for not creating synergistically anthropogenic disturbance in these coastal habitats. According to the data, this result is clearer in coastal than oceanic populations, which did not show significant differences in their abundance during this period.

Implications for Conservation: The two transects studied by the Cetacean Sighting Net are planned to be covered by Fast Ferries. The one running from Tenerife - Gran Canaria (top speed: 41 knots, 45,000 CV, 100 m. length) started working in April 1999. The one from Tenerife - La Gomera is still under study.

There are two areas proposed to the European Community for their resident bottlenose dolphin communities as part of the Natura 2000 network: one off the WSW coast of Tenerife (LIC ES7020017), and the other along the SW coast of Gran Canaria (LIC ES7010017). The first would be crossed by the Fast Ferry; the second would not, although the results of the sightings net show that there is probably a resident population of bottlenose dolphins within the area crossed by this ferry. This population is probably the same as that under protection in the Gran Canaria LIC, since it follows the same pattern of distribution to that of the resident bottlenose dolphin population off the WSW coast of Tenerife, which is considered as the only one in the area.

Browning *et al* (1997) studied the sound profile of a fast ferry which showed a very strong noise output in the frequency range of 500 Hz to 10-20 kHz, typically 3 db and 30 db respectively above normal ambient noise. These frequencies are well inside the hearing sensitivity and communication range of dolphins. The results show that fast ferries are likely to contribute to acoustic pollution mainly in the high frequency bands, where until now there has not been much alteration from anthropogenic activities. The experience in UK is that there has been a strong increase in fast ferry numbers: from 0 to 20 in seven years. The precautionary approach should be considered for cetaceans in such a rich area as the Canary Islands.

The possible impact on the populations force one to the following recommendations: a) to reduce speed to 20 knots from Agaete (Gran Canaria) to at least 15°49´ W; and b) To avoid the fast ferry line through LIC ES7020017 (SW Tenerife), where there is also a resident population of short-finned pilot whales (Heimlich-Boran, 1991; Martín & Montero, 1994) and an annual average of 0.94 cetacean sightings/hr of transect (Aguilar, 1998).

CONCLUSIONS Stations 1-4 have a high number of sightings of bottlenose and common dolphins, which is related to the resident population with an unknown degree of individual residency.

The bottlenose dolphin population may be part of that whose habitat is proposed within the Nature 2000 network of protected areas a few miles south of the same coast.

Global scale oceanographic phenomena may influence the abundance of small cetacean coastal populations since they affect prey distribution.

A precautionary approach should be considered when physical, chemical, or acoustical damage to these highly vulnerable coastal habitats is increased, particularly from marine traffic.

ACKNOWLEDGEMENTS Thanks a lot to the ferry company, Fred. Olsen, and the bus company: Titsa, because without their boats and buses, this study would not have been possible. Thanks also go to the volunteers and ferry crews for recording sightings with interest and understanding. Finally, we are grateful to the Spanish Oceanographic Institute in Tenerife for supplying sea temperature data.

REFERENCES

Heimlich-Boran, J. R. 1993. *Social organisation of Globicephala macrorhynchus with special reference to the comparative social ecology of delphinids*. PhD Thesis, Dept. of Zoology, Cambridge University.

Hernández-García, V. and Martín, V. 1994. Stomach contents of two short-finned pilot whale (*Globicephala macrorhynchus*, GRAY, 1846) off the Canary Islands: a preliminary note. ICES. Mar. Mamm. Comm. C.M. N116.

Martín, V. and Montero, R. 1993. Estudio del impacto que provocan las embarcaciones en la población de Calderón Tropical (*Globicephala macrorhynchus*) residente en aguas del SO de la isla deTenerife. Consejería de Transportes y Pesca del Gobierno de Canarias.

Weimerskirch, H. 1996. Technological developments in the study of albatross ecology and conservation. *Proceedings of the Fifth Conference on Wildlife Telemetry*. Council of Europe.

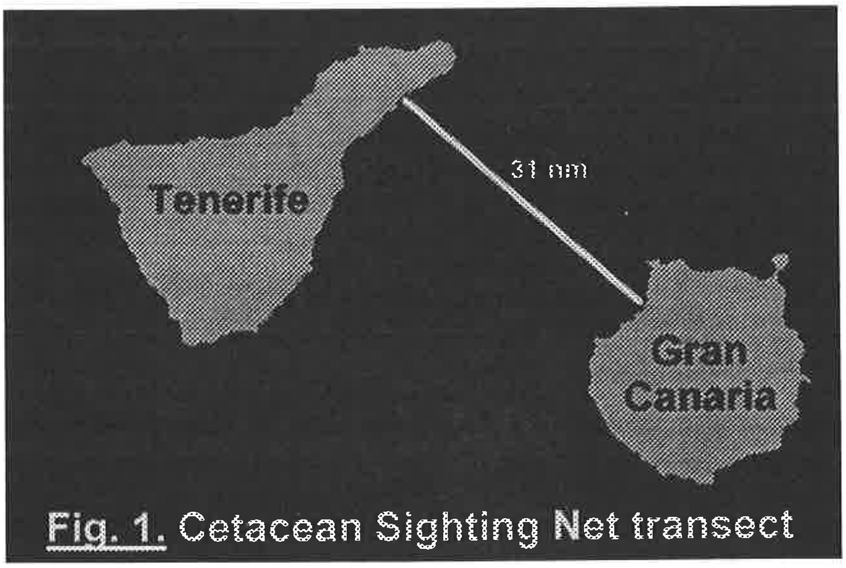
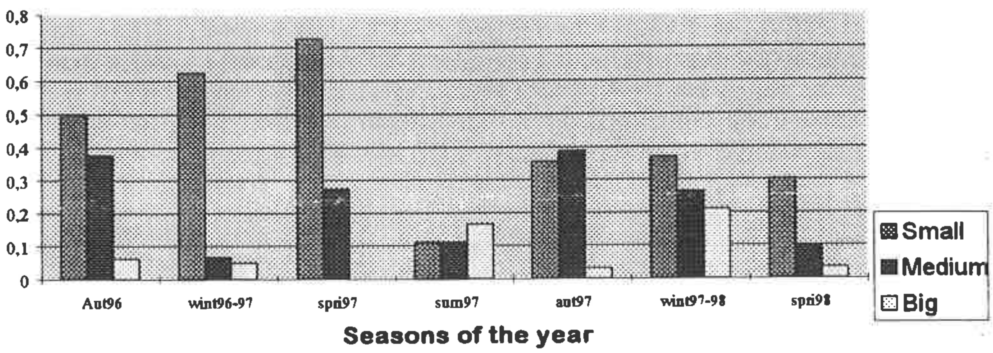


Fig. 1. Cetacean Sighting Net transect

TENERIFE-GRAN CANARIA: Temporal distribution of the number of cetacean sightings per volunteer trips, divided in size classes.



WHALE WATCHING IN ITALY: RESULTS OF THE FIRST THREE YEARS OF ACTIVITY

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INTRODUCTION The western Ligurian Sea, included in the future "Ligurian Sea International Sanctuary for Mediterranean Cetaceans", is characterised by high abundance of cetaceans. All species regularly observed in the Mediterranean can be found in the area. "Portofino 82", the first and only dedicated commercial whale watching enterprise in Italy, conducted daily cruises during three summers (1996-98) in the waters off Imperia (Italy).

The cruises afforded the opportunity of conducting educational activities and collecting scientific data. The operations were characterised by a "symbiotic" relationship between the operator and a research team, which acted as naturalist guides in exchange for the possibility of collecting scientific data. Sightings data provided basic information on cetacean distribution in the western Ligurian Sea, and allowed comparisons among years and among species of group structure and selective habitat use.

A voluntary code of conduct to minimise disturbance to the animals, based on guidelines well-established world-wide, was adopted and explained to the public of whalewatchers aboard.

MATERIALS AND METHODS Daily cruises, lasting generally 5-6 hrs, were conducted in 1996 (July to September), 1997 and 1998 (June to September). The area covered approximately comprised 43°52' - 43°30' N and 7°45' - 8°37' E., within a radius of 40 km from Imperia (Fig. 1). The platform used was a 19 m-long vessel cruising at an average speed of 10 knots. Survey effort, environmental and sighting data were recorded using the LOGGER software (IFAW) running on a GPS-interfaced laptop computer. Position, water depth, distance from the nearest coast, group size, and major age classes were recorded at each sighting. Observation sessions were carried out by one or more trained observers. For calculation of sighting frequencies, data were discarded when wind speed was three or more on the Beaufort scale. When conditions allowed, photo-identification was conducted on different species: fin whales (*Balaenoptera physalus*), sperm whale (*Physeter macrocephalus*), Risso's dolphins (*Grampus griseus*), and Cuvier's beaked whales (*Ziphius cavirostris*).

RESULTS AND DISCUSSION A total of 167 daily cruises were made (39 in 1996, 57 in 1997, 71 in 1998) adding up to 14,315.4 km spent searching for cetaceans, 8,943.2 of which (62.5%) were made in good weather conditions (Beaufort <3).

Cetaceans were sighted 328 times. Eight species were observed: striped dolphins (*Stenella coeruleoalba*), fin whales (*Balaenoptera physalus*), Cuvier's beaked whales (*Ziphius cavirostris*), sperm whales (*Physeter catodon*), Risso's dolphins (*Grampus griseus*), long-finned pilot whales (*Globicephala melas*), bottlenose dolphins (*Tursiops truncatus*), and common dolphins (*Delphinus delphis*). The time spent with cetaceans was 28% of the total observation time in good weather conditions.

The overall sighting frequencies (no. of sightings/100 km) observed are compared for species in Table 1. The most frequently sighted species was the striped dolphin. The rarest was the common dolphin, observed only once in a mixed school with striped dolphins. The relatively high incidence of sightings of Cuvier's beaked whales in 1998, a species very rarely observed in the Mediterranean Sea, was notable.

Group size descriptive statistics are shown in Table 2. Long-finned pilot whales had the greatest mean group size (38.5), followed by striped dolphins (16.2), Risso's dolphins (8.2), bottlenose dolphins (7.5), Cuvier's beaked whales (2.3), common dolphins (2), fin whales (1.7), and sperm whales (1.6). Results showed that striped dolphins showed significant differences in mean group size between years (Anova: F ratio = 10.664, p <0.01), groups being greater in 1996 than in 1997 and 1998 (Table 3).

Differences among species in water depth and distance from the nearest coast at the sighting locations are summarised in Table 4. Only one species, the fin whale, showed significant differences in water depth and distance from the coast between years (Table 5). In 1997, fin whales were observed closer to the coast compared with 1996 and 1998 (Anova: F ratio = 11.91, p <0.01) and in shallower waters in comparison with 1996 (Anova: F ratio = 10.36, p <0.01). This might have been a reflection of shifts in the distribution of the whales' preferred prey, *Meganyctiphanes norvegica* (Relini *et al.* 1992).

Photo-identified individuals of different species were recorded in the Tethys Research Institute catalogues.

CONCLUSION This paper contributes to the knowledge of the summer cetacean distribution in a portion of the region proposed as the future "Ligurian Sea International Sanctuary for Mediterranean Cetaceans", and demonstrates that whalewatching activities – if performed in a respecteful, regulated fashion – can promote conservation by generating meaningful data at zero cost to the research programme.

REFERENCES

Duguy, R., Casinos, A., Di Natale, A., Filella, S., Ktari-Chakroun, F., Lloze, R., and Marchessaux, D. 1983. Répartition et frequence des mammifères marins en Méditerranée. *Rapp. P. V. Reun. Comm. int. Explor. sci. Mer Medit. Monaco,* 28: 223-230

Forcada, J., Aguilar, A., Hammond, P. S., Pastor, X. and Aguilar, R. 1993. Distribution and abundance of fin whales in the western Mediterranean Sea during the summer. Pp. 128-130. In: *European Research on Cetaceans* – 7. Proc. 7th Ann. Conf. ECS, Inverness, 18-21 Feb., 1993 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Gannier, A. 1997. Summer abundance estimates of striped dolphins and fin whales in the area of the future International Marine Sanctuary (N.W. Spain). Pp. 95-98. In: *European Research on Cetaceans* – 11. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Notarbartolo di Sciara, G., Venturino, M. C., Zanardelli, M., Bearzi, G., Borsani, F. J., and Cavalloni, B. 1993. Cetaceans in the central Mediterranean Sea: distribution and sighting frequencies. *Boll. Zool.* 60: 131-138.

Notarbartolo di Sciara, G., Forcada, J., Acquarone, M., and Fabbri, F. 1993. Population estimates of the fin whale and striped dolphin summering in the Corso-Ligurian Basin. Pp. 135-138. In: *European Research on Cetaceans* – 7. Proc. 7th Ann. Conf. ECS, Inverness, 18-21 Feb., 1993 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Relini, L. O. and Giordano, A. 1992. Summer feeding of the fin whale, *Balaenoptera physalus*, in the Liguro-Provençal Basin. Pp. 138-141. In: *European Research on Cetaceans* – 6. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb., 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Zanardelli, M., Notarbartolo di Sciara, G., and Jahoda, M. 1992a. Photo-identification and behavioural observation of fin whales summering in the Ligurian Sea. Pp. 86-89. In: *European Research on Cetaceans* – 6. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb., 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Table 1 - Sighting frequencies (no. of sightings/100km) of cetaceans observed

	1996	N	1997	N	1998	N	1996-98	N
Sc	1,36	27	1,77	56	2,53	96	2,00	179
Bp	0,56	11	0,35	11	1,03	39	0,68	61
Zc	0,10	2	0,03	1	0,32	13	0,17	15
Pc	0,29	4	0,00	0	0,32	2	0,07	6
Gg	0,00	0	0,09	3	0,05	2	0,06	5
Gm	0,05	1	0,03	1	0,03	1	0,03	3
Tt	0,05	1	0,00	0	0,03	1	0,02	2
Dd	0,00	0	0,00	0	0,03	1	0,01	1

Table 2 - Group size summary statistics for the encountered species

	N	Mean	SD	SE	Mode	Range
Sc	206	16.14	13.91	0.97	10	1 - 100
Bp	75	1.71	0.94	0.11	1	1 - 5
Zc	11	2.36	1.21	0.36	2	1 - 4
Pc	12	1.33	0.89	0.26	1	1 - 4
Gg	6	8.17	4.99	2.04	-	2 -15
Gm	4	38.50	30.42	15.21	-	9 - 80
Tt	2	7.50	3.53	2.50	-	5 - 10
Dd	1	2.00	-	-	-	-

N = total number of groups sighted for each species, SD = standard deviation of the mean, SE = standard error of the mean

Table 3 - Group size statistics for striped dolphin during 1996-1998

	N	Mean	SD	SE	Mode	Range
1996	33	25.48	18.85	3.28	30	3 - 100
1997	58	16.33	14.41	1.89	10	1 - 65
1998	115	13.36	10.54	0.98	10	1 - 40

N = total number of groups sighted for each species, SD = standard deviation of the mean, SE = standard error of the mean. Anova: F ratio = 10.664, $p < 0.01$

Table 4 - Summary statistics for water depth (m) and distance from the nearest coast (km) at sighting locations for all cetacean species encountered

	Water Depth (m)				Dist. from the nearest coast (km)			
	N	Mean	SE	Range	N	Mean	SE	Range
Sc	211	1919	45	95 - 2560	211	23.5	0.6	5.6 - 51.8
Bp	78	1878	761.5	30 - 2550	78	23.11	9.74	1.3 - 43.7
Zc	15	2012	144	1000 - 2500	15	24.1	1.2	15.7 - 33.3
Pc	11	1994	5.34	1200 - 2440	11	20.72	1.79	11.3 - 30.7
Gg	5	900	14.96	300 - 2300	5	13.4	4.5	5.5 - 30.6
Gm	4	2267	5.26	1900 - 2450	4	28.3	4.3	17.4 - 37

N = total number of groups sighted for each species, SE = standard error of the mean

Table 5 - Statistics for water depth (m) and distance from the nearest coast (km) at sighting locations for fin whale during 1996-98

	Water Depth (m)				Dist. from the nearest coast (km)			
	N	Mean	SE	Range	N	Mean	SE	Range
1996	12	2293	147.03	700 - 2520	12	31.73	147.03	10.5 - 43.7
1997	20	1301	225.69	30 - 2500	20	14.13	225.69	1.3 - 34.3
1998	46	2021	78.56	800 - 2550	46	23.60	78.56	12.1 - 40

N= number of groups of fin whale sighted in the covered area, SE= standard error of the mean.
Anova: F ratio = 10.36, p <0.01

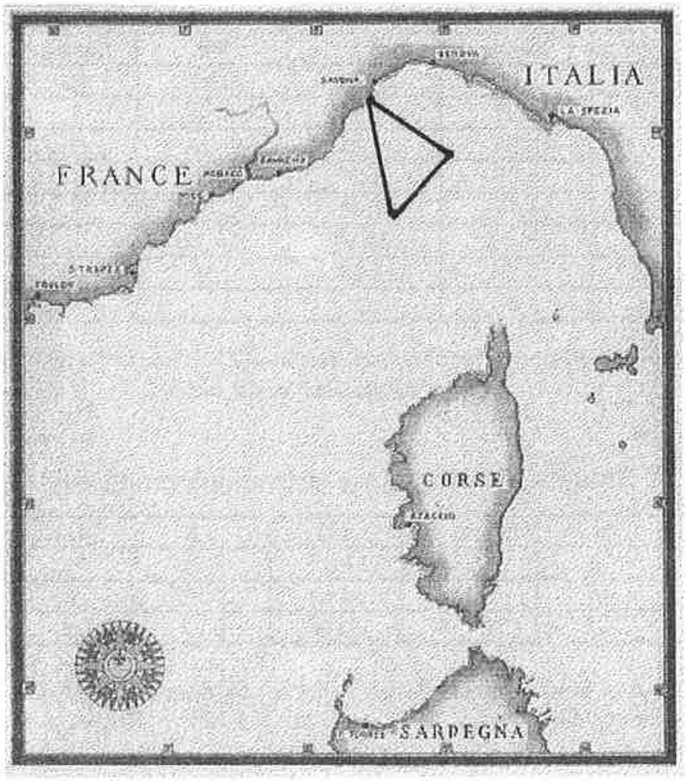

Fig. 1 - Map of Study Area

INVESTIGATING THE MOVEMENTS OF GREY SEALS BETWEEN WALES AND IRELAND USING PHOTO-IDENTIFICATION

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BACKGROUND Approximately 1,300 grey seal (*Halichoerus grypus*) pups are born each year in south-west Wales (Baines *et al.*, 1995), making this the largest known breeding concentration of the species in southern Britain.

Previous studies in which pups were tagged (Johnson, 1972), suggest that weaned pups disperse widely from Wales, many reaching Ireland, Cornwall, and Brittany within the first three months of life.

We have used a photo-identification technique (Hiby & Lovell, 1990) to investigate the movements of adult seals, compiling a database – EIRPHOT – holding the capture histories of grey seals photographed in Wales and Ireland.

Movements of seals between Wales and Ireland: Preliminary results show that adult seals disperse widely outside the breeding season. Some individual seals have been photographed at haul-outs on both sides of the Irish Sea. The degree of interchange between haul-out sites in south-west Wales and in east and south-east Ireland, suggest that the grey seals in these areas can no longer be considered as belonging to separate populations. This has implications for the management and conservation of seals in the region.

Site fidelity at breeding sites: A total of 53 breeding-age female seals were photographed at pupping sites in Wales in both the 1996 and 1997 pupping seasons. In 43% of these recaptures, the animal had returned to the same pupping site, but in 57% of cases the animal had chosen different sites on which to pup in the two years (Table 1). Females tend to move towards regularly used moulting haul-outs soon after weaning their pups.

CONCLUSIONS Photo-identification has proved to be a valuable technique for the investigation of the population dynamics of this species. It is hoped to develop the EIRPHOT database in the future by including data collected in south-west England and Brittany.

An improved understanding of the dynamics of grey seal populations would benefit the management of human impacts such as interactions with fisheries, disturbance at breeding sites, and natural events such as outbreaks of disease.

ACKNOWLEDGEMENTS Photographs were digitised and the EIRPHOT database compiled by Conservation Research Ltd, Cambridge. Data were contributed by University College Cork in Ireland and the Wildlife Trust, West Wales.

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REFERENCES

Baines, M. E., Earl, S. J., Pierpoint, C. J. L. and Poole, J. 1995. The West Wales Grey Seal Census. *Countryside Council for Wales Contract Science* Report 131.

Hiby, A. R., and Lovell, P. 1990. Computer aided matches of natural markings: a prototype system for grey seals. Rep. *Int. Whal. Commn.*, (Special issue 12: 57-61.

Johnson, A. L. 1972. Seal markings. *Nature in Wales*, 13: 66-80.

Table 1 – The number of breeding females photographed at the same and at different pupping sites in the 1996 and 1997 breeding seasons. The mainland coast is sub-divided into 4 sub-sections

1996 Pupping site	Mainland Section C	Mainland Section D	Mainland Section E	Mainland Section F	Ramsey Island
Returned to the same site in 1997	2	1	13	6	1
Returned to a different site in 1997	2		14	7	7

OBSERVATIONS OF SEALS ON THE NORTH ATLANTIC MOROCCAN COASTS

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INTRODUCTION The Mediterranean monk seal *Monachus monachus* is known from the Black Sea, the Mediterranean Sea, the north-west African coasts down to Gambia, and from some islands situated off these coasts. In the Atlantic, the archipelago of Madeira and the peninsula of Cape Blanc, in the south of Morocco, have held the most important populations of this region.

On the Atlantic Moroccan coasts situated between the Gibraltar Straits and Agadir, the observations of Mediterranean monk seal are few and relatively old (Bayed and Beaubrun, 1987). In spite of the effort of prospecting undertaken by a network of observers co-ordinated by the "Groupe d'Etude des Cétacés et Pinnipèdes du Maroc (GECPM)", no supplementary reliable observations of Mediterranean monk seal have been added to the database of GECPM until 1993 for this sector of the coast.

This paper details the case of an individual Mediterranean monk seal seen and photographed at the beach of Imesouwane in 1994, relates the observation of another individual sighted at Plage Blanche in 1988-89, reports a dead animal at the mouth of Oued Tinkert, and discusses the validity of some observations of seals seen in the region situated north of Agadir.

Observations of the Mediterranean Monk Seal

The specimen of Imesouwane: The bay of Imesouwane (30°50' N - 9°50' W) is situated 60 km north of Agadir (30°25' N - 9°38' W). It is open towards the ocean and is sheltered by a cape localised at the north. The whole of the bay is dominated by an elevated relief which is part of the mountainous High Atlas. There is a fishing village where fishermen keep their boats and undertake local fishing activities (Fig. 1).

In January 1994, an individual of *Monachus monachus* was observed and photographed on the beach in the middle of the afternoon at low tide. It was lying on the sand at the mid level of the beach. When the animal was approached, it immediately escaped towards the ocean and continued until reaching the first waves which were of little height. Then it disappeared into the water and was not observed again. This individual had been lying for less of an hour on the beach. If we refer to Morphological Categories of Mediterranean Monk Seal established from Cape Blanc Peninsula colony (Samaranch & Gonzales, 1996), this individual was a medium grey seal with an estimated age of more than 18 months and size less than 2 m.

The specimen of plage Blanche: Between Agadir and Tarfaya, another confirmed sighting of Mediterranean monk seal was reported from Plage Blanche (28°55' N- 10°30' W) at 200 km south of Agadir (Fig. 1). This individual was seen in 1988-89, and remained for several days moving between the sea and the beach where it rested. It left the area when it was approached by a fisherman. No precise indication was given of the coloration of the animal or of its size. In this region, we know of no other sighting of Mediterranean monk seals before this one. The fact that this individual remained on this immense beach (40 km of length) for several successive days is probably due to the calm weather and the abundance of fish for which this zone is reputed.

The dead animal of Tamri: The animal was lying at the mouth of Oued Tinkert at Tamri (20 km north of Agadir and 40 km south of Imesouwane) on February 1999 (Fig. 1). "It had a greyish-brown or light brown ground colour. As it lay a bit on the side, the belly seemed somewhat brighter in colour" (Hansen, *in litt.*). The length was less than 2 m. It is probably a medium grey seal. This animal was stranded on the beach since few days.

Observations of other seals at north of Agadir: Other observations of seals have been reported, some of which have been attributed to the species *Monachus monachus*, but could not be confirmed. These include:

- One skeleton of seal stranded on a beach situated, 12 km north of Rabat, in July 1972 (Fig. 1).
- Three seals sighted on July 1973 in the sea, 12 km north-west of Rabat.
- One seal stranded on a beach, 30 km north of Casablanca, in May 1982.

These observations involve seals probably coming from the European Atlantic populations which reached the Moroccan coasts to about 250 km at the south of Gibraltar straits.

DISCUSSION On the Moroccan coast situated at the north of Agadir, some previous observations of Mediterranean monk seals are available: an individual observed in 1947 in front of the mouth of the Oued Yquem (15 km south of Rabat), two individuals in 1955-60, and an individual reported in 1977 from the region of Agadir.

Due to the absence of a permanent presence of groups of individuals or a population of the Mediterranean monk seal on the Moroccan Atlantic coasts in the north of Tarfaya, it is highly probable that the individuals from Imesouwane and Plage Blanche originated from the population at Madeira or from the colony of Cape Blanc Peninsula in the south of Morocco, or perhaps, from groups situated northwards of this. Imesouwane and Plage Blanche are respectively located 700 km and 750 km to the east of the colony of Desertas Islands of the archipelago of Madeira, and at 1,700 km and 1,450 km north of the colony at Cape Blanc Peninsula (Fig 1).

Not far from the Moroccan coasts, the Canary Islands also received some visits of seals, of which the last confirmed was reported in 1983 (Aguilar, 1998). In the majority of cases, these were young individuals. The Canary Islands are situated at 500 km to the south of Madeira archipelago, and 880 km to the north of Cape Blanc Peninsula.

Do these observations correspond to regular movements, which mean round-trips from the original colony? Or to erratic wanderings of young individuals with no obvious return? For the colony on the Peninsula of Cape Blanc, some seals may make movements of up to one hundred kilometres to search the food when this becomes scarce (Marchessaux, 1989). In other cases, the movements could be induced by social constraints between individuals. In this case the non-reproductive individuals (medium grey seals) leave the colony and browse several hundreds of kilometres away. It could be possible that the migrating individuals remain a sufficiently long time in a given area to tfind adequate conditions of food and tranquillity. It may have been the case of the seal of Plage Blanche which did not return until it was disturbed.

However, we must pay some attention also to unconfirmed observations of Mediterranean monk seals, because some other seal species, known mainly from the North European coasts, may make movements to the south as has been the case of the hooded seal, *Cystophora cristata*, and ringed seal, *Phoca hispida*, recorded in the south of Spain (Van Bree, 1997). The harbour seal, *Phoca vitulina*, the distribution of which is more southern than the previous ones, can also penetrate the Mediterranean through the Gibraltar straits (Raga, 1996).

REFERENCES

Aguilar, A. 1998. *Current status of Mediterranean Monk Seal (Monachus monachus) populations. Mediterranean Action Plan.* Meeting of experts on the implementation of Action Plans for marine mammals (Monk seal and Cetaceans) adopted within MAP, Arta, Greece, 29-31 October 1998, UNEP(OCA)/MED WG.146/4: 34p.

Bayed, A. and Beaubrun, P. Ch. 1987. Les mammifères marins du Maroc. Inventaire préliminaire. *Mammalia*, 51 (3): 437-446.

Marchessaux, D. 1989. *Recherches sur la biologie, l'écologie et le statut du phoque moine, Monachus monachus.* Thèse de l'université d'Aix Marseille II, GIS Posidonie Publishers. 280pp.

Mas, J., Jimenez, J., and Raga, J. A. 1996. First record of harbour seals in the western Mediterranean sea. Pp. 59-59. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Samaranch, R. and Gonzales, L.M. 1996. *Monachus news*, n°2: 5-5.

Van Bree, P. J. H., 1997. On extralimital records of arctic seals (Mammalia, Pinnipedia) on the west European continental coast in the past and at present - A Summary. *Beaufortia*, 47, 5: 153-156.

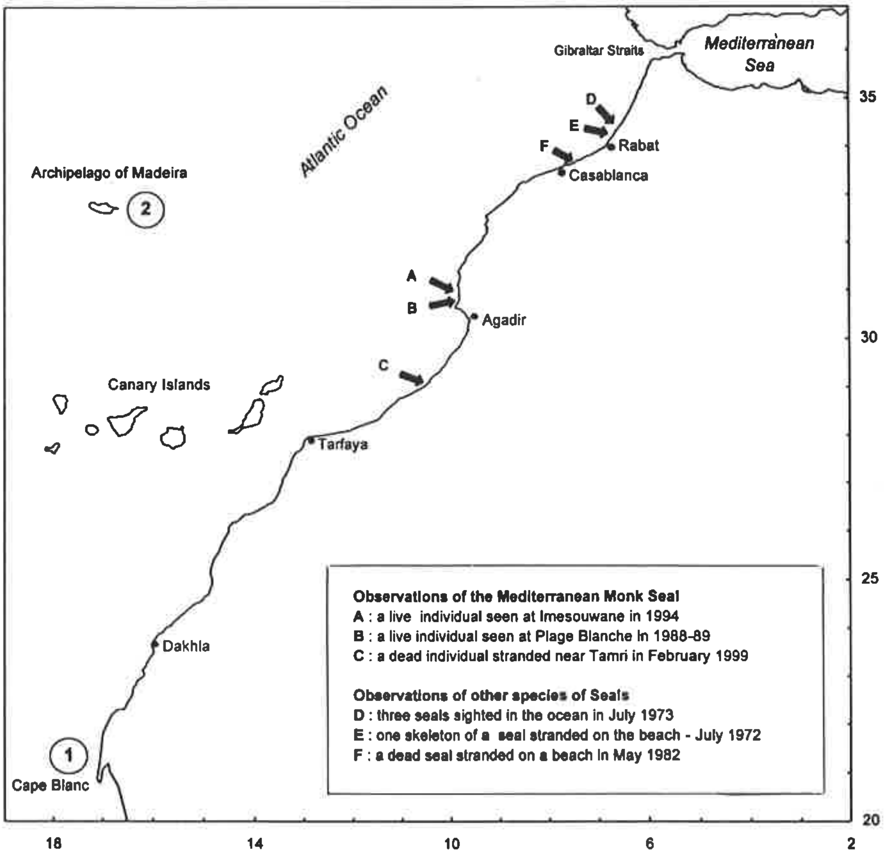

Fig. 1 - Map with location of areas where the Mediterranean seals and other species of seals were observed on the Atlantic Moroccan coasts (arrow). The numbers 1 and 2 indicate the location of Atlantic colonies of *Monachus monachus* : (1) colony of Cape Blanc Peninsula in the south of Morocco; (2) colony of Desertas islands in the Archipelago of Madeira.

EXCEPTIONAL APPEARANCE OF FIN WHALES (*BALAENOPTERA PHYSALUS*), DURING THE SUMMER 1997, IN THE GULF OF LION (FRENCH MEDITERRANEAN COAST)

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INTRODUCTION In the northern part of the occidental Mediterranean basin, fin whales are specially observed in open seas or at the escarpments of the continental slope. They sometimes approach the coastline in areas of steep bottoms, like the eastern part of the French littoral and the coast of west Corsica. But they generally avoid sectors where the continental shelf is wide, that is to say the western Balearic Sea, the Gulf of Lions (western part of the French continental coast), and the Gulf of Genoa (eastern part of the Ligurian Sea). To support this, we refer to the "Preliminary Atlas of Mediterranean Cetacean distribution" (Beaubrun, 1995) which shows that in those three areas, and despite any particular methodology of survey applied, no fin whale was recorded during a twenty-one year period of study.

That is why several fin whales encountered in the Gulf of Lions all along the summer of 1997 constitute a sufficiently exceptional phenomenon to be reported here.

MATERIALS AND METHODS On the 25th June 1997, at 09:35 hrs, the signal station of "L'Espiguette" alerted us that they "had an individual fin whale of approximately 15 metres length in their telescope, over an 8 metres deep sandy bottom, heading slowly to the coast". It was a very surprising event, because the L'Espiguette station is the most internal point of the Gulf of Lions (70 kilometres inshore from the 100 metres sounding line) as we prepared to operate for an eventual stranding operation. Nothing happened, but, four days later, the same informant phoned us that "It is 09:10 a.m., and the fin whale, still alive, is once again here".

Immediately, we decided to inform all the signal stations and the harbour authorities along the coast of Languedoc-Roussillon region. We asked them to be vigilant and to contact us immediately of any information they could obtain. Later on, and with the help of some journalists, several sailors, private individuals or institutions joined this network. By another route, records from the zone of Marseilles were also obtained from Dhermain (1997).

This organisation has enabled us to obtain a total of 59 sightings of fin whales (Fig. 1), all in very shallow waters from Marseilles in the east to the Cap Béar (Spanish Frontier) in the south.

RESULTS All these data clearly show that several individuals have frequented, with a high regularity, the shallowest parts of the Gulf of Lions, through the summer period of 1997, from mid-June to the first ten days of October.

A minimum of three separated groups can be distinguished, each of them including at least three individuals, milling around three sectors: one extended from the Spanish frontier to Port-la-Nouvelle (area 1), the second from the west of Sète to the east of l'Espiguette (area 2), and the third in the bay of Marseilles (area 3).

Most sightings have been of isolated individuals (12th June, area 1; 25th June, area 2), except for area 3 where five fin whales were recorded just near the island of Tiboulen de Maïre (Marseilles archipelago) at the end of June. On and after the 15th July, animals were observed either alone or in pairs and, after mid August, sightings were mostly of three whales together. The last fin whales were seen on the 21st September (a group of four, area 2), 28th September (two individuals, area 1, which have spent two days in the coastal marine Reserve of Cerbère-Banyuls, near Cap Béar) and the 9th October (one individual, area 3, in 10 metres depth near the piers of the little harbour of Les Goudes, next to Marseilles).

All these whales were encountered close to the coast in specially shallow waters (<55 m depth), generally between 10 to 30 m. The nearest cases included: one individual at 50 m offshore of Cerbère (area 1) very early in the morning of the 15th August (a fisherman said), and another was hit in 3 m depth by a motor boat along the inner part of the pier of Port Camargue (area 2) on the 2nd August at 21:00 hrs (M. Baille *inf.*). On the 18th August, at 09:00 hrs, a group of three individuals entered into the little harbour of L'Estaque (area 3, near Marseilles) and remained inside for two and a half hours before they went out.

All the fin whales were unobtrusive and their blows were not always visible. They swam calmly, generally milling in a small sector and, when they were on a trip, they hugged the coast along variable depth contours, travelling at between 2 and 3 knots. None seemed bewildered; some of the tracked animals strongly showed that they knew perfectly where they were, modifying their course in the vicinity of a small boat or a fishing net. Several times, some individuals frightened fishermen by swimming under the boats anchored in 6-8 metres of water.

DISCUSSION It is well known that Mediterranean fin whales, in summer, gather with a high degree of fidelity (Zanardelli *et al.*, 1998) in the northern part of the occidental basin, where they found a lot of *Meganyctiphanes norvegica* to eat in the waters of at least 2,000 metres depth (Orsi Relini and Giordano, 1992). Their exceptional presence in the Gulf of Lions during the summer of 1997 is certainly related to particular hydrological and ecological phenomena.

The amount of chlorophyll *a* registered during 1997 in a coastal station near Banyuls (Service d'Observation du Laboratoire Arago [S.O.L.A.]*in litt.*) clearly showed a strong peak of phytoplankton from the 20th May to the 10th June. On the other hand, similar studies at the same station indicate that this peak usually occurs from mid-April to mid-May (Lantoine, 1995; Service d'Observation du Laboratoire Arago *in litt.*; M. J. Chrétiennot Dinet, *pers. comm.*). So the bloom of primary productivity, during the summer 1997, was a month late related to the normal condition.

From another source (B. Liorzou and Y. Guénnégan *in litt.*), studies conducted by the IFREMER Station of Sète on the stocks of small pelagic fishes in the Gulf of Lions have revealed that in the summer of 1997, populations of sardines and anchovies were more abundant than usual, especially at depths of 90-100 metres, with astonishing high densities of anchovies until the coastline in the north-east and in the south of the Gulf. Finally, our own data collected on cetacean abundance in the north occidental Mediterranean Basin gives evidence that, in their usual offshore zones, fin whales were less frequent in 1997 than normal.

In conclusion it is certain that on account of unusual climatic and hydrological conditions in 1997, the summer plankton productivity was delayed that season and probably included more coastal species than usual. These conditions were not so attractive for fin whales andmany individuals did not return to their normal feeding grounds. This caused the animals to search for alternative food resources, and that is the reason why at least nine and perhaps twelve fin whales were forced to explore the continental shelf of the Gulf of Lions and to spend more than three months there.

REFERENCES

Beaubrun, P. 1995. *Atlas préliminaire de distribution des Cétacés de Méditerranée.* (Ed.) Musée Océan. Monaco et CIESM ed., 87 pp.

Dhermain, F. 1997. *Chronique naturaliste provençale 48.* Feuillet naturaliste du CEEP, 48: 2-23.

Lantoine, F. 1995. *Caractérisation et distribution des différentes populations du picoplancton (picoeucaryotes, Synechococcus* spp., *Prochlorococcus* spp.*) dans diverses situations trophiques (Atlantic tropical, Golfe du Lion).* Thèse Doct. Univ. Paris 6.

Orsi Relini, L., and Giordano, A. 1992. Summer feeding of the Fin whale *Balaenoptera physalus* in the Liguro-Provençal Basin. Pp.138-141. In: *European Research on Cetaceans - 6.* Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb, 1992 (Ed. P.G.H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Zanardelli, M., Panigada, S., Airoldi, S., Borsani, J. F., Jahoda, M., and Notarbartolo di Sciara, G. 1998. Site fidelity, seasonal residence and sex ratio of fin whales (*Balaenoptera physalus*) in the Ligurian sea feeding grounds. P. 124. In: *European Research on Cetaceans -12.* Proc. 12th Ann. Conf. ECS, Monaco, 20-24 Jan 1998. (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Valencia, Spain. 436pp.

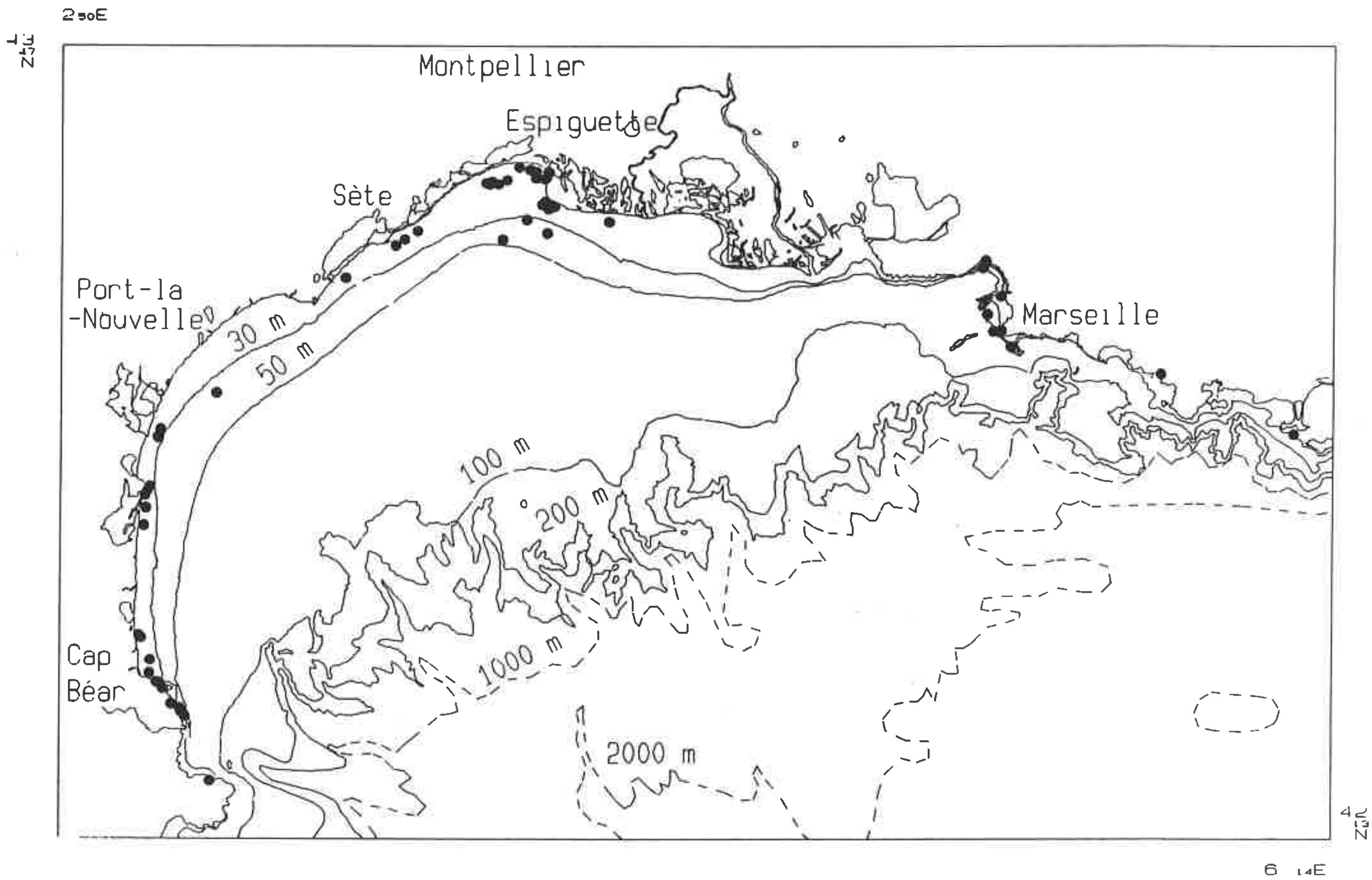

Fig. 1 - 59 sightings of fin whales in the Gulf of Lions during the summer 1997

CETACEAN SURVEY IN MANADO BAY AND ADJACENT WATERS, NORTH SULAWESI, INDONESIA: PRELIMINARY RESULTS

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INTRODUCTION During spring - summer 1998, a preliminary census of cetacean species was started in the area of Manado Bay and Bunaken Archipelago, North Sulawesi, Indonesia. The aim of this longterm project is to determine present situation of cetacean abundance and distribution in an area that has been protected since 1989. Known as one of the best place for diving in Indonesia because of its intact and rich coral reef, Bunaken Manado Tua Marine National Park also presents a great variety of cetacean species that have not been studied on a regular basis until now.

This project is sponsored by WWF Italia and supported by volunteers.

MATERIALS AND METHODS The study area covers a deep-sea zone of about 960 km^2 between 1°49' N and 1°24' N. Here, Celebes Sea reaches over 1,000 m depth in less than a mile from the coast, and it is possible to meet both coastal and pelagic species with no great effort.

Surveys took place daily using an 8 m *perahu*, typical Indonesian wooden motor boat, on a random basis.

During each encounter, data about the species sighted, the number of individuals, social structure and behaviour were all recorded. The position of each encounter was noted using a nautical compass. Photo-ID methods were used to create a catalogue of identified animals.

A stationary hydrophone "Cetacean Research Technology C20b1" (18 Hz – 22 kHz, acoustic sensitivity – 157 dB) connected to a portable DAT recorder was used in order to obtain more detailed results. The hydrophone was plunged into the water after the visual sightings.

In North Sulawesi, weather conditions are generally good from March to November; therefore, sighting effort achieved good results. Observations were suspended when sea state was >3.

RESULTS A total of 47 days at sea from May to September, with the survey effort amounting to c. 232 hr, resulted in 129 sightings with 13 different species identified, and c. 10 hours of digital underwater sound recordings. Fig. 1 shows number of sightings per day of observation. Three days only were without any sightings, and there was an average of three sightings per day. Fig. 2 shows the number of encounters per species.

Sperm whales (*Physeter machrocephalus*) were encountered eight times. 13 individuals were photo-identified, eight flukes are stored in the catalogue and two individuals have been re-sighted twice. Females with calves/juveniles were seen during four encounters. 4h 37m recordings of echolocation clicks contained a short series of coda sequences repeated four times. The structure of coda (/// /) recorded is similar to the one displayed by sperm whale in the Mediterranean Sea (Borsani *et al.*, 1996).

Pilot whales (*Globicephala macrorhynchus*) were encountered fourteen times. Groups were of 20-60 individuals, 55 animals were photo-identified, and 11 of these were re-sighted from two to four times. Groups displayed logging, milling, and long diving. 1hr 15 min. of recordings have been collected.

Pantropical spotted dolphins (*Stenella attenuata*) were encountered 25 times in groups of 20-100 individuals, mainly associated with tuna fishermen's boats. They have been frequently encountered associated with spinner dolphins. Pantropical spotted dolphins were more elusive than spinner dolphins, displaying travelling and feeding as the most frequent behaviour.

Spinner dolphins (*Stenella longirostris*) were encountered 36 times, resulting in it being the most frequent species in the study area. Big herds of more than 100 individuals were frequently seen displaying: spinning and half-breaching. Clicks, high frequency whistles, and short burst pulse sounds have been recorded for a total amount of 2 hrs 52 min. 51 sec.

Risso's dolphins (*Grampus griseus*) were encountered only three times during September, in groups of 10-15 individuals. Thirty-six animals have been photo-identified, and two of them were re-sighted twice. Recordings of sounds were unsuccessful. During each encounter, animals were not vocalising. Logging, line formation, travelling and lobtailing were noted as the most frequent behaviours.

Rough-toothed dolphins (*Steno bredanensis*) were encountered once in a group of ten individuals associated with pilot whales and Fraser's dolphins. At first they were milling and then suddenly they accelerated and dived a few times all together in the same spot.

Fraser's dolphins (*Lagenodelphis hosei*) were encountered three times and twice they were associated with melon-headed whales. They were in groups ranging from ten individuals to about 100, displaying their typical "aggressive" swimming style.

Striped dolphins (*Stenella coeruleoalba*) were encountered only once in a group of 50 individuals that came bow-riding under the boat for a long period.

Bottlenose dolphins (*Tursiops truncatus*) were encountered six times in groups of 10-50 individuals. They were mainly travelling fast or, when sighted in bad weather conditions, they disappeared immediately.

***Kogia* sp.** were encountered twelve times in very small group of 1-2 individuals. Once. four individuals were sighted together. Sightings were possible only in conditions of flat calm sea. Animals disappeared quickly and no sound was recorded.

Melon-headed whales (*Peponocephala electra*) were encountered eleven times in big groups of about 100 animals. Spyhopping permitted us to see clearly their typical triangular head and to distinguish them from pygmy killer whales.

Pygmy killer whales (*Feresa attenuata*) were encountered ten times in small groups of 5-20 animals. A close inspection permitted us to distinguish them from melon-headed whales.

A ***Balaenoptera* sp.** was sighted three times, but the shortness of the encounter did not permit us to recognise the species.

These results confirm and enlarge data from a previous study in the same area (Rudolph, 1995). A comparison with Rudolph's report revealed that nine out of 13 cetacean species had already been sighted in the study area. Killer whales (*Orcinus orca*) were not seen during 1998, but had been previously observed. On the other hand, striped dolphins, Risso's dolphins, pygmy killer whales and *Balaenoptera* sp. are reported for the first time.

CONCLUSIONS Preliminary results of this research have already highlighted that North Sulawesi can be considered a highly rewarding site for cetacean studies with a representative sample of marine biodiversity, confirming other authors' previous findings (Rudolph *et al.*, 1997). Manado Bay and Bunaken Archipelago has been a Marine National Park since 1989, but no actions to protect this area are currently in progress. Fishing with dynamite and poison is still popular, and plastic bags make huge floating patches after abundant rains. How long will we be able to see dolphins here?

ACKNOWLEDGEMENTS Special thanks are due to all the volunteers who helped with fieldwork, to Mr Joe Olson (Cetacean Research Technology) for technical support, and to Ika and Ciun as great "dolphin spotters".

REFERENCES

Borsani, J. F., Pavan, P., Gordon, J. C. D. and Notarbartolo di Sciara, G. 1996. Regional vocalisations of the sperm whale: mediterranean codas. Pp. 78-81. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Rudolph, P. 1995. Observations on cetaceans in the waters off Manado, north-eastern Sulawesi, Indonesia. In *SEAMAM (Southeast Asian Marine Mammals)*, Nov. 1996.

Rudolph, P., Smeenk, C., and Leatherwood, S. 1997. Preliminary checklist of Cetacea in the Indonesian Archipelago and adjacent waters. *Zool. Verh.* 312pp.

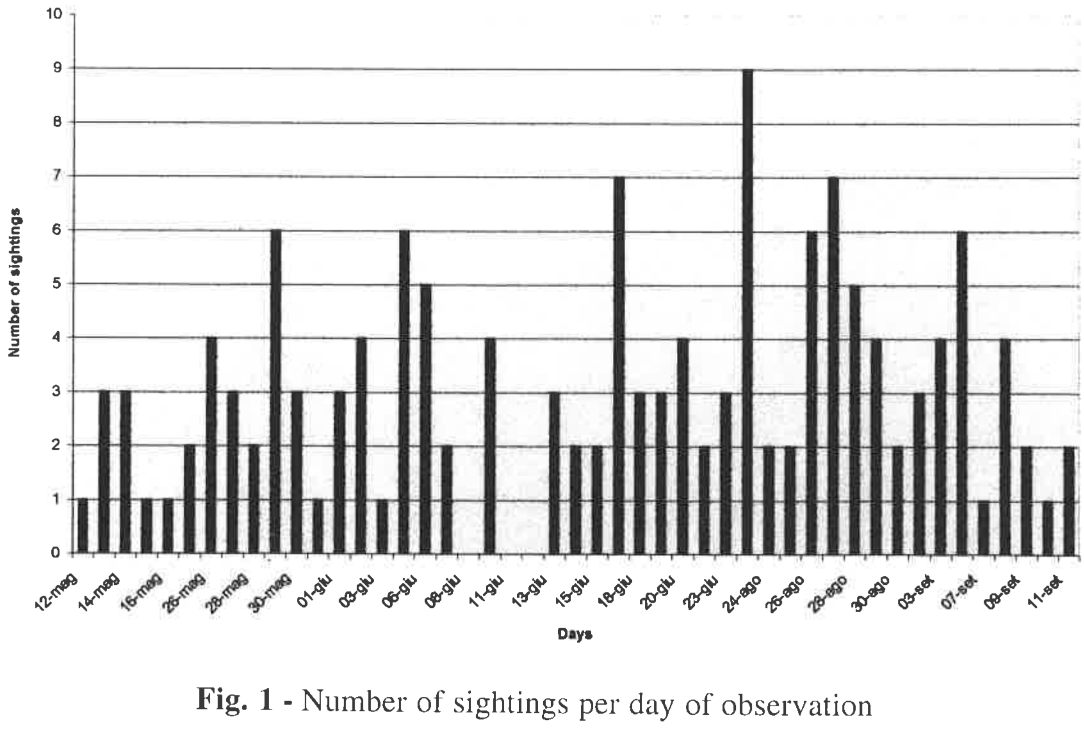

Fig. 1 - Number of sightings per day of observation

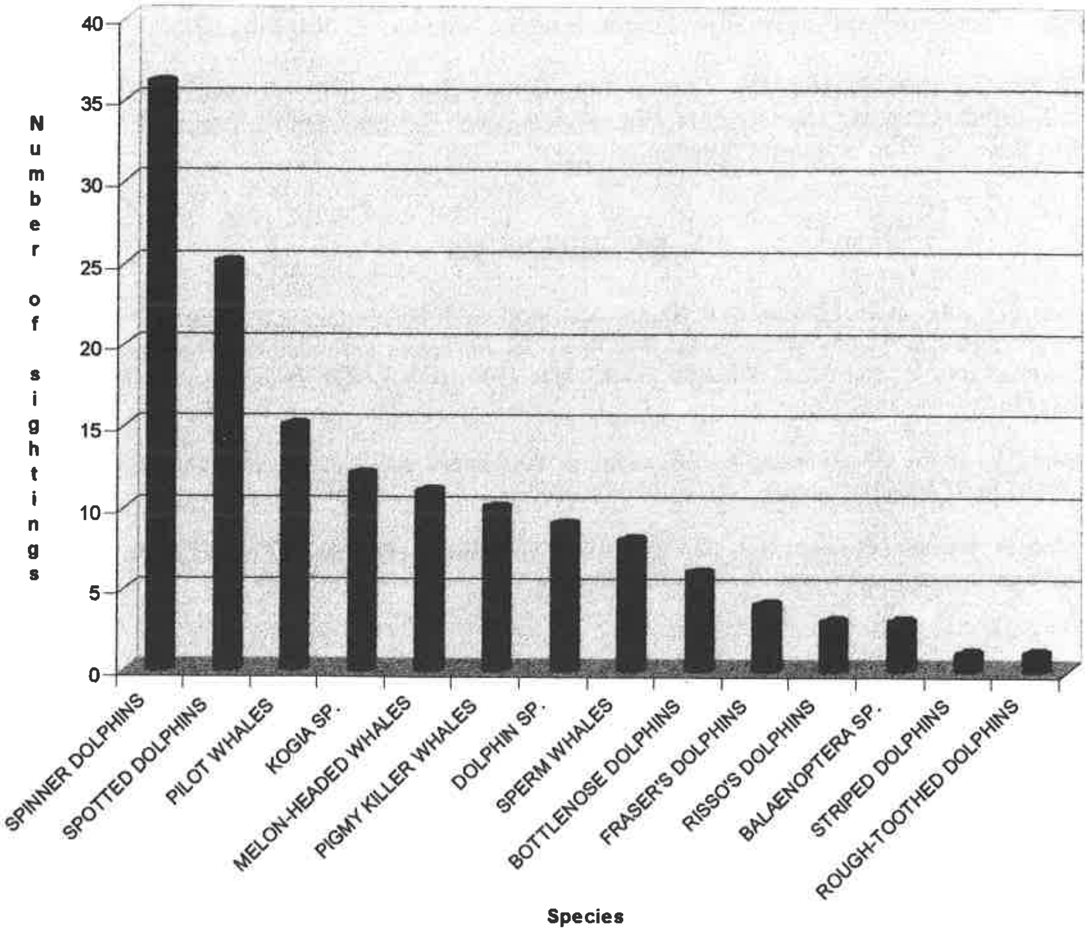

Fig. 2 - Number of sightings per species

CETACEANS OF THE HEBRIDES: SEVEN YEARS OF SURVEYS

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INTRODUCTION Between the Outer Hebrides and the coast of West Scotland lies an area of sea comprising the Minches (north of the Isle of Skye) and Sea of Hebrides (south of the Isle of Skye) which is very rich in whales and dolphins. Nutrient upwellings around headlands and islands provide suitable conditions for plankton concentrations to develop, and upon these feed large numbers of fish which then fall prey to seabirds, seals and cetaceans.

Since 1992, the UK Sea Watch Foundation has conducted dedicated cetacean surveys every summer between June and September aboard the 26 m gaff-rigged ketch "Marguerite Explorer", in conjunction with its commercial whale-watching operations.

METHODS A total of just under 20,000 km of surveys have been undertaken during the seven years 1992-98, with effort greatest in July and August. Continuous watches were made during daylight hours using rotas of observers; all sightings made were logged along with distance and angle from the vessel, group size estimate and behaviour, and a variety of environmental variables such as sea state and wind speed were recorded. Pre-determined transect lines were traversed annually for year to year comparisons, and some of the results are presented here in terms of numbers per unit effort (distance travelled) on a grid cell basis.

RESULTS Eleven cetacean species have been recorded in the area during the surveys. Of these, by far most frequently recorded species is the harbour porpoise, followed by minke whale, Risso's dolphin, common dolphin, and white-beaked dolphin, although in terms of overall numbers of individuals, the common dolphin is second in abundance to the harbour porpoise, followed by Risso's dolphin, minke whale, and white-beaked dolphin. For the purpose of this contribution, detailed analyses of effort-related sightings are conducted only for the two most common species: harbour porpoise and minke whale.

Harbour porpoise, *Phocoena phocoena*, is the most common and widely distributed cetacean in the region, occurring in 82% of squares surveyed, with 2,742 sightings comprising 5,531 individuals (Fig. 1). The most common group sizes was 1-2, although aggregations of larger numbers also occurred, particularly in late summer (Aug-Sept). Larger numbers were recorded in 1994 than in the years adjacent to this, although since 1995 there is evidence of a steady increase in numbers (Fig. 2). Porpoise distribution, in terms of the percent of total effort cells surveyed, increased during the first few years and then remained constant after a low in 1995 (Fig. 3). In those years where porpoises were seen most frequently, they also were most widely distributed (Fig. 4).

Minke whale, *Balaenoptera acutorostrata*, is also widely distributed, being recorded in 61% of squares surveyed (Fig. 5). A total of 897 sightings have been made involving 1,174 individuals. The most common group size was one, although aggregations of up to 14 individuals have been recorded, mainly in late summer (Aug-Sept). Annual changes in relative abundance (Fig. 6) and distribution (percent effort cells occupied: Fig. 7) closely mirrored those observed for the harbour porpoise with a peak in 1994 and a steady increase since 1995. And likewise, the minke whale was most widely distributed in years of peak sightings rate (Fig. 8).

Risso's dolphin, *Grampus griseus*, is the third most frequently recorded species with 167 sightings comprising 1,247 individuals. Though widely distributed, it was recorded particularly along the east coast of the Outer Hebrides from the Butt of Lewis right down to Barra Head. The most common group size was 7-8 individuals, but larger groups up to 50 individuals were recorded. Numbers were greatest in August and September.

Common dolphin, *Delphinus delphis*, mainly occurred in the Sea of Hebrides south of the Isle of Skye. A total of 138 sightings were made comprising 3,274 individuals. Numbers were greatest in June and early July, declining sharply from August onwards. The most common group size was 8-10 individuals, but larger groups up to 350 animals were recorded.

White-beaked dolphin, *Lagenorhynchus albirostris*, was most common in the Minches particularly at the northern end. It also occurred in the Sea of Hebrides but mainly in the western sector. A total of 128 sightings were made comprising 872 individuals. Numbers were greatest in August and early September. The most common group size was 4-6 individuals with groups ranging up to 50 individuals.

Six species have been recorded on less than twenty occasions. In descending order of sightings frequency, these include killer whale, Atlantic white-sided dolphin, northern bottlenose whale, striped dolphin, and fin whale, with white-sided dolphin the most abundant of these.

CONCLUSIONS Harbour porpoise and minke whale were the most frequently recorded species in the Minches and Sea of Hebrides. Annual variation in abundance indices of both mirrored one another closely, with both steadily increasing since 1995. This could either reflect year to year variation in food abundance which similarly influenced the presence of both species (although they occurred most frequently in different areas); or it could be due to some set of environmental conditions varying in a particular way. Further analyses will need to be conducted to investigate this.

Common dolphins and white-beaked dolphins were relatively abundant although their distributions were broadly allopatric, with the former occurring mainly in the central and eastern Sea of Hebrides and the latter in the western Sea of Hebrides and Minches. Risso's dolphins were widely distributed along the chain of the Outer Hebrides.

ACKNOWLEDGEMENTS This project has involved a large number of persons from a wide variety of backgrounds. First and foremost, we thank Christopher Swann ('Swanny'), the skipper of the "Marguerite Explorer" and his crew, particularly Teo, Scott, Figgy, Guga and Colin. Amongst those who assisted in the fieldwork, the following deserve special mention: Paula Barnett, Sarah Bowe, Francesca Bradbury, Deborah Brady, Samantha Chalis, Cheryl Ann Cross, Heidi-Jayne Cluley, Sharon Cumberworth, Hajni Elekes, Mick Green, Tony Green, Sara Heimlich, Wilma Hendriks, Dorien Hoogerheide, Rachael Hunt, Tara Jersey, Lisa Kendrick, Caroline Laburn, Lori Lawson, Emily Lewis, Mairi Macleod, Colin MacLeod, Maria Mikkelsen, Maria Manuela Nunes, Magnus Robb, Jo Rose, Petra van Wezel and Andy Williams. Those who assisted with data processing include Deborah Brady, Alex Gaut, Patricia Gonzalbes, Tara Jersey, Sara Maxwell, Chris Parsons, Eva Pubill, and especially Caroline Weir.

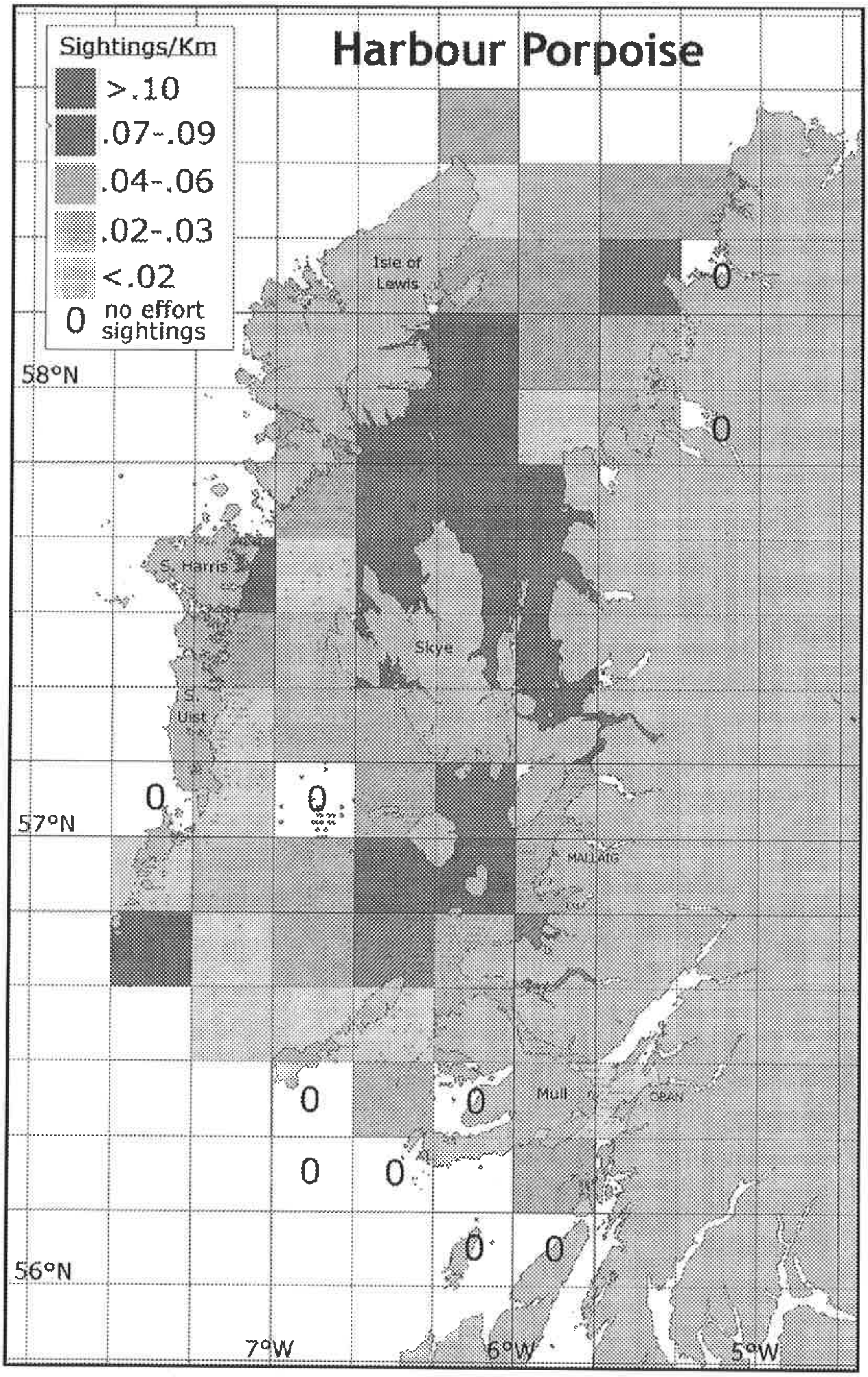

Fig. 1 - Map of harbour porpoise sightings with mean grid cell sighting rates for all surveys in all years (1992-1998). Some sightings were collected opportunistically without associated effort records and were not used in the grid cell analyses

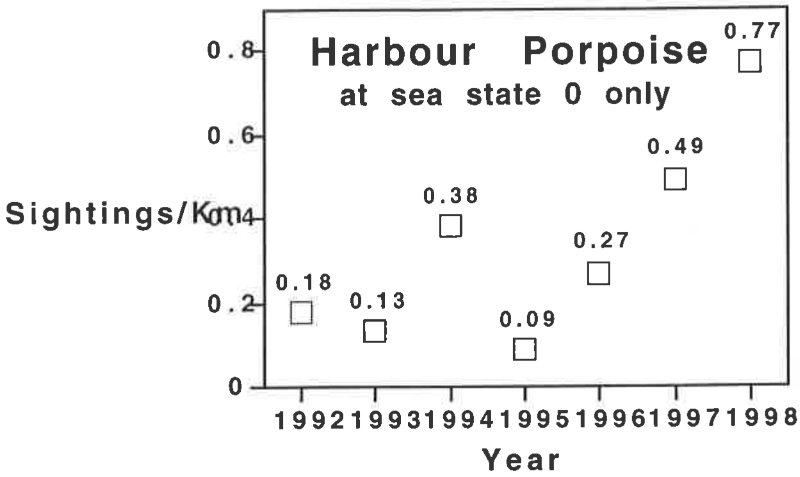

Fig. 2 - Harbour porpoise mean sighting rates (at sea state 0) have increased over the seven years of surveys

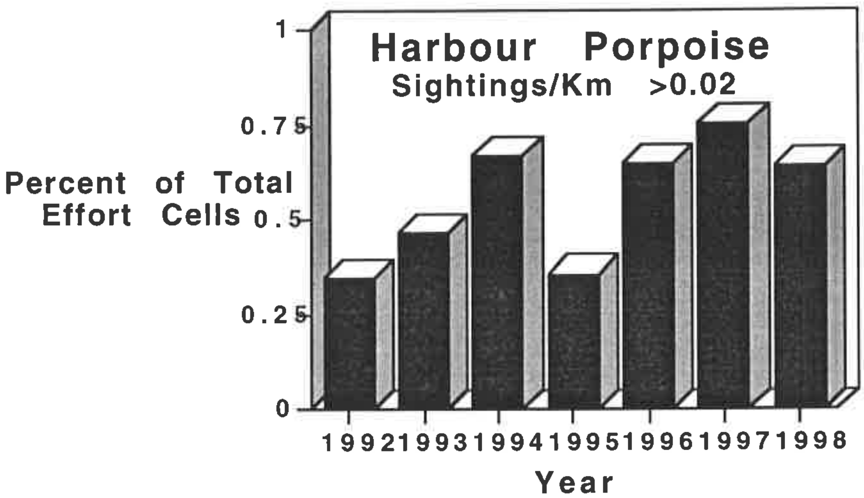

Fig. 3 - Harbour porpoise habitat use: percent of total effort cells in which sighting rates were greater than 0.2 sightings per kilometre

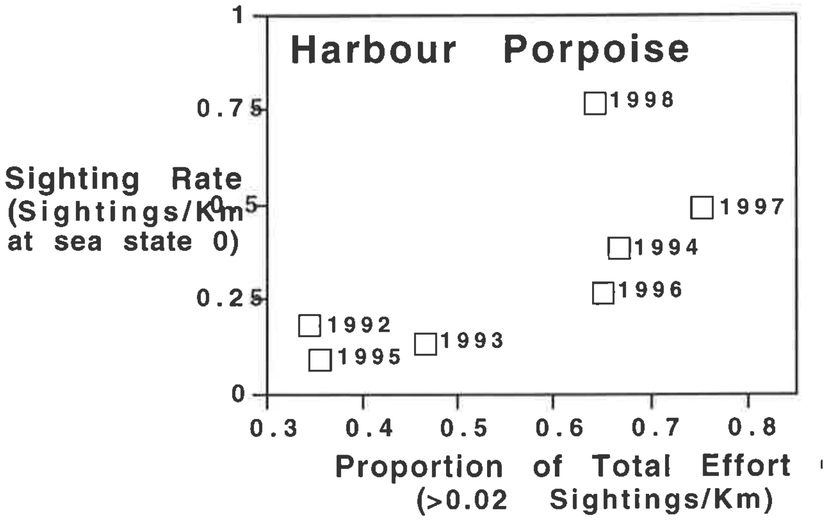

Fig. 4 - Harbour porpoise annual changes in sighting rates correspond to an increase in area occupied

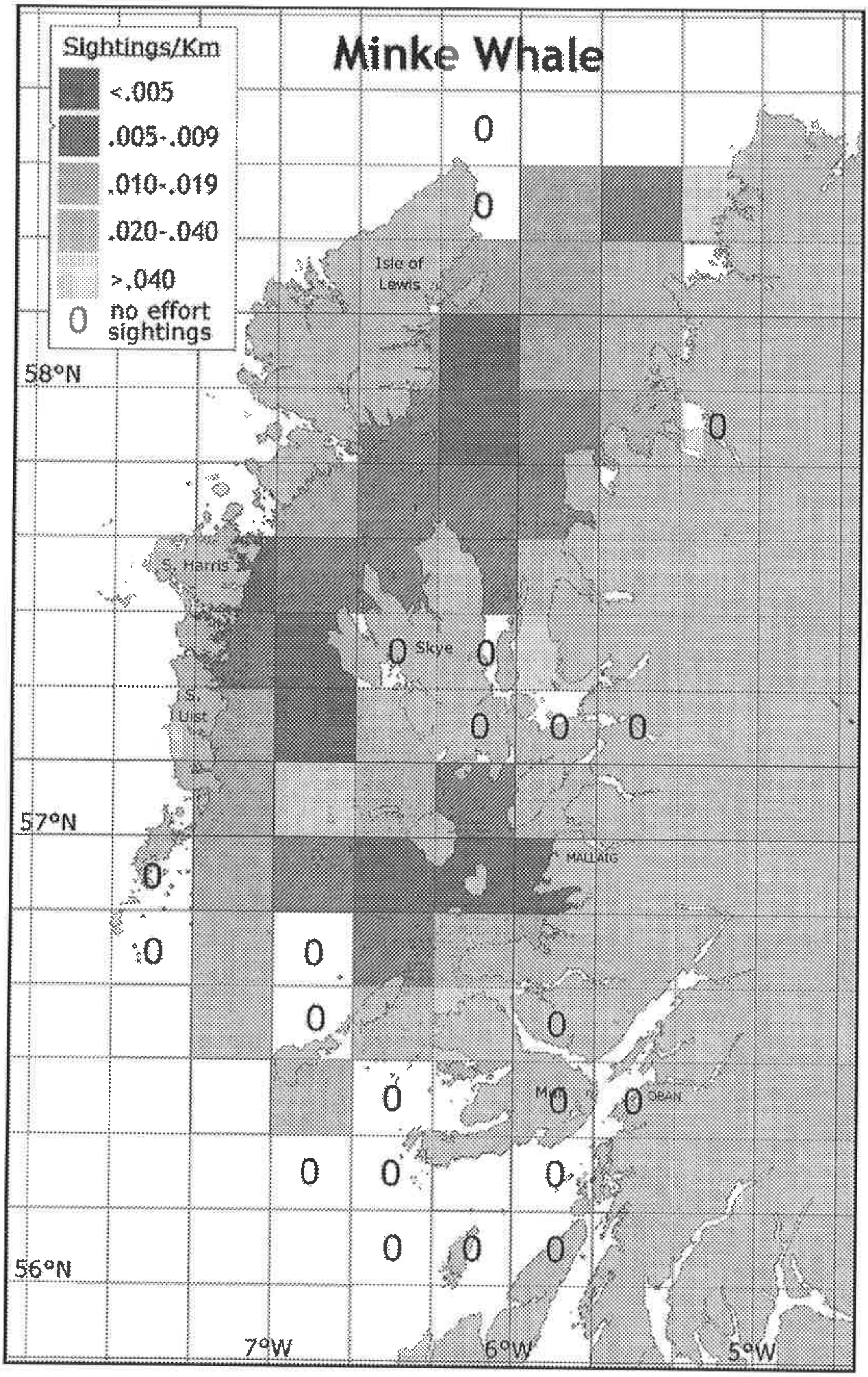

Fig. 5 - Map of minke whale sightings with mean grid cell sighting rates for all surveys in all years (1992-1998). Some sightings were collected opportunistically without associated effort records and were not used in the grid cell analyses

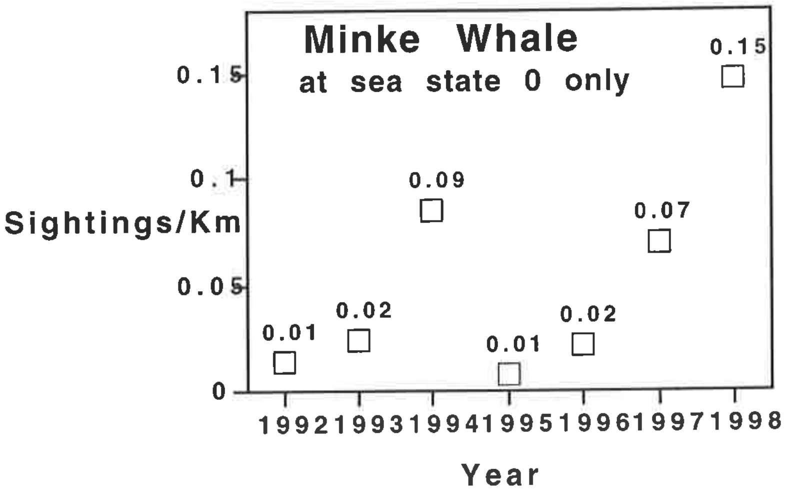

Fig. 6 - Minke whale mean sighting rates (at sea state 0) have increased over the seven years of surveys

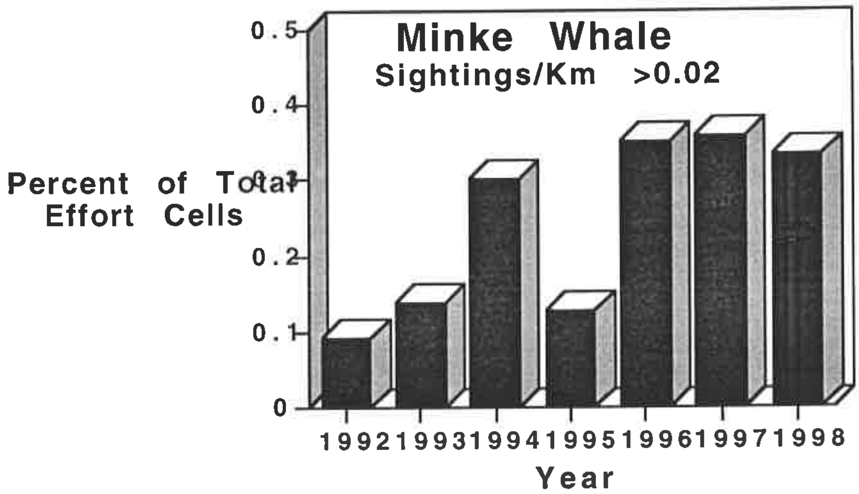

Fig. 7 - Minke whale habitat use: percent of total effort cells in which sighting rates were greater than 0.2 sightings per kilometre.

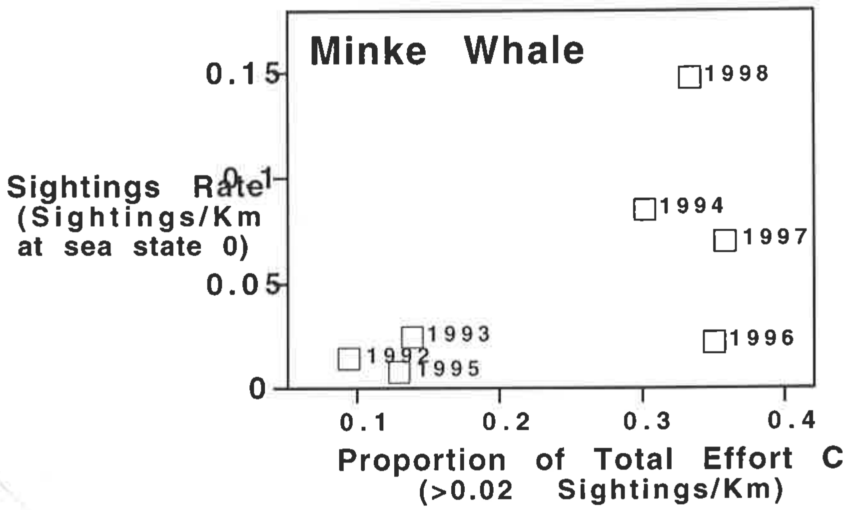

Fig. 8 - Minke whale annual changes in sighting rates correspond to an increase in the area occupied

CETACEAN DISTRIBUTION WITH RESPECT TO THE PHYSIOGRAPHY OF THE ALBORAN SEA

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INTRODUCTION The present study constitutes a preliminary review of a long-term cetacean monitoring programme, whose main aims are: 1) to establish the present conservation status of cetaceans in Spanish southeastern Mediterranean waters, and 2) to identify habitats that allow one to assess areas of special protection, for the reproduction, feeding, breeding, and migration of these species

After several years of shipboard research along the south-eastern coast of Spain, studies are now concentrating on specific regions of the Alboran Sea, which have been highlighted as possible critical habitats for the conservation of threatened species in the Mediterranean. Previous studies in the Gulf of Mexico (Mullin *et al.*, 1994; Baumgartner, 1997), eastern North-Pacific (Hui, 1985; Perrin *et al.*, 1985; Taylor, 1992) and North Atlantic (Scott *et al.*, 1985; Kenney and Winn, 1987), have suggested the possibility of defining habitat in terms of physiography for several species of cetaceans. We are assuming that whereas the physical environment probably cannot be considered directly significant as such, the primary influence over cetacean distribution is likely to be the aggregation of prey species, which is promoted by the physical environment (Rubin, 1994). This research has focused mainly on common, striped, bottlenose and Risso's dolphins, and long-finned pilot whales, although occasional data were recorded for sperm whales and Ziphiidae as well. The research site has an extremely complex physiography and oceanography, playing a mayor role as a hydrological motor of the Mediterranean Sea, and as transition chamber where Atlantic and Mediterranean oceanographic masses collide, creating important thermohaline fronts (Rubin *et al.*, 1992).

For the analysis, the research site was divided into two main regions of distinct oceanographical characteristics, which have been further subdivided in two by two nautical mile quadrats. We examined the distribution data, considering two variables: water depth and slope (or depth gradient), which were calculated for each of these quadrats. Whereas the southern part, or Alboran region, is under an important Atlantic influence due to the inflow of water through Gibraltar, the northern region, or Gulf of Vera, is more typically Mediterranean (Deyá *et al.*, 1990). In terms of physiography, the Gulf of Vera, or "Mediterranean influenced region", is characterised by its very narrow shelf and its very steep physiography (Díaz del Rio, 1991). The Alboran region, or "Atlantic influenced region", has a wider continental shelf, and although depth gradient values are still relatively high, they are inferior to those of the Vera region. An important characteristic of this region, is the presence of mountains that range in dimension from small dries as the Seco de los Olivos, to high mountains such as that giving rise to the Island of Alboran (Parrilla and Kinder, 1987).

METHODOLOGY The survey transects were conducted from the Alnitak research motorsailer "Toftevaag", sampling the research region throughout the months of April, June, July, August and September, from 1992 until 1998. The observation platform had a height of eye of twelve metres above sea level. In order to homogenise sighting effort, only two trained observers occupied this lookout post. Cetaceans observed during other sightings involving photo-ID and acoustic or behaviour recordings were not included in this analysis. Sighting effort was stopped when sea states of 3 (Douglas scale) or more were reached.

Geographic position of the ship during sightings was recorded directly by the ship's computer from a GPS navigation system, using IFAW's logger software. Other data concerning time, species, number of individuals, behaviour, and social structure were recorded, together with other complementary environmental data. To complete this study, we carried out a bibliographic compilation of data on stomach contents of the cetacean species considered, as well as on the distribution of the cetacean prey species commonly found in the Mediterranean.

RESULTS.......The shipboard surveys covered a total of twelve thousand four hundred nautical miles under adequate effort. During this effort, one thousand one hundred and eighty one sightings of cetaceans were made.

Statistical analysis of the distribution in relation to ocean depth showed this physiographic factor to play an important role in the distribution of these species. For all species, except one, the relation between ocean depth and distribution was found to be significant or very significant, using a z test and a chi-square analysis. On the other hand, the analysis of the distribution with respect to the depth gradient did not show values as highly significant as those of the ocean depth analysis.

The more coastal species was the bottlenose dolphin, showing a clear distribution throughout the continental shelf. Their preferential depth was found to be 10 to 400 metres. However, in the Alboran region, where it was highly significantly more abundant than in the Gulf of Vera, the distribution had a wider range, entering the pelagic domain to depths of over 1,000 metres, showing a very significant preference for the waters surrounding the "Seco de los Olivos" dry. There were no significant differences for depth gradient. This species appears to be feeding mainly on demersal fish such as *Micromesistius poutasou* and some Merluccidae, Sparidae and others, as well as a small amount of some species of cephalopods (Relini *et al.*, 1994; Santos *et al.*, 1996; Salomon, 1997), having mainly a distribution confined close to the sea floor around depths of 20 to 400 metres (FAO, 1987)

The common dolphin also showed a highly significant preference for the Alboran region. With respect to depth, it showed a very different picture for both regions, although it did not show significant differences for depth gradient. In the Gulf of Vera we obtained an apparently bi-modal distribution with a significant preference for depths of 600-800 m. and a secondary peak from 1,600-1,800 m. In the Alboran region, no significant differences were obtained, but the distribution here also showed an apparent bi-modal distribution with a tendency of preference for shelf and shelf edge waters ranging from 10-400 m. and a second peak around depths of 1,200-1,400 m. If we analyse the data taking into account behaviour, group size and presence of calves, the importance of the continental shelf and its edge becomes even more significant in the region of Alboran. This species appears as a very opportunistic feeder, targeting mainly small neritic epi-pelagic fish, especially of the family Clupeidae and some Gadidae, as well as a small amount of cephalopods (Collet *et al.*, 1981; Cordeiro, 1996; Berrow and Rogan, 1995; Santos *et al.*, 1996).

The striped dolphin did not show any significant difference in presence in both areas, although a clear positive tendency was observed for the Gulf of Vera. This species was very rarely found on continental shelf waters, showing, however, a very wide distribution from the shelf edge across the pelagic domain, preferring waters with depths greater than 1,000 m. Striped dolphin showed a clear preference for areas with depth gradients of 30-50 m. in the Alboran region, and more than 50 m. in the Gulf of Vera. This species is considered to have very opportunistic feeding habits, but does seem to prefer some oceanic epi- or meso-pelagic fishes, mainly of the family Gadidae, Myctophidae, and others, and especially several species of oceanic meso-pelagic cephalopods (Würtz and Marrale, 1993; Blanco *et al.*, 1995; Santos *et al.*, 1996)

The long-finned pilot whale showed a highly significant preference for the Alboran region, and very widespread distribution throughout pelagic waters, significantly preferring, however, depths of 600-1,000 m. The species also showed a preference for areas with depth gradients of 30-50 m., but only in the Alboran Sea, with no significant differences in the region of Vera. This species feeds not only on cephalopods, but also occasionally on some pelagic fish (Desportes and Mouritsen, 1993; Santos *et al.*, 1996).

The Risso's dolphin showed a significant preference for depth ranges of 600-1,000 m. in the Gulf of Vera and 1,000-1,200 m. in the Alboran region. Similarly, the Ziphiidae showed a preference for depths of 800-1,200 m. in both regions. No significant differences were found in terms of distribution per area for both species, probably due to the small sample size, although a clear tendency was observed in the Ziphiidae for the Alboran region. Both Risso's dolphins and whales from the family Ziphiidae showed a preference for areas with depth gradient of 30-80 m. These species appear to feed only on cephalopods, and their most common prey species are from the family Histioteuthidae (Carlini *et al.*, 1992; Santos *et al.*, 1996; Blanco *et al.*, 1997), which are oceanic and meso- or bathypelagic inhabiting those depths, with preference for escarpments (FAO, 1987).The sperm whale showed preference for depth gradients of 30-50 m. and depths of 500-1,000 m.

DISCUSSION The results of this study indicate that physiography does have an important relationship with the distribution of certain species. The distribution of cetaceans clearly matches that of their prey. In the case of demersal prey species, physiography plays a very direct role limiting distribution directly by depth, slope and type of substrate (Gil de Sola, 1993). For other species of cetacean prey, physiography could play a more indirect role through such mechanisms as topographically induced up-welling of nutrients (Rubin, 1997), increased primary production, and aggregation of zooplankton due to the enhanced secondary production or convergence of surface waters (Rubin *et al.*, 1992; Rubin, 1994). A very clear distinction can be made between mainly-squid-eaters and mainly-fish-eaters. In the latter group we have the bottlenose and the common dolphin, showing a preference for shallower waters, whereas the other species which feed mainly on squid prefer deeper waters.

This study has also allowed us to highlight several regions where local physiography can play an important role in prey aggregation for cetaceans. In the Alboran Sea, some of these habitats seem to play a crucial role in supporting species that are under decline in other regions of the Mediterranean Sea, such as the bottlenose and the common dolphin (Pelegrí, 1980; Viale, 1980; Evans, 1987; Laurent, 1991; Aguilar, 1991; Viale, 1993; Notarbartolo di Sciara, 1993). Habitats such as the shelf waters around the Alboran Sea, and shelf slopes of dries such as that of "Seco de los Olivos" appear to be particularly important for the conservation of the bottlenose dolphin, and clearly illustrate the role of local physiography for this species. Local physiography also plays an important role in concentrating prey for the common dolphin. Several species of small pelagic fish included in the main diet of this species are seasonally very abundant along various parts of the continental shelf and first section of the slope of the Alboran region, which they use as breeding sites (Rubin *et al.*, 1992; Gil, 1992). This abundance of prey of a high nutritional value could explain the very significant large group sizes and percentage of calves found for the common dolphin on the shelf waters of the Alboran region.

Future research efforts will focus on the apparently bi-modal distribution of common dolphins in order to establish possible segregations of age/sex classes. More analysis remains to be done in the future also taking into account some other variables such as physical and chemical oceanography, fisheries effort, maritime traffic, chemical and acoustic pollution, etc. These analyses and the very significant preference of certain species for the Alboran region complement others in highlighting the importance of the Alboran Sea for the conservation of cetaceans in the Mediterranean, probably as a result of its unique phisiographic and oceanographic characteristics. However, increasing fishing effort both by local fleets and by international industrial fleets on previously un-exploited species and the use of illegal driftnets are threats that require the adoption of urgent and adequate conservation policies.

REFERENCES

Aguilar, A. 1991. Calving and early mortality in the western Mediterranean striped dolphin, *Stenella coeruleoalba. Can. J. Zool.*, 69, 5: 1408-1412.

Baumgartner, M. F. 1997. The distribution of Risso's dolphin (*Grampus griseus*) with respect to the physiography of the Northern gulf of Mexico. *Marine Mammal Science*, 13, 4: 614-638.

Berrow, S. D., and Rogan, E. 1995. Stomach contents of harbour porpoises and dolphins in Irish waters. In *European Research on Cetaceans – 9*. Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb., 1995. European Cetacean Society. (Eds. P. G. H. Evans and H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Blanco, C., Aznar, J., and Raga, J. A. 1995. Cephalopods in the diet of the striped dolphin *Stenella coeruleoalba* from the western Mediterranean during an epizootic in 1990. *J. Zool. Lond.*, 237: 151-158.

Blanco, C., Salomon, O., and Raga, J. A. 1997. Stomach contents of *Ziphius cavirostris* stranded on the western Mediterranean coast. In: *European Research on Cetaceans – 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997, (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Carlini, R., Pulcini, M. and Würtz, M. 1992. Cephalopods from the stomachs of Risso's dolphins, Grampus griseus, (Cuvier, 1812) stranded along the central Thyrrenian coast. In: *European Research on Cetaceans – 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February, 1992. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Collet, A., Buit, M. H., and Duguy, R. 1981. Regime alimentaire de *Delphinus delphis* dans le nord-est Atlantique. *Conseil International pour l'Exploration de la Mer. C.M. 1981/ N:5.* Comité des Mammiferes Marins.

Cordeiro, M., 1996. Contribuição para o conhecimento do regime alimentar e da biologia da reprodução do golfinho-comum, *Delphinus delphis* (Linnaeus, 1758), na costa Portuguesa. Master Thesis. Depart. de Zoologia e Antropologia. Facultad de Ciências da Universidade de Lisboa.

Desportes, G. and Mouritsen, R. 1993. Preliminary results on the diet of long-finned pilot whales off the Faroe Islands. *Rep. Int. Whal. Commn* (Special Issue 14): 305-324.

Deyá, M., Guerrero, J., Rodríguez, C. 1990. Distribución de partículas en suspensión de las aguas del Golfo de Vera. *Inf. Téc. del Inst. Esp. Oceanog.*, 90.

Díaz del Río, V. 1991. El Margen Continental Bético Mediterráneo. Extremo Bético Oriental: Cuenca de Murcia - Escarpe de Mazarrón. *Publ. Espec. Inst. Esp. Oceanogr.*, 6.

Evans, P. G. H. 1987. *The Natural History of Whales and Dolphins*. Christopher Helm Mammal Series. London. 387pp.

FAO 1987. *Fiches FAO d'identification des especes pour les besoins de la peche. Mediterranée et Mer Noire*. Zone de Peche 37. Révision 1. Volume II. Vertebres. FAO, Rome.

Gil de Sola, L. 1993. Las pesquerías demersales del mar de Alborán (surmediterráneo ibérico), evolución en los últimos decenios. *Inf. Téc. del Inst. Esp. Oceanog.*, 142.

Gil, J. 1992. Consideraciones sobre el hábitat medioambiental de los cardúmenes de sardina en la plataforma continental mediterránea y Golfo de León. *Inf. Téc.Esp.Inst. Esp. Oceanog.*, 114.

Hui, C. A. 1985. Undersea topography and the comparative distributions of two pelagic cetaceans. *Fishery Bulletin*, 83, 3: 472-475.

Kenney, R. D., and Winn, H. E. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/ slope areas. *Continental shelf Research*, 7, 2: 107-114.

Laurent, L. 1991. Observations cétologiques en Méditerranée occidentale. Vie Milieu, 41, 4: 263-269.

Mullin, K. D., Hoggard, W., Roden, C. L., Lohoefener, R. R. and Rogers, C. M. 1994. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. *Fishery Bulletin*, 92: 773-786.

Notarbartolo di Sciara, G. 1993. Cetacei del Mediterraneo. Contributi del Centro Linceo Interdisciplinare "Beniamino Segre" N. 86. *XIX Seminario sulla Evoluzione Biologica e i grandi problemi della biologia*: 39-52

Parrilla, G. and Kinder, T. H. 1987. Oceanografía física del mar de Alborán. *Boletín del Instituto Español de Oceanografía*, 4(1): 133-165.

Pelegrí, J. 1980. Recull de la Comisó de Cetologia de la Institució Catalana d'Història Natural. II: anys 1974 i 1975. *Butll. Inst. Cat. Hist. Nat.*, 45, Sec. Zool., 3:155-165

Perrin, W. F., Scott, M. D., Walker, G. J. and Cass, V. L. 1985. *Review of geographical stocks of tropical dolphins (Stenella spp. and D. delphis) in the Eastern Pacific*. U.S. Department of Commerce. National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Relini, L.O., Capello, M., and Poggi, R. 1994. The stomach content of some bottlenose dolphins (*Tursiops truncatus*) from the Ligurian Sea. In: *European Research on Cetaceans – 8*. Proc. 8th Ann. Conf. ECS, Montpellier, France, 2-5 March, 1994. (Ed. P. G. H. Evans). European Cetacean Society, Lugano, Switzerland. 288pp.

Rubín, J. P. 1994. El ictioplacton y el medio marino en los sectores norte y sur del mar de Alborán, en Junio de 1992. *Inf. Téc. del Inst. Esp. Oceanog.*, 146.

Rubin, J. P. 1997. La influencia de los procesos fisico-quimicos y biológicos en la composición y distribución del ictioplacton estival en el mar de Alborán y estrecho de Gibraltar. *Inf. Téc. del Inst. Esp. Oceanog.*, 24.

Rubín, J. P., Gil, J., Ruiz, J., Cortés, M. D., Jiménez-Gómez, F., Parada, M., and Rodriguez, J., 1992. La distribución ictioplanctónica y su relación con parámetros físicos, químicos y biológicos en el sector norte del Mar de Alboran, en Julio de 1991 (Resultados de la Campaña "Ictio.Alboran 0791"). *Instituto Español de Oceanografía. Informe Técnico*, 139. Madrid.

Salomón, O., 1997. *Estudio de la alimentación del delfín mular (Tursiops truncatus) en las costas de la Comunidad Valenciana*. Tesis de Licenciatura. facultat de Ciénces Biológiques. Universitat de Valencia.

Santos, M. B., Pierce, G. J., López, A., Barreiro, A., and Guerra, A. 1996. Diets of small cetaceans stranded NW Spain. *International Council for the Exploration of the Sea, 11. Marine mammal Committee*.

Scott, G. P., Kenney, R. D., Owen, R. E., Hyman, A. M. and Winn, H. E. 1985. Biological and physical oceanographic correlatives to cetacean density distribution in the Great South Channel. *International Council for the Exploration of the Sea. C.M. 1985/ N:6/ REFL. Marine Mammal Committee.*

Taylor, L. T. 1992. Habitat use patterns and ranges of the bottlenose dolphin in the Gulf of California, Mexico. *Marine Mammal Science*, 8, 3: 262-274.

Viale, D. 1980. Les modifications du peuplement de cétacés de Méditerranée occidentale. *Journées Étud. Systém. Et Biogéogr. Médit. Cagliari*, C.I.E.S.M.

Viale, D. 1993. Cetaceans as indicators of a progressive degradation of Mediterranean water quality. *Pr. Malaysia*:, 183-198.

Würtz, M. and Marrale, D. 1993. Food of striped dolphin, *Stenella coeruleoalba*, in the Ligurian Sea. *J. mar. Biol. Ass. UK*, 73: 571-578.

CABO VERDE SIGHTINGS SURVEY 1997-1998: FIRST RECORD OF ROUGH-TOOTHED DOLPHIN (*STENO BREDANENSIS*)

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A technical co-operation programme between the Government of the Canary Islands and the Republic of Cabo Verde has allowed us to conduct surveys on board of the R/S Corvette, on three occasions in the waters of the Archipelago of Cabo Verde.

During the cruises around the islands, a total of 44 sightings of cetaceans were made, allowing the identification of six species: (8) *Stenella frontalis*, (3) *Stenella attenuata*, (5) *Tursiops truncatus*, (6) *Steno bredanensis*, (4) *Globicephala macrorhynchus*, (1) *Physeter macrocephalus*. In 17 cases it was impossible to determine the exact species: (1) Balaenopteridae and (9) Delphinidae, (4) *Stenella* sp., and (3) *Globicephala* sp. For each species, we have included some observations on the behaviour, size and structure of the group.

Special interest is given to the six sightings of rough-toothed dolphin *Steno bredanensis* (Lesson, 1828), a species whose presence was not reported until now in the region.

FIRST SIGHTING OF GERVAIS' BEAKED WHALE (*MESOPLODON EUROPAEUS* GERVAIS, 1855) (CETACEA; ZIPHIIDAE) FROM THE NORTH ORIENTAL ATLANTIC COAST

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The Gervais' beaked whale *Mesoplodon europaeus* Gervais, 1855, is an endemic species of warm temperate, subtropical and tropical waters from the North Atlantic where it is partially sympatric with the True's beaked whale *M. mirus* and its distribution seems to be closely connected to the Gulf Stream. Nevertheless, a few records have been cited in the southern hemisphere. It is the member of the genus *Mesoplodon* with the largest number of strandings on the west coast of the United States.

The species has stranded on the North-east Atlantic coast, specially in Ireland, Portugal, southern Spain, Azores, Mauritania, and Guinea-Bissau. Between 1985 and 1997, five strandings of the Gervais' beaked whale have been registered on the coast of the Canary islands, involving 11 specimens. However, there is no evidence of sightings of the species due to its cryptic habits. On 15th January 1998, a group of three specimens was seen at 10:10 hrs at 28° 26' 86'' N and 16° 56' 95'' W, at approximately six nautical miles from the Pto. of Teno, in the north-west coast of the island of Tenerife at c. 1,700 m. depth. The whales showed an interesting behaviour, getting close to the vessel and swimming around it for c. 10 min. They were filmed and photographed.

HISTORIC PRESENCE OF MARINE MAMMALS ON THE ECUADORIAN COAST

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Records of first human settlements on the Ecuadorian coast date back 500 years before Christ. Different Indian cultures along the coast left behind numerous ceramics and shells, proof of the relationship between man and nature for one of the oldest cultures of mankind These groups of native Indians in the Ecuadorian littoral zone were communities dedicated to commercial trade and sailing. Different objects of ceramics and metals were studied, some of which were household items and others had a ritual function. Within some of the objects from the Manteña culture - Huancavilca (800 to 1535 years BC) ,there are some zoological objects on ceramics used as musical instruments in the form of sea lions or dolphins.

The design of the dolphin is very naturalistic with well defined dorsal fins, blowhole, genital slits and nipple slits. In 1780, Juan de Velasco gave the first review of whales present off the Ecuadorian coast. Sir Onfroy Thoron described singing fishes in the sea in 1866. These might be humpback whales singing off the Ecuadorian coast. These reports suggest that humpback whales off the Ecuadorian coast can be dated back to 300 years.

DISTRIBUTION AND ABUNDANCE OF SOUTHERN FUR SEALS, *ARCTOCEPHALUS AUSTRALIS*, ALONG THE COASTS OF ARGENTINA

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This paper summarises new information on distribution, abundance and seasonal variation of southern fur seals along the coasts of Argentina. Fur seal rookeries have been surveyed after 50 years for the whole coast and after 25 years for Chubut coast.

From 1994 to 1998 the rookeries were surveyed by means of land, boat and aerial surveys in which the individuals were censused on location and by means of photographs. The individuals were classified in adult males and females, juveniles, pups and unidentified individuals. Considering the 17 rookeries along the coast, the population is considered to be close to 20,000 individuals with a maximum concentration during the breeding season from December to February.

The largest rookery is located at Isla Rasa (Chubut) with around 60% of the total population in Argentina and with a seasonal variation ranging from 2,000 to 12,000 individuals. The next largest is located at Isla de los Estados (Tierra del Fuego) with six rookeries and accounting for 3,000 individuals and Isla Escondida with 600 to 2,300 individuals.

Chubut islands were monitored in 1946-49, 1972 and 1994-98. A clear increase is shown and a rough estimate would be around 8% annually. Females were recorded with pups only at Isla Escondida but the number detected (around 200) would not account by itself for the total population estimated for the coast. Isla Rasa, which was surveyed for several years between November and February, did not show reproductive social structure, reproductive behaviour among the individuals, or females lactating pups. In fact, it is exclusively populated by juveniles.

The results presented in this paper, show a clear change with respect to previous information. They establish an important base for monitoring the population trend of one of the species reduced almost to extinction during the 18th and 19th centuries in the Southern Ocean.

LONG-FINNED PILOT WHALES (*GLOBICEPHALA MELAS*) IN THE STRAITS OF GIBRALTAR - A PRELIMINARY STUDY

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Although east and west of the narrow passage of the Straits of Gibraltar, population estimation of whales as well as other different whale-related research have been carried out, the Strait itself has not been investigated. It is recognised that the wind velocity and the surface currents make it very difficult to work on a daily basis. In particular, the 'Levante', a wind from the south-east, often hits this area with forces above 6 (Beaufort scale) against the surface current. The direction of the dominating surface current is west to east (Rodrigues, 1982). Because of the heavy currents in this area and the fact that it is a zone of heavy traffic, it has never been considered as a possible residence or feeding area of the whales. However, this small area seems to be a very frequently visited place for foraging by several whale species. The following species were encountered during the survey: striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus griseus*) and long-finned pilot whale (*Globicephala melas*) (Grau *et al.*, 1980, 1985; Rey *et al.*, 1979, 1982; Evans, 1987).

INTRODUCTION During the survey trips, data were collected regarding general abundance, behaviour and individual recognition. The measured abundance is to characterise the areas used more frequently by the animals in the Strait (Walmsley, 1996).

The recorded behavioural aspects contain, besides the three major categories of foraging, socialising and travelling, also a catalogue of special behaviours (Heimlich-Boran, 1993). As a result of these very general behavioural catalogues, the socialising and foraging ones will be investigated more thoroughly, because pilot whales are thought to maintain very strong social contacts with other members of the pod. Individual recognition was used to record the frequency of area-use by certain individuals. Photo-identification shots were taken of pilot whales and also of other species, especially bottlenose dolphins. This method was applied to measure several parameters: 1) to collect abundance and area-use data of individuals; 2) to create a catalogue of individuals (Giordano *et al.*, 1992), in order to compare it with that collected in subsequent years in the Strait as well as with data from other investigations; to create a comprehensive area-abundance chart; 3) to be able to recognise and distinguish easily different pods/schools in one area at the same time; 4) to obtain data of interspecific interactions, for example pilot whales with bottlenose dolphins (Heimlich-Boran, 1993).

MATERIALS AND METHODS The surveys took place from 19th July until 20th October on a research vessel 'Beluga', an inflatable of 7.5 m. length with inboard jet propulsion, and on a whale-watching boat 'Rajorca', a 13 m. inboard diesel engine powered boat with propeller propulsion. The area covered included the 14 km wide passage in the Strait between Tarifa (Spain) and Punta Cires (Morocco), lying between 36°01' N – 35°56' N and 005°23' W – 005°39' W, and in wind conditions below 7 Beaufort from the west and 4 Beaufort from the east (Fig. 3). All the data were recorded on tape during the trips with photo-identification and positioning by GPS.

RESULTS AND DISCUSSION From the 19th July to 17th October a total of 205.87 hours were spent on 91 trips with MTD (mean trip duration) of 2.26 hrs (0.36 hrs standard deviation). In 151.18 hours, there were a total of 1,273 long-finned pilot whales sighted with an IUE-effective (individuals per unit of effort with pilot whale sightings) of 8.41 (5.51 standard deviation), and an IUE-total of 6,181. The effective number of animals was 964 on 52 trips. In addition, on 14 occasions we sighted the whales but were unable to count them. Therefore, we applied a binomial distribution on the sighted animals resulting in an estimate of 18.44 individuals for those trips. For the period 09:00-13:00 hrs (morning), the figure was 16.42 IUE-trip (328); for 13:00-17:00 hrs (afternoon) it was 13.34 IUE-trip (440), and for 17:00-21:00 hrs (evening), it was 13.27 IUE-trip (504) (Fig. 1).

Micro-migration: During the period of July to October, there was a shift of the sighting area from west to east (Fig. 2). In the month of July, the whales were mostly seen south of Tarifa in the Mid-Strait section, while in August the animals were seen more eastward most of the time, albeit with clear tendencies to move west in front of Punta Cires. In September, the sightings were almost without exception in the east Strait section, off Punta Cires and east, about 5 km off the coast of Morocco. Finally, in October, they were entirely within the east Strait.

General and special behaviours: During the encounters, the behaviour of the individuals was recorded (Martin, 1996). The decision to characterise in detail the three major behaviours - foraging, socialising and travelling, was based on the different parameters sampled (Martin and Bateson, 1994). The most frequent behaviour observed in the survey area was foraging (34.88%), followed by travelling (21.92%), socialising (18.93%), and unknown behaviours (24.27%) (Fig. 3). There was a shift of these behavioural categories depending on the time of day (Fig. 4). However, throughout the survey time from July to September there were no significant changes (Martin *et al.*, 1996) in the rates of the behavioural patterns (Fig. 4)

Foraging: moderate speed; each animal was within a visible range from each other (c. 10 m.). There were clear hunting patterns seen, carried out by all adult animals, including synchronised diving patterns. Young and immature animals stayed more or less close to their mothers. However, they were not taking part in the hunting; our vessel was neglected except when we were directly in the way.

Socialising: slow movements; all animals stayed very close, even with direct body contact to eachother. Young ones were not directly attached to their mothers, but all animals were taking care of offspring while some large individuals (thought to be males) stayed at a certain distance (150-200 m) from the group; the boat was an enormous attraction to the pod, and they included the vessel in their socialising behaviour. The average distance during these encounters was about 20 m. During this behaviour, the animals usually came close to the boat by themselves.

Travelling: high speed (c. 14-17 knots); animals of the same pod swimming further apart (50-100m) from each other. Young ones stayed very close to their mother, synchronising the dive pattern. However, no clear pattern was observed among the adults. Travelling was only recorded in a westward direction.

Unknown: although not the best expression to describe all other observed behaviours, 'resting' is definitely a part of it, showing all individuals close together at the surface, the whole pod staying very close together while they are at the surface.

In the Straits, pilot whales seem to have developed a special foraging strategy, taking advantage of the strong currents (c. 14 knots) c. 2 km off Punta Cires. The animals swim against the current, however, with the same velocity. By this manoeuvre, they maintain their position. This behaviour has only been observed while foraging. The interspecific interactions with bottlenose dolphins only took place during 'foraging'. No aggressive tendencies among them were observed. The dolphins made use of the same manoeuvre as described above.

CONCLUSION The results obtained during only one summer season indicates the importance of the area between the two continents for pilot whales. The encounter rates show an area of intense use for feeding as well as for socialising. Some individuals were "re-captured" by photo-identification several times throughout the whole survey time.

Regarding the reports of the neighbouring Alboran Sea in the east (Cañadas *et al.*, 1996, 1997; Castells *et al.*, 1991; Gannier *et al.*, 1989; Di Natale, 1986), the possibility of the existence of a resident pod seems to be quite reasonable (Amos *et al.*, 1993). However, this pod seems to use the Straits mainly as a foraging area. The changes in the behaviour during the day indicate a change in prey availability. The methods used for the assessment of the population need to be refined during the coming years, and genetic fingerprints should be taken for comparisons with existing data from the Alboran Sea (Casinos, *et al.*, 1977; Franco, *et al.*, 1994). Photo-identification may give us a close-up picture of the social structure of long-finned pilot whales. Since pilot whales are known to be squid hunters (Relini *et al.*, 1992; Carwardine *et al.*, 1995), an understanding of the foraging behaviour may serve us to better understand the ecology of the Straits with its enormous depths.

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REFERENCES

Amos, B., Bloch, D., Desportes, G., Majerus, T., Bancroft, D., Barret, J. A., and Dover, G. A. 1993. A review of molecular evidence relating to social organisation and breeding system in the long-finned pilot whale. *Rep. Int. Whal. Comm.*, (Special issue 14): 204-217.

Cañadas, A. M., and Saraminaga, R. 1996. A long-term survey on distribution and dynamics of cetaceans along the South-Eastern coast of Spain: fourth year of research, 1992-95: Pp. 125-129. In: *European Research on Cetaceans - 10:* Proc. 10th Ann. Conf. ECS, Lisboa, Portugal, 20-24 Jan, 1996. (Ed. P. G. H. Evans), European Cetacean Society, Kiel, Germany. 334pp.

Cañadas, A. M. and Sagarminaga, R. 1997. A long-term survey on distribution and dynamics of cetaceans along the South-Eastern coast of Spain: five year of research, 1992-96. P. 104. In: *European Research on Cetaceans - 11:* Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997. (Eds. P. G. H. Evans, E. C. M. Parson & S. L. Clark), European Cetacean Society, Kiel, Germany. 314pp.

Carwardine, M., Evans P. G. H. and Weinrich, M. 1995. *Whales, dolphins and porpoises*, Stoddart, London.

Casinos, A. and Filella, S. 1977. Les cétacés de la Mediteranée espagnole:État actuel de nos connaisances, *Rapp. Comm. Int. Mer. Medit.*, 24:5

Castells, A. and Mayo, M. 1991. *Cetáceos de las costas españolas y portugesas*, Quercus, Madrid

Di Natale, A. 1986. New information about pilot whale, Globicephala melaena Traill, in the Mediterranean Sea, XVIII. Congress and Plenary Assembly of C.I.E.S.M., Cannes, December 2-11

Evans, P. G. H. 1987. *The natural history of whales and dolphins.* Christopher Helm, London & Facts On File Publications, New York.

Franco, I. and Mas, J. 1994, Distribution and evaluation of cetaceans in the Alborean Sea. P. 103. In: *European Research on Cetaceans - 8.* Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P.G.H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Gannier, A. and Gannier, O. 1989, Some sightings of cetaceans in the western Mediterranean Sea. Pp. 62-64. In: *European Research on Cetaceans -3,* Proc. 3rd Ann. Conf. ECS, La Rochelle, France,24-26 Feb, 1989 (Eds. P. G. H. Evans & C. Smeenk), European Cetacean Society, Leiden, The Netherlands. 132pp.

Giordano, A. and Tringali, M. 1992. Presence and individual recognition of *Globicephala melas* in the Liguro Provencal Basin. In: *European Research on Cetaceans* - Proc. 6th Ann. Conf. ECS, Sam Remo, Italy,20-22 Feb, 1992 (Ed. P. G. H. Evans), European Cetacean Society, Cambridge, UK. 254pp.

Grau, E., Aguilar, A. and Filella, S. 1980. Cetacean stranded, captured or sighted in the Spanish coasts during 1976-1979. *Bull. Inst. Cat. Hist. Nat.*,45.

Grau, E., Filella, S., Raga, J. A. and Raduán, A. 1985. Cetacéos varados en las costas del mediterráneo ibérico, durante los años 1980-1981, *Misc. Zool.*,10

Heimlich-Boran, J. R. 1993. Review of the life history and behaviour of pilot whales (*Globicephala* sp.). Social organisation of the short-finned pilot whale, *Globicephala macrorhynchus*, with special reference to the comparative social ecology of delphinids. DPhil. Thesis, Cambridge, UK

Martin, P. and Bateson, P. 1994. *Measuring behaviour* (2nd ed.), Cambridge University Press, Cambridge.

Martin, V. 1996. Diurnal activity patterns and behaviour in the short-finned pilot whale (*Globicephala macrorhynchus)* off SW Teneriffe, Canary Islands. P. 199. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Martin, V. and Santiago Medina, J. A. 1996. Acoustic behaviour of the short-finned pilot whale (*Globicephala macrorhynchus*) off the South-West coast of Teneriffe, Canary Islands: preliminary findings. Pp. 74. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Relini, L. O. and Garibaldi, F. 1992. Feeding of the pilot whale, *Globicephala melas*, in the Ligurian Sea. A preliminary note. Pp. 138-145. In: *European Research on Cetaceans - 6*: Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb, 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Rey, J. C. and Cendero, O. 1979. Les cétacés vus en mer et echoués sur les côtes espagnoles en 1977 et 1978. *Conseil International pour l'Exploitation de la Mer. C.M.(/N:2).*

Rey, J. C. and Cendero, O. 1982. Les mammifères marins trouvés sur les côtes espagnoles en 1981, *Conseil International pour l'Exploitation de la Mer. C.M. (/N:6).*

Rodrigues, J. 1982. *Oceanographia del mar Mediterráneo*, Ed. Pirámide, Madrid.

Walmsley, T. 1996. Cetacea survey around Gibraltar. P. 130. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

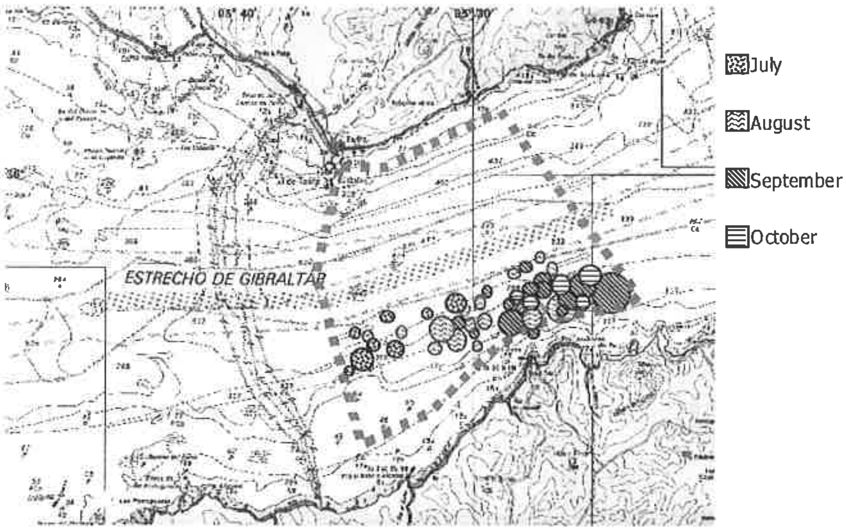

Fig. 1. - Survey area (dotted line) and sightings of pilot whales in monthly order (a clear shift of the used area from West to East)

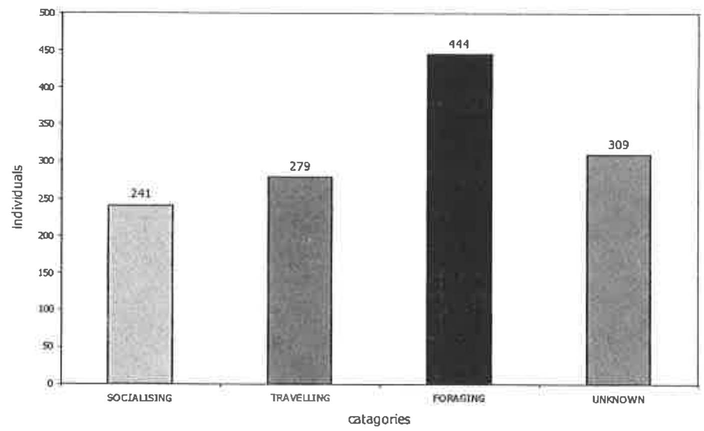

Fig. 2 - The four behavioural categories, in which foraging shows a significant higher rate than in others

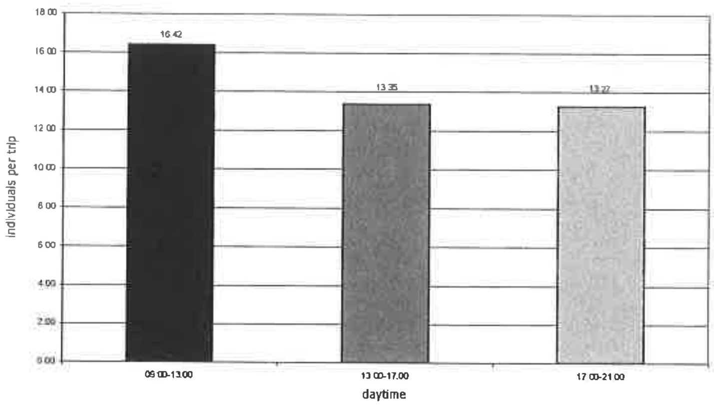

Fig. 3 - General encounter rate is higher in the morning hours while afternoon and evening rates are almost the same.

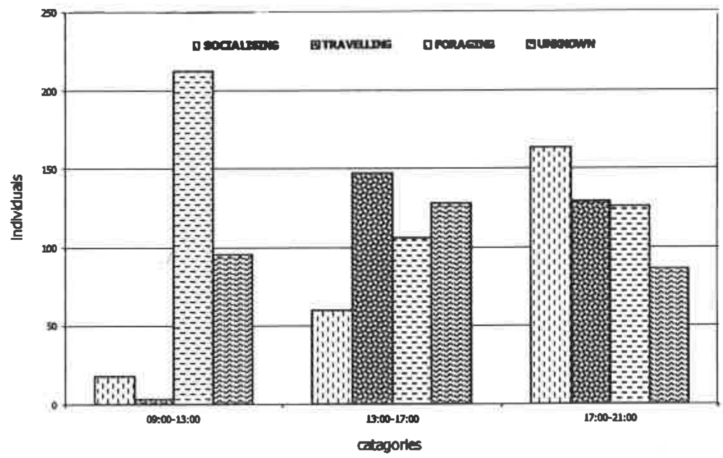

Fig. 4 - The morning time shows significant preference for foraging behaviour while evening hours are prefered for social events (columns: 1. – socialising, 2. travelling, 3. foraging, 4. unknown)

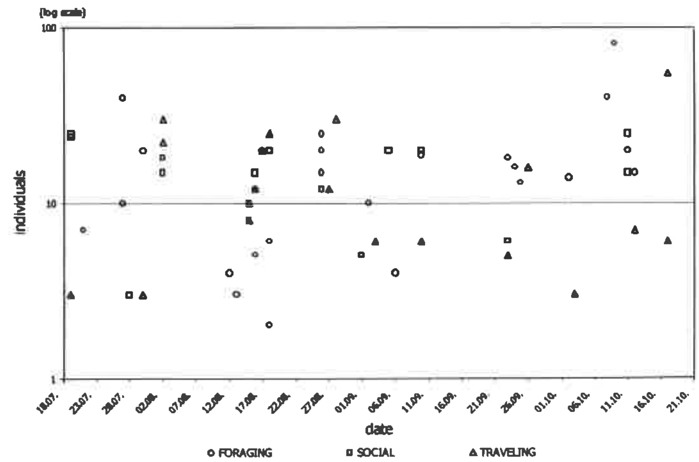

Fig. 5 - The three major behavioural patterns put into a comparative picture to date (y-axis is in a 10-base logarithmic scale)

FIRST RESULS OF SUMMER MOVEMENTS OF *GRAMPUS GRISEUS* (CUVIER, 1812) IN THE NORTH-WESTERN MEDITERRANEAN SEA.

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INTRODUCTION The photo-identification of the Risso's dolphin (*Grampus griseus,* Cuvier 1812) in the Mediterranean Sea is quite recent, and has taken place in only small areas of the Alboran Sea (Cañadas and Sagarminaga, 1996) and the Liguro-Provence region (Bompar, 1997). The observations obtained from this newly applied tool have highlighted the fact that these dolphins return to one particular site from one year to the next, and that their occurrence varies between months in one area.

During four years of study, we regularly followed Risso's dolphins through the vast zone of the north-western Mediterranean Sea. For this purpose, we applied a capture-recapture method by using the technique of photo-identification. This work shows the existence of some regions frequented preferentially by Risso's dolphins, and that during the summer season, their movements are of variable amplitude between different parts of the north occidental basin of the Mediterranean Sea.

MATERIALS AND METHODS Cruises were conducted in summertime (June to September) from 1994 to 1997, in order to study the distribution of cetaceans over an area between the Spanish frontier, to the north-western Sardinia and the Gulf of Genova. During the fieldwork, we also applied photo-identification technbiques to Risso's dolphin.

Photographs were taken with a reflex autofocus camera Canon EOS 100 and a focal length zoom 100-300 mm on colour daylight film Kodak 200 ASA and black and white film Kodak tri-X pan 400 ASA.

The catalogue of photographs obtained lists animals identified from their left and/or right sides. Individuals are identified from the pigmentation of both the whole body and dorsal fin, as well as natural marks and scars.

RESULTS Along 9,176 nautical miles of survey in the north-western Mediterranean Sea, 38 sightings were obtained, among which 14 groups were photographed (Fig. 1). Among these groups, we obtained pictures from 11-100% of the animals seen. By the end, 158 individuals were identified by one side (82 from their right side and 76 from their left), and 26 from both sides, resulting in a total number of 108-184 different animals. Among these, 17 have been resighted once and only one was resighted twice. Thus the "recapture" rate represents 9.2-15.7% of the total number of photo-identified animals.

Intervals of time between the sighting and the re-sighting of an animal ranges from 14 to 742 days, and the distance separating both sightings extends from 2-88.5 nm (Table 1).

Other results from our surveys are that Risso's dolphins were sighted exclusively over the continental slope between Spain and Italy. The encounters were mainly distributed over two regions separated by an area where Risso's dolphins were absent. This absence during summertime in this particular area has already been noted by Beaubrun (1995) and Bompar (1997).

Individuals recaptured within the year: Several movements of great amplitude were noted, some animals (B, E) shifting from the west, near Cap Sicié, to the east near Cap Camarat (44 nm) and Cap d'Antibes (76.8 nm), respectively in 19 and 38 days (Table 1, Fig. 2). Others were sighted first near Cap d'Antibes (A) or even offshore the coast of Corsica (D) and resighted 14 and 28 days later respectively, at the south-west of Cap Camarat. Thus these two animals A and D had moved 30.2 and 57.2 nm away from their first location. Totalling those four observations, we calculated a mean travel speed ranging from 2.02 to 2.32 nm/day.

However, in 1997, none of the resighted individuals was seen far from the first place of sighting. All were encountered twice (F, G, H, I) and even three times (C) in the same area near Cap Sicié; some of them were resighted up to two months later and only 2-7.8 nm distant (Fig.2).

Individuals recaptured from one year to another: Some Risso's dolphins were resighted in the same area from one year to another (J, L on the east of Hyères Islands; and M, N, O on the west of these islands), between the end of August and the end of September (Fig.3). On the contrary, at the same period of time, other individuals did not come back to the same region: K and P were encountered first in 1996 and 1995 respectively in the east of Hyères Islands, and resighted in 1997 in the south-west of Cap Sicié.

DISCUSSION Over the two large areas of its natural distribution, the Risso's dolphin was mainly encountered between the south of Marseilles to Giens, and between the south of Cap Camarat to the Côte d'Azur.

Among the 17 resightings made, 12 were recorded in the area of first identification, seven of those within the same season and five from one year to another. This means that Risso's dolphins tend to return to the same location over seasons or years, thus showing a kind of site fidelity. Such behaviour has been already noted along the coast of the Var region (Bompar, 1997) and in the south of Spain (Cañadas and Sagarminaga, 1996). Risso's dolphins can travel over quite long distances within a short period of time throughout the north-western Mediterranean Sea, particularly between the Gulf of Lions and the Ligurian Sea or even between Corsica and the French continental coasts.

This kind of movement occurs principally from the end of July to September and converge mainly on an area of the south-east of Cap Camarat, where six of seven resightings were made within a year. The groups encountered also showed an overall increase in mean size from June to September (Table 2). Moreover, over the whole study area, the presence of new-borns was more important in August (Table 2). Both findings suggest that the gathering of Risso's dolphins at this period of the year is linked to a reproductive behaviour (Bompar, 1997; Duguy *et al* ,1979; David and Di-Méglio, 1999), especially in the Liguro-Provence area, along the coasts of the Var and Côte d'Azur regions.

Nevertheless, from 1994 to 1996, these concentrations from the end of summer occur offshore of the Cap Camarat, while in 1997, they took place in an area near Cap Sicié (Table 3). The results of the photo-identification reveal that in 1997, Risso's dolphins remained mainly within the same region. Also, some individuals, seen elsewhere during previous years, were resighted near the Cap Sicié in 1997. This reverse situation implies the occurrence of peculiar hydrological conditions for this year. This environmental effect has also been noticed in the behaviour of fin whales (Beaubrun *et al.*, 1999).

CONCLUSIONS In conclusion, two trends in Risso's dolphin behaviour can be highlighted. First, Risso's dolphins travel over distances of variable amplitude within a year. Indeed, throughout the summer the species exploits essentially the continental slope from the north-western Mediterranean Sea. At the end of this season, Risso's dolphins gather in a specific area from the province region to mate and give birth. This area may certainly fulfil special requirements, most probably those related to tropical conditions.

The second fact drawn from our study is that Risso's dolphins change their location from one year to another between different parts of the north-western Mediterranean Sea. Although some individuals come back regularly to one area, they do not seem to be resident or attached to a particular site. These observations could result from either a rapid turn-over of the Risso's dolphin population in the north-western Mediterranean, such as in the case of Monterey Bay (Kruse, 1989). Or, it could be the result of a high level of mixing of Risso's dolphins between different parts of the occidental basin of the Mediterranean.

At the present time, the comparison between catalogues of photo-identification from different Mediterranean countries is in progress. From this collaboration between scientists, we will get a better understanding of Risso's dolphin movements within the occidental Mediterranean Sea.

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REFERENCES

Beaubrun, P. 1995. *Atlas préliminaire de distribution des Cétacés de Méditerranée*. CIESM, Musée océanographique, Monaco, 87 pp.

Bompar, J. M. 1997. *Etude de la population de Dauphins de Risso (Grampus griseus) fréquentant la corne nord ouest du futur Sanctuaire de Mer Ligure*. Rapport G.E.C.E.M./Parc National de Port-Cros. 32 pp + 11pp d'annexes.

Cañadas, A. and Sagarminaga, R. 1996. Preliminary results of photo-identification studies on Risso's dolphin *(Grampus griseus)* undertaken during surveys of cetacean distribution and dynamics along the south-east coast of Spain: 1992-95. p.221-224. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P.G.H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Di-Méglio, N., David, L. and Beaubrun P. 1999. Distribution of *Grampus griseus* in summer in the north-western Mediterranean Sea (this volume).

Duguy, R., Vallon, D. and Guigo, C. 1979. Note sur *Grampus griseus* en Méditerranée occidentale. *Rapp. Comm. int. Mer Médit.*, 25/26(10): 151-152.

Kruse, S. L. 1989. *Aspects of the biology, ecology and behaviour of Risso's dolphin (Grampus griseus) off the Californian coast.* MSc Thesis in Marine Science, University of California, Santa Cruz, June 1989. 120pp.

Table 1 - Data on recaptured animals

Identified individuals	Individuals associated	Year of identification (1)	Year of recapture (2)	No. of days between (1) and (2)	No. of NM between (1) and (2)
A		95	95	14	30.2
B		96	96	19	44.1
C		97	97	21	5.9
D		95	95	28	57.2
E		96	96	38	76.8
C	F	97	97	39	7.8
F	C	97	97	39	7.8
G	H, I	97	97	60	2.0
H	G, I	97	97	60	2.0
I	G, H	97	97	60	2.0
J		94	95	343	34.4
K		96	97	346	88.5
L		95	96	369	34.3
M	N, O	96	97	384	13.9
N	M, O	96	97	384	13.9
O	M, N	96	97	384	13.9
P		95	97	742	61

Table 2 - Group sizes and proportion of newborns between the east and west of Hyères Islands

Continental slope area	1994 - 1997	Number of sightings	Number of individuals	Group size	Number of new-borns	% of new-borns
WEST	June	2	13	6.5	0	0
	July	7	37	5.3	0	0
	August	3	21	7	3	14.3
	September	5	38	7.6	5	13.2
	Total	*17*	*117*	*6.9*	*8*	*6.8*
EAST	June	0	0	0	0	0
	July	6	22	3.7	1	4.5
	August	5	38	7.6	6	15.8
	September	5	58	11.6	2	3.4
	Total	*16*	*133*	*8.3*	*9*	*6.8*

Table 3 - Comparison of relative abundance of Risso's dolphin in different periods between the region situated at the east and west of Hyères Islands

June to September	WEST		EAST	
	NM	nb ind/MN	NM	nb ind/MN
1994 to 1996	1058	0.031	2710	0.048
1997	729	0.066	888	0.002

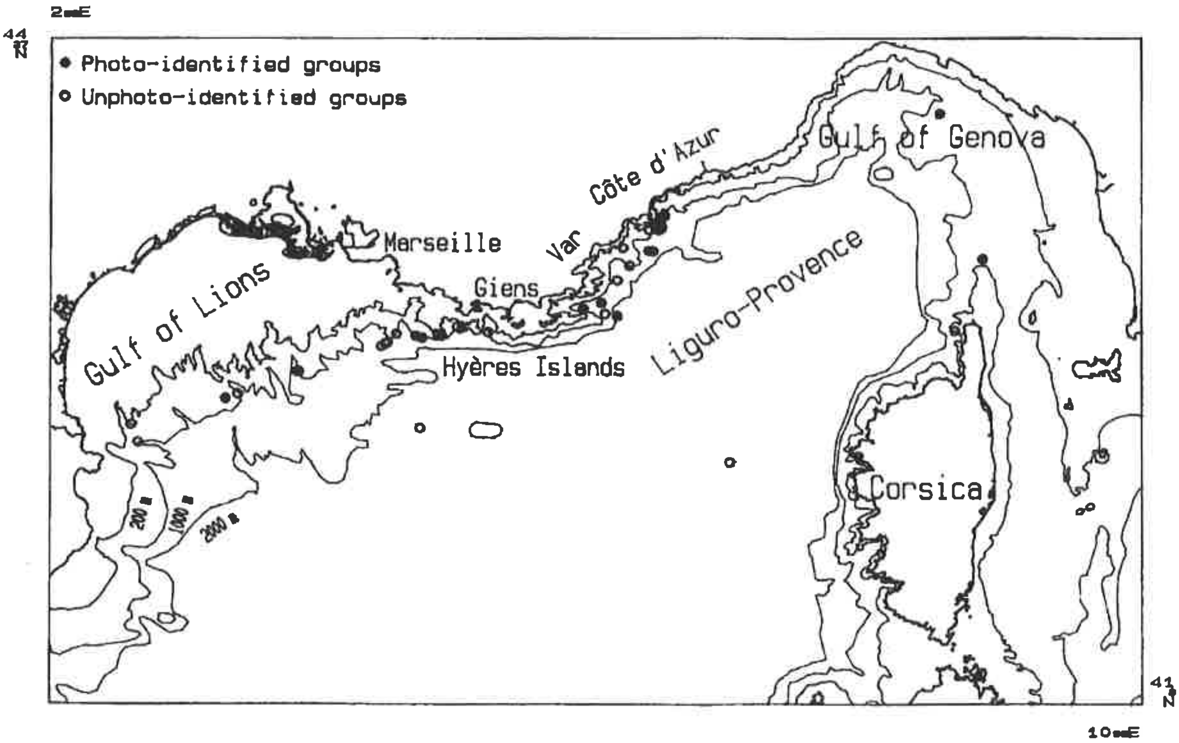

Fig. 1 - Sightings of Risso's dolphin and groups photographed

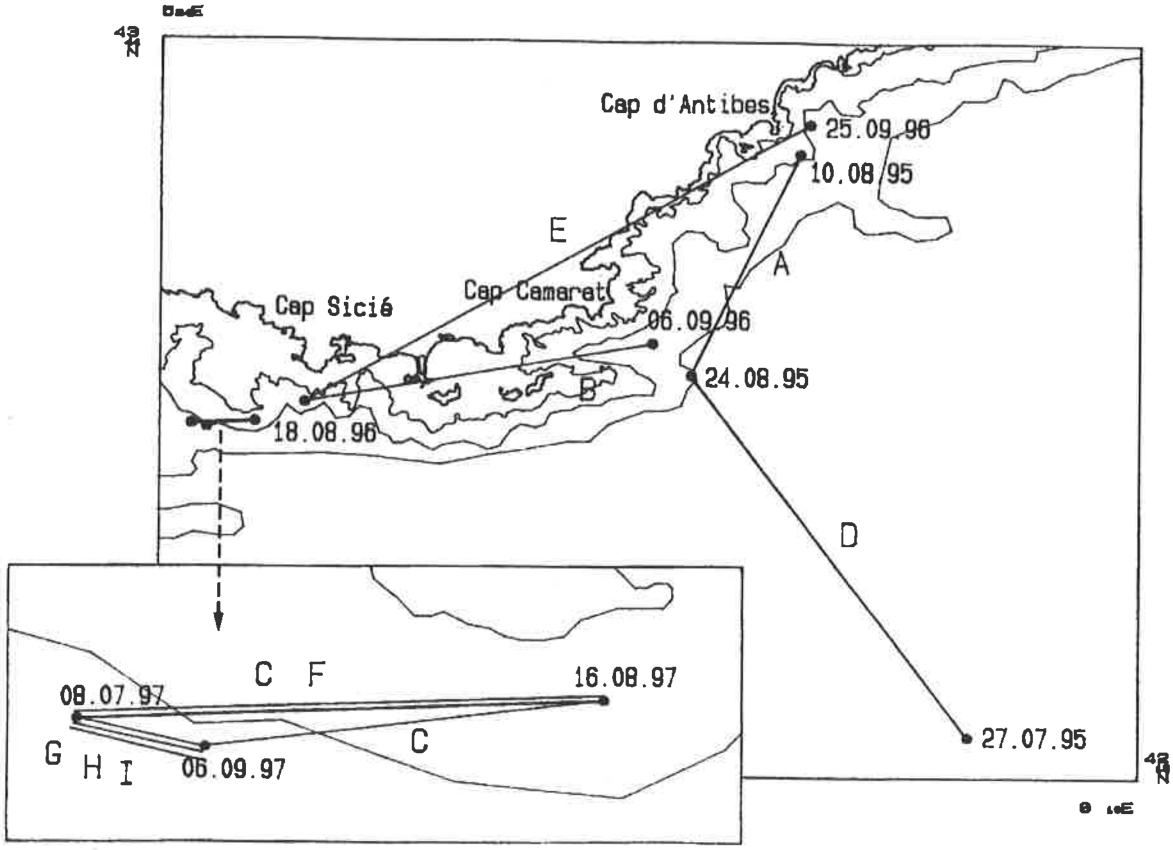

Fig. 2 - Individuals recaptured within the same year (see Table 1 for the letters)

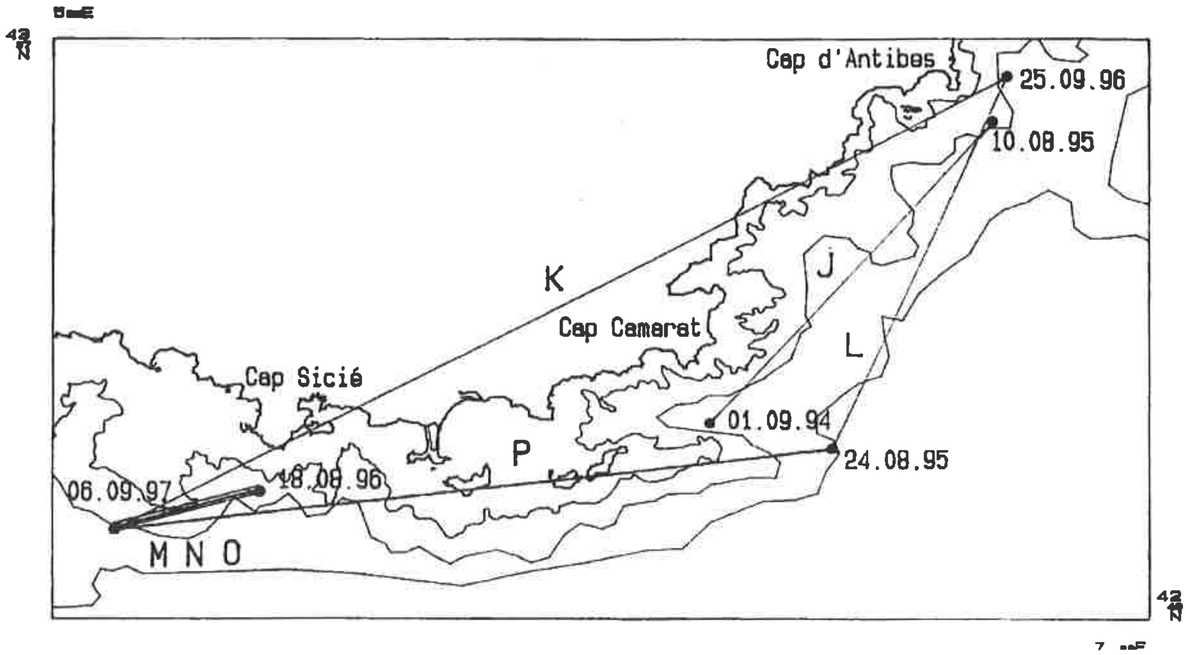

Fig. 3 - Individuals recaptured between years (see Table 1 for the letters)

SPATIO-TEMPORAL DISTRIBUTION OF RISSO'S DOLPHIN *GRAMPUS GRISEUS* (CUVIER, 1812) IN SUMMER IN THE NORTH-WESTERN MEDITERRANEAN SEA

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INTRODUCTION Since 1991, the "Ecole Pratique des Hautes Etudes" (EPHE) has led research projects in the north-western Mediterranean Sea to study the distribution of cetaceans. During those studies, we sighted regularly Risso's dolphin (*Grampus griseus* [Cuvier, 1812]), a species known to frequent this part of the Mediterranean all the year round (Beaubrun, 1995). In this paper we will analyse the spatio-temporal dispersal of Risso's dolphins during the summer months to highlight the existence of variations in the occurrence of this species.

MATERIALS AND METHODS This work is based on data gathered from 1991 to 1997, between the months of June and September, over an area between the Spanish frontier to north-western Sardinia and the Gulf of Genova. It includes campaigns of fieldwork by boat or hydroplane (Table 1, Fig. 1). We applied the line transect method aboard boats and the strip transect method aboard the hydroplane (cf. Buckland 1993). In order to analyse how Risso's dolphins are distributed in accordance with the bathymetry of the north western Mediterranean Sea, we take into account all the sightings collected, regardless of the meteorological conditions. In order to test the influence of the steepness of the continental slope on the location of Risso's dolphins, we defined four areas (Fig. 2): Area 1 (Gulf of Lions) and 3 (Gulf of Genova) are characterised by a smooth slope and a continental slope spreading over 30 to 40 nm offshore; Area 2 (Liguro-Provence) and 4 (Corsica) present a steep and narrow continental slope.

To calculate relative abundances of Risso's dolphins, we used only those transects conducted in the same conditions. These transects took place aboard sailboats in a sea state of 3 or less on the Beaufort scale, with a constant speed of about 5.5 to 7 knots and with three permanent observers. Finally, when the animals sighted were more than 0.5 nm away from the boat, we recalculated their true geographical position and depth on a 1/250 000 scaled map.

RESULTS During the surveys, 49 sightings of Risso's dolphin were made, 46 of which were over ocean floor depths between 400 and 2,000 m., three beyond 2,000 m. and none over depth less than 200 m. Thus Risso's dolphins are distributed mainly over the continental slope at the mean depth of 1,045.1 m. (SD = 562.8 m., n = 49). This value is quite similar to those found in the literature for different parts of the Mediterranean Sea. Indeed, Gannier (1998) found a bathymetric affinity of 66% for the 500-1,000 m. depth stratum. Also, Lauriano and Notarbartolo di Sciara (1995) gave a mean depth of about 1,100 m for north-western Sardinia.

Moreover, a comparison between steep and smooth slope of the mean depth and median of the sightings of Risso's dolphin shows no significant difference (Table 2). However, the median and mode of the individuals diverge, more animals frequenting the upper part of the continental slope when it is smooth, whereas Risso's dolphins tend to stay at greater depths over a steep slope. Nevertheless, this result needs to be confirmed by more sightings in order to be sure whether this phenomenon is constant or influenced by the period of the day or the season.

In conclusion, the distribution of the sightings of Risso's dolphin are rather dependent on the depth, regardless of the steepness of the slope.

We also wanted to determine monthly variation in relative abundance over the whole area first, and then within the four zones. During the summer, Risso's dolphins were seen only in July in areas 3 and 4, whereas they were regularly encountered in areas 1 and 2 (Fig.3).

During June and July, in area 1, abundances were more than three times those found in area 2, whereas it was the reverse in August with values 7.4 times less than in area 2 (Fig.3). The same trend can be seen in the number of sightings with a ratio of 2 in June and July and 6.5 in August (Fig.4).

On the other hand, in September the abundance of individuals in area 2 were three times higher than those in area 1, while the abundance of sightings was almost similar in both areas. This means that Risso's dolphins tend to gather in bigger groups in area 2 in September. Indeed, in this last region, the mean size of the groups rises from June (6) to September (11.5), whereas in area 1 it stays constant (around 7) through August before dropping in September to 4.7 (Table 3).

DISCUSSION Thus, during summer time, the regions of Corsica and Gulf of Genova are visited weekly by the Risso's dolphin. Nevertheless, it is quite certain that the small number of sightings made in area 3 is due to a lack of survey effort there (160 nm), since this species is regularly encountered near the Capo Noli (Podesta *et al.*, 1997). On the contrary, the low abundance noted in the region of Corsica, despite an important survey of about 1,057 nm, agrees with the results of different studies conducted around Corsica. Indeed, Dintheer (1982) and Terris and Viale (1995) mentioned only few sightings of Risso's dolphin during their summer surveys in the Corsica region.

On the other hand, the Gulf of Lions and the Liguro-Provence regions are regularly visited throughout the summer, but with monthly variations well marked in both regions. Risso's dolphins appear more numerous in the Gulf of Lions from June onwards and reach a maximum in July. On the contrary, in the Liguro-Provence region, numbers of Risso's dolphin are highest in August, while they are at their lowest in other areas during this month. This could imply that at least a portion of this Risso's dolphin population converges on area 2 at this period. This hypothesis can be supported by the results from the "Capture-Recapture" study of photo-identified individuals of Risso's dolphin (David and Di-Méglio, 1999). Indeed, one individual was sighted first in July in the Corsica region and "recaptured" in August in the Liguro-Provence region. This kind of movement, at this period of the year, could be linked with some peculiar trophic conditions in the Liguro-Provence region. However, through lack of study, this relationship needs to be more precisely demonstrated.

Moreover, during September, some Risso's dolphins move back to the Gulf of Lions. During this month, we made 75% of our sightings in the east part of the Gulf whilst Risso's dolphins gathered in bigger groups in the Liguro-Provence region. This gathering is certainly due to social behaviours associated with reproduction, as already noted by different studies (Bompar 1997; Duguy *et al.*, 1979; David and Di-Méglio 1999).

CONCLUSION During summer, Risso's dolphins frequent the whole north-western Mediterranean Sea, especially the continental coasts, regardless of the steepness of the slope. As evidenced by the monthly abundance estimates, the Liguro-Provence region becomes important for this species at the end of the summer for reproduction, and probably for trophic reasons also. These results require confirmation with more detailed study. Due to the particular interest of the Liguro-provence region from August to September, it would be worthwhile to pay special attention to it in terms of study and protection.

ACKNOWLEDGEMENTS We wish to thank the "Centre Océanologique Européen" (Monaco), Prince Khaled Bin Sultan Bin Abdulaziz (Saudi Arabia), and I.C.S.E.M. (Monaco) for their very considerable help; IFREMER for giving us the opportunity to participate in their campaigns; the G.R.E.C. for his collaboration; and the French Ministry of Environment for financial support.

REFERENCES

Beaubrun, P. 1995. *Atlas préliminaire de distribution des Cétacés de Méditerranée.* CIESM, Musée océanographique, Monaco. 87 pp.

Bompar, J. M. 1997. *Etude de la population de Dauphins de Risso (Grampus griseus) fréquentant la corne nord ouest du futur Sanctuaire de Mer Ligure.* Rapport G.E.C.E.M./Parc National de Port-Cros, 32 pp + 11pp d'annexes.

Buckland, S. T., Anderson, D. R., Burnham, K. P. and Laake, J. L. 1993. *Distance sampling estimating abundance of biological populations.* Chapman et Hall Ed., London. 446 pp.

David, L. and Di-Méglio, N., 1999. First results of summer movements of *Grampus griseus* in the north-western Mediterranean sea (this volume).

Dintheer, C., 1982. Distribution des grands pélagiques autour de la Corse: campagne de prospections aériennes, 1980. *Science et Pêche, Bull. Inst. Pêches Marit.*, 322: 1-14.

Duguy, R., Vallon, D. and Guigo, C. 1979. Note sur *Grampus griseus* en Méditerranée occidentale. *Rapp. Comm. int. Mer Médit.*, 25/26, 10: 151-152.

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

Lauriano, G. and Notarbartolo di Sciara, G. 1995. The distribution of Cetaceans off northwestern Sardinia. Pp.104-106. In: *European Research on Cetaceans - 9.* Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Podesta, M., Magnaghi, L. and Gorlier, G. G. 1997. Sightings of Risso's dolphin in the Ligurian waters. Pp. 167-169. In: *European Research on Cetaceans - 11.* Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Terris, N. and Viale, D. 1995. Recensement des populations de cétacés autour de la Corse. *Rapp. Comm. int. Mer Médit.*, 34: 258.

Table 1 - Effort and characteristics of our different campaigns at sea

	PLATE-FORM	PERIOD	NM
- - - - - - - - -	Hydroplane	July 1996	1540
....	Oceanographic ship from IFREMER	July / August / September 1991 to 1997	4258
———	Sailboat EPHE (*)	June to September 1994 to 1997	9176

(*) Only these transects were hold to calculate relative abundances

Table 2 - Distribution of Risso's dolphins over depth strata from 200 to 2,000 m., according to two types of slope

	SMOOTH SLOPE	STEEP SLOPE
Mean (sightings)	931.0 m	958.5 m
Standard deviation	384.5 m	441.0 m
min	500 m	400 m
max	1898 m	2000 m
Median (sightings)	] 800-900]	] 800-900]
Median (individuals)	] 500-600]	] 900-1000]
Mode (sightings)	] 500-600]	(4 distinct modes)
Mode (individuals)	] 500-600]	] 900-1000]
Total (sightings)	22	24
Total (individuals)	241	182

Table 3 - Monthly variation of mean group sizes of Risso's dolphin in areas 1 and 2

	JUNE	JULY	AUGUST	SEPTEMBER
AREA 1	7	6.9	7	4.7
AREA 2	6	4	8.1	11.5

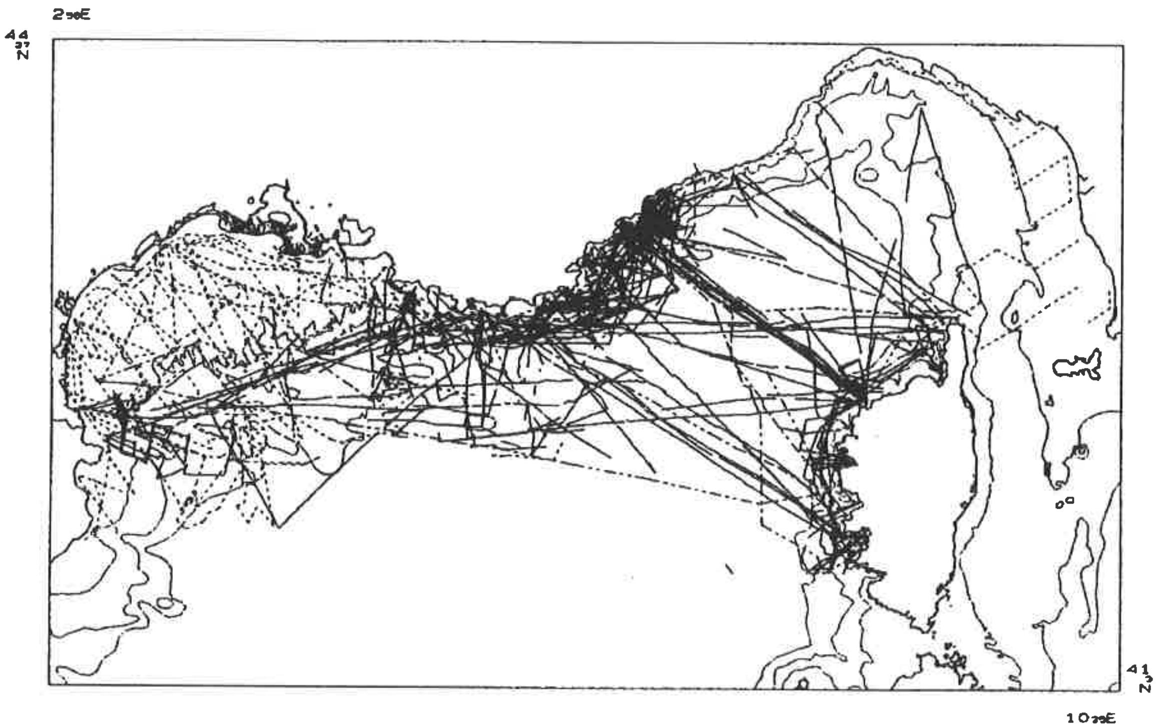

Fig. 1 - Surveys between 1991 to 1997 (see Table 1 for legend)

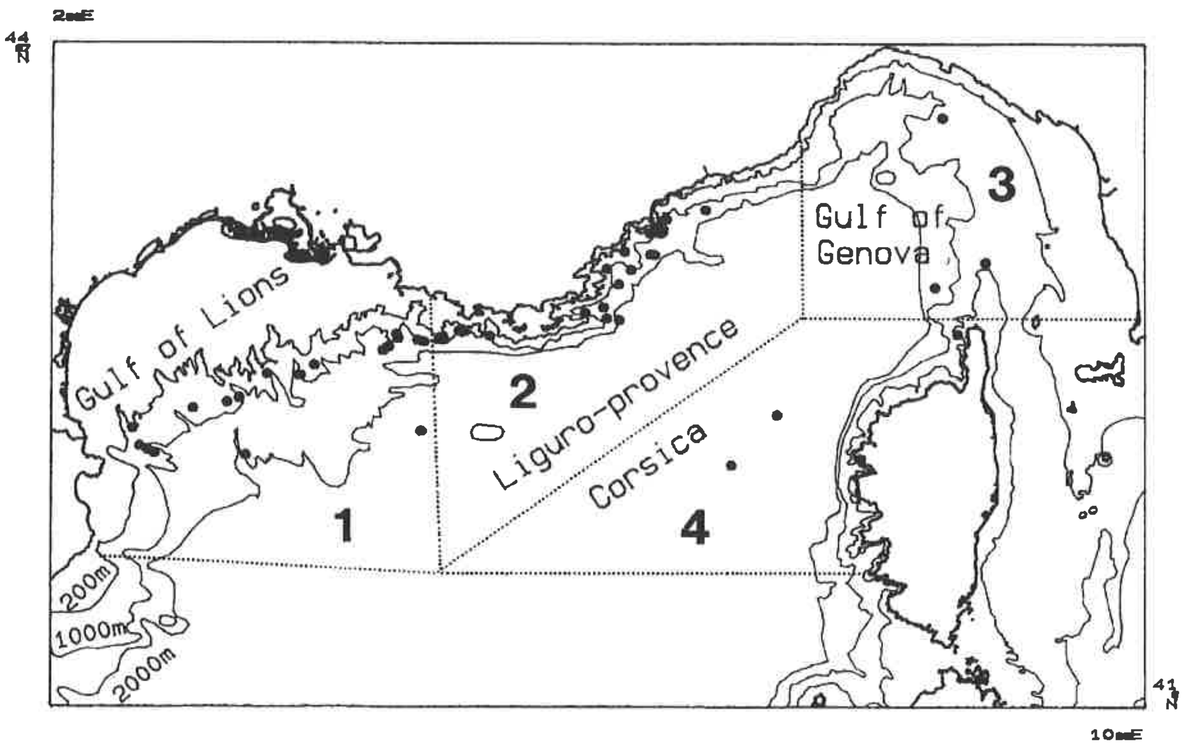

Fig. 2 - Distribution of sightings of Risso's dolphin and limits of the four areas

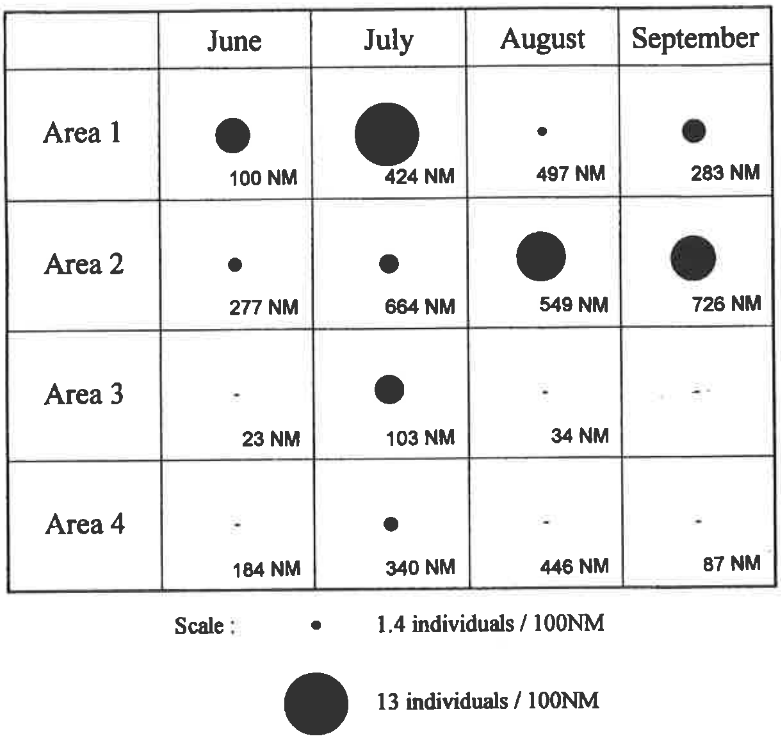

Fig. 3 - Monthly abundance of individuals of Risso's dolphin within four areas

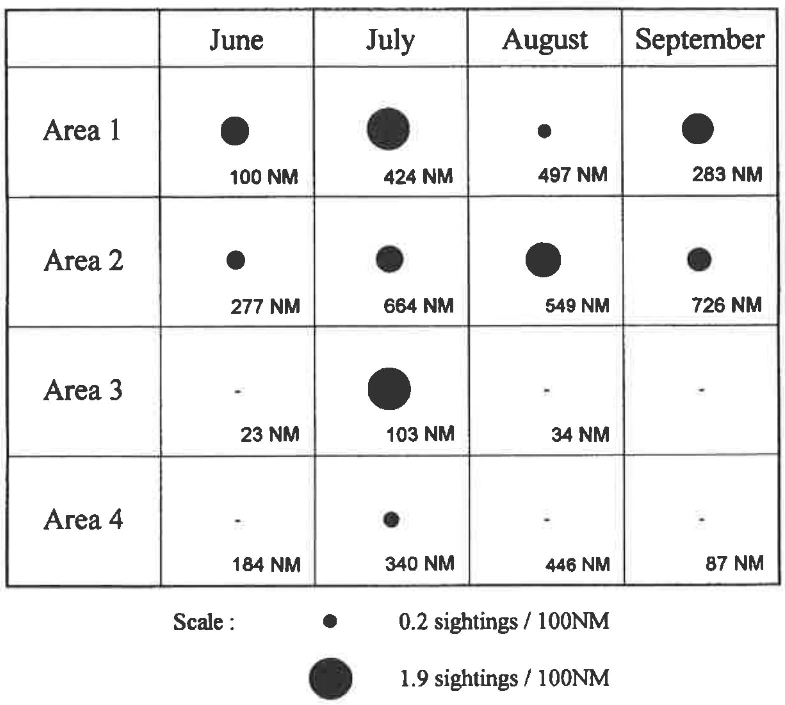

Fig. 4 - Monthly abundance of sightings of Risso's dolphin within four areas

RECORD OF STRANDED CETACEANS ON THE ANDALUSIAN COAST (SOUTHERN IBERIAN PENINSULA), CEUTA AND MELILLA (NORTHERN AFRICA) DURING THE PERIOD 1996-1998

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INTRODUCTION The Andalusian coast is located in the southern Iberian Peninsula and extends over 871.7 km. Part of the Andalusian coast is on the Atlantic Ocean, another part on the Mediterranean Sea, and between those there is a mixture of both sorts of waters called the Alboran Sea (see Maps 1 and 2), which also covers the Spanish provinces of Ceuta and Melilla, located in northern Africa. The analysis of stranded records is helpful to determine trends in the distribution and abundance of cetaceans in adjacent waters and to obtain information about them without having to resort to their capture. The Centre for the Recuperation of Endangered Marine Species (C.R.E.M.A.) of Andalucía has been recording and studying the cetaceans stranded along the Andalusian coastline, Ceuta and Melilla, since 1995. The data for the period 1996-98 are presented here.

METHODS Cetacean strandings on Andalusian coasts, Ceuta and Melilla, have been recorded by C.R.E.M.A., helped by the existence of an organised stranding network of volunteers and collaborators who belong to all the coastal Andalusian provinces. Data regarding date, location, taxonomic identification, sex, morphological measurements, external signs and possible cause of stranding is recorded. Whenever possible, detailed necropsies are performed and biological samples are taken by C.R.E.M.A. for analysis (osteologic material and tissues samples to study toxicology, stomach contents, external and internal parasites, etc.). The inspections are supported by video and photographic material. The records are inputted in a database.

RESULTS During the period 1996-98, 306 strandings have been reported on the Andalusian coast, Ceuta and Melilla, with 11 cases of Mysticeti and 295 cases of Odontoceti. 70 strandings were recorded in 1996, 93 in 1997 and 143 in 1998. The stranded specimens belong to 13 different species: 26 bottlenose dolphins (*Tursiops truncatus*), 39 striped dolphins (*Stenella coeruleoalba*), 145 common dolphins (*Delphinus delphis*), 6 Risso's dolphins (*Grampus griseus*), 8 long-finned pilot whales (*Globicephala melas*), 2 killer whales (*Orcinus orca*), 3 harbour porpoise (*Phocoena phocoena*), 1 sperm whale (*Physeter macrocephalus*), 2 dwarf sperm whales (*Kogia simus*), 7 Cuvier's beaked whales (*Ziphius cavirostris*), 5 minke whales (*Balaenoptera acutorostrata*), 5 fin whales (*Balaenoptera physalus*) and 1 humpback whale (*Megaptera novaengliae*). Data about percentages of the stranded species are shown in Figure 1. 56 animals were not identified to species due to the poor condition of the animals, but all of them were small odontocetes. All recorded strandings were of single animals, with the exception of two specimens of *S. coeruleoalba*, which were stranded together and alive. There were 21 live strandings (6.9% of the stranded animals). The rest, 93.1%, were found dead and in different categories of preservation: very fresh (20.3%), fresh (19%), decomposing (17.3%), putrescent (20.3%) and only skeletal remains (3.3%). The rest 13.3% of the strandings had no data.

The **Temporal distribution** of strandings is shown in Figure 2.

The **Spatial distribution** of the strandings of the recorded species is shown in Table 1. Figure 3 shows the most frequent small odontocete species stranded on Andalusian coast, which has been arbitrarily divided into three areas: the Atlantic area (Portugal border to Barbate), the Gibraltar Strait and surrounding area (Barbate to Guadiaro River, including Ceuta) and the Mediterranean area (Guadiaro River to Murcia limit, including Melilla).

CONCLUSIONS The data suggest the following conclusions:

The number of reported strandings has increased from 1996 to 1998, which is thought to be mainly due to increased collaboration and notification to C.R.E.M.A. resulting from the public awareness campaign that this organisation has carried out along the Andalusian coastal locations.

There were no significant differences between sexes. The degree of preservation of the stranded animals did not show significant differences either. Only *D. delphis* had a major percentage of very fresh and fresh animals, which is considered to be due to the coastal habits of this species in the area.

Although animals were found all year round, the strandings tend to show a seasonal pattern with two annual peaks: one during the winter months and another during the summer months.

The most frequent stranding points were located in the area between the Gibraltar Strait and the province of Málaga (Alboran Sea). It may be that more strandings were registered at these points because C.R.E.M.A. is better known in these locations, and, thus, there is more collaboration in the notification of strandings. In addition, other natural factors such as currents, winds, etc., should be considered as influential causes of strandings in these areas.

Common dolphin was the most frequent stranded species, representing 47.4 % of the strandings. 90.3% of these animals were found in the Mediterranean area of the Andalusian coast. These data suggest that there is an important population of this species in the Alboran Sea. These are significant data for further studies, considering the clear decline of the species in the Mediterranean Sea during the last few years (Silvani, 1992). Cabo de Palos seems to be at the actual northern limit for this species (Sagarminaga and Cañadas, 1995), sightings of common dolphins being very scarce north from Cabo de Palos (Duguy *et al*, 1983; Evans, 1987). Common dolphin is considered as very endangered in the Mediterranean Sea (D.G. Conservación de la Naturaleza, Ministerio de Medio Ambiente, 1997). 11.7% of stranded common dolphin were less than 120 cm length, 37.2% were between 120 and 180 cm, and 40,7% were more than 180 cm. Size was not measured in the other 10.3% of the animals.

The second most common stranded species was striped dolphin (12,7% of strandings). 92.3% of the strandings was on Mediterranean coasts. This species is considered as vulnerable in the Mediterranean Sea (D.G. Conservación de la Naturaleza, MIMAM, 1997). 12.8% of stranded striped dolphin were less than 120 cm long, 35.9% between 120 and 180 cm, 38.5% were more than 180 cm. Size was not measured in the remaining 12.8% of the animals.

The most frequent stranding of small odontocete species in the Atlantic area was bottlenose dolphin (48,5%), followed by common dolphin (36,4%) and striped dolphin (9,1%). Common dolphin was the species that was most frequently stranded in the Strait area and the Mediterranean area (35.7% and 62.1%, respectively), followed by striped dolphin (21.4% and 13.7%, respectively) and bottlenose dolphin (14.3% and 2.1%, respectively).

Some special cases were recorded such as: a newborn minke whale (a female, 300cm long), which swam into Algeciras port for a few hours and had been seen in La Herradura (Granada) a week before. It was assisted back to the sea, and 15 days later was found dead on shore in a location not far from the first one; a pregnant female common dolphin with a 94 cm foetus inside her, appeared in May; one long-finned pilot whale calf (a male, 204 cm long), which appeared alive and was reintroduced to the sea three miles off the coast, with a group of the same species; two newborn Risso's dolphins (172 and 171 cm.), which died hours later; seven Cuvier's beaked whales, two of them stranded alive; two killer whales; and one sperm whale.

The cause of stranding could only be determined in some cases. Some of the causes found in small odontocete strandings are: severe pathologies associated with parasitic infestations, where a toxic component may exist and induce immunosuppression states; respiratory processes of bacterial etiology; although they are mainly opportunistic pathogens, non-diagnosed viral processes have not been rejected; animals of an advanced age, with multiple afflictions, commonly renal failure; and, of course, interaction with fishing gears which constitute between 15-25% of the observations, depending on the year. Other unusual causes included plastics in the digestive system, traumatism caused by boats, shark attacks on living cetaceans, or shooting impacts.

ACKNOWLEDGEMENTS We would like to thank all the volunteers and collaborators of C.R.E.M.A. Without them these studies would not have been possible. Thanks go also to the members of the Guardia Civil, Local Police, Environmental Agencies, etc., who support and help us along the entire Andalusian coast.

REFERENCES

Dirección General de Conservación de la Naturaleza. Ministerio de Medio Ambiente Español. *Inventario Nacional de Cetáceos.* 1997.

Duguy, R., Casinos, A., Di Natale, A., Filella, S., Ktari-Chakroun, F., Lloze, R., and Marchessaux, D., 1983. Repartition et fréquence des mammiferes marins en Mediterranée. *Rapp. Comm. Int. Mer Medit*, 25(5): 223-230.

Evans, P. G. H. 1987. *The Natural History of Whales and Dolphins.* Christopher Helm Mammal Series. London. 343pp.

Sagarminaga, R. and Cañadas, A. 1995. Studying a possible competition between the common dolphin, *Delphinus delphis* and striped dolphin, *Stenella coeruleoalba*, along the southeastern coast of Spain. In: *European Research on Cetaceans - 9.* Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Silvani, L. 1992. *Actividad pesquera en el litoral mediterráneo andaluz. Problemas de interacción con cetáceos.* Unpubl. Report, Greenpeace, Italy.

Table 1 - Spatial distribution of cetacean strandings on Andalusian provinces, Ceuta and Melilla

PROV.	Ttr	Sco	Dde	Ggr	Gme	Oor	Pph	Pma	Ksi	Zca	Bac	Bph	Mno	NI0	TOTAL
Huelva	14	1	9	-	1	1	3	-	2	-	-	1	1	1	34
Cádiz	7	11	15	1	2	1	-	-	-	1	3	-	-	3	44
Málaga	2	20	101	3	3	-	-	1	-	6	1	1	-	28	166
Granada	1	2	9	-	-	-	-	-	-	-	-	-	-	6	18
Almería	1	4	6	2	2	-	-	-	-	-	-	2	-	8	25
Ceuta	1	1	3	-	-	-	-	-	-	-	1	-	-	10	16
Melilla	-	-	2	-	-	-	-	-	-	-	-	1	-	-	3
TOTAL	26	39	145	6	8	2	3	1	2	7	5	5	1	56	306

Tr=*Tursiops truncatus*, Sco=*Stenella coeruleoalba*, *Dde=Delphinus delphis*, Ggr= *Grampus griseus*, Gme=*Globicephala melas*, Oor=*Orcinus orca*, *Pph=Phocoena phocoena*, Pma=*Physeter macrocephalus*, Ksi=*Kogia simus*, Zca=*Ziphius cavirostris*, Bac=*Balaenoptera acutorostrata*, Bph=*Balaenoptera physalus*, Mno=*Megaptera novaengliae* and NIO= non identified odontoceti.

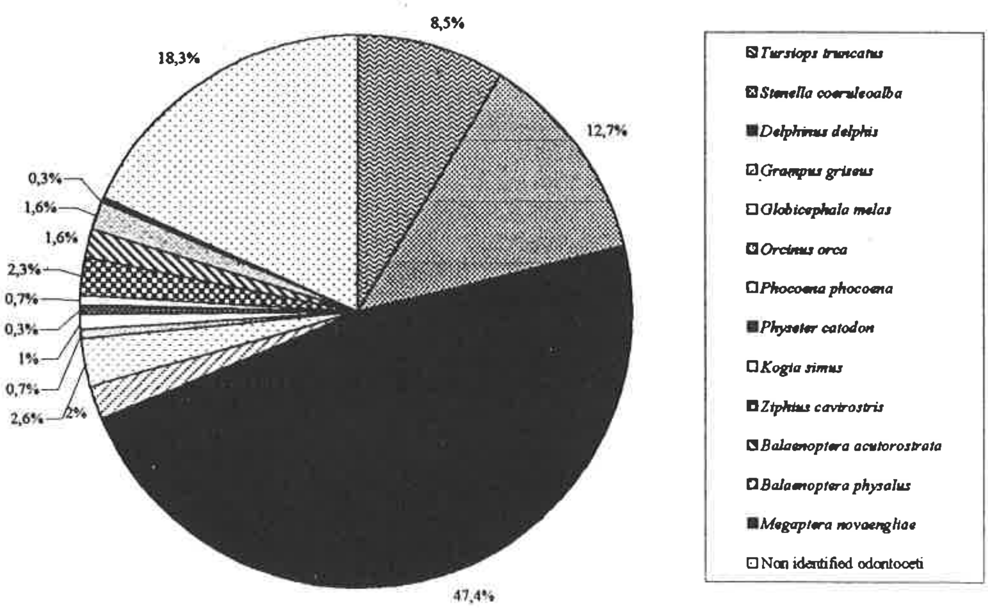

Fig. 1 - Percentage on stranded cetacean species on Andalusian coast, Ceuta and Melilla

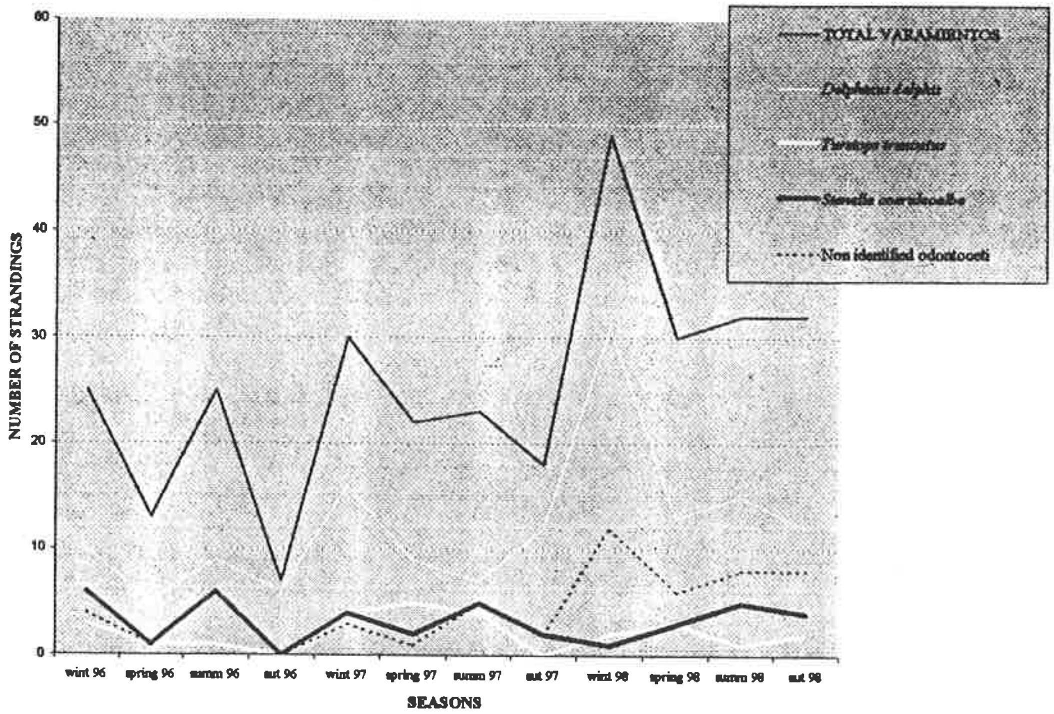

Fig. 2 - Temporal distribution of strandings on the Andalusian coast, Ceuta and Melilla

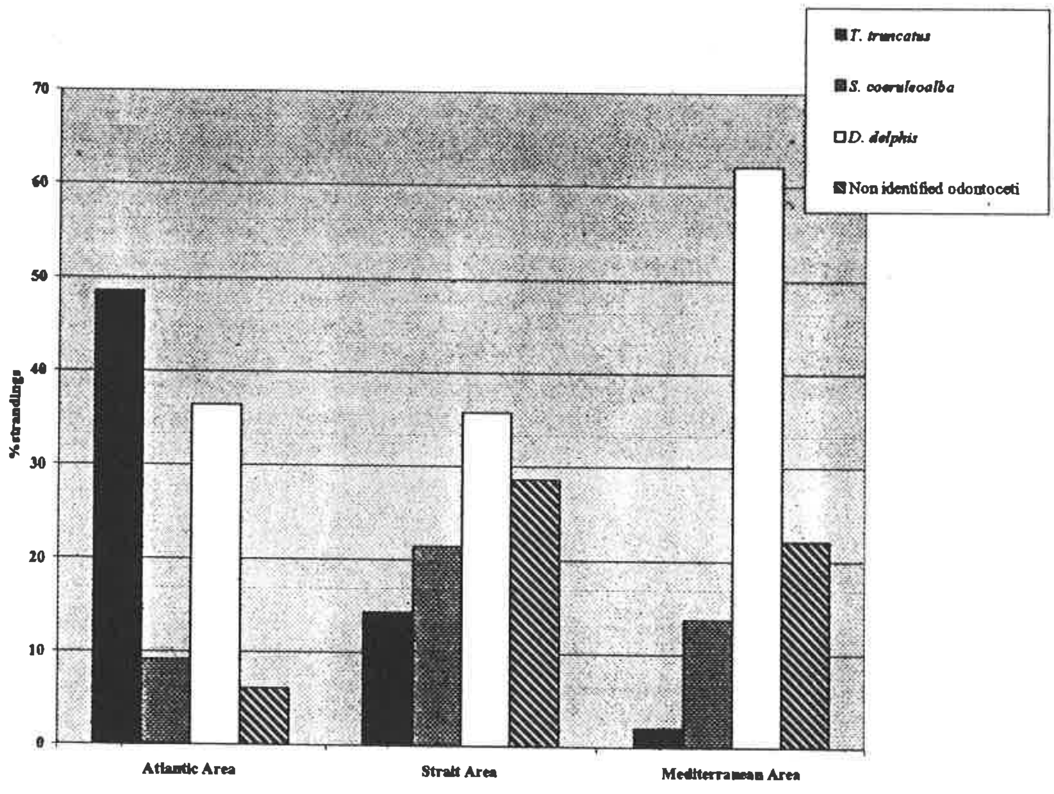

Fig. 3 - Percentages of small odontoceti strandings on the Atlantic area, Gibraltar Strait area and Mediterranean area of the Andalusian coast

KILLER WHALES (*ORCINUS ORCA*) IN SHETLAND WATERS

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INTRODUCTION The resident killer whale (*Orcinus orca*) pods off the Norwegian, Icelandic and Faroese coasts have been well documented with established photographic identification catalogues and studies on their movements and diet. The Shetland Islands (60°N, 1-2°W) are situated in the northern North Sea, and are frequented by many species of cetacean. Until recently, killer whales were fairly uncommon in Shetland. The increase in sightings may well reflect an expansion in the range of North Atlantic killer whales, relating to changes in the distribution and migration routes of fish stocks, due to climatic changes affecting the marine environment (North Atlantic Drift), or changes in the habits and prey of pods.

During June/July, killer whales are seen offshore by local fishing vessels, with aggregations of pods, 50-100+ animals, 60-90 km north west of Shetland. The home range of these pods are not known. However, small calves have been noted in pods visiting Shetland waters, suggesting that mating outwith family groups may occur in these aggregations. Pods which are sighted in Shetland are of stable family groups, moving inshore to feed co-operatively on shoaling fish and seals.

RESULTS **Sightings:** Since 1989, there have been 288 reported sightings of killer whales inshore around Shetland. As can be seen from Figure 1, most sightings are in areas of Sumburgh Head, Yell and Bluemull Sounds. These areas are regularly observed by members of the public, with inter-island ferries crossing Yell and Bluemull Sounds on a regular basis. These three areas are also characterised by strong tidal streams.

Movements: Pods appear to be transient in nature, rarely spending more than a day in each area of coastline. Pods appear to arrive in coastal waters from the north, passing through the Sounds in the North Isles, following the east coast, passing Noss, Mousa Sound and Sumburgh Head. Sightings from the outlying islands of Foula and Fair Isle, suggest that some pods do have a wide range. It is possible that pods sighted in Orkney may be the same as those visiting Shetland. There has been a similar increase in sightings around Orkney (1996-97) with similar pod sizes noted, although insufficient data are available to compare records.

Observations: Trends in Sightings There has been an increase in the number of records since systematic recording began in 1989 (Figure 2) which reflect an increase in the number of pods visiting and returning to Shetland. The increase in pods in recent years may be due to any number of reasons, for example, changes in the distribution and or abundance of prey or changes in movements of killer whales from offshore to inshore in summer.

Peaks in sightings occurred in the first two weeks of June and July in most years since recording began. This may reflect pods returning to feeding sites, or inshore movement of killer whales from different aggregations in the North Atlantic.

Seasonal Trends: Killer whales have been sighted inshore in all months except February (one dead stranding only) and October, with most records in the summer months peaking in June (99 records, 34%, Figure 3). The increase in reported sightings during summer months was found to be highly significant (Kruskal-Wallis test, $H = 60.90$, $d.f. = 11$, $P<0.0001$). A clear seasonal trend in sightings was evident; that is, increasing throughout the spring, reaching a peak in June and July, and least common in winter (Figure 3).

Pod Size: Killer whale pods were reported to range from one to 12 animals. Of 270 killer whales pods classified to size, the majority of these (n= 132) were between four to six, with pods numbering three or less also common (Figure 4). Variation in pod size in relation to month of year was found to be significant (1-way ANOVA, $F_{9,269} = 4.99$, $P < 0.001$), with pod size generally highest in the summer and lowest in the winter.

Diet: The Shetland harbour seal (*Phoca vitulina*) population has increased to c. 6,000 since the introduction of protective legislation in the 1970's and grey seal (*Halichoerus grypus*) numbers have remained relatively constant at c. 3,500 since the 1970's. Both species are hunted by killer whales in Shetland (and Orkney) at their haul out sites, one pod reported taking as many as four seals during a single feeding episode. Seal colonies are located throughout Shetland.

Records suggest that killer whales return to seal haul-out sites, some pods visiting Mousa and Sumburgh Head more than once during a summer. Seals are apparently taken in the water, with none reported taken directly from rocks or beaches, possibly because of few areas where killer whales can approach without detection from seals.

Killer whales also feed on shoals of mackerel (*Scomber scombrus*) found inshore, occasionally close to line-fishing boats (particularly off Vaila, west Shetland). There has been no detailed study of their diet, with all observations from fishing boats or land. There are no confirmed records of killer whales hunting harbour porpoise (*Phocoena phocoena*), which are common during the summer months; however, this prey is likely to be taken on an opportunistic basis. A juvenile minke whale (*Balaenoptera acutorostrata*) was chased into Levenwick Bay in July 1997 by a pod, though unconfirmed by further sightings of the pod.

Strandings: Since 1940, there have been ten reported incidences of strandings of killer whales around Shetland. All the strandings have involved single individuals, except the mass stranding at Uyeasound (Unst) which involved 11 animals, several of which were successfully refloated. Where data are available on these strandings, it appears that all animals have been males, ranging from juveniles to adults.

The male which live-stranded at Catfirth (16.11.94) was later examined by vets from the Scottish Agricultural College, as part of the Scottish Strandings Scheme, and was found to have died as the result of ingesting a small hook, which had caused toxic peritonitis.

CONCLUSIONS The numbers of killer whales sighted in Shetland waters have increased over the last ten years, with sightings peaking during the summer months. Pod sizes appear to be larger in summer than winter.

Regular predation of grey and harbour seals around the coastline has been reported.

Observations on well marked individuals suggests that the same killer whales are returning to Shetland each year.

There is currently no evidence that human activities are detrimental to killer whales visiting Shetland waters. Whale watching is increasing in importance to the local tourism industry and killer whales may be seen as a flagship species to promote marine nature conservation.

ACKNOWLEDGEMENTS This project has been supported by Greenpeace Environmental Trust, Shetland Wildlife Fund, Shetland Sea Mammal Group, Shetland Islands Tourism, Shetland Enterprise, and Scottish Natural Heritage.

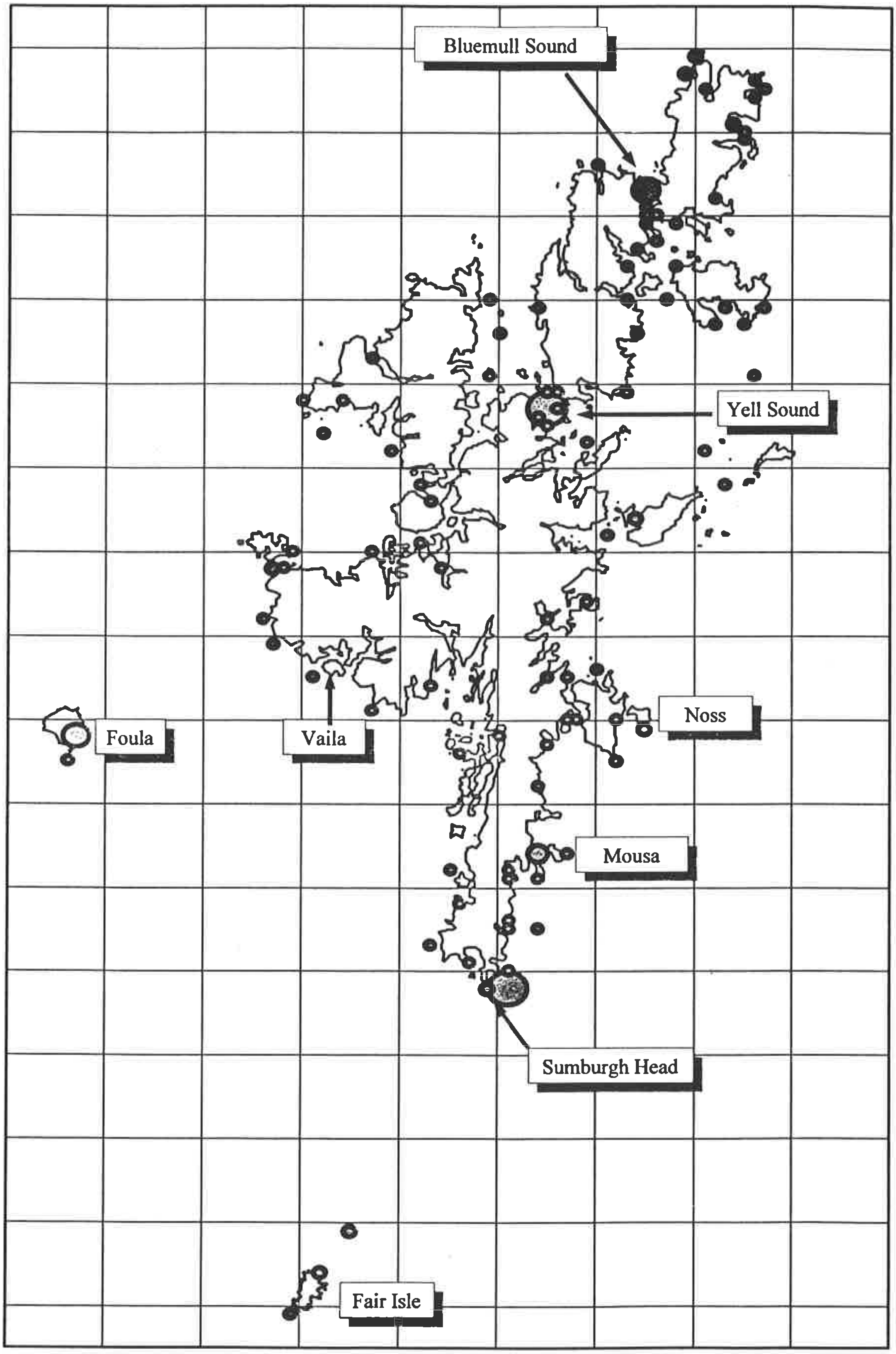

Fig. 1. Distribution of killer whale sightings around Shetland over the period 1989 - 1998 (n = 288) by 1km grid squares, size of circle indicates relative number of sightings.

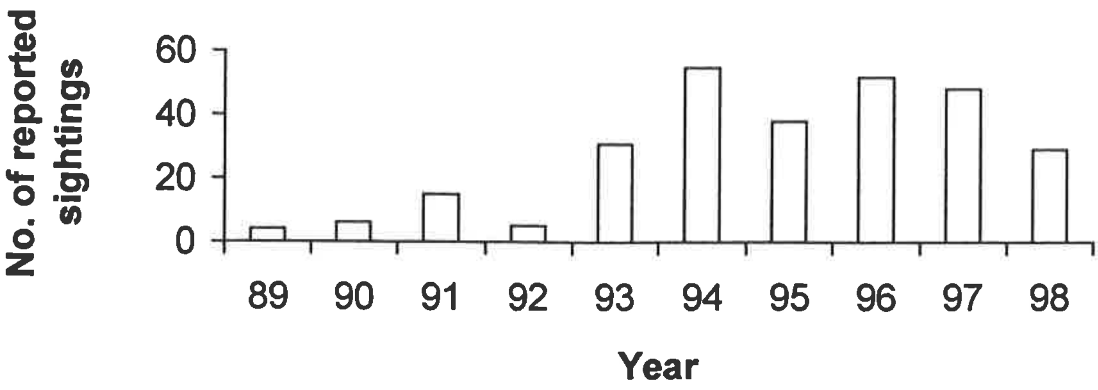

Fig. 2 - Frequency of killer whales sightings by year, 1989-98 (n=288)

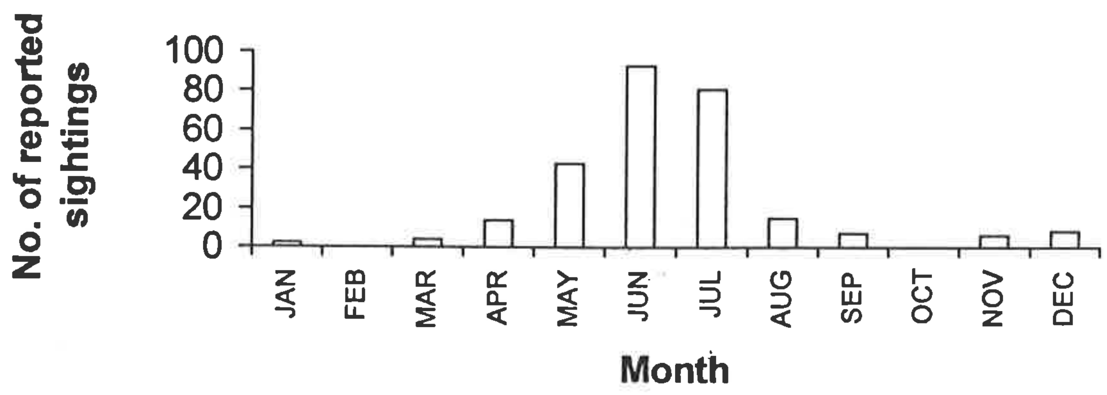

Fig. 3 - Frequency of killer whale sightings by month, 1989-98 (n=288)

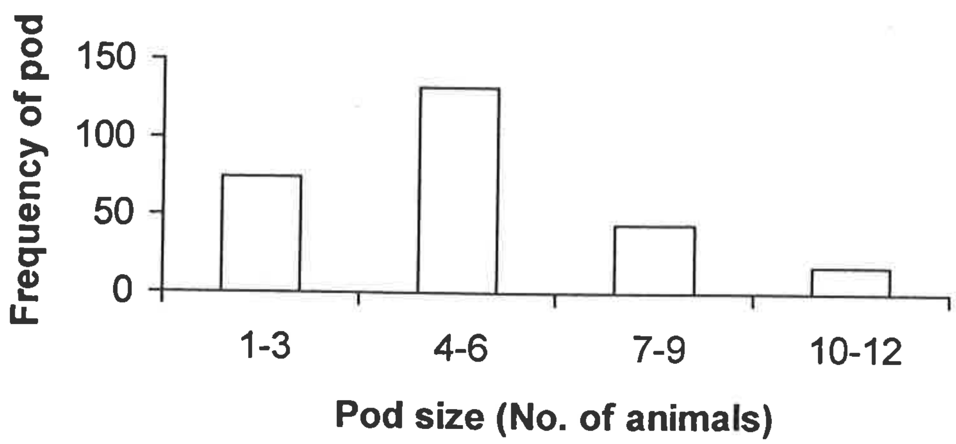

Fig. 4 - Frequency of killer whale pods categorised by number of animals (n=270)

CETACEAN MONITORING IN THE ENGLISH CHANNEL AND BAY OF BISCAY, FROM A PLATFORM OF OPPORTUNITY, OVER SIX YEAR PERIOD (1993-1998)

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A survey began in March 1993 to gather information about the spatial and temporal distribution of cetaceans in the English Channel and Bay of Biscay. Brittany Ferries, who run the ferry service from Plymouth to Santander (Northern Spain), were approached with the survey proposal by the first author, and agreed to give free passage for two observers to make monthly crossings. The vessel provided an excellent stable viewing platform with a height above sea level of 30 metres, which allowed observations in conditions up to sea state 4. Trips were made throughout the year from March to November. Additional trips were attempted in December to February but conditions in the Bay of Biscay were consistently too poor to allow collection of worthwhile data.

For analysis, the route was stratified into nine 50 nautical mile zones and the sightings per km travelled were calculated in each of these zones, for the six-year period. The highest number of sightings occurred in August, and the most frequently sighted cetaceans were common dolphins in schools estimated to include up to 100 animals. Separate mother and calf schools were also seen as well as mixed schools of common, striped and bottlenose dolphins. Common dolphins were also the main species seen feeding with gannets, particularly along the Brittany coast. Fin whales were the most commonly sighted large whale in deep waters in the Bay of Biscay and were seen from March through to November. Other species have included sei whales, Cuvier's beaked whales, pilot whales, bottlenose whales, minke whales, and a range of dolphin species including striped, bottlenose, and Risso's dolphins.

COMMON DOLPHIN (*DELPHINUS DELPHIS*, L.) OBSERVATION PROGRAM IN IONIAN GREEK ISLANDS: VISUAL AND ACOUSTIC CONTACTS DURING SUMMER 1998.

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INTRODUCTION Since 1993, Ambiente Mare carries out a research campaign during summer to acquire data on the resident population of common dolphins in the Ionian Greek islands area. The on-board researchers completed behavioural description forms and started to build a photo-ID catalogue (Bearzi, 1994).

In summer 1998, researchers from the Centro Interdisciplinare di Bioacustica e Ricerche Ambientali of University of Pavia took part in cruises that started from June until late October.

MATERIALS AND METHODS During 42 days effectively spent in the area (Fig.1), cruising for 8-10 hours and 30 miles per day, 15 groups of dolphins ranging from 2-30 individuals each were sighted (Table 1).

In addition to the previous research tasks, acoustic recording sessions were dedicated to collect dolphin vocalisations. Recordings were made using a stationary omni-directional hydrophone CRT (Cetacean Research Techonologies) model C-300 with 500 kHz bandwidth. The hydrophone was connected either to a double bandwidth DAT recorder Pioneer DC88 or to a PC based DSPW (digital signal processing workstation).

After visual contact, following photo-ID and behavioural observations, if the meteorological conditions were favourable dolphins were carefully approached with a little inflatable boat in order to obtain noise-free recordings at short range. The DSPW, due to its power supply requirements, was operated solely on the main boat (Aleph, schooner 16 mt). This gave the opportunity to record echolocation clicks in wideband mode (sampling rate 400k samples/sec, 120 kHz bandwidth, work in progress).

RESULTS Recordings were included in the Centre's sound library (Priano *et al.*, 1997) and the successive sound analysis made it possible to describe some traditional vocalisations already observed in other odontocetes: whistles (Fig. 2) and clicks. Three different categories of impulsive sounds (clicks and click trains) were recorded: echolocation clicks (Fig.3), "buzzes" (Fig.4) and "moans" (Fig.5) (Benoldi *et al.*,1997). A catalogue of the most common and significant of them is in preparation in order to correlate behavioural observations scheduled for summer 1999 with dolphin sound production.

ACKNOWLEDGEMENTS We thank Marco Priano and Gianni Pavan from Centro Interdisciplinare di Bioacustica e Ricerche Ambientali, University of Pavia, Italy.

REFERENCES

Bearzi, G. 1994. Photoidentification: field methods. Pp. 22-26. In: *Methods for the Study of Bottlenose Dolphins in the Wild.* (Eds. G. Notarbartolo di Sciara, P. G. H. Evans.and E. Politi). ECS Newsletter no. 23, Special Issue. 42pp.

Benoldi, C., Evans, P. G. H., Manghi, M., Pavan, G. and Priano, M. 1997. Risso's dolphin (*Grampus griseus*) acoustic survey in the Hebridean waters, Scotland. Pp. 232-236. In: *European Research on Cetaceans - 11.* Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Priano, M., Pavan, G., Manghi, M. and Fossati, C. 1997. The Cetacean Sound Library of the Interdisciplinar Center for Bioacoustic and Environmental, Research of the University of Pavia. *Proc.I.O.A.*,19, 9: 245-250.

Table 1 - Field data

date	lat	long	depht	n° of individuals	daytime	sighting duration
26-giu-98	38 44 60	20 49 33	70	6	9.30	3h05'
26-giu-98	38 44 70	20 50 19	70	3	10.10	2h25'
28-giu-98	38 44 85	20 48 03	50	15-20	10.35	2h25'
9-lug-98	38 37 45	20 58 09	50	3	12.50	2'
11-lug-98	38 43 51	20 50 29	70	5	11.55	1h15'
22-lug-98	38 31 49	20 59 00	60	4-7	11.10	2h20'
26-lug-98	38 34 89	20 51 35	110	15	11.45	1h35'
6-ago-98	38 45 48	20 50 13	50	2	11.30	35'
23-ago-98	38 44 00	20 45 00	60	20	8.55	1h
24-ago-98	38 37 23	20 51 93	70	7	11.40	1h10'
25-ago-98	38 43 08	20 45 71	70	12	13.10	1h30'
7-set-98	38 42 62	20 52 58	60	6	12.30	40'
20-set-98	38 44 01	20 50 57	80	15	15.15	1h30'
15-ott-98	38 43 20	20 49 22	80	12	14.50	1h25'
16-ott-98	38 42 58	20 50 93	115	25-30	15.00	1h36'

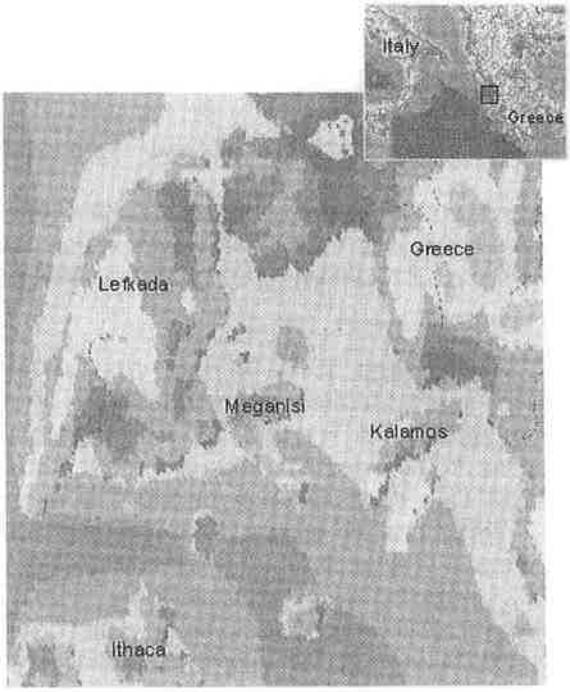

Fig. 1 The research area.

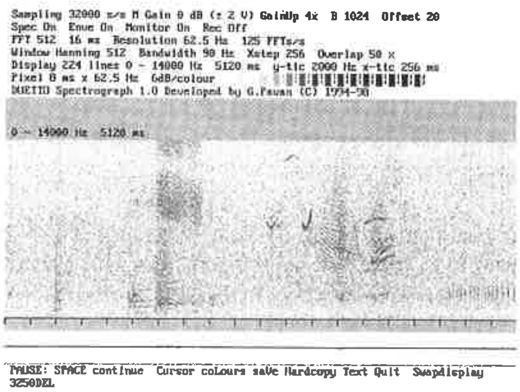

Fig. 2 Whistles.

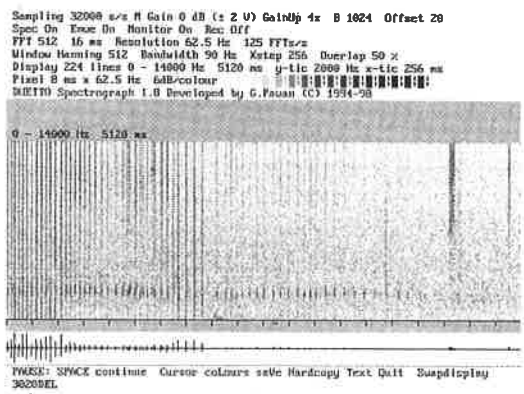

Fig. 3 Regular clicks.

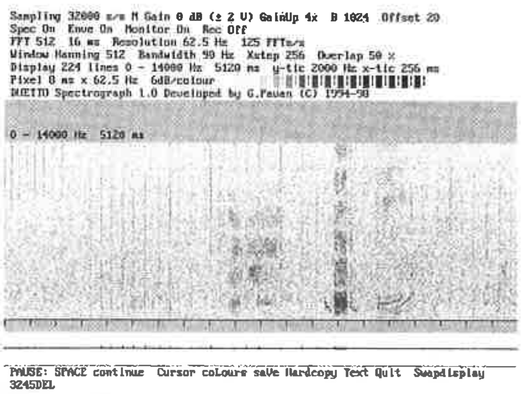

Fig. 4 Buzzes.

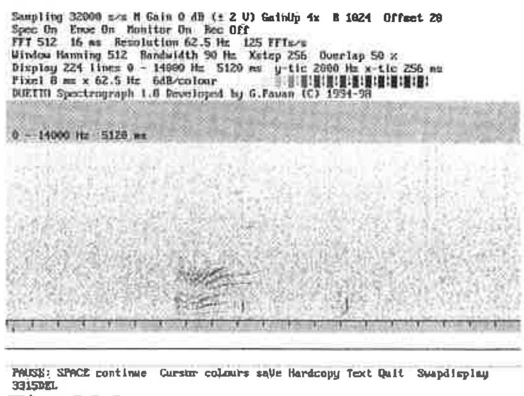

Fig. 5 Moan.

SPERM WHALE PRESENCE OFF SOUTH-WEST CRETE, GREECE, EASTERN MEDITERRANEAN

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INTRODUCTION Although it is known that sperm whale (*Physeter macrocephalus*) inhabits the entire Mediterranean Sea (Notarbartolo di Sciara, 1997), the relative literature is sparse. No long-term studies have been undertaken and no consistent information exist concerning the species' presence and distribution in the eastern Mediterranean basin. Most data come from strandings or unpublished opportunistic sightings (Marchessaux, 1980; Frantzis, 1997). In Greece, sightings and strandings have been recorded in both Ionian and Aegean Seas: North-west Zakynthos Island (Drouot & Gannier, 1999), West Peloponnisos coasts (Anonymous, 1998), North and North-west Aegean Sea (Frantzis, unpubl. data), Cyclades Islands area (Frantzis, 1997), South-east Aegean (Marini *et al.*, 1996) and Cretan Sea (this paper). According to the above preliminary data, the two most important areas of the Greek Seas for sperm whales seem to be the Chalkidiki Peninsula - northern Sporades area and South-west Crete. This paper summarises the results of opportunistic sightings and one dedicated survey off South-west Crete. The objective of this survey was to initiate a longterm sperm whale project off South-west Crete as well as in other areas of Greece.

Data gathered before our survey: In 1992, two reports from individual observers (local mariners) suggested that sperm whales were present off South-west Crete. In 1995, photographic evidence confirmed these reports and S. Gialinakis started to record opportunistic sighting data, while operating dolphin-watch vessels in the above area. Although few opportunities exist for observations during the cold months, the data gathered from 1995 to 1998 indicate year round presence of sperm whales. In total, 32 sightings have been made in January, April, May, June, July, August, September and October. These sightings were of 25 single individuals (most of them 9-12 m. long), six schools of 2-8 individuals, and a big social group of 15-20 sperm whales. In at least one case, a 4-4.5 m. long calf was present among adult sperm whales.

Dolphin-watch vessels operate on average twice a week from mid April to mid October, and trips typically last for three hours. Although it is not possible to make any useful estimates from the existing data due to lack of scientific methodology, the "sighting frequency" of sperm whales is approximately one every 18 hours of visual search, for sea states 0 to 4 Beaufort scale. Figure 1 shows that almost all sightings were made at 1-4 miles from the coast in depths of 500-1,200 m. Although this is not surprising (considering that sperm whales prefer steep slopes of the sea bottom at the edge of the continental shelf), it could be just an artifact of the routes followed by the dolphin-watch vessels, which usually stay close to the coasts.

Our survey: Visual and passive acoustic surveys were conducted, between 22nd Sept 1998 and 2nd Oct 1998. A stereo towed hydrophone array and simple monitoring system allowed us to cover 229 nm (nautical miles) actively listening and searching for cetaceans (in 57.6 hours) with positive sea conditions (<3 Beaufort scale) and 69 nm tracking sperm whales that had been localised (in 16.7 hours). Twenty-eight nm (10.3 hours) were spent "with cetaceans", observing surface behaviour and taking photo-ID shots. The survey area extended from the 200 m. contour to 6 nm offshore (1,500-2,500 m. depth) along 50 nm of the south-west coastlines of Crete. Sperm whales were both located and tracked acoustically, then observed and photo-identified when they surfaced. Sperm whale clicks could be heard over ranges up to 7 nm, as a result of which whales were always detected before being sighted.

Twenty five sightings of four positively identified species were made: seven of sperm whales (*Physeter macrocephalus*), four of Cuvier's beaked whales (*Ziphius cavirostris*), three of Rissos' dolphins (*Grampus griseus*), ten of striped dolphins (*Stenella coeruleoalba*) and one of common or striped dolphins (*Delphinus delphis* or *S. coeruleoalba*).

Sperm whale sightings and diving behaviour: Sperm whales were encountered or heard on six of the ten working days in the field. All sightings were of single individuals, although in one case, two sperm whales surfaced at 0.5 nm from each other. Photo-identification methods revealed the presence of two or three different individuals in the study area. Figure 2 shows the positions of sperm whale sightings. All individuals observed were engaged in "deep dive" behaviour except in one case, when one of the two whales present in the area fluked and shallow dived before breaching on the surface. Subsequently, this individual re-fluked and reverted to normal deep dive behaviour.

Dive and surface time was recorded on 7 and 14 occasions respectively. Average dive time was 50.6 min (n=7, SD=5.6) and varied from 45 to 61 min. The average surface interval between successive deep dives was 9.8 min (n=14, SD=1.6) and varied from 7 to 12 min.

Sperm whale acoustic behaviour: Vocalisations of all species have been recorded. However, here, we present only the most interesting results concerning sperm whales. Apart from regular clicks and creaks, two types of codas were recorded in two different kinds of situations: i) at the end of a long dive e.g. after the animal stopped clicking and before it reached the surface; ii) at the beginning of a deep dive, e.g. after fluking and before the animal produced its first click. In total, twelve typical Mediterranean "3+1" codas (Pavan *et al.*, 1998) and twelve new, "2+1" codas were recorded on three occasions. The "2+1" coda which we recorded had never been heard before in the Mediterranean or other seas, so far as we know. The interval between the first and second click of this coda is very short, c. 0.03 secs, then the third click comes approximately 0.26 secs later (Fig. 3).

REFERENCES

Anonymous. 1998. Report of the Biocoustic Panel, NATO-SACLANTCEN Meeting, 15-17 June 1998, La Spezia, Italy. 72pp.

Drouot V. and Gannier A. 1999. New sperm whale vocalisations recorded in the Mediterranean Sea. (this volume).

Frantzis, A. 1997. Cetaceans and cetology in the Hellenic Seas. Pp. 114-118. In: *European Research on Cetaceans - 10*. Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Marchessaux, D, 1980. A review of the current knowledge of the cetaceans in the Eastern Mediterranean Sea. Vie Marine, 2: 59-66.

Marini, L., Carpentieri, P. and Consiglio, C. 1996. Presence and distribution of the cetological fauna of the Aegean Sea: Preliminary results. Pp. 99-101. In: *European Research on Cetaceans - 9*. Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Notarbartolo di Sciara G. and Demma M. 1997. *Guida dei Mammiferi Marini del Mediterraneo*. Muzzio Editore, Padova, Italy. 264pp.

Pavan G., Hayward T., Borsani J. F., Priano M., Manghi M. and Fossati C. 1998. Time Pattern of Sperm Whale Codas Recorded in the Mediterranean Sea 1985-1996. Pp. 1809-1810. In: *Proc. 135th ASA Meeting, Seattle, 9-11 June, 1998*. Acoustical Society of America.

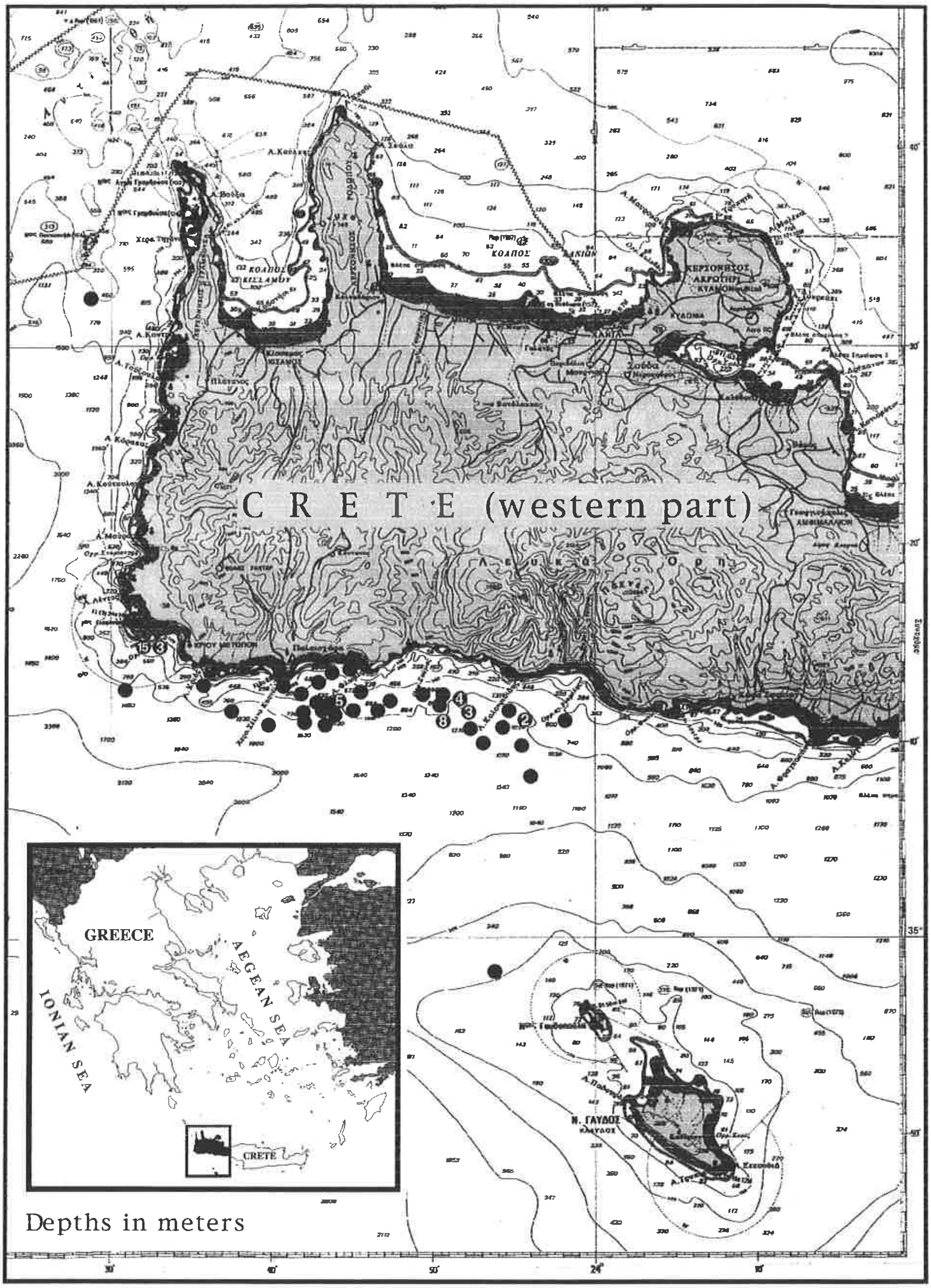

Fig. 1 - The sea area of South-west Crete, with positions of 32 opportunistic sightings of sperm whales (black circles). Sightings were recorded by dolphin-watch vessels in 1992 (two sightings) and from 1995 to 1998. Numbers inside the circles indicate the size of the schools. Circles with no number indicate single individuals

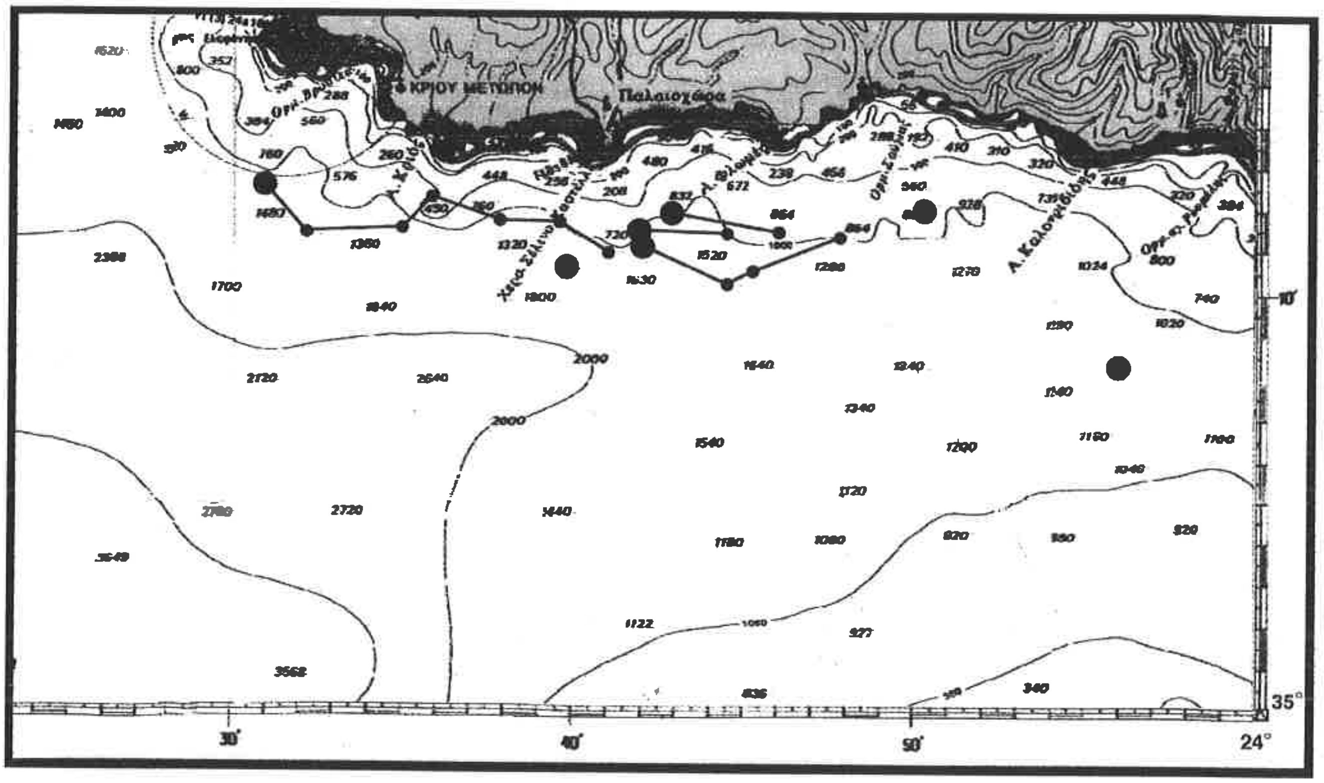

Fig. 2 - Single sperm whale sightings and tracks recorded during our survey. Big circles represent positions of sperm whales when first encountered. Small circles correspond to successive positions where they surfaced, after a deep dive. Lines represent their theoretical track. Note that in all cases, sperm whales stayed very close to the 1,000 m bathymetric contour.

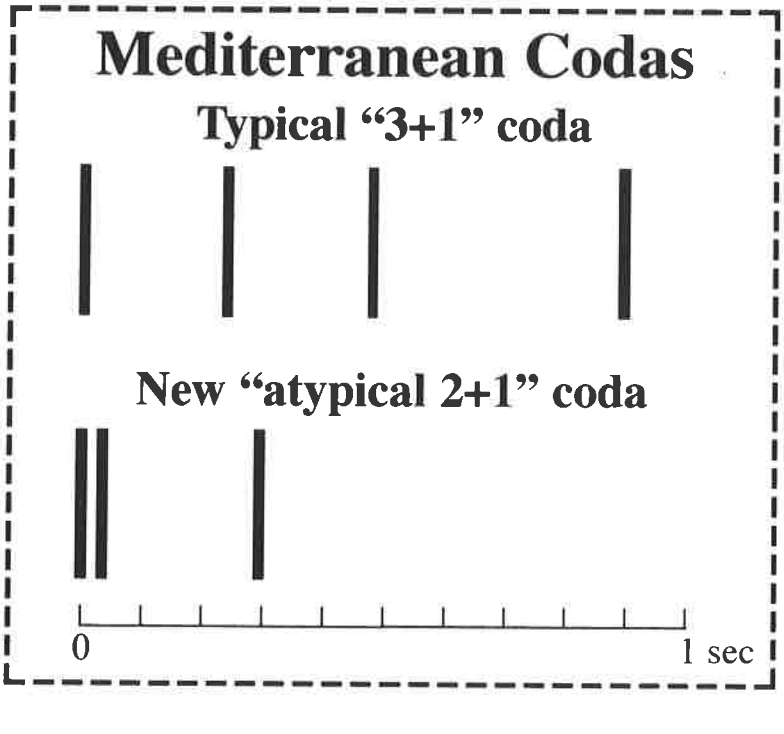

Fig. 3 - Characteristics of "3+1" and "atypical 2+1" codas recorded during our survey. Interclick intervals represent average values

ANNUAL INCREASE OF ABUNDANCE OF HUMPBACK WHALES AT ABROLHOS BANK, BRAZIL

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INTRODUCTION Abrolhos Bank, in Brazil, is an important breeding ground for humpback whales (*Megaptera novaeangliae*). First surveys of this population began in 1988 with the creation of the *Projeto Baleia Jubarte*. Since 1992, daily shore-based surveys and boat surveys were carried out during the breeding season from July to November. In the present study, we analyse the abundance of whales recorded between 1992 and 1996.

METHODS Observations of humpback whales were carried out in Abrolhos Bank, Brazil, between 1992 and 1996. They were conducted during the breeding season, from July to November, through shore-based surveys and boat surveys.

The shore-base station was located at Santa Barbara Island, Abrolhos Archipelago, 35 m above sea level. Visibility angle was nearly 320° around the archipelago. Observations were made daily. From 1992 to 1995, watches of eight hours of observation effort per day were introduced. In 1996, the effort was reduced to six hours per day, but was very often carried out by two observers simultaneously. Standardised watches were not followed when wind speed was higher than 20 knots. Such conditions are known to reduce the probability of seeing the whales present on the visual horizon. Binoculars (10x50 and 10x60) were used for the observations. In 1996, a Wild T2 theodolite was also used.

Boat surveys were conducted aboard a 35 ft boat and lasted between one and four days. In 1992 and 1993, they were mainly conducted between the mainland (Caravelas) and Abrolhos Archipelago. In the following seasons, cruises covered other areas within the bank, but the area mainland-Abrolhos Archipelago was always surveyed more intensely. The area surveyed per unit time was not constant between and within each cruise. The main purpose of the cruises was whale photo-identification, so area surveyed depended upon the amount of whales found and the time spent with each group.

In both shore-based and boat surveys, the number of whales observed was recorded. It should be noted that in this context, the number of whales is not the absolute number of individuals but the number of visual contacts with whales (some whales were probably recorded more than once during the season). Observation effort was also recorded. The number of whales seen per hour was later calculated and used in the present study as a relative abundance index.

RESULTS Between 1992 and 1996, a total of 1,191.9 hrs of boat survey observation effort were conducted and 3,361.6 hours of shore-based surveys. The number of whales recorded per hour (i.e. the abundance of whales) increased through the years, mainly during the peak months (Fig. 1). Abundance recorded in August 1996 from boat surveys was three times higher than in August 1992. In the shore-based surveys, sightings per hour increased from 3.57 (1992) and 2.08 (1993) to 5.98 (1994), 4.92 (1995) and 6.3 (1996) during the peak month (September).

Covariance Analysis (ANCOVA's) was used to compare the gradient and the slope of the linear regressions that fitted the monthly cumulative abundance across months (Fig. 2). In each case, the linear regression fit was significant at a level exceeding 0.05. Since the relative rates of immigration and emigration of whales in Abrolhos were similar across years (Freitas, 1997), significantly higher gradients indicate a significant increase in abundance. Thus, the increase in whale abundance between 1992 and 1996 was significant (boat surveys: $F = 18.209$, $p=0.001$; shore-based surveys: $F = 13.480$, $p=0.001$). Pair-wise comparison of slopes and gradients were made after the overall ANCOVA's, through Tukey tests. Results indicated that abundance was not significantly different in 1992 and 1993. In 1994 and 1995, it was also similar but significantly higher than in the previous two years. According to shore-based data, abundance in 1996 was significantly higher than in 1994 and 1995. Boat surveys indicates a 1996 abundance similar to 1994 and 1995, but clearly higher than in 1992 and 1993.

The increase rate in abundance between 1992 and 1996 was calculated through exponential regressions that fitted abundance recorded in the peak months (August, September and October) of each year along the sampling years (Fig. 3). Fitted regressions were significant at a level greater than 0.01. The number of whales observed per hour from the shorebase increased by 25.0% (7.7%) between 1992 and 1996 (Y = 7.11E - 217e0.250x; $r^2 = 0.45$; $p=0.0063$) (Fig. 3A). Boat surveys indicated an increase in abundance of 22.8% (6.1%) for the same years (Fig. 3B) (Y = 2.88E - 198 e0.228x; $r^2 = 0.52$; $p = 0.0024$).

DISCUSSION Increase rates in the number of whales recorded per hour in Abrolhos between 1992 and 1996 (25.0% for land-based surveys and 22.8% for boat surveys) are very high. They probably do not represent only an increase in the whale population size, since rates of this magnitude are not possible for a population estimated to have 928-1,265 indivs. in 1996 (Bethlem *et al.*, 1998). Increased sightings per hour are probably also a result of an increase in the survey efficiency. Concerning boat surveys, cruises during 1992 and 1993 surveyed mainly the area between the mainland and Abrolhos archipelago. In the following seasons, the survey area increased progressively, covering probably areas with higher whale densities. In 1996 boat surveys were sometimes made in conjunction with land-based observers who indicated, via radio those areas where more whales were to be seen. Furthermore, the area surveyed per unit time varied between and within each cruise. Since the main purpose of the cruises was whale photo-ID, the area surveyed per unit time was dependent on the quantity of whales found and on the time spent with each group. The increase in experience of the observers and the skipper allowed us to record and photograph whales faster and thus to survey a greater area per unit time in the most recent years.

During land-based surveys, there should not be an increase in observer experience, since observers changed each year. However, changes in the sampling methodology could have increased the number of whales recorded. The number of observers and searching time were similar from 1992 to 1995. However, in the last two years (1994 and 1995), whales were recorded by one observer in the first four hours and by another one in the next four, enhancing the probability of making re-sightings. In 1996, survey time was reduced, but very often was made by two observers simultaneously. The number of whales recorded in such a situation is surely higher, specially when the density of whales around the archipelago was also higher.

A possible variation in the spatial distribution pattern of these whales within the bank area, could also contribute to the increase in whale records in the most recent years.

Whale populations have been increasing world-wide (Sigurjonsson & Gunnlaugsson, 1990, Best, 1993; Bannister, 1994 Paterson *et al.*, 1994). Although increased sightings might result partly from factors like the increase in survey efficiency, some growth of the population is certainly also responsible for the observed numbers. A more accurate value is needed for this population, so surveys directed to the determination of whale densities should be conducted in Abrolhos in the seasons to come.

REFERENCES

Bannister, J. L. 1994. Continued increase in humpback whales off western Australia. *Rep. int. Whal. Commn,* 44: 309-310.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES *J. mar. Sci.*, 50: 169-186.

Bethlem, C. B. P., Kinas, P. G., Engel, M. H. and Freitas, A. C. S. 1998. Empirical biased estimates of population size of humpback whale breeding off Abrolhos Bank, Brazil. P. 15. In *The World Marine Mammal Science Conference* - Abstracts, Monaco, 20-24 January, 1998.

Freitas, C. M. A. 1997. Análise da abundância das baleias-de-bossa (*Megaptera novaeangliae*) no Banco dos Abrolhos, Brasil. "Licenciatura" Thesis, University of the Algarve, UCTRA, Portugal. 42pp.

Paterson, R.; Paterson, P. and Cato, D. H. 1994. The status of humpback whales *Megaptera novaeangliae* in east Australia thirty years after whaling. *Biol. Conserv.*, 70: 135-142.

Sigurjønsson, J. and Gunnlaugsson, T. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off West and Southwest Iceland, with a note on occurrence of other cetacean species. *Rep. int. Whal. Commn*, 40: 537-551.

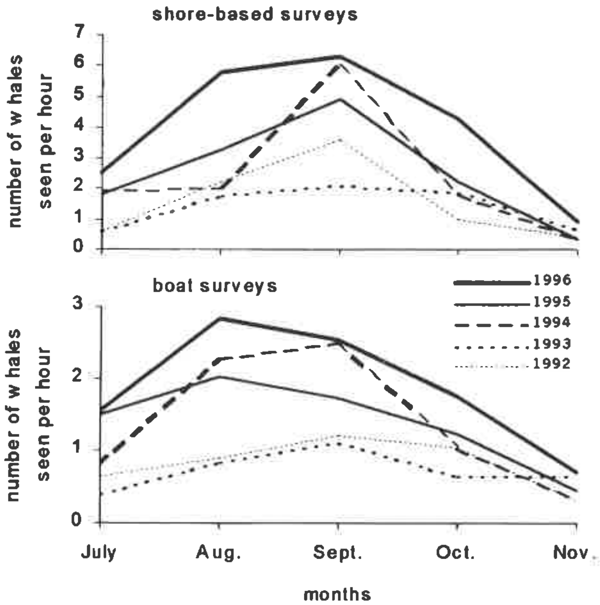

Fig. 1 - Average number of whales seen per hour in Abrolhos in each month of the breeding seasons of 1992 to 1996

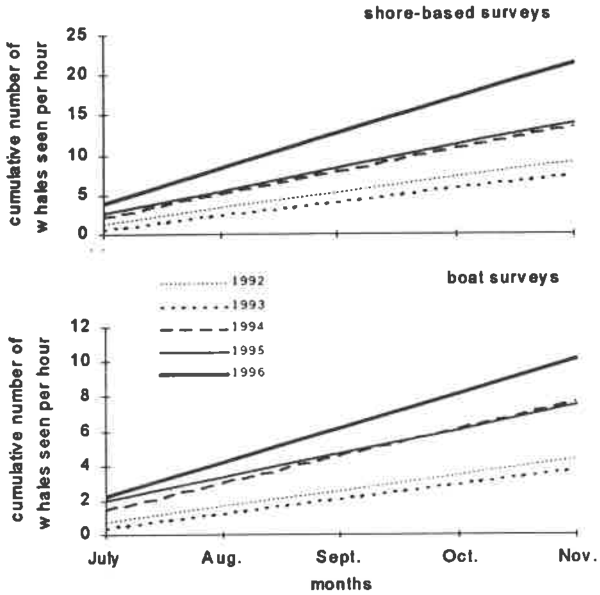

Fig. 2 - Regression lines fitted to the cumulative number of whales seen per hour in each month of the breeding seasons of 1992 to 1996

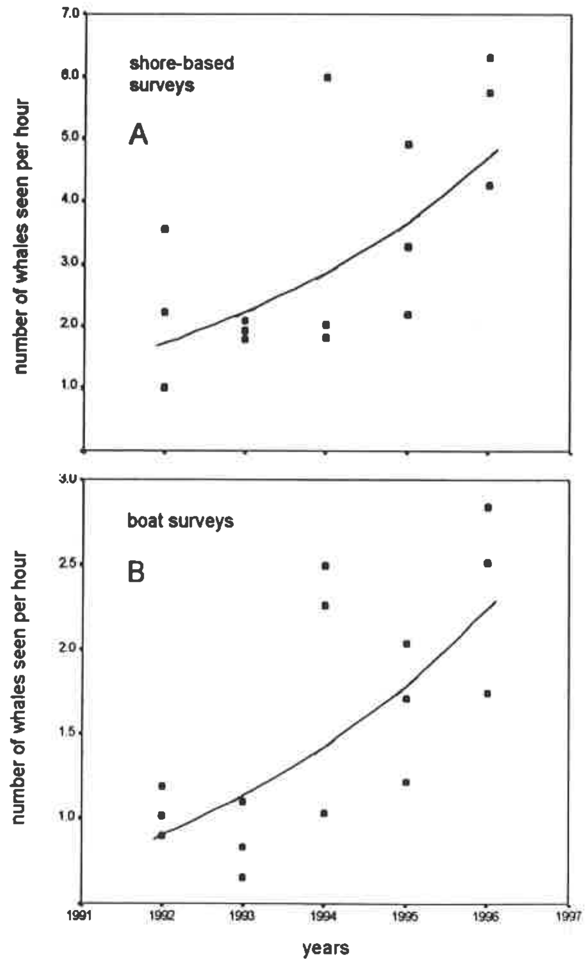

Fig. 3 - Average number of whales seen in August, September and October of the 1992 to 1996 seasons from shore-based surveys (A) and from boat survey (B) (points). Expected exponential curve fitted through the following relationships: Y = 7.11E - 217 e0.250x (shore-based surveys); Y = 2.88E - 198 e0.228x (boat-surveys)

COMPARISON OF CETACEAN POPULATIONS FROM SIMULTANEOUS SURVEYS IN THE GULF OF LION AND LIGURIAN AREAS

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INTRODUCTION While much attention is given to abundance studies in the area of the future International Marine Sanctuary, little effort has been devoted to the Gulf of Lion. However, an analysis of available results suggests that offshore areas in the Gulf of Lion shelter an abundant cetacean population, particularly if large odontocetes are considered (Gannier *et al.*, 1994; Gannier, 1997a). Because of the intense fishery activity in the Gulf of Lion, and the unknown conservation status of some Mediterranean species, such as the sperm whale (*Physeter macrocephalus*), additional results in that area were urgently needed. Furthermore, it was interesting to have comparative results with the Ligurian sector for which abundant literature is now available (Forcada *et al.*, 1994, 1995; Gannier, 1997b, 1998). We present here the results of comparative surveys conducted simultaneously with two similar small boats in August 1998.

METHODS The field surveys took place from 2nd to 20th August from a 10 m. ketch (Ligurian Sea) and a 12 m. motorsailer (Gulf of Lion). Line transect protocols were similar: both boats moved on predetermined zig-zag tracks off the 200 m. isobath, cruising on diesel engine at a mean speed of 5.5 knots. The sampling design featured a stratification in two sub-areas: a near-shore stratum and an off-shore stratum (Fig. 1). Three observers were on duty during the surveys, searching with naked eyes. Upon detection, measurements of relative position of cetaceans were made with reticuled binoculars; the animals were then approached. Acoustic sampling was conducted from both platforms, with a rate of 0.5 listening per mile. A 30-min. stop for visual searching was allowed if a sperm whale was acoustically detected in the vicinity of the boat. The sighting conditions were defined on a 0-6 scale from wind, sea state, and light (Table 1). All effort with a sighting conditions index of over 4 is considered for the data analysis.

Data Analysis: An acoustic relative abundance index, $\underline{A}$, is derived from the sperm whale hydrophone sampling data:

$$\underline{A} = (n \,.\, \underline{s} / L)$$

where n is the number of sperm whale agregations detected in an area, L is the effective effort in that area, and $\underline{s}$ is the mean school size in the area. A sperm whale aggregation is defined as a sequence of consecutive positive listenings. The cluster size is obtained aurally by listening to the click recordings; school sizes of over three individuals are difficult to determine.

The Shannon-Weaver index is used to describe the diversity of both cetaceans communities:

$$H = - S\ Fi \log2 (Ni / Nt)$$

with Ni as the number of observed individuals belonging to species i, and Nt the total number of cetaceans sighted in the area during the survey period.

Relative abundances, R, for each stratum were calculated in individuals/km:

$$\underline{R} = (n / L) \,.\, \underline{E(s)}$$

where n is the number of primary detections of a given species in one stratum, L is the effective effort in that stratum, $\underline{E(s)}$ is the mean school size in the area. $\underline{R}$ is obtained from the density definition given by Buckland *et al.* (1993), when the effective search width is eliminated. It can be used for comparative purposes provided that esw is assumed to be constant across the different areas. Estimates were obtained for each region by a surface-weighted sum of each stratum result. The estimates of variances and

CV's were obtained with the delta method, as implemented in *Distance* 2.1 software (Laake *et al.*, 1994).

RESULTS From a total of 1,302 miles cruised during the period, 1,102 were covered with good to excellent sighting conditions. The effective effort was 219 miles for the Gulf of Lion, including 24.6% in excellent conditions, 46.5% in very good conditions, and 28.7% in good conditions. The effective effort was 217 miles in the Ligurian area, including 18.9% in excellent conditions, 50.2% in very good conditions and 30.8% in good conditions. Sighting effort was considered equivalent in both areas.

Seventy-nine sightings of six species were obtained during the course of the survey (Table 2). From that total, we considered 12 on-effort sightings in the Gulf of Lion, including seven of striped dolphin (*Stenella coeruleoalba*) and five on four other species (Figure 3). We considered 21 on-effort sightings in the Ligurian area, including 13 of striped dolphin, five of fin whale (*Balaenoptera physalus*) and three of sperm whale (Figure 4). The distribution of sightings is less heterogeneous in the Ligurian area than in the Gulf of Lion, where the inshore stratum was almost deserted by cetaceans. Fin whales and sperm whales were sighted in the two sectors, although with different frequencies (Tables 3 and 4). Risso's dolphins (*Grampus griseus*) and bottlenose dolphins (*Tursiops truncatus*) were only sighted in the Gulf of Lion. The resulting Shannon index is much higher for the Gulf of Lion (1.26) than for the Ligurian area (0.28).

Detections of striped dolphins were analysed for each platform. For the boat in charge of the Ligurian area sampling, 87.5% of sixteen primary detections were obtained within a perpendicular distance of 300 metres. For the boat in charge of the Gulf of Lion sampling, 81.8% of 22 primary detections were obtained within the same perpendicular distance. This suggests that a wider detection range may have been achieved in the Gulf of Lion. For the striped dolphin, the relative abundance estimate is significantly higher (T-test, $p<0.05$) in the Ligurian area, with 0.67 indiv./km (CV=35%), than in the Gulf of Lion, with 0.35 indiv./km (CV=53%). The same situation arises for the fin whale, with a relative abundance of 0.013 indiv./km (CV=109%) in the Gulf of Lion and 0.002 indiv./km (CV=53%) in the Ligurian area. In the Gulf of Lion, relative abundances of 0.10 indiv./km (CV=90%) and 0.024 indiv./km (CV=90%) have been estimated for the Risso's dolphin and the bottlenose dolphin, respectively. In both cases, this is due to sightings obtained in the inshore stratum (Table 5). For the sperm whale, nine acoustic detection sequences were obtained in the Gulf of Lyon against seven for the Ligurian sector (Figs. 5 and 6). The resulting acoustic abundance indices are 0.033 indiv./km in the Gulf of Lyon and 0.034 indiv./km in the Ligurian area. Detections occurred in both strata.

DISCUSSION Few studies provide comparison of abundances between different areas in the Mediterranean. Forcada *et al.* (1994) give estimates of the striped dolphin for the Ligurian Sea and a wide area encompassing the rest of the Northwestern basin: they find the Ligurian Sea to be slightly more populated. From a limited effort and set of data, Gannier *et al.* (1994) suggest that striped dolphin populations are perhaps equally abundant in the western and eastern parts of the Northwestern basin.

In a recent paper, Gannier (1999) suggests that striped dolphins and fin whales are more abundant in the Ligurian Sea and off the Provençal shore than in the Gulf of Lion. For medium and large-sized pelagic odontocetes, the situation tends to be opposite, with higher relative abundance in the Gulf of Lion and off the Provençal shore than in the Ligurian Sea. This study also suggests that diversity is higher in the Gulf of Lion than in other areas of the Northwestern Mediterranean.

The absence of the pilot whale from our records in the two areas seems to be anecdotal, since we observed the species during the survey period in the Provençal basin (separating the two survey areas), and shortly afterwards in the Ligurian Sea.

One problem inherent to slow boat surveys is the possibility of a bias arising from distribution shifts, whenever they occur across the survey area during the sampling. For this study, this aspect was alleviated by simultaneaoulsy sampling the two regions for which a comparison was sought.

CONCLUSIONS These results suggest that large odontocetes are quite abundant in the Gulf of Lion, while fin whales and striped dolphins are more frequent in the Ligurian Sea. The sperm whale seems to be equally frequent in both areas. It is becoming clear that the summer cetacean population is not homogeneous in the Northwestern basin. A diversity and density gradient is apparent on an east-west axis across the whole area, with the Gulf of Lion sheltering a cetacean community of higher diversity in summer, while the Ligurian Sea is characterised by higher densities of the two dominant species, the fin whale and the striped dolphin.

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REFERENCES

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

Forcada, J., Aguilar, A., Hammond, P., Pastor, X. and Aguilar, R. 1994. Striped dolphin abundance in the northwestern Mediterranean. Pp. 96-98. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G .H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Forcada, J., Notarbartolo di Sciara, G. and Fabbri, F. 1995. Abundance of the fin whales and the striped dolphin summering in the corso-ligurian basin. *Mammalia, 59:* 127-140.

Gannier, A. 1997a. *Abondance et activité des Cétacés au voisinage du littoral provençal.* Rapport final de l'étude 97/00122 réalisée pour le Service Mer du Conseil Régional de Provence Alpes Côte d'Azur: 44pp.

Gannier, A. 1997b. Estimation de l'abondance estivale du Rorqual commun *Balaenoptera physalus* (Linné, 1758) dans le bassin liguro-provençal (Méditerranée nord-occidentale). *Rev. Ecol. (Terre Vie)*, 52: 69-86.

Gannier, A. 1998. Une estimation de l'abondance estivale du Dauphin bleu et blanc *Stenella coeruleoalba* (Meyen, 1833) dans le futur Sanctuaire Marin International de Méditerranée nord-occidentale. *Rev. Ecol. (Terre Vie),* 53: 255-272.

Gannier, A. 1999. Les cétacés de Méditerranée nord-occidentale: nouveaux resultats sur leur distribution, la structure de leur peuplement et l'abondance relative des différentes éspèces. *Mésogée*, in print.

Gannier, A., Beaubrun, P. and Di-Méglio, N. 1994. Cetacean occurrence in the Gulf of Lion and surroundings. Pp. 87-91. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Laake J. L., Buckland S. T., Anderson D. R. and Burnham K. P. 1994. *Distance user's guide V2.1*. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, 72pp.

Table 1 - Sighting conditions index derived from environmental parameters

wind speed (Beaufort)	0	1, 2-	2+, 3	4	5	6, 7	>8
sighting conditions index	6	5	4	3	2	1	0
index (swell or cloudy sky)	5	4	3	2	1	1	0

Table 2 - Summary of the sightings during the survey period

species	n sightings	mean school size	max school size	min school size
striped dolphin	54	19.5	150	1
bottlenose dolphin	1	-	9	9
Risso's dolphin	2	-	35	3
pilot whale	2	-	25	4
sperm whale	7	1.1	2	1
fin whale	17	1.4	3	1

Table 3 - In-effort sightings during the gulf of Lion transect (with the frequency Fi and the diversity contribution Hi)

species	n sightings	N individuals	Ni / Nt	diversity Hi
striped dolphin	7	92	0.652	0.402
bottlenose dolphin	1	9	0.063	0.251
Risso's dolphin	2	38	0.269	0.509
pilot whale	0	0	0	0
sperm whale	1	1	0.007	0.050
fin whale	1	1	0.007	0.050

Table 4 - In-effort sightings during the Ligurian transect (with the frequency F_i and the diversity contribution H_i)

species	n sightings	N individuals	Ni / Nt	diversity Hi
striped dolphin	13	247	0.961	0.055
sperm whale	5	6	0.023	0.125
fin whale	3	4	0.016	0.095

Table 5 - Relative abundance indices R (individual/km) for the striped dolphin, Risso's dolphin, bottlenose dolphin, and fin whale

area	Lion stratum 1	Lion stratum 2	LION	Ligure stratum 1	Ligure stratum 2	LIGURE
R (CV%)	0.01	0.59	0,35 (53)	0.49	0.83	0.67 (39)
R (CV%)	0.20	0	0,10 (90)	0	0	0
R (CV%)	0.048	0	0.024 (90)	0	0	0
R (CV%)	0	0.005	0.002 (109)	0	0.025	0.013 (53)

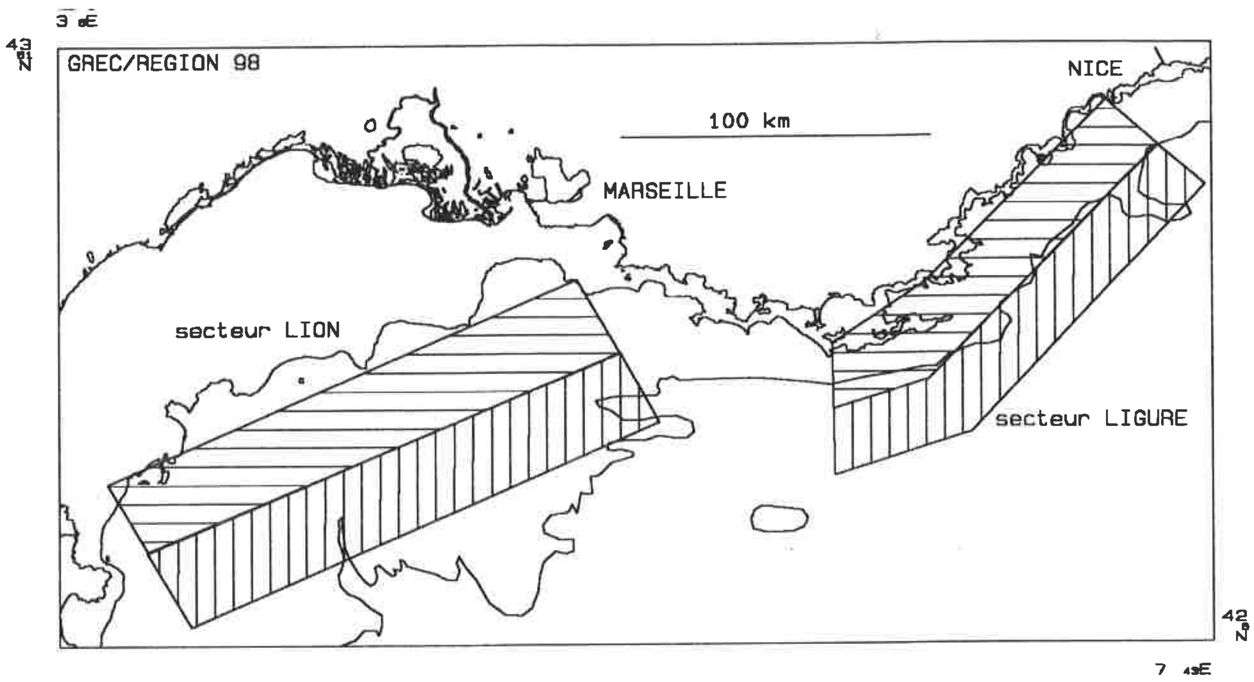

Fig. 1 - Areas of study

DISTRIBUTION AND RELATIVE ABUNDANCE OF THE SPERM WHALE IN THE CENTRAL AND WESTERN MEDITERRANEAN

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INTRODUCTION The sperm whale is one of the eight common species of cetaceans in the Mediterranean Sea. Its conservation status in the Mediterranean Sea is unknown. A decrease of the number of sperm whale observations, and, in particular, of sightings of large schools has been suggested (Di Natale and Mangano, 1983). Sperm whale local populations may be threatened by continuous by-catch due to the driftnet fisheries (Di Natale and Notarbartolo di Sciara, 1994). This paper deals with the distribution and relative abundance of sperm whales in the Mediterranean Sea. During the summers 1997 and 1998, we conducted a combined acoustic and visual survey covering homogeneously four distinct regions of the Mediterranean Sea: the North-western basin, the South-western basin, the Tyrrhenian Sea and the Ionian Sea. We estimated relative abundance indices through the use of both acoustic and visual data. We also assessed the distribution of the species in relation to underwater topography.

MATERIALS AND METHODS The survey was conducted during both summer 1997 (from 7th July to 8th August) and 1998 (from 18th June to 13th August). Four distinct regions of the Mediterranean were investigated: the North-western basin, the South-western basin, the Tyrrhenian Sea, and the Ionian Sea.

The platform was a 12 metre motor-sailer with a 80 HP diesel engine. For the acoustic sampling, a dual channel hydrophone was used in 1997 (IFAW type) and a mono hydrophone in 1998 (MAGREC HP30/MT). A high-pass filter (MAGREC) was added to remove excessive noise. Either a Sony WMD 6 analogue recorder or a Sony TCD 7 DAT were used for the recordings. Each region was divided into sampling boxes where zig-zag cruise tracks were defined. One-hour time lag was allowed to locate visually a whale previously detected acoustically. No attempt was made to photo-ID the animals.

The visual survey consisted of continuous observation, as described by Gannier (1998), with a minimum of three observers (four on average). The effective effort was defined in terms of transect length when wind conditions were less than Beaufort 4. The acoustic sampling consisted of one-minute listening every two miles along the transect to detect the characteristic sperm whale clicks. From the visual data, two variables were calculated for each box: the *Sighting frequency* (number of sightings per km) and the *Visual Relative Abundance Index* or VRAI (number of animals per km). From the acoustic data, one variable was calculated for each 40-mile segment: the *Acoustic Relative Abundance Index* (ARAI), defined as the ratio of the number of positive samples / total number of acoustic samples.

The relationship between the occurrence of sperm whales and the underwater topography was assessed by measuring the water depth, the distance to the nearest coast, and distance to the 200 m. contour for each sighting location. With respect to the acoustic data, a comparison was made between the mean ARAI values obtained for the continental slope (between 200 m. and 2,000 m. contours) and the offshore stratum (off the 2,000 m. contour) segments.

RESULTS An effective visual effort of 5,825 km and 1,614 acoustic samples were achieved during the survey. This effort was fairly evenly shared between the regions, given that North-western boxes were covered both in 1997 and 1998 (Table 1). With regard to visual surveys, sperm whales were sighted on 11 occasions on-effort (total of 13 indiv.) out of 181 on-effort sightings, being the third most frequent species observed (6.6% of the sightings). The mean school size was 2.0 whales (SE=0.519). The schools ranged from solitary animals to a group of seven individuals, but 62% of the sightings were of single animals. Two nursery groups were observed, in the Ionian and in the Tyrrhenian Seas. Sperm whales were most frequently sighted in the Northwestern basin, with 0.65 sightings/100 km and a VRAI of 0.76 animals/100 km (Table 2). A relatively high abundance index is also obtained in the Ionian Sea, due to the large school sighted in this area. The Southwestern basin shows the lowest relative abundance, with an VRAI of 0.08 animals/100 km.

The results of the acoustic survey suggest regional variations in relative abundance (Table 3). Higher occurrences were observed in the North-western and South-western basins, with mean ARAI's of 20% and 10%, respectively. These two regions may be seen as a single area of high relative abundance (Kruskall-Wallis test: h = 0.10, with p = 0.753). By contrast, the Tyrrhenian Sea appears to be a region of low relative abundance (ARAI=1%), and the Ionian Sea, a region of medium abundance (ARAI=4%). Within the Western Mediterranean region (Table 4), North and South, three sectors may be distinguished: a sector of high relative abundance (including the Gulf of Lion , Provence coast and South-Lion); a sector of medium relative abundance (West Corsica, West Sardinia, Balearics and South Balearics); and a sector of low relative abundance including the Ligurian Sea.

In the Provence and Gulf of Lion sampling boxes, data were obtained during two successive summers. The mean ARAI's found for these two boxes combined (16.5% in 1997, and 27.5% in 1998) were not significantly different between 1997 and 1998 (T-test, T = 1.27, p = 0.22). This suggest a regular use of Provence and Gulf of Lion as summer feeding grounds.

As regards the relationship with topographic features, it was found that sperm whales were more frequent in waters from 200 to 2,000 m. deep (92% of the sightings), with more than 50% occurring in waters less than 1,000 m. Only one group was sighted offshore of the 2,000 m. contour. The sightings were distributed at a mean distance of 17 km from the 200 m. contour. More than 60% of the sightings occurred at less than 10 km off the 200 m. contour. These results strongly suggest a preference of sperm whales for the continental slope waters (Table 5). Futhermore, sperm whales were acoustically detected more often in the continental slope than in oceanic waters (Table 6), as shown by the difference between the ARAI's, 12.5% and 8.3%, respectively.

DISCUSSION The small number of sightings resulted in non-significant comparisons between regions in term of visual abunadance index (VRAI). In general, the acoustic results confirmed trends suggested by the visual resuts, and allowed meaningful statistical comparisons to be undertaken between the regions, due to the increased number of whale detections.

Both the acoustic and visual results show that sperm whales are more frequent in the North-western basin than in the other regions surveyed during summer. This region is known for a primary production higher than average in the Mediterranean, Alboran Sea excepted (Morel and André, 1991). The Gulf of Lion, in particular, remains mesotrophic throughout the summer. Several authors previously noted a link between sperm whale density and biological productivity, even though a scale effect is sometimes to be found (Jaquet *et al.*, 1995). In the Ligurian Sea, although a frontal system enhances primary production in summer (Prieur, 1981), a low abundance was recorded at the time of the survey. This may result from short-term variations in sperm whale distribution, since sperm whale sightings and acoustic detections were reported there later in the season (Gannier, 1998a) and have been recorded from previous surveys (Gannier, 1998; Pavan *et al.*, 1997). The relative abundance in the Ligurian Sea may peak later in the summer, and during autumn. In the Southwestern Basin, the acoustic results suggest medium - high abundance of whales, noticeably around the Balearics and Sardinia. The results in the Tyrrhenian and Ionian Seas revealed a low occurrence of sperm whale groups. In the Tyrrhenian Sea, the large number of bycatches caused by the pelagic driftnet fishing activity are considered as a major source of mortality for the species (Di Natale and Notarbartolo di Sciara, 1994). For the Ionian Sea, no comparison is possible with previous findings. The sightings and detections are restricted to the Greek continental slope. In each of these two regions of low relative abundance, a nursery school was observed, in contrast to the Western Basin. This suggests there could be segregation between feeding clusters and nursery schools, the latter being common in the warmer regions of the Mediterranean Sea, and the former in the northern regions. This is consistent with the species ecology in other areas of the world (Rice, 1989).

The distribution of visual sightings strongly suggests that sperm whales have a habitat preference for the continental slope, in waters between 200 m. and 2,000 m. deep, which is consistent with several surveys conducted in the Mediterranean Sea (Notarbartolo *et al.*, 1993; Pavan *et al.*, 1997). Gannier (1998) found, on the contrary, an affinity of sperm whales for the open sea, from visual surveys in the Ligurian Sea.

Sperm whale habitat preferences may be linked to the diet of the species, which mainly feed on mesopelagic cephalopods (Evans, 1987). Several potential prey inhabit the continental slope and oceanic waters in the Mediterranean.

CONCLUSIONS This study confirms that the sperm whale is still distributed over a large area in the Mediterranean, and suggests some striking trends concerning geographical variation in sperm whale school size and composition. The Western basin, particularly the Gulf of Lion and Provence slope, may represent important feeding grounds for the sperm whale. A longer-term, more localised, study is required to assess the consistency of this area as a sperm whale feeding site. Other similar studies using standard methods should investigate different regions, to make possible an overall assessment of the status of the sperm whale in the Mediterranean.

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REFERENCES

Di Natale, A. and Mangano, A. 1983. Biological and Distribution new data on sperm whale, *Physeter macrocephalus*, L. in the Central Mediterranean Sea. *Rapp. Comm. Int. Mer Medit.*, 28, 5: 183-184.

Di Natale, A. and Notarbartolo di Sciara, G. 1994. A review of the passive fishing nets and trap fisheries in the Mediterranean Sea and of the cetacean bycatch. *Rep. Int. Whal. Commn*, (special issue 15), 189-202.

Drouot, V. and Gannier, A. 1999. Sperm whales vocalisations in the Mediterranean Sea. (This volume).

Evans P. G. H. 1987. *The Natural History of Whales and Dolphins*. Christopher Helm Ltd, London. 343pp.

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

Gannier, A. 1998. Une estimation de l'abondance estivale du Dauphin bleu et blanc *Stenella coeruleoalba* (Meyen, 1833) dans le futur Sanctuaire Marin International de Méditerranée nord-occidentale. *Rev. Ecol. (Terre Vie)*, 53: 255-272.

Jaquet, N., Whitehead, H. and Lewis, M. 1995. Spatial scale and temporal lag in correlations between chlorophyll and sperm whale. Pp. 188-192. In: *European Research on Cetaceans - 9*. Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Mangano, A. 1983. *Physeter macrocephalus nel Mediterraneo centrale: riserche eto-ecologiche.* Thesis of the University of Messine. 136pp.

Morel, A. and André, J.-M. 1991. Pigment distribution and primary production in the western Mediterranean, as derived from space (CZCS) observations. *Journal of Geophysical Research*, 96, C7: 12685-12698.

Notarbartolo di Sciara, G., Venturino, M. C., Zanardelli, M., Bearzi, G., Borsani, F. and Cavalloni, B. 1993. Cetaceans in the central Mediterranean Sea: distribution and sighting frequencies. *Boll. Zool.* 60: 131-138.

Pavan, G., Priano, M., Manghi, M., Fossati, C. and Bergamasco, L. 1997. Sperm whales (*P. macrocephalus*) off the north-west coast of Corsica, France, in summer 1996: acoustic and surface behaviours. Pp. 218-221. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Prieur L. 1981. Hétérogénéité temporelle dans le bassin liguro-provençal. *Rapp. Comm. Int. Mer Médit.*, 27: 177-179.

Rice, D. W. 1989. Sperm Whale *Physeter macrocephalus* Linnaeus, 1758. Pp. 177-233. In *Handbook of Marine Mammals Volume 4: River Dolphins and the Larger Toothed Whales* (Eds. S. H.Ridgway and R. Harrison). Academic Press, London. 442pp.

Table 1 - Visual and acoustic sampling effort

Region	Number of boxes	Area (km^2)	Visual effort (km)	N acoustic sampling
North western Basin	5	43261.7	2419.6	611
South western Basin	3	44044.8	1185.1	316
Tyrrhenian Sea	4	61911.5	1234.2	321
Ionian Sea	3	50199	986.0	293
Total	15	199416.7	5824.9	1614

Table 2 - Mean sighting frequency (number of sighting/100 km) and visual relative Abundance index (number of animals/100 km) and of sperm whales (with n, number of sightings and N, number of animals, SE Standard Error)

Area	n	N	Sighting Frequency (SE)	Visual Abundance Index (SE)
North western Basin	8	10	0.647 (0.34)	0.758 (0.37)
South western Basin	1	1	0.080 (0.08)	0.080 (0.08)
Tyrrhenian Sea	1	5	0.065 (0.06)	0.325 (0.32)
Ionian Sea	1	7	0.121 (0.10)	0.849 (0.69)

Tab. 3 - Mean Acoustic Relative Abundance Index in the four regions (N, number of segments, SE Standard Error)

Area	N	Acoustic Abundance Index (in %)	SE
North Western Basin	36	20.06	3.79
South Western Basin	17	10.28	4.45
Tyrrhenian Sea	20	0.96	0.06
Ionian Sea	15	4.37	4.37

Table 4 - Acoustic Relative Abundance Indices for the sampling boxes of the North and South-western Mediterranean (N, number of segments, SE, Standard Error)

Sampling boxes	N	Mean	SE	Min	Max
N1: Ligure	8	0	0	0	0
N2: Provence	12	20.55	5.14	0	55.56
N3: Gulf of Lion	10	25.91	7.41	0	63.38
N4: South Lion	3	61.77	6.12	50	70.59
N5: West-Corsica	3	10.44	8.07	0	26.32
S1: Baleares	3	9.52	9.52	0	28.57
S2: Minorca-Sardinia	6	9.58	5.42	0	31.58
S3: West-Sardinia	8	11.09	8.73	0	70.00

Table 5 - Distance to the coast, bottom depth and distance to the 200 m. contour of the sperm whales sightings made during 1997 and 1998 in the Mediterranean Sea

	Mean	SE	Min	Max
Distance to Coast (in km)	37.52	10.22	5	117.3
Bottom Depth (in m)			270	2800
Distance to 200m (in km)	17	8.55		

Table 6 - Mean Acoustic Relative Abundance Index for the continental slope (200-2,000 m.) and the open sea (>2000 m.) strata. N, number of segment, SE, Standard Error

Stratum	N	Mean	SE
Continental slope	62	12.55	2.83
Open sea	25	8.27	3.12

STATUS OF CETACEANS IN THE FARASAN ISLANDS MARINE PROTECTED AREA (RED SEA)

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INTRODUCTION Thirteen species of cetacea have been reported from the waters of the Red Sea (for further reading, see Gladstone and Fisher, in press. *Fauna of Arabia*). They include 11 species from the family Delphinidae: common dolphin *Delphinus delphis* cf. *tropicalis*; short-finned pilot whale *Globicephala macrorhynchus*; Risso's dolphin *Grampus griseus*; killer whale *Orcinus orca*; false killer whale *Pseudorca crassidens*; Indo-Pacific hump-backed dolphin *Sousa chinensis*; spotted dolphin *Stenella attenuata*; striped dolphin *S. coeruleoalba*; spinner dolphin *S. longirostris*; rough-toothed dolphin *Steno bredanensis*; bottlenose dolphin *Tursiops truncatus*; and two species from the family Balaenopteridae: minke whale *Balaenoptera acutorostrata* and Bryde's whale *B. edeni.*

Most reports are based on incidental sightings or specimens, and there is very little published information on the ecology, behaviour, or conservation status of Red Sea cetacea. Most of our observations were made within the boundaries of the Farasan Marine Protected Area (MPA). The information was gathered as part of the development of the management plan for the Farasan MPA on the use of the MPA by important species, and possible conflicts with human uses.

MATERIALS AND METHODS The Farasan Islands (16°40'N, 42°00'E) are located in the southern Red Sea within the borders of the Kingdom of Saudi Arabia, 42 km offshore of the coastal city of Jizan. Within the boundaries of the MPA, there are 128 islands (representing 630 km of shoreline) with extensive areas of shallow, fringing coral reefs and sand shelves. Water depths extend to greater than 250 m. in parts; however, about 50% of the sea floor is less than 10 m. deep. Sea surface temperatures vary between 33°C (Aug-Oct) and 26°C (Dec-Jan); salinity is usually around 40-45 ppt.

Observations reported here were made during August 1993 - May 1994 and in October 1994 (by WG), and from November 1995 to April 1996 (by PRF). Almost all observations were made from a small boat, and the positions were recorded with a portable global positioning system (GPS). A small number of incidental observations were made during other surveys within the Farasan MPA. Most observations were made in good visibility, and in relatively calm sea conditions of less than sea state 3.

RESULTS A total of 314 individuals were observed in 51 separate sightings during the study, comprising three species of delphinids (*Sousa chinensis*, *Stenella longirostris*, *Tursiops truncatus*) and one species of balaenopterid (*Balaenoptera edeni*).

Indo-Pacific hump-backed dolphin (*Sousa chinensis*): Sixty-nine individuals of *S. chinensis* were observed over a total of 21 observations (Figure 1). *Sousa chinensis* was the most frequently observed cetacean in the Farasan MPA (though not the most abundant). Group sizes ranged from 2-8 individuals, and lone individuals were observed on four occasions. *Sousa chinensis* were always observed in close proximity to islands, in shallow often turbid water with a sandy substrate, in depths of 3.5 - 8 m. *Sousa chinensis* were observed at different locations throughout the Farasan MPA (Figure 1). However, the majority were observed in the vicinity of the largest island, Farasan Island. Pods and individuals were usually observed slowly swimming over shallow water, or milling at the surface between foraging dives. Two adult males were observed on separate occasions in social activity, swimming quickly around other individual pod members and breaching clear of the water. On two occasions, *S. chinensis* were observed swimming with a pod of *T. truncatus*. They were sensitive to human approaches and avoided approaching boats by diving, but in some areas habitualised to boat activity. Pods were observed on two occasions in the Farasan Port where there is considerable human activity in small speed boats, barges, and ferries.

Spinner dolphin (*Stenella longirostris*): We observed *S. longirostris* on eleven occasions in the Farasan MPA, comprising a total of 157 individuals (Figure 2). This species was observed less frequently than the other delphinids, but because of its larger pod sizes, it is probably the most abundant delphinid in the Farasan MPA. All individuals were observed in pods of two size classes: smaller pods of 3-15 individuals, and larger pods of 30-50+ individuals. A juvenile, about one-third adult size, was observed in September 1993. *Stenella longirostris* were mostly observed in deep waters between islands (depths over 50 m.). On one occasion a mixed pod of six *S. longirostris* and eight *T. truncatus* was observed near Abker Island. The observed behaviour of *S. longirostris* involved either slow swimming, milling in groups on the surface, or travelling fast and leaping clear of the surface in open water. They generally avoided approaching boats, but they readily swam towards boats that were not moving towards them, occasionally bow riding the Jizan to Farasan ferry.

Bottlenose dolphin (*Tursiops truncatus*): This was the second most frequently observed cetacean in the Farasan MPA: we recorded 84 individuals in 16 separate observations (Figure 3). Pod sizes ranged from 2-12 individuals, and lone individuals were observed on three occasions. Single juveniles (approximately one-half adult size) was observed with family pods on two separate occasions, in April 1995 and March 1996. *Tursiops truncatus* were observed in a range of habitats: in shallow water over a sandy substrate (depths of 3-5 m.), in deeper water adjacent to islands (depths of 10-25 m.) and in deeper water between islands (depths around 20 m.). Like *S. chinensis*, they were mostly observed close to islands, but not usually in water as shallow. *Tursiops truncatus* were observed throughout the Farasan MPA. On one occasion, a mixed pod of *T. truncatus* and *S. longirostris* was observed. Unlike the other species of delphinids observed, *T. truncatus* readily approached slow moving boats and allowed passive observation underwater. Play and possibly courtship behaviour were observed underwater on one occasion.

Bryde's whale (*Balaenoptera edeni*): A total of four individuals of *B. edeni* were observed on three occasions (Figure 3) in the Farasan MPA, in the months of October 1993, January 1994 and March (1996). *Balaenoptera edeni* were observed as single individuals on two occasions, and as a pair on a single occasion. A single individual was observed outside the boundaries of the MPA approximately midway between Farasan Island and Jizan in October 1993. *Balaenoptera edeni* were always observed in deep water (>50 m.), either between islands within the Farasan MPA, or between Farasan Island and the mainland. In addition, one freshly dead specimen drifted and stranded on the southern coast of Rumain Island (Figure 3) in January 1996 (>10 m. total length); a second dead individual was observed on the coast in September 1993 (15 m. total length), 45 km south of Jizan.

Farasan Islands' artisanal fishermen reported sightings of killer whales (*Orcinus orca*) which they had observed at two locations within the Farasan MPA in 1992 and 1994. Although recorded from elsewhere in the Red Sea, killer whales appear to be more common in the Gulf of Aden. Sperm whales (*Physeter macrocephalus*) have been reported from the Arabian Sea, but have not been reported from the Red Sea. However, artisanal fishermen informed us that they occasionally find ambergris on the beaches of the Farasan Islands, suggesting that *P. macrocephalus* either occur in the vicinity of the Farasan Islands, or the ambergris may have drifted in from the Gulf of Aden. Skeletal remains (including rostrum, part of the vertebral column, pelvic girdle) of two balaenopterid whales were located on two beaches in the Farasan MPA (Figure 3); however, it was not possible to positively identify them.

DISCUSSION The cetacean fauna of the Farasan MPA represents about one-third of the species recorded from the Red Sea, and includes *S. chinensis* and *T. truncatus* which appear to be localised to inshore or reef-island ecosystems, and the widely distributed and mainly pelagic *S. longirostris*. The Farasan MPA may be an important wintering area for *B. edeni*. This appears to be the first report of living individuals of Bryde's whales (*B. edeni*) in the Red Sea. *Balaenoptera edeni* were previously known in the Red Sea from records of only a few stranded specimens. More recently (February 1996), a single living *B. edeni* was observed by WG, approximately 10 km off the coast of Jeddah in the central Red Sea. Both living and dead *B. edeni* have been observed from the Arabian Gulf, which has high water temperatures and salinity similar to the Red Sea. Our observations of *B. edeni* at different times of the year (October, January and March) indicate that the Farasan MPA could be used either as a feeding or breeding ground by this species. More detailed and focused surveys, along with regular monitoring, are needed to further clarify the status of these species' populations in the Farasan MPA, and may reveal additional species not observed by us. Considering the location of the Farasan MPA in the southern Red Sea, the cetacean fauna is considerably less than that reported from the waters of the Gulf of Aden and Indian Ocean.

The size and form of *Tursiops truncatus* observed inshore in Farasan waters appeared to be more synonymous with *Tursiops t. aduncus*. Some confusion still exists about the taxonomic status of *aduncus*. It is, however, outside the scope of this paper to discuss the problem further.

The current human activities within the Farasan MPA do not 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, and shark fishing. Regionally, potential threats to cetaceans include oil spills, accidental capture in fishing nets, and uncontrolled ecotourism. At present, logistical constraints restrict the potential for regional systematic inshore and offshore cetacean surveys. The establishment of the Farasan MPA is significant in the global conservation of these cetaceans. *Stenella longirostris* is classified as "conservation dependent", and *S. chinensis*, *T. truncatus*, and *B. edeni* are classified as "data deficient" in the IUCN Red List. Available information on *S. chinensis* suggests that it is declining in several parts of its range due to incidental captures in gill nets, fishing, pollution, development, and collection for aquaria. The apparently good numbers of cetacea in the Farasan MPA, and the lack of comparable damaging human activities further highlights the conservation significance of these islands.

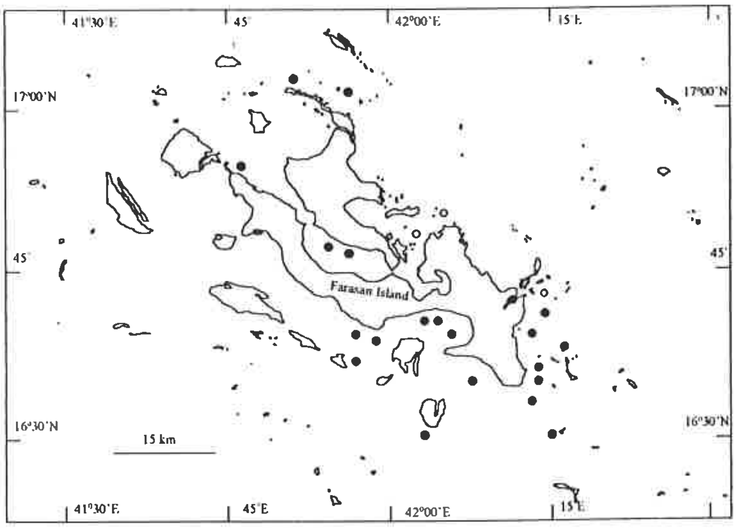

Fig. 1 - Locations of sightings of Indo-Pacific hump-backed dolphins, *S. chinensis* (**o**). Incidental observations (o) are also shown

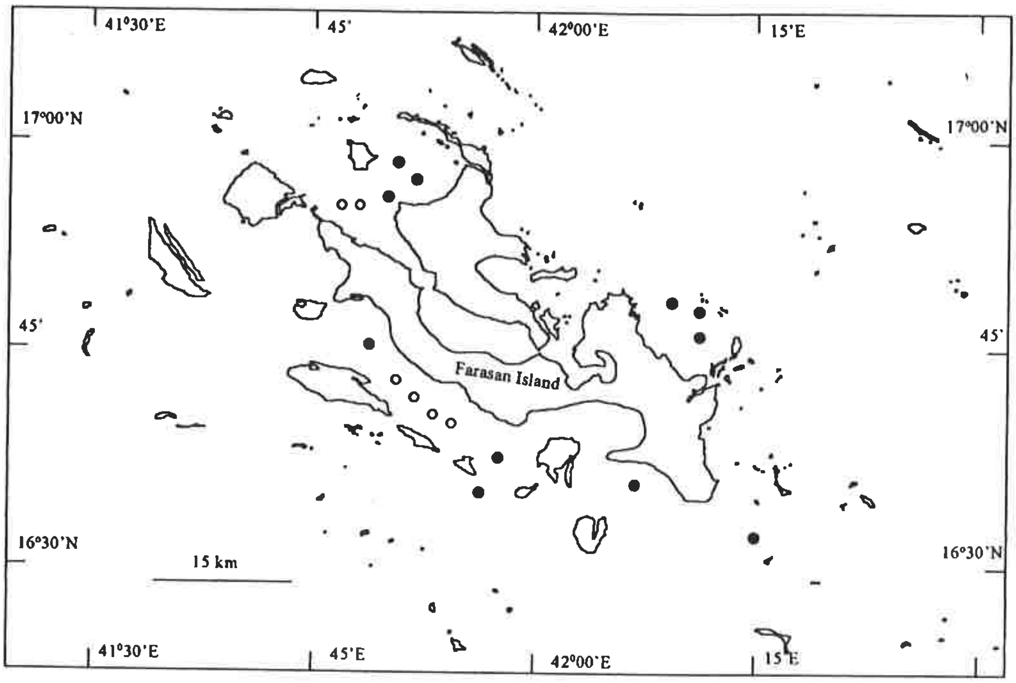

Fig. 2 - Locations of sightings of spinner dolphins, *S. longistostris* (**o**). Incidental observations (o) are also shown.

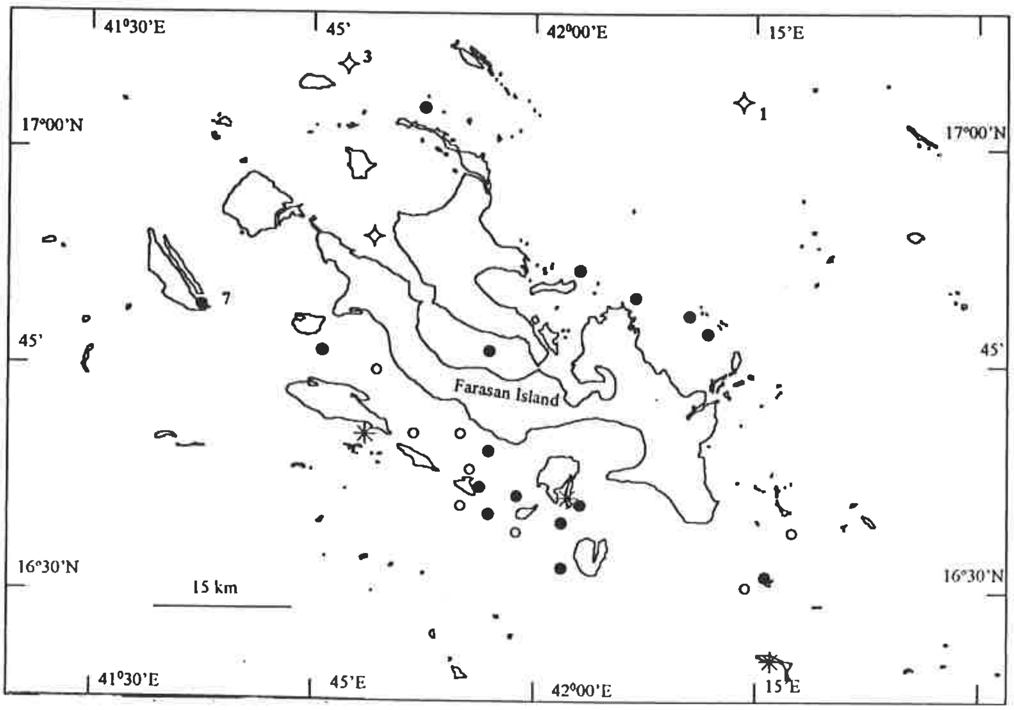

Fig. 3 - Locations of sightings of bottlenose dolphins, *T. truncatus* (**o**), Bryde's whales, *B. edeni* (◊) living and balaenopterid skeletal remains (*). Incidental observations (o) are also shown

THE CURRENT KNOWLEDGE OF MARINE MAMMALS IN MALAYSIA

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The scientific study of marine mammals in Malaysia is still in its infancy. Available information is scanty and comes from records of mostly stranded or dead specimens washed ashore since the early 1950's, and from observational records of a few naturalists. Whales, dolphins, and dugong are protected by law in Malaysia.

In 1996, "The Malaysian Marine Mammals and Whale Shark Working Group" was established to plan and co-ordinate research and conservation activities with members drawn from local universities, marine research institutions, government departments, the navy, and eco-tourism operators. There is a three-year government funded project currently in progress, which aims to establish a database of marine mammals and whale shark through inventory surveys, habitat assessments, and collections of dead specimens throughout the country.

At present, dugong, two species of whales, 11 dolphin species, and one porpoise are known to occur in Malaysian waters. There is evidence to suggest that another six species of cetaceans are likely to pass through the area occasionally. International support is urged for the development of specialised research on marine mammals and particularly at postgraduate level.

OPERATION SIGHTINGS: SIGHTINGS OF CETACEANS IN THE SOUTHERN HEBRIDES, SCOTLAND

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INTRODUCTION The Hebrides, Scotland, are situated geographically at the northwestern edge of the European continental shelf. The waters around the Hebrides have the lowest annual variation in sea temperature of any area around the British Isles, which, together with strong tidal streams, complex seabed topography, and mixing of water bodies around islands and headlands, results in areas of high biological productivity and hence high cetacean abundance.

Since 1997, the Hebridean Whale and Dolphin Trust has been assisting the Sea Watch Foundation in collating sightings of cetaceans from the coastal waters of Northwest Scotland. The aim of the *Operation Sightings* project is to establish and execute a co-ordinated programme of cetacean sightings throughout the Hebrides utilising a network of observers from whale and wildlife watching vessels, fishing boats, private yachts, and ferries.

A summary of the data collected from this project is regularly collated and circulated to Scottish Natural Heritage (Scotland's governmental conservation body), participants of the scheme, and wildlife tour operators. In addition, the summaries have been published in a variety of local newspapers, magazines and displayed upon the internet. This process of dissemination greatly increases local awareness of cetaceans in the Hebrides, helps with the process of monitoring cetacean populations, and, moreover, allows contributors to the scheme to feel that their sightings are of value and are helping to contribute to the conservation of cetaceans in Northwest Scotland.

MATERIALS AND METHODS The Operation Sightings programme was conducted using simple sighting sheets and identification charts which were specifically designed for those taking part in the programme. Each sighting was defined as an encounter with an animal or a group of animals until such time that the animal is no longer in view.

The area within which sightings were collected ranged from 55°20' N - 59°20' N and 4°30' W - 9°00' W. Details were taken of the time and date of the sighting, the species observed and the reliability of this identification, as well as the estimated number of individuals within the encountered group. In most cases, environmental data were also recorded (such as sea state, wind direction, and water depth).

RESULTS In 1998, there were a total of 758 cetacean sightings collected from 42 vessels (including private yachts, commercial boats, fishing boats and ferries) and also reported by members of the general public. These sightings comprised eleven species. the most commonly sighted species were the harbour porpoise, *Phocoena phocoena*, (372 sightings) and minke whale, *Balaenoptera acutorostrata*, (245 sightings). In addition, there were eleven sightings of killer whales, *Orcinus orca*; 42 sightings of common dolphins, *Delphinus delphis*; 31 of bottlenose dolphins,*Tursiops truncatus*; three of Atlantic white-sided dolphins, *Lagenorhynchus acutus*; seven of white-beaked dolphins, *Lagenorhynchus albirostris*; 24 of Risso's dolphins, *Grampus griseus*; five sightings of northern bottlenose whales, *Hyperoodon ampullatus*; two sightings of long-finned pilot whales, *Globicephala melas*, and two sightings of striped dolphins, *Stenella coeruleoalba*. In addition, there were 14 sightings of unidentified delphinids, although judging from their distribution, the majority of these may have been bottlenose dolphins, and 45 sightings of basking sharks. Seasonal patterns in sightings frequency are summarised in Figure 1, and the distribution of sightings are displayed in Figure 2.

DISCUSSION **Harbour porpoise:** Harbour porpoises were sighted throughout the year. A large percentage of the total number of porpoises sighted were reported from the waters around the Small Isles (Rum, Eigg and Muck) and around the Isle of Mull. Porpoise sightings were predominantly in inshore waters of depths of 30 metres or less. The number of reported sightings was greatest between May and September, which was probably also influenced by an increase in sightings effort during this period (Fig. 1A).

Killer whale: This species was frequently sighted off the Ardnamurchan peninsula, and one identifiable individual was sighted around Coll and Tiree on at least three occasions from between May and September (Fig. 1B). This particular individual killer whale has been sighted regularly for the past twelve years, as far north as the Isle of Lewis and as far south as the Isle of Islay (Evans, unpubl. data).

Minke whale: Sightings of minke whales predominated around the Small Isles and the north of Mull, but there were sightings throughout the Hebrides. The peak period for minke whale sightings was between May and September (Fig. 1C), but there were also sightings as late as December. Minke whales and harbour porpoises were often sighted in the vicinity of one another.

Common dolphin: Common dolphins were regularly sighted in the Sea of Hebrides and the waters around Skye and the eastern Outer Hebrides. They were not often seen inshore nor further north than the Isle of Skye. This species was only sighted between the months of May and September (Fig. 1D).

Risso's dolphin: This species was sighted to the north of Mull and the Small Isles, and also south of Skye and south of Tiumpan Head, Isle of Lewis. They were sometimes seen associating with white-beaked dolphins.

Atlantic white-sided and white-beaked dolphins: Atlantic white-sided dolphins were sighted around the Isle of Barra, whilst white-beaked dolphins were rarely seen in the southern Hebrides, but they were sighted around North Uist and Tiumpan Head, Isle of Lewis.

Bottlenose dolphin: Bottlenose dolphins were sighted throughout the year. Sightings were distributed around Mull, Coll, Loch Maddy (Uist) and Tiumpan Head (Isle of Lewis). These give possible evidence for a few resident groups of bottlenose dolphins existing within the Hebrides. It was discovered through the course of this project that bottlenose dolphins were often assumed to be common dolphins as many people were unaware of the existence of bottlenose dolphins in the area. On the other hand, systematic surveys of the Minches and Sea of Hebrides over the last seven years indicated the species to be scarce at least during summer in the region (Boran *et al.*, this volume).

ACKNOWLEDGEMENTS We wish to thank all those who have participated in the *Operation Sightings* scheme. We especially thank Brennan Fairbairns and Christopher Swann for their major contributions to the scheme through their whalewatching operations.

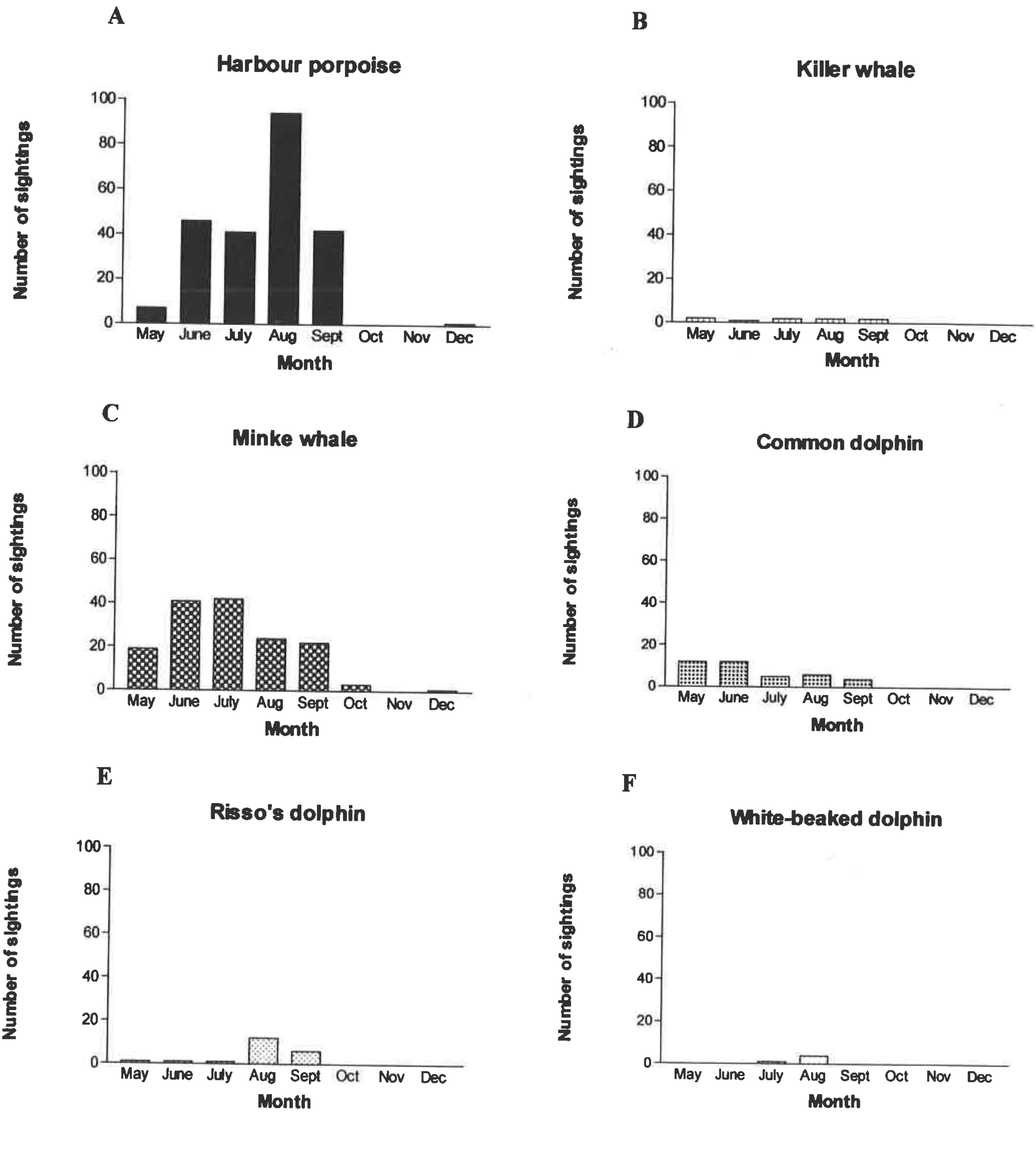


Fig. 1 - Seasonal distribution of cetacean sightings in Northwest Scotland

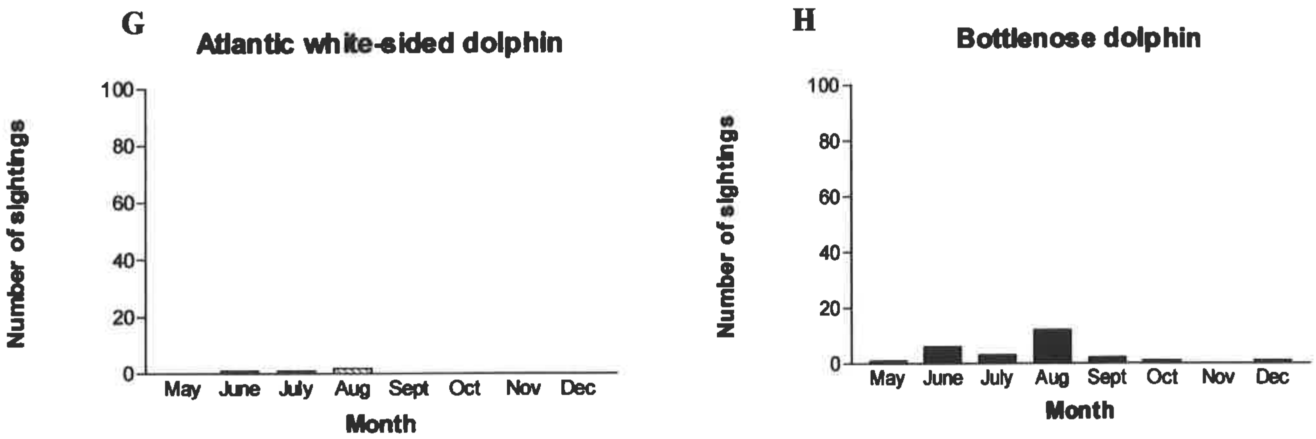
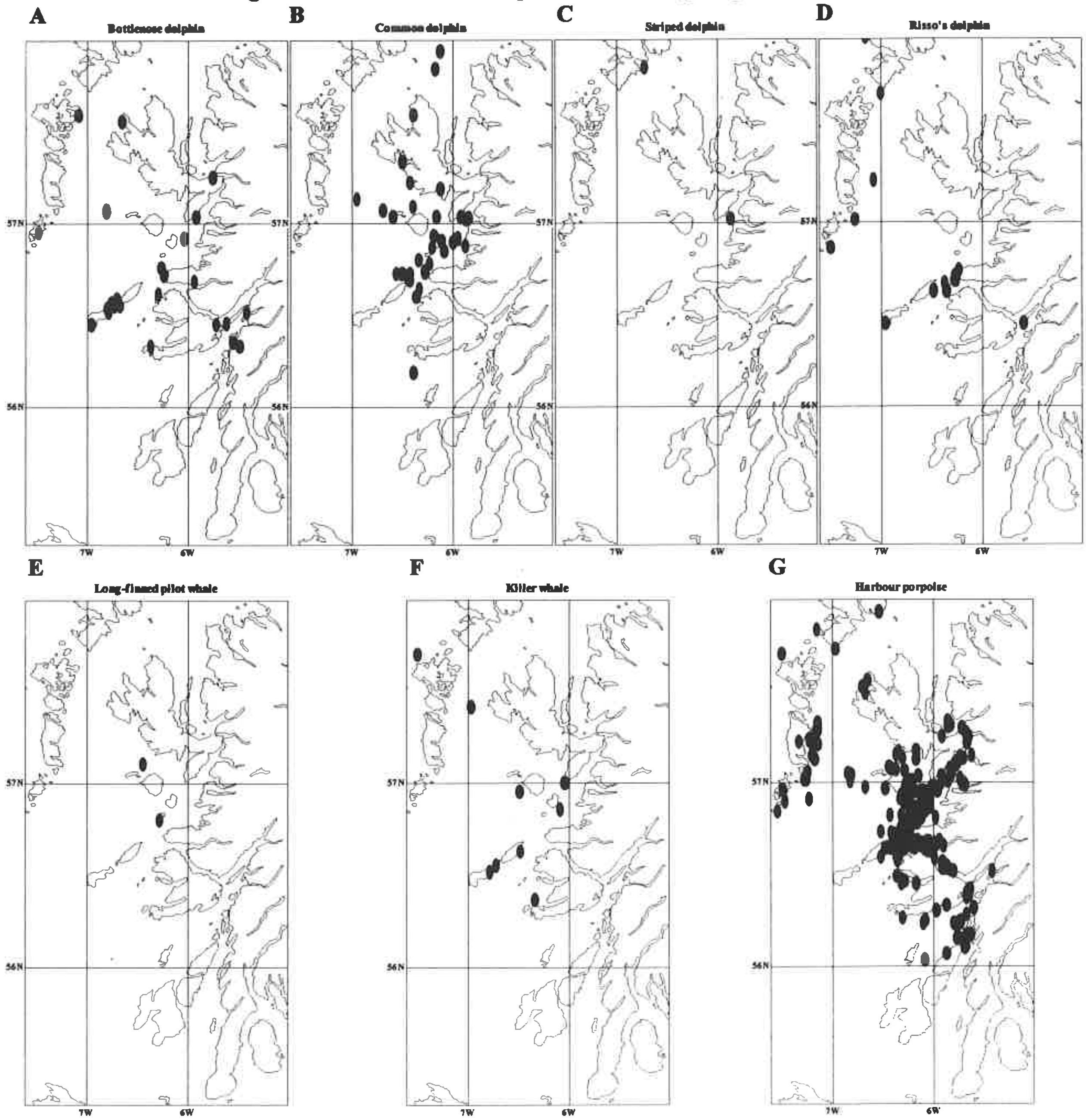
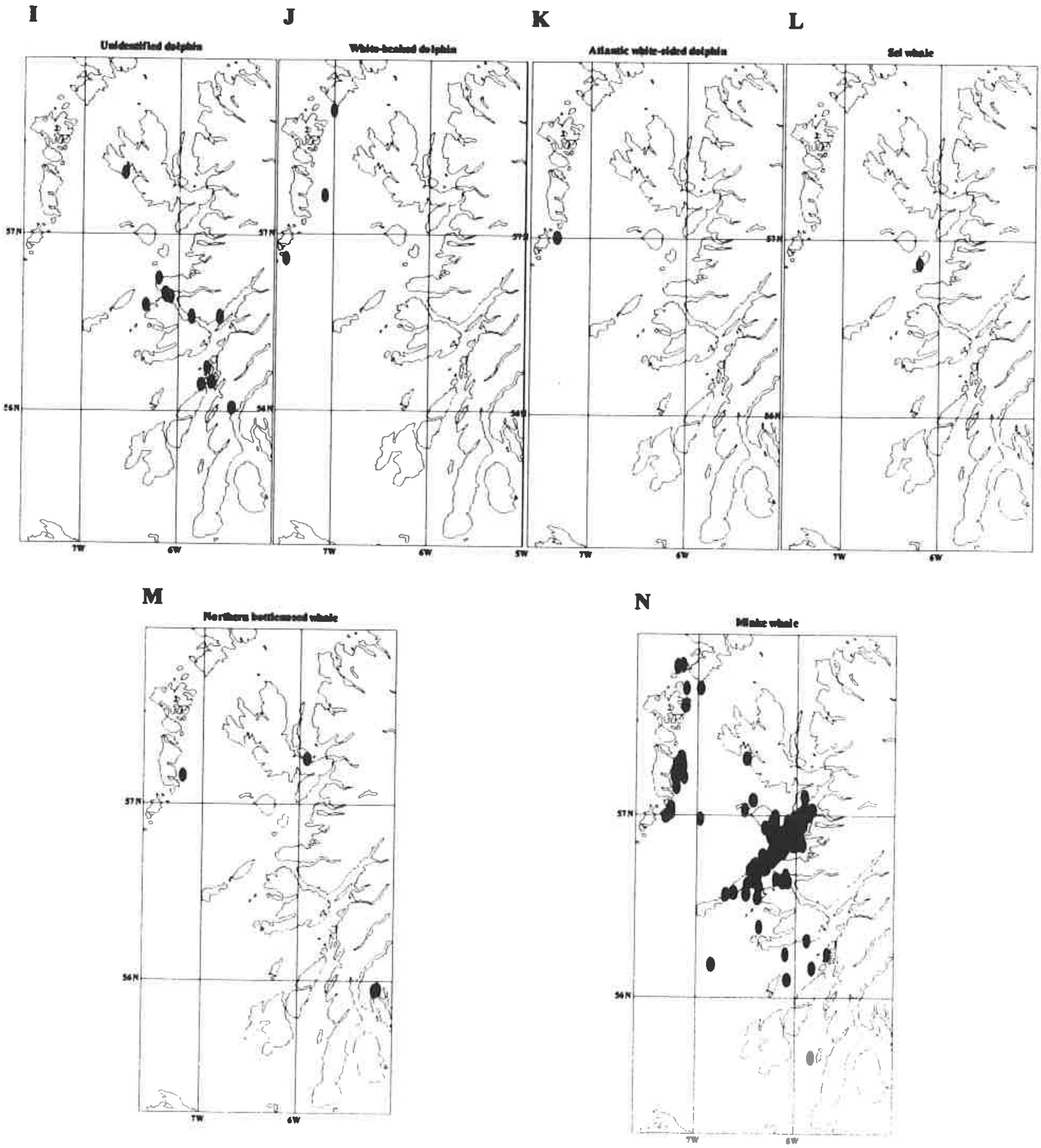


Figure 2. The distribution of reported cetacean sightings during 1998.




I
Unidentified dolphin
J
White-beaked dolphin
K
Atlantic white-sided dolphin
L
Sei whale
M
Northern bottlenosed whale
N
Minke whale
57N
56N
7W
6W
5W

CETACEANS OF THE BALEARIC ISLANDS

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The cetacean fauna of the Balearic islands has received rather little attention from researchers, various references being spread through the literature although, so far, no systematic research has been carried out in connection with stranded animals or those at sea. The present work analyses the cetaceans of the Balearic archipelago from two perspectives. The first offers an historical synthesis of the records from the last century from old historical documents, press, and various literature, and the second one presents the results of a study on the strandings and sightings which occurred in the islands during the years 1993-98.

Data are presented in connection with the biology of these species, the possible causes of their deaths as well as their frequency, distribution, and seasonality. Up to date, the following cetaceans have been reported to be present within the archipelago: the bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), false killer whale (*Pseudorca crassidens*), Cuvier's beaked whale (*Ziphius cavirostris*), sperm whale (*Physeter macrocephalus*) and fin whale (*Balaenoptera physalus*). It is worth highlighting the large number of strandings of bottlenose dolphins. The coastal habits of this species makes them susceptible to being trapped by gill nets from the several local fisheries existing within the island.

DOLPHIN STUDY ON THE NORTH COAST OF TUNISIA

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Bibliographic works that deal with cetaceans refer only to strandings or to accidental captures. They do not give sufficient information about ecology and behaviour of the species. For this reason, we have conducted an inquiry from the observations of fishermen.

Despite the imperfections related to these data which are not very scientific and are of a subjective nature, this type of approach constitutes a contribution to our knowledge about dolphins, their composition, frequency, distribution, behaviour, and their interaction with fishing activities along the north coast of Tunisia.

IS IT THE GUINNESS? THE RELATIVELY HIGH LEVEL OF LIVE CETACEAN STRANDINGS OBSERVED ALONG THE IRISH COASTLINE DURING 1998

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The stranding of cetaceans along the Irish coastline has been observed and recorded on an *ad-hoc* basis since 1901. However, since 1992, the Irish Whale and Dolphin Group has co-ordinated a dedicated strandings programme, which records the number, species, and location of cetacean strandings. During 1998, 51 stranding events, involving 81 cetaceans, were recorded along the Irish coastline. Of these, 46 individuals (57%) were noted from 18 separate live stranding events, involving six different species (four delphinids, one phocoenid, and one Ziphiid). This level of live stranding is much higher than that observed in the previous annual period, where only seven animals (11%) were involved in six live stranding events.

The number of multiple live strandings also displayed an increase in 1998. Seven mass stranding events involving 35 individuals were recorded, and group sizes ranged from 2-17 animals. By comparison, only one multiple live stranding event was noted in 1997.

A number of animals were successfully refloated. These included three Risso's dolphins (*Grampus griseus*), two northern bottlenose whales (*Hyperoodon ampullatus*) and 15 common dolphins (*Delphinus delphis*). However, five Atlantic white-sided dolphins (*Lagenorhynchus acutus*) which live-stranded in Co. Mayo died, despite rescue attempts.

During the period 1901-97, only 38 records of live strandings, including 12 multiple strandings, were observed along the Irish coastline. The reason for the increase in live strandings in 1998 is unclear. However, it is not thought to be a result of recording or observer effort.

HIGH SIGHTING FREQUENCY OF THE PELAGIC SPECIES STRIPED DOLPHIN *STENELLA COERULEOALBA* IN A CLOSED SEA AREA

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INTRODUCTION In August 1996, July and August 1997, the Cetacean Research Group of the University of Athens conducted a sighting survey in Korinthiakos Gulf (Fig. 1), in order to determine the distribution and relative abundance of small cetaceans. The main subject was striped dolphin *Stenella coeruleoalba*, a pelagic species whose presence, according to previous observations, was intense.

MATERIALS AND METHODS The survey took place with the use of two sailing boats (Kamari and Argo) and two inflatable crafts (Oceanos I and Archran) which operated at different time periods and areas. The presence of animals was assessed visually, and a strip transect sampling technique was applied. In addition, a preliminary photo-ID study was carried out. The fieldwork was assisted by ten researchers including the authors. We used GPS units for vessel tracking, motor drive autofocus cameras equipped with 80-200 mm lenses, and SeaPro 2000 navigation software to process the results.

RESULTS Table 1 includes detailed data of distances travelled every day in the field. During a total of 189 hrs of effort time, which covered 983 nautical miles, 33 sightings of striped dolphins were made (Fig. 2). The school size varied from few individuals to large aggregations of fifty or more dolphins (Table 1). We also witnessed the phenomenon of interspecies association (*Stenella coeruleoalba* with *Delphinus delphis* and *Grampus griseus*). The analysis of the photo-ID data enabled the recognition of 45 individuals.

DISCUSSION Striped dolphin *Stenella coeruleoalba* is abundant mainly in offshore waters, at depths greater than 800 metres and at least 15 nautical miles away from the nearest coast (Beaubrun, 1995; Forcada *et al.*, 1990; Franco *et al.*, 1995; Nortabartolo di Sciara and Bearzi, 1992; Nortabartolo di Sciara and Demma, 1994; Politi *et al.*, 1992).

The diet of this dolphin consists of fish (*Diaphus*, *Erythocles*, *Micromesistius*, *Trisopterus*, *Gadinculus*, *Merluccius*, *Merlangius*, *Trachurus*, *Atherina*, *Chauliodus*, *Engraulis*) and squid (Ommastrephidae, Chiroteuthidae, Loliginidae, Histioteuthidae) and decapods (Evans, 1987; Nortabartolo di Sciara and Demma, 1994).

The data obtained lead to the conclusion that we are witnessing an unusually high density of this pelagic species in the closed sea of Korinthiakos Gulf and, in some cases, closer than half a mile to the coast. The most probable causes of this phenomenon are:

- The geomorphology of the study area which is characterised by great depths very close to the shore (Fig. 2), (Jefferson *et al.*, 1993).
- The abundance of certain fish (*Micromesistius, Merluccius, Trisopterus*, *Gadinculus*, *Trachurus*, *Engraulis*) (Papakonstandinou, 1986) which represent a main element of this dolphin's diet.

ACKNOWLEDGEMENTS We would like to express our gratitude to Dr. A. Frantzis for his invaluable help. We also thank Dr. D. Zafiropoulos, V. Karpouzlis, M. Trivourea, A. Verriopoulou, T. Hassidis and G. Paximadis for their support, and last but not least, to the Kostopoulos Foundation and A. Efstathiou for providing the necessary equipment.

REFERENCES

Beaubrun, P. C. 1995. *Atlas preliminaire de distribution des cetaces de Mediterranee.* CIESM, Musee Oceanographique Monaco. 87pp.

Forcada, J., Aguilar, A., Evans, P. G. H. and Perrin, W. F. 1990. Distribution of common and striped dolphins in the temperate waters of the Eastern North Atlantic. Pp. 64-66. In: *European Research on Cetaceans - 4* Proc. 4th Ann. Conf. ECS, Palma de Mallorca, Spain, 2-4 Mar, 1990. (Eds. P. G. H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, UK. 140pp.

Franco, I., Mas, J. and Rodriguez C. 1995. Cetacean sightings in the Alboran Sea .July 1993. *Rapp. Comm. Int. Medit.*, 34.

Evans, P. G. H. 1987. *The natural history of whales and dolphins.* Academic Press, London. 343pp.

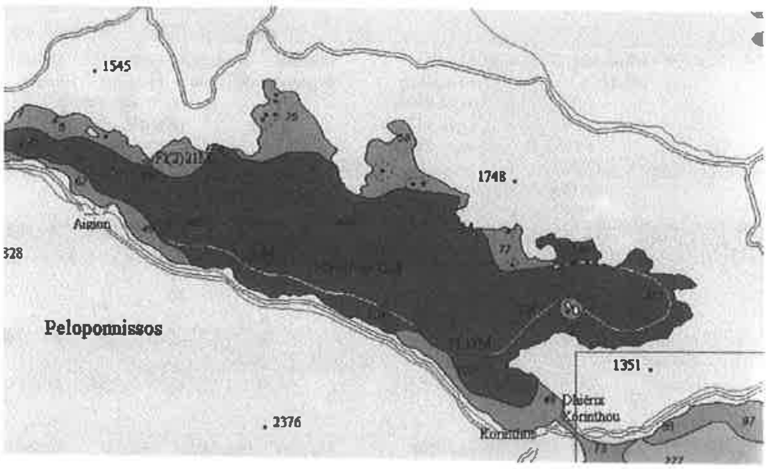
Jefferson, T., Leatherwood, S. & Webber, M. 1993. *Marine mammals of the world.* UNEP/FAO. 320pp.

Notarbartolo di Sciara, G., Bearzi, G. 1992. Cetaceans in the Northern Adriatic Sea: past, present and future. *Rapp. Comm. Int. Mer Medit.*, 33: 303.

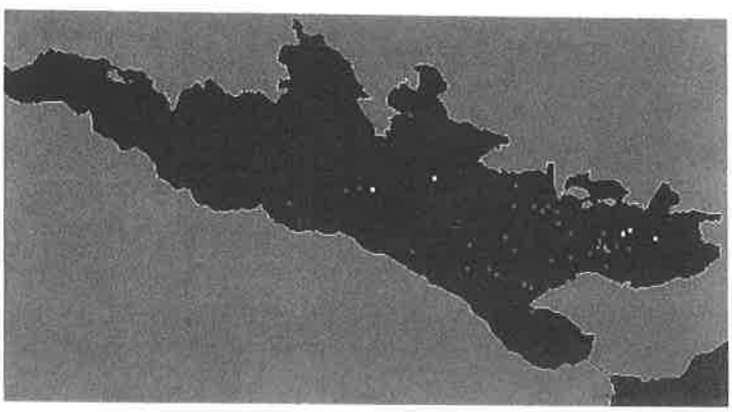
Nortabartolo di Sciara, G. and Demma, M. 1994. *Guida dei mammiferi marini del Mediterraneo.* Editore Franco Muzzio. Scienze Naturali. 262pp.

Papaconstantinou, C. 1986. The ichthyofauna of Korinthiakos and Patraikos Gulfs and the Ionian Sea. *Biologia Gallo-hellenica*, 12: 229-236.

Politi, E., Bearzi, M., Notabartolo di Sciara, G., Cussino, E. and Gnone, G. 1992. Distribution and frequency of cetaceans in the waters adjacent to the Greek Ionian Islands. Pp. 75-78. In: *European Research on Cetaceans - 6*: Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb, 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.



Map 1 - The geomorphology of the study area
Maximum Length: 65 nm. Maximum Width: 19 nm. Maximum Depth 905 m.



Map 2 - The 33 sightings in the study area

Table 1 - Distances travelled and time spent every day in the field

Sightings of Stenella coeruleoalba (S.c.) - Korinthiakos gulf

Date	Miles "-"	Miles "+"	Miles with dolphins	Tot.miles	Number of sighting	Number of groups	Number of dolphins	Groups/ /n.miles	Dolphins/ /miles	Groups/ / miles "+"	Doplhins/ miles"+"
Sailing boat "Kamari "											
22/8/1996	42,54	18,61	3,25	64,4	sight#1Sc	1	25	1/64,4	25/64,4	1/18,61	25/18,61
Total result "Kamari "	42,54	18,61	3,25	64,4		1	25	1/64,4	25/64,4	1/ 18,61	25/ 18,61
Sailing boat "Argo "											
Date	Miles "-"	Miles "+"	Miles with dolphins	Tot.miles	Number of sighting	Number of groups	Number of dolphins	Groups/ /n.miles	Dolphins/ /miles	Groups/ / miles "+"	Doplhins/ miles"+"
5/7/1997	0	22,73	5,01	27,74	sight.#2 Sc	1	22	1/ 27,74	22/ 27,74	1/22,73	22/22,73
6/7/1997	0,81	17,57	14,3	32,68	sight.#3 Sc,Dd	1	18	1/ 32,68	18/ 32,68	1/17,57	18/17,57
7/7/1997	4,1	0	0	4,1		0	0	0	0	0	0
8/7/1997	17,78	3,92	0	21,7		0	0	0	0	0	0
11/7/1997			1,02		sight.#4Sc*	1	30	(** s#6 is the	*Beginning of research		
			3,03		sight.#5Sc	1	15	same with	conducted by the		
			3,23		sight.#6Sc**	1	15	"Okeanos I")	inflatable boat "OKEANOS I"		
Total	3,47	23,81	7,28	34,56		3	60	3/ 34,56	60/ 34,56	3/23,81	60/23,81
12/7/1997			6,81		sight.#9Sc	1	5				
			3,89		sight.#10Sc,Dd,G	1	7				
Total	0	30,83	10,7	41,53		2	12	2/41,53	12/41,53	2/ 30,83	12/ 30,83
13/7/1997	10,95	19,44	1,23	31,62	sight.#13 Sc	1	42	1/31,62	42/31,62	1/19,44	42/19,44
14/7/1997			2,28		s#14 Sc,Dd	1	55				
			3,25		s#15Sc,Dd,Gg	1	18				
			1,15		s#16 Sc	1	17				
Total	0,13	31,22	6,68	38,03		3	90	3/38,03	90/38,03	3/ 31,22	90/ 31,22
15/7/1997	15,96	7,23	0	23,19		0	0	0	0	0	0
16/7/1997	3,91	2,47	0	6,38		0	0	0	0	0	0
17/7/1997	0	49,16	0,72	49,88	T.truncatus	0	0	Σύνολο	0	0,0000	0
18/7/1997			0,59		sight.#20Sc	1	25		*Beginning of research		
			0,86		sight.#21Sc	1	12		conducted by the		
			2,33		sight.#22Sc,Dd	1	26		inflatable boat "Archran"		
Total	18,09	21,44	3,78	43,31		3	63	3/43,31	63/43,31	3/ 21,44	63/ 21,44
20/7/1997	21,41	0	0	21,41		0	0	0	0	0	0
21/7/1997	12,92	6,91	1,27	21,1	sight.#24Sc	1	11	1/21,1	11/21,1	1/ 6,91	11/ 6,91
22/7/1997	22,96	2,69	0	25,65		0	0	0	0	0	0
23/7/1997	3,07	38,9	0	41,97		0	0	0	0	0	0
24/7/1997			3,55		sight.#25Sc	1	21				
			2,09		sight.#26Sc	1	23				
Total	0,58	43,91	5,64	50,13		2	44	2/50,13	44/50,13	2/43,91	44/ 43,91
25/7/1997	0,62	14,24	0	14,86		0	0	0	0	0	0
Total result "Argo"	136,76	336,47	56,61	529,84		17	362	17/529,84	362/529,84	17/336,47	362/336,47
Inflatable boat "Okeanos I "											
Date	Miles "-"	Miles "+"	Miles with dolphins	Tot.miles	Number of sighting	Number of groups	Number of dolphins	Groups/ /n.miles	Dolphins/ /miles	Groups/ / miles "+"	Doplhins/ miles"+"
11/7/1997			4,34		sight.#6 Sc*	1	15	(** s#6 is the	* 5th day of the research		
			1,8		sight.#7 Sc	1	10	same with	conducted by the		
			1,54		sight.#8 Sc	1	11	"Argo")	sailing boat "Argo"		
Total	6,13	48,99	7,68	62,8		3	36	3/62,8	36/62,8	3/ 48,99	36/48,99
12/7/1997			16,13		sight.#11 Sc	1	14				
			1,97		sight.#12Sc	1	9				
Total	19,33	38,9	18,11	76,34		2	23	2/ 76,34	23/76,34	2/ 38,9	23/ 38,9
13/7/1997	7,39	12,43	0	19,82		0	0	0	0	0	0
14/7/1997			0,63		sight.#17 Sc	1	1				
			8,56		sight.#18Sc,Dd	1	40				
			3,62		sight.#19 Sc	1	2				
Total	0	19,47	12,81	32,28		3	43	3/ 32,28	43/32,28	3/ 19,47	43/ 19,47
15/7/1997	19,15	34,14	0	53,29		0	0	0	0	0	0
Total result "Okeanos"	52	153,93	38,6	244,53		8	102	8/ 244,53	102/244,53	8/ 153,93	102/ 153,9
Inflatable boat "Archran "											
Date	Miles "-"	Miles "+"	Miles with dolphins	Tot.miles	Number of sighting	Number of groups	Number of dolphins	Groups/ /n.miles	Dolphins/ /miles	Groups/ / miles "+"	Doplhins/ miles"+"
18/7/1997	8,23	6,03	4,87	19,13	sight.#23 Sc	1	25	1/19,13	25/19,13	1/ 6,23	25/ 6,23
				* 13th day of the research conducted by the sailing boat "Argo"							
29/7/1997	0	26,38	0	26,38		0	0	0	0	0	0
4/8/1997				End of the field trips conducted by "Argo"							
Total	20,7	31,46	4,1	56,26	sight #27Sc	1	8	1/56,26	8/56,26	1/ 31,46	8/ 31,46
6/8/1997	1,27	22,72	0	23,99		0	0	0	0	0	0
8/8/1997			3,56		sight.#28 Sc	1	7				
			0		sight.#29 Sc	1	3				
Total	1,85	0	3,56	61,58		2	10	2/61,58,82	10/61,58	2/ 56,17	10/ 56,17
9/8/1997	0	20,24	0	20,24		0	0	0	0	0	0
10/8/1997	0	11,69	7	18,69	sight.#30Sc,Dd	1	24	1/18,69	24/18,69	1/ 11,69	24/ 18,69
12/8/1997	0	24,27	0	24,27		0	0	0	0	0	0
13/8/1997			7,13		sight.#31Sc	1	20				
			0		sight.#32Sc	1	6				
Total	0,19	37,43	7,13	44,75		2	26	2 /44,75	26/44,75	2/ 37,43	26/ 37,43
14/8/1997	0	15,62	13,71	29,33	sight.#33Sc,Dd	1	40	1/ 29,33	40/29,33	1/ 15,62	40/ 15,62
Total result "Archran"	32,24	252,01	40,37	324,62		8	133	8/ 324,62	133/324,6	8/ 252,01	133/ 252,
Total result for the whole research on Stenella coeruleoalba	Miles"-"	Miles"+"	Miles with dolphins	Total miles	sightings	Total no. of groups	Total no. of dolphins	Total no. of groups/ /total miles	Total no. of dolpins /total miles	Total no. of groups /total miles "+"	Total no. of dolpins /total miles "+"
	263,54	680,58	138,83	1139,12	33	33	607	33/ 1139,1	607/ /1139,1	36/ /736,75	607/ /736,75

Sightings of Stenella coeruleoalba (S.c.) - Korinthiakos gulf

Sailing boat "Kamari "

Date	Minutes "-"	Minutes "+"	Minutes with dolphins	Tot.minute	Number of sighting	Number of groups	Number of dolphins	Groups/ /t.minutes	Dolphins/ /t.minutes	Groups/ minutes "+"	Doplhins/ minutes"+"
22/8/1996	497	117	33	647	sight#1Sc	1	25	1/ 647	32/ 647	1/ 117	25/ 117
Total result "Kamari "	497	117	33	647		1	25	1/ 647	25/ 647	1/ 117	25/ 117

Sailing boat "Argo "

Date	Minutes "-"	Minutes "+"	Minutes with dolphins	Tot.minute	Number of sighting	Number of groups	Number of dolphins	Groups/ /t.minutes	Dolphins/ /t.minutes	Groups/ minutes "+"	Doplhins/ minutes"+"
5/7/1997	0	303	107	410	sight.#2 Sc	1	22	1/ 410	22/ 410	1/ 303	22/ 303
6/7/1997	8	210	355	573	sight.#3 Sc,Dd	1	18	1/ 573	18/ 573	1/ 210	18/210
7/7/1997	61	0	0	61	0	0	0	0	0	0	0
8/7/1997	68	270	0	338	0	0	0	0	0	0	0
11/7/1997			37		sight.#4Sc*	1	30	(** s#6 is the	*Beginning of research		
			114		sight.#5Sc	1	15	same with	conducted by the		
			95		sight.#6Sc**	1	15	"Okeanos I")	inflatable boat "OKEANOS I"		
Total	73	0	246	319		3	60	3/ 619	60/ 619	3/300	60/ 300
12/7/1997			111		sight.#9Sc	1	5				
			71		sight.#10Sc,Dd.(	1	7				
Total	0	0	182	182		2	12	2/ 575	12/ 575	2/ 393	12/393
13/7/1997	173	265	29	467	sight.#13 Sc	1	42	1/ 467	42/ 467	1/ 265	42/19,44
14/7/1997			74		s#14 Sc,Dd	1	55				
			54		s#15Sc,Dd,Gg	1	18				
			25		s#16 Sc	1	17				
Total	7	0	153	160		3	90	3/565	90/ 565	3/ 405	90/ 405
15/7/1997	244	101	0	345		0	0	0	0	0	0
16/7/1997	73	46	0	119		0	0	0	0	0	0
17/7/1997	0	626	18	644	T.truncatus	0	0	0	0	0	0
18/7/1997			16		sight.#20Sc	1	25	*Beginning of research			
			23		sight.#21Sc	1	12	conducted by the			
			40		sight.#22Sc,Dd	1	26	inflatable boat "Archran"			
Total	0	0	79	79		3	63	3/620	63/ 620	3/ 278	63/ 278
20/7/1997	237	0	0	237		0	0	0	0	0	0
21/7/1997	231	122	30	383	sight.#24Sc	1	11	1/ 383	11/383	1/ 122	11/ 122
22/7/1997	349	37	0	386		0	0	0	0	0	0
23/7/1997	51	517	0	568		0	0	0	0	0	0
24/7/1997			81		sight.#25Sc	1	21				
			62		sight.#26Sc	1	23				
Total	17	565	143	725		2	44	2/ 725	44/ 725	2/ 565	44/ 565
25/7/1997	2	206	0	208		0	0	0	0	0	0
Total result "Argo"	1857	4644	1342	7843		17	362	17/ 7843	362/ 784	17/ 4644	362/4644

Inflatable boat "Okeanos I "

Date	Minutes "-"	Minutes "+"	Minutes with dolphins	Tot.minute	Number of sighting	Number of groups	Number of dolphins	Groups/ /t.minutes	Dolphins/ /t.minutes	Groups/ minutes "+"	Doplhins/ minutes"+"
11/7/1997	58	322	80		sight.#6 Sc*	1	15	(** s#6 is the	* 5th day of the research		
			20		sight.#7 Sc	1	10	same with	conducted by the		
			25		sight.#8 Sc	1	11	"Argo")	sailing boat "Argo"		
Total	58	322	125	505		3	36	3/ 505	36/ 505	3/ 322	36/ 322
12/7/1997	48	225	115		sight.#11 Sc	1	14				
			10		sight.#12Sc	1	9				
Total	48	225	125	398		2	23	2/ 398	23/ 398	2/ 225	23/ 225
13/7/1997	17	22	0	39		0	0	0	0	0	0
14/7/1997	0	219	70		sight.#17 Sc	1	1				
			142		sight.#18Sc&Dd	1	40				
			50		sight.#19 Sc	1	2				
Total	0	219	262	481		3	43	3/ 481	43/ 481	3/ 219	43/ 219
15/7/1997	98	221	0								
Total	98	221	0	319		0	0	0	0	0	0
Total result "Okeanos"	221	1009	512	1742		8	102	8/ 1742	102/174	8/ 1009	102/ 1009

Inflatable boat "Archran "

Date	Minutes "-"	Minutes "+"	Minutes with dolphins	Tot.minute	Number of sighting	Number of groups	Number of dolphins	Groups/ /t.minutes	Dolphins/ /t.minutes	Groups/ minutes "+"	Doplhins/ minutes"+"
18/7/1997	42	47	126	215	sight.#23 Sc	1	25	1/ 215	25/ 215	1/ 47,0	25/ 47
				* 13th day of the research of the sailing boat "Argo"							
29/7/1997	0	427	0	427		0	0	0	0		0
4/8/1997				End of the field trips conducted by "Argo"							
Total	105	279	46	0	sight.#27Sc	1	8	1/ 430	8/ 430	1/ 279	8/ 279
6/8/1997	161	5	0	166		0	0	0	0	0	0
8/8/1997			58		sight.#28Sc	1	7				
			11		sight.#29Sc	1	3				
Total	9	296	69	374		2	10	2/ 374	10/ 374	2/ 296	10/ 296
9/8/1997	0	222	0	222		0	0	0	0	0	0
10/8/1997	0	101	146	247	sight.#30Sc ,Dd	1	24	1/247	24/247	1/ 101	24/ 101
12/8/1997	0	159	0	159		0	0	0	0	0	0
13/8/1997	5	290	144		sight.#31Sc	1	20				
			50		sight.#32Sc	1	4				
Total	5	290	194	489		2	24	2 /489	26/ 489	2/ 290	26/ 290
14/8/1997	0	116	217		sight.#33Sc						
		12			&D.delphis						
Total	0	128	217	345		1	40	1/ 345	40/ 345	1/ 128	40/ 128
Total result "Archran"	322	1954	798	3074		8	131	8/ 3074,0	133/3074	8/1954,0	133/ 1954

Total result for the whole research on Stenella coeruleoal	Minutes"-"	Minutes"+"	Minutes with dolphins	Total Minutes	sightings	Total no. of groups	Total no. of dolphin	Total no. of groups/ /Total Minutes	Total no. of dolpins /Total Minutes	Total no. of groups/ /Total Minutes "+"	Total no. of dolpins/ /Total Minutes "+"
	2823	7413	2795	12653	33	33	607	33/ 12653	607/ /12653	33/ /7413	607/ / 7413

CUVIER'S BEAKED WHALES *ZIPHIUS CAVIROSTRIS* CUVIER, 1823 (CETACEA; ZIPHIIDAE) IN THE CANARY ARCHIPELAGO

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The Cuvier's beaked whale *Ziphius cavirostris* Cuvier, 1823, is currently the member of the Ziphiidae family with more records due to its cosmopolitan distribution in warm-temperate, subtropical and tropical waters of all the oceans. However, little is known about its natural history. Between May 1980 and February 1998, 31 strandings, involving 40 specimens, were registered along the coasts of the Canary Islands.

From the latter, 15 were males, 18 females, and 7 were undetermined. Three of the cases were mass strandings, and two were couples. Most of the specimens were photographed, measured, and a necropsy made. The present work reviews the historical strandings in the Canary Archipelago and their distribution along the south side of the northoriental Atlantic, offering information regarding frequency, spatial and temporal distribution of the strandings in the Canaries, as well as the age class and sex, in addition to results regarding their biology such as reproduction, feeding habits and parasitism.

BOTTLENOSE DOLPHINS *TURSIOPS TRUNCATUS* STRANDED IN THE CANARY ISLANDS

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The bottlenose dolphin *T.truncatus* can be found in many types of marine habitats, from shallow to oceanic waters, with presence in warm temperate, warm, subtropical and tropical waters of all the oceans. To date, there are records of 26 strandings of bottlenose dolphins in the coasts of the Canary islands. All cases were individual strandings. From the latter, 7 (28.0%) were passive, 7 (28.0%) were active and 11 (44%) were unknown. At the time of finding, the condition of the 24 specimens was the following: 7 (29.2%) fresh, 6 (25.0%) moderately decomposed, and 11 (45.8%) in advanced state of decomposition. The spatial distribution of the strandings amongst the islands was the following: none in Lanzarote and its small islands, two (7.7%) in Fuerteventura, three (11.5%) in Gran Canaria, 18 (69.2%) in Tenerife, two (7.7%) in La Gomera, none in La Palma, and one (3.8%) in the island of El Hierro.

The sex was determined in 23 (88.5%) of the cases from which 14 (60.9%) were males and nine (39.1%) were females. From the males, eight (57.1 %) were adults or subadults, 5 (35.7%) immature and one (7.1%) calf. From the females, four (57.1%) were adults or subadults and two (28.6%) subadults. The smallest calf was 118 cm long. No foetus were registered. The mean length of the adults or subadults was 310 cm (n = 8, range 280-340 cm, SD = 18.7 and E.T ± 6.7 cm), and 251 cm (n = 5, range 220-270, SD = 21.1 and E.T ± 9.8) for the immature ones. The mean length of the female adults and subadults was 284.3 cm (n = 4, range 266-306 cm, SD =16.6 and E.T ± 8.3 cm).

The mean number of teeth in the maxillary series was 22.6 (n = 6, range 21-25, SD = 1.6 and E.T ± 0.7) and 21.8 in the lower ones (n = 6, range 21-23, SD = 0.8 and E.T ± 0.3). Regarding the coloration pattern, in the Canary specimens, the dorsal cape and the spinal blaze are clearly distinguished from the rest of the coloured elements.

OBSERVATIONS OF HARBOUR PORPOISES IN THE MARINE REGION ADJACENT TO THE SADO ESTUARY, PORTUGAL

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INTRODUCTION During recent decades, there has been a decline in abundance of harbour porpoises (*Phocoena phocoena*) in Portuguese waters (S.N.P.R.C.N., 1990). Nevertheless, studies on this species are scarce (Sequeira and Ferreira, 1994; Sequeira, 1996; Sequeira *et al.*, 1996). The conservation status of harbour porpoises along the Portuguese coast remains undetermined (S.N.P.R.C.N., 1990).

Occasional observations indicate the presence of harbour porpoises in the marine region adjacent to the Sado estuary (Gaspar, unpubl. data; Vieira, unpubl. data). The aim of this work was to study the occurrence pattern of harbpour porpoises in this region. Here, we present our preliminary findings.

MATERIALS AND METHODS The study area: The study area is located in the marine region adjacent to the Sado estuary (Fig. 1). In general, it is characterised by shallow (depths less than 5 m.) and deep waters (depths between 10 and 50 m.), including a ship channel. The seabed is mainly sandy; rock formations are only found on the shoreline of Arrabida.

Fishing activity in the area include gillnets, fishing traps and trawlers. Recreational and tourist boats also operate in the region, mainly during summer months. Part of the study area is located in a Marine Park ("Parque Marinho do Professor Luiz Saldanha"), estalished in 1997.

Sampling Strategy: Land-based observations using 15x80 binoculars and naked eye were conducted on 60 days between April and October 1998, totalling 188 hours. Observations were made between 06:00 hrs and 16:00 (sunset) from three elevated points on the coastline: Portinho da Arrábida, Outão, and Tróia. Observations were limited to between 3 and 3.9 km from the shore (Fig.1).

Watches were made by one of us (A. Martins) and were initiated when visibility was greater than the observational limits, and wave height was less than 1 metre. At each observation point, the entire observation area was scanned every 30 min. for at least 15 min. if no porpoises were seen. When a porpoise sighting was made, they were observed for as long as possible. Position relative to known points, behaviour, number, and age class of animals (calves or adults) were recorded for each sighting. The presence of other cetacean species in the study area was also recorded.

Occasionally, simultaneous boat observations were conducted by the second author (R. Gaspar).

RESULTS Harbour porpoises were sighted on 45% of sampling days, and were observed during all study months (Fig. 2). In June, July, August and October, they were observed on at least 50% of sampling days.

Overall, the number of sightings per hour increased from April to October, with the exception of September (Fig. 3).

Gruop size varied between 1 and 10. Mean group size overall was 3.2 (S.D.= 1.8) but decreased from June to October (Fig. 4).

Calves were observed from August to October. Boat surveys recorded the presence of foetal folds in one calf observed in August.

Behaviour such as jumping, pop-splashing, spy-hopping, and staying-at-the-surface were occasionally observed.

Bottlenose dolphins from coastal and local resident populations were also observed in the study area. In none of these instances were encounters with harbour porpoises observed. However, some observations were made very close in time in separate locations.

DISCUSSION Our results show that this species occurred in the area from April to October. Previous occasional observations of harbour porpoises in the study area were made in June 1994 (Gaspar, unpubl. data), June to August, and October to November 1997 (Vieira, unpubl. data). These observations occurred in months in which, according to our study, the presence of harbour porpoises is more probable in this area.

The observations also indicate an increase in the number of sightings per hour and a decrease in the mean group size from June to October. This suggests a change in group structure with a tendency for increased dispersion of the animals during this period.

The calving season is poorly known for this species along the Portuguese coast. Previous records are scarce (one lactating female and a newborn in January; one pregnant female, and a newborn calf in March, both reported by Sequeira, 1996). Our observations add the record of a newborn calf in August.

Elsewhere in the North Atlantic, interactions betwen harbour porpoises and bottlenose dolphins are known to occur (Patterson *et al*., 1998). Although these species are sympatric in our study area, such encounters were not observed.

Future work towards conservation: To study the occurrence pattern of harbour porpoise in the region, land observations will continue throughout a year cycle. Future work will survey a bigger study area from both land and sea.

Our findings show that harbour porpoises are common in the area at least during a certain period of the year. Nevertheless, strandings of this species in the region are rare (Sequeira *et al*., 1996). Local fishermen will be interviewed in an attempt to evaluate fishing effort and possible impacts of bycatches.

There is a higher concentration of recreational and tourist boats during summer months. Because calves were also observed in that period, future work should address the impact of these activities on the behaviour of porpoises.

The study area is mainly located in a recently created Marine Park. Our aim is that this and future work will contribute to management and protection measures for this species in the area.

ACKNOWLEDGEMENTS This work was made possible through the support of the Parque Natural da Arrábida, Instituto Português da Juventude, Câmara Municipal de Setúbal, Belos transportes S.A. and C.P.- Caminhos de Ferro Portugueses.

We would like to thank to Hospital Ortopédico de Santiago do Outão and Torralta for allowing the use of their buildings to make observations.

REFERENCES

Patterson, I. A. P., Reid, R. J., Wilson, B., Grellier, K., Ross, H. M. and Thompson, P. M. 1998. Evidence for infanticide in bottlenose dolphins: An explanation for violent interactions with harbour porpoises? *Proceedings of the Royal Society of London*. Series B, 265: 1167-1170.

Sequeira, M. 1996. Harbour porpoises, *Phocoena phocoena*, in Portuguese waters. *Rep. Int. Whal. Commn.*, 46: 583-586.

Sequeira, M. and Ferreira, C. 1994. Coastal fisheries and cetacean mortality in Portugal. *Rep. Int. Whal. Commn.*, 15: 165-181.

Sequeira, M., Inácio, A., Silva, M. A. and Reiner, F. 1996. Arrojamentos de Mamiferos Marinhos na costa Continetal Portuguesa entre 1989 e 1994. *Estudos de Biologia e Conservação da Natureza 19.* Instituto da Conservação da Natureza, Lisboa. 52pp.

S.N.P.R.N. 1990. *Livro Vermelho dos Vertebrados de Portugal.* Vol I. 219pp.

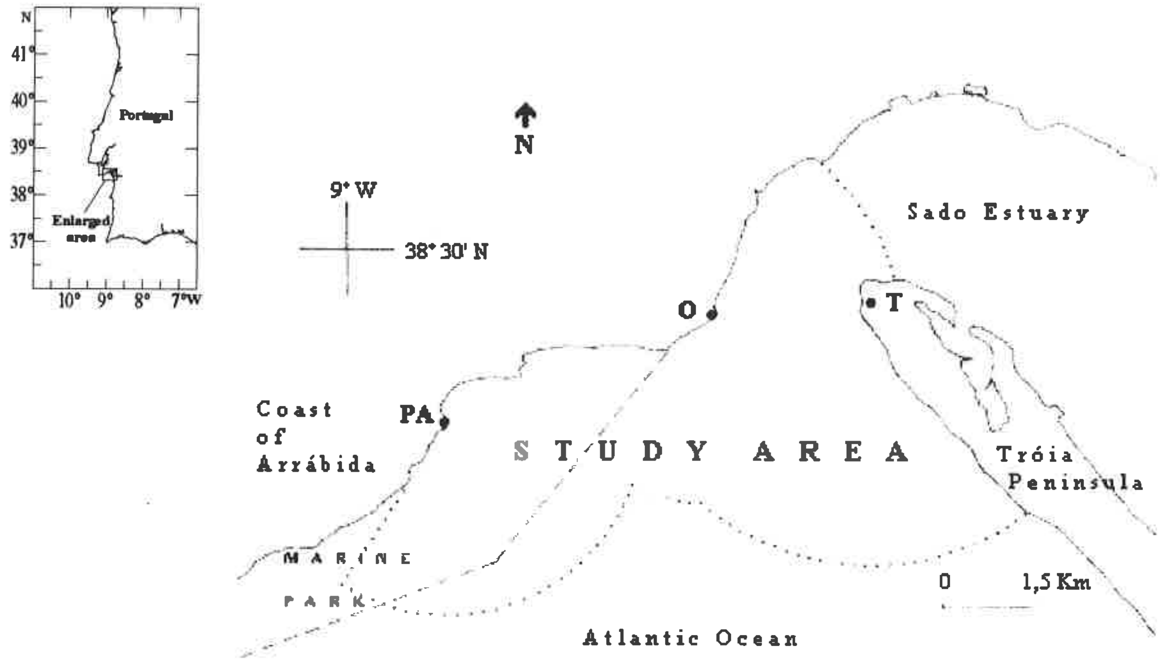

Fig. 1. Study area limits (•) and location of the observation points: O = Outão, PA = Portinho da Arrábida, T = Tróia.

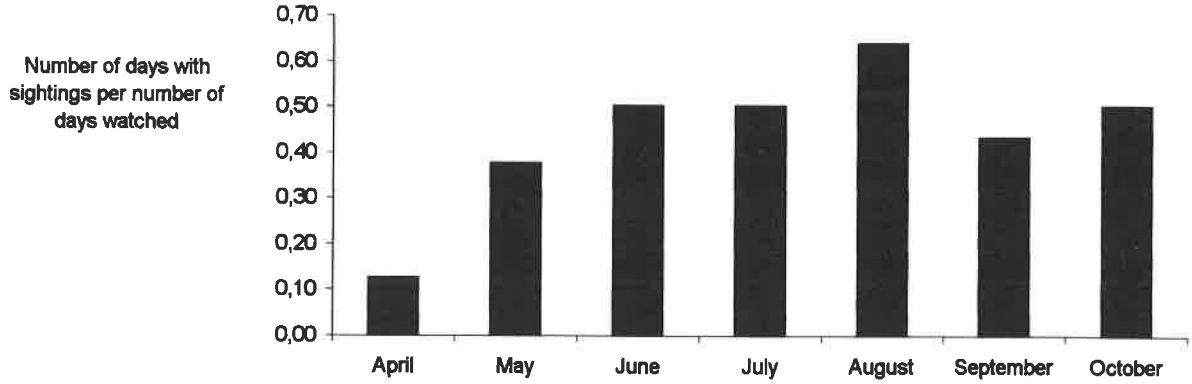

Fig. 2. Monthly distribution of the frequency of days in which sightings occurred.

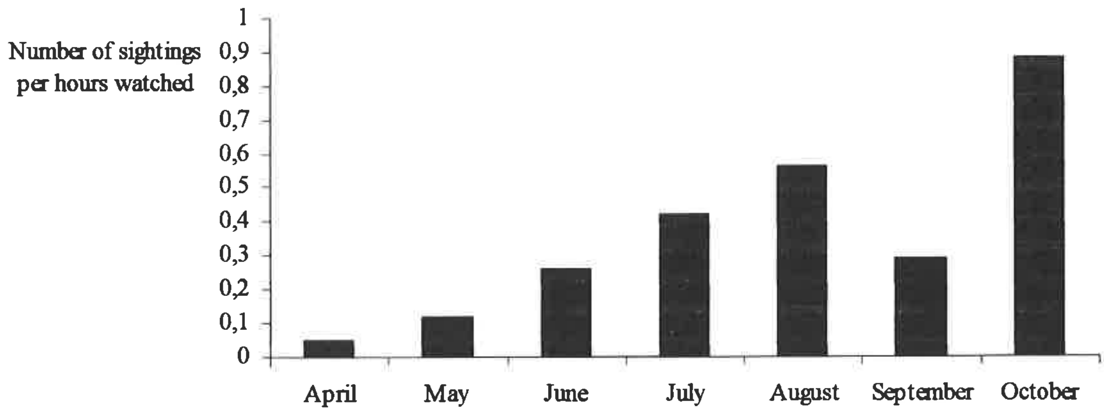

Fig. 3. Monthly distribution of the frequency of sightings.

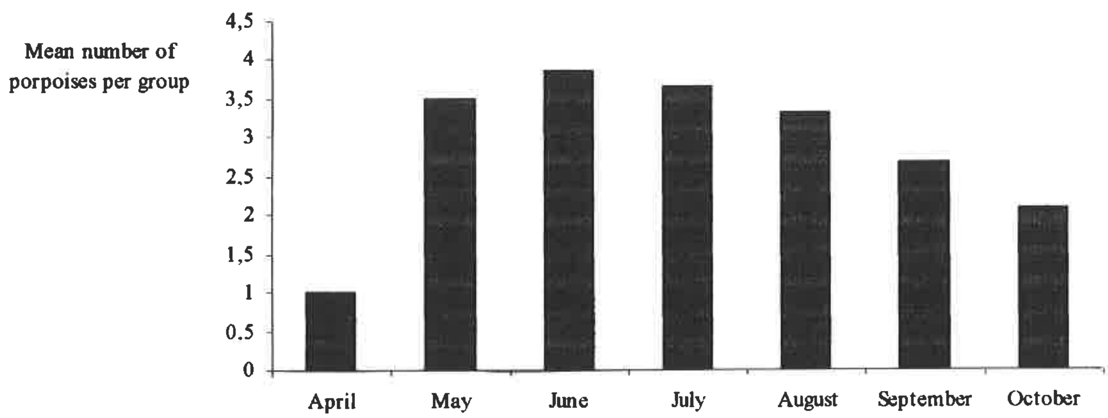

Fig. 4. Monthly distribution of the observed mean group size.

PHOTO-IDENTIFICATION AND ECOLOGY OF THE BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS*, AROUND THE AZORES

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INTRODUCTION The archipelago of the Azores is located in the middle of the North Atlantic on the Mid-Atlantic ridge and consists of nine volcanic islands. It is an interesting place to study cetaceans due to its remarkable geographic location. Continental shelf habitats are reduced, and the oceanic habitats come near the shore, the two merging into each other. The occurrence of coastal populations is restricted to a short zone around the islands, making their study easier compared with wider areas.

The study of cetaceans in the Azorean archipelago has been increasing due to their relevance to species and habitat conservation, interaction with fishing activities and whale-watching. About 23 cetacean species have been recorded in the Azores (Santos *et al.*, 1995), with the bottlenose dolphin (*Tursiops truncatus*) being one of the most frequently sighted species.

Aims:

- Study the distribution and abundance of the bottlenose dolphin during the summer months;
- Analyse the frequency of behavioural activities;
- Study the associations with other animals;
- Start up a catalogue of recognisable bottlenose dolphins for the region;
- Identify the dolphins individually and look for re-sightings during the five months of data collection.

MATERIAL AND METHODS The data were collected between May and September 1997, aboard a 21-metre schooner used for whale-watching and research.

The animals were detected by visual and acoustic surveys. No pre-defined routes were used. Whenever a group of any species of cetaceans was sighted, the sailing yacht would change its direction and try to approach the group. Hence the sampling effort was not focussed on the species studied here.

The data collected when a group of bottlenose dolphins was sighted included date, hour, GPS position, a visual estimate of the number of individuals, apparent activity (travel, feeding, socialising and milling), associated species, and environmental data.

Dolphins were systematically photographed, and photos of the dorsal fins analysed with a magnifying glass. The main characteristics examined were the number of nicks, their relative position (superior, intermediate, inferior), and their shape. The matching process used to compare photos was manual.

RESULTS **Effort and Occurrence:** A total of 67 days of surveys at sea were made, corresponding to 621 hours of observation. Only 16 days were without sightings of bottlenose dolphins.

A total of 95 sightings of bottlenose dolphins were made around the central group of islands (Faial, Pico, and S. Jorge). These represent 27% of the total cetacean sightings during the five months of study, being the second most frequently observed species after the common dolphin (Fig. 1.).

Groups of 2-100 individuals were sighted. The average number of dolphins in a group was 24 (SD = 21.9; n =95) and the median was 20 (Fig. 2.).

Ecology: The most frequent activity observed was "travel", followed by "feeding" (Fig. 3.). Bottlenose dolphins were frequently observed in association with other species (seabirds and cetaceans), on 40% of the sightings (Fig. 4.).

Photo-identification: Of the 1,078 photos obtained, only 584 had acceptable quality. These represented 56 sightings. 286 dolphins were photo-identified and 35 of these were sighted more than once. The dolphin "wl" had the greatest number of sightings, two in May, one in June, two in July and one in August. The greatest time lag between two sightings of a same dolphin was between the 13th May and the 25th August (Fig.5.).

Dolphins appeared in groups of different sizes; some of them were photographed as part of the same group more than once. The "wl" and the "n" were together on four occasions (Figs. 6 and 7.).

DISCUSSION The bottlenose dolphins are sighted throughout the summer in the Azores archipelago (in the central group of islands), which seems to be a favoured site for the occurrence of this species, probably due to a high concentration of prey near the coast. This species shows some level of residence that can be annual or seasonal.

It was noticed that the group size of bottlenose in the Azores was intermediate between the ones registered for coastal habitats (Harzen and Brunnick, 1997) and those for oceanic ones (Saayman and Tayler, 1973) which somehow reflects the intermediate character of the Azores marine habitat.

The most frequently observed activity was "travel". This has also been observed in other areas of the world (Shane, 1990). Prey is not evenly distributed around the coast of the islands, so the dolphins need to range around looking for food.

There is a high percentage of interspecific associations between bottlenose dolphins and other species, which is in accordance with the observations from other areas (e.g. Kenney, 1990).

There is a high number of identified dolphins when compared with other regions (Hansen and Defran, 1990). The number of re-sightings, however, is quite low. These two factors suggest a numerous population of bottlenose in the archipelago, and a possible transitory residence for some dolphins.

Although there are apparently more stable associations between individuals, fluidity seems to be the general pattern as the same dolphin is usually found in different sized groups.

By comparing the peculiarities of the ecology of the bottlenose in this island habitat with other areas, we may understand better the versatility of this species.

Future work:

- To extend the study to all the year and all the islands.
- To carry out surveys exclusively for the study of the bottlenose dolphin;
- To digitise the photos of the catalogue;
- To try to implement a software capable of an automatic matching procedure;
- To have trained volunteers participating in the study;

ACKNOWLEDGEMENTS Thanks go to Chris Beer for all his support, help and motivation.

REFERENCES

Hansen, L. and Defran, R. 1990. A comparison of photo-identification studies of California coastal bottlenose dolphins. *Rep. Int. Whal. Commn*, special issue 12: 101-104.

Harzen, S. and Brunnick, B. J. 1997. The social structure of the bottlenose dolphin, *Tursiops truncatus*, in the Sado estuary, Portugal. P. 212. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Kenney, R. 1990. Bottlenose dolphins off the Northeastern United States. Pp. 369-383. In: *The Bottlenose dolphin* (Eds. S. Leatherwood and R. Reeves). Academic Press, San Diego. 635pp.

Saayman, G. S. and Tayler, C. K. 1973. Social organisation of inshore dolphins (*Tursiops aduncus* and *sousa*) in the Indian Ocean. *Journal of Mammalogy*, 54, 4: 993-996.

Santos, R. S., Hawkins, S., Monteiro, L. R., Alves, M. and Isidro, E. J. 1995. Marine research, resources and conservation in the Azores. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 5: 311-54.

Shane, S. H. 1990. Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. Pp. 245-65. In: *The Bottlenose dolphin*, (Eds. S. Leatherwood and R. Reeves). Academic Press, San Diego. 635pp.

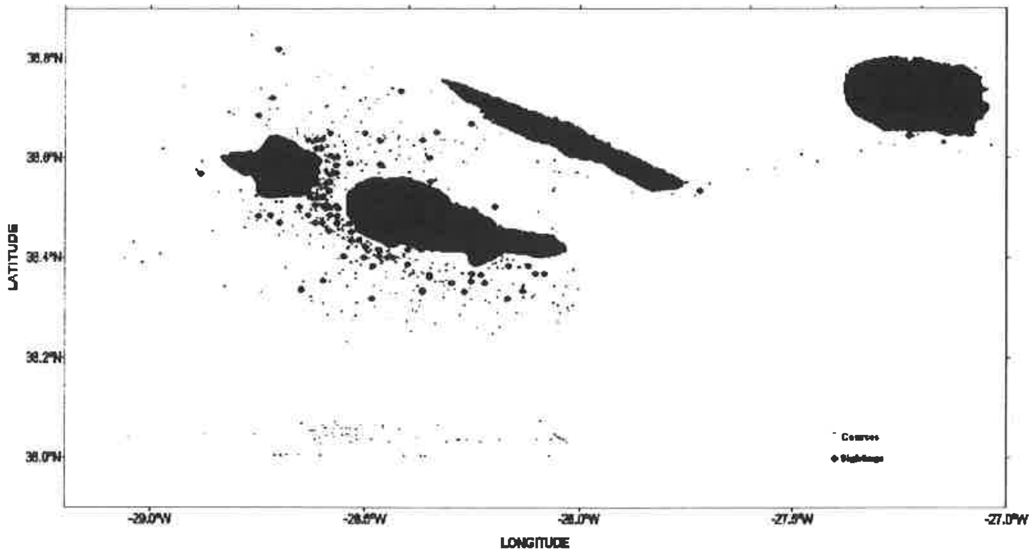

Fig. 1. Distribution of the bottlenose dolphin's sightings and the GPS positions registered in the courses of the boat.

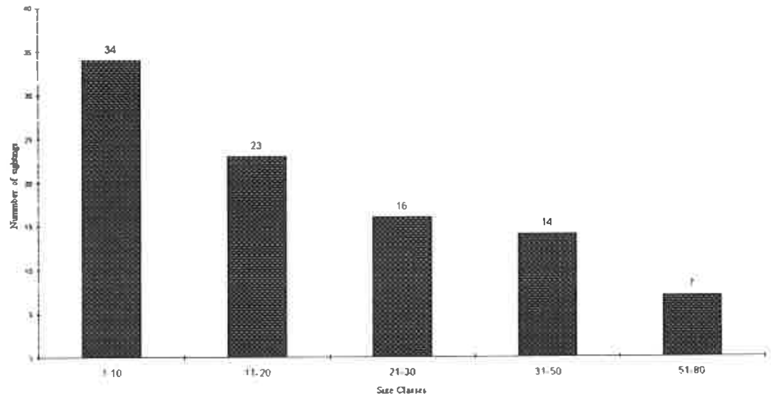

Fig. 2. Frequency of sightings per group size class (number of individuals).

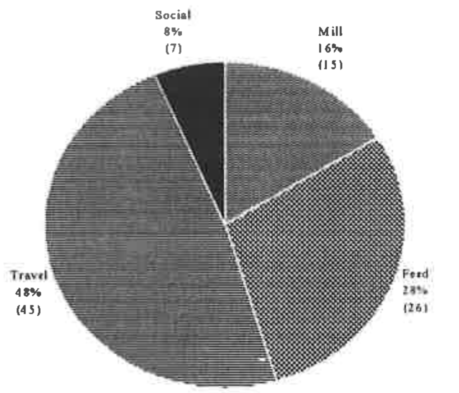

Fig. 3. Percentage of the dolphins' activities. The number in brackets refers to the number of sightings.

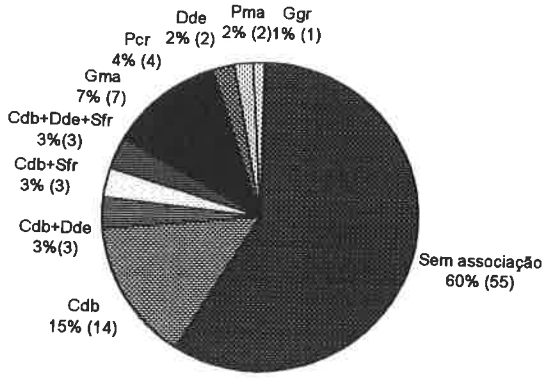

Fig. 4. Frequency of the associations of bottlenose dolphins with seabirds and other species of cetaceans. The numbers in brackets refer to the number of sightings. Gma, *Globicephala macrorhynchus*; Cdb, *Calonectris deomedea borealis*; Pcr, *Pseudorca crassidens*; Dde, *Delphinus delphis*; Sfr, *Stenella frontalis*; Pma, *Physeter macrocephalus*; Ggr, *Grampus griseus*.

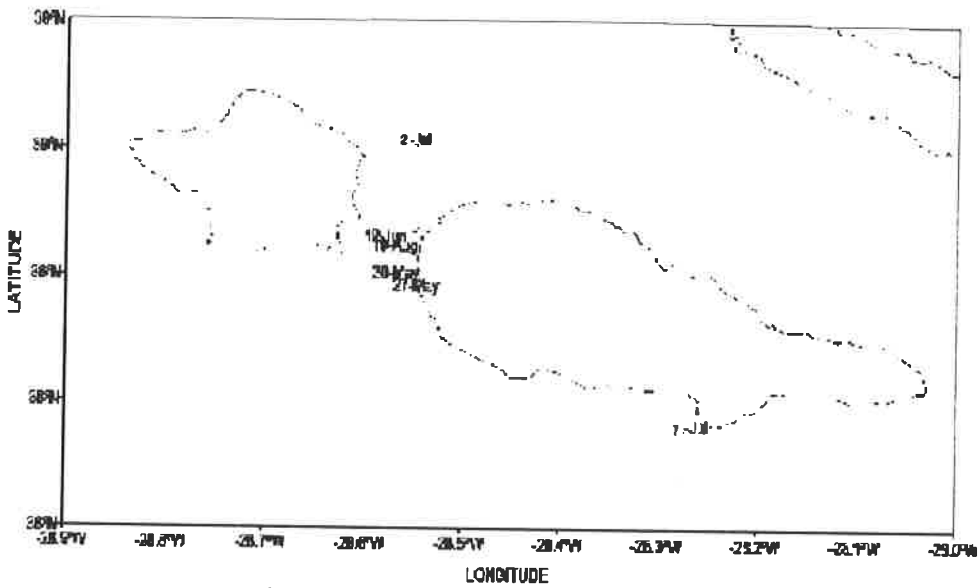

Fig. 5. Distribution of "wl" sightings.

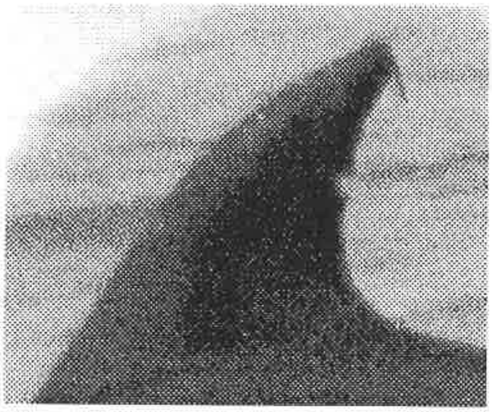

Fig. 6. Dolphin "n".

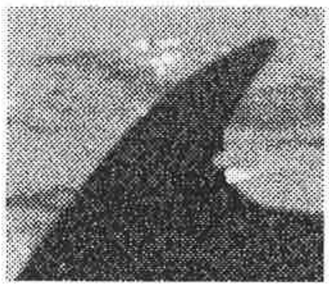

Fig. 7. Dolphin "wl".

CETACEAN STRANDINGS IN THE MARMARA SEA

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The Marmara Sea is a deep transit basin situated between the Mediterranean Sea and Black Sea. Cetacean strandings in the Marmara Sea have not been reported. In this study, cetacean strandings along the coast of the Marmara Sea were collected to monitor cetacean mortality between January 1993 and November 1998. A total of 16 stranded animals were recorded. Those were harbour porpoise *Phocoena phocoena* (4), bottlenose dolphin *Tursiops truncatus* (4), common dolphin *Delphinus delphis* (6) and striped dolphin *Stenella coeruleoalba* (2).

This is the first record of *S. coeruleoalba* occurring in the Marmara Sea. All strandings were of single animals except two *T. truncatus* (one adult female and one calf) in Hosköy area. The cause of death for seven animals was determined as bycatch and that of the other nine animals was unknown.

ABUNDANCE AND DISTRIBUTION OF CETACEANS OFF LA GOMERA (CANARY ISLANDS)

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A study on the abundance and distribution of cetaceans off La Gomera (Canary Islands) was conducted from September 1995 through April 1998.

The platform for the collection of data were small, former fishing boats, which now are used for whale watching. Sightings data included date, time, position, distance to coast, depth and sea state.

A total of 701 encounters with cetaceans were recorded, and 17 species could be identified. Most abundant were the bottlenose dolphin (241 sightings, 34%) and the pilot whale (122 sightings, 17%), followed by the Atlantic spotted dolphin. Surprisingly abundant were the Rough-toothed dolphin (*Steno bredanensis*) and the dense-beaked whale (*Mesoplodon densirostris*). Other species sighted were common, striped and Risso´s dolphins, Cuvier´s beaked whales, northern bottlenose whales, killer whales, false killers, as well as sperm, sei, fin and blue whales. Details on the sightings are presented in the poster.

Thus, an extraordinary species diversity could be documented for the waters south of La Gomera. 17 species represent 65% of the 26 cetacean species recorded for the Canary Island archipelago, and they also represent 49% of the species recorded for the North-east Atlantic Ocean.

CETACEANS SIGHTING IN THE NORTH-WESTERN MEDITERRANEAN SEA

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In summer 1998, during the period from 27th July to 9th August, a survey was conducted on cetaceans in the area of the Mediterranean Marine Mammal Sanctuary aboard the 62 m. ship, the M/S "Bannock", property of the Italian Coast-Guard.

During the cruise a total distance of 668 nm was covered, including Genoa, Calvi, Marseille and Livorno, for 108 hours of observation.

The research was aimed at studying the distribution and abundance of cetaceans in the Ligurian-Provençal Basin and data were collected on average school size, behaviour and population size.

Photo and video images allowed photo-identification of nineteen fin whales, *Balaenoptera physalus*. During the campaign, 68 sightings, involving only two species of cetaceans, were recorded, whilst 11.76% were unidentified cetaceans. The two species identified were striped dolphin, *Stenella coeruleoalba* (29.41%), and *Balaenoptera* sp. (58.8%, of which 35% was identified as fin whale, *Balaenoptera physalus*).

CETACEAN STRANDINGS IN THE NORTHEASTERN ATLANTIC: THE ATLANCETUS PROJECT

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INTRODUCTION Cetacean strandings in the Northeastern Atlantic have been regularly monitored in the last few decades, and important biological information has been gathered on the most abundant species. Both national and regional networks of volunteers and organisations have been created in different countries to collect and analyse data on cetacean strandings. Data collected by these networks are included in databases, and usually an annual review of strandings reported in a given area is produced.

The work already developed along the Atlantic coasts of the Iberian Peninsula have revealed that for some cetaceans the geographical distribution of strandings is better understood if adjacent areas are analysed together. This is the case for the coasts of Portugal and northern Spain where a significant number of strandings have been recorded in the last three years. In order to analyse these data, the ATLANCETUS Project has been developed in 1996, aiming at collecting information on cetacean strandings in the Northeastern Atlantic. Scientists and institutions from Portugal, Spain, Madeira, Azores and the Canary Islands are involved in the collection of standardised information on cetacean species, causes of death, and collection of biological samples. Data are compiled into a database specially designed for this project and annual reports will be produced and published by the participating institutions.

Results presented in this report refer to the year 1997 and for some sectors, data are still incomplete. Total number of strandings reported for Portugal and the islands of S. Jorge and Sta. Maria (Azores) are still incomplete. A detailed and definitive report will be produced later this year.

METHODS For each stranding, data included in the ATLANCETUS database are collected according to standard protocols: collection of biometric data follows Norris (1961), methodology and postmortem examination and tissue sampling follows the standard protocol established by Kuiken & Hartmann (1991).

Stranded cetaceans are always identified to species level, except in those cases where the advanced decomposition does not allow a positive identification. For those cases, four categories were considered: small odontocete (code POD), odontocete (code ODO), unidentified mysticete (code MIS) and unidentified cetacean (code NID).

RESULTS AND DISCUSSION Although data from the Portuguese coast and the islands of S. Jorge and Sta. Maria (Azores) are still incomplete, a clear pattern of abundance and geographical distribution of cetacean species can already be recognised.

During 1997, a total of 386 cetaceans were reported stranded in the area covered by ATLANCETUS. The Spanish coasts (the Canary islands included, n=36) registered the higher number of strandings, with 254 (65.8%) animals involved.

The common dolphin (*Delphinus delphis*) stands as the most common species in the study area (n=153). Other odontocetes were also regularly reported, including bottlenose dolphins (*Tursiops truncatus*) (n=43), striped dolphins (*Stenella coeruleoalba*) (n=27), pilot whales (*Globicephala melaena*) (n=20) and harbour porpoises (*Phocoena phocoena*) (n=17). A total of 64 Delphinidae (*D. delphis, S. coeruleoalba* or *T. truncatus*) were also registered (Table 1). It should also be noted that two unusual strandings occurred, involving two Atlantic white-sided dolphins (*Lagenorhynchus acutus*) stranded on the Asturian coast (northern Spain)

The geographical distribution of strandings reveals a higher concentration in the Coruña (20.7%) and Pontevedra (19.2%) sectors (northern Spain). On the Portuguese coast, the higher number of strandings occurred at Setúbal (n=17) and Leiria (n=14) sectors (central Portugal).

Live strandings: During 1997, a total of 38 live strandings were reported in the study area, with common dolphins (n=13) and striped dolphins (n=5) as the most common species involved. Seventeen animals could be rescued and returned to sea, and 21 died either at the beach or during treatment (Table 2).

Bycatches: Some sectors of the ATLANCETUS area are heavily fished, and as a consequence, interactions between cetaceans and fishing gear can be quite common. From a total of 386 strandings reported in the area, 112 (29.0%) referred to animals showing signs of bycatch (n=96) or confirmed to have been entangled in fishing gear (n=16). For the purpose of this project "bycatch signs" include amputated fins, fluke or tail, removal of dorsal muscles, rope around tail stock and net marks around beak, head, fins and body.

Of 16 confirmed bycatches, only nine could be positively attributed to a specific type of fishing gear: five cases involved bycatches in purse seine nets, three in gillnets and one in a semi-pelagic trawl.

Common dolphins (n=62) and cetaceans identified as Delphinidae (n=20) (some of these animals are probably common dolphins which could not be positively identified) were the species most regularly involved in interactions with fishing gear. Other species bycaught or showing signs of bycatch include bottlenose dolphins (n=10) and even baleen whales (one minke whale and one fin whale) (Table 3).

ACKNOWLEDGEMENTS Thanks are due to all participants in the ATLANCETUS Project, specially to those people involved in the collection of data on the beaches: NGO's, CoastGuard and Maritime Delegations. We also thank Gerardo Garcia Castrillo (Santander), Pablo Cemenho (Euskadi), and Luis Mons (Andalucia) for their contribution to the data presented here.

REFERENCES

Kuiken, T. and Hartmann, M. (Eds.) 1991. Proceedings of the first European Cetacean Society workshop on cetacean pathology: dissection techiques and tissue samplings. *ECS Newsletter 17* (Special Issue). 39pp.

Norris, K. S. 1961. Standardized methods for measuring and recording data on the smaller cetaceans. *J. Mamm. 42*: 471-476.

Table 1. - Total number of strandings recorded in 1997 (data from Portugal and the islands of S. Jorge and Sta. Maria, Azores, are still incomplete)

Species	**Country**		**Total**
	Spain	Portugal	
P. phocoena	7	10	17
D. delphis	93	60	153
T. truncatus	23	20	43
S. coeruleoalba	22	5	27
S. frontalis	13	1	14
L. acutus	2		2
G. griseus	8	1	9
G. melas	17	3	20
G. macrorhynchus	2		2
Delphinidae	41	23	64
P. macrocephalus	4	1	5
K. breviceps	4	1	5
Z. cavirostris	1		1
M. europaeus	1		1
Mesoplodon sp.	1		1
Small odontocete (POD)	9	3	12
Odontocete (ODO)	1	1	2
B. acutorostrata	2	3	5
B. physalus	2		2
Non-identified cetacean (NID)	1		1
TOTAL	**254**	**132**	**386**

Table 2 - Live strandings

Species	**Dead**	**Rescued**	**Total**
P. phocoena		1	1
D. delphis	6	7	13
T. truncatus	1		1
S. coeruleoalba	2	3	5
S. frontalis	3		3
L. acutus	1		1
G. melas	2	2	4
G. macrorhynchus	1		1
Delphinidae		2	2
K. breviceps	3		3
B. acutorostrata		1	1
B. physalus	1		1
Small odontocete (POD)	1	1	2
Total	**21**	**17**	**38**

Table 3 - Interactions with fishing gear

Species			**Total**
	Spain	Portugal	
P. phocoena	2	1	3
D. delphis	42	20	62
T. truncatus	6	4	10
S. coeruleoalba	2	2	4
L. acutus	1		1
G. griseus	1		1
G. melas	4		4
Delphinidae	14	6	20
B. acutorostrata	3		3
B. physalus	1		1
Small odontocete (POD)	2	1	3
Total	**78**	**34**	**112**

STATUS OF THE WEST AFRICAN MANATEE (*TRICHECHUS SENEGALENSIS*) IN GUINEA-BISSAU

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INTRODUCTION The known range of the West African manatee (*Trichechus senegalensis*) includes the rivers, estuaries, lagoons, and coastal regions of western Africa, from Mauritania to Angola (Husar, 1978; Nishiwaki *et al.*, 1982; Powell, 1996). Information on the distribution of the species in Guinea-Bissau is scarce. According to previous studies, manatees seem to occur in the main rivers of the country, and in some of the islands of the Bijagós Archipelago (Limoges, 1989; Powell, 1990; Schuhmann, 1995). Although it was never hunted commercially, subsistence hunting appears to have been responsible for the population decline in the past.

The aim of this study was to assess the current distribution and status of the manatee population in the country.

MATERIALS AND METHODS In March 1998, following contacts previously established with several Guinean authorities, the IUCN Representation in Guinea-Bissau signed a protocol with the Fisheries Applied Research Centre and the Forestry and Game Department in Guinea-Bissau, in order to develop a National Conservation Plan for the West African Manatee. Another international partner in this project was the Portuguese Institute for the Conservation of Nature, which ensured the scientific co-ordination of the study. A standardised interview form was designed to provide information on the distribution, mortality, current threats, demographic trend, feeding habits and behaviour of the species.

On 7th June 1998, a military rebellion emerged in Guinea-Bissau, preventing the completion of the interview survey in the central and eastern areas of the country.

RESULTS AND DISCUSSION From April to June 1998, 241 villages and fishing camps were visited and 520 people were interviewed, among fishermen, hunters, farmers, and former manatee hunters. According to the interview survey, the species occurs in all the areas studied, although it seems to be more abundant in the Bijagós Archipelago (Fig.1). Over 94% (n=106) of the persons interviewed in the Bijagós claimed to have sighted manatees at least once. This area also concentrated the higher number of sightings made by persons interviewed (2.57). Manatees were observed in all the islands of the Archipelago (even in the outermost ones, such as Unhocomo and Unhocomozinho), although more sightings were recorded in the islands of the Orango group and in Bubaque, Rubane, Uno, Eguba, Formosa and Carache. On the mainland, manatees seem to be present in all the main rivers and associated tributaries.

No differences were detected in the overall number of manatee sightings made in each season. However, percentage of sightings made during the dry season (November to April) decreased from north (66%) to south (35%) (Fig.2) of the country, which could reflect a seasonal migration related to the water level in the rivers and canals. During the dry season, insufficient water in the rivers of the southern area may prevent manatees from reaching vegetation in the banks. Thus, animals would concentrate in the northern area, travelling to the south in search of new feeding areas only after the first rains, when the water level increases. In the Bijagós Archipelago, the small variation in the water level would not justify a seasonal migration. Such seasonal movements have already been identified in other areas where the West African manatee occurs (Powell, 1996).

According to the interviewees' opinions, the manatee population in Guinea-Bissau has been steadily decreasing, since the end of the Independence War (1963-74). This demographic trend is similar to that reported for other areas (Powell, 1985, 1996; Reeves *et al.*, 1988), and appears to be the consequence of the hunting pressure and an increase in fishermen numbers. In spite of the population trend, between January and May 1998, 110 manatees were sighted in the areas surveyed, which indicates that Guinea-Bissau still holds an important population of this species.

Data collected during the interviews showed that 209 manatees died in the area studied, from January 1990 to May 1998, yielding 24.5 animals/year. Bycatch was responsible for 72% of the deaths, 14% of the animals were hunted, and eight stranded after a reduction in the water level. Approximately 47% of the persons interviewed claimed to have captured at least one manatee in their fishing nets. In just 16 months, 69 cases of entanglement were registered, resulting in an average of 3.8 incidents/month. Although fishermen declared that in the majority of the cases the animal involved managed to escape alive, injuries caused by entanglement may result in the subsequent death of the animal (Reeves *et al.*, 1988). These results clearly attest to the frequency and severity of bycatch situations. According to the interview survey, incidental captures of manatees occur in both seasons and everywhere in the country. Manatees were caught in set gillnets, seine nets, small nets set across canals, and traps.

Although illegal, manatee hunting is still a common practice in many countries and represents a significant mortality factor (Reeves *et al.*, 1988; Powell, 1996). In Guinea-Bissau, however, hunting activity seems to be declining and could eventually disappear in the near future. Manatees were usually hunted with a special harpoon from a canoe or a platform built near freshwater springs. Manatee hunting is a special activity and can only be performed by those who know the prayers and ceremonies that assure its success. Manatees are mainly used for their meat but their important medicinal properties are also valued.

CONCLUSIONS Results from the present study indicate a more extensive range of the West African manatee in Guinea-Bissau than previously thought. Although recent sightings suggest that Guinea-Bissau still holds an important manatee population, present mortality levels may be unsustainable. According to data from the interview survey, man-induced mortality, mainly that resulting from bycatch, and habitat alteration and destruction, represent the most significant threats to the population survival. Future conservation efforts should focus on these aspects. Better knowledge of the distribution, relative abundance and habitat requirements of the species is urgently needed. Additional research should concentrate on the identification of less destructive fishing gear, and government authorities, with the collaboration of foreign agencies, should promote its use. Manatee conservation ultimately depends on public awareness. Therefore, management actions should include the development of education campaigns, directed at all levels of society.

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REFERENCES

Husar, S. L., 1978. *Trichechus senegalensis*. American Society of Mammalogists, Mammalian Species, 89: 1-3.

Limoges, B. 1989. Résultats de l'inventaire faunique au niveau national et propositions de modifications à la loi sur la chasse. Étude Financée par le CECI et l'/UICN. MDRA-DGFSC da Guiné-Bissau, 144pp.

Nishiwaki, M., Yamaguchi, M., Shokita, S., Uchida, S. and Kataoka, T. 1982. Recent survey on the distribution of the African manatee. *Scientific Reports of the Whales Research Institute*, 34: 137-147.

Powell, J. A. 1985. Status of the West African manatee in The Gambia, West Africa. Sixth Biennial Conference on the Biology of Marine Mammals, Vancouver, British Columbia, Canada, 22-26 November. Sponsored by the Society for Marine Mammalogy. [Abstracts].

Powell, J. A. 1990. Manatees in the Bijagós Archipelago: recommendations for their conservation. IUCN, Wetland Program. Unpubl. Report. 24pp.

Powell, J. A. 1996. The distribution and biology of the West African manatee (*Trichechus senegalensis* Link, 1975). UNEP, Regional Seas Program, Oceans and Coastal Areas. Unpubl. Report. 61pp.

Reeves, R. R., Tuboku-Metzger, D. and Kapindi, R. A. 1988. Distribution and exploitation of manatees in Sierra Leone. *Oryx*, 22: 75-84.

Schuhmann, H. J. 1995. Der Manati, *Trichechus senegalensis*, im Rio Geba, Guinea-Bissau. *Natur und Museum*, 125: 402-409.

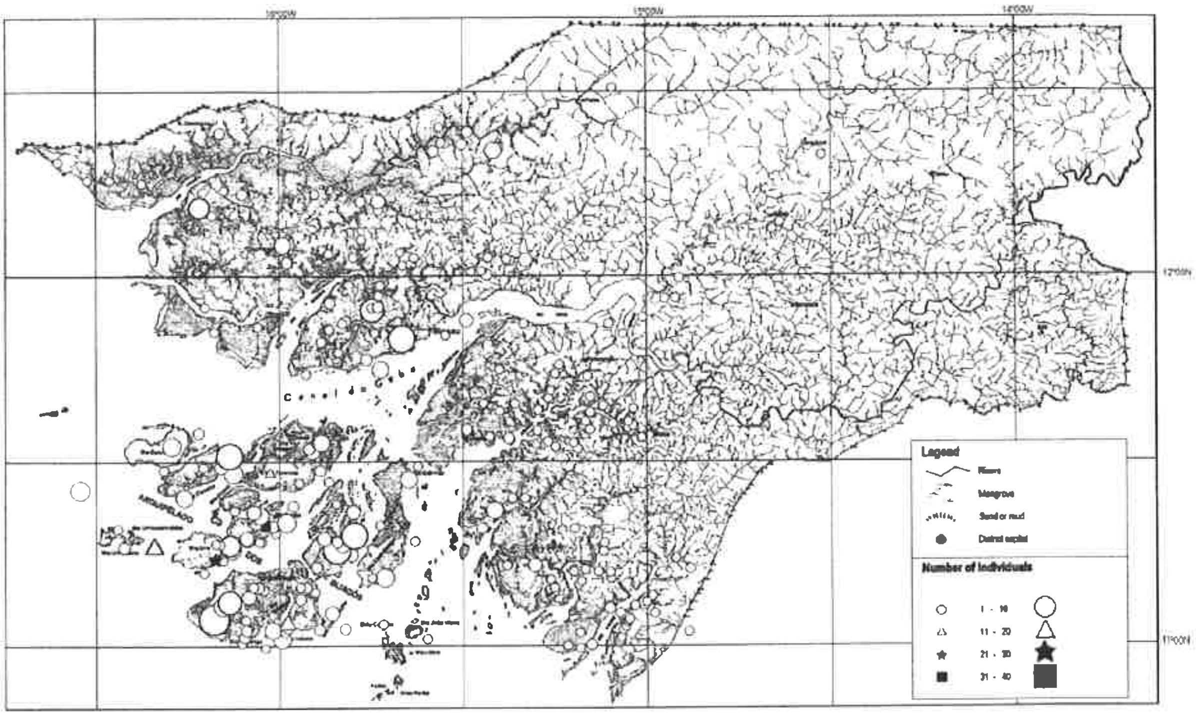

Fig. 1. Sightings of live manatees recorded during the interview survey (number of animals is proportional to symbol size)

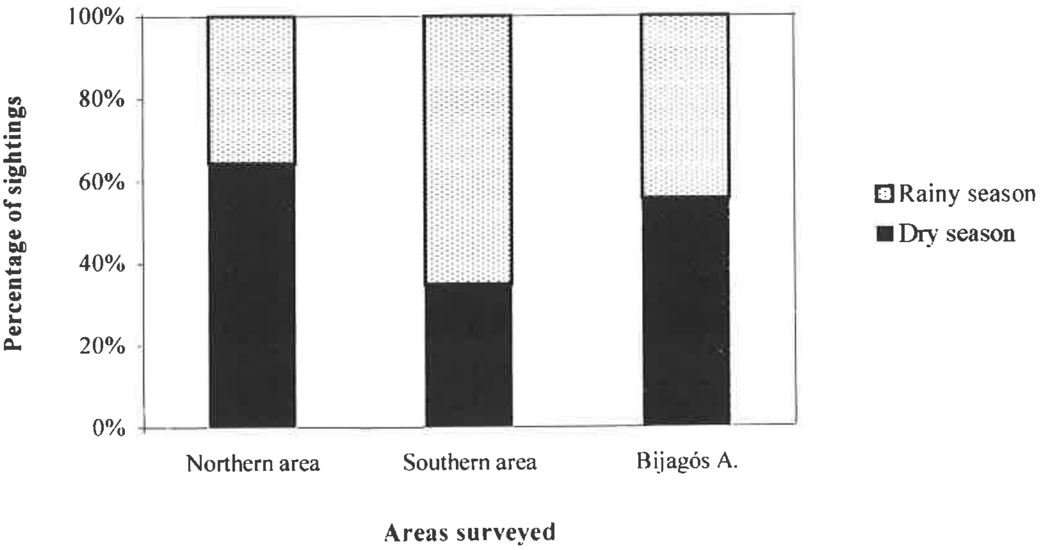

Fig. 2. Percentage of sightings of live manatees reported in each of the areas surveyed, according to the season

OBSERVATIONS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) ON THE NORTHERN COAST OF PORTUGAL

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INTRODUCTION Although once considered a common species along the Portuguese coast (Teixeira, 1979), harbour porpoises (*Phocoena phocoena*) are rarely sighted now and most of the available information comes from stranded animals (Sequeira, 1996). Geographical distribution of strandings seems to indicate a higher concentration in the northern and central zones of the country, particularly in the area between Aveiro and Figueira da Foz (Sequeira, 1996). Being essentially a coastal species, harbour porpoises are quite vulnerable to entanglement in fishing gear, especially gillnets and beach seine nets that are frequently used in these areas.

The main objective of this study was to assess the importance of the area between Aveiro and Figueira da Foz to the porpoises, and to identify and evaluate the existence of conflicts with human activities.

MATERIALS AND METHODS This preliminary study was carried out through systematic land-based observations, using 7x50 binoculars and a 20-50x80 binocular telescope. From April to September 1997, an average of five observation days was conducted each month. Observations usually started at 08:00 hrs finishing at 20:00 hrs, weather permitting. A minimum of two observers would search the entire area, rotating between positions every 30 minutes, and resting for 15 minutes after one hour of observation. Weather conditions and sea state information were recorded every half hour. Data collected for each sighting included time, species, number of individuals, presence of juveniles or calves, distance from shore, direction, behaviour, and presence of other cetaceans, seabirds, boats or nets. Observations were only conducted at sea state less than or equal to Beaufort 3.

RESULTS During the study period, a total of 135 hours of observation were made. Harbour porpoises were sighted on 64 different occasions, yielding an average of 0.47 sightings/hour. Group size ranged from one to five individuals, with a mean of 1.63 (± 0.85), but in more than half of the sightings only one porpoise was sighted. Calves were observed on eight occasions during the months of August and September.

Ventilation cycles could be recorded in 18 of the sightings that involved a single animal. Average dive time for all the animals was 45 sec. (± 117 sec.) but more than 85% of dives recorded were less than 1 min. long. Diving pattern was usually characterised by a series of short dives averaging 12 sec. (± 12 sec.), followed by a more prolonged dive (231 ± 224 sec.).

Sighting rate (number of sightings / hour of observation) reached a peak at 09:00 hrs and then slightly decreased throughout the day (Fig.1). Fewer sightings were made at peak water levels, although no evident pattern could be found between sighting rate and tidal cycle (Fig. 2).

In most of the sightings, porpoises were engaged in foraging activities, often changing direction and swimming speed. The animals were frequently observed close to fishing nets but when approached by a boat, they would normally change direction and sometimes dived for several minutes.

CONCLUSIONS Data from the present study agrees with information from stranding records (Sequeira, 1996) and seems to indicate that harbour porpoises frequently use this area. However, the present study only reports on the spring and summer months, and no data on the occurrence of porpoises during the winter are currently available. Land-based observations should be conducted year-round in order to investigate seasonal variation in porpoise distribution

Calves were observed for the first time in the beginning of August, which conforms to the available information on a main calving season in European waters from May to July (Lockyer, 1995; Bandomir-Krischak *et al.*, 1995).

The ventilation cycle recorded for harbour porpoises in Figueira da Foz is similar to the one described by Watson and Gaskin (1983) for animals engaged in feeding activities. These results are further supported by observations of porpoise behaviour in the area, where the animals exhibited an irregular swimming speed and no evident trend in movement direction was detected.

Although no obvious diurnal pattern could be found, there seemed to be a slightly decrease in the number of porpoises sighted in the area throughout the day. The existence of a relationship between porpoise occurrence and tidal cycle has already been described for several areas (Evans and Lane, 1989; Evans and Gilbert, 1991; Evans *et al.*, 1993; Kremer *et al.*, 1994) but we failed to find a consistent pattern. Porpoise numbers in Figueira da Foz seem to be lowest around high and low tides, a result similar to the one reported by Evans and Lane (1989) for North Scotland.

According to the preliminary results of this study, the area between Figueira da Foz and Aveiro may constitute an important area for harbour porpoises in Portuguese waters, although other equally important areas have since been identified. Porpoises observed are mainly engaged in foraging activities. The area's high value in fishing resources makes it a preferred target for commercial fisheries, increasing the probability of interactions with harbour porpoises. Given the decreasing trend in harbour porpoise numbers in Portuguese waters, special management actions should be taken in order to prevent the porpoise population from further declining.

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REFERENCES

Bandomir-Krischak, B., Siebert, U., Benke, H. and Bohlken, H. 1995. Preliminary results on reproduction of harbour porpoises in German coastal waters. Pp. 212-214. In: *European Research on Cetaceans – 9.* Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 February, 1995 (Ed. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Evans, P. G. H. and Lane, M.-R. 1989. Field studies of harbour porpoises *Phocoena phocoena* in North Scotland. Pp. 99-107. In: *European Research on Cetaceans – 3.* Proc. 3rd Ann. Conf. ECS, La Rochelle, 24-26 February, 1989 (Ed. P. G. H. Evans & C. Smeenk). European Cetacean Society, Leiden, The Netherlands. 132pp.

Evans, P. G. H. and Gilbert, L., 1991. Distributional ecology of harbour porpoises in the Shetland Islands, North Scotland. Pp. 47-52. In: *European Research on Cetaceans – 5.* Proc. 5th Ann. Conf. ECS, Sandefjord, Norway, 21-23 February, 1991 (Ed. P. G. H. Evans). European Cetacean Society, Leiden, The Netherlands. 148pp.

Evans, P. G. H., Fisher, P., Rees, I., Wainwright, J., Farrell, J. and Mayo, W. 1993. Foraging ecology of harbour porpoises in Shetland. Pp. 33-38. In: *European Research on Cetaceans – 7.* Proc. 7th Ann. Conf. ECS, Inverness, 18-21 February, 1993 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, UK. 306pp.

Kremer, H., Koch, L., Adloff, B., Baschek, B., Schneider, O. and Fischer, W. 1994. Results from a pilot study on sightings of harbour porpoises, *Phocoena phocoena*, at the North-Sea coast of Schleswig-Holstein, F.R.G. *Arch. Fish. Mar. Res.*, 42: 35-45.

Lockyer, C. S. 1995. Investigation of aspects of the life history of the harbour porpoise, *Phocoena phocoena*, in British waters. *Rep. int. Whal. Commn* (special issue 16): 189-197.

Sequeira, M. 1996. Harbour porpoises, *Phocoena phocoena*, in Portuguese waters. *Rep. int. Whal. Commn*, 46: 583-586.

Teixeira, A. M. A. P. 1979. Marine mammals of the Portuguese coast. *Z. Säugetierkd*, 44: 221-238.

Watson, A. P. and Gaskin, D. E. 1983. Observations on the ventilation cycle of the harbour porpoise, *Phocoena phocoena* (L.) in coastal waters of the Bay of Fundy. *Can. J. Zool.*, 61: 126-132.

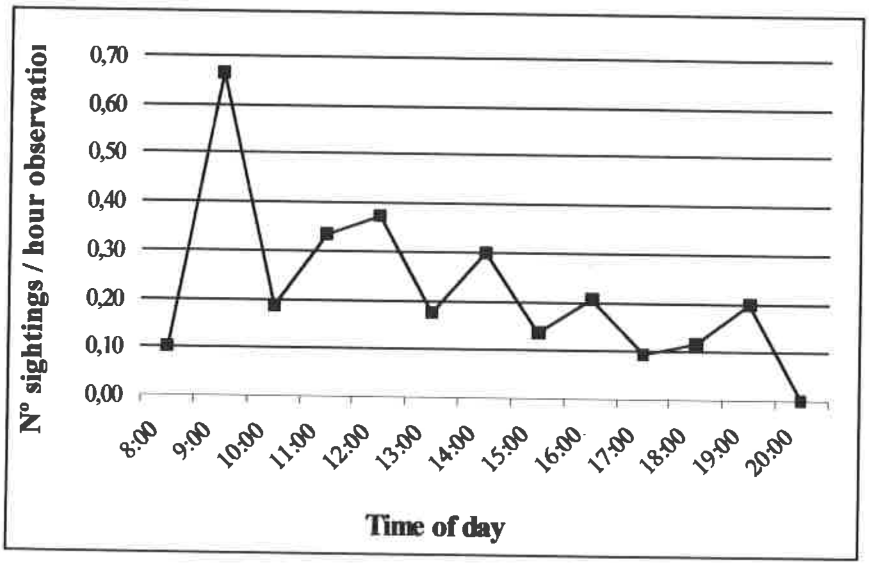

Fig. 1. Diurnal pattern of harbour porpoise occurrence in the study area

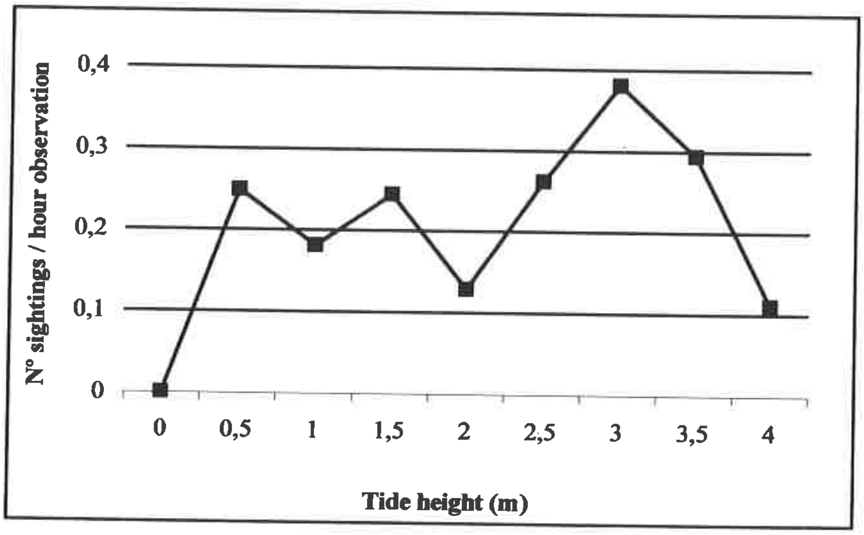

Fig. 2. Relationship between sighting rate (number of sightings per hour of observation effort) and tide height

OBSERVATION AND IDENTIFICATION OF CETACEANS OFF THE ISLANDS OF FAIAL AND PICO, AZORES

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The objective of this work was to observe and identify cetaceans off the islands of Faial and Pico in the Azores. The comparison of estimates based on land and sea observation points was also of interest. Three watch towers were used on the coast (Capelinhos, Cedros and Monte-da-Guia) situated on the island of Faial. Two sea stations were also considered off the coast of this island, covering areas surrounding the watching towers of Cedros and Monte-da-Guia. Another sea observation zone was off the island of Pico, close to the S. Mateus watch tower.

For each station, abundance indexes were calculated, using the number of observations per unit of time. Land-based observations were made during 65 days (337.5 hours), distributed over a five-month period from May to September 1996. The sea observations were made on board of a zodiac over 18 days (88.5 hours) distributed over the same time period.

In total, 274 sightings were made from land and 82 from the sea. A total of 13 species were identified. The areas of S. Mateus, Capelinhos and Cedros, present better conditions for the observation of cetaceans, in particular small odontocetes, due to its protected nature and food abundance, favouring the occurrence of the animals in these areas. The larger odontocetes, in particular the sperm whale, *Physeter macrocephalus*, were more frequently observed at S. Mateus. The two most commonly observed species were the sperm whale and the common dolphin, *Delphinus delphis*.

A COMPARISON BETWEEN THE FOURTH AND THE FIFTH WWF'S RESEARCH CAMPAIGN IN THE LIGURIAN SEA

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INTRODUCTION Since 1993, Liguria has been investing many resources to organise whale-watching activities that study the animals respecting their natural environment. The area most extensively studied is the Ligurian basin (Upper Tyrrhenian Sea), not only for its position near Genova, but because it is known as an important habitat for the Mediterranean cetaceans. In the last two years, WWF focused its attention on the area between San Remo and Antibes, one of the richest for cetaceans.

Every summer, thousands of whales and dolphins come here to feed in preparation for winter. Due to the quite favorable climatic and geophysical conditions, this area is exceptionally rich in elements needed by the microscopic algae essential for the sea's food chain: the most recent analytic methods show that the productivity values of the Upper Tyrrhenian Sea approach the ones of the rich Atlantic Ocean.

MATERIALS AND METHODS During the summers of 1997 and 1998, a study was carried out on the daytime distribution of cetaceans on the Ligurian Basin, between San Remo (Italy) and Antibes (France).

The aim of this work is to compare the sightings of cetaceans occurred during the summer 1998 with those of the summer 1997, in the same period, in the same area, and collected in the same way. For the research, two 14 m. sailing boats were used. Sampling has taken place in 1997 from 19th July to 16th August; in 1998 from 18th July to 23rd August by sailing along coastal waters in the daylight hours. Observation shifts were organised to cover the entire sailing time; cetaceans were detected by naked eye, and identified with binoculars. At each sighting, WWF's researchers noted on a form: position (calculated with GPS system), time of sighting, group size, presence of juveniles, and observations about behaviour.

RESULTS In 1997, during 28 days of navigation, 18 sightings were made and four species were identified: striped dolphin (*Stenella coeruleoalba*), fin whale (*Balaenoptera physalus*), sperm whale (*Physeter macrocephalus*), and bottlenose dolphin (*Tursiops truncatus*). Striped dolphins was seen eight times, fin whale three times, sperm whale and bottlenose dolphin only once.

In 1998, during 35 days of navigation, 28 sightings were made and three species were identified: striped dolphin (*Stenella coeruleoalba*), Risso's dolphin (*Grampus griseus*) and long-finned pilot whale (*Globicephala melas*). Striped dolphin was seen 19 times, Risso's dolphin nine times, and pilot whale once.

Sightings from 1997 and 1998 are summarised in Fig. 1. In both years, the most frequently sighted species was the striped dolphin.

DISCUSSION AND CONCLUSIONS The high density of striped dolphins in the sighting area is evident from Fig. 1, indeed in 1997, they represented 71% of the total sightings, and in 1998, 68%. This observation confirms not only that this species is the most frequent in the High Tyrrhenian Sea, but also that it is the easiest one to meet due to its trusting and curious demeanor.

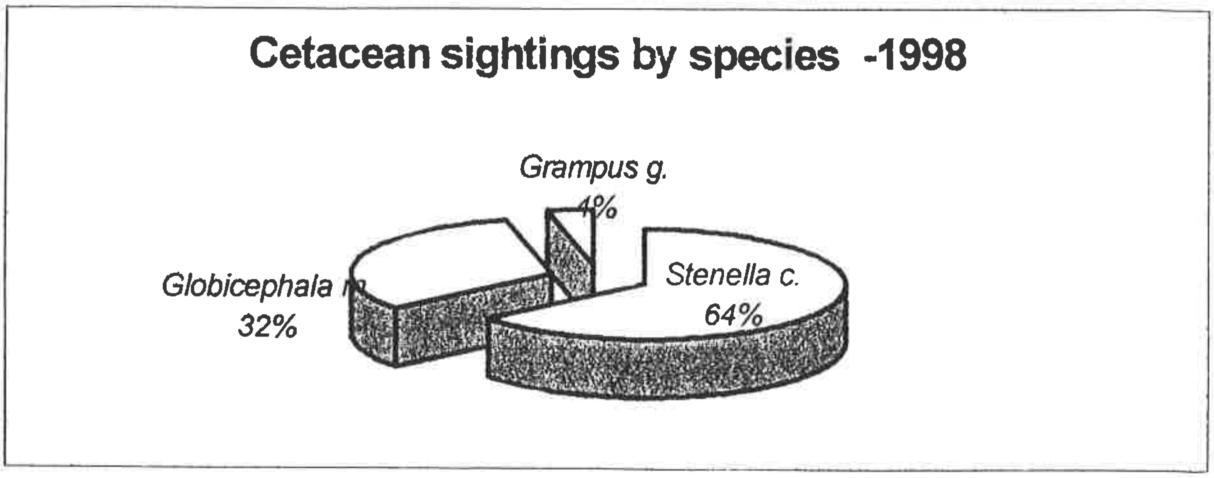
During the first week of 1998, the sightings consisted almost only of schools of Risso's dolphin, while during the following four weeks, mostly schools of striped dolphins were observed. This phenomenon could not be observed in the 1997 campaign. Some differences can be detected between those sightings occurring during 1997 and 1998. In fact, the only species observed in both years is striped dolphin, and that is why we have collected more information about it.

Comparing the numerical composition of the striped dolphin schools in the two years, it is easy to note that in 1997, they were, on the average, larger than in 1998 (Fig. 2). Plotting the sighting positions of both campaigns on a nautical chart, it is possible to note that 65% of all sightings were made in the area between 7°31' N and 7°44' N and 43°40' E and 43°44' E. In this area, in front of Cape S. Ampeglio (Bordighera), the continental slope is steeper since the bathymetric lines are nearer to each other than in other areas. These observations will be the basis for the new 1999 research campaign.

Table 1 - The number of cetaceans at the different times of sighting.
It is easy to notice that during the first week of 1998 the sightings consisted only of schools of *Grampus*. This phenomenon cannot be detected in the 1997 campaign

Date	*Stenella*	*Physeter*	*Balaenoptera*
22/7/97	10		
27/7/97	50		
28/7/97	25		
29/7/97			1
29/7/97	10		
30/7/97	35		
30/7/97	10		
31/7/97	3		
4/8/97	40		
5/8/97	10		
5/8/97	50		
6/8/97		1	
7/8/97	50		
8/8/97			1
9/8/97	50		
12/8/97		1	
13/8/97	50		
14/8/97			1

Date	*Stenella*	*Grampus*	*Globicephala*
19/7/98		10	2
20/7/98		60	
23/7/98		59	
24/7/98		45	
24/7/98	50		
25/7/98	20		
27/7/98	56		
31/7/98	43		
6/8/98	12		
7/8/98	13		
11/8/98	2		
13/8/98	15		
15/8/98	18		
19/8/98	13		
20/8/98	13		
21/8/98	6		



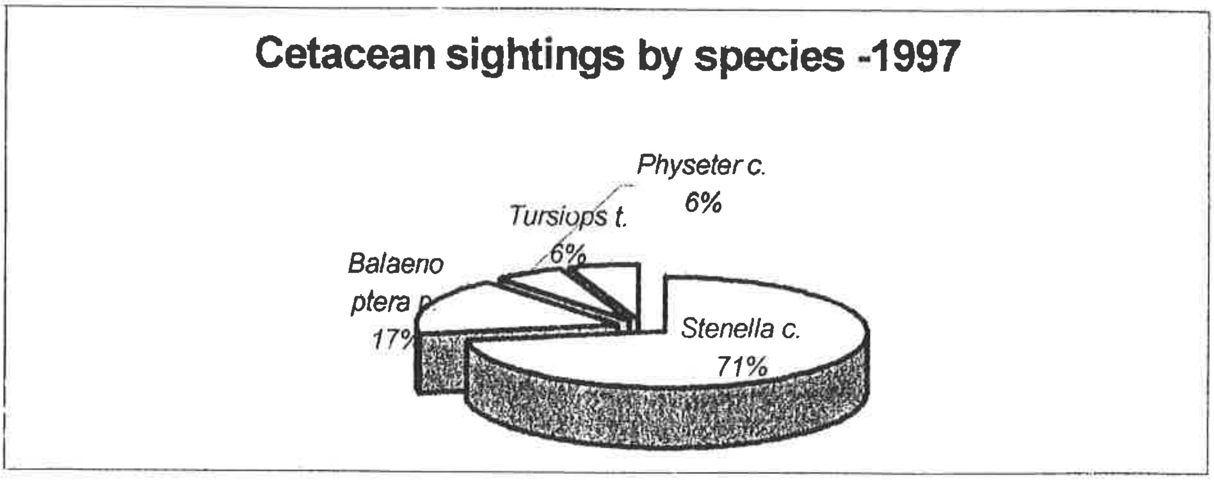


Fig. 1. - Sightings' species composition (in percentage). The high density of striped dolphins in the sighting area is evident from Fig. 1: in 1997, they constituted 71% of the total sightings and in 1998, 68%

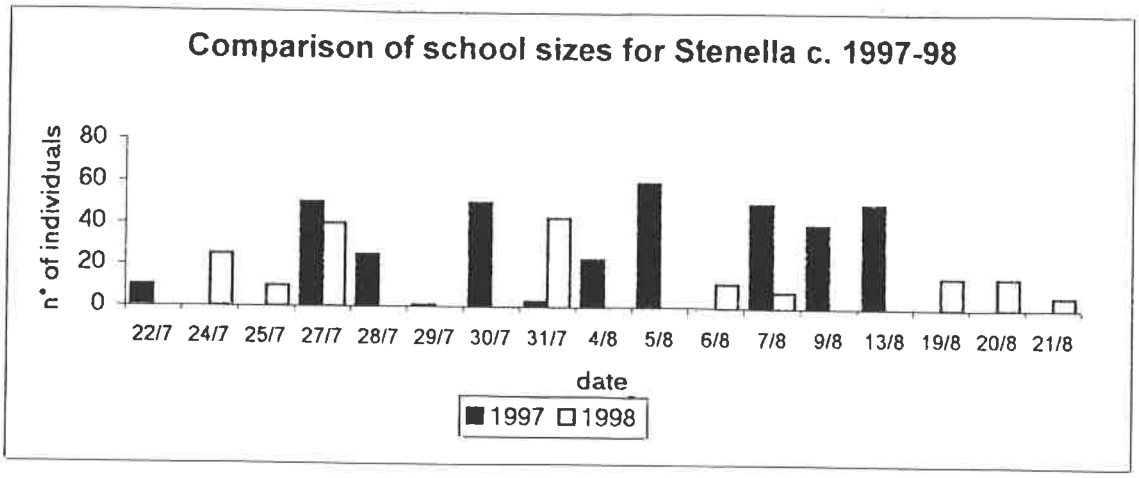


Fig. 2. School sizes for striped dolphin for each sighting. Comparing the numerical composition of the striped dolphin schools in the two years, one may note that in 1997, they were, on the average, larger than in 1998

CETACEAN RESEARCH AND CONSERVATION AROUND THE MALTESE ISLANDS

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Line transect surveys, over a total area of 76,000 km^2, have been undertaken since summer 1997, with the onset of the first cetacean research project around the Maltese Islands (Central & Southern Mediterranean region). The purpose of this study is to investigate cetacean species diversity and abundance encountered at different times of the year in this region of the Mediterranean.

The aerial and boat surveys around these Islands show the following results: 1) dolphin pods of up to 50 individuals have been observed; 2) the species which have been seen most often were the bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*) and common dolphin (*Delphinus delphis*); 3) small dolphin groups consisting of two to ten were the most common sightings, with an average of eight individuals per group; 4) the local strandings in 1997 of a Risso's dolphin in March, a young striped dolphin in June, a common dolphin in October, together with two sighting records of single unidentified whales and one with a group of sperm whales (*Physeter macrocephalus*), should stimulate sustained research work in this part of the Mediterranean.

Abundance indices obtained separately using aerial surveys and boat surveys are compared, thus allowing critical comparison of the strengths and weaknesses of both techniques in cetacean density/abundance estimations. Another important issue tackled is the difference in these estimates between different seasons and thus the importance of year-round monitoring if more realistic measures of cetacean abundance and distribution is required. Overall, when comparing the results of this study with those reported in 1993 for central and northern Mediterranean, it is apparent that the abundance of certain species, particularly *T. truncatus* and *D. delphis*, are more abundant than previously observed.

The overall results highlight the importance of the Central Mediterranean region as a zone for year-round cetacean monitoring. Such monitoring would increase our knowledge on Mediterranean cetacean distribution and movements, thus allowing us to improve our tools for effective conservation of cetacean species year-round.

SEASONAL VARIATION IN THE OCCURRENCE OF BEAKED WHALES IN THE SOUTHERN BAY OF BISCAY

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INTRODUCTION This paper describes the presence and distribution of beaked whales in the Bay of Biscay between 1995 and 1998, from analysis of the sightings database of the Biscay Dolphin Research Programme (BDRP).

The Biscay Dolphin Research Programme (BDRP) is a voluntary conservation body sponsored by the shipping company *P&O European Ferries* (Portsmouth) and affiliated to the Cetacean Monitoring Unit, *Sea Watch Foundation*. The mission statement of BDRP is to further the conservation of cetaceans and other marine life in the Bay of Biscay through scientific study and educational activities.

The BDRP database comprises sightings and effort data collected on survey trips each month from August 1995 to December 1998 (n = 38 monthly trips). On each trip, a team of three experienced recorders carry out standardised vessel-based effort cetacean surveillance work.

METHODS The distribution of the Cuvier's beaked whale (*Ziphius cavirostris*), northern bottlenose whale (*Hyperoodon ampullatus*), and Sowerby's beaked whale (*Mesoplodon bidens*) in the Bay of Biscay, 1995-98, was determined by an analysis of sightings data collected by recorders from the BDRP (Figs 1-4).

The BDRP undertakes monthly surveillance surveys across the Bay of Biscay by travelling aboard the 37,000 tonne P&O ferry, the Pride of Bilbao. The ferry follows a (more or less) fixed route between Portsmouth, England and Santurtzi (Bilbao), Spain, and samples a representative range of topographical features and underwater habitats found in the Bay of Biscay. These include: the continental shelf west and south-west of Brittany, France (46-49° N by 4-6° W, depth <200 m.); the shelf edge (46-47° N by 3-5° W, depth 200-1,000 m.); the abyssal plain (44-46° N by 3.5-4.5° W, mean depth 4,000 m.) and the Cantabria coast, northern Spain (43° N by 3° W, depth <200 m.).

On each trip, cetaceans are recorded by systematic watches carried out using standard methodology developed by the UK Mammal Society Cetacean Group for effort-based recording (by volunteers) on platforms of opportunity, (Evans, 1981). Watches are maintained continuously from dawn until dusk. The return ferry journey extends over four days, and enables the whole of the route to be sampled at least once during daylight in the summer, and approximately 75% of the route in the winter.

On each trip, a team of three experienced observers scan ahead from 22.5° ahead of the beam, on both the port and starboard sides. The methodology is essentially that of an unlimited distance single line transect, with every cetacean and other animal visible and identifiable being recorded once only. Recording is made from the ship bridge, at a height of 32 m. and a mean ship speed of between 15 and 22 knots.

For each beaked whale sighting, the number of animals is counted and, where possible, the age, sex, and behaviour of individuals is recorded. At the time of sighting, the following recordings are also made: time, position of the ship (using the ship's global positioning system), position and orientation of the animal(s) relative to the ship, and environmental conditions such as: sea state, swell height, wind speed and direction, and visibility. These details are entered onto a standardised *Sea Watch Foundation* sighting forms (Evans, 1995).

For cetaceans passing close to the boat (within c. 200 m.), more detailed behavioural observations are made. At half-hourly intervals, ship position, ship speed, and environmental recordings are repeated and entered onto a standardised *Sea Watch Foundation* vessel based effort recording form (Evans, 1995). Effort data enables the number of sightings to be scaled according to effort, and thus the calculation of relative abundance indices.

To standardise data collection, trips are made at the same time each month (in the third week) and are carried out by a select number of experienced observers (more than 97% of trips are led by the authors).

Between August 1995 and December 1998, 38 monthly trips were made, with a total of 19,994 km of recording effort being made in light to moderate seas (sea state four or less).

To determine the distribution of beaked whales in the sample area, sightings have been summed as numbers of individuals by grid square (which measure 1° longitude by 0.5° latitude), using the standardised system developed by the International Council for the Exploration of the Sea (ICES) grid cells (n=29).

RESULTS Within the survey area, both Cuvier's beaked whales and northern bottlenose whales extend throughout a large part of the deep water area of the Bay of Biscay (Fig. 1-4). The two species have only once been recorded in the same month, whilst Fig. 5 shows that there is some significant seasonal variation in the presence and absence of these two species.

75% of Cuvier's beaked whale sightings have been made between March and May (Fig. 5) whilst 93% of northern bottlenose whales were recorded between May and August (Fig. 3), with 64% of sightings during May and June (Fig. 5). On only one occasion were Cuvier's beaked whale and northern bottlenose whale seen during the same survey. The only other beaked whale species that has been recorded during these surveys is Sowerby's beaked whale.

Cuvier's beaked whales were recorded mainly during the period March to May (Fig 2), with 50% occurring in March and April (Fig. 5). Northern bottlenose whales were recorded in the period May to August (Fig 3), with 64% of sightings occurring in May and June (Fig. 5). Both species have been recorded outside of the peak period. Sowerby's beaked whales have been recorded in the area, but the sample size is so small that no further inferences can be drawn from this here.

Group sizes vary, but the Cuvier's beaked whale has been observed in generally larger groups (Fig. 6) than northern bottlenose whales.

The most northerly Cuvier's beaked whale sighting was at 45.38° N whilst that of northern bottlenose whale was at 46.05° N. The furthest south for Cuvier's beaked whale is 43.39°N and northern bottlenose whale 43.42° N. These data indicate that the two species broadly occupied the same area during different months. The results suggest that the sightings of Cuvier's beaked whale occur over particular submarine features that indicate these animals may be feeding during their time in the southern part of the Bay of Biscay. All of the sightings have been recorded in deep waters off the continental shelf, north of 43°39' N in waters of 1,000 m. depth or greater.

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK Beaked whales may occur in deep offshore areas and those areas of interesting topography, characterised at the continental shelf edge in the southern Bay of Biscay. Our data suggest that the sightings of Cuvier's beaked whales occur over particular submarine features that indicate these animals may be feeding during their time in the southern part of the Bay of Biscay. It is significant that northern bottlenose whales occur when Cuvier's beaked whales are absent. This could indicate competition for the prey species within the area. Cuvier's beaked whale seems to feed predominantly on cephalopods (Heyning, 1989) whilst northern bottlenose whale also feeds largely on squid (Evans, 1987).

It has been suggested that Naval manoeuvres may be instrumental in the dis-orientation and death of some species of beaked whales (Frantzis, 1998; Simmonds, 1991). In the Bay of Biscay, there are large areas that are used by the military as firing or exercise areas. Both of these species have been recorded in those areas, and it is important now to develop a programme to carry out photo-ID and acoustic programmes to investigate the behaviour and site fidelity of these species. Group sizes and structure will also play an important part in any further work, particularly with the relatively enigmatic Cuvier's beaked whale. Cuvier's beaked whales were most often seen in groups of three (Fig. 6), whilst northern bottlenose whales were seen most often in groups of two (Fig. 6). Previously, reports from the Bay of Biscay area had not recorded Cuvier's beaked whales or northern botlenose whales (McBrearty *et al*, 1986). Cuvier's beaked whale behaviour and group structure has been recorded, but require further analysis.

REFERENCES

Evans, P. G. H. 1981. *A guide to identification of cetaceans in the Northeast Atlantic.* Occasional Publication, Mammal Society. 20pp.

Evans, P. G. H. 1987. *Natural History of Whales and Dolphins.* Christopher Helm/Academic Press. 343pp.

Evans, P. G. H. 1995. *Guide to the identification of whales, dolphins and porpoises in European seas.* Sea Watch Foundation, Oxford. 40pp.

Heyning, J. E. 1989. Cuvier's Beaked Whale *Ziphius cavirostris* G. Cuvier, 1823. Pp. 289-308. In *Handbook of Marine Mammals 4: River dolphins and larger toothed whales.* (Eds. S. M. Ridgway & R. Harrison). Academic Press, London. 442pp.

McBrearty, D. A., Message, M. A., and King, G. A. 1986. Observations on small cetaceans in the north-east Atlantic Ocean and the Mediterranean Sea: 1978-1982. Pp. 225-249. In: *Research on Dolphins* (Eds. M. M. Bryden & R. J. Harrison). Oxford University Press, Oxford, UK.

Simmonds, M. P. and Lopez-Jurado, L. F. 1991. Whales and the Military. *Nature*, Lond., 351: 448.

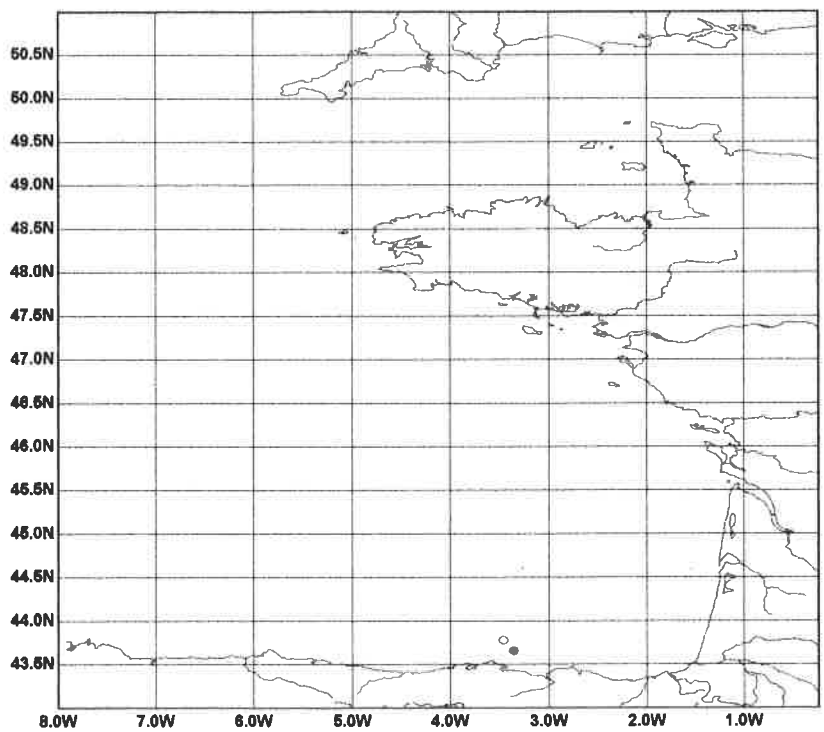

fig 1
Dec-Feb

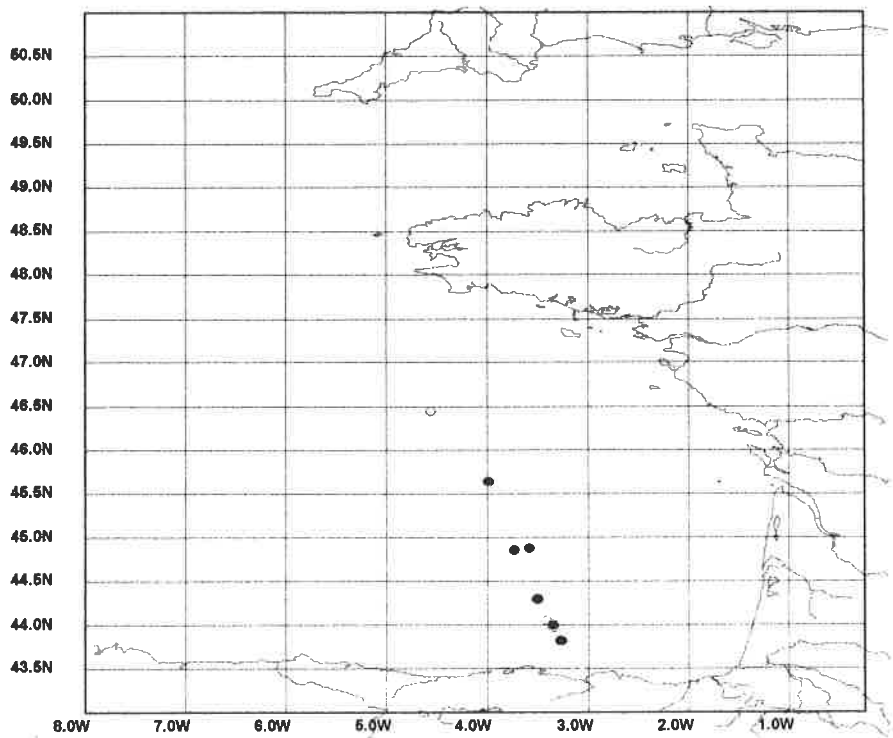

fig 2
March-May
Open circles northern bottlenose whale. Closed circles-Cuvier's beaked whales Grey circles unidentified beaked whales

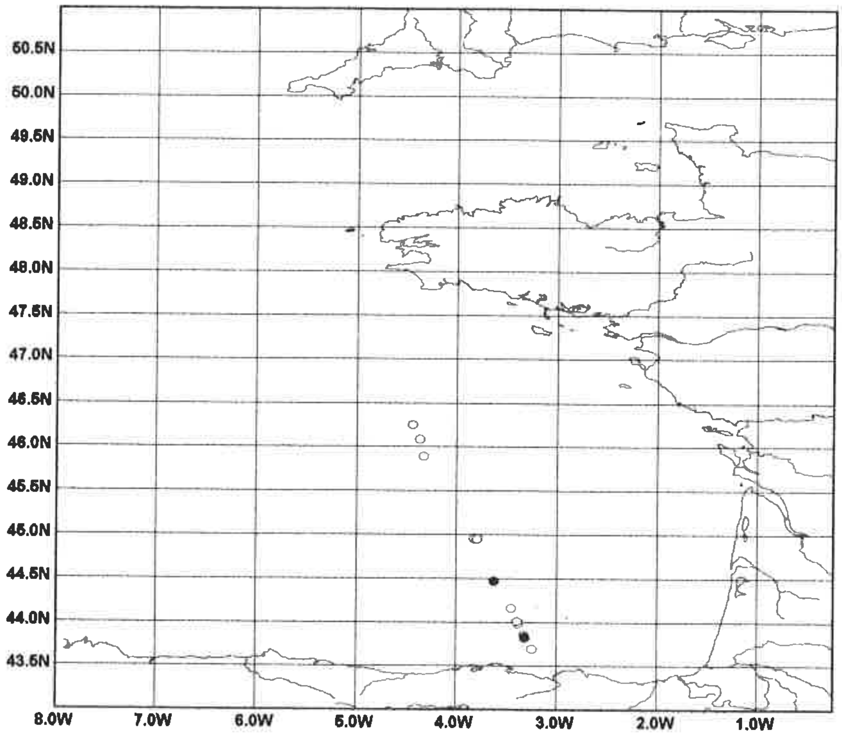

fig 3
June-August

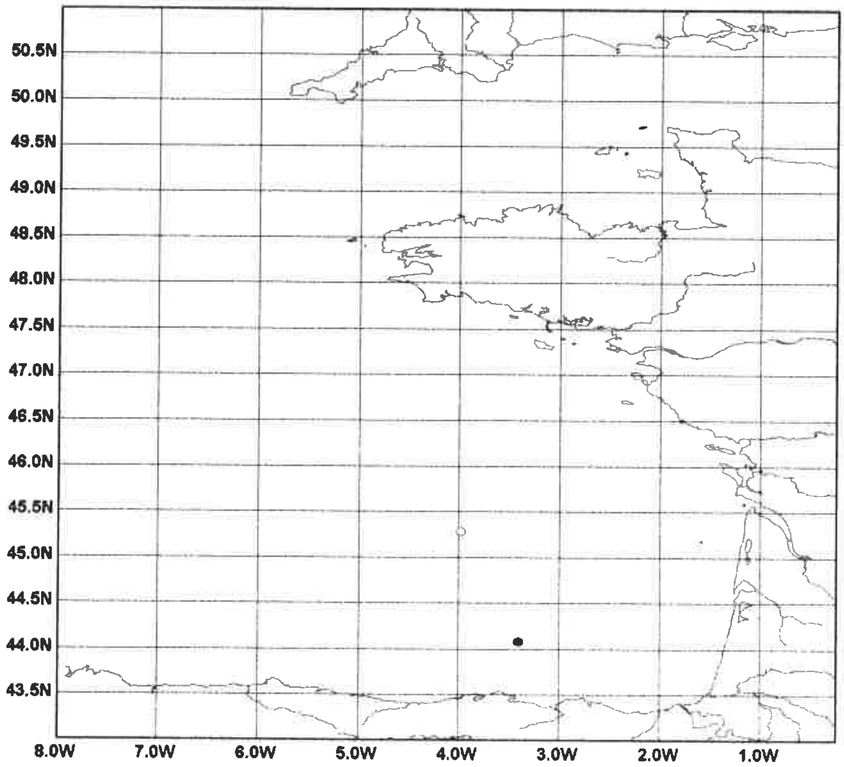

fig 4
Sept-Nov

Open circles northern bottlenose whale. Closed circles-Cuvier's beaked whales Grey circles unidentified beaked whales

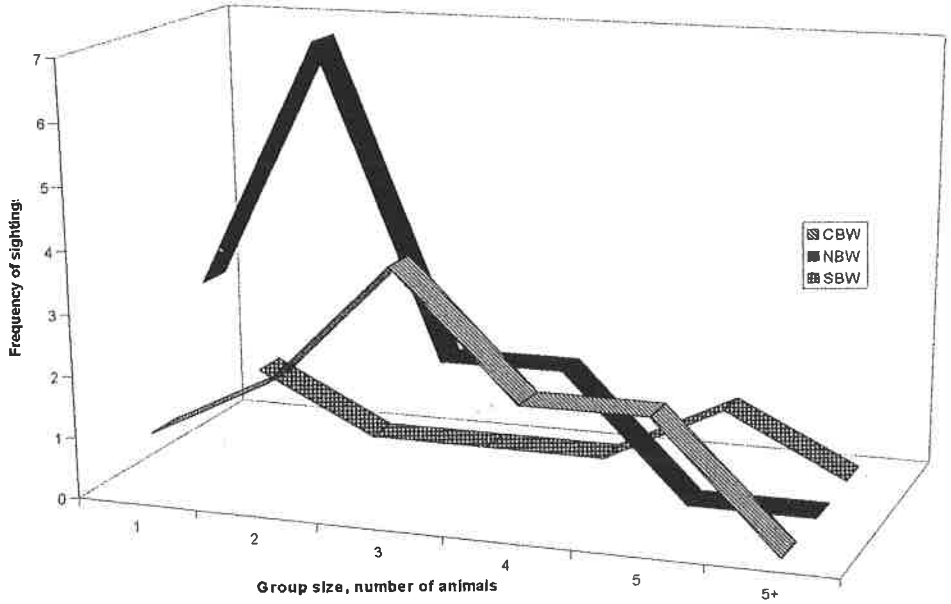

fig 5
% of Cuvier's beaked whale and northern bottlenose whale sightings Bay of Biscay all months

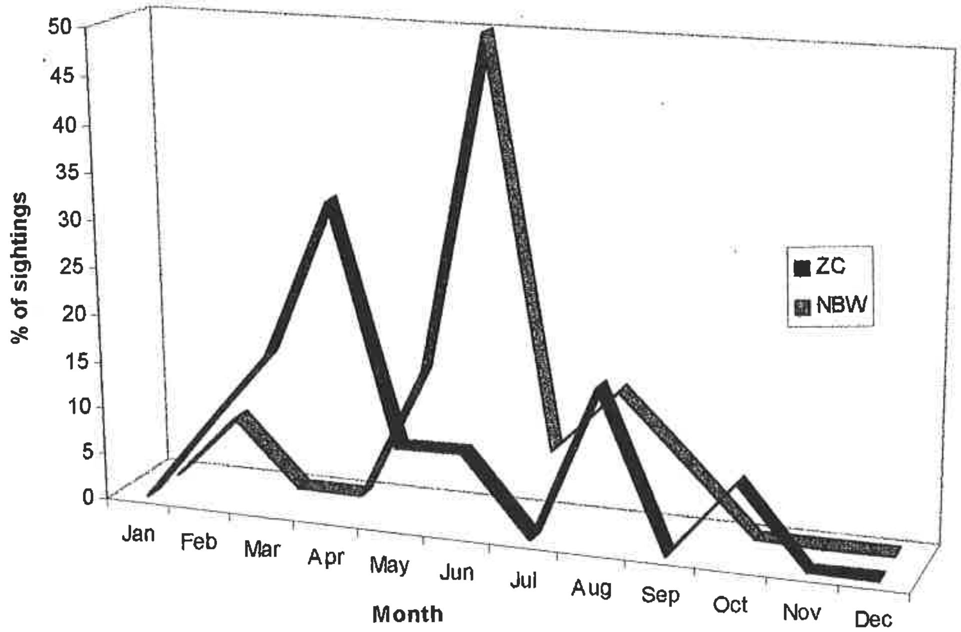

fig 6
Group size of beaked whales observed in the Bay of Biscay all months

SOWERBY'S BEAKED WHALE (*MESOPLODON BIDENS*) SIGHTING OFF THE ISLAND OF MADEIRA

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All twelve species within the genus *Mesoplodon* are poorly known, commonly regarded as rare and officially classed as Data Deficient (DD) by the IUCN (Leatherwood & Reeves, 1983, Jefferson *et al.*, 1993 and IUCN, 1996). Many species of beaked whales are notoriously difficult to identify at sea due to similarities in their morphology. Although relatively little is known of the global distribution and ecology of Sowerby's beaked whale, *Mesoplodon bidens* (Sowerby, 1804), in recent years our understanding of these animals in certain areas has increased (J. Nicolas, *pers. comm.*). However, there are few papers describing stranding records or live sightings (Lien & Barry, 1990; Lien *et al.*, 1990; Reiner, 1986; McBrearty *et al.*, 1986; Mead, 1989). Off the coast of Madeira, there is only one other reported sighting of *M. bidens*, an animal caught in 1941(Maul and Sergeant, 1977) during whaling.

A preliminary acoustic/visual investigation of cetaceans around Madeira was carried out over several days by scientists from the International Fund for Animal Welfare (IFAW) and the Museu de Baleia in Caniçal, Madeira, using '*Song of the Whale*', a 14 m. auxiliary powered ketch, operated by IFAW. Two beaked whales, later identified as *M. bidens*, were encountered together on the 4th October 1995 off the south coast of Madeira at position 32°38' N and 17°04' W. Photographs were taken, behavioural observations were recorded, and subsequent comparisons with other *M. bidens* sightings were made.

GEOGRAPHICAL DISTRIBUTION OF SMALL CETACEANS IN SEVERAL GREEK COASTAL AREAS

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INTRODUCTION With the exception of the Ionian Sea which has been systematically surveyed by the Tethys Research Institute, and the Gulf of Corinth studied since 1995 by the Cetacean Research Group of the University of Athens, our knowledge about the geographical distribution of small cetaceans in the Greek seas is limited, and it is mainly based on what is found in the literature and in stranding data.

Marchessaux (1980) reviewed the current knowledge of cetaceans in the eastern Mediterranean, based on literature as well as personal data. In a more recent paper, Frantzis (1997) reviewed and assessed stranding data collected mostly after the epidemic of dolphin morbillivirus. He reported the presence of six species of small cetaceans (*Tursiops truncatus, Stenella coeruleoalba, Delphinus delphis, Grampus griseus, Ziphius cavirostris and Pseudorca crassidens*) in the Aegean Sea and coastal areas of the southern Evoikos and Pagassitikos Gulfs, as well as the Cyclades and northern Sporades islands.

Personal observations, as well as a careful evaluation of amateur reports, indicated the regular presence of bottlenose dolphins (*Tursiops truncatus*) and striped dolphins (*Stenella.coeruleoalba*), and the occasional presence of common dolphins (*Delphinus.delphis*) in several coastal areas of Greece such as northern and southern Evoikos, Saronikos, Amvrakikos, and Patraikos Gulfs. Based on this information, the American College of Greece, in collaboration with the University of Athens, decided to survey these coastal areas of Greece.

The purpose of this survey was to study the geographical distribution of small cetaceans, and set up the background for the assessment of their present status in the Greek seas. Of particular interest is the assessment of the actual status of the common dolphin, the population of which is considered in decline.

MATERIAL AND METHODS During the spring, summer and autumn of 1998, surveys were carried out using a 38 ft sailing boat (*Argo*) and a 17 ft rigid inflatable (*Oceanus III*). The following coastal areas were surveyed: southern and northern Evoikos Gulfs including the Orei channel, Saronikos Gulf, the Gulf of Corinth and Patras including the Achelloos river estuary, Echinades as well as the Gulf of Amvrakikos.

The surveys were conducted *ad libitum*, and transects were planned so that the areas surveyed were equally covered. Conditions were considered positive when at least one observer was on watch and the sea state was less than 3 Beaufort scale (Bearzi and Notarbatolo di Sciara, 1995). The position of the boat was determined using GPS units and data on transects, and the sightings were processed using SeaPro navigation software.

RESULTS AND DISCUSSION During the spring, summer and autumn cruises, total effort was 2,948 km. There were 56 sightings of bottlenose dolphins, 13 sightings of common dolphins, and 20 sightings of striped dolphins.

In southern Evoikos, an open oligotrophic gulf between the Greek mainland and the island of Evia and adjacent to the Aegean Sea, a total of 1,003 km were surveyed. There were 13 sightings of bottlenose dolphins and two sightings of common dolphins. Sighting frequencies per 100 km were 1.2 for bottlenose and 0.2 for common dolphins respectively (Table 1). Bottlenose dolphins were usually sighted very close to the coast, and in areas where coastal waters adjoin the more open waters of the Aegean sea. School size ranged from one to 15 individuals.

In the northern Evoikos Gulf, including the Orei channel, due to adverse weather conditions, only 196 km with positive conditions were covered and three sightings of bottlenose dolphins occurred. Although reports from amateurs indicated relatively high population densities of bottlenose dolphins in this Gulf, the sighting frequency was not very high (1.5/100 km).

Korinthiakos, is a narrow, very deep (maximum depth of 905 m.) and relatively productive Gulf formed between Greece and Peloponissos. It is adjoined on the west by the Patraikos Gulf and the Ionian sea. Work carried out by the Cetacean Research Group of the University of Athens in 1996 and 1997 (Mardikis, *pers. comm.*) has shown that not only striped dolphins but also common dolphins are regularly and predictably observed.

During the 1998 survey, a total of 562 km of effort resulted in twenty sightings of striped dolphins and ten of common dolphins, with sighting frequencies of 3.6 and 1.8/100 km respectively. The size of the schools of striped dolphins ranged from a few individuals up to more than 50, and common dolphins were observed in association with them. Bottlenose dolphins were also observed in Gulf of Korinthiakos, with sighting frequencies of 1.4/100 km, but never in association with either striped or common dolphins. These sighting frequencies are significantly higher than the mean sighting frequencies of 1.4 for common and 0.7 for bottlenose dolphins reported in the eastern Ionian sea inshore waters (Politi *et al.*, 1994, 1999).

A total of 286 km were covered in the Saronikos, a gulf which forms on the south of Athens and adjoins the Aegean Sea. This gulf receives the combined domestic sewage and industrial effluents of the Greater Athens area, and its eutrophication and chemical pollution has been extensively documented. Moreover, there is a very heavy traffic of freighters, ferry and pleasure boats in the gulf. Bottlenose dolphins were regularly observed in this gulf with a surprisingly high sighting frequencies of 3.1/100 km.

Patraikos Gulf adjoins on the east, Korintiakos, and on the west, the Ionian Sea. Sighting frequencies were relatively low - 0.28/100 km for bottlenose dolphins and 0.14/100 km for common dolphins.

In the Gulf of Amvrakikos, a small, shallow, and very productive estuary communicating with the Ionian Sea through a narrow passage, a total effort of 182 km resulted in 21 sightings of bottlenose dolphins and the surprisingly high sighting frequency of 11.5/100 km. School size ranged from one to 30 individuals. Bottlenose dolphins were regularly observed in the northern part of the gulf close to river mouths, surface feeding, probably on small clupeids. This surface feeding behaviour has never been observed in the bottlenose dolphins in the adjacent inshore waters of the Ionian Sea (Natoli, *pers. comm.*), and it is very probable that the population of bottlenose dolphins in Amvrakikos Gulf is a resident population.

CONCLUSIONS Although only tentative, the results of this study indicate the regular presence of bottlenose dolphins in several coastal areas of Greece. In the Gulf of Amvrakikos, there is a very high population density of bottlenose dolphins which is most probably resident. Further investigation and assessment of its status is urgently needed since this population seems to be interacting heavily with commercial fishing. Bottlenose dolphins are also regularly observed in the southern Evoikos Gulf in waters adjoining the Aegean Sea. Also this population is interacting with commercial fishing.

Common dolphins are regularly observed in the Gulf of Korintiakos, always in association with striped dolphins and occasionally in the southern Evoikos Gulf. This is rather surprising because they are considered a pelagic species and their population is thought to be in decline. Further investigation and assessment of their status is needed.

REFERENCES

Bearzi, G. and Notarbatolo di Sciara, G. 1995. A comparison of the present occurrence of bottlenose dolphins, *Tursiops truncatus*, and common dolphins, *Delphinus delphis,* in the Kvarneric (Northern Adriatic Sea). *Annals for Istrian and Mediterranean Studies*, 7: 61-68.

Frantzis, A. 1997. Cetaceans and Cetology in the Hellenic Seas. Pp. 114-118. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Marchessaux, D. 1980. A review of the current knowledge of the cetaceans in the Eastern Mediterranean Sea. *Vie Marine*, 2: 59-60.

Politi, E., Airoldi, S., and Notarbatolo di Sciara, G. 1994. A preliminary study of the ecology of cetaceans in the waters adjacent to Greek Ionian islands. Pp. 111-115. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Politi, E., Airoldi, S., Natoli, A. and Frantzis, A. 1999. Unexpected prevalence of common dolphins over sympatric bottlenose dolphins in Eastern Ionian sea inshore waters. P. 120. In: *European Research on Cetaceans -12*. Proc. 12th Ann. Conf. ECS, Monaco, 20-24 Jan 1998. (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Valencia, Spain. 436pp.

Table 1 - Total effort (km), sightings and sighting frequencies (/100 km) of bottlenose, striped and common dolphins

AREA	EFFORT (km)	SIGHTINGS	SPECIES	SIGHTING FREQ.
South Evoikos	1,003	13	bottlenose dolphin	1.2
		2	common dolphin	0.2
North Evoikos	196	3	bottlenose dolphin	1.5
Amvrakikos	182	21	bottlenose dolphin	11.5
Patraikos	719	2	bottlenose dolphin	0.28
		1	common dolphin	0.14
Korinthiakos	562	20	striped dolphin	3.6
		10	common dolphin	1.8
		8	bottlenose dolphin	1.4
Saronikos	286	9	bottlenose dolphin	3.1

ECOLOGY

BIOLOGY OF SOME OCEANIC CEPHALOPOD SPECIES, ESTIMATED FROM CETACEAN STOMACH CONTENTS FROM THE WESTERN MEDITERRANEAN

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Life cycles of oceanic cephalopod species are unknown, due to their difficult capture. The analysis of the stomach contents of their predators may give some interesting information about aspects of population dynamics.

Four oceanic cephalopod species *Chiroteuthis veranyi*, *Ancistrocheirus lesueuri*, *Octopoteuthis sicula* and *Ctenopteryx sicula*, have been studied. Cephalopod beaks were obtained from the stomach contents of two *Ziphius cavirostris* and 16 *Stenella coeruleoalba*, stranded in February 1996 and August 1990, respectively.

The scarcity of data precludes definitive conclusions being drawn, but the estimated mantle length, based on the regression of the rostral or hood lower beak length, suggests a one-year life cycle for members of the above cephalopod species. During the life cycle, an increase in size of summer juvenile populations seems to occur, continuing until winter. This is clearly shown by the distribution of members of *C. veranyi* and *A. lesueuri*, which present two different year-class populations in summer, the older formed by the higher sizes found in the literature.

The differences in diving behaviour of both teuthophagous cetaceans, Cuvier's beaked whale *Z. cavirostris* and striped dolphin *S. coeruleoalba*, and the ontogenic vertical migration of cephalopods do not seem to be the explanation for the presence of these different populations.

This is the first attempt to reveal biological aspects of these cephalopod species.

FACTORS AFFECTING THE DISTRIBUTION, AND PIGMENTATION PATTERN OF RISSO'S DOLPHIN (*GRAMPUS GRISEUS*) IN THE LIGURO-PROVENCAL BASIN DURING 1990-1998

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INTRODUCTION Risso's dolphin (*Grampus griseus*) is a 4 m. blunt faced odontocete, whose worldwide distribution has often been reported (see, for example, Evans, 1987, Kruse, 1989). In the Italian seas, its presence is reported for the northern Tyrrhenian Sea between the islands of Elba and Corsica (Beaubrun, 1995), and the Central Tyrrhenian Sea (Di Natale, 1986, *pers. comm.*; Notarbartolo di Sciara *et al.*, 1993).

Consistent relationships between Risso's dolphin distribution and topographic features have emerged from a number of studies (Kruse, 1989; Fabbri *et al.*, 1992; Gannier *et al*, 1994; Podestà, 1997; Bompar, 1997). These relationships are particularly evident in the Liguro-Provençal basin as well as in the Tyrrhenian Sea (Marini *et al.*, 1992).

The presence of Risso's dolphins in the Liguro-Provençal basin is well known from stranded/by-catch specimens and ship-based investigations (Podestà, M., 1989, *pers. comm.*). Recently, aerial surveys over more than 60,000 km^2-wide area confirm the patchy distribution of the species, whose groups are present only above the edge of the continental shelf (200-1000 m.) (Beaubrun *et al.*, 1997). Additionally, several links among geological, physical and biological oceanographic factors have been proposed, and the trophic importance of the Liguro-Provençal basin in sustaining cetacean population has been emphasised (Würtz and Palumbo, 1985; Jacques, 1989; Würtz *et al.*, 1992).

This work mainly aims a) to use the results from long-term observation to establish the true role of water depth on the habitat selection of this species; and b) to propose some useful measurable parameters for better quantifying and describing the bottom topography.

MATERIALS AND METHODS The tentire study area was in the north-western Mediterranean between Nice (France) and Bocche di Magra (LI-Italy). The study area was then divided into three sectors (sub-areas A, B and C) based on their different geo-structural features, which were well categorised by 6 kjoule Sparker profiles (Figs. 2 a, b, c, d). The extent and boundaries of the region are shown in Figs.1 and 2, and summarised in Table 1.

Effort: Some dedicated ship-based campaigns were conducted from June to August (1990), June and July (1991), May, June, July and August (1994), late in September (1994), at the end of April and June (1994), and in April and June 1998. Data were collected by a variety of vessels and boats (6-18 m. length) in randomly sampled areas, and the survey consisted of a series of transect strips (5-25 nm width) performed at a constant cruising speed of five knots. Results from 1990 and 1991 surveys, and a refined series of interviews (1990-93), were then used in planning further 1994 and 1998 spring-summer investigations in more focused areas, characterised by middle and outer slope environments (Figs. 2a, b, c, d). A total of 133 transects were conducted and a surface area of over 12,546 sq. nm was monitored between 1990 and 1998 (Table 1). Total effort in 1990-94 and 1998 amounted to 4,942 nm, and 1,164.4 hours, of which, 4,152.8 nm (936.4 hours) involved effective observation.

Fieldwork: Sightings were made by skilled teams of observers (3-11 persons) searching for surfacing cetacean schools using both naked-eye and binocular observations. When cetaceans were detected, GPS position of the boat and animals were immediately registered and plotted onto a map to estimate water depth (m.) and distance from the coastline (nm) for each group. The number of encountered groups was conventionally assumed to be equal to the number of sightings separated by at least a 10-minute interval. For each sighting, parameters such as species, size of group(s), activities, behavioural patterns, and presence of cow-calf pairs were identified. A total of 345 photos were collected and analysed to obtain complementary information on the school size composition and to attempt Photo-ID. Finally, we employed the same definitions used by Kruse (1989) to describe the school's composition and assess any potential segregation by age via pigmentation pattern observations.

Statistical Methods: We used the statistical package SPSS 7.0 to process a data set of thirty-five. Long-term results were also used to select another suite of thirty-five control points (points of absence), randomly located around parts of the study area where no sightings of Risso's dolphin were reported (Barberis *et al.*, 1995). The Contour Index (C.I.) (Kruse, 1989) was thus calculated for a circular area (1 nm radius) centred on each of the selected sites (35 presence plus 35 absence points). We have identified several significant variables and determined values for them using commercial GIS software (MapInfo 3.0) to obtain additional data both from the presence and absence points. The variables were:

1. Distance from the coast (Dist. Coast, nm).
2. Depth (metres).
3. Linear extension of the Canyon axes (Extn Lin. Can., nm)
4. Distance from the nearest Canyon system (Dist. Can., nm)
5. The bathymetric linear density (Bathy. Density) which is the length measured along the steepest gradient divided by the number of isobaths within the sampling unit (3.14 sq. nm).
6. The C.I. (max. depth - min. depth / max. depth).

We have used the ANOVA one-way test to evaluate any differences existing between presence and absence points. The Stepwise forward method was independently applied to the same variables to determine their statistical sensitivity and to isolate the variables best correlated with the presence of Risso's dolphins. Finally, the Spearman Rank correlation coefficient was used to identify relationships among the variables themselves.

RESULTS Fieldwork: The sightings are not scattered throughout the entire area, but rather are localised in a few restricted areas (Fig. 2), and the species seems to inhabit only a small portion (9.49%) of the study area (Table 1).

Statistical analyses: Results from 1) ANOVA One way test, 2) Stepwise forward method (with the Chi-square - two degrees of freedom test), and 3) Spearman Rank correlation coefficient, are provided in Tables 2, 3, and 4, respectively. The Stepwise forward method shows that a highly significant relationship exists between the location of the pods and variables 1 and 4 (see Table 2); Chi square Test (two degrees of freedom) has levels of significance higher than 9.21 (16.957, $p = 0.0002$) for these two variables (Table 2), and the standardised coefficients are 0.612 for variable 1 and 0.693 for variable 4. The percentage of correct classifications clearly shows a strong difference between absence and presence points (Table 3). Surprisingly, the depth (variable 2) had no statistical significance when considered as a single parameter.

OTHER RESULTS (i) A wide variety of natural markings (such as white and dark teeth rake scars; epidermal lesions; linear, parallel and/or crossed marks; circular, irregular well-shaped, or smoothed depigmentation patterns) have been observed (Figs. 3, 4, 6), supporting similar observations by Atkinson *et al.* (1997). (ii) Large, similarly sized, animals (i.e., sub-adults of the same age) are present in all sightings. Familiar sub-groups are somehow composed of animals that show a clear pigmentation pattern (Fig. 5). Circular pale grey scars, which probably result from predator-prey interactions, occur around the mouth of some individuals (Fig. 6). (iii) In five cases, the same group was re-sighted in the same area (sub-area A) over a period of one week. (iv) In sub-area B, segregation by age is suggested by a sub-group of six pure white animals observed in June 1994 and June 1998 (Figs. 7 & 8). The presence of cow-calf pairs and newborns was detected in late spring and summer months, except for early May 1994 and April 1998 (Fig. 5).

DISCUSSION Throughout the Ligurian Basin, many local phenomena occur where particular features of the bottom topography are present. The 1990 and 1991 observations, as well as 1998 early summer data, confirm that the distribution patterns of Risso's dolphin are consistent with previous independent results from other parts of the Liguro-Provençal basin (Fabbri *et al.*, 1992; Podestà *et al.*, 1997; Bompar, 1997).

A potential link between topographic and hydrologic features in sub-area A has been previously discussed by Podestà and Coll (1997). They focus on a small 10 km^2-wide area immediately off Cape Noli (A/B boundary) where the shelf break is less than 1-2 nm from the coast. In fact, daily sightings of Risso's dolphins were initially reported quite close to the town of Savona (Podestà *et al.*, 1997). A mass stranding of eurybathic and eurythermal species of cephalopods which performed daily vertical and/or lateral migration in the water column, was cyclically recorded (Torchio, 1966). This phenomenon is still present (Tarditi, M. 1993, *pers. comm.*) and is correlated with changes in physico-chemical parameters of the coastal waters from the very strong river discharges along the adjacent littoral zone.

Generally, potential feeding activities of Risso's dolphins were observed in areas characterised by waters with a depth range from 400 to 750 m. (Fabbri *et al*, 1992; Würtz *et al.*, 1992; Gannier *et al.*, 1994, Bonaccorsi, 1997). This depth range is strongly consistent with i) the presence of ammonia calcium-rich mesopelagic (300-500 m.) cephalopods such as *Histiotheuthis reversa* (Würtz *et al.*, 1992), and ii) well identified exchanges in the water column particularly acting between the intermediate and surface layers.

Further results confirmed the Polcevera Canyon to be the most important area inhabited by Risso's dolphin, at least in the late spring months. Seasonal fluxes in the water column were previously investigated (Corradi *et al.*, 1987). They are predominantly vertical, and achieve maximum strength close to the slope with the steepest bottom topography (500-1,200 m.), and high C.I. values (Kruse, 1989). Therefore the hydrology of submarine canyon systems could be a primary or contributing factor controlling the patchy distribution pattern of the species in the Liguro-Provençal basin.

Whereas in the Mediterranean Sea, the Risso's dolphin inhabits waters surrounding the submarine canyon system, off the east coast of the Isle of Lewis (NW Scotland), the species selects waters shallower than 30 m. and characterised by a rocky seabed (Gill *et al.*, 1997). This implies a particular habitat selection related to the presence of a target prey group, such as the octopus *Eledone cirrhosa*, which is thought to be the main prey from stomach contents analysis of a stranded specimen in Scottish waters (Santos *et al.*, 1995). On the other hand, the stomach remains obtained from a young entangled specimen suggests that animals in sub-area B may feed mainly on neritic and meso-pelagic taxa.

CONCLUSION In the Liguro-Provençal basin, the habitat selection by Risso's dolphin is strongly affected by a) the presence of a canyon system (such as the Varo, San Remo, and Polcevera), b) the steepest submarine slopes (i.e., Capo. Vado, Noli, and Portofino slopes), and c) other steep topographies breaking the monotony of the continental shelf in the eastern part of the basin (i.e., along the areas surrounding Levantine Canyon). Furthermore, the inverse correlation between distance from the coast and the C.I. can be explained by the particular topography of the Liguro-Provençal basin itself (Fanucci *et al.*, 1987).

The fact that the Risso's dolphin selects different habitats based on the presence of prey is consistent with our results. Furthermore, in different environmental conditions this widely distributed species does not exploit the same depth range. Indeed, depth has not shown any statistical relevance if considered with respect to the bottom topography, which is the only significant parameter correlated with the distribution of the species in the Liguro-Provençal basin.

Further investigations either in the study area or in other important parts of the basin could enhance our understanding of the relationships existing among topographic features, oceanographic features, biomass layer(s) of prey, and feeding habits of predators such as Risso's dolphin.

Our study confirms the great importance of including morphological factors in any further abundance estimation, especially for a species so irregularly distributed as Risso's dolphin. Finally, we would like to emphasise the importance of some very localised sites (e.g., the sub-area B) frequented by schools, groups and sub-groups of different types and age composition. Particularly, the cow-calf pairs and presence of newborns in late spring and summer also attest to the strategic role of those coastal zone regions for breeding as well as for other vital activities (feeding, travelling and resting) observed.

In a wide variety of contexts (stock management and protection, conservation of rare or endangered species, Marine International Sanctuaries, and environmental health monitoring), it is essential to investigate habitat selection by this species, as well as to establish its population size.

ACKNOWLEDGEMENTS The authors wish to thank F. Fabbri (Greenpeace Italia), Mr. A. Leverone (WWF Ligurian Delegation), Comm. Nascetti (Italian Navy) for sponsoring and partially supporting the 1990-94 phases of research, and Drs. Matricardi, Mori, and Würtz (University of Genoa) for their advice and helpful suggestions. We are also very grateful to Prof. Fanucci (University of Trieste) for permission to use sparker seismic profiles and for fruitful discussions, and to Prof. Antonio Brambati (University of Trieste) for practical support and encouragement of this study. Our deepest thanks go to Dr. Al-Saadi and Ms. Lisa Ray for their patient work in reviewing the paper, and to Mrs. Angela Di Prima for her strong, kind support in organising the 1998 trip. We are also extremely grateful to all of the volunteers who helped collect data from 1990 to 1994, and particularly to A. Codari, C. Dionisi, M. Tarditi, M. Magliano, P. Valdittaro, E. Murialdo, F. Toscano, A. Spotorno, B. Veirana, and Capo Zippo ("Lega Navale" and "Capitaneria di Porto"di Savona) for hosting one of us on their ships.

REFERENCES

Atkinson, T., Gill, A., and Evans, P. G. H., 1997. Notes on the natural markings on Risso's dolphins (*Grampus griseus*) photographed in the coastal waters around the Eye Peninsula, Isle of Lewis, Scotland P. 209. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 Mar 1997. (Eds. P. G. H. Evans, E. C. M. Parsons and S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Barberis, S., Bonaccorsi, R., Chiarlone, F., Chiesa, O., Davico, A., Davico, L., Massajoli, M., and Trucchi., R. 1995. Introduction to collected data, Summer 1994, during WWF's Research Campaign in Ligurian Sea. Pp. 107-109. In: *European Research on Cetaceans - 9*. Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb, 1995 (Eds. P. G. H. Evans & H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Beabrun, P. 1995. *Atlas préliminarie de distribution des cétacés de Méditerranée.* CIESM, Musée océanographique, Monaco. 87pp.

Beabrun, P., David, L., Di-Méglio, N., Gannier, A., and Gannier, O. 1997. First aerial survey in the north-west Mediterranean - Preliminary results. Pp.100-103. In *European Research on Cetaceans -11.* Proc. 11th Ann. Conf. ECS, Straslund, Germany, 10-12 Mar 1997. (Eds. P.G.H. Evans, E.C.M. Parsons and S.L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Bompar, J. M. 1997. Winter presence of Risso's dolphins, Grampus griseus, in the Western part of the Ligurian Sanctuary. Pp.164-166. In: *European Research on Cetaceans* - 11. Proc. 11th. Ann. Conf. ECS, Straslund, Germany, 10-12 March, 1997 (Eds P. G. H. Evans, E. C. M. Parson & S. L. Clark) European Cetacean Society, Kiel, Germany. 314pp.

Bonaccorsi, R. 1997. *Ecoethology of some species of cetacean in the Ligurian Sea - Some open questions on the population estimation problems.* Graduation Thesis in Natural Sciences, University of Milan, July 1997. 150pp.

Corradi, N., Fanucci, F., Fierro, G., Firpo, M., Piccazzo, M., Ramella, A., and Tucci, S. 1987. Importance des canyons sous-marins dans la dynamique sédimentaire de la Mer Ligure. *Quaderni Ist. Geol. Univ. Genova*, 8 ,4: 73-104.

Evans, P. G. H. 1987. *The Natural History of whales and dolphins.* Christopher Helm, London. 343pp.

Fabbri, F., Giordano, A., and Lauriano, G. 1992. A preliminary investigation into the relationship between the distribution of Risso's dolphins and depth. Pp. 146-151. In: *European Research on Cetaceans* - *6*: Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb, 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Fanucci, F., Corradi, N. F., Fierro, G., Firpo, M., Piccazzo, M., Ramella, A., and Tucci, S. 1987. Sismostratigrafia e neotettonica del Mar Ligure - *Quaderni Ist. Geol. Univ. Genova*, 8, 3: 41-72.

Gannier, A., Beaubrun, P., and Di-Méglio, N. 1994. Cetacean occurrence in the Gulf of Lion and surroundings. Pp. 87-91. In: *European Research on Cetaceans - 8.* Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Gill, A., Atkinson, T. and Evans, P. G. H. 1997. Cetacean sightings off the East Coast of the Isle of Lewis, Scotland. Pp. 109-111. In: *European Research on Cetaceans - 11.* Proc. 11th Ann. Conf. ECS, Straslund, Germany, 10-12 Mar 1997. (Eds. P. G. H. Evans, E. C. M. Parsons and S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Jacques, G. 1989. L'oligotrophie du milieu pélagique de Méditerranée occidentale: Un paradigme qui s'estompe?. *Bulletin de la Societè zoologique de France*, 114, 3: 17-29.

Kruse, S. 1989. *Aspects of the Biology, Ecology, and Behavior of Risso's Dolphin (Grampus griseus) off the California Coast.* MSc Thesis in Marine Sciences, University of California Santa Cruz. June 1989. 120pp.

Marini, L., Consiglio, C., Angradi, A. M., Finoia, M. G., and Sanna, A. 1992. *Cetacei nel Mar Tirreno Centrale, Risultati della Campagna d'avvistamento 1989-1991.* Printed by the authors. 107pp.

Notarbartolo di Sciara, G., Venturino, M. C., Zanardelli., M., Bearzi, G., Borsani, F. J., and Cavalloni, B., 1993. Cetaceans in the Central Mediterranean Sea: distribution and sighting frequencies. *Boll. Zool.*, 60: 131-138.

Podestà, M., Magnaghi, L., and Gorlier, G. G. 1997. Sightings of Risso's dolphins in the Ligurian waters. Pp. 167-169. In: *European Research on Cetaceans - 11.* Proc. 11th Ann. Conf. ECS, Straslund, Germany, 10-12 Mar 1997. (Eds. P. G. H. Evans, E. C. M. Parsons and S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Santos, M.B., Pierce, G., Wijnsma, G., Ross, H. M., and Reid, R. J., 1995. Diets of small cetaceans stranded in Scotland. *Intl. Council. Expl. Sea*, CM/N:6. 16pp.

Torchio, M. 1966. Euribatia dei Teutacei, spiaggiamento ed apporto di acque di origine continentale (Cephalopoda, Dibranchiata). *Atti Soc. It. Sci. Nat.*, 105: 317-342.

Würtz, M., and Palumbo, F. 1985. Notes on the role of Cephalopods in the bathyal food-webs of the Ligurian Sea. *Rapp. Comm. Int. Mer Médit.*, 29, 8: 227-230.

Würtz, M., Poggi, R. and Clarke, M., 1992. Cephalopods from the stomach of a Risso's dolphin (*Grampus griseus*) from the Mediterranean. *J. Mar. Biol. Ass.* U.K. 72: 861-867.

Table 1 - Boundaries and extensions of the Study Area, and percentages of sub-areas A, B and C inhabited by Risso's dolphin

	Sub-A	Sub-B	Sub-C	Total Study Area
Lat.	43°,50	43°,69	44°,67	
Lat.	44°,32	44°,43	43°,24	
Long.	7°,30	8°,49	8°,49	
Long.	8°,49	9°,23	9°,23	
Sq. Nautical Miles	4,940	3,667	3.939	12,546
Total selected Areas	797.1	202.5	191.2	1,190.8
% of the selection	16.14	5.53	4.83	9.49

Table 2 - ANOVA One-Way test results

FACTORS	Presence + St. Err.	Absence + St. Err.	n	Z	P	
1 - Dist. from Coast	6.91 (0.87)	13.84 (1.939)	70	19.46	0.0019	P<0.01
2 - Depth	759 (75)	1030 (139)	70	2.86	0.09	n.r.
3 - Extn Lin. Can.	1.33 (0.21)	0.61 (0.14)	70	7.81	0.0068	P<0.01
4 - Dist. from Canyon	0.97 (0.17)	5.09 (1.13)	70	12.47	0.0008	P<0.001
5 - Batymetric density	0.58 (0.43)	0.94 (0.11)	70	7.21	0.009	P<0.01
6 - C.I.	0.48 (0.04)	0.33 (0.04)	70	7.81	0.0068	P<0.01

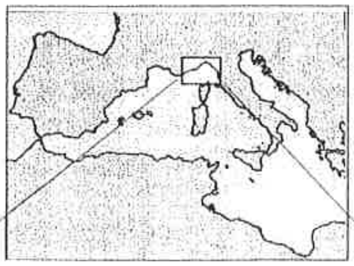
Table 3 - Stepwise forward method. Percentages of right classification

	Absence	Presence
Absence	54.3%	45.7%
Presence	8.8%	91.2%

Table 4 - Correlation Spearman Rank Coefficient: note the absence of relationship (n.r.) for the Depth. The abbreviations are referred to the same parameters (from 1 to 6) described in the main text

	Depth	Extn Lin. Can.	Dist. Can.	Bathy. density	C.I
1-Dist. Coast	0.64 (P<0.0001)	-034 (P<0.01)	0.43 (P<0.0001)	0.47 (P<0.0001)	-0.83 (P<0.0001)
2-Depth	–	n.r.	n.r.	n.r.	-0.63 (P<0.0001)
3- Extn Lin. Can.	–	–	-0.85 (P<0.0001)	-0.53 (P<0.0001)	037 (P<0.01)
4-Dist. Can.	–	–	–	0.62 (P<0.0001)	-0.45 (P<0.0001)
5-Bathy. density	–	–	–	–	-0.67 (P<0.0001)

Figure 1. Western Mediterranean and location of the Liguro-Provençal basin



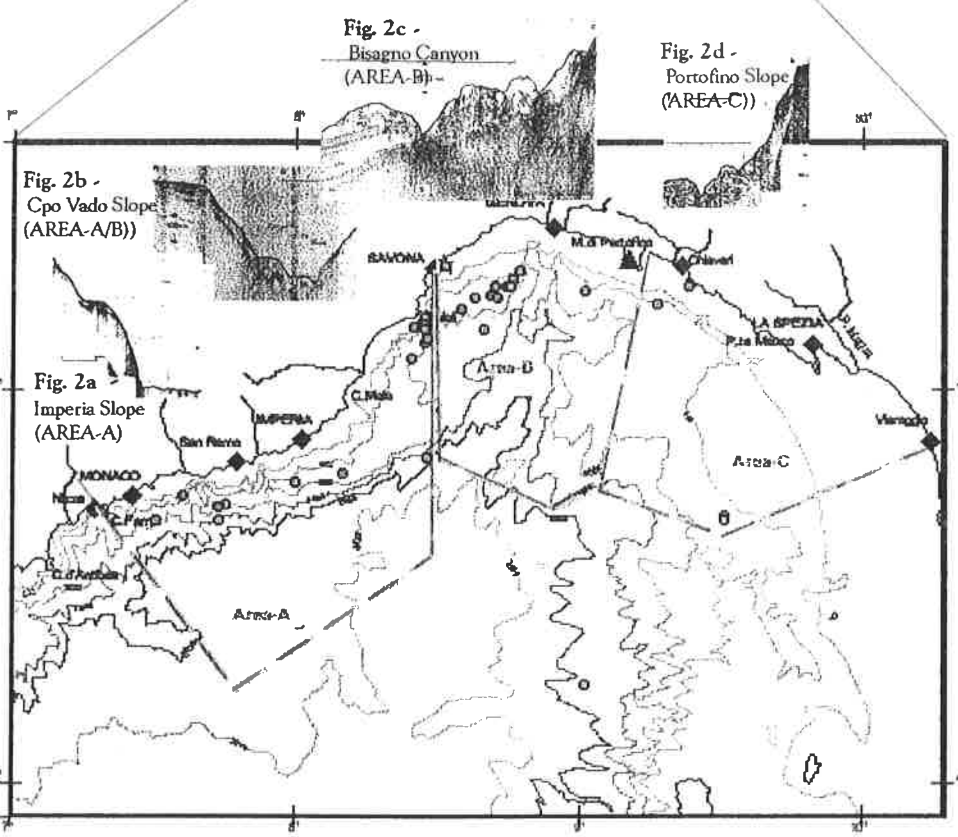


Figure 2. Map of the Study Areas and location (dots) of the G.g. sightings from 1990 to 1998

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

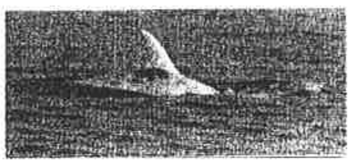


Figure 8

DISTRIBUTION, AND RELATIVE ABUNDANCE OF THE COMMON DOLPHIN (*DELPHINUS DELPHIS*) IN THE BAY OF BISCAY

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INTRODUCTION The common dolphin *Delphinus delphis* has a widespread global distribution, occurring in offshore waters of nearly all tropical, subtropical, and warm temperate seas. This paper presents information on the distribution (spatial and temporal), and relative abundance of the common dolphin in the Bay of Biscay (the sea bordering western France and northern Spain), from an analysis of sightings collected under the Biscay Dolphin Research Programme, between 1995 and 1998.

The Biscay Dolphin Research Programme (BDRP) is a voluntary conservation body sponsored by the shipping company *P&O European Ferries* (*Portsmouth*) and affiliated to the cetacean monitoring unit, *Sea Watch Foundation*. The mission statement of BDRP is to further the conservation of cetaceans and other marine life in the Bay of Biscay through scientific study and educational activities.

The BDRP database comprises sightings and effort data collected on monthly survey trips established in 1995. On each trip, effort-based cetacean surveillance work is carried out by a team of three experienced recorders, using standard methods developed for determining cetacean distribution and relative abundance by the Cetacean Group of the Mammal Society (latterly Sea Watch Foundation). Between August 1995 and December 1998, thirty-eight monthly trips were undertaken, with 19,994 km of trackline searched in good-fair weather (sea state four or less and good visibility), and approximately 30,000 km overall.

Survey effort has produced 220 common dolphin sightings of c. 9,000 animals, located in 16 ICES grid cells of the Bay of Biscay. These data confirm that common dolphins occur widely across the sampled areas of the Bay of Biscay, and in a few areas at very high density. There are marked seasonal patterns in common dolphin distribution. The core area of distribution appears to be a large, but mobile, population present through much of the year along the northern edge of the continental shelf. The available data indicate that there is a marked seasonal movement along the continental shelf, north into the English Channel and Celtic Sea in the winter, and south into deeper waters of the central Bay of Biscay during the summer.

METHODS **Survey vessel and study area:** The BDRP undertakes monthly surveillance surveys across the Bay of Biscay by travelling aboard the 37,500 ton P & O ferry, the *Pride of Bilbao*. The ferry follows a (more or less) fixed route between Portsmouth, England, and Santurtzi (Bilbao), Spain, and samples a representative range of topographical features and underwater habitats found in the Bay of Biscay. These include: the continental shelf west and south-west of Brittany, France (46-49° N by 4-6° W, depth <200 m.); the shelf edge (46-48° N by 3-5° W, depth 200-1,000 m.); the abyssal plain (44-46° N by 3.5-4.5° W, mean depth 4,000 m.) and the Cantabria coast, northern Spain (43° N by 3° W, depth <200 m.).

Survey method: On each trip, common dolphins and other cetacean species are recorded on systematic cetacean watches, which adopt standard recording methodology developed by the Mammal Society / Sea Watch Foundation for effort-based recording (by volunteers) on platforms of opportunity (Evans, 1981, 1995).

Watches are maintained continuously from dawn until dusk. On the Portsmouth to Bilbao ferry, the return journey extends over four days, and enables the whole of the route to be sampled at least once during daylight in the summer, and approximately 75% of the route in the winter.

On each trip a team of three experienced observers scan ahead, 22.5 degrees on both the port and starboard sides. The methodology is essentially that of an *unlimited distance single line transect*, with every cetacean and other animal visible and identifiable being recorded once only. Recording is made from the bridge of the ship, at a height of 32 m. and at a ship speed of 15-22 knots.

For each common dolphin sighting, the number of animals is counted and, where possible, the age and behaviour of individuals are recorded. At the time of sighting, the following recordings are also made: time, position of the ship (using the ship's global positioning system), position and orientation of the animal(s) relative to the ship, and environmental conditions such as sea state, swell height, wind speed, and direction, and visibility. These details are entered onto a standardised *Sea Watch Foundation* sighting forms (Evans, 1995).

At half-hourly intervals, ship position, ship speed, and environmental recordings are repeated and entered onto a standardised *Sea Watch Foundation* vessel based effort form (Evans, 1995). Effort data enable the number of sightings to be scaled according to effort, and for the calculation of relative abundance. To standardise data collection, trips are made at the same time each month (in the third week) and are carried out by a select number of experienced observers (97% of trips have been led by the authors).

Analysis: All field data collected are computerised and stored in spreadsheet and relational database formats. Between August 1995 and December 1998, thirty-eight monthly trips were made, with a total of 19,994 km of recording effort being made in good-fair weather (sea state four or less, and visibility more than 5 km).

Dolphin sightings along the ferry route have been grouped into 24 grid cells (measuring 1° longitude by 0.5° latitude), thus adopting the standard system developed by the International Council for the Exploration of the Sea (ICES). The relative abundance of common dolphins (all years combined) for each grid cell has subsequently been expressed as the number of animals seen per 1,000 km of search effort in good-fair weather. Common dolphin distribution maps have been generated by DMAP biological mapping software supplied by Dr Alan Morton. To describe seasonal patterns of distribution, sightings have been grouped into 3-monthly periods (first quarter of the year – January to March, second quarter - April to June, etc.).

RESULTS Overall distribution: Fig.1 shows that over the 3.5 year study period, the common dolphin has a cosmopolitan distribution in the sampled areas of the Bay of Biscay, occurring in both shallow and deep water areas. Common dolphins have been widely recorded in all months, and are the most frequently recorded cetacean species.

Relative abundance: Over the recording period (n=38 surveys), common dolphins have been sighted on 220 occasions in the Bay of Biscay, with over 9,000 individuals recorded. Common dolphins have been most abundant in the northern part of the Bay, along the continental shelf edge (46-48° N, Fig. 2). In this area, densities (per ICES grid cell) of up to 1,501-2,000 individuals per 1,000 km have been recorded. In contrast, common dolphins appear to be much less abundant in the southern half of the Bay, with densities (per ICES grid cell) mostly lower than 11-100 individuals per 1,000 km.

Seasonal patterns of distribution: In the first and final quarter periods (Jan - Mar and Oct - Dec) the majority of sightings have been from the northern part of the Bay, in the shallow waters off the Brittany peninsula (Fig. 3). In the second quarter (April - June), common dolphins are largely absent (suggesting dispersal) from this area, with the majority occurring much further south in the deeper waters of the middle of the Bay. In each quarter period, a large but mobile population has been located along the edge of the continental shelf in the north part of the Bay.

DISCUSSION Survey data indicate that common dolphins in the Bay of Biscay show marked seasonal patterns in their distribution. During the winter, the shallow Brittany coast supports large numbers of common dolphins. At this time, common dolphins are also at their most abundant in the adjacent English Channel (BDRP, unpubl. data), and nearby Celtic Shelf (Tregenza *et al.*, 1997), and it seems likely that this entire region is an important wintering ground for the species. During the spring/early summer, the deep waters of the middle of the Bay of Biscay support large numbers of common dolphins. These larger numbers further south could be explained by dispersal from wintering grounds further north or by immigration of oceanic common dolphins (as has been observed in other temperate regions - Forcada, 1990).

Forcada *et. al.*, (1990) describe two possible populations of common dolphin in the eastern North Atlantic: one that inhabits the deeper oceanic waters, and one that inhabits neritic waters. Whilst common dolphins are distributed throughout the sampled areas of the Bay of Biscay, the effort adjusted data tend to indicate that the majority of animals occur in water depths of between 80-140 m, along the edge of the continental shelf. This in turn suggests that the majority of common dolphins sighted in the Bay of Biscay are of the neritic population.

REFERENCES

Evans, P. G. H. 1981. *A Guide to Identification of Cetaceans in the Northeast Atlantic.* Occasional Publication, Mammal Society. 20pp.

Evans, P. G. H. 1995. *Guide to the identification of whales, dolphins and porpoises in European seas.* Sea Watch Foundation, Oxford. 36pp.

Forcada, J., Aguilar, A., Evans, P. G. H., and Perrin, W. F. 1990. Distribution of Common and Striped dolphins in the temperate waters of the eastern North Atlantic. Pp. 64-66. In: *European Research on Cetaceans - 4* Proc. 4th Ann. Conf. ECS, Palma de Mallorca, Spain, 2-4 Mar, 1990. (Eds. P. G. H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, UK. 140pp.

Tregenza, N. J. C., Berrow, S. D., Hammond, P. S. and Leaper, R. 1997. Common dolphin, *Delphinus delphis* L., bycatch in bottom set gillnets in the Celtic Sea. *Rep. Int. Whal. Commn*, 47: 835-839.

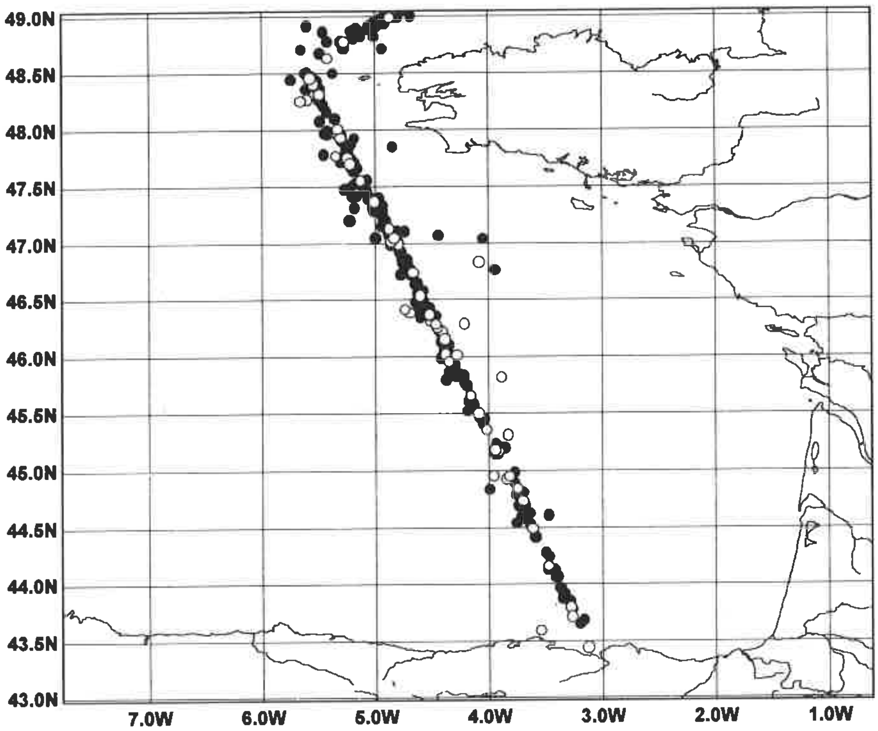

Fig. 1 - Common dolphin sightings in the Bay of Biscay, recorded from the Pride of Bilbao ferry 1995-98. Closed circles represent definite sightings, open circles unidentified Delphinidae

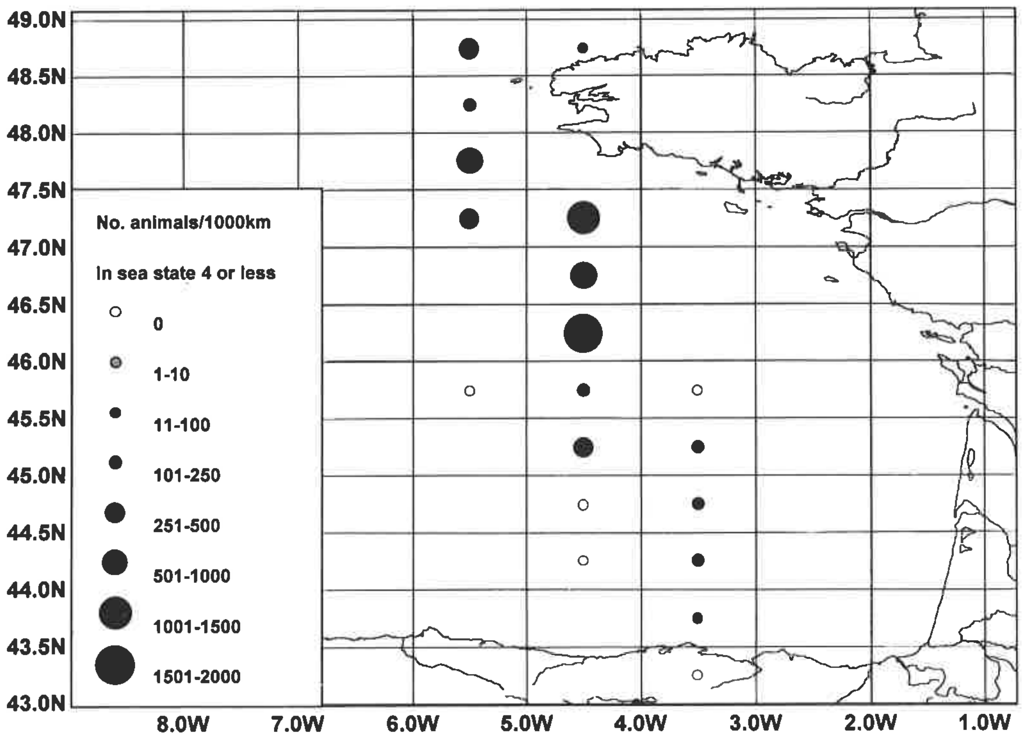

Fig. 2 - Relative abundance of common dolphin in ICES grid cells of the Bay of Biscay sampled by the Pride of Bilbao ferry 1995-98

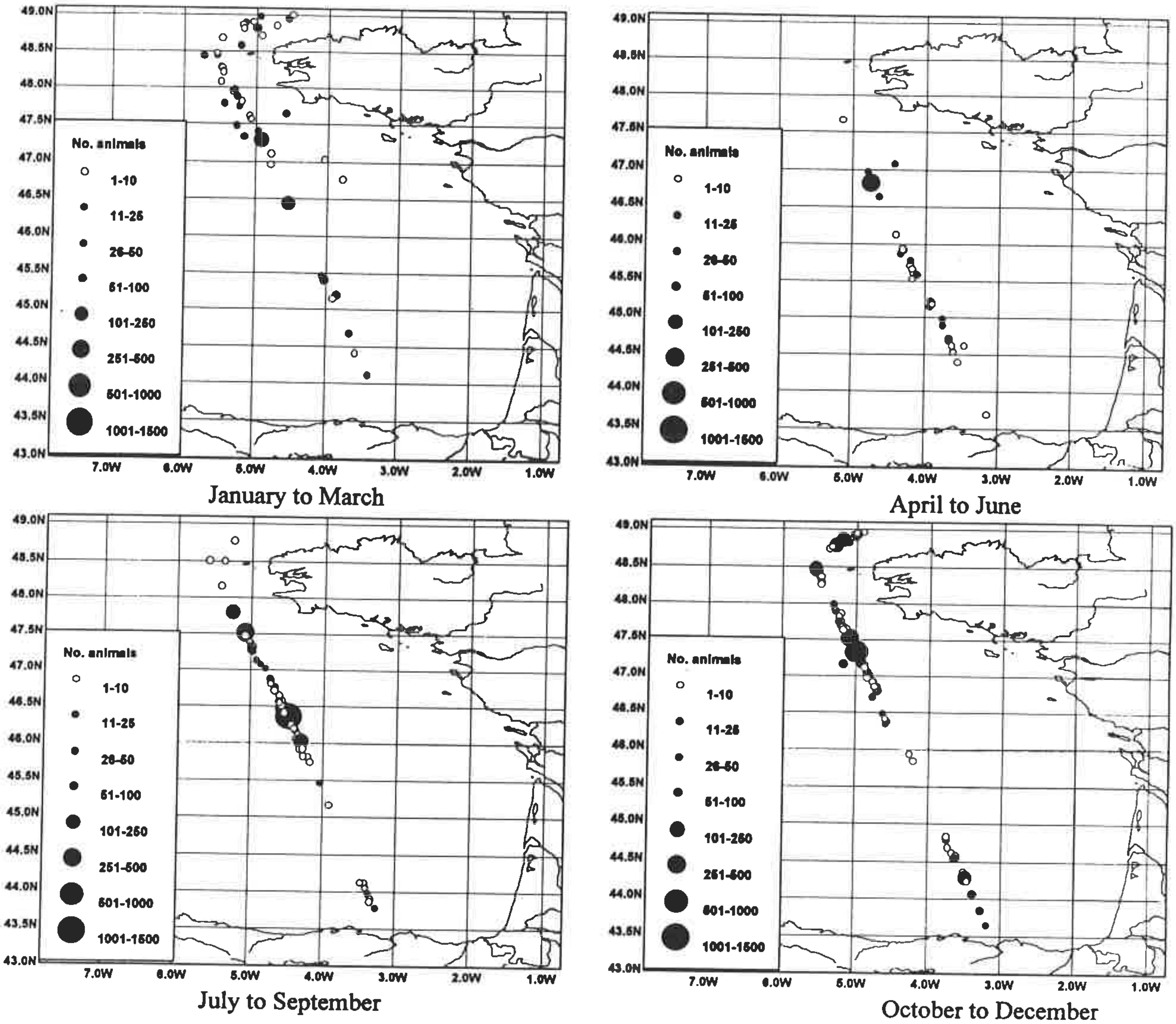

Fig. 3 - Seasonal distribution of common dolphin in the Bay of Biscay 1995-98 from surveys on the P&O Ferry, the Pride of Bilbao

FIN WHALES (*BALAENOPTERA PHYSALUS*) IN THE NORTHERN PART OF THE ALBORAN SEA AND STRAITS OF GIBRALTAR

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INTRODUCTION Research effort on the fin whale (*Balaenoptera physalus*) 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.*, 1995; Gannier, 1997). This importance has encouraged scientists, NGO's and politicians from France, Monaco and Italy to propose the creation of a sanctuary in order to ensure the future of this species in the Mediterranean (Notarbartolo di Sciara *et al.*, 1993). Research on this species has focused on different aspects of the fin whale population observed in the Liguro-Provençal basin. Line transect surveys place the size of the population at 901 indiv. (95% C.I.: 591-1,374) (Forcada *et al.*, 1995).

Oceanographic research in the region and stomach content analysis has highlighted the importance of certain favoured prey species such as the euphausiid *Meganyctiphanes norvegica*, which reaches a peak of abundance during the summer months, showing a direct correlation with the distribution of the fin whales (Zanardelli *et al.*, 1992; Relini *et al.*, 1992; Vikingsson, 1997). The decrease of the fin whale population in Liguria during the winter puts forward the question of where these whales go to, which has focused the attention of researchers during the last decade (Marini *et al.*, 1995). With research effort very much reduced outside the summer months in the Mediterranean, the question is difficult to answer. Comparative genetic analysis of fin whales in Ligurian and Atlantic waters has highlighted an important degree of genetic isolation (Bérubé *et al.*, 1998), thus supporting the need to give fin whales in the Mediterranean, special attention.

Several hypotheses have been examined concerning the dynamics of this population. Genetic analysis seems to indicate that a migration out of the Mediterranean waters during winter towards both waters of Mauritania or North Atlantic waters, as suggested by some authors (Viale, 1977; Viale, 1980; Duguy *et al.*, 1983), is very unlikely. The possibility of a non-migratory population of mysticetes has been suggested previously for certain groups of whales in the North Atlantic (Evans, 1987). A similar energy saving alternative to long migrations has also been suggested for the fin whales of the Mediterranean (Marini *et al.*, 1992). Observations at sea have, however, shown a migration of individuals and small groups of fin whales heading south through the Tyrrhenian Sea and southwest to the Balearics at the end of summer and an opposite migration during late spring (Marini *et al.*, 1995). Although concentrations of the species similar to that occurring in Liguria during the summer have not been observed, research carried out to find possible wintering grounds have highlighted certain areas of the southern part of the Mediterranean as possible destinations for many fin whales moving away from Liguria. This is the case for the waters around the island of Lampedusa and sections of the North African coast (Marini *et al.*, 1995). Unfortunately, great extensions of this coastline have at present little or no research effort either on live animals or strandings. The movement of fin whales in and out of the Mediterranean through Gibraltar in recent years has rarely been observed. However, when analysing the lack of data on sightings and strandings, we must take into consideration the scarce and heterogeneous research effort along a great portion of the Spanish coast and, in particular, that of the Alboran Sea. The most accurate numbers concerning the species in the area come from the listings of captured animals of several whaling stations in the region of Gibraltar, which probably have almost driven to extinction an important population in the waters of the Bay of Cadiz.

The research region: The area where this study was conducted is the Alboran Sea and its contiguous Gulf of Vera. This region has an extremely complex physiography and oceanography playing a major role as a hydrological motor of the Mediterranean Sea, and as transition chamber where Atlantic and Mediterranean oceanographic masses collide, creating thermohaline fronts and areas of important upwellings (Rodríguez, 1982; García *et al.*, 1988; Gil, 1992; Rubín *et al.*, 1992). The effort of this study was concentrated mainly in three portions of this area: the Gulf of Vera, the region of Almeria, and the region of Malaga, although some data were collected also from other regions such as the Straits of Gibraltar.

METHODS Shipboard surveys: Shipboard surveys were carried out in the Alboran Sea from 1992 to 1998 by Alnitak and C.R.E.M.A. (Regional Endangered Marine Species Stranding Network and Recovery Centre). 12,400 nautical miles (23,000 km) were sailed under effort with good conditions of sea state less than 3 Douglas (3-4 Beaufort at high sea with no current). For these surveys, the research ship Toftevaag was used for the eastern portion of the Alboran Sea, sailing at an average speed of five knots (9.3 km/hr) with two observation platforms at 14 metres and 3 metres respectively. Survey transects were carried out in the months of April, June, July, August and September, covering a research region extending from Cabo de Palos to Adra and to the 2,000 m. depth contour. For the area of Málaga, a dedicated motor boat was used for several days during the summers of 1997 and 1998.

Interviews and information from fishermen, yachtsmen and authorities: For several years, some fishermen, yachts and specially customs and police ships and planes have been sending sighting sheets to C.R.E.M.A. and ALNITAK. Interviews were held by members of C.R.E.M.A in all ports and tourist resorts of the Andalousian coast from 1995 to 1998. Interviews were held also by Alnitak crew members with selected fishermen, maritime authorities and yachtsmen in all ports along the coastline of the research region throughout the years of research. Only interviews and sighting sheets of fishermen, yachtsmen 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 Shipboard surveys and opportunistic sightings: Eighteen sightings of fin whales were made from the research vessel Toftevaag in the regions of Murcia and Almeria, four by the motor boat of CREMA in the region of Málaga, and 35 by the opportunistic observers in the Gulf of Vera, Málaga, Gibraltar, and Gulf of Cádiz (see Table 1), totalling 57 sightings. From these data, two main points can be obtained:

- The sightings of fin whales, except those of the area of Málaga, consisted usually of lone individuals, or sometimes small groups of two or three, always swimming towards the west (or SW in the eastern portion of the research area), more or less parallel to the shore line.
- Almost all the sightings of the area of Málaga (85%) were of lone individuals or small groups apparently feeding (sighted with open mouth, or moving slowly with immersions, and surrounded by many small pelagic fish jumping out of the water), or described as "milling" (moving around very slowly without any apparent direction; staying always in the same area), in very shallow waters, without travelling. Only three sightings in this area consisted of lone individuals travelling westwards.

Strandings: Only six strandings have been recorded in the area since 1996 (see Table 2). The most interesting one was a very small female calf (5.96 m) stranded in Chipiona, in the Gulf of Cadiz, in January 1999.

Interviews: Fin whales are considered a very rare species, to the extent that in most fishermen's families, they could only recall one or two encounters over the last couple of decades. Reports from fishermen and maritime authorities have been increasing over the last five years, coinciding also, however, with the increasing interest in cetaceans and increasing presence of yachts and patrol boats in the region.

DISCUSSION At present, we use whatever scarce and scattered information we can to obtain a clear picture of the importance of the Alboran Sea for the migration, breeding, and feeding of the fin whale. The increase in reports over the last few years of this species in the Gulf of Vera, Alboran Sea and Gibraltar region may simply be the result of the increase in research effort and interest by yachts, maritime authorities, and fishermen. However, it could also be the result of a new migration to feeding grounds in the Alboran Sea or in the Atlantic Ocean as a result of oceanographic changes or a displacement of existing migration routes moving closer inshore. Interviews and past records seem to indicate that the species was more abundant in the past, giving rise even to a whaling industry around Gibraltar. However, by contrast, in other parts of the coast the species does not seem to be considered common by local fishing communities. Fishermen can often give us very detailed information on species such as the bottlenose, common, striped and Risso's dolphin, the killer whale, or the pilot whale, whereas the fin whale was considered by them as a very rare species. What seems to be very clear from the data collected is that the area where fin whales were observed very frequently feeding or "milling" but not travelling, coincides precisely with one of the areas with highest productivity in the whole northern Alboran Sea. In this area, the coast of Málaga, we find one of the most important upwellings of this Sea, which provides the highest concentrations of zooplankton and sardine biomasses.

Several questions are still to be answered:

- Why are all the fin whales sighted travelling, going westwards? If they are to go back to the Mediterranean basin, where is their path eastward?
- Is this area in Málaga, a "new" feeding ground for Mediterranean fin whales?, or if there was always a portion of the population coming to this area to feed, why have the local people almost never seen them before?
- Are the sightings of this species crossing the Straits of Gibraltar towards the Atlantic a "new" fact, or have they always been doing that (maybe in small numbers)?
- Does all this mean a "change" of migratory and/or feeding habits as a result of global oceanographical changes in the Mediterranean, or is it just the result of the more intensive research effort of the last years?

More research effort will be invested in future years focusing on migratory paths as well as on possible feeding and breeding grounds of this species along the Spanish coast. In order to complement these studies with data on oceanographic cycles affecting this region, research will be carried out in co-operation with research teams working in these fields of oceanography.

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REFERENCES

Bérubé, M., Aguilar, A., DenDanto, D., Larsen, F., Notarbartolo di Sciara, G., Sears, R., Sigurjónson, J., Urban-Ramírez, J., and Palsboll, P. J. 1998. Genetic analysis of the North Atlantic fin whale: insights into migration patterns. P. 318. In: *European Research on Cetaceans – 12*. Proc. 12th Ann. Conf. ECS, Monaco, 20-24 January 1998 (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Cambridge, England. 436pp.

Duguy, R., Casinos, A., Di Natale, A., Filella, S., Ktari-Chekroun, F., Lloze, R., and Marchessaux, D. 1983. Répartition et fréquence des Mammifères marins en Méditerranée. *Rapp. Comm. Int. Mer Médit.*, 28 (5): 223-230.

Evans, P. G. H. 1987. *The Natural History of Whales and Dolphins*. Christopher Helm, London. 343pp.

Forcada, J. Aguilar, A., Hammond, P. Pastor, X., and Aguilar, R. 1993. Distribution and abundance of fin whales in the western Mediterranean during summer. Pp. 128-130. In: *European Research on Cetaceans – 7.* Proc. 7th Ann. Conf. ECS, Inverness, 18-21 February, 1993. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Forcada, J., Notarbartolo di Sciara, G. And Fabbri, F. 1995. Abundance of fin whales and striped dolphins summering in the Corso-Ligurian Basin.. *Mammalia*, 59(1): 127-140.

Gannier, A. 1997. Estimation de l'abundance estivale du rorqual commun, *Balaenoptera physalus* (Linné, 1758) dans le bassin Liguro Provençal (Mediterranée occidentale). *Rev. Ecol (Terre Vie)*, 52: 69-86.

García, A., Rubín, J. P. and Rodríguez, J. M. 1988. La distribución de las áreas de puesta y cria de sardina (*Sardina pilchardus*, Walb.) en el sector noroccidental costero del mar de Alborán, en Marzo de 1982. Complementado con información adicional de parámetros biológicos y fisico-químicos. *Inf. Téc. Inst. Esp. Oceanog.* N° 59 –1988.

Gil, J. 1992. Consideraciones sobre el hábitat medioambiental de los cardúmenes de sardina en la platforma continental mediterránea española y Golfo de León. *Inf. Téc. Inst. Esp. Oceanog.* N° 114–1992.

Marini, L. Consiglio, C. Sanna, A., and Angradi, A. M. 1992. Some notes of the fin whale (*Balaenoptera physalus*) in the Western Mediterranean Sea. Proceedings of the Symposium *"Whales: Biology – Threats – Conservation"*, Brussels, 5-7 June 1991. (Ed. J. J. Symoens). Royal Academy of Overseas Sciences (Brussels): 63-71.

Marini, L. Villetti, G., and Consiglio, C. 1995. Wintering areas of fin whales (*Balaenoptera physalus*) in the Mediterranean Sea: a preliminary survey. Pp. 126-128. In: *European Research on Cetaceans – 9.* Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, 9-11 Feb., 1995. (Eds. P. G. H. Evans and H. Nice). European Cetacean Society, Kiel, Germany. 302pp.

Notarbartolo di Sciara, G. Forcada, J., Acquarone, M., and Fabbri, F. 1993. Population estimates of fin whales and striped dolphins summering in the Corso-Ligurian basin. Pp. 135-138. In: *European Research on Cetaceans – 7.* Proc. 7th Ann. Conf. ECS, Inverness, Scotland, 18-21 February, 1993. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Relini, G. Relini, L. O., Cima, Ch., Fasciana, C., Fiorentino, F., Palandri, G., Relini, M., Tartaglia, M. P., Torchia, G., and Zamboni, A. 1992. Macroplankton, *Meganyctiphanes norvegica*, and fin whales, *Balaenoptera physalus*, along the same transects in the Ligurian Sea. Pp. 134-137. In: *European Research on Cetaceans – 6.* Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February, 1992. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Rodriguez, J. 1982. *Oceanografia del mar Mediterráneo.* Ed. Pirámide.

Rubín, J. P., Gil, J., Ruiz, J., Cortés, M. D., Jiménez-Gómez, F., Parada, M., and Rodriguez, J. 1992. La distribución ictioplanctónica y su relación con parámetros físicos, químicos y biológicos en el sector norte del Mar de Alboran, en Julio de 1991 (Resultados de la Campaña "Ictio.Alboran 0791"). *Instituto Español de Oceanografía. Informe Técnico*, 139. Madrid.

Viale, D. 1977. *Ecologie de Cétacés en Méditerranée nord-occidentale: leur place dans l'ecosystème, leur réaction à la pollution marine par les métaux.* Thése Doctorat és Sciences, Paris IV: 312pp.

Viale, D. 1980. Les modifications du peuplement de cetacés de Méditerranée occidentale. *Journées Ëtud. Systém. Et Biogéogr. Médit. Cagliari*, C.I.E.S.M.

Vikingsson, G. A. 1997. Feeding of fin whales (*Balaenoptera physalus*) off Iceland – Diurnal and Seasonal variation and possible rates. *J. Northwest. Atl. Fish. Sci.* 22: 77-89.

Zanardelli, M., Notarbartolo di Sciara, G., and Jahoda, M. 1992. Photo-identification and behavioural observations of fin whales summering in the Ligurian Sea. Pp. 86-89. In: *European Research on Cetaceans – 6.* Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb., 1992. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Table 1 - Sightings of fin whales from the Gulf of Vera to the Gulf of Cadiz, both by researchers and by opportunistic observers

Region	No. of sights.	No. of whales	Behaviour	Direction of swimming	Month	Year	Comments
Gulf of Vera	17	13 = 1 ind. 3 = 2 ind. 1 = 3 ind.	17=travelling	4 = W 13 = S/SW	1 = May 1 = June 9 = July 6 = Aug	2 = 94 1 = 95 3 = 96 10 = 97 1 = 98	2 juveniles (10-12 m) observed in July '95 and August '96
South of Almería	11	9 = 1 ind. 2 = 2 ind.	9 = travelling 1 = feeding 1 = ?	9 = W 1 = - 1 = ?	1 = June 3 = July 2 = Aug 5 = Sept.	2 = 96 9 = 97	
Málaga	24	16 = 1 ind. 3 = 2 ind. 4 = 3-4 ind. 1 = 5-7 ind.	3 = travelling 15= feeding 6 = milling	3 = W 21 = -	3 = May 3 = July 6 = Aug 10 = Sept. 2 = Oct	7 = 96 11 = 97 6 = 98	1 calf seen in September '97
Gibraltar	5	3 = 1 ind. 2 = 2 ind.	3 = travelling 2 = milling	3 = W 2 = -	1 = June 3 = July 1 = Aug	3 = 97 2 = 98	1 calf seen in July '98

Table 2 - Strandings of fin whales in the Alboran Sea and Gulf of Cádiz since 1996

Situation	**Month**	**Year**	**Comments**
Doñana (Huelva) – Gulf of Cadiz	April	1996	
Ceuta – North African coast, close to Gibraltar	April	1998	
Mijas (Málaga)	May	1998	
Almeria	June	1998	
Almería	Dec	1998	
Chipiona (Cádiz) – Gulf of Cadiz	Jan	1999	Female calf, 5.96 m

HABITAT USE, SITE FIDELITY, OCCURRENCE AND ACTIVITY PATTERNS OF BOTTLENOSE DOLPHINS, *TURSIOPS TRUNCATUS*, IN THE GALVESTON SHIP CHANNEL (TEXAS, USA)

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This research consists of a 12-month study (May/96-May/97), pursued through co-operation with the Texas A&M University's Marine Mammal Research Program. The Galveston Bay system is a centre of the petrochemical industry and has been considered one of the most polluted and industrial large bays in the United States. Nevertheless, bottlenose dolphins thrive here and high numbers can be observed in this 6.8 km-long channel, heavily disturbed through shrimp-fishing, industrial and leisure activities. Local ecological conditions appear to determine aspects of their behaviour, and behavioural patterns respond to such ecological variables as circadian rhythms, seasonal changes, and human activities. Since they live in such a disturbed habitat, members of this population can help us to understand how they are affected by habitat change and degradation, in terms of numbers present and the manner in which they use this waterway. Being near the top of the marine food chain, dolphin reactions to man-induced changes in their environment are worthy of consideration when tackling conservation and management issues, both short- and long-term.

Boat-based surveys were conducted, using two distinct techniques: a) strip transect along mid-channel, to collect dolphin and shrimp boat information, as well as environmental parameters; b) photo-identification survey, to allow dorsal fin photography and individual cataloguing. Each spotted group was followed until several attempts were made to photograph all individuals in the group. This study is based on 43 boat trips, evenly sampled over time of day and season, comprising 137 hours of boat surveying. Throughout the survey period, dolphins were noticeably more abundant during the morning period, specially when shrimp-fishing boats were present and salinity was higher; feeding behind trawling shrimp boats and socialising were the most frequently observed behaviours.

The photograph cataloguing and matching process is being completed, and around 150 individuals have been identified, including resident individuals that have been frequently re-sighted over the last decade. Further research on this human-disturbed waterway will continue to supply information for a comparison with undisturbed habitats. These habitats constitute a reference basis for the understanding of these adaptive processes, and in assessing the degree of human impact to the Galveston Ship Channel's bottlenose dolphins.

FIRST EVIDENCE OF THE MOVEMENT OF A BOTTLENOSE DOLPHIN *TURSIOPS TRUNCATUS* BETWEEN CORSICA AND HYERES ARCHIPELAGO, SOUTH-EASTERN FRANCE.

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INTRODUCTION Bottlenose dolphin *Tursiops truncatus* populations have been studied for 30 years in many different areas of the world. Most of the photo-identification studies deal with sedentary or resident populations, which allow a lot of re-sightings and a regular monitoring of each individual within a group (for example: Cardigan Bay, Wales (Arnold, 1993), Sea of Iroise, Britanny (Carcaillet, 1992), Isle of Sein (Dilliere, 1995), Arcachon basin (Ferrey *et al.,* 1993), County Clare, Ireland (Kiely *et al.*, 1994), Moray Firth, Scotland (Wilson *et al.*, 1994), Canary Islands (Escorza *et al.*, 1992), Sardinia (Ferrecio *et al.*, 1992), Adriatic coast (Bearzi *et al.*, 1997), Galveston Bay, Texas (Henningsen & Würsig, 1991), Florida (Scott *et al.*, 1990), Gulf of California (Ballance, 1990), Argentina (Würsig & Harris, 1990), Shark Bay, Australia (Connor & Smolker, 1995), etc. In well-studied areas, such as the Moray Firth, Scotland, researchers have shown the presence of two distinct populations: resident dolphins, regularly contacted year after year, and wandering pods, seen only occasionally. Some of these non-sedentary dolphins have been sighted as far as 110 km away from the Moray Firth (Wilson *et al*, 1994). However, there is no known exchange between the two well studied populations from the Moray Firth and from Cardigan Bay, Wales, 800 km away (Lewis & Evans, 1993). On the other hand, some North American Atlantic bottlenose dolphins undertake a migratory journey, travelling south in winter and back north in summer (Thompson & Wilson, 1994). Age and sex influence travelling tendency, subadult pods and male coalitions, wherever they do exist, being less sedentary than matriarchal groups (Leatherwood & Reeves, 1990; Bearzi *et al.*, 1997).

MATERIALS AND METHODS Studies on the bottlenose dolphins of the French Mediterranean coast are just beginning. In Corsica, the species is fairly common and mainly resident (Viale 1977). Here, the GECEM has been studying and photo-identifying several groups in the north-western part of the island since 1994, during the summer months. Some individuals have been re-contacted in the same area up to four years after their first sighting (Baril *et al.*, 1994 ; Ripoll, 1995, 1997). Off the coast of Provence, however, the bottlenose dolphin is a very elusive species, with only 60 observations during the last ten years. Here, photo-ID studies are being undertaken in order to determine the current status of the species around Hyères archipelago, Port-Cros National Park (Dhermain, 1997).

RESULTS On 5 September 1997, we (FD, JMB) followed a group of 11 bottlenose dolphins near the eastern end of the Levant Island. The group included seven adults, one subadult and three juveniles, and photo-ID of the whole group was achieved. One of the adults, called Ag34, had been previously photographed off Saint-Florent, Corsica, on 17 July 1997 (TR), 50 days earlier. This is the first evidence of movement of a bottle-nose dolphin between Corsica and south-eastern continental France.

The distance through open sea between St. Florent and Levant island is 123 nm (228 km) with depths reaching more than 2,000 m. (Fig.1). Bottlenose dolphins are regularly seen offshore in this region of the Mediterranean (Beaubrun, 1995). Alternatively, by following the shoreline of Cape Corse, north-western Italy and south-eastern France, it is possible to travel between Corsica and Levant island staying in the shallower waters (less than 200 m. deep) that the species prefers (Notarbartolo & Demma, 1994).

We have calculated a sociability rate for each of the eleven dolphins photographed on 5 September 1997 near Levant Island, based on the percentage of slides where dolphin *y* is associated with another individual on surfacing. Ag34 showed the smallest sociability rate within the group (Fig.2). The Association Index (IA2) represents the partnership between two dolphins within the group. For the individuals *y* and *j*,

$$IA^2{}_{yj} = 2\ X_{yj} / (X_y + X_j)$$

where X_{yj} = number of slides where *y* and *j* are shown surfacing together; and X_y or X_j= number of slides where *y* or *j* respectively is shown surfacing with an other member of the group. Figure 3 shows the association index for duos photographed within the group. These results are presented more graphically in Figure 4, each dolphin being linked with the dolphins with which it is associated, the thickness of the line being proportional to their Association Index. Again, Ag34 shows the smallest Association Index and therefore appears less well integrated into this group. In Corsica, Ag34 was photographed three times near another adult (Ag39), which was not present in the Levant group. One explanation for this behaviour may be that Ag34 is a wandering male. Unfortunately, this cannot be tested as we have no indication of the sex of Ag34.

It is worth noting that another adult sighted on 5 September 1997 had also been seen two years previously (19 September 1995) in the Hyères archipelago (LD, NDM). In 1995, this individual was a member of a group of 14 bottlenose dolphins, six of which were photo-identified. None of these other individuals was found again in the Levant group.

CONCLUSIONS These recaptures clearly show the necessity for international co-operation among the photo-identification teams working on the bottlenose dolphin in the north-western Mediterranean. To this end, we place all of our pictures at the disposal of any other researchers. Scanned slides stored on CD-Rom are probably the best way to exchange such information.

We hope that this dolphin's journey between Corsica and the Hyères archipelago will symbolise the need for a Marine Sanctuary in the Ligurian Sea, which will involve a favoured habitat of a highly important species, the bottlenose dolphin.

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REFERENCES

Arnold, H. 1993. Distribution, abundance, and habitat use of Bottle-nosed Dolphins in Cardigan Bay, Wales, 1992. Pp. 63-66. In: *European Research on Cetaceans - 7*. Proc. 7th Ann. Conf. ECS, Inverness, 18-21 Feb, 1993 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Ballance, L. T. 1990. Residence patterns, group organization, and surfacing associations of Bottlenose dolphins in Kino Bay, Gulf of California, Mexico. Pp. 267-283. In: *The Bottlenose dolphin*. (Eds S. Leatherwood S. & R. R. Reeves R.R.). Academic Press, San Diego. 653pp.

Baril, D., Bompar, J. M., Dhermain, F., and Ripoll, T. 1994. *Recensement de la population de Grand Dauphin (Tursiops truncatus) de Corse. Campagne 1993.* Rapport GECEM-WWF France, Montpellier 22pp.

Bearzi G., Notarbartolo di Sciara G., and Politi E. 1997. Social ecology of bottlenose dolphins in the Kvarneric (northern Adriatic Sea). *Marine Mammal Science* 13, 4: 650-668.

Beaubrun, P. C. (Ed.) 1995. *Atlas préliminaire de distribution des cétacés de Méditerranée*. CIESM, Musée Océanographique, Monaco, 87pp.

Carcaillet, C. 1992. *Impact des activités humaines sur les Grands Dauphins et Phoques gris des archipels de Molène et Ouessant, et mesures de préservation des mammifères marins sur ce site.* Rapport de stage, Université de Rennes 1. MST "AMVR", Océanopolis, Brest. 65pp.

Connor, R. C. and Smolker, R. A. 1995. Seasonnal changes in the stability of male-male bands in Indian Ocean bottle-nosed dolphins (*Tursiops* sp.). *Aquatic Mammals*, 21, 3: 213-216.

Dhermain, F. 1996. *Etude des Grands Dauphins Tursiops truncatus de l'ouest de la mer Ligure (archipel de Port-Cros, côtes des Bouches-du-Rhône et du Var).* Rapport GECEM au Parc National de Port-Cros, rapport dactylographié 43pp. + 48pp. annexes

Dhermain, F. 1997. *Le Grand Dauphin Tursiops truncatus sur les côtes provençales du Sanctuaire de la Mer Ligure. Rapport intermédiaire octobre 1997.* Rapport GECEM pour le Parc National de Port-Cros, Ministère de l'environnement. rapport dactylographié. 9pp.

Dillière, L. 1995. Modalités d'étude d'une population de grands dauphins (*Tursiops truncatus*) en milieu naturel : à propos d'une observation. *Le Point Vétérinaire* 27, 167: 69-72.

Escorza, S., Heimlich-Boran, S., and Heimlich-Boran, J. 1992. Bottle-nosed dolphins off the Canary islands. Pp. 117-120. In: *European Research on Cetaceans - 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb, 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Ferreccio, P., Milella, I., Pedde, M., Saba, S., Solinas, P. L., and Di Natale, A. 1992. Contribution to knowledge of geographical distribution of bottle-nosed dolphins, *Tursiops truncatus*, off the coasts of northwestern Sardinia. 121-126.

Ferrey, M., Collet, A., and Guinet, C. 1993. Statut et comportement social du Grand Dauphin *Tursiops truncatus* Montagu 1821 dans le bassin d'Arcachon. *Rev. Ecol. (Terre Vie)* 48 : 257-278.

Henningsen, T., and Würsig, B. 1991. Bottle-nosed dolphins in Galveston Bay, Texas: numbers and activities. Pp. 36-39. In: *European Research on Cetaceans - 5*. Proc. 5th Ann. Conf. ECS, Sandefjord, Norway, 21-23 Feb, 1991. (Ed. P. G. H. Evans). European Cetacean Society, Leiden, The Netherlands. 132pp.

Kiely, O., Berrow, S. D., and Holmes, B. 1994. Occurrence and group size of bottle-nosed dolphins *Tursiops truncatus* off Kilcredaun Head, County Clare, Ireland. Pp. 69-72. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Leatherwood, S., and Reeves, R. R. (Ed.). 1990. *The Bottlenose dolphin*. Academic Press, San Diego, 653pp.

Lewis E. J., and Evans, P. G. H. 1993. Comparative ecology of bottle-nosed dolphin (*Tursiops truncatus*) in Cardigan bay and the Moray Firth.Pp. 57-62. In: *European Research on Cetaceans - 7*, Proc. 7th Ann. Conf. ECS, Inverness, 18-21 Feb, 1993 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Notarbartolo di Sciara, G.and Demma, M. 1994. *Guida dei Mammifieri Marini del Mediterranea*. Franco Muzzio, Padova : 262pp.

Ripoll, T. and Dilliere, L. 1995. *Etude comportementale de deux groupes de Grands Dauphins (Tursiops truncatus) sur la côte corse*. Rapport du GECEM pour le WWF France.

Ripoll, T. 1997. *Etude comportementale et photoidentification d'un groupe de Grands Dauphins (Tursiops truncatus) sur la côte nord-ouest de la Corse*. Rapport intermédiaire du GECEM pour le Parc National de Port-Cros, Ministère de l'environnement, 20pp., dactylographiées.

Scott, M. D., Wells, R. S., and Irvine, A. B. 1990. A long-term study of Bottlenose dolphins in Florida. Pp. 73-75. In: *European Research on Cetaceans - 4*. Proc. 4th Ann. Conf. ECS, Palma de Mallorca, 2-4 March 1994. (Eds. P. G. H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, England. 140pp.

Thompson, P., and Wilson, B. 1994. *Bottlenose dolphins*. Voyageur Press, Stillwater, USA. 72pp.

Viale, D. 1977 . *Ecologie des Cétacés en Méditerranée nord-occidentale: leur place dans l'écosystème, leur réaction à la pollution marine par les métaux*. Thèse doct. état Univ. P&M Curie, Paris. 311pp.

Wilson, B., Thompson, P., Hammond, P., and Curran, S. 1994. The distribution of bottle-nosed dolphins in the Moray Firth, Northeast Scotland. P. 67. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Würsig, B. and Harris, G. 1990. Site and association fidelity in bottlenose dolphins off Argentina. Pp. 361-365. In: *The Bottlenose dolphin*. (Eds. S. Leatherwood & R. R. Reeves). Academic Press, San Diego. 653pp.

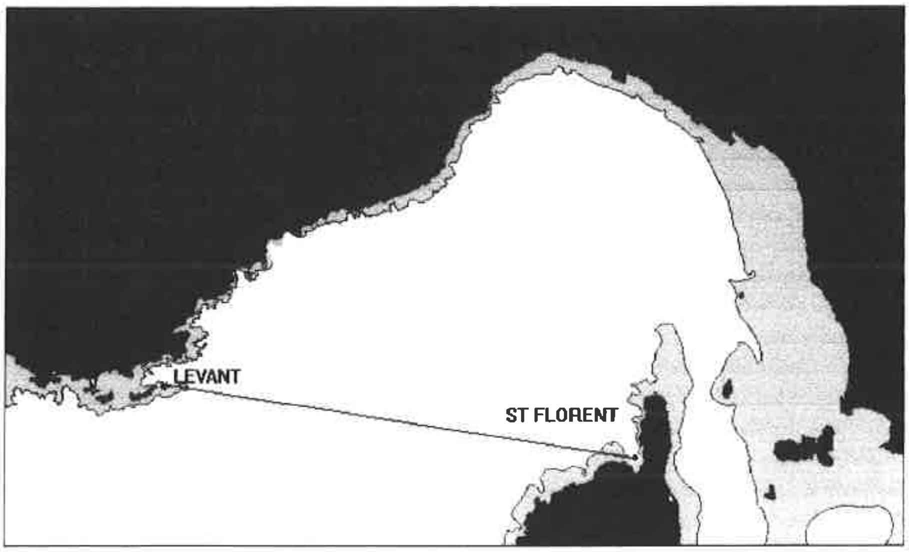

Fig 1. Map of the area between Corsica and the Hyeres archipelago. In light grey, depth less than 200 metres

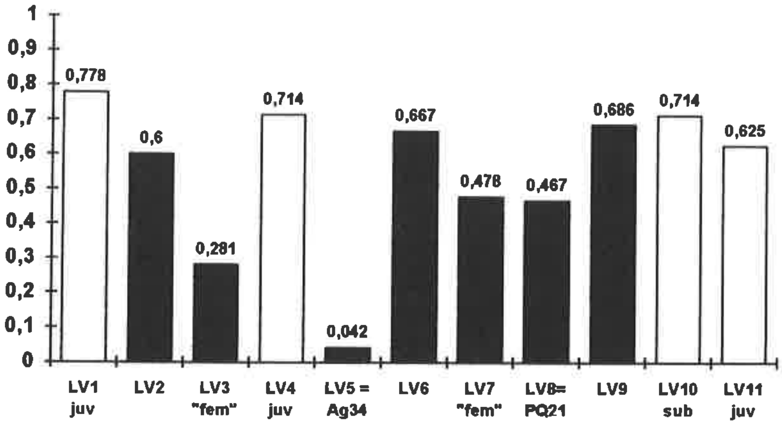

Fig. 2. Sociability index within the Levant group - 5th Sept 1997. Black / adults; white / subadults and juveniles

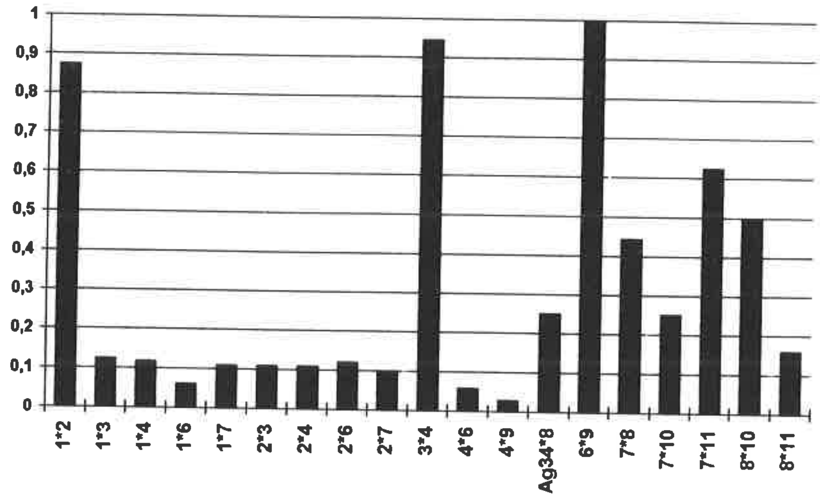

Fig. 3. Duo Association Index within the Levant group - 5th Sept 1997.
1*2 shows the association between the dolphins Lv1 and Lv2

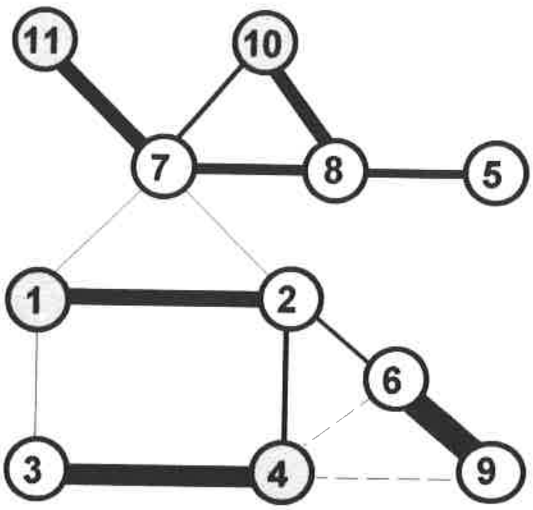

Fig. 4. Duo Association Index within the Levant group – 5th Sept 1997.
White circles: adults; grey circles: juveniles or subadult (10). Arrangement of the circles is arbitrary. Thickness of the line between two circles is proportional to the association index between the two dolphins considered (see Fig. 3).
Ag 34 = number 5 in this figure

SUMMER ACTIVITY PATTERNS OF THE STRIPED DOLPHIN IN THE NORTHWESTERN MEDITERRANEAN SEA

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INTRODUCTION The striped dolphin (*Stenella coeruleoalaba*) is an abundant species in the Western Mediterranean Sea and the Liguro-Provençal basin (Forcada *et al.*, 1994, 1995; Gannier, 1998a). The Northwestern basin has been described primarily as a summer feeding area, although breeding and calving also occur during that season (Aguilar, 1990; Gannier, 1999). The striped dolphin shows a migratory pattern, although a proportion of the summer population is still found in the northwestern basin during the winter (Gannier and Gannier, 1997; Gannier, 1998b).

Few results exist to describe the summer activity patterns of the striped dolphin, although evidence of night feeding associated with a nocturnal distribution shift exists (Gannier and David, 1997). It has also been suggested that daytime is mainly devoted to resting and socialising activities (Gannier, 1997). From 1988 to 1996, information on activity was recorded during the summer surveys of the GREC, including surface behaviour, dive and surfacing cycles, movements. We present here analyses conducted on the very large data set available from these surveys.

METHODS The field surveys took place between 15 June and 15 September from a 9 m. sloop (1988-94) and a 12 m. motorsailer (1995-96). Observation protocols remained similar, although the number of observers varied from 2-3 (1988-94) to 3-4 (1995-96). Boats moved off the 100 m. isobath on random linear tracks, either on pre-determined or weather-dependent routes. The area of study was restricted to the Western Mediterranean, north of the 40° parallel. The sighting conditions were defined on a 0-6 scale from wind, sea state, and light. A mean speed of 5 kts (prior to 1995) or 6 kts was obtained by cruising mainly on diesel engine. Three observers on average were on duty, searching with naked eyes. Upon detection, measurements of relative position of cetaceans were made with reticuled binoculars. The animals were then generally approached (except during one month in 1996) to collect data on group structure, behaviour, and activity. From 1994 onwards, systematic acoustic sampling was simultaneously conducted, with a rate of 0.5 listening per mile. Listenings were performed in the presence of dolphins to provide information on activity. Sighting information was recorded manually on a standard form shortly after the observation and was later loaded onto a Dbase 4 database. The sighting form varied little during the period of study.

We only kept for analysis the records featuring: a sighting conditions index of over 4, wind speed below or equal to Beaufort 3, and records with a sighting duration of over two minutes. A total of 490 sightings were then selected: 3 in 1988, 39 in 1989, 29 in 1990, 43 in 1991, 67 in 1992, 78 in 1993, 58 in 1994, 77 in 1995, and 96 in 1996.

Two types of variables were retained for the analysis: activity-related variables and environment/time-related variables. Activity related variables included group structure (GRP), group size (EST), activity (COM) and the frequency of juveniles (JEU) and calves (NOU) in the school. Environment/time-related variables included year (ANN), month (MOI), hour (HEU), distance to the coast (COT), depth (PRO) and sighting duration (DUR).

The activity was analysed as a function of bottom depth. The activity was sorted into four classes (columns): socialising, travelling, feeding and resting. The bottom depth was sorted into four strata (rows): 200-1,100 m., 1,100-1,700 m., 1,700-2,300 m., 2,300-

3,000 m. This 4x4 distribution was analysed with *StatXact* ® by performing a Pearson Chi-2 test for independence of rows.

For the purpose of the multivariate analysis, every variable was sorted into 6-8 classes, trying to obtain an approximately equal sample size for each category (Table 1). The group structure was sorted into 7 categories, including the «unknown» class. The activity variable was sorted into 8 categories, including three for which the activity could not be determined with certainty. Frequency of juveniles and calves variables include a category (NOU5 or JEU5) describing schools where only mother-calf (-juveniles) pairs could be seen.

A contingency table was formed with environmental variables as rows and activity-related variables as columns. A factorial analysis was run with *Statos* ® software. Taking account of the first results, several categories were pooled for a similar and improved analysis.

RESULTS During the period of study, feeding was the most frequent activity, with 37.0% of 319 cases. Travelling represents 29.8% of the cases recorded, and socialising, 20.3%. Resting was apparently the least frequent, with 12.9%. However, this activity pattern shows significant variation across the different depth strata (Table 2). The feeding activity is predominant in the 200-1,100 m. depth stratum (56.7%), when travelling is more frequent in the 1,100-1,700 m. stratum (36.1%). Resting is very uncommon inshore (3.3%) and relatively more frequent offshore, with the greatest frequency in the deeper stratum (15.3%). The Monte Carlo estimate of the Chi^2 probability was 0.090 when all rows were considered (differences across rows insignificant). When the second row (with smaller samples) was omitted from the comparison, the activity pattern was then found to be significantly dependent on bottom depth, with a Chi^2 probability of 0.035.

The results of the Factorial Analysis are plotted on a two-axis schematic diagram (Fig. 1). These two axes represent about 38% of the total inertia. The first axis contains much information on time and bottom depth. The second axis contains much information on group size and structure. The most significant variables (in term of contribution to the analysis) have been displayed, together with the time and activity variables. We traced a path between the successive time periods. The following results became apparent:

- early morning and late evening periods are associated with feeding activity, and the presence of shallow water and scattered groups;
- on the other hand, socialising occurs mainly during the afternoon and in offshore areas;
- groups occur mainly in the late afternoon, when resting and the presence of numerous calves and young occur.

This suggests a cyclic activity pattern, with feeding occurring between evening and early morning (including night), and socialising and resting activities taking place during the middle of the day. The activity cycle appears to be coupled with a shift in spatial distribution. A simultaneaous variation in school structure is apparent, with small and scattered subgroups during the morning, and larger schools with calves and juveniles during the afternoon.

DISCUSSION The complex overall picture given by the factorial analysis can be supported by simpler analyses already available. In a study undertaken during summer 1997, within 30 miles of the French continental coast (Gannier, 1997), the temporal variation in the activity of 81 striped dolphin schools was shown: feeding was recorded in 93% of cases during the early morning period. This proportion fell to 40% and 0% for the late morning and afternoon, respectively, before rising to 57% during the evening. Travelling activity accounted for 27% of the total during the late morning, and resting was the most frequently recorded activity during the afternoon. Socialising was the least frequent activity, culminating in 14% during the afternoon.

It must, however, be added that activity patterns (as observed in the field) do not easily fit into one of the four categories adopted. Nevertheless, the description from the survey in 1997 fits well within the schematic cycle depicted above (Fig. 1).

From the same field study, an offshore movement of dolphins was shown during the late morning, and an inshore movement during the evening (Gannier and David, 1997). In the same paper, sighting rate estimates also clearly suggested a distribution shift, with a steep decline in the nearshore area from the morning to the afternoon, and an increase in sightings rate over the shelf break, from the afternoon to the evening.

CONCLUSIONS This study gives new information on the habitat use of the striped dolphin in an area where numerous human-induced perturbations might affect the long-term status of the species. This aspect of dolphin ecology needs more research when commercial and recreational dolphin-watching develops, particularly in areas close to the populated and popular Riviera shore.

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REFERENCES

Aguilar, A. 1990. Calving in the striped dolphin from the western Mediterranean Sea. Pp. 67-68. In: *European Research on Cetaceans - 4*. Proc. 4th Ann. Conf. ECS, Palma de Mallorca, Spain, 2-4 Mar, 1990. (Eds. P. G. H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, UK. 140pp.

Forcada, J., Aguilar, A., Hammond, P., Pastor, X. and Aguilar, R. 1994. Striped dolphin abundance in the northwestern Mediterranean. Pp. 96-98. In: *European Research on Cetaceans - 8*. Proc. 8th Ann. Conf. ECS. Montpellier, France, 2-5 Mar, 1994. (Ed. P. G. H. Evans) European Cetacean Society, Lugano, Switzerland. 288pp.

Forcada, J., Notarbartolo di Sciara, G. and Fabbri, F. 1995. Abundance of the fin whales and the striped dolphin summering in the Corso-Ligurian basin. *Mammalia, 59:* 127-140.

Gannier, A. 1997. *Abondance et activité des Cétacés au voisinage du littoral provençal.* Rapport final de l'étude 97/00122 réalisée pour le Service Mer du Conseil Régional de Provence Alpes Côte d'Azur. 44pp.

Gannier, A. 1998a. Une estimation de l'abondance estivale du Dauphin bleu et blanc *Stenella coeruleoalba* dans le futur Sanctuaire Marin International de Méditerranée nord-occidentale. *Rev. Ecol. (Terre Vie),* 53: 255-272.

Gannier, A. 1998b. Variation saisonnière de l'affinité bathymétrique des Cétacés dans le bassin liguro-provençal. *Vie et Milieu* 48, 1: 25-34.

Gannier, A. 1999. Les cétacés de mediterranée nord-occidentale: nouveaux resultats sur leur distribution, la structure de leur peuplement et l'abondance relative des differentes especes. *Mésogée* (in press).

Gannier, A. and Gannier, O. 1997. New results on the seasonal variation of the cetacean population in the Liguro-Provençal basin. Pp. 91-94. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Gannier, A. and David, L. 1997. Day and night distribution of the striped dolphin (*Stenella coeruleoalba*) in the area off Antibes (Ligurian Sea). Pp. 160-163. In: *European Research on Cetaceans - 11*. Proc. 11th Ann. Conf. ECS, Stralsund, Germany, 10-12 March, 1997 (Eds. P. G. H. Evans, E. C. M. Parsons & S. L. Clark). European Cetacean Society, Kiel, Germany. 314pp.

Table 1 - Multivariate analysis: variables classification

variables	cat	cat	cat	cat	cat	cat	cat	cat
group structure (GRP)	GRP0 unknown	GRP1 tight	GRP2 in line	GRP3 grouped	GRP4 spread	GRP5 scattered	GRP6 subgroups	
group size (EST)	EST1 1 to 5	EST2 6 to 10	EST3 11 to 15	EST4 16 to 20	EST5 21 to 35	EST6 36 to150		
activity (COM)	COM1 feeding	COM2 traveling	COM3 resting	COM4 socializin g	COM5 rest-/soc	COM6 rest-/trav.	COM7 trav/soc.	COM8 breeding
freq. juveniles (JEU)	JEUO unknown	JEU1 none	JEU2 less 25%	JEU3 25-50%	JEU4 over 50%	JEU5 w/mother		
freq. calves (NOU)	NOUO un-known	NOU1 none	NOU2 less 25%	NOU3 25-50%	NOU4 over 50%	NOU5 w/mother		
hour (HEU)	HEU1 500- 925	HEU2 925-1140	HEU3 1141-1400	HEU4 1401-1615	HEU5 1616-1830	HEU6 1831-2115		
dist. to coast (COT) (n. miles)	COT1 0-8	COT2 8.1-14	COT3 14.1-18.7	COT4 18.8-24	COT5 24.1-34	COT6 34.1-76		
depth (PRO) (meter)	PRO1 <1140	PRO2 1150-2000	PRO3 2010-2200	PRO4 2210-2450	PRO5 2460-2550	PRO6 2560-3200		
duration (DUR) (minutes)	DUR1 0-3	DUR2 4-5	DUR3 6-9	DUR4 10-13	DUR5 14-21	DUR6 22-330		

Table 2 - Depth related activity patterns (number of sightings)

depth	socialising	travelling	feeding	resting
200-1,100 m	8	13	34	2
1,100-1,700 m	8	13	10	5
1,700-2,300 m	16	30	30	10
2,300-3,000 m	33	39	44	21

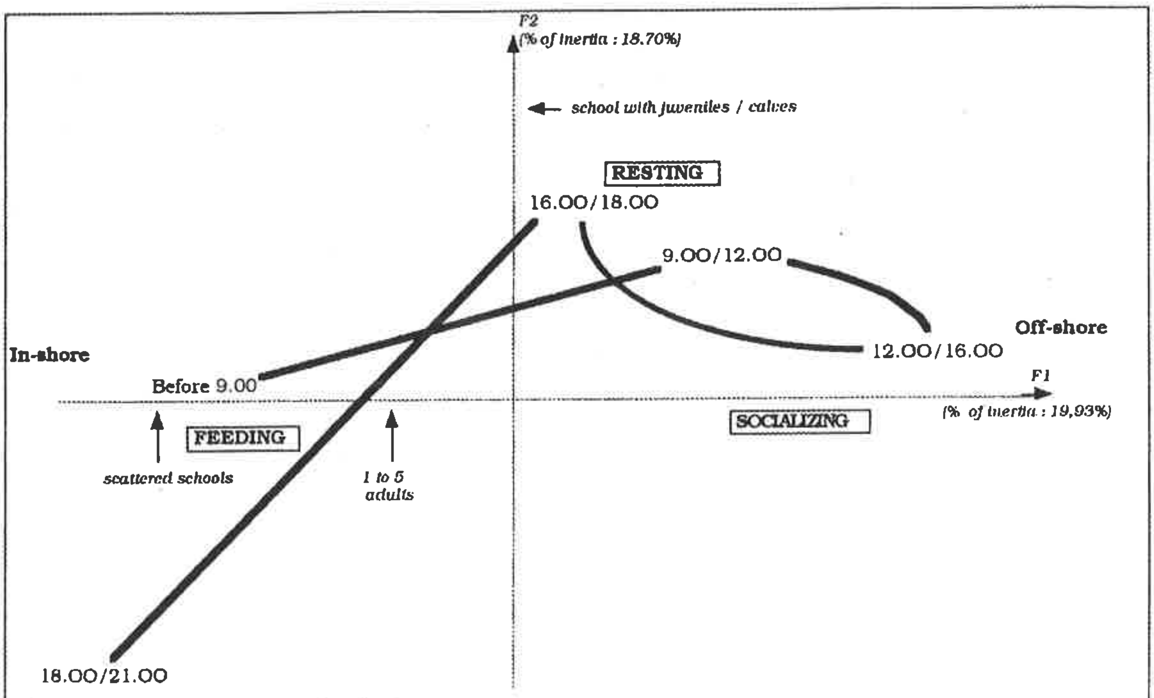

Figure 1 : Schématic description of main activity distribution with caracteristics of the group and environmental factor (from AFC).

Fig. 1. Schematic graph of the factorial analysis

HOW DO SUBANTARCTIC FUR SEALS EXPLOIT THE MARINE ENVIRONMENT? FORAGING HABITAT AND DIVING ACTIVITY IN RELATION TO SEA SURFACE TEMPERATURES

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INTRODUCTION The marine environment presents spatio-temporal heterogeneity (i) at the physical level (e.g. frontal systems) and (ii) at the biological level such as productivity and biomass that are known to be enhanced in the vicinity of oceanic fronts (Mann & Lazier, 1991). As expected from optimal foraging theory (Stephens & Krebs, 1986), marine predators respond to this spatio-temporal heterogeneity by their distribution, abundance, and behaviour. This has been shown for seabirds (Hunt & Schneider, 1987), whales (Machida, 1974; Tynan, 1998), and elephant seals (Boyd & Arnbom, 1991; Hindell *et al.*, 1991; McConnell *et al.*, 1992), but data are lacking for fur seals. That is why we investigated foraging habitat and diving activity in relation to sea surface temperature (SST) in lactating Subantarctic fur seals (*Arctocephalus tropicalis*) breeding on Amsterdam Island, Indian Ocean. In this species, mothers alternate between sea foraging trips and visits ashore to nurse their pups. During the 10-month pup rearing period, foraging trip duration increases from on average 11 days in summer to three weeks in winter (Georges & Guinet, in press).

MATERIALS AND METHODS The **oceanographic context** was obtained from the IGOSS NOAA weekly SST database (Reynolds & Smith, 1994; http://ingrid.ldgo.columbia.edu).The main oceanographic context was similar during the three study years but all the analyses were performed using weekly SST data. In December, when mothers performed their first trip after parturition, the SubTropical Front (STF) defined by the 14°C surface isotherm was in the vicinity of Amsterdam Island, while the SubAntarctic Front (SAF, 12°C surface isotherm) was about 400 km south from Amsterdam Island. Later in summer (February), the STF migrated 300 km south while the SAF was about 400 km south of Amsterdam Island. Accordingly, the SST gradient was very strong at this time. Finally, in winter (July), the 14°C surface isotherm migrated 200-300 km north from Amsterdam Island, while the SAF was 300 km south from Amsterdam Island. The SST gradient was consequently very low.

The **foraging habitat** was investigated using three different techniques: (i) In February 1995, satellite tags were deployed to determine the geographical positions of four mothers; (ii) In February 1996, one route recorder was deployed to record every 16 seconds the route used by one seal. We defined the foraging range as the furthest location determined by both techniques; (iii) Time Depth Recorders (TDRs) were deployed on 29 mothers from December to July during the 1995, 1996, and 1997 reproductive seasons. Sea temperature was also recorded for 20 TDRs. For each night spent at sea, we defined the SST recorded by the TDRs (SSTTDR) as the mean value of sea temperature recorded between surface and 3 m. in depth between 23:00 and 01:00 hrs (to exclude daily variations of SST). Foraging range was defined as the nearest point (given by the IGOSS NOAA SST database) corresponding to the extrem (minimum or maximum) SSTTDR.

The **organisation of the foraging trip** was investigated using a statistical interative technique searching the day for a change in diving activity that differed significantly from the previous set since a last significant change (see Boyd *et al.*, 1994). This allowed us to determine different phases in terms of diving activity, i.e. (i) diving frequency (number of dives per hour), (ii) vertical travel distance (sum of the dive depths multiplied by two to consider descent and ascent phases during the dives, in metres per hour; Horning & Trillmich, 1997); and (iii) time spent diving (sum of the dive durations, in mins. per hr).

Table 1 - Foraging habitat in relation to SST was investigated using Time Depth Sea Temperature Recorders on 20 lactating Subantarctic fur seals breeding on Amsterdam Island during their first trip after parturition (n = 6), later in summer (n = 9), and in winter (n = 5). This table does not show data of one seal performing a particular trip in summer (see text)

Trip type	Date	n	Trip durat. (days)	Extreme SST (°C)	Forag. range (km)
First	Dec. 1995	6	6.7±0.6 (6-10)	15.4-16.6	60-130
Summer	Feb. 1995	8	10.6±1.1 (8-15)	14.0-16.0	210-320
Winter	July 1995	5	28.0±3.7 (20-42)	11.4-15.6	410-530

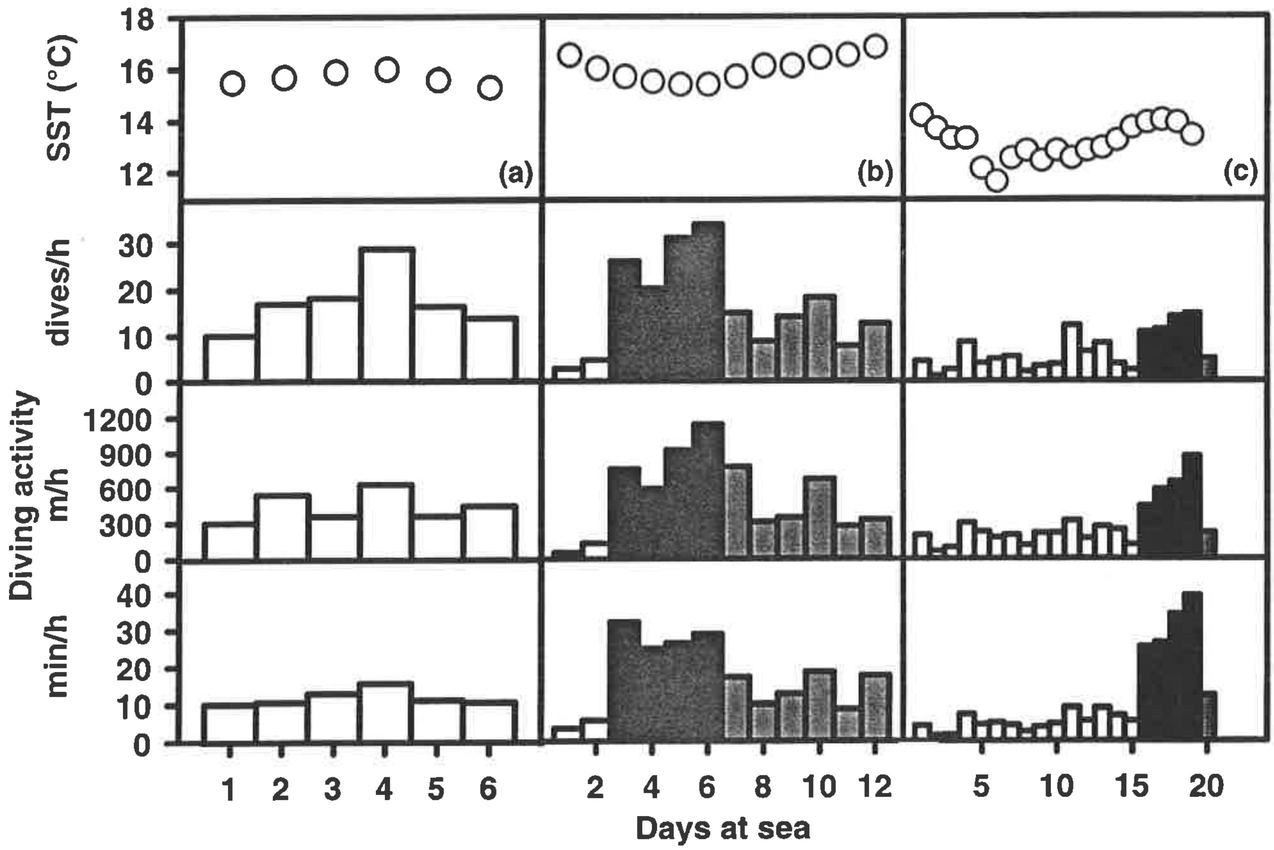

Fig. 1. Typical example of the organisation of the foraging trip (a) after parturition, (b) in summer, and (c) in winter according to diving activity, in the lactating subantarctic fur seals breeding on Amsterdam Island

FIRST RESULTS OF A PHOTO ID STUDY ON HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) OFF THE MACHALILLA NATIONAL PARK, ECUADOR

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From the months of May to September, humpback whales are abundant off the coast of the Machalilla National Park in Ecuador. Since July 1996, demographic studies are carried out on this population. The aim of this study is to find out about population size, habitat use, and the influence of the growing whalewatching industry. Therefore photo-identification studies are made from whalewatching vessels and land-based observations from the La Plata Island. A photo-identification catalogue is being established using natural markings of the fluke and dorsal fin.

Out of 58 pictures, a total of 26 animals could be identified according to different pigmentation patterns or deformations on the fluke. Two of these animals have been re-sighted, one after 28 days and another one the following season in August 1997.

These first registered re-sightings of humpback whales off the Ecuadorian coast provide evidence that the study area is a summer breeding ground for this species. In 1996, 100 sightings of humpback whales were made on 22 trips, with 89 hrs of observation, whereas only 58 humpback sightings could be made on 25 trips. with 100 hours of observation in 1997. The reduced number of humpback whale sightings could be due to the phenomenon of El Niño, when the water temperature increased by about 6°C. The results of 1997 and 1998 are currently being analysed.

DISTRIBUTION OF THE FORAGING ACTIVITY OF ANTARCTIC FUR SEAL (*ARCTOCEPHALUS GAZELLA*) FEMALES IN RELATION TO PREY AVAILABILITY AT KERGUELEN ISLAND

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The distribution of foraging activity of Antarctic fur seal females was investigated at Cap Noir, Kerguelen Island during February 1998. Eleven females were fitted with satellite PTT (ST 10 Telonics) combined with a Time Depth Recorder (MK5 Wildlife Computer), and ten females were equipped with a TDR fitted with a velocity recorder (MK6 Wildlife Computer). Software was developed to combine data on the location at sea and diving activity of the females, to investigate the spatial distribution of diving activity of individual fur seals on their foraging trips.

The fish component of the diet of female fur seals was determined from the occurrence of otoliths found in 55 scats collected during the study period on the breeding colony. An oceanographic vessel, La Curieuse, sampled the mesopelagic fish community along four transects at the same time and geographical scale conducting epipelagic trawls at night at 50 m. of depth.

Foraging trips lasted on average eight days. The combination of satellite and TDR data indicates that diving started only after the fur seal females reached the edge of the Kerguelen Plateau. Diving activity was only observed at night, and 95% of the dives were less than 100 m. Females tracked by satellite were found to concentrate their diving activity in two main locations beyond the slope of the Kerguelen plateau. These foraging locations were associated with polar front waters and characterised by high chlorophyll *a* concentration. Myctophid fish (*Gymnoscopelus piabilis*, *Electrona subaspera*, *G. nicholsi*) and gunnary (*Champsocephalus gunnari*) were the main prey items consumed by Antarctic fur seal females during the study period.

The two main foraging locations of Antarctic fur seal females were found to coincide with locations where the main fish prey species were most abundant, and when leaving the colony, females travelled directly to rich areas and spent little time prospecting for prey in less rich areas.

RELATIONSHIP BETWEEN CETACEAN SPECIES AND ENVIRONMENTAL PARAMETERS IN THE ALBORAN SEA

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INTRODUCTION 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. Some researchers have used the concept of Whittaker's (1973) multidimensional niche and the use of indirect gradient analysis to explore the relationships between habitat species (Jongman *et al.*, 1987). When the ordination axis of the species data cannot be readily interpreted with the measured environmental variables, the canonical ordination (direct gradient analysis) renders a more appropriate approach, because it has been designed to detect patterns of variation in species data explained by these variables (Jongman *et al.*, 1987).

The identification of biological, chemical, and physical parameters that are important to species, allow us to understand what constitutes a critical habitat so that conservation and management may be more successfully performed (Ballance *et al.*, in prep.). Thus ordination techniques can be understood as a first step of modelling because they permit the selection of variables which are involved in species distribution.

So far as we know, only a few studies (e.g. Fiedler & Reilly, 1994; Reilly & Fiedler, 1994; Ballance *et al.*, in prep.; Reilly *et al.*, in prep.) have been conducted to elucidate relationships between cetacean species and their habitat, and none of them in the Mediterranean Sea. These studies suggest that salinity, temperature, depth and chlorophyll *a* content are potential indicators of cetacean habitats.

MATERIALS AND METHODS During summer of 1998 (last week of each month), oceanographic (surface temperature, salinity, and chlorophyll *a*) and cetacean presence-absence (common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba*, bottlenose dolphin *Tursiops truncatus*, long-finned pilot whale *Globicephala melas*, Risso's dolphin *Grampus griseus*) (Fig. 1) data were collected every fifteen minutes, from vessel surveys conducted on the north-western Alboran Sea (Almería, SE of Spain). The location of all encounters was recorded using GPS. Depth data was added from a Digital Elevation Model (1 km^2 grid) derived from Spanish Navy nautical charts. (Fig. 2). Surface temperature was measured with an analogue thermometer (0.1°C of precision), and salinity with a refractometer (1‰ precision). Determination of chlorophyll *a* content was conducted by the spectrophotometric method (Parsons *et al.*, 1984).

The study area is located from 40°23.000' to 40°74.500' UTM Latitude coordinates and from 50°9.500' and 62°0.000' Longitude coordinates in the North-western Alboran Sea, including depths between 0 and 1,700 m. (Fig. 2).

The Alboran Sea is a very interesting area, characterised by its proximity to the Almería-Orán Front. Its hydrodynamics make it a zone with an extraordinary interest not only oceanographically, but also ecologically. The zone off Almería is of recognised importance due to the curvature of the Atlantic stream that turns from the Andalucian coast to Algeria, forming the Almería-Orán Front and fertilising the waters of this open sea area. The ecological effects of this circulation pattern mark an important difference between the occidental part of Cape of Gata (Alboran Sea) and the oriental zone (Levante

Sea). The high productivity of the Front is reflected by the presence of nekton fauna such as predatory fishes and many cetacean species have been witnessed feeding along it (Viale & Frontier, in Powell, 1997).

During the sample period, temperature ranked from 22.2° to 28.7° C, salinity varies between 35 and 39‰ and Chlorophyll *a* content from 0.052 to 0.56 $\mu g \cdot L^{-1}$. Values smaller than 0.052 are considered as zero (not detectable by this method).

The relationship between cetaceans and environmental variables was explored using indirect gradient analysis (Correspondence Analysis) and direct gradient analysis (Canonical Correspondence Analysis). Correspondence Analysis (CA) is an ordination technique that constructs theoretical variables, which are orthogonal axes of variation in data structure, while CCA selects linear combination of environmental variables to make an ordination of the species (Jogman *et al.*, 1987). A Monte Carlo permutation test was used to evaluate the significance of environmental variables in the ordination. All ordination was performed using CANOCO version 3.15 (Ter Braak, 1987)

RESULTS AND DISCUSSION Besides the use of environmental variables, in a strict sense, we have used parameters such as longitude and latitude, which can detect spatial habitat variations (water masses movements, bottom topography, etc.), and day and month, which are related to temporal variations (temperature, irradiance, etc.), not measured in this study. All these parameters correlate with some measured variables, for example, in this case, latitude correlates with depth (-0.56), and month and day correlates with temperature (-0.68).

CA ordination axis I - IV explain 72.9% of the variance of cetacean species (28.2, 15.7, 14.6 and 14.5% respectively), and account for 64.2% of the variance of species-environmental variables relationships (27.4, 11.2, 11.5 and 14.1 respectively). While CCA ordination axis I - IV explains 6.9% of the variance of cetacean species (3.4, 1.8, 1.2 and 0.5 respectively), and account for 94.5% of the variance of species environmental variables relationships (46.5, 24.5, 16.7 and 6.6% respectively).

The forward selection procedure, using the Monte Carlo test, showed that the most significant variables ($p<0.05$) in the ordination were: depth, month, day, temperature, and longitude. The only appreciable information added by CCA and subsequent forward step procedure was the importance of longitude in ordination axis, which has no correlation with environmental axis in CA.

In spite of the low explained variance by the CCA axis for data structure it may be interesting to explain the ordination of species with respect to environmental variables. The axis I has a poor correlation with month (0.37). The axis II shows a very high correlation with depth (-0.91), and a poor one with latitude and longitude (0.49 and -0.43 respectively). The axis III has a high correlation with temperature (0.71) and a poor one with longitude, month, day and salinity (0.42, -0.41, -0.4 and -0.4 respectively). The axis IV shows a significant correlation with chlorophyll (0.51) and a poor one with latitude (0.41). The latitude, which appears as an important factor in CA (it correlation with the axis III were -0.85), is eliminated by the forward selection due to its significant correlation with depth (-0.56), and has been replaced by longitude which has a significant correlation (-0.55) with the former.

The decrease of explained variance for cetacean species by CCA ordination axis with respect to CA ones implies that the set of selected explanatory variables was incomplete (Fig. 3). For the same reason, the ordination of variables and species were different in CA and CCA (Fig. 3). The short length of the arrows for the environmental variables in the current analysis (Fig. 3) indicates its reduced explanation capacity. One possible explanation for this situation would be that cetaceans have a wide range of physiological adaptability, and hence probably select habitats primarily due to other reasons such as prey abundance, competition, etc. However, in our view, the best explanation is the reduced number of samples, distributed over a short time period.

CONCLUSIONS We explore the relationship between environmental variables and cetacean presence using Correspondence Analysis and Canonical Correspondence Analysis. We use Monte Carlo permutation test to evaluate the significance of environmental variables in the ordination.

The percentage of cetacean species variance explained by the first and second ordination axes of the CA was 43.8, and for the species-environmental relationship was 38.6, while CCA explains only 5.1% of species variance and 71% of the relationship between environmental variables and species. The forward selection of variables for the analysis, using Monte Carlo test, showed that the more significant variables ($p<0.05$) in the ordination were depth, month, day, temperature, and longitude

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REFERENCES

Ballance, L. T., Pitman, R. L., Reilly; S. B. and Fiedler, P. C. (In preparation). Habitat relationships of cetaceans in the Western Tropical Indian Ocean. Draft ms.

Davis, R. W., Fargion, G. S., May, N., Leming, T. D., Baumgartner, M., Evans, W. E., Hansen, J. L. and Mullin, K. 1998. Physical habitat of cetaceans along the continental slope in the Northcentral and western Gulf of Mexico. *Marine Mammal Science*, 14, 3: 490-507.

Fiedler, P. C. and Reilly, S. B. 1994. Interannual variability of dolphin habitats in the Eastern Tropical Pacific. II: Effects on abundances estimated from tuna vessel sightings; 1975-1990. *Fishery Bulletin,* 92: 451- 463.

Jongman, R. H. G., Teer Braak, C. J. F., and Van Tongeren, O. R. F. 1987. *Data Analysis in community and Landscape Ecology*. Pudoc, Wageningen. 299pp.

Parsons, T. R., Maita, Y., and Lalli, C. M. 1984 *A manual of chemical and biological methods for seawater analysis.* Pergamon Press. Oxford. 173pp.

Powell, D. K. 1997. *The horizontal distribution of pelagic fauna across the Almería-Orán Front, SW Mediterranean Sea.* MSc. Project. University of Southampton. 107pp.

Reilly, S. B. and Fiedler, P. C. 1994. Interannual variability of dolphin habitats in the Eastern Tropical Pacific. I: Research vessel surveys; 1986-1990. *Fishery Bulletin*, 92: 434 - 450.

Reilly, S. B., Fiedler, P. C., Forney, K. A., and Barlow, J. (In preparation). Cetacean habitats in the California Current: Partitioning Oceanographic and Geographic Patterns. Draft ms.

Teer Braak, C. J. F. 1990. *Update notes: CANOCO version 3.10.* Agricultural Mathematics Group, Wageningen. 35 pp.

Whittaker, R. H. 1973. Approaches of classifying vegetation. Pp. 325-354. In: *Ordination and classification of communities* (Ed. R. H. Whittaker). Junk, The Hague.

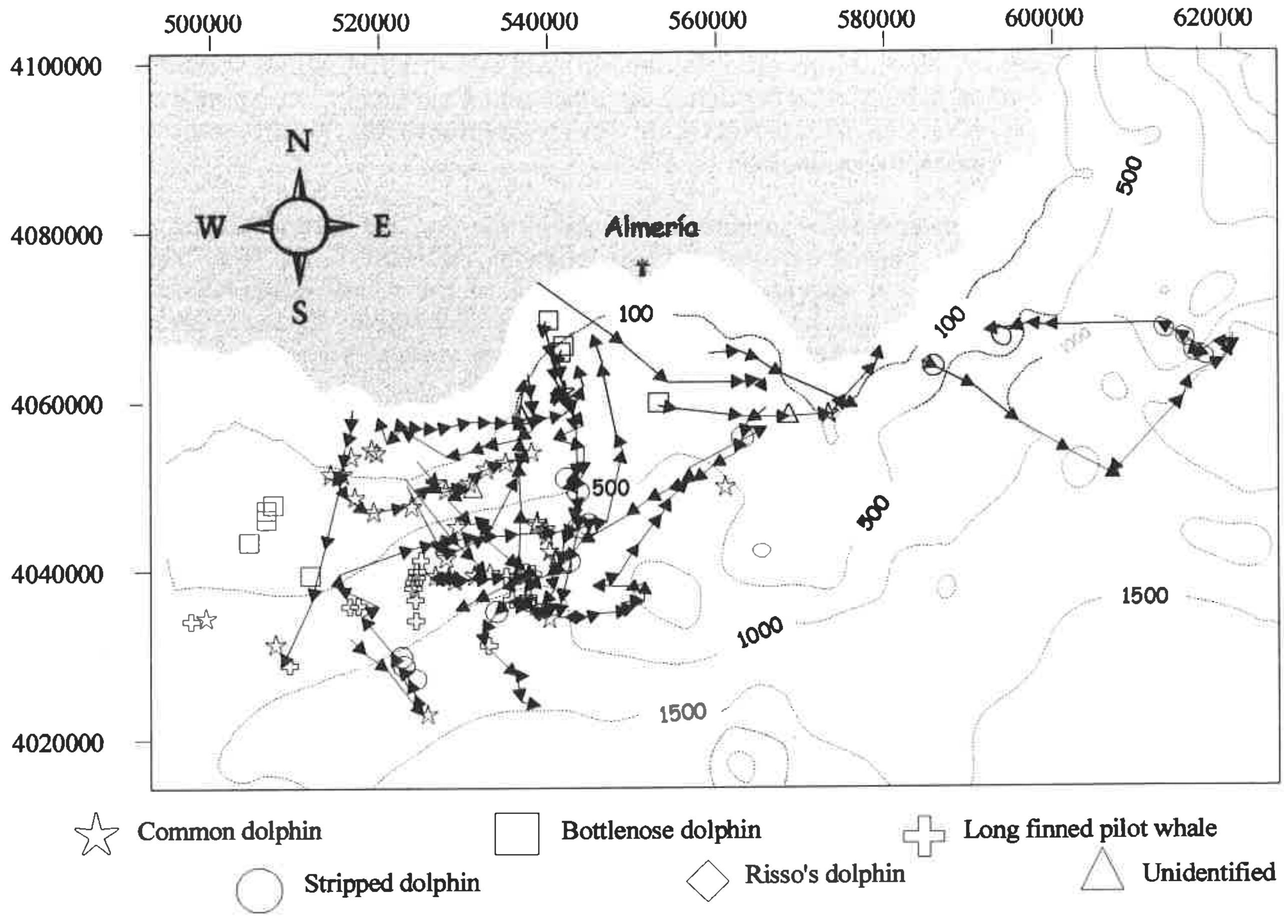


Fig. 1. Study area (transects and sightings)

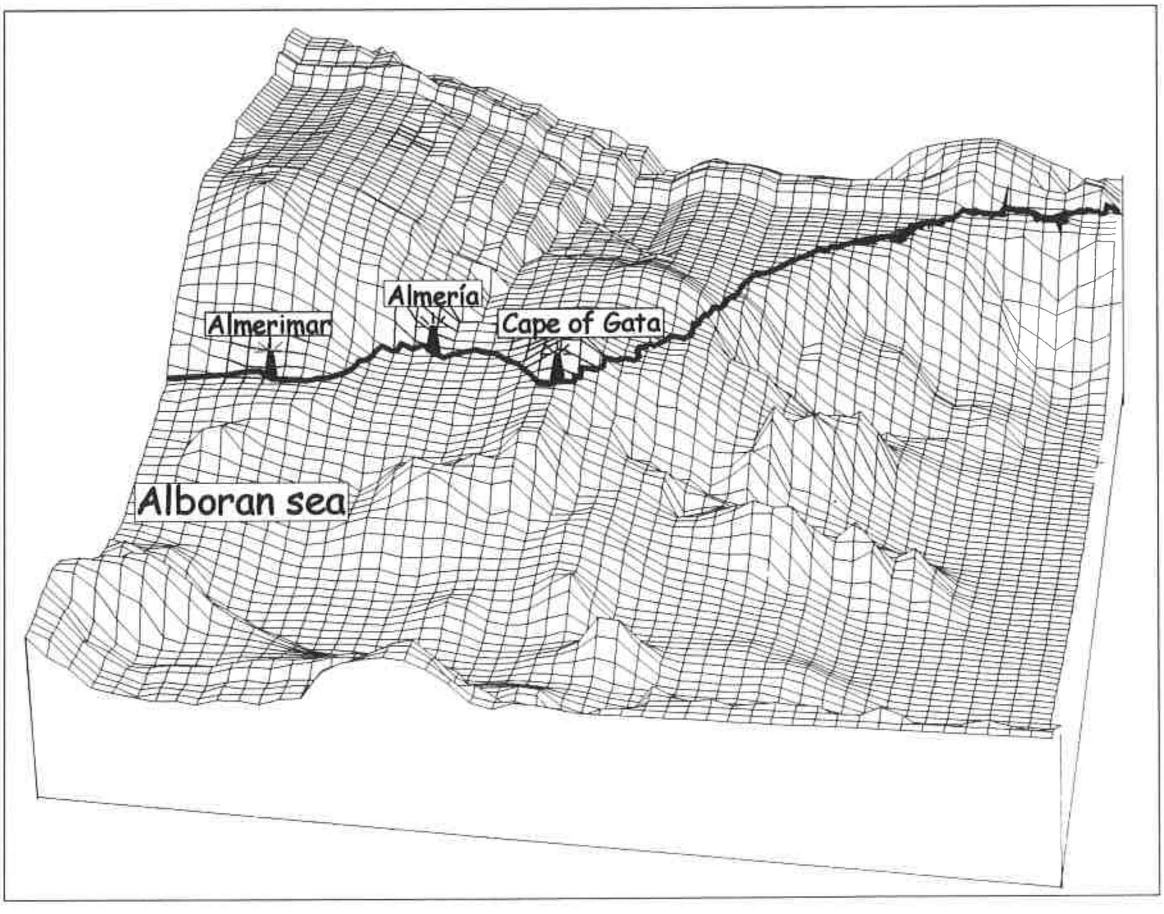
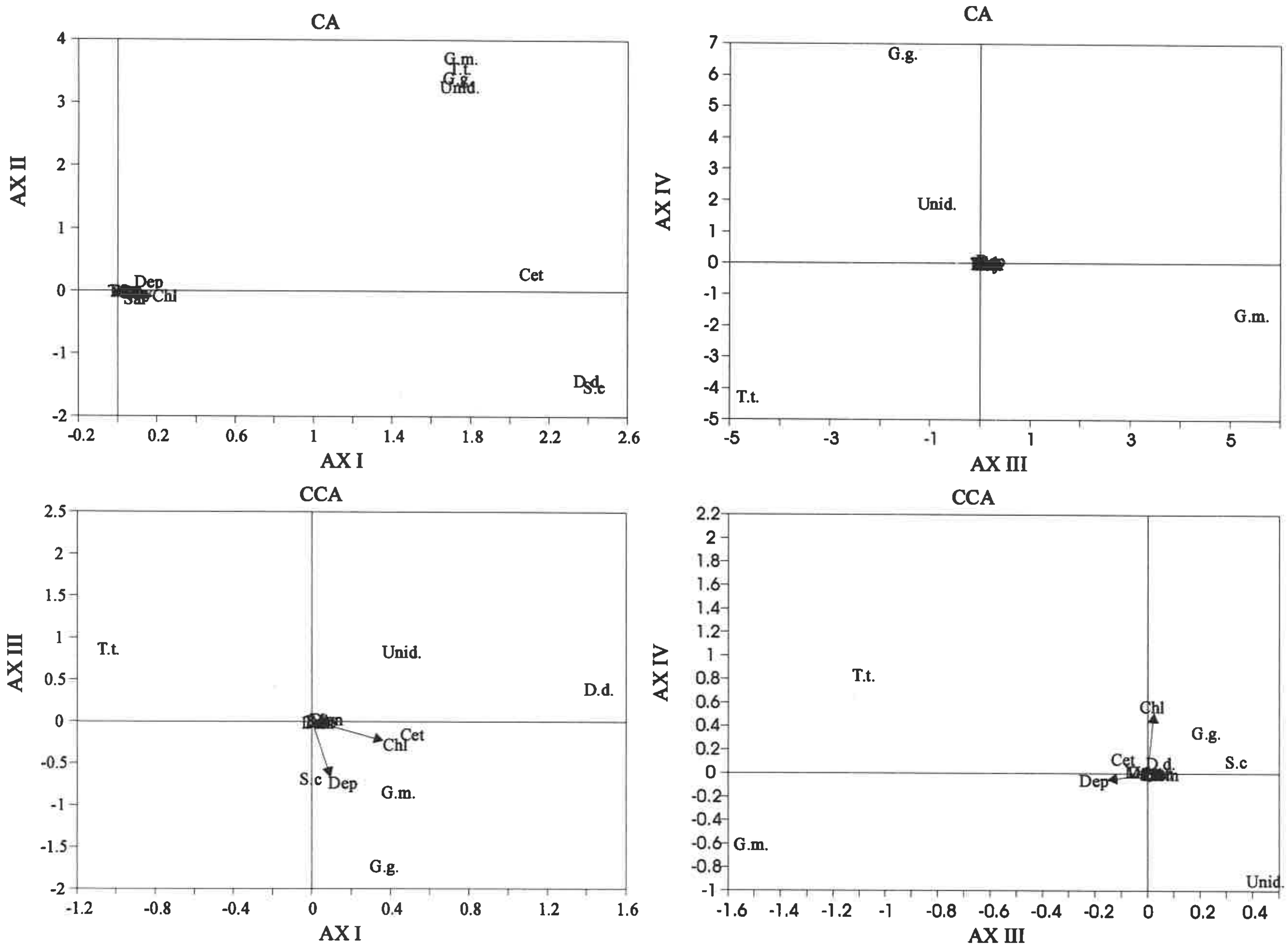


Fig. 2. Digital Elevation Model of the study zone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POPULATION ESTIMATES AND SEASONAL CHANGES IN ABUNDANCE OF RESIDENT BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE SHANNON ESTUARY, IRELAND

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Between April 1996 and August 1998, we examined the abundance of bottlenose dolphins using the Shannon Estuary, on Ireland's west coast. A combination of boat-based and shore-based fieldwork techniques were employed, together with data from casual sightings. Regular boat-based, photo-ID surveys showed the population to be resident, with repeated sightings of identified individuals throughout the study period. Dolphins were recorded during every month of the study. However, data collected from standardised boat surveys, shore watches, and casual sightings, all showed a marked increase in the number of dolphins using the Estuary during the summer months (May-Sept). Simultaneous shore-based counts of dolphins were made to establish minimum population estimates on four separate occasions. This method gave low and variable estimates of between 10 and 30 animals. In comparison to these instantaneous samples, a cumulative minimum estimate of 115 dolphins was derived from the photo-ID catalogue of recognised dolphins. Both these minimum estimates are compared with mathematically derived population estimates using capture-recapture models. The merits of a multi-disciplinary approach for surveying wild cetacean populations, and the importance of understanding seasonal changes in abundance, are discussed.

FOOD CONSUMPTION BY THE SOUTHERN SEA LION (*OTARIA FLAVESCENS*) POPULATION IN NORTHERN AND CENTRAL PATAGONIA

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The objective of this paper was to estimate food consumption by the Southern sea lion population in northern and central Patagonia. The estimation was performed on the basis of individual daily intake and population size. In order to obtain mean daily intakes for males and females, growth curves, age and sex composition, and the rates of biomass ingestion equations for juveniles and adults Otariidae were used. Total population consumption was obtained on the basis of the 1996 population size. The consumption by prey was obtained from the proportion in weight of each prey species in the Southern sea lion diet, and considering sex differences. For a population of 67,800 southern sea lions, the total consumption was estimated in 148,000 metric tons, which include the following details for the most important prey species: 65,000 tons of Argentine hake (*Merluccius hubbsi*), 41,000 tons of red octopus (*Enteroctopus megalocyathus*), 16,000 tons of Argentine shortfin squid (*Illex argentinus*), 4,300 tons of the "raneya" (*Raneya brasiliensis*) and 1,800 tons of the Patagonian squid (*Loligo gahi*). The remaining 19,900 tons correspond to 31 prey species. The order of magnitude of the estimated consumption for commercial species like Argentine hake, indicate that this consumption should be considered an important factor in the management models for those species in Patagonian waters.

POPULATION STATUS AND DYNAMICS OF GREY SEALS (*HALICHOERUS GRYPUS*) ON THE EAST AND SOUTHEAST COAST OF IRELAND

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There have been few population surveys for the grey seal on the east and south-east coast of Ireland and all have concentrated their effort during the breeding season and comprise single counts. With the intensifying conflict between seals and fisheries, a detailed two-year survey was conducted to determine the population status and dynamics of grey seals within this area.

The survey was conducted from June 1997 to December 1998. Standard population survey methods were used to assess the population size and the use of key moult, summer and breeding sites. Photo-identification techniques were used to movement between sites.

The total grey seal pup production for 1998 was 174, giving an all-age population estimate of 609 to 783. The main pupping sites were Lambay Island (east coast) and the Great Saltee (south-east coast). The primary moult and summer haul-out sites were Lambay Island and St Patrick Island (east coast) and the Great Saltee, Blackrock and Ravens Point (south-east coast). Numbers of grey seals at these sites fluctuated considerably throughout the year. The east coast was more important during the summer season, while the south-east coast was important throughout the year. Movement was seen between all sites within the east coast and between all sites within the south-east coast; however, there was little interchange between the east and south-east coast.

By comparison with population estimates from the south-west coast of Wales and the UK, the east and south-east Ireland population is considered small. However, the population is quite dynamic, fluctuating considerably during the year and with individuals moving between sites.

THE DIET OF ANTARCTIC FUR SEAL *ARCTOCEPHALUS GAZELLA* DURING THE BREEDING SEASON AT CAP NOIR, KERGUELEN

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This study describes the diet of the Antarctic fur seal (*Arctocephalus gazella*) during the late summer at the Cap Noir's colony, Kerguelen, Southern Indian Ocean. Scats were analysed to identify prey species. Undigested items, like otoliths, were used to identify which species were taken.

At the beginning of February, seals fed essentially on mesopelagic Myctophid fish. At the end of February, two different diets were identified: one composed of Myctophids, the other of *Champsocephalus gunnari*, a neritic fish. We compared the diet of juvenile and female seals using samples taken at the beginning of March. The diet of the two groups was similar.

As part of a larger progamme on the use of Antarctic fur seals as bioindicators of marine environment, the present study was undertaken to complete data on fur seal feeding ecology. These results, together with those already collected on diving and foraging behaviour, will allow us to establish a model of the feeding strategy of this species.

FIN WHALE (*BALAENOPTERA PHYSALUS*) FEEDING GROUND IN THE COASTAL WATERS OF ISCHIA (ARCHIPELAGO CAMPANO)

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INTRODUCTION The Campano Archipelago has been the subject of a long-term study on cetaceans since 1991. In this area, from spring to autumn, in different periods we have regularly recorded 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).

The analysis of our data from previous surveys undertaken in this area has indicated that the sightings of fin whale, *Balaenoptera physalus*, are generally higher during summer months, and this is in accordance with what has been observed by other researchers working in the Italian seas (Marini *et al.*, 1991, 1992; Zanardelli *et al.*, 1992; Notarbartolo di Sciara *et al.*, 1998).With the help of local fishermen, we concentrated our efforts in the waters surrounding the island of Ischia throughout 1996.

In the subsequent two years, it was possible to ascertain the presence of a large number of fin whales in the zone between the islands of Ischia and Procida and the mainland coast, in a comparatively small area (about 35 square miles) roughly corresponding to the submarine canyon of Cuma (Pennetta *et al.*, 1998). It was possible to repeatedly observe fin whale feeding behaviour.

METHODS Observations and research were carried out in the following periods: 16 July - 19 Aug 1996, 9 July - 31 Aug 1997, and 3 July - 19 Aug 1998, on board "Barbarian", a 15 m. long sail-boat fully equipped for high-sea navigation. The routes were chosen to optimise sightings and were determined daily on the basis of previous sightings, particular attention being paid to follow the bathymetric contours. 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 exposures faster than 1/250 sec. To better describe the behaviour of fin whales, we have defined three different types of swimming speed: rest = speed <1 knots; slow swim = speed >1/<3 knots; fast swim = speed >3 knots. Along with weather conditions (sea and wind), distance from the coast and depth were also recorded. Pictures for individual identification were made only in July 1998; the characters employed being in accordance with methods suggested by Agler *et al.*, 1990 (dorsal fin shape, presence/shape of chevron, scars and nicks).

RESULTS 102 surveys have been carried out; 1,616 nm have been covered for a total of 892 hrs of navigation during which we recorded 66 sightings of fin whale for a total of 94 individuals and 52.4 hrs of direct observation. In the summer, the surface water temperature varied between 26.5° and 24.2°C with an average of 25.6°C ±0.7 SD. The average depth for encounters was 280 m. (±193.8 SD; range 25-900); the average distance from the nearest coast was 5.6 km (±3.2 SD; range 0.6-13.1). Fin whales were followed for periods of 1-244 min. (av. 48 min., ± 61 SD). The mean group size of fin whale was 1.5, with a maximum of six individuals; 69% of sightings included a single individual; in 8% of sightings, young whales (length <11 m., Zanardelli *et al.*, 1992) were observed with adults; on six occasions, isolated young were seen. During July 1998, 12 individuals were photo-identified, two of which were detected twice.

Ten defaecation episodes occurred during feeding activities. The analysis of faecal material, according to what had been already observed (Orsi Relini *et al.*, 1992; Relini *et al.*, 1992-1997), has revealed the presence of crustacean exoskeletons belonging to the euphausiid *Meganyctiphanes norvegica*. An indirect indication of the abundance of these euphausiids in the area comes from some records of beach strandings detected in winter along the coasts of Ischia (M.C. Gambi, *pers. comm.*).

The mesopelagic crustacean euphausiid *M. norvegica* is a key species in the pelagic trophic web, since it is also the main food for the fin whales in the Mediterranean Sea (Forcada *et al.*, 1993; Orsi Relini *et al.*, 1994) and it plays an important role in the feeding for other cetaceans such as odontocetes as the food for squid and fishes which themselves are prey of these marine mammals (Orsi Relini *et al.*, 1994). The analysis of faeces of a single fin whale specimen revealed the occurrence, although with a scarce frequency and abundance, of vertebrae of fish larval stages (ichthyoplankton). Although fish larvae have probably been ingested together with euphausiids and possibly other planktonic organisms, this finding suggests that fin whale may supplement its diet with different "accessory" trophic resources.

Spatial relationships, as a consequence of a high concentration of shared prey or of trophic levels depending on them, have been observed with several other cetacean species. Odontocetes such as striped and common dolphins have been frequently observed in the area, along with a large number of pelagic fishes such as *Mobula mobular*, *Thunnus* sp. and seabirds such as *Calonectris diomedea*, *Puffinus puffinus* and *Larus ridibundus*.

Feeding has been observed on 19 occasions, always in association with circle swimming with fluke- and tail-surfacing (Friis *et al.*, 1992; Armstrong *et al.*, 1998). On four occasions, bubble clouds have been noted produced by the diving animals (Martin, 1996). We have observed fin whales quickly stirring their flukes while swimming with belly upwards in order to increase water turbulence. Most of the time spent on the surface by fin whales was at sunset (Friis *et al.*, 1992), which is probably associated with the vertical nocturnal migrations of euphausiid prey (Riedl, 1991); on these occasions, they were seen to emerge with mouth open, with vertical lunges.

The fish resources of the area are daily exploited by 20 trawl netters, 12 bottom set gillnetters for *Merluccius merluccius*, ten encircling netters for *Scombersox saurus*, eight small mesh driftnetters for Scombridae, five bottom longliners, and one purse seiner.

In 41% of sightings of feeding, the whales were involved in opportunistic feeding from fishermen's gear - encircling nets and trawling nets.

While interacting with encircling nets, the whales would approach the seine boat, swiftly swimming around it (Martin, 1996), trying to catch the fish that had escaped from the net; with trawling nets, whales would follow the trawler's wake in order to profit from the movement of the net and from the fish coming out of the net itself.

Whales have also been observed spending a lot of time swimming round bottom set gillnets, performing long dives (<6 min.).

CONCLUSIONS This research has enabled us to highlight a significant presence of fin whales in the coastal waters of Ischia. The specific topographical features of the area have been described by Pennetta (1998) who explains how the continental slope is dissected by submarine canyons, of which the deeper one is that of Cuma. These canyons seem to be the main reason for the concentration of fin whales in such a small area (35 square miles) so close to the island.

Physical features such as submarine canyons also increase the speed of upwellings: in a specific case study, the speed in a submarine canyon increased from about one m./day to about 30 m./day (T. De Pippo, *pers. comm.*).

Recent circulation models in submarine canyons indicate that upwelling phenomena are typical along the canyon axis and over the downstream wall (Hickey, 1995; Signorini *et al.*, 1997). Submarine canyons penetrating the continental slope may also act as transport conduits to the waters of the deep ocean. Great accumulations of sediments and detritus have been observed on the floor of several submarine canyons in different oceans, forming a persistent set of organic and inorganic debris (Vetter, 1995).

Both phenomena - sedimentation and hydrodynamics, help us to create a special habitat characterised by a great local density and diversity of benthic and pelagic fauna exceeding that of other habitats along the continental shelf and slope (Green *et al.*, 1992; Gage and Tyler, 1992; Vetter, 1995).

This production enhancement apparently penetrates the food chain down to seabirds and mammals. For example, The Gully, a 1,200 m. deep, 12 km wide, submarine canyon off the coast of Newfoundland, Canada, is the home of a resident population of 200-300 northern bottlenose whales, *Hyperoodon ampullatus* (Faucher and Whitehead, 1992).

The presence of large pelagic predators (whales, common and striped dolphins, tuna), along with the daily takes of a remarkable quantity of commercial fisheries, suggest a big concentration of food resources.

Direct observations, convoluted courses, circle swimming, bubble production, and defaecation episodes all point to foraging activity being undertaken by fin whales in the area.

In spite of the high percentage of isolated individuals, the concentration of fin whales in such a small area urge us to think that they keep in contact through low frequency sounds (Notarbartolo di Sciara *et al.*, 1998). The decrease in the presence of fin whales at the end of summer in the west Mediterranean has already been observed. Many questions remain open concerning the movement of mysticetes during winter months.

We hope that future researches may define the huge importance of the role played by submarine canyons at least in the distribution and abundance of trophic resources of these marine mammals, since submarine canyons are an important habitat, where a particular pelagic marine assemblage can be found.

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REFERENCES

Agler, B. A. Beard, G. A., Bowman R. S., Corbett, H. D., Frohock, S. E., Hawvermale, M. P., Katona, S. E., Sadove, S. S. and Seipt, I. E. 1990. Finback whale, *Balaenoptera physalus*, photographic identification: methodology and preliminary results from the Western North Atlantic. *Rep. Int. Whal. Commn.* (Spec. Issue 12): 349-357.

Aguilar, A. 1985 *Biologia y dinamica poblacional del rorqual común (Balaenoptera physalus) en las aguas atlanticas ibericas.* Memoria redactada par optar al grado de Doctor en Ciencias Biológicas, Depto Zoología, Cátedra de Vertebrados, Fac. Biología, Univ. Barcelona. 488pp.

Armstrong, W. A., Curry, B. E. and Hewitt, R. P. 1998. Fin whale (*Balaenoptera physalus*) feeding behaviour in antarctic waters: herding and/or concentrating of krill. P. 6. In *World Marine Mammal Conference Abstract Book*, 20-24 January 1998, Monaco, France.

Faucher, A. and Whitehead, H. 1992. *The bottlenosed whales of the Gully*. Final report for 1998-91 to WWF-Canada (unpublished).

Gage, J. D. and Tyler, P. A. 1992. *Deep-Sea Biology*. A Natural History of organism at the deep sea floor. Cambridge University Press, New York.

Friis, L. W., Pedersen, J. U., Rebsdorf, M. and Skytte, E. 1992. Fin whale (*Balaenoptera physalus*), surfacing rates in west Greenland. Pp. 90-93. In: *European Research on Cetaceans - 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February 1992 (Ed. P.G.H. Evans). European Cetacean Society, Cambridge, UK.

Gili, J. M., Ros. J. D. and Pages, F. 1987. Types of bottom and benthic cnidaria fron the trawling grounds (littoral and bathyal) off Catalonia (NE Spain). *Vie et Milieu*, 37: 85-98.

Gili, J. M., Murillo, J. and Ros, J. D. 1989. The distribution pattern of benthic Cnidarians in the Western Mediterranean. *Scient. Mar.*,53(1): 19-35.

Green, C. H., Wiebe, P. H., Burczynski, J and Youngbluth, M. J. 1992. Acoustical detection of high-density demersal krill layers in the submarine canyons off Georges Bank. *Science*, 241, 359-361.

Hikley, B. M. 1995, Coastal submarine canyons. Pp. 95-110. In: *Topographic effects in the ocean*. (Ed. P. Muller and D. Henderson). SOEST Special Pubblication, University of Hawai, Manoa.

Lafortuna C. L., Jahoda, M., Biassoni, N., Almirante C., Azzellino, A., Zanardelli, M., Panigada, S., Notarbartolo di Sciara, G. and Saibane, F. 1998. Locomotor behaviour and respiratory pattern in the Mediterranean fin whale (*Balaenoptera physalus*) tracked in the summer feeding ground. Pp. 156-160. In: *European Research on Cetaceans -12*. Proc.12th Ann. Conf. ECS, Monaco, France, 20-24 January 1998 (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Cambridge, UK.

Marini, L., Consiglio, C., Angradi, A. M. and Sanna, A. 1991. Preliminary results of the first year of a sigtings survey of cetaceans in the Central Tyrrhenian Sea. Pp 22-25. In: *European Research on Cetaceans - 5*. Proc. 5th Ann. Conf. ECS, Sandefjord, Norway, 21-23 February 1991 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, UK.

Marini, L., Consiglio, C., Maria, A., Sanna. A. and Valentini T. 1992. Cetacean sightings programme in the Central Tyrrhenian Sea: results of the second years of activity. Pp. 66-68. In: *European Research on Cetaceans - 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, UK.

Martín, V. 1996. Opportunistic feeding behaviour by minke whales (*Balaenoptera acutorostrata*) in association with sardine purse-seine fishery operation in Garnet Bay. North-Western Sahara. P. 252. In: *European Research on Cetaceans - 10*. Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 March 1996 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, UK.

Mussi, B., Gabriele, R., Miragliuolo, A. and Battaglia, M. 1999. Cetacean sightings and interaction with fisheries in the Archipelago Pontino-Campano, South Tyrrhenian Sea, 1991-1995. Pp. 63-65. In: *European Research on Cetaceans -12*. Proc.12th Ann. Conf. ECS, Monaco, France, 20-24 January 1998 (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Valencia, Spain.

Notarbartolo di Sciara, G., Clark, C. W., Zanardelli, M. and Panigada, S. 1999. Migration patterns of fin whales, *Balaenoptera physalus*: shaky old paradigms and local anomalies. P. 118. In: *European Research on Cetaceans -12*. Proc. 12th Ann. Conf. ECS, Monaco, France, 20-24 January 1998 (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Valencia, Spain.

Pennetta, M., Valente, A., Abate, D., Boudillon, G., De Pippo, T., Leone, M. and Terlizzi, F. 1998. Influenza della morfologia costiera sulla circolazione e sedimentazione sulla piattaforma continentale tra Gaeta e Cuma (Italia Meridionale) *Boll. Soc. Geol. It.*, 117 (1998), 281-295.

Relini, L. O. and Giordano A. 1992. Summer feeding of the fin whale, *Balaenoptera physalus*, in the Liguro-Provençal Basin. Pp. 138-141. In: *European Research on Cetaceans - 6*. Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, UK.

Relini, G., Orsi Relini, L., Chantal, C. Fasciana, C., Fiorentino, F., Palandri, G., Relini M., Tartaglia M. P., Torchia, G. and Zamboni, A. 1992. Macroplancton, *Meganyctiphanes norvegica*, and fin whales, *Balaenoptera physalus*, aling some transects in the Ligurian sea. Pp. 134-137. In: *European Research on Cetaceans - 6* Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 February 1992 (Ed P. G. H. Evans). European Cetacean Society, Cambridge, UK.

Relini G., Orsi Relini, L., Palandri, G., Relini, M., Garibaldi, F., Cima, C., Torchia, G. and Costa, C. 1997. Aspetti della distribuzione, ecologia e storia vitale del krill mediterraneo (*Meganyctiphanes norvegica*) che possono influenzare il comportamento delle balene. In *3° Convegno Nazionale sui cetacei, Abstracts Book.* 5-6 Dicembre 1997, Napoli, Italia. Dipartimento di Zoologia dell' Università di Napoli Federico II, Centro Studi cetacei della Società Italiana di Scienze Naturali, Museo civico di Storia Naturale di Milano.

Riedl, R., Abel, E., Kohlmeyer, J., Kusel, H., Matthes, D., Rossi, L., Salvini-Plawen, L. and Sarà, M. 1991. *Fauna und Flora des Mitterlmeeres.* Verlag Paul Parley, Hamburg-Berlin, Germany.

Signorini, S. R. *et al.* 1997. Flow dynamics of a wide Arctic canyon. *Journal of Geophysical Research*, 102, 18661-18680.

Vetter, E. W. 1995. Detritus-based patches of high secondary production in the nearshore benthos. *Marine Ecology* Progress Series, 120, 251-262.

Zanardelli, M., Notarbartolo di Sciara, G. and Jahoda, M. 1992. Photo-identification and behavioural observation of fin whales summering in the Ligurian Sea. Pp. 86-89. In: *European Research on Cetaceans - 6.* Proc. 6th Ann. Conf. ECS, San Remo, Italy, 20-22 Feb 1992 (Ed P. G. H. Evans). European Cetacean Society, Cambridge, UK.

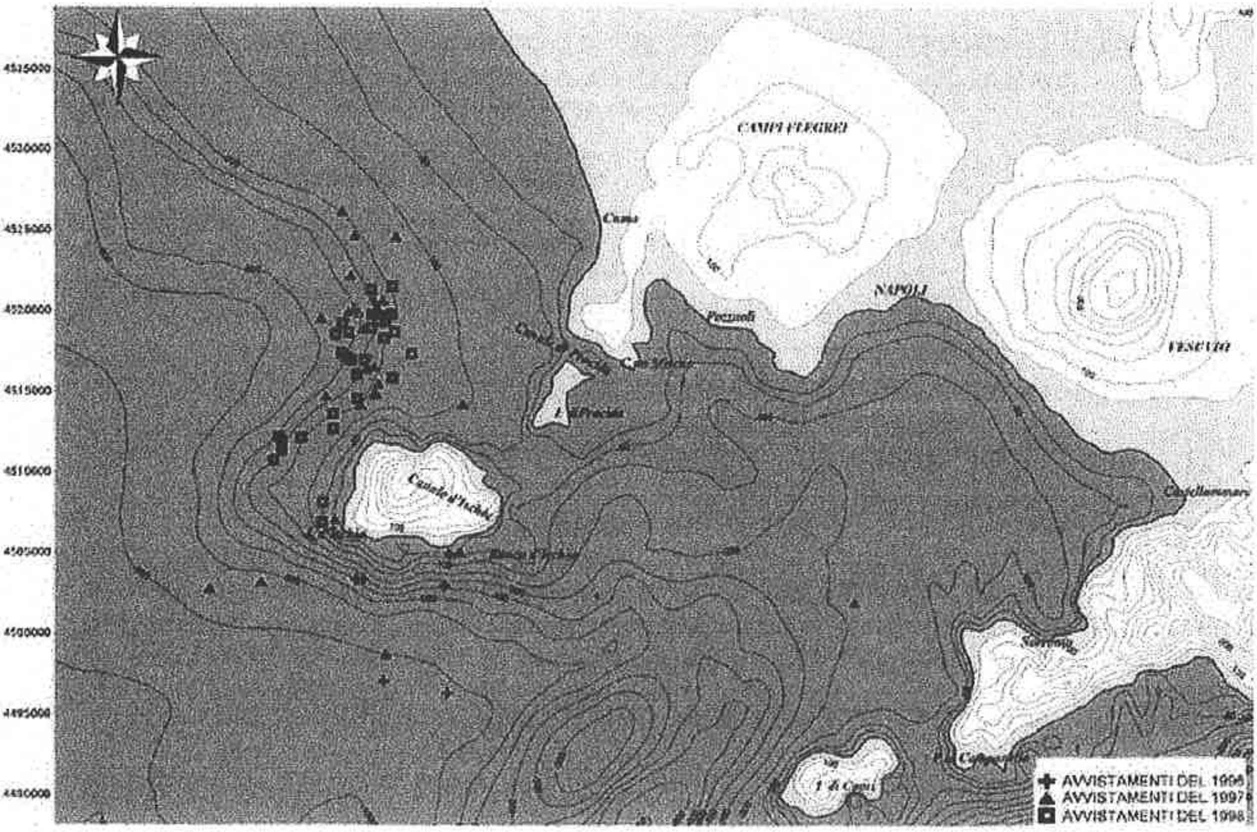

Fig 1 Study area

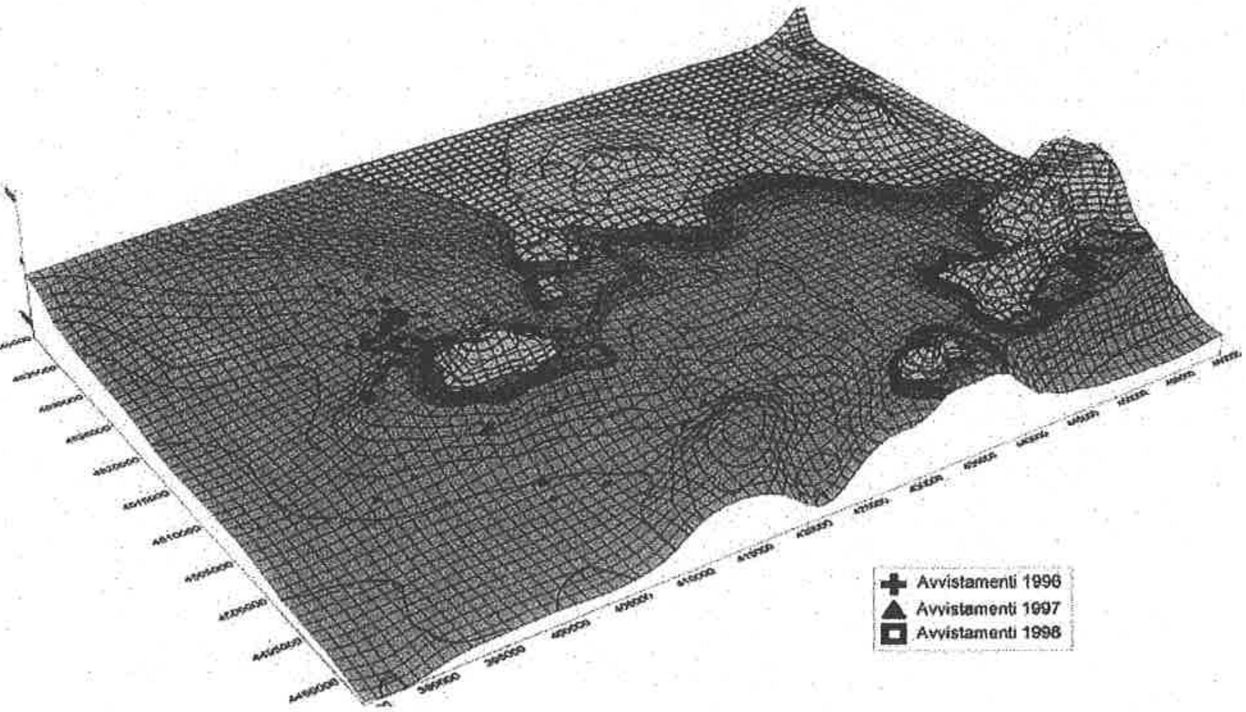

Fig 2 Study area

STOMACH CONTENT ANALYSIS OF PYGMY AND DWARF SPERM WHALES AND ITS ECOLOGICAL IMPLICATIONS: IS THERE NICHE PARTITIONING?

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INTRODUCTION Little work has been carried out on stomach content analysis of pygmy (*Kogia breviceps*) and dwarf (*Kogia simus*) sperm whales (Ross, 1979; Klages *et al.*, 1989). The literature available indicates that both species forage over the continental shelf and slope (Ross, 1979; Candela, 1989), but few researchers cover the possibility of niche partitioning between the two species of *Kogia*.

MATERIALS AND METHODS The stomach contents of 42 *K. breviceps* (21 females, 20 males, and one animal of unknown sex) and of 33 *K. simus* (20 females and 13 males) stranded along the South African coastline were examined. Lower beaks of cephalopods and otoliths found in the stomachs were identified to species level with reference to the prey-identification collection at the Port Elizabeth Museum. Identification to species level and calculation of length and reconstituted mass was done following standard techniques (Clarke, 1986; Fitch and Brownell, 1968). The percentage number, percentage mass, and percentage frequency of the individual prey items were calculated for each animal as well as for each species and for groups of different reproductive status:

- Group 1: sexually mature males and sexually mature females neither lactating, pregnant or accompanied by a calf;
- Group 2: immature animals of both sexes and females that were lactating and/or pregnant and/or accompanied by a calf.

The main prey species were identified by excluding any prey species that numerically amounted to less than 10 individuals per group considered. A niche overlap index (Pianka, 1975) was calculated for the two species, as well as for males and females of the same species, and for groups of different reproductive status within a species using the percent numerical data.

RESULTS AND CONCLUSIONS The diet of *Kogia breviceps* comprised 55 different cephalopod species and 22 other prey species including fish, crustaceans, molluscs, and other invertebrates. In *K. simus*, the diet was made up of 33 cephalopod species and seven others. There were 40 main prey species that numerically made up 92% and 97.8% of the total diet of *K. breviceps* and *K. simus*, respectively (Table 1). This indicates that *K. breviceps* has a slightly more diverse diet than *K. simus*. In both species, *Histioteuthis* sp. and *Lycoteuthis diadema* were the most important prey items (Table 2).

Although the main prey items of the two *Kogia* species are the same (Table 2), statistically, the diet is significantly different (Table 3). This indicates that both *Kogia* species share the same main prey items, but additionally each feeds on a suite of other prey items, which differs between the two species (Table 1). The niche overlap index of 0.88 (where 1.0 indicates complete overlap and 0.0 indicates none) shows that the diet and, therefore, the foraging areas of the two species overlap to a great extent (Table 3).

Similar results were found when the two sexes for each *Kogia* species were considered. The diets between males and females were statistically significantly different, but the niche overlap was large, and the largest overlap was found between males and females of *K. simus* (Table 3).

The diets of group 1 and group 2 of both *Kogia* species were also significantly different (Table 3). The niche partitioning index between the two groups was 0.84 for *K. breviceps* and 0.61 for *K. simus* (Table 3). This shows clear differences in diet for animals of different reproductive status in *K. simus*, with animals belonging to group 2 feeding to a larger extent on inshore cephalopods like *Sepia papillata* (Table 4). Although the results for *K. breviceps* were different, animals belonging to group 2 feed to a larger extent on inshore cephalopods like *Sepia* sp. (8.57%) and *Sepia papillata* (5.32%) than animals belonging to group 1 (0% and 0.47%, respectively) (Table 4). This trend was even stronger in *K. simus* (Table 4), and was possibly responsible for the reduced niche overlap.

The above results show that both *Kogia* species share the same ecological niche in terms of main prey items and foraging area off South Africa. However, differences in reproductive seasonality were observed between the two species (Plön *et al.*, 1997). While *K. simus* shows a calving peak during the austral summer months (December and January), *K. breviceps* shows a peak in the austral autumn (March and April). These differences in reproductive seasonality may have been selected for in order to prevent utilisation of the same resource at a time when energetic demands are highest. Several other factors may also contribute to the niche partitioning of the two species, such as oceanographic conditions (currents, sea surface temperatures, bottom topography) or differences in the size of the prey they feed on.

REFERENCES

Candela, S. M. 1987. Cephalopod prey of pygmy and dwarf sperm whales (*Kogia breviceps* and *K. simus*) stranded in Florida and Georgia. *Abstracts*, Seventh biennial conference on the biology of marine mammals, 5-7 December, Miami, Florida, USA.

Clarke, M. R. (Ed.) 1986. *A handbook for the identification of cephalopod beaks*. Clarendon Press, Oxford. 273pp.

Fitch, J. E. and Brownell, R. L. 1968. Fish otoliths in cetacean stomachs and their importance in interpreting feeding habits. *J. Fish. Res. Bd. Canada*, 25, 12: 2561-2574.

Klages, N., Cockcroft, V. G. and Best, P. B. 1989. Stomach contents of pygmy *Kogia breviceps* and dwarf *Kogia simus* sperm whales stranded on South African beaches. *Abstracts*, Eighth biennial conference on the biology of marine mammals, December 1989, Monterey, California, USA.

Pianka, E. 1975. Niche relations in desert lizards, Pp. 299-314. In: *Ecology and evolution in communities*, (Eds. M. L. Cody and J. M. Diamond), Harvard University Press, Cambridge, Mass., USA.

Plön, S. E. E., Bernard, R. T. F., Cockcroft, V. G. and Best, P. B. 1997. Age, growth and reproduction of Pygmy (*Kogia breviceps*) and Dwarf (*Kogia simus*) Sperm Whales stranded along the Southern African coastline. *Working paper SC/49/SM45 of the 49th, International Whaling Commission Meeting*. Scientific Committee Annual Meeting. Bournemouth, United Kingdom, 29 Sept - 11 Oct 1997.

Ross, G. J. B. 1979. Records of pygmy and dwarf sperm whales, genus *Kogia*, from southern Africa, with biological notes and some comparisons. *Ann. Cape Prov. Mus.* (Nat. Hist.) 11, 14: 259-327.

Table 1 - Main stomach contents of *K. breviceps* and *K. simus* presented as numerical percentages

Main Prey Species	Stomach Content (Numerical %)	
	Kogia breviceps	*Kogia simus*
Histioteuthis sp.	33.29	23.20
Lycoteuthis diadema	17.49	24.54
Sepia papillata	2.62	13.34
Taonius pavo	4.19	8.60
Chiroteuthis sp.	4.10	8.23
Loligo vulgaris	6.19	2.08
Sepia sp.	4.43	< 2
Taonius sp.	< 2	3.71
Photychthys argenteus	2.43	< 2
Gonatus antarcticus	< 2	2.00
Todaropsis eblanae	< 2	2.00
Other	25.27	12.31

Other = all prey species that comprised less than 2% of the total prey number

Table 2 - The two main prey items of *K. breviceps* and *K. simus* presented in percentage number, percentage mass and percentage frequency of occurrence

	Kogia breviceps			*Kogia simus*		
Prey species	% No.	% Mass	% Freq.	% No.	% Mass	% Freq.
Histioteuthis sp.	32.9	30.9	90.5	22.6	45.3	66.7
Lycoteuthis diadema	17.3	10.3	76.2	23.9	15.8	66.7

Table 3 - Niche overlap index calculated for different groups of *K. breviceps* and *K. simus*

Groups examined	x^2-test ($p< 0.005$)	Niche overlap index
K. breviceps vs *K. simus*	729.77	0.88
K. breviceps males vs *K. breviceps* females	942.37	0.80
K. simus males vs *K. simus* females	207.48	0.92
K. breviceps group 1 vs *K. breviceps* group 2	789.72	0.84
K. simus group 1 vs *K. simus* group 2	353.46	0.61

Table 4 - Main stomach contents of group 1 and group 2 of *Kogia breviceps* and *Kogia simus* presented as numerical percentages

Main Prey Species	Stomach Content (Numerical %)			
	Kogia breviceps		*Kogia simus*	
	Group 1	Group 2	Group 1	Group 2
Histioteuthis sp.	36.26	24.77	18.55	22.77
Lycoteuthis diadema	9.91	21.76	43.13	15.09
Sepia papillata	-	5.32	-	24.69
Taonius sp.	*	*	-	10.70
Chiroteuthis sp.	5.72	2.75	8.92	10.15
Loligo vulgaris	9.71	3.44	2.17	2.61
Sepia sp.	< 2	8.57	*	*
Taonius pavo	6.25	2.44	4.34	7.54
Photychthys argenteus	5.26	-	*	*
Octopoteuthis sp.	4.13	4.88	*	*
Merluccius capensis	-	2.56	4.82	-
Teuthowenia sp.	< 2	< 2	3.61	< 2
Vampyroteuthis infernalis	*	*	3.61	-
Gonatus antarcticus	< 2	< 2	3.61	< 2
Lycoteuthis sp.	-	-	3.13	-
Todaropsis eblanae	< 2	3.31	3.13	< 2
Ommastrephis bartrami	< 2	2.00	< 2	2.74
Squilla sp.	-	2.38	-	-
Gnathophausia ingens	2.20	< 2	*	*
Myctophidae	2.00	< 2	*	*
Diplospinus sp.	2.00	< 2	-	-
Other	16.57	15.82	0.96	3.70

- = prey species was not present.
* = prey species was represented by less than 10 individuals in both groups combined and thus not considered for calculations of main prey items.
Other = all prey species that comprised less than 2% of the total prey number.

ANALYSIS OF THE DIET OF MALE AND FEMALE *TURSIOPS TRUNCATUS* FROM WESTERN MEDITERRANEAN

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Fourteen stomach contents of *Tursiops truncatus* stranded on the Valencian coast (Western Mediterranean), from August 1983 to January 1997, were analysed. Six males and eight females, with food remains in their stomachs, were considered for this study.

A total of nineteen species (nine fish, seven cephalopod, and three crustacean species) were found in the stomach. Bottlenose dolphins, *T. truncatus*, from this area feed primarily on fish, mainly on neritic, mesopelagic, demersal, and benthic species. The hake, *Merluccius merluccius*, was the most important prey from this area, in both sexes. The differences in number and size of hakes between dolphin males and females were statistically (Mann-Whitney text) non-significant (U=10.0, p>0.05, and U=21495.5, p>0.05, respectively). However, significant differences (U=7.5, p<0.05) in the consumption of cephalopods versus fishes were detected: dolphin males feed mainly on fishes (only one cephalopod specimen in all dolphin males), but dolphin females also consume cephalopods, mainly octopods.

FEEDING ECOLOGY OF COMMON DOLPHIN (*DELPHINUS DELPHIS*, L.) STRANDED ON THE GALICIAN COAST (NW SPAIN)

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Stomach contents of 91 common dolphins (*Delphinus delphis*, L.) stranded on the Galician coast between 1991 and 1995 were examined to identify prey remains. A total of 16,490 otoliths, representing at least 8,902 fish, were recovered from the stomachs, together with 866 upper and 872 lower beaks belonging to at least 987 cephalopods. Twenty fish taxa and fourteen cephalopod taxa were identified from these remains. Crustacean and Polychaete remains were also found in several stomachs. Blue whiting (*Micromesistius poutassou*), scad (*Trachurus trachurus*), and sardine (*Sardina pilchardus*) were the most important prey eaten, together making up two-thirds of the estimated prey weight.

Few differences were found between diets of male and females, or mature and immature dolphins. Female dolphins ate larger blue whiting while males ate slighter larger sardines than females. Mature dolphins had more scad in their diets than did immature dolphins, but fewer gobies and crustaceans. Also, mature dolphins had taken larger blue whiting but smaller scad than immature dolphins. Correlation analysis showed a positive relationship between dolphin size and the importance of blue whiting and scad in the diet, but no relationship between dolphin length and the importance of sardine. A significant positive correlation was also found between size of scad eaten and dolphin size. Little seasonal and interannual variation in the diet was found. No significant differences were found between diets of bycaught dolphins and the diets of those for which the cause of death was unknown. Tentative calculations on the amount of commercially important fish consumed by common dolphins in the area are presented and compared with landings by the Spanish fishery in the same area during the period studied.

THE EFFECTS OF THE DEEP SCATTERING LAYER ON THE DIVING BEHAVIOUR OF SPERM WHALES OFF ANDØYA, NORWAY

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INTRODUCTION The aim of this study was to obtain a better understanding of the foraging behavior of sperm whales in the waters off Andøya, Norway, by examining the relationship between the dive cycle times of the whales and their potential feeding depths: the deep scattering layer and the sea floor.

The deep scattering layer is a sound reflecting layer in seawater caused by aggregations of organisms. Outside the continental shelf in the eastern Norwegian Sea, the deep scattering layer is located at a depth of between 300 and 500 metres. The layer consists mainly of midwater fish and macroplankton (Melle *et al.*, 1993, Torgersen *et al.*, 1997). Marine mammals foraging within the deep scattering layer include pilot whales and common dolphins (Evans, 1974) and probably also northern elephant seals (Stewart and DeLong 1993). As sperm whales seem to feed in depths similar to those where the deep scattering layer is found (Gordon, 1987, Papastavrou *et al.*, 1989; Whitehead *et al.*, 1992), this layer is also a potential feeding place for them. Another possible feeding place, the sea floor, is at 400 to 2,000 m. depth in the study area.

There have been no studies on the diet of the sperm whales in the Norwegian Sea. Some information suggests that they feed on the squid *Gonatus* sp., as well as several fish species, including lumpsucker (Øynes, 1957) and redfish (Christensen, 1980). In the waters between Iceland and Greenland, fish was found to be the dominant food of the sperm whale, squid being a secondary food item. Important species in the diet included lumpsucker, redfish, anglerfish, cod, and blue whiting (Martin and Clarke, 1986).

MATERIALS AND METHODS The study site was the waters off Andøya, Norway, 69°N, 15°E, an important feeding area for male sperm whales (Christensen *et al.*, 1992). The material was collected 7 between June and 4 August, 1997, from the whalewatching vessel M/S Reine, a 30 m. wood-hulled boat. Information collected at sea included: surface times and dive cycle times of the whales, surface behaviour, estimated distance from the boat to the whale, and boat manoeuvres. The whales were identified photographically from the trailing edge of their flukes (Arnbom, 1987). An echo sounder, Furuno FCV-291, 50 kHz frequency, was used to obtain information about the depth and relative density of the deep scattering layer, as well as the depth of the sea floor. Occasionally, the diving whale was tracked with the echo sounder for the first one to eight minutes of its dive.

The dive cycle times were chosen to be used in the analysis instead of dive times, because they could be measured more accurately, dive times being often biased due to the difficulty of observing the time of surfacing. The density of the scattering layer was estimated by the colour of the layer in the echosounder monitor. The following density groups were used: 1) sparse – no continuous layer or a layer with only blue colour, 2) dense – a continuous blue layer with green, yellow or red colour.

RESULTS The dive cycle times of the sperm whales varied from 21 to 53 min. The median dive cycle time was 31 min. ($\bar{x}$ = 33 min., SD = 7 min., n = 40). The surface times varied from 5.4 to 9.7 min. and the median value was 6.7 min. ($\bar{x}$ = 6.8 min., SD = 1.2 min., n = 17). The dive times were from 15 to 34 min., the median being 25 min. ($\bar{x}$ = 25 min., SD = 5 min., n = 17).

There was no indication of a correlation between the dive cycle time and the scattering layer depth, p = 0.2, n = 40 (Fig.1). No significant correlation was found between the dive cycle time and bottom depth either, when testing the entire material, p = 0.8, n = 38

(Fig. 2). The dive cycle times associated with sparse scattering layers, were longer, averaging 36 min., than the ones associated with dense scattering layers, averaging 30 min., $p = 0.006$ (Fig. 3). The bottom depth correlated positively with the dive cycle times which were associated with sparse scattering layers, $r = 0.52$, $p = 0.01$, $n = 17$ (Fig. 4), while the dive cycle times associated with dense scattering layers did not show any indication of being affected by the bottom depth, $p = 0.4$, $n = 21$.

The dive cycle times and the scattering layer density were both affected by the time of the summer season. The scattering layer was stronger in the beginning of the summer than at the end of the summer, $r_s = -0.61$, $p < 0.001$, $n = 40$, and the dive cycle times were shorter in the beginning of the summer than in the end, $r_s = 0.49$, $p = 0.001$, $n = 40$.

The thirteen echo sounder traces obtained from diving whales were of two different types: six traces levelled out at depths from 220 to 265 m., and in seven traces, no levelling out was seen. Unfortunately, there were so little data that it was not meaningful to test the relationship between the trace types and scattering layer densities. The existing data, however, gave some indication that the traces of the former type were associated with denser scattering layers than the traces of the latter type. The descent rates of the traces that levelled out varied from 12 to 80 m./min., decreasing with increasing depth. In the traces where no levelling was seen, the descent rates varied from 50 to 100 m./min. and stayed fairly constant regardless of dive depth, the mean descent rate being 81 m./min.

DISCUSSION The variation in the depth of the deep scattering layer during the study period was very small and thus the fact that no significant correlation was found between dive cycle times and the scattering layer depths may be due to the limited range of depths. The fact that there was no significant correlation between the dive cycle times and bottom depths, when testing the entire material, indicates that the sperm whales in the area do not, at least regularly, feed on the sea floor.

The results show clearly that the density of the deep scattering layer affects the diving behaviour of the sperm whales. The whales dive for shorter periods when the layer is dense than when it is sparse. This suggests that the whales feed on the scattering layer organisms when the layer is dense, and when it is sparse they dive deeper, possibly even to the sea floor, to search for alternative prey. Diving deeper would thus account for the extra time spent. The fact that a correlation was found between the bottom depth and the dive cycle times when the scattering layer was sparse supports this suggestion. The dive traces also support this since the traces seem to level out more often in depths from 200 to 300 m. when the scattering layer is dense, and go straight down when it is sparse.

The median dive cycle time and the median dive time, as well as their usual range in this study, are remarkably (10-20 min.) short compared with those reported by sperm whale studies in other areas. Also, the median surface time is somewhat shorter (1-3 min.) (Gordon, 1987, Papastavrou *et al.*, 1989, Gordon and Steiner, 1992). When measuring dive cycle times of sperm whales, the fact that longer cycle times are more difficult to record makes the material negatively biased. This is a problem in all studies on the diving behaviour of sperm whales, but the use of directional hydrophones for tracking the whales in other studies might have diminished this bias. This could thus be partly the reason for shorter values in this study, but hardly explains entirely such a big difference.

Another reason for shorter cycle times could be that the whalewatching vessel, used as a research platform in this study, affected the behaviour of the whales and thus their dive cycle times. We believe, however, that the vessel had little effect on the diving behaviour of the whales. The whales were always approached in a way that caused least possible disturbance to them, i.e. from behind, and the engine was set close to idle when at c. 200 m. from a whale. In a study of the effects of whalewatching on the behaviour of sperm whales off Kaikoura, some differences were found in their surface behaviour which correlated with the presence of whalewatching vessels, but no significant differences were found in either dive times or dive cycle times of the whales (Gordon *et al.*, 1992).

We suggest that the shorter dive cycle times observed in this study were due to differences in the diet of the whales in this area compared with other study areas. Differences in diet are likely to favour different foraging strategies and thus to be reflected by differences in diving behaviour. The sperm whales off Andøya probably eat more fish than sperm whales in tropical and subtropical waters, where the diet consists mainly of squid (Kawakami, 1980). This might result in a difference in foraging behaviour, and thus explain the difference in the dive cycle times.

The increase in dive cycle times towards the end of summer was likely caused by the decrease in density of the scattering layer. Since there were fewer organisms in the scattering layer at the end of summer, the whales probably foraged deeper, on other prey. This is supported by the fact that five of the six dive traces that levelled at certain depths were recorded at the beginning of summer, and six of the seven traces where no levelling was seen, were recorded at the end of summer. The diet of the whales probably differs between seasons, since the availability of prey species in the area also varies.

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REFERENCES

Arnbom, T. 1987. Individual identification of sperm whales. *Rep. Int. Whal. Commn.*, 37: 201-204.

Christensen, I. 1980. Observations of large whales (minke not encluded) in the North Atlantic 1976-78 and markings of fin, sperm and humpback whales in 1978. *Rep. Int. Whal. Commn.*, 30: 205-208.

Christensen, I., Haug, T. and Øien, N. 1992. Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (Mysticeti) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. ICES *J. Mar. Sci.*, 49: 341-355.

Evans, W. E. 1974. Radio-telemetric studies of two species of small odontocete cetaceans. Pp. 385-394. In: *The whale problem: a status report.* (Ed. W. E. Schevill). Harvard University Press, Cambridge.

Gordon, J. C. D. 1987. *The behaviour and ecology of sperm whales off Sri Lanka.* Ph.D Thesis, University of Cambridge. 347pp.

Gordon, J., Leaper, R., Hartley F. G. and Chappell O. 1992. Effects of the whale-watching vessels on the surface and underwater acoustic behavior of sperm whales off Kaikoura, New Zealand. *Science & Research Series*, 52: 1-64. Department of Conservation, Wellington.

Gordon, J. and Steiner, L. 1992. Ventilation and dive patterns in sperm whales, *Physeter macrocephalus*, in the Azores. *Rep. Int. Whal. Commn.*,42: 561-565.

Kawakami, T., 1980. A review of sperm whale food. *Sci. Rep. Whales Res. Inst.*, 32: 199-218.

Martin, A. R. and Clarke, M. R., 1986. The diet of sperm whales (*Physeter macrocephalus*) captured between Iceland and Greenland. *J. Mar. Biol. Ass.* U.K., 66: 779-790.

Melle, W., Kaartvedt, S., Knutsen, T., Dalpadado, P. and Skjoldal, H. R. 1993. Acoustic visualisation of large scale macroplankton and mikronekton distributions across the Norwegian shelf and the Norwegian Sea. ICES Council Meeting 1993/L:44. 23pp.

Papastavrou, V., Smith, S. C. and Whitehead, H. 1989. Diving behavior of the sperm whale, *Physeter macrocephalus,* off the Galapagos Islands. *Can. J. Zool.*, 67: 839-846.

Stewart, B. S. and DeLong, R. L. 1993. Seasonal distribution and habitat use of foraging northern elephant seals. *Symp. Zool. Soc. Lond.*, 66: 179-194.

Torgersen, T., Kaartvedt, S., Melle, W. and Knutsen T. 1997. Large scale distribution of acoustic scattering layers at the Norwegian continental shelf and the eastern Norwegian Sea. *Sarsia*, 82: 87-96.

Whitehead, H., Brennan, S. and Grover, D. 1992. Distribution and behavior of male sperm whales on the Scotian Shelf, Canada. *Can. J. Zool.*, 70: 912-918.

Øynes, P., 1957. Om spermhvalen. *Fauna*, 4: 125-132.

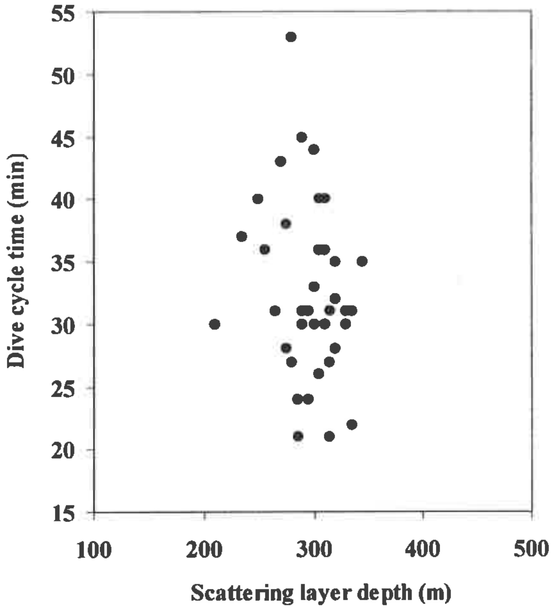

Fig. 1 - Dive cycle time against scattering layer depth

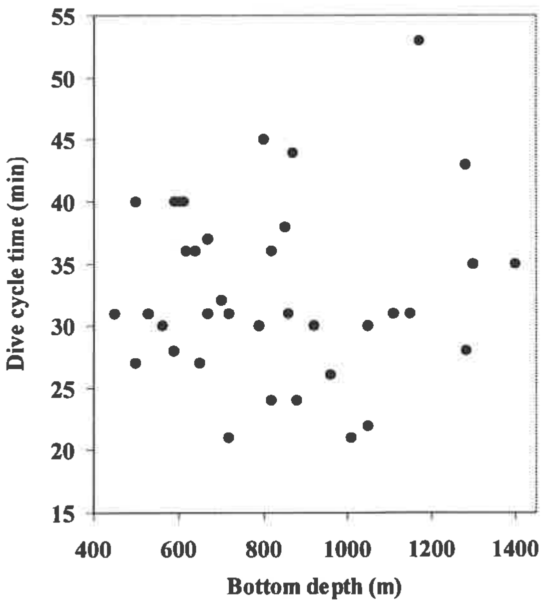

Fig. 2 - Dive cycle time against bottom depth

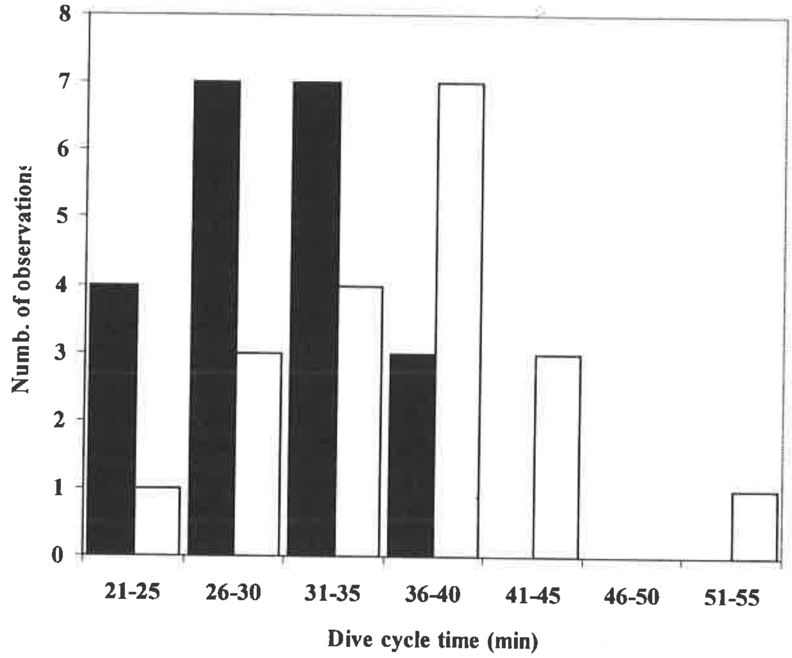

Fig. 3 - Frequency distribution of dive cycle times connected with dense scattering layer (black) and those connected with sparse scattering layer (white)

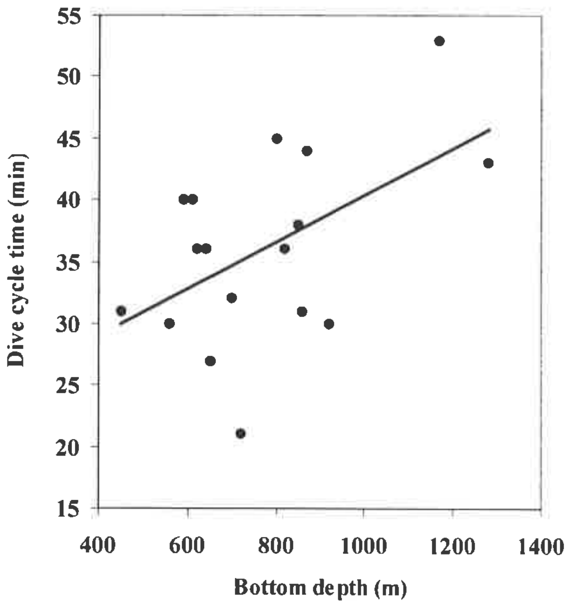

Fig. 4 - Dive cycle times connected with sparse scattering layer against bottom depth, with linear trend line

HABITAT USE OF THE FRESHWATER DOLPHIN *INIA GEOFFRENSIS* IN THE AMAZON AND ORINOCO BASINS IN COLOMBIA

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Patterns of habitat use by the freshwater dolphin *Inia geoffrensis* were described in the Amazon and Orinoco basins from 1996 to 1998. Over 1,800 boat surveys and 3,476 hours of effort were conducted simultaneously in both study areas.

Group size, composition by age, distance from the shore, and type of shore were considered over different seasonal periods (low, high, and transitional water levels). Photo-identification was used to record some daily and seasonal movements as well as residence patterns. The average group size in the Amazon was three individuals with ranges from 1-21 dolphins, and in the Orinoco 4 to 7 individuals with ranges from 1-35.

During low water level, dolphins spent most of their time in the main river and in the confluence of tributaries, and when the water rose, they moved into the lakes, small tributaries and the flooded forest searching for prey. Sixty-six percent of feeding behaviour occurred in the lakes and confluences; 69% of travelling was in the main river; 80% of mating occurred in low waters close to sandbanks in the main rivers in both study areas; and 56% of parental care occurred in special nursery areas in lakes in the Amazon river, while in the Orinoco, parental care was most frequent in the main river.

Some residence patterns were observed in lakes and in some stretches of rivers in the study areas. Dolphins were seen in all months of the year but there were consistent seasonal fluctuations in the number, behaviour, and habitat use. Differences in habitat use occurred between dolphins in the Orinoco and the Amazon. This may be due to different environments, human pressures, and possibly to the presence of the tucuxi,*Sotalia fluviatilis*, in the Amazon, and the sympatry between these two species.

SEASONAL SITE FIDELITY OF LONG-FINNED PILOT WHALES (*GLOBICEPHALA MELAS*) IN THE PERTUIS CHARENTAIS (FRANCE, BAY OF BISCAY)

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INTRODUCTION Long-finned pilot whales (*Globicephala melas*) are relatively common in the North Atlantic, with a largely pelagic distribution. There is little direct information on migration. There is no evidence for north-south long-distance migrations, but seasonal movements from offshore to coastal waters have been observed during summer and autumn (IWC, 1990; Bloch *et al.*, 1989).

The present study analyses the occasional sightings and the results of dedicated cruises carried out in the coastal waters of the Pertuis Charentais.

MATERIALS AND METHODS The Pertuis Charentais are three connected sheltered areas in the Bay of Biscay in the middle of the French Atlantic coast. They are bordered by the continental coast and the Islands of Ré and Oléron (Fig.1). They are generally shallow waters with a maximum depth of 58 m.

Incidental sightings of long-finned pilot whales have been recorded in the Pertuis Charentais since 1974. Since 1996, a campaign to encourage yachtsmen and fishermen to report cetacean sightings has increased the amount of information collected.

In addition, a monitoring programme began in July 1997, comprising both dedicated cruises and photo-ID studies. Each time that opportunistic sightings of pilot whales are made, observers are able to report their position to us by VHF radio. We are based in La Rochelle (located in the middle of the studied area) and can then immediately go to the sighting using our rubber inflatable (4.5 m. long with a 30CV engine). We try to confirm species identity and school size, and obtain suitable photographs for individual identification. Dorsal fin shape and notches were used for photo-identification.

RESULTS Between 1974 and 1998, 145 incidental sightings have been recorded. Sightings occurred between May and September, with a maximum of 77 records (55.4%) in July (Fig.2). Since 1996, pilot whales have been seen on 30 different days, including 18 in July (60.0%).

Three dedicated surveys have been carried out in August 1997 and July 1998. A total of 19 hrs was spent with pilot whales. On each occasion, the estimated number of individuals was over 80, spread out in sub-groups of 6-25 whales. The sub-groups were swimming in the same direction a few hundred metres apart, along a line 1.5-2.0 nm wide. The general movements observed were into or off the Pertuis, mainly against the ebb tide.

During these cruises, foraging behaviour has been observed on several occasions. A comparison of whale positions (recorded by GPS) with accurate depth (allowing for tides and coefficients), revealed that the animals were foraging over depths of 44 m. to less than 10 m.

From 290 photographs, a photo-identification catalogue of two juveniles and 16 adults has been established. Four adults were present in the study area on two consecutive days, and four others have been seen both in August 1997 and July 1998.

DISCUSSION Results form both incidental sightings and dedicated cruises suggest possible site fidelity of long-finned pilot whales in the Pertuis Charentais. However, the whale distribution will be biased to some extent by the observer distribution. Nevertheless, the photo-identification cruises indicate that some individuals, at least, may be present on several consecutive days (daily site fidelity) and/or on two consecutive years during the same season (seasonal site fidelity - Shane & McSweeney, 1990).

In the Bay of Biscay, Desportes (1985) showed that long-finned pilot whales feed on squid and bony fish (frequency of 70% and 30% respectively in stomach contents). According to the French fishery office, the main marine species taken in the study area during July 1998 when many whales were sighted, was the cuttlefish, *Sepia officinalis*. Other pilot whale prey (Desportes, 1985) known to occur in the Pertuis include species from the families Merluccidae and Percichtydae. Squid (*Loligo* sp.) are not a target of the local fisheries, and so their status in the study area remains unknown. The foraging behaviour observed, and the seasonal occurrence of potential prey suggest that pilot whales may be attracted each summer in the Pertuis Charentais for feeding. To our knowledge, this is the first time that long-finned pilot whales have been reported foraging in waters less than 10 m. deep.

CONCLUSIONS This preliminary study suggests some seasonal site fidelity of long-finned pilot whales in the Pertuis Charentais. Their behaviour, as well as the occurrence of potential prey, indicates that the whales may be able to forage in very shallow waters.

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REFERENCES

Bloch, D., Gunnalaugsson, T., Hoydal, K. and Sigurjónsson, J. 1989. Distribution and abundance of pilot whales (*Globicephala melas*) in the Northeast Atlantic in June-August 1987 based on shipboard sighting surveys. *Paper SC/41/SM10* presented to the IWC Scientific Committee, May 1989 (unpublished). 16pp.

Desportes, G. 1985. *La nutrition des Odontocètes en Atlantique Nord-Est (côtes françaises et îles Féroé).* Thèse de Doctorat d'Université, Université de Poitiers. 190pp.

International Whaling Commission. 1990. Report of the sub-committee on small cetaceans. *Rep. int. Whal. Commn*, 40: 144-157.

Shane, S. H. and McSweeney, D. 1990. Using photo-identification to study pilot whale social organisation. *Rep. Int. Whal. Commn*, (special issue 12): 259-263.

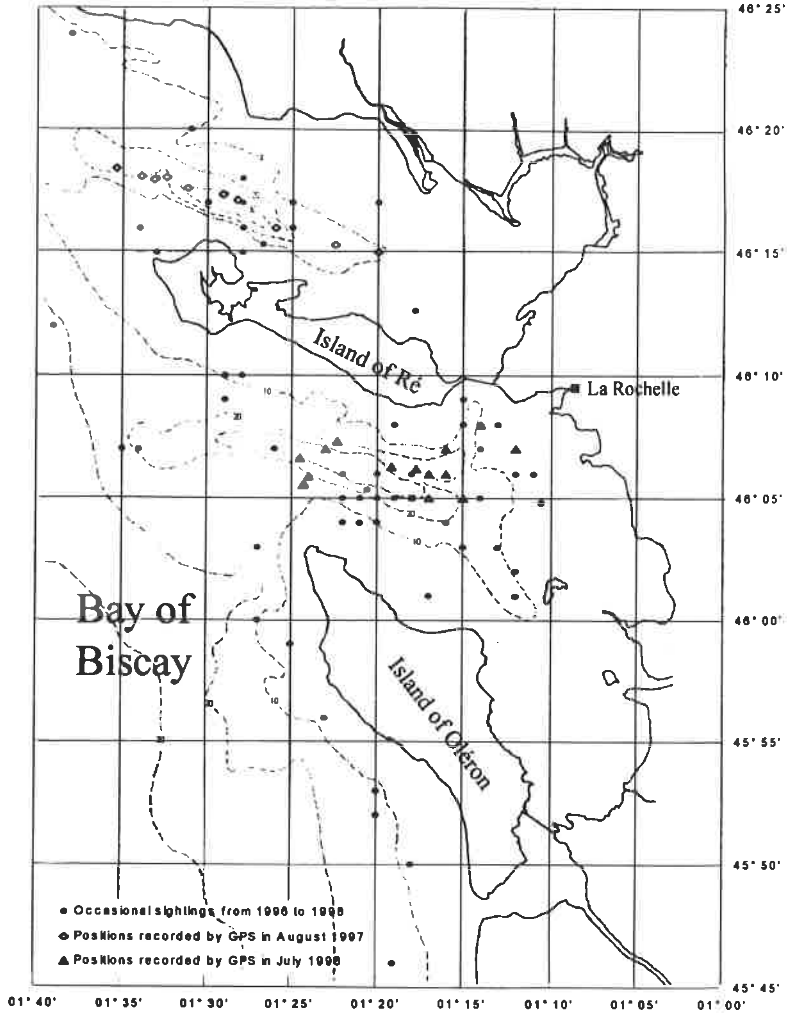

Fig. 1 - Map of the Pertuis Charentais showing the location of long-finned pilot whale sightings with o for incidental sightings from 1996 to 1998; * for sightings from dedicated surveys in August 1997; and ^ for sightings from dedicated surveys in July 1998.

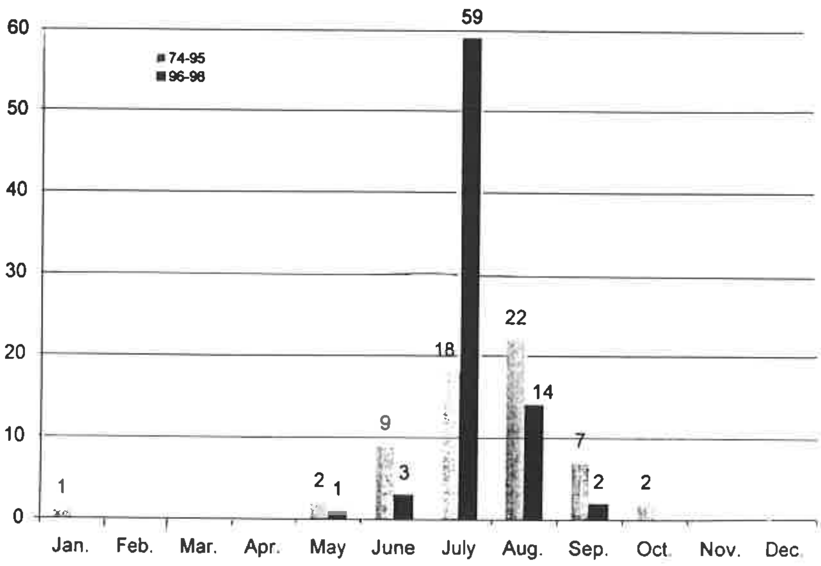

Fig. 2 - Monthly distribution of incidental sightings of long-finned pilot whales in the Pertuis Charentais from 1974 to 1995 (clear bars) and from 1996 to 1998 (dark bars)

DISPERSAL OF RESCUED JUVENILE GREY SEALS

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Grey seals, *Halichoerus grypus*, are at the southern limit of their breeding range in Brittany, France, where resident populations are estimated at only 100-150 individuals. Births occur annually in very low numbers (0-10). During the last decade, an average of 15 young grey seals were found dead stranded each year, together with 12 others found alive and brought to OCEANOPOLIS rescue centre. From 1989 onwards, 120 such individuals were admitted, of which 85 were rescued and released at sea. The fate of these animals is therefore a key issue in evaluating the role of a rescue centre in a conservation strategy for the grey seal in France.

Different techniques were successively used to obtain some information about the survival, dispersal and activities of these seals. 85 flipper tags, 40 colour head markings, 14 numbered «hats» and 4 satellite tags were deployed. Flipper tags mostly produced records from seals later found dead, whereas head markings and hats allowed repetitive information of animals sighted from the coasts, and satellite tags provided continuous tracks of the animals. The data obtained are presented and discussed in two respects: the fate of individuals and the local impact on wild populations.

Sightings of the animals and the tracks determined by Argos locations were recorded mostly along the coasts of France, but some also reached the south-west coast of England and east coast of Ireland. The data show that these young seals can travel extensively out of the area from where they originally stranded and were released. The impact of the rescue centre on wild populations must therefore be estimated at a broader scale.

GLOBAL CLIMATE CHANGE AND MARINE MAMMALS

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There is substantial credible evidence that we are presently experiencing a global changing of the climate (Moore *et al.*, 1996, ATOC, 1998). This is caused in at least some part by human-controlled emissions of substances that deplete the ozone layer (Ashmore and Bell, 1991; UNEP, 1987, 1993), increasing worldwide use of hydrocarbons for energy and fuel (Flavin, 1992; Wellburn, 1994), and large-scale deforestation and desertification (Barbier *et al.*, 1994). Predictions for the world's oceans range from little or no change to partial melting of Arctic and Antarctic loose ice and shelves, with concomitant rises of sea levels. While many "alarmist" scenarios have been proposed, it is generally accepted that in the next 100 years, temperature will rise by about 1.0 to 3.5°C, and overall sea level will rise by anywhere from 15 to 95 cm (summarised in IWC, 1997). Because of the overall global change, there are likely to be more local fluctuations in rain showers and violent storms, abrupt cold and dry spells, and other mesoscale changes. Hurricanes (and monsoons) are known to reproduce best at water temperatures at and above 27°C, and even seasonal changes in climate (for example, El Niño Southern Oscillation events, ENSO's) can affect the incidence and ferocity of such storms. This general scenario could be improved if present lowering of ozone depleting emissions continues, or if energy substitutes to fossil fuels are further refined and more fully developed (Moore *et al.*, 1996).

Global climate change should not be thought of as an inevitable "doom and gloom" situation for terrestrial and aquatic biodiversity, but a reasonable cautionary approach to making predictions is, we feel, of value. The precautionary principle also has been invoked for considerations of effects on marine mammals, by participants of a 1996 Workshop on Climate Change and Cetaceans, held in Hawaii by the International Whaling Commission (IWC, 1997). We will address several of their strongest recommendations after brief consideration of some of the complicated matrices of potential effects caused by predicted global warming.

Potential impacts of climate change are heavily reliant on questions of time and geographic scales of the environment, as well as on the longevity, reproductive generations, and physical ranges of the animals in question. "Slow" (in the order of decades or centuries), at times large, shifts in climate have occurred throughout Earth's history, and we suspect that these changes have helped to prompt evolution of adaptive characteristics, clinal variations, population discreteness, as well as, of course, extinctions. A recent laudable analysis of bowhead whale (*Balaena mysticetus*) bony remains demonstrates that these pagophylic ("ice-loving") whales have changed their eastern Arctic habitat use patterns drastically and that at numerous times in the past 20,000 or so years, most likely due to changes in seasonal as well as year-round ice cover and concomitant changes in currents and productivity (Dyke *et al.*, 1996). These climate changes, that were responsible for major ice ages and even far-south glaciations in the northern hemisphere, shifted bowhead whale habitat but did not cause them to go extinct. We suspect that human-caused climate change would create similar shifts for those animals mobile enough to adapt rapidly; but we worry about effects of rapid changes for those not able to move as well, such as some land-breeding pinnipeds or coastal cetaceans and sirenians.

Tynan and DeMaster (1997) present a cogent analysis of the effects of Arctic climate change on carnivores and cetaceans that feed in the marine environment, including the polar bear. They predict, with caution, that the Arctic sympagic ("ice-living") amphipods, copepods, and Arctic cod (*Boreogadus saida*), major parts of the Arctic food web, will undergo highly variable distributions and biomass in different areas. Some areas will become wetter, thereby increasing local snow cover, ice from snow, and melt waters that lower ocean salinities in spring and summer. Other areas will be drier, and so forth. Pinnipeds that need ice to breed and rest, are likely to be affected particularly strongly, but the more mobile bowhead whales, white whales (*Delphinapterus leucas*), and narwhals (*Monodon monocerus*) also may be strongly affected due to shifts in primary to consumer prey productivities. One important possibility is that more freshwater from melting snow-formed ice will be released into the North Atlantic, through the Fram Straight between North-east Greenland and Svalbard. This could strongly affect salinities of the North Atlantic, shift the surface-moving Gulf Stream, and even affect upwelling related to the Great Ocean Conveyor Belt current system (Tynan and DeMaster, 1997). A possibly more limited effect of Arctic warming is the likely seasonal opening of the Northwest Passage between the Canadian and U.S. Arctic, and with it, increased tanker and other traffic increasing oil, other toxins, and sound pollution in this presently "pristine" area.

Considerations of potential effects are incomplete because of presently unknown levels of future climate change, and incomplete knowledge of how climate change will affect weather, ocean circulation, and biological productivity. Predictions of effects for species and populations are therefore likely fraught with difficulty. Nevertheless, we are foolish enough to present several broad scenarios, to alert us to at least some potential problems in enough time to lead to research and possible management (and political lobbying) action.

Randall Reeves presented what we believe is a heuristically valuable model for describing potential effects (Reeves, 1990). According to him, primary effects would be those that debilitate or cause death at the individual level. For example, the water is too warm and an individual Galapagos fur seal (*Arctocephalus galapagoensis*) fails to reproduce or dies. Secondary effects would be those of pervasive enough or ecologically-encompassing nature to affect a substantial part or all of a community. For example, it is too warm, and mullets (*Mugil* sp.) die, perhaps causing higher mortality, calf mortality, and immune dysfunction that leads to inshore bottlenose dolphin (*Tursiops truncatus*) population decline. Tertiary effects also can be thought of as occurring at the community level, but that contain a feed-back loop generally involving the original initiator of the problem (humans, in the scenario of anthropogenically-caused global warming). For example, it is too warm and fish die. These fish were part of human prey that has now become scarce or not available. Humans therefore may target dusky dolphins (*Lagenorhynchus obscurus*) as an *Ersatz* fishery, for bait to enhance fishing, as direct food, or because of perceived or real competition for scarce marine resources. Many other potential tertiary effect scenarios could be considered, but in general we lack enough detail even for primary and secondary effects to predict these more complicated "chain reactions". However, it is easy to see how the primary, secondary, and tertiary effects are inter-related, and in practice difficult to separate except as a modelling tool for more efficient understanding and potential prediction.

Reeves (1990) outlines several potential effects for the broad categories of manatees and dugongs (sirenians); whales, dolphins, and porpoises (cetaceans); and pinnipeds, sea and marine otters, and the polar bear, *Ursus maritimus* (carnivores). Due to global warming, rise in sea levels, potential increase in numbers and intensities of storms, and changes in circulation and productivities, at the primary level: the tropical sirenians are likely to encounter overall fewer deaths due to seasonal thermal stress, but more periodic deaths due to local cold snaps and storms, and due to increased toxic waterblooms, such as "red tide" (for example, *Ptychodiscus brevis*). Cetaceans are likely to be even less affected at the primary level, except for the increase in toxic waterblooms. However, those cetaceans with very limited distributions or in "pockets" of water surrounded by land (such as the vaquita, *Phocoena sinus*, of the northern Gulf of California), may be impacted directly by warmer water. Carnivores will probably be most vulnerable, with increased deaths of pups on unstable ice, increased pup (and possibly adult) mortality on ice and land birthing and mating sites, and increased deaths due to outbreak of epizootics, such as morbillivirus, implicated in the recent massive deaths of Mediterranean monk seals (*Monachus monachus*, Gazo *et al.*, 1999).

At the secondary level, all primary effects can, of course, act on the entire community, population, or species. Beyond that, we concur with Reeves (1990) in predicting potential problems to sirenians because of loss of freshwater habitat, and potential loss of habitat to cetaceans who live in shallow waters (such as, again, the vaquita) or who feed on the sea bottom, such as the gray whale (*Eschrichtius robustus*). Reeves forecasts secondary-level problems for the already-beleaguered river dolphins, especially the two susu species of the Indian subcontinent, and the baiji of China. We suspect that river dolphins will continue to decline, mainly due to effects of increased damming, flood controls, and wholesale habitat changes in the name of human progress, and potentially in the face of increased human poverty due at least in part to climate change. Carnivores will be affected at the secondary level by an increased loss of sea ice and some land mating and haul-out areas. For example, it is difficult to imagine where tens of thousands of walrus (*Odobenus rosmarus*) will rest when steep mountainous islands lose beaches due to rapidly rising seawater. These beaches may take tens of years to centuries to be formed, with rising waters outstripping their re-generation capability.

At the tertiary level, predictions become more tenuous. Sirenians and river dolphins may become even more isolated due to flood construction problems; more recreation-caused boat collisions due to longer summers in some areas such as Florida for manatees (*Trichechus manatus*), or northern Australia for dugongs (*Dugong dugon*); more hunting pressures due to general increase of poverty in Africa (*T. senegalensis*) and the Amazon basin (*T. inunguis*). Overall, a potentially increasing level of climate-induced human poverty could well lead to a decrease in interest in conservation, park designations, and management, thereby indirectly affecting especially coastal and riverine ecosystems and their marine mammal inhabitants.

Most discussions of effects on animals have not been for the marine environment, but we might draw lessons from studies of reproductive failure of marine birds and pinnipeds subjected to ENSO events. During recent El Niños, there has been reproductive failure (and especially deaths of juveniles) in many colonies of seabirds (Guinet *et al.*, 1998) and some colonies of fur seals (Guinet *et al.*, 1994). For example, during the major El Niño year of 1982, all Galapagos fur seal (*Arctocephalus galapagoensis*) females lost their pups. It was hypothesised that this occurred because of shifts in prey distribution, as at least some lethal and sub-lethal effects were brought on by starvation (Trillmich and Dellinger, 1991). Of course, a slower prolonged ocean warming than presented by the "natural" occurrence of El Niños may create shifts in habitat use that simply alter the site fidelity patterns of some marine mammals. However, we believe that land-living pinnipeds are particularly vulnerable to such changes due to their need to haul out at mating, pupping, resting, and, often, moulting times. Sirenians that rely on more restricted near-shore habitat may also be affected by changes in physical habitat involving their sea grass diet. However, all but the least mobile of cetaceans may be less affected by "long-term" El Niño events. Several examples of odontocete distributional shifts have been described: During the 1982-83 El Niño, near-bottom spawning market squid (*Loligo opalescens*) left the southern California area, and so did the short-finned pilot whales (*Globicephala macrorhynchus*) that normally fed on them.(Shane, 1994). It is unknown whether this apparently climate-induced shift resulted in whale mortalities due to fewer energetically-valuable prey. Interestingly, the absence of pilot whales was followed several years later by an influx of Risso's dolphins (*Grampus griseus*), also feeding on (the returned) market squid. Risso's dolphins may have taken advantage of a temporarily-vacant niche left by the pilot whales, and there was a shift in cetacean species composition, apparently as a result of the El Niño warming episode (Shane, 1995). During that same El Niño event, nearshore bottlenose dolphins expanded their range from southern to central California, and stayed in the new northern range after the warming event subsided in the mid-1980's (Wells *et al.*, 1990). They are still there. Sperm whales (*Physeter macrocephalus*) of the eastern tropical Pacific had reduced fecundity or calf survival during and after an El Niño event of the late 1980's

(Whitehead, 1997). We can surmise but do not know that overall climate change can create similar potentially far-reaching effects.

The need for better information leads us to wonder how to obtain it. Efforts at gathering enough data for large scale and mesoscale predictions need to be made at both the climate and the ecosystem/marine mammal level (Fig. 1). Certainly, better information on habitat use and needs can be obtained for almost all species. Even where species are relatively well-known, such as bottlenose dolphins, there are many populations for whom we know virtually nothing. Ocean current models that have climate prediction capabilities are constantly being refined (ATOC, 1998), and there are relatively recent attempts at multi-level global integrated assessment models, such as TARGETS (Tool to Assess Regional and Global Environmental and Health Targets for Sustainability - Rotmans and DeVries, 1997). For marine mammalogists, the best advice may be to do as good environmentally-oriented science as possible; and whenever possible, integrate knowledge of the animals with knowledge of the ecosystem at multiple levels. This translates to more than the usually-practised collaboration, with (for example) behavioural ecologists, physiological ecologists, physical oceanographers, biological oceanographers, and toxicologists working together to integrate results not merely in the discussion of a final paper, but proceeding from the early design phase of an ecology-based research project. The recently finished GulfCet (Cetaceans of the Gulf of Mexico) project that links cetacean distribution with moving oceanic cyclonic and anticyclonic current systems may be one good model for integration (Davis *et al.*, 1998, 1999), and we predict many more for the future.

REFERENCES

Ashmore, M. R. and Bell, J. N. B. 1991. The role of ozone in climate change. *Annals of Botany*, 67: 39-48.

ATOC. 1998. Ocean climate change: comparison of acoustic tomography, satellite altimetry, and modeling. *Science*, 281: 1327-1322.

Barbier, E. B., Burgess, J. C. and Folke, C. 1994. *Paradise lost: the ecological economics of biodiversity.* Earthscan Press, London.

Davis, R. W., Fargion, G. S., May, N., Leming, T. D., Baumgartner, M., Evans, W. E., Hansen, L. J. and Mullin, K. 1998. Physical habitat of cetaceans along the continental slope in the North-Central and Western Gulf of Mexico. *Marine Mammal Science*, 14: 490-507.

Davis, R.W., Evans, W. E. and Würsig, B. 1999. *Distribution and abundance of cetaceans in the northern Gulf of Mexico.* Volume II: Technical Report. Minerals Management Service and U.S. Geological Service. Available from Gulf of Mexico OCS Region, MMS, 1201 Elmwood Park Blvd., New Orleans, LA 70123, U.S.A. 319pp.

Dyke, A. S., Hooper, J. and Savelle, J. M. 1996. A history of sea ice in the Canadian Arctic archipelago based on postglacial remains of the bowhead whale (*Balaena mysticetus*). *Arctic*, 235-255.

Flavin, C. 1992. Natural gas production climbs. In: *Vital signs.* (Eds. L.R. Brown, C. Flavin, and H. Kane). Earthscan Press, London.

Gazo, M., Forcada, J., Pastor, T., Cantos, G., Gram, E. and Aguilar, A. 1999. Status and reproductive output of the Mediterranean monk seal population of Cap Blanc (Western Sahara) which survived the 1997 die-off. (This volume)

Guinet, C., Chastel, O., Koudil, M., Durbec, J. P.and Jouventin, P. 1998. Effects of warm sea-surface temperature anomalies on the blue petrel at the Kerguelen Islands. *Proceedings of the Royal Society of London* - Series B: Biological Sciences, 265: 1001-1006.

Guinet C., Jouventin, P. and Georges, J-Y. 1994. Long term population changes of fur seals *Arctocephalus gazella* and *Arctocephalus tropicalis* on subantarctic (Crozet) and subtropical (St. Paul and Amsterdam) islands and their possible relationship to El Niño Southern Oscillation. *Antarctic Science*, 6: 473-478.

International Whaling Commission. 1997. Report of the IWC workshop on climate change and cetaceans. *Rep. Int. Whal. Comm*, 47: 293-313.

Moore, P. D., Chaloner, B. and Stott, P. 1996. *Global environmental change.* Blackwell Scientific Press, Oxford.

Reeves, R. R. 1990. Speculations on the impact of global warming on aquatic mammals. *Proceedings of the American Cetacean Society, Monterey, CA, November 9-11, 1990.* Published by ACS, P.O. Box 2639, San Pedro, CA 90731.

Rotmans, T. and de Vries, B. 1997. *Perspectives on Global change: The targets approach.* Cambridge University Press, Cambridge.

Shane, S. H. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. *Bulletin Southern California Academy of Sciences*, 93: 13-29.

Shane, S. H. 1995. Relationship between pilot whales and Risso's dolphins at Santa Catalina Island, California, USA. *Marine Ecology Progress Series*, 123: 5-11.

Trillmich, F. and Dellinger, T. 1991. The effect of El Niño on Galapagos pinnipeds. Pp. 66-74. In: *Pinnipeds and El Niño: Responses to environmental stress.* (Eds. F. Trillmich and K. A. Ono). Springer Verlag, Berlin.

Tynan, C. T. and Demaster, D. P. 1997. Observations and predictions of Arctic climatic change: Potential effects on marine mammals. *Arctic*, 50: 308-322.

UNEP. 1987. The ozone layer. UNEP/GEMS *Environmental Library* 2: 1-36.

UNEP. 1993. *Environmental data report 1993-94.* Blackwell Press, Oxford.

Wellburn, A. 1994. *Air pollution and climate change: the biological impact.* Longman Press, New York. 2nd Ed.

Wells, R. S., Hansen, L. J., Baldridge, A., Dohl, T. P., Kelly, D. L. and Defran, R. H. 1990. Northward extension of the range of bottlenose dolphins along the California coast. Pp. 421-431. In: *The bottlenose dolphin* (Eds, S. Leatherwood and R.R. Reeves). Academic Press, San Diego, CA.

Whitehead, H. 1997. Sea surface treatment and the abundance of sperm whale calves off the Galapagos Islands: Implications for the effects of global warming. *Report of the International Whaling Commission*, 47: 941-944.

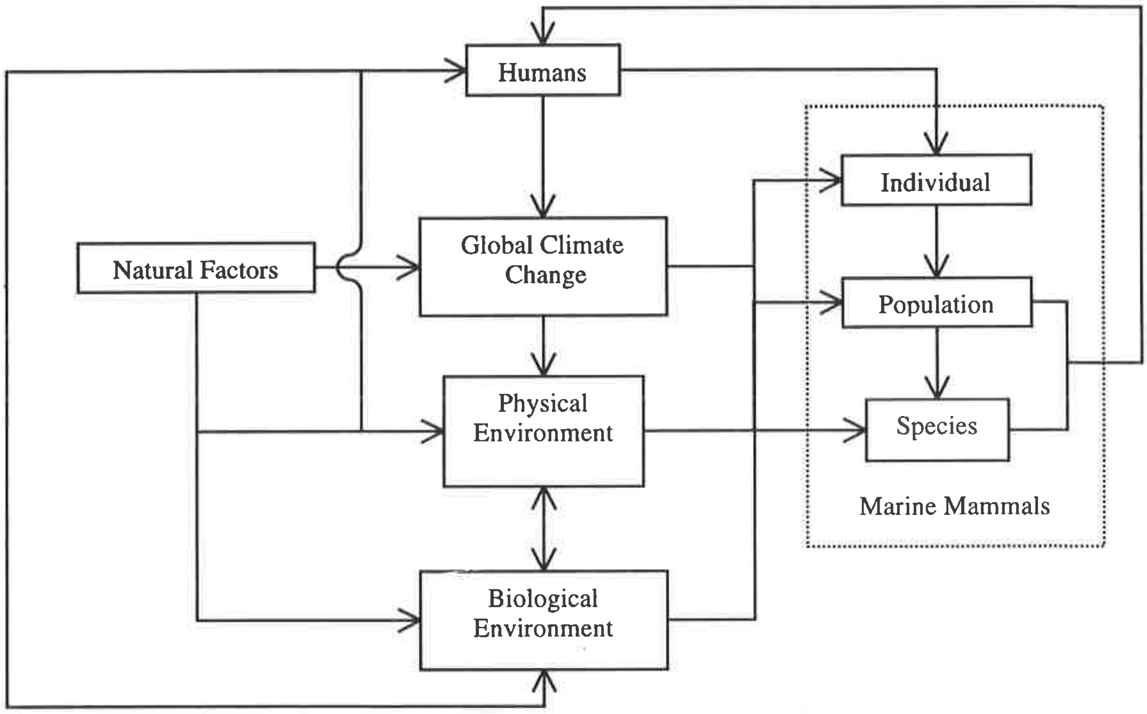

Fig. 1 - A flow diagram of the major relationships of humans, climate change, the affected environment, and marine mammals. Note that climate change is also affected by non-human ("natural") factors, and that climate change impacts on the environment are likely to feed back to humans as well. Likewise, effects on marine mammals at especially population and species levels are likely to impact humans. For example, if human-caused climate change affects the distribution of humpback and right whales feeding off Cape Cod in the U.S., a major tourism industry would decline as a result

GENETICS & EVOLUTION

PRELIMINARY RESULTS OF GENETIC ANALYSIS OF MEDITERRANEAN COMMON DOLPHINS (*DELPHINUS DELPHIS*)

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INTRODUCTION Over the last decades, the decline of the short beaked common dolphin (*Delphinus delphis*) in the Mediterranean Sea has become an increasingly preoccupying issue for scientists and conservationists (Pelegrí, 1980; Viale, 1980; Evans, 1987; Laurent, 1991; Aguilar, 1991; Viale, 1993; Notarbartolo di Sciara, 1993; Gannier, 1995). At present, the distribution of the common dolphin in the Western Mediterranean basin can be considered to have a northern limit close to latitude 38° North (Duguy *et al.*, 1983; Evans, 1987). The species is, however, still very frequently observed in waters of the Alboran Sea (Laurent, 1991; Sagarminaga and Cañadas, 1995; Forcada and Hammond, 1998). Moving north and east from here, it becomes rarer. In the northern part of the basin the species is at present only sporadically observed (Fabri and Lauriano, 1992; Notarbartolo *et al.*, 1993, Pulcini *et al.*, 1993, Gannier, 1995). In the Greek Ionian waters, there is still a small population of this species (Politi *et al.*, 1992). Logistical difficulties are responsible for the lack of information from the southern coasts of the Mediterranean basins which nevertheless are expected to be important to cetaceans.

Over recent years, molecular analysis has incorporated a new tool in phylogenetic studies. Comparative analysis with microsatellites and mitochondrial sequences has allowed evolutionary inter- and intra-specific relations to be established in greater detail. In this sense, a molecular genetic research program was initiated in 1998 on common dolphins, with the following aims: a) to establish the degree of genetic variability existing between individuals from the Alboran Sea, b) to define the population identity of the Mediterranean common dolphin through the analysis of the relationships between the population of the Alboran Sea and that of Greek waters, c) to determine if there is any gene flow between the Mediterranean (or Alboran Sea) population and the Atlantic one through the Straits of Gibraltar, and if so, to what extent, and d) to determine genetic distances between the Alboran Sea population and those from other geographic regions (i.e. N.E. Atlantic, Pacific, Black Sea).

In order to apply strategies for the conservation of the threatened Mediterranean common dolphin, it is important to study the extent, if any, of genetic isolation of this population. Studying the genetic proximity of different common dolphin populations can reveal important information necessary for determining gene flow between populations. This is a vital part of the research for understanding more of the past situation of the common dolphin populations, and addressing conservation problems.

In this paper, we analyse the preliminary results obtained for the first and the fourth objectives mentioned above, comparing the mtDNA control region of the Alboran Sea samples with those published from the N.E. Pacific and the Black Sea (Rosel *et al*, 1994)

METHODS Genetic analysis of microsatellites and mtDNA were carried out at the Laboratory of Human Molecular Genetics of the Universidad Autónoma de Madrid. The samples were taken from freshly dead stranded animals of the Alboran Sea during 1997 and 1998. Samples were stored in DMSO and frozen at -20° C. DNA was extracted with phenol-chlorophorm-isoamyl (25:24:1) and chlorophorm-isoamyl (24:1) extractions, followed by 0.5M NaCl-Ethanol 100% precipitation.

Amplification reactions contained approximately 100 ng DNA, 10 mM Tris (pH8.4), 50 mM KCl, 1.5 mM MgCl2, 1 unit of Taq polymerase (Ecogen), and 0,2 μM of each primers. The primers of the mitochondrial control region were amplified with the primers 5'-ACACCAGTCTTGTAAACC-3' and 5'-TACCAAATGTATGAAACCTCAG-3' (Rosel *et al.*,1994). Microsatellite EV37, simple sequence (AC)24 primers: 5'-AGCTTGATTTGGAAGTCATGA-3' and 5'-TAGTAGAGCCGTGATAAAGTGC-3'. Microsatellite EV94 simple sequence (TC)6[...](AC)20 primers: 5'-ATCGTATTGGTCCTTTTCTGC3' and 5'-AATAGATAGTGATGATGATTCACACC-3'. Microsatellite EV14 simple sequence (GT)11 primers: 5'-TAAACATCAAAGCAGACCCC-3' and 5'-CCAGAGCCAAGGTCAAGAG-3' (Valsecchi and Amos, 1996).

The thermocycle profile consisted of 1.5 min. at 94° C, 2 min. at 48° C, and 2 min. at 72° C for 35 cycles to the control region test and 1 min. at 94° C, 1 min. at 55° C, and 1 min. at 72° C for 35 cycles to the microsatellites. Microsatellites PCR products were separated in 6% denaturing acrylamide- 7M urea - 0,5x TBE buffered gels. After electrophoresis, DNA fragments were stained by silver staining. DNA sequence to the control region was carried out with a 373 DNA Automatic Sequencer (Applied BioSystems, Perkin Elmer). The resultant sequence were aligned by the ClustalW programme comparing the mtDNA control region of the Alboran Sea samples with those published from the ET Pacific and the Black Sea, and the region control sequences were analysed using the DNA maximum likelihood programme in the phylogenetic Inference Package (PHYLIP, version 3.4) (Rosel *et al.*, 1994).

RESULTS AND DISCUSSION We have analysed the phylogenetic relationship between Mediterranean common dolphins and those published from the N.E. Pacific and the Black Sea (Rosel *et al.*, 1994), comparing the mtDNA control region. Although all analysed specimens are short beaked common dolphins, the phylogenetic study using the mitochondrial control region showed differences between individuals from California coast, eastern tropical Pacific, Black Sea and Alboran Sea (Mediterranean Sea). The differences in geographical position corresponded with the variation at genomic level. The mtDNA control region sequences of Alboran Sea dolphins were aligned with the same sequences of Black Sea, Californian coast, and eastern tropical Pacific dolphins (Rosel *et al.*, 1994). Dolphins of the Alboran Sea showed more similarity of sequences with Black Sea dolphins than with the dolphins from the Pacific. The study of microsatellites showed polymorphic variations and allelic variants among individuals.

REFERENCES

Aguilar, A. 1991. Calving and early mortality in the western Mediterranean striped dolphin, *Stenella coeruleoalba*. *Canadian Journal of Zoology*, Vol. 69. No. 5: 1408-1412

Duguy, R., Casinos, A., Di Natale, A., Filella, S., Ktari-Chakroun, F., Lloze, R., and Marchessaux, D. 1983. Repartition et fréquence des mammiferes marins en Mediterranée. *Rapp. Comm. int. Mer Medit.*, 25, 5: 223-230.

Evans, P. G. H. 1987. *The Natural History of Whales and Dolphins*. Christopher Helm, London. 343pp.

Fabri, F. and Lauriano, G. 1992. Greenpeace report on two year research in the Ligurian Sea. Pp 69-74. In: *European Research on Cetaceans - 6*. Proc. 6th Ann. Conf. ECS, San Remo, 20-22 February, 1992 (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Forcada, J. and Hammond, P. 1998. Geographical variation in abundance of striped and common dolphins of the western Mediterranean. *Journal of Sea Research,* SEARES, 68.

Gannier, A. 1995. *Les cétacés de Méditerranée nord-occidentale: estimation de leur abondance et mise en relation de la variation saisonnière de leur distribution avec l'ecologie du milieu*. Masters Thesis. Ecole Pratique des Hautes Etudes. Montpellier, France

Laurent, L. 1991. Observations cétologiques en Méditerranée occidentale. *Vie Milieu*, 41, 4:263-269.

Notarbartolo di Sciara, G. 1993. Cetacei del Mediterraneo. *Contributi del Centro Linceo Interdisciplinare "Beniamino Segre" No. 86. XIX Seminario sulla Evoluzione Biologica e i grandi problemi della biologia*: 39-52

Pelegrí, J. 1980. Recull de la Comisó de Cetologia de la Institució Catalana d'Història Natural. II: anys 1974 i 1975. *Butll. Inst. Cat. Hist. Nat.*, 45 (Sec. Zool., 3):155-165

Pulcini, M. Angradi, A. M. and Sanna, A. 1993. Distribution and frequency of cetaceans in the Ligurian-Provençal basin and in the north Tyrrhenian sea (Mediterranean Sea). Pp. 144-147. In: *European Research on Cetaceans - 7*. Proc. 7th Ann. Conf. ECS, Inverness, Scotland. 18-21 February 1993. (Ed. P. G. H. Evans). European Cetacean Society, Cambridge, England. 306pp.

Rosel, P. E., Dizon, A. E., and Heyning, J. E. 1994. Genetic analysis of sympatric morphotypes of common dolphins (genus *Delphinus*). *Marine Biology*, 119: 159-167.

Sagarminaga, R., and Cañadas, A. 1995. Studying a possible competition for ecological niche between the common dolphin, *Delphinus delphis*, and striped dolphin, *Stenella coeruleoalba*, along the southeastern coast of Spain. Pp. 114-117. In: *European Research on Cetaceans - 9*. Proc. 9th Ann. Conf. ECS, Lugano, Switzerland, March 1995. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Valsecchi, E., and Amos, W. 1996. Microsatellite markers for the study of cetacean populations. *Molecular Ecology*, 5: 151-156.

Viale, D. 1980. *Les modifications du peuplement de cétacés de Méditerranée occidentale*. Journées Étud. Systém. Et Biogéogr. Médit. Cagliari, C.I.E.S.M.

Viale, D. 1993. Cetaceans as indicators of a progressive degradation of Mediterranean water quality. *Pr. Malaysia*: 183-198.

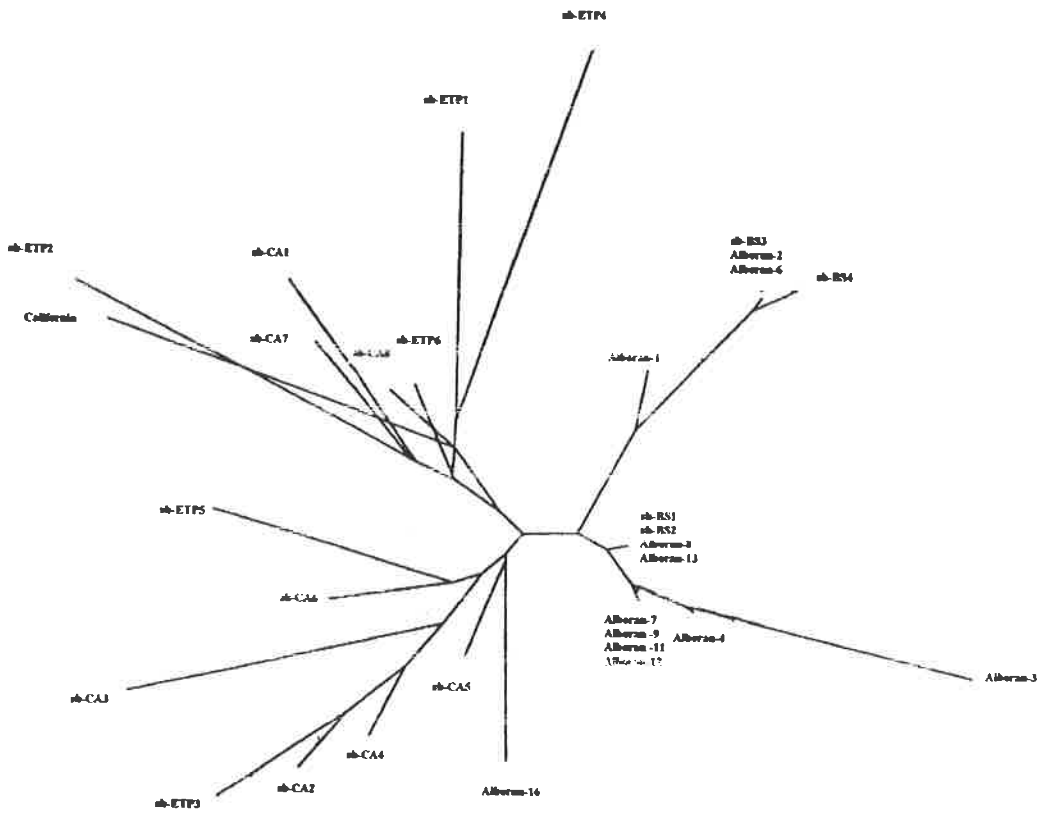

Fig. 1 - *Delphinus delphis*. Phylogenetic relationship among short beaked specimens as determined by maximum likelihood analysis of 404 pair of mtDNA control region sequence. sb: short beaked; BS: Black Sea; CA: California; California: DNA sequence under accession number UO1956 in GeneBank; ETP: Eastern Tropical Pacific

GEOGRAPHICAL VARIATIONS OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*, L.) POPULATIONS IN THE NORTH AND BALTIC SEAS USING MORPHOMETRIC COMPARISONS

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INTRODUCTION The existence of a separate population of the harbour porpoise (*Phocoena phocoena* L.) in the Baltic Sea has been the matter of scientific discussion during the last decades (Kinze, 1985, Utrecht, 1978, Yurick & Gaskin, 1987), especially following the significant decrease in the Baltic stock. Some decades ago, harbour porpoises were seen more frequently in the eastern part of the Baltic Sea (Siebert *et al.*, 1996). Baltic harbour porpoises have been found to differ in non-metrical skull characters (Kinze, 1990, Huggenberger, 1997), skull measurements (Kinze, 1985, Kinze, 1990, Börjesson & Berggren, 1997, Huggenberger, 1997), mitochondrial DNA (Wang & Berggren, 1997, Tiedemann *et al.*, 1996), enzyme analysis (Andersen, 1990) and contaminant profiles (Berggren, 1995, Bruhn, 1997).

In this study, we scored morphometric characters of harbour porpoises from different areas of German, Danish and Swedish waters to recognise different populations in the North and Baltic Seas.

MATERIALS AND METHODS In this study, we measured metric and scored non-metric characters of 242 harbour porpoise skulls from the North and the Baltic Sea area and subdivided them into the following areas.

Area 1: German Bight
Area 2: Transition area of the Baltic Sea (Skagerrak off Sweden, Kattegat, Belt Seas, Öresund and Fehmarn Belt Sea)
Area 3: Central Baltic Sea (Arkona Sea and waters off East Sweden)

The examined skulls are stored in the Museum of Natural History in Göteborg (Sweden), Swedish Museum of Natural History in Stockholm (Sweden), Zoological Museum, University of Copenhagen (Denmark), and German Oceanographic Museum in Stralsund (Germany).

Skull measurements were taken with a vernier calliper. Technical errors for the vernier calliper are shown in Table 1. These errors were determined by repeated measurements of ten specimens. Male and female harbour porpoises were evaluated separately.

All measurements are listed in Table 1. Bilateral measurements of the skulls were only done on the left side in order to avoid a bias of asymmetry. These measurements are marked with L for left side as the last letter in the abbreviation code (Table 1).

Ten non-metric characters of skulls were examined (Table 2), six bilateral (SOF, MXF, MDF, MES, PNF, AON) and four unilateral characters (FMN, DXL, PPT, BSF). The non-metric data were summarised in configurations (Kinze, 1990). The right and left side configuration of bilateral characters were considered as "code". MXF code 01, for example, is a skull with two or less on the right, and more than two Foramina maxillaria on the left side. For unilateral characters the configurations were used directly for the analyses.

Harbour porpoises from the three named groups were tested statistically. The metric data were converted into residuals with the condylobasal length (CBL), and tested with MANOVA and discriminant analysis. The non-metric data were tested by Chi^2 tests for differences of the same three areas.

RESULTS The MANOVA showed significant differences between sexes and all three areas. Female harbour porpoises had an F-value of 0.375 with a significance of 0.0, while males had a value of 0.565 and the significance was 0.022. More detailed information is shown in Tables 3 and 4.

The discriminant analysis showed also significant differences between sexes as well as the three areas. Female porpoises had a canonical discriminant coefficient of 0.67 with a significance of 0.0, while males had a coefficient of 0.51 and a significance of 0.049. 73.3 percent of "grouped" cases were correctly classified for female harbour porpoises, and 61.1 percent for the male animals.

Summary of relevant values of the discriminant analysis:

Canonical Discriminant Coefficients of female harbour porpoises for function 1: 0.67 and for function 2: 0.59.
Wilks' Lambda after Function 0: 0.362; df=40; p=0.0
Wilks' Lambda after Function 1: 0.657; df=19; p=0.007
Percent of "grouped" cases correctly classified: 73.28%

Canonical Discriminant Coefficients of male harbour porpoises for function 1: 0.513 and for function 2: 0.444.
Wilks' Lambda after Function 0: 0.592; df=40; p=0.049
Wilks' Lambda after Function 1: 0.803; df=19; p=0.219
Percent of "grouped" cases correctly classified: 61.11%

The Chi^2 tests of the non-metric data revealed also significant differences for at least one non-metric character between sexes and the three areas. Table 5 summarises the significant results.

DISCUSSION The statistical analysis (MANOVA, Discriminant Analysis and Chi^2 tests) comparing the morphometric skull characters showed significant differences between the porpoises of all three areas (see statistical results).

The results of this study support the existence of populations in the Baltic significantly different from the North Sea. Furthermore, we found differences between the animals from the transition area of the Baltic Sea and the central Baltic indicating the existence of two separate populations: one in the transition area and another in the Baltic proper. The threshold of Darss and the Öresund may form a barrier between the two Baltic populations.

Statistical results for a separation into discrete populations were more powerful in females than in males, which could be due to migrations between areas in the latter. However, the data do not show any support for seasonal migrations, as discussed by some authors (Kinze, 1990; Schulze, 1996).

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REFERENCES

Andersen, L. W. 1990. The population structure of *Phocoena phocoena* in Danish waters. Paper SC/42/SM50, *IWC Scientific Committee*. 25pp.

Berggren, P. 1995. *Stocks, status and survival of Harbour Porpoises (Phocoena phocoena) in Swedish waters.* Stockholm University Press.

Börjesson, P. and Berggren, P. 1997. Morphometric comparisons of skulls of harbour porpoises (*Phocoena phocoena*) from the Baltic, Kattegat and Skagerrak seas. *Can. J. Zool.*, 75: 280-287.

Bruhn, R. 1997. *Chlorierte Schadstoffe in Schweinswalen (Phocoena phocoena).* Ph.D. Thesis, Christian-AlbrechtsUniversität, Kiel.

Huggenberger, S. 1997. *Schweinswale (Phocoena phocoena L.) der Nord- und Ostsee.* Masters Thesis, Albertus Magnus Universität, Köln.

Kinze, C. C. 1985. Intraspecific variation in Baltic and North Sea Harbour Porpoises (*Phocoena phocoena* (L., 1758)). *Vidensk. Meddr. dansk. naturh. Foren.*, 146: 63-74.

Kinze, C. C. 1990. *The Harbour Porpoise (Phocoena phocoena (L.): Stock identification and migration patterns in Danish and adjacent waters.* University of Copenhagen: PhD. Thesis.

Schulze, G. 1996. *Die Schweinswale. Spectrum Akad. Verl.*. Heidelberg. 191pp.

Siebert, U., Benke, H., Schulze, G. and Sonntag, R.P. 1996. Über den Zustand der Kleinwale. Pp. 242-248. In: *Warnsignale aus der Ostsee.* (Eds. J. L. Lozan, R. Lampe, W. Matthäus, E. Rachor, H. Rumor, and H. von Westernhagen). Blackwell Wissenschaftsverlag, Berlin.

Tiedemann, R., Harder, J., Gmeiner, C. and Haase, E. 1996. Mitochondrial DNA sequence patterns of harbour porpoises (*Phocoena phocoena*) from the North and the Baltic Sea. *Z. Säugetierkunde*, 61: 104-111.

Utrecht, W. L. 1978. Age and growth in *Phocoena phocoena* Linnaeus, 1758 (Cetacea, Odontoceti) from the North Sea. *Bijdragen tot de Dierkunde*, 48,1: 16-28.

Wang, J. Y. and Berggren, P. 1997. Mitochondrial DNA analysis of harbour porpoises (*Phocoena phocoena*) in the Baltic Sea, the Kattegat-Skagerrak Seas and of the west coast of Norway. *Marine Biology*, 127: 531-537.

Yurick, D. B. and Gaskin, D. E. 1987. Morphometric and meristic comparisons of skulls of Harbour Porpoises *Phocoena phocoena* (L.) from the North Atlantic and North Pacific. *Ophelia*, 1: 53-75.

Table 1 - Metric measures, abbreviation and technical errors

Abbrev.	Description of metric measures	technical error (mm)
BCKL	length from the frontal crest of Os supraoccipitale to the ventral base of Condylus occipitalis left	0.2
CBL	maximum condylobasal length; distance parallel of midline from the anterior margin of rostrum to the posterior margin of Condylus occipitalis, maximum value (left or right)	0.1
CND	maximum width from the left to the right edge of Condylus occipitalis	0.3
CONL	length from posterior limit of Incisura antorbitalis to posterior margin of Condylus occipitalis left	0.3
CPNL	length from posterior margin of Condylus occipitalis to posterior point of nare left	0.3
DFL	maximum length of Foramen mandibulae from anterior point of Foramen mandibulae to posterior margin of Condylus mandibularis left	0.2
FMW	maximum width from left to right of Foramen magnum	0.2
MINL	minimal height of mandibula posterior of SUBL	0.2
MNLL	maximum length of mandibula from anterior margin of Os dentale to posterior margin of Condylus mandibularis left	0.1
MXHL	maximum height of mandibula from ventral margin of Os dentale at right angel to dorsal margin of Processus coronoideus mandibulae left	0.3
MXLL	maximum length from anterior to posterior margins of maxilla left	0.2
NAR	maximum inside width from right to left of both nares	0.2
PLLL	maximum length from anterior to posterior margins of praemaxilla left	0.2
PRE	maximum width from right to left of praemaxilla	0.2
PST	maximum width from right to left of Os nasale	0.1
RSLL	length of rostrum from anterior margin of rostrum to posterior point of Incisura antorbitalis left	0.3
RSW	maximum width of rostrum at Incisurae antorbitalis	0.2
SUBL	maximum height of mandibula at Processus subapicalis left	0.2
TRUL	length of Processus alveolaris (upper tooth row) from anterior margin of rostrum to the posterior margin of last alveolus left	0.3
WAN	maximum width from right to left anterior of Processi postorbitalium	0.3
ZYG	maximum width from right to left across Processi postorbitalium	0.1

Table 2 - Configuration of non-metric characters

Abbrev.	Description	Config. 0	Config. 1	Config. 2	Config. 3
AON	Incisura antorbitalis	Number of AON=0	Number of AON>0	not defined	not defined
BSF	Configuration of the margin between Basisphenoid and Pars basilaris of Os occipitale	no specific shape	shape with two tips in posterior dirn.	shape with bend in posterior dirn.	shape with bend in anterior dirn.
DXL	Position of right Foramen maxillaris (V_2)	not defined	anterior of left Foramen maxillaris	same posn as left Foramen maxillaris	posterior of left Foramen maxillaris
FMN	Notch dorsal of Foramen magnum	Number of FMN=0	Number of FMN=1	not defined	not defined
MDF	Foramen mentale	Number of MDF2	Number of MDF>2	not defined	not defined
MES	Foramen mesoideus	Number of MES=0	Number of MES>0	not defined	not defined
MXF	Foramen maxillaris (Foramen infraorbitalis, V_2)	Number of MXF2	Number of MXF>2	not defined	not defined
PNF	Foramen praenasalis (Foramen infraorbitalis, V_2)	Number of PNF=0	Number of PNF>0	not defined	not defined
PPT	Posterior edge of Os palatinum	not defined	Vomer covers the edge	Vomer does not cover edge	not defined
SOF	Foramen supraorbitalis (Foramen infraorbitalis, V_2)	Number of SOF=1	Number of SOF>1	not defined	not defined

Table 3 - MANOVA-results for groups German Bight, transition area of the Baltic Sea and the central Baltic Sea, female harbour porpoises

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Wilks	0.37545	2.49649	40.00	158.00	0

Table 4 - MANOVA-results for groups German Bight, transition area of the Baltic Sea and the central Baltic Sea, male harbour porpoises

Test Name	Value	Approx. F	Hypoth. DF	Error DF	Sig. of F
Wilks	0.56525	1.58441	40.00	192.00	0.022

Table 5 - Significant results (5% niveau) of the Chi-Square-Test (Likelihood ratio) of the nonmetric characters for the three sea areas (German Bight, transition area of the Baltic Sea, central Baltic Sea) of female and male harbour porpoises

Sex	Character	Chi^2-Value	DF	Significance
female harbour porpoises	BSF	15,5	6	0.016
female harbour porpoises	MXF	13,2	6	0.04
female harbour porpoises	PPT	8,9	6	0.012
male harbour porpoises	DXL	21,2	6	0.0

AN ABNORMAL CALF OF HUMPBACK WHALE OBSERVED OFF RURUTU ISLAND (FRENCH POLYNESIA)

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INTRODUCTION The islands of French Polynesia host a wintering population of southern humpback whale, *Megaptera novaeangliae,* during the July-November period (Poole, 1993; Gannier, 1998). Female-calf pairs can be seen in the Australes and Society archipelagos, as well as around some islands of the Tuamotus and the Marquesas. A small-scale commercial whalewatching industry has been operating since 1997 in Rurutu (Australes Islands). One of the four calves seen regularly in 1998 was remarkable for several external features.

METHODS The Raie Manta Club is a scuba diving club with a seasonal base in Rurutu. It provides the opportunity to observe humpback whales during the calving period. Two tours are organised daily with one small boat, equipped with in-board engines. Up to 12 passengers can be accommodated, but an average of five is usually achieved. The crew includes two qualified guides and the skipper. Snorkel swimming is proposed to volunteer tourists when suitable sea conditions and whale behaviour allow safe underwater observation. In 1998, the tour focused on the sites mostly favoured by the whales: the Moerai and Avera bays, and inshore waters of the north coast. One unusual calf was seen with its (supposed) mother from 15 August (Fig. 1), when it was assumed to be 5-5.5 m. long, to 20 October, when it was estimated to reach a length of 7-8 m. The (supposed) mother of this calf was a «classic» humpback whale, well identifiable because of a white patch on top of the back. A description of the unusual features is supported by many good quality underwater pictures and some video footage.

Description of the abnormal calf: The overall shape was found to be close to that of a rorqual, with a robust tail stock, although a number of external features were characteristic of the humpback whale. About thirty ventral grooves were counted and a long slit was visible from the ombilic to the anal region. No mammary slit was visible in the genital region. A short flipper was estimated to be 1/5 of the body length (from photogrammetry), with much attenuated knobs. A relative flipper length of about 1/3 of body length is more characteristic for the species (Evans, 1987), as can be seen on the picture of a normal calf. The broad chord rorqual-shaped flukes do not feature the trailing edge knobs. A high and very falcate dorsal fin, without the usual hump, was found to be different from that of the majority of humpback whales. The head was rather typical of a young humpback whale, but the knobs were quite attenuated on top of the head and on the sides of the mouth, as was the «barbet» protuberance at the tip of the jaw. A mottled pigmentation was apparent over much of the body, excepted in a thin ventral area.

Unusual behaviours were recorded during the period, the individual being found to be very friendly by comparison with other calves in the area. During the period, the calf was observed suckling 20-30 times every day, each «session» lasting a few seconds. The most remarkable behaviour was perhaps the «gulping» attitude frequently displayed after suckling. The baleen plates were not unlike those of other humpback whales.

DISCUSSION This calf may be an unusual offspring of regular humpback whale parents. It may also be a hybrid from a female humpback and a male of an unknown rorqual species. Interspecific breeding between balaenopterid whales has been recently documented by genetic studies, notably between fin whale *Balaenoptera physalus* and blue whale *B. musculus* (Bérubé and Aguilar, 1998). The successful breeding between two different genera of baleen whales is not mentioned in the literature. But successful breeding is known to have occurred between different genera of delphinids, false killeer whale *Pseudorca crassidens* and bottlenose dolphin *Tursiops truncatus*, for example (Nishiwaki and Tobayama, 1984).

Because no biological sample has been collected, it is impossible to ascertain whether this calf was a hybrid or not. Future sightings of the specimen may provide opportunities to collect skin samples.

REFERENCES

Bérubé, M. and Aguilar, A. 1998. A new hybrid between a blue whale, *Balaenoptera musculus*, and a fin whale, *B. physalus*. Frequency and implications of hybridization. *Marine Mammal Science*, 14, 1: 82-98.

Evans, P. G. H. 1987. *The natural history of Whales and Dolphins*. Christopher Helm, London. 343pp.

Nishiwaki, M. and Tobayama, T. 1984. Hybrids between *Pseudorca crassidens* and *Tursiops truncatus*. *Rep. Int. Whal. Commn* (special issue 6): 481.

DESCRIPTION AND SYSTEMATICS OF A FOSSIL ODONTOCETE SKULL FROM PERUVIAN MIOCENE

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A morphological study has been carried out on the skull and sternum of a fossil odontocete specimen from the Pisco Formation, Mio-Pliocene, Peru. Cetacean plesiomorphic and apomorphic platanistoid characters together with apomorphic delphinid characters seem to contradict with each other (delphinids are considered as a sister group of platanistoids).

The skull was considered to belong to the Eurhinodelphid family, its genus being close to but not similar to that of *Schizodelphis* and it must therefore be considered as a new genus and species. The existence of this family (already discovered in the Atlantic and Mediterranean) on the western coast of South America, and not (until now) on western coast of North America, seems to confirm the existence of a fossil climatic barrier between the North and South pacific as a fossil El Niño.

THE MINKE WHALE, *BALÆNOPTERA ACUTOROSTRATA*, A NEW CANDIDATE FOR MEDITERRANEAN ENDEMIC SPECIES?

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In May 1998, a minke whale calf was caught by fishermen from Toulon's region (South-east France). It was immediatly autopsied, and tissues were sampled for histological observations. In addition, the skeleton was preserved and prepared by selective bacterial digestion. We found that it was a 365 cm. unweaned male calf, and we estimated its age at 1.5-2 months by linear regression. It was in poor fattening condition and showed evident signs of starvation. Coloration patterns of this whale did not show chevrons but a whitish expansion of ventral coloration on both sides, close to the flipper. Skeletal observations showed uncommon features for North Atlantic individuals. Since the species is thought to migrate from Mediterranean breeding grounds northwards to Northern Europe, the finding at this date of an individual certainly born in the basin in the northern part of the Mediterranean is very surprising. In order to investigate to which population it could belong, we are performing mitochondrial control region sequencing. We should therefore be able to test the hypothesis of an endemic form of minke whale in Mediterranean waters.

POPULATION GENETIC STRUCTURE OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM THE NORTH SEA AND BARENTS SEA

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The harbour porpoise (*Phocoena phocoena*) is subject to a high rate of incidental kill in fisheries worldwide. In some areas, these rates are sufficiently high to warrant concern over population sustainability. Thus, the definition of subpopulations is paramount to conservation of this species. To investigate the population structure in Norwegian waters, genetic variation in mitochondrial DNA was examined in porpoises incidentally killed in the salmon drift-net fishery. The first 350 bp of the control region were sequenced in 34 females and 41 males from the Barents and North Seas. One haplotype was found to be common in both geographic groups, accounting for 48% of all individuals. An analysis of molecular variance showed no significant difference among males from these two regions. However, over 5% of the variation in females was due to among group differences. A phylogenetic tree revealed several monophyletic clades; the haplotypes found amongst males were distributed within all clades, while the female haplotypes were chiefly partitioned into clades with respect to geographic location.

These results are consistent with findings from other areas and suggest that females comprise genetically distinct groups, while males are less philopatric. The results are also in general agreement with the International Whaling Commission's division of stocks in Norwegian waters near 66° N. To improve our understanding of the population structure, we plan to include new data from adjacent areas and to compare our data with existing data from other areas.

LIFE HISTORY, PHYSIOLOGY & ANATOMY

SUB-ADULT GROWTH IN HARBOUR PORPOISES *PHOCOENA PHOCOENA* FROM DUTCH WATERS

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As part of an ongoing study of the harbour porpoise *Phocoena phocoena*, in Dutch waters, we have analysed the growth pattern of harbour porpoises stranded and bycaught between 1970 and 1996, with an emphasis on animals collected during the last ten years. The parameters used are age, body length and weight. We compared between sexes and between populations. Rules-of-thumb were determined in order to estimate weight from length and *vice versa*, since both parameters are not always available.

Growth has been defined as the relationship between body size and age, as described by the Gompertz model:

$$S = A \exp[-b \exp(-kt)]$$

where S is body size, A is asymptotic ('mature') body size, b and k are integration constants, and t is age. We used the least squares method to estimate growth curves fitting our data, and a multivariate Hotelling's T^2 test to compare between results. Relationships between body length and weight were estimated by fitting (log)linear regressions, with either weight or length as the independent variable. The resulting growth rates (increase of body length per year) are similar for males and females: both sexes reach their mature length at the same age, but females become larger. Increase rates of body weight differ slightly, with females becoming somewhat heavier and reaching their mature weight earlier than males (7-8 versus 10 yrs), due to a higher absolute growth rate in their first three years. Length can best be predicted from weight according to a loglinear curve, whereas prediction of weight from length is better based on a linear curve.

MULTIDISCIPLINARY APPROACH OF A HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*) STRANDING IN MATALASCAÑAS, HUELVA (SPAIN)

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On 5th April, 1997, one specimen of a humpback whale (*Megaptera novaeangliae*) was found stranded on Matalascañas (Huelva) Beach. The Andalucian Society of Cetacean Research (ESPARTE) was the responsible organisation in charge of this event. This unusual appearance led to an immediate action for collecting and managing the maximum information and biological material possible. First, biometry studies were carried out and external details of the animal, including pictures and sketches, were taken. Over the most important parts of the whale's body, some dermoplastic studies were performed, due to the impossibility of a study of the entire body because of its size. Post-mortem studies were also carried out to determine the condition of the animal. Finally, there was treatment to provide osteological material, with it moved to a solitary place (Cercado de los Corzos in the Parque Nacional de Doñana) for the natural degradation of organic material and for further treatment of the bones. Collaboration with the Archaeology Centre of Huelva allowed the preparation and classification of the bone material, using archaeological methods. For this activity, on August 1998 a workshop was organized under auspices of Parque Nacional de Doñana. This multi-disciplinary approach will allow a more complete analysis, the building of a natural mould, and the placing of the skeleton in the future Marine Museum of Matalascañas.

CYTOLOGICAL EXAMINATION OF THE BLOWHOLE SPUTUM IN DOLPHINS AND WHALES

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Respiratory diseases are especially frequent in marine mammals, both those in human care and those in the wild. Moreover, there is only little knowledge of the local bacterial flora in the respiratory systems of wild living cetaceans. A total of 43 blowhole samples of seven marine mammals in human care were examined. The material used in our study was taken from four bottlenose dolphins*Tursiops truncatus*, two belugas *Delphinapterus leucas*, and one Commerson's dolphin *Cephalorhynchus commersoni*.

The aim of this study was to examine the spectrum of cells found in the blowhole sputum. The microscopic examination of blowhole samples resulted in a great cytological variety that allowed a division into three main groups: (a) animals with unsuspicious results in both clinical and cytological examination, (b) animals with unsuspicious results in clinical examination, but suspicious cytological findings, and (c) one animal with both suspicious clinical and cytological findings. Overall, the following cells could be identified: cocci, non-sporulating rods, neutrophil leucocytes, structures resembling hyphae, fungal spores, epithelial cells, and ciliates. Cytological examination of blowhole sputum is clearly a very useful diagnostic method for the veterinarian, by contributing to the overall diagnosis. It can be undertaken easily and without stress to the animals during regular health checks. It enables one to recognise potential respiratory diseases at an early subclinical state, as well as immunological variations in healthy animals.

EFFECTS OF INCIDENTAL MORTALITY ON DUSKY DOLPHINS POPULATION IN NORTHERN PATAGONIA

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The effects of incidental mortality of dusky dolphins in trawl nets were evaluated by means of population projection models. An age classified Leslie matrix model was used. Survival rates were distinguished among calves and non calves, and one value for the first year of life was considered and another and constant one for all other age classes. The values for these parameters were chosen within the range described for other delphinids. The upper limit for survival rate of calves was calculated as the square of the adult survival rate. Fertility rate was defined as the number of female offspring per female born each year multiplied by the adult survival rate. Reproductive data indicated a biannual calving interval. Nevertheless since it can vary with age, a 3-yr calving period was also considered. Fertility rates were calculated as 0.25 and 0.1667 times the adult survival rate. Age at first birth was taken as 7 yr. old with a maximum age of 27 yr. old. Maximum population growth rates reached in the best survival conditions were 7.93% and 4.76% for calving intervals of 2 and 3 yrs respectively. Incidental catches were simulated with additional mortality rates up to 10%, and applied only to the age classes affected by the fishery. Growth rates decreased to 2.50 and -0.25% for 2 and 3 yr. calving periods respectively. Catch rates of dusky dolphins were estimated between 0.8 and 3% of the population size between 42 and 47° S during 1984 and 1995. Considering that this population may have been stable prior to 1980, when the incidental catches began, those rates could have produced considerable reductions in population size. This approximation may be improved by modelling age specific survival rates.

GLANDULAR AND LYMPHOID TISSUES IN THE NASAL TRACT OF ODONTOCETES: FUNCTIONAL ANATOMY

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Anatomical studies of the odontocete forehead are numerous, due to the suggested importance of the nasal tract as the site of ultrasound production during echolocation. In spite of this, the presence of glandular tissues in the nasal passages has been largely overlooked, and there is no reference to lymphoid tissues. In this study, the presence of glands and lymphoid infiltrates located in the wall of the nasal passage, and of the nasofrontal sacs in several odontocete species, their tissue structures, characteristics and possible implications, are all reported.

For the purpose of this study, the facial anatomy of the striped dolphin,*Stenella coeruleoalba*, was studied in depth, with several other species of Delphinoidea and Phocoenoidea for comparison. The glandular and lymphoid tissues were studied by means of gross dissection, light microscopy including histochemistry, and both transmission and scanning electron microscopy.

Two distinct glandular tissues were consistently found. Large and small glands located respectively on the posterior wall of the respiratory tract and the nasofrontal sacs, were tentatively named nasal and nasofrontal glands. We have found these glands to be similar in character to exocrine, compound, acinar, merocrine and serous. The secretion was a mucopolysaccarid acid related fluid. Moreover, numerous plasmatic cells surrounded the acini. Lymphoid infiltrates were discovered with the nasofrontal glands both in association and isolated forming patches.

The strategic location, morphology, nature of the glands, and their secretion, all suggest their possible role in lubrification, vibration transfer, refrigeration and as a surfactant agent in playing a contributory role in echolocation. Otherwise, the presence of lymphoid tissues, previously undescribed, may mean a first barrier of the immune response system in the upper respiratory tract.

MULTIPLE INSIGHTS INTO THE REPRODUCTIVE GAME OF A MALE AND A FEMALE HARBOUR PORPOISES: HOW TO BECOME MATURE

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A male and a female harbour porpoise, bycaught in the same pound net, were brought to the Fjord and Belt Centre, Kerteminde, Denmark, in April 1997, and kept there for research purposes in a semi-natural environment. They were estimated to be 2-3 years old, and immature. This offered a unique opportunity to study the transition from puberty to reproductive maturity in terms of behaviour and physiological changes.

A combination of different methods were used: on line behavioural recordings using a behaviour study software; analyses of video recordings; recordings of acoustic activity through click detectors; titration of plasma testosterone, progesterone and oestrogens; cytological analysis on vaginal and prepucial smears; body temperature monitoring; and ultrasound imaging of genital tracts.

With findings supporting each other, each of the techniques sheds a different light on the maturation process, the appearance and development of sexual behaviour, and the relative responsiveness of the subjects. Vaginal cytology revealed that intromission became successful in the summer of 1998, although mating attempts had been ongoing since September 1997, but without resulting in a diagnosed pregnancy. The pubertal male of a reproductively, highly summer seasonal, species using the first winter to "test" himself, may or may not be an artifact of being in captivity.

STATUS AND REPRODUCTIVE OUTPUT OF THE MEDITERRANEAN MONK SEAL POPULATION OF CAP BLANC (WESTERN SAHARA) WHICH SURVIVED THE 1997 DIE-OFF

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The Mediterranean monk seal is an endangered species, of which no more than about 500 individuals are estimated to survive today. At present, the only large aggregation of the species inhabits the Cabo Blanco peninsula in the Western Sahara. In 1997, a mass mortality devastated this colony, severely reducing its size.

Using photo-identification and direct observation techniques, we studied demographic parameters before and after the event. Distribution was initially altered by the mortality, but after a 2-month period it returned to usual patterns. Seasonality of reproduction remained unaltered. Because mortality mostly affected adults, the age-structure of the colony was profoundly affected; the proportion of juveniles in the population, which was about 13% before the event, increased to about 38% after the die-off. Overall population numbers fell from about 317 individuals to slightly over 100 individuals, *i.e.*, to about 33% of original levels. However, the number of pups born during the year following the die-off, only fell to 42%. Also, pup survival rate increased from about 0.45 before the event, to about 0.64 in the following year. These changes suggest density-dependent responses in the population after the mass mortality, as a consequence of severe reduction in population numbers. This research was funded by EU-LIFE through project B4-3200/96/510 and by UNEP/GEF through IBN/DLO contract 35169.01.3.

INDIVIDUAL CHARACTERISTICS, DIVING PERFORMANCES AND MASS GAIN IN LACTATING SUBANTARCTIC FUR SEALS

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We investigated the relationships between individual characteristics (body length and mass), diving performance, and mass gain in lactating Subantarctic fur seals, *Arctocephalus tropicalis*, breeding on Amsterdam Island, Indian Ocean. During the 1997 austral summer, we deployed Time Depth Recorders on ten individuals for which we monitored mass changes during the foraging trip at sea.

Foraging trip duration averaged 9.1±3.6 days, range (6-15 days), regardless of maternal characteristics. Mean dive performances were 19±18 m., and 59±45 sec., and varied widely among individuals (depth: $F_{9, 7468} = 111.5$, $P<0.001$; duration: $F_{9, 7468} = 28.7$, $P<0.001$), regardless of maternal characteristics. After the foraging trip, absolute maternal mass gain was 4.7±3.1 kg (2.0-12.0 kg), corresponding to a rate of mass gain of 479±169 g/day at sea (250-800 g/day). Rank correlations indicated that absolute and rate of mass gain were not related either to maternal characteristics, nor average diving performances (mean dive depth, mean dive duration, mean rate of dives, mean rate of distance dived, mean rate of time spent diving). However, individuals enhanced their mass gain by increasing their total foraging effort (foraging trip duration, total number of dives, total vertical distance dived, total time spent diving during the foraging trip).

These results suggest that individuals seals have the same foraging efficiency whatever their own characteristics, probably because prey are equally available for all seals. This is supported by the fact that Subantarctic fur seals rarely exceed their physiological limits during dives. Similar relationships were found when considering pup mass gain, supporting the hypothesis that maternal performances at sea affect their reproductive success (York, 1994).

SEASONAL DIVING BEHAVIOUR IN LACTATING SUBANTARCTIC FUR SEALS BREEDING ON AMSTERDAM ISLAND

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INTRODUCTION Lactating fur seals alternate at-sea foraging trips and visits ashore to nurse their pups. On Amsterdam Island, Indian Ocean, lactating Subantarctic fur seals (*Arctocephalus tropicalis*) perform one of the longest foraging trips, spending from 11 days at sea in summer to 3 weeks in winter (Georges & Guinet, in press). However, little is known about their at sea ecology, feeding behaviour, and their relationships with marine resources. We investigated the diving behaviour in 19 lactating Subantarctic fur seals breeding on Amsterdam Island.

MATERIALS AND METHODS Time depth recorders (TDRs) were deployed during the first trip after parturition (December, n = 5), later in summer (February, n = 10), and in winter (July, n = 4) during the 1995-96 reproductive season. TDRs were programmed to record depth (± 1m) and time every 10 sec. for a depth of 3 m. The number of dives recorded per individual varied widely (205-2,456 dives per trip). To avoid pseudo-replication, analyses were performed considering 200 dives (>4 m., >10 sec.), sampled randomly for each individual (see Cherel *et al.*, in press).

RESULTS Among the 24,880 recorded dives, the deepest dive reached 208 m. during a 200-sec. dive, while the longest was 390 sec. and was 50 m. deep (both in winter). Ninety-nine percent of the 3,800 dives sampled randomly, were performed during night (Fig. 1).

There were significant differences in dive depth, dive duration, and bottom time between seasons, all of these parameters increasing from the first trip after parturition in December to winter (ANOVA, P <0.001; Fig. 2). Diving effort, calculated in terms of dive frequency (in dives per hour of night), vertical travel distance (VTD, in m. per hr of night), and time spent diving per hr of night (TSD, in min. per hr of night), did not differ between the first foraging trip and summer (Posthoc tests, P >0.05 in all cases). However, vertical travelled distance, and time spent diving per hr of night, were significantly higher in winter than during the previous seasons (Fig. 2).

For all seasons (for illustration, results and figures are given for summer only), there was significant variation in dive depth ($F_{10, 1967} = 3.328$, P <0.001), dive duration ($F_{10, 1967} = 21.345$, P <0.001), and bottom time ($F_{10, 1967} = 14.077$, P <0.001) throughout the night (Fig. 3). Posthoc Bonferonni tests indicate that dives were deeper, longer, and with a longer bottom time between 18:00 and 20:00 hrs. Furthermore, dives between 03:00 and 05:00 hrs were also longer, with a longer bottom time than during the remaining night (Fig. 3).

DISCUSSION Lactating Subantarctic fur seals behave in relation to nocturnal migrations of their main prey, myctophid fish (Klages & Bester, 1998). A previous study (Georges & Guinet, in press) showed that maternal foraging efficiency decreased in winter, despite the increase in diving effort shown in the present study, suggesting that prey availability decreased in winter, compared with earlier seasons.

REFERENCES

Cherel, Y., Tremblay, Y., Guinard, E., and Georges, J-Y. (In press). Diving behaviour of female northern rockhopper penguins *Eudyptes chrysocome moseleyi* during the brooding period at Amsterdam Island. *Marine Biol.*

Georges, J-Y. and Guinet, C. (In press). Maternal care in the Subantarctic fur seals on Amsterdam Island. *Ecology.*

Klages, N. T. W. and Bester, M. N. 1998. Fish prey of fur seals *Arctocephalus spp.* at subAntarctic Marion Island. *Marine Biol.*, 131: 559-566.

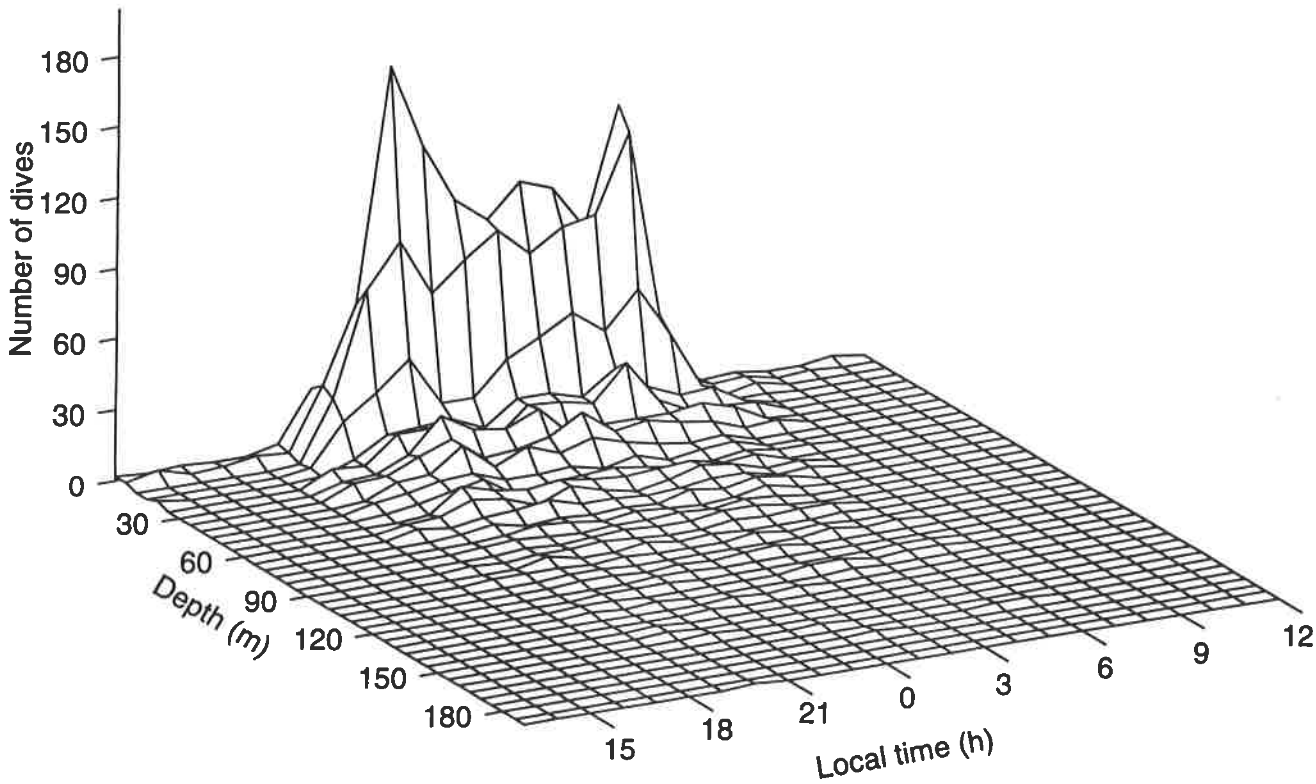

Fig. 1. Distribution of the number of dives in relation to time of the day and dive depth (n = 3,800) in lactating Subantarctic fur seals breeding on Amsterdam Island

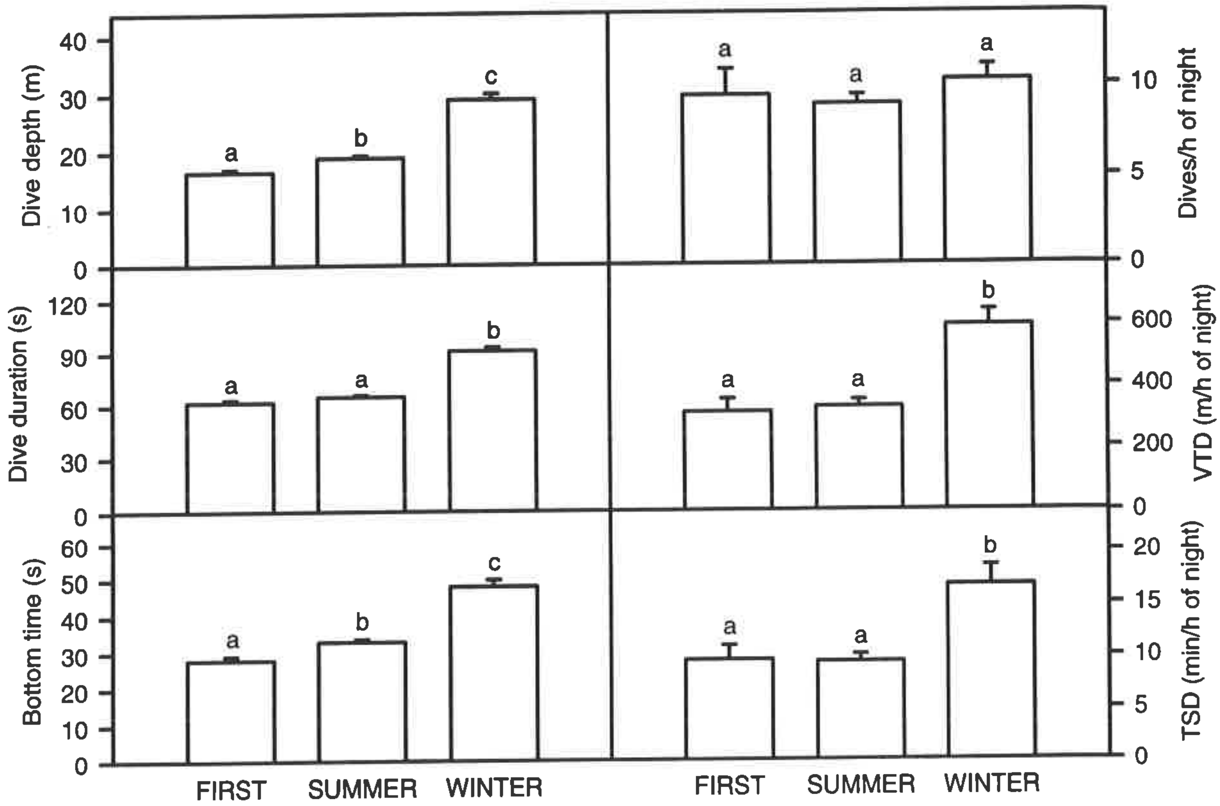

Fig. 2. Seasonal variations in dive depth, dive duration, bottom time, Vertical Travel Distance (VTD), and Time Spent Diving (TSD). Values are means + SE. Different letters indicate a significant difference between seasons (Bonferroni test, P <0.05)

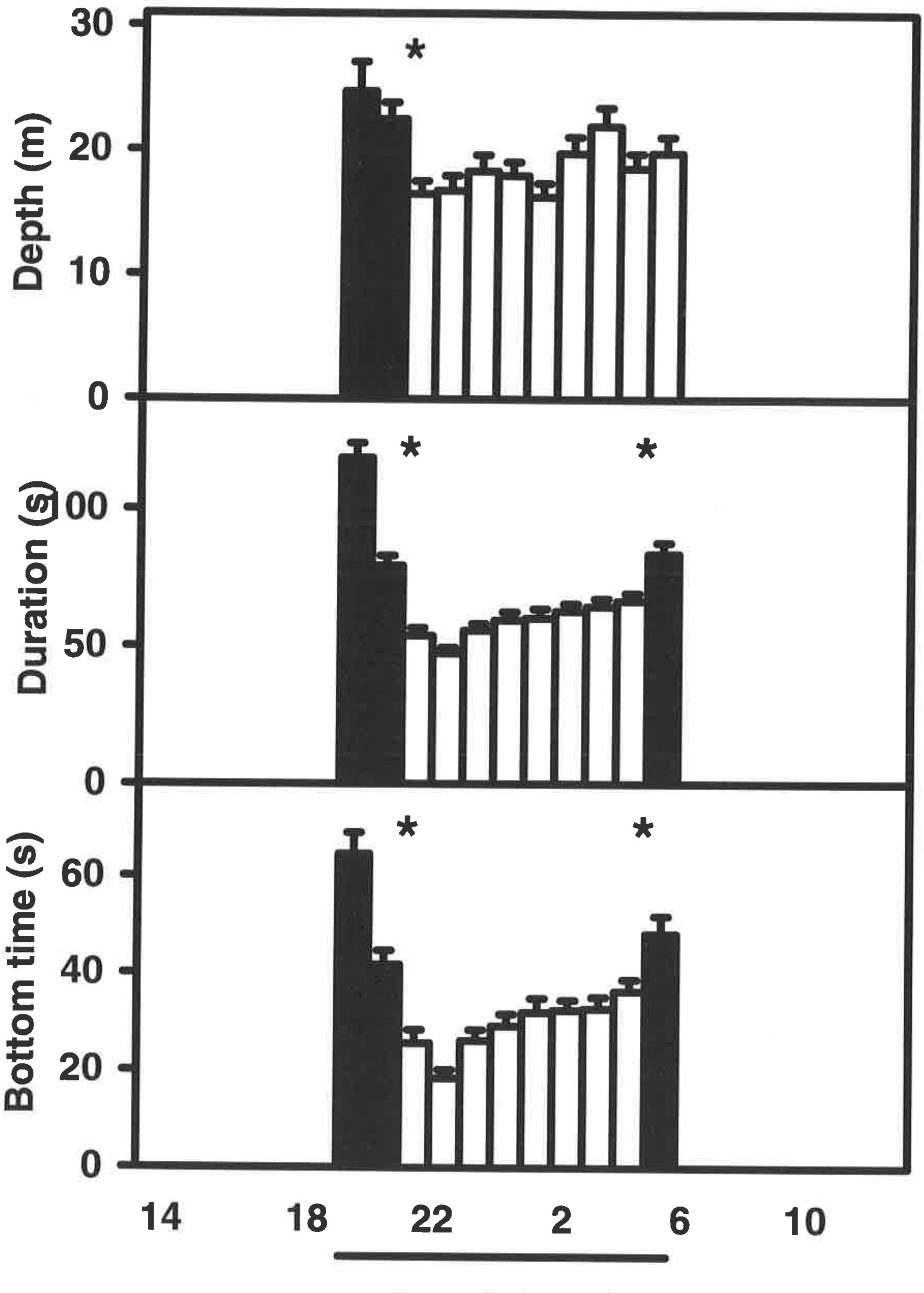

Fig. 3. Variation in dive depth, dive duration, and bottom time with time of the day in summer. The black line indicates the night. Different colors and asteriscs indicate a significant difference between hours (Bonferroni test, P < 0.05).

CHANGES IN PLASMA TESTOSTERONE AND BEHAVIOUR IN A MALE HARBOUR PORPOISE, DURING SEXUAL MATURATION

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A male and a female harbour porpoise, bycaught in the same pound net, were brought to the Fjord and Belt Centre, Kerteminde, Denmark, in April 1997 and kept there for research purposes in a semi-natural environment. They were estimated to be 2-3 yrs old and immature, which offered a unique opportunity to study the development of sexual behaviour as well as the changes in testosterone levels during the transition from puberty to the mature stage in the male.

The behaviour of the porpoises was recorded using a behaviour study software, during two-hr sessions and over 24-hr observation periods. Sexual behaviour was also recorded daily during feeding/training. Blood was sampled from the flukes during medical checks using consistent techniques, once to three times a month. Observations and sampling were intensified during the normal reproductive season for the species, *i.e.* June-September. Blood was collected on 35 days between April 1997 and November 1998, and testosterone levels were measured by radioimmunoassay.

Erection was observed from the time of arrival, but mating attempts were only recorded from September 1997 onwards. They continued through winter and spring, increased in frequency during the summer 1998 and ceased in October 1998. In parallel with sexual activity, testosterone levels increased, peaked during summer 1998 and decreased again in the autumn. In daytime, male mating attempts were often triggered by the female stationing herself in front of the trainer. When the porpoises were left undisturbed, sequences of several mating attempts were separated by longer periods dedicated to pool investigation, play, and resting behaviour.

HOW WELL WE GROW - MONITORING GROWTH OF HARBOUR PORPOISE IN CAPTIVITY

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INTRODUCTION Two harbour porpoises, *Phocoena phocoena,* were taken into captivity in April 1997, after rescue from pound nets set in inner Danish waters. They are presently housed in a natural outdoor pool which is a penned-off area of Kerteminde fjord. Their growth has been monitored regularly since capture by means of the parameters of total body length, body weight and blubber thickness, as well as dietary intake by weight and dietary composition. The general activity of the animals has been recorded in relation to gradual release from the indoor holding tank to the outside holding pool and finally the entire pool area. The water temperature has also been recorded.

The aim of the monitoring, apart from health checks, is to assess growth rate and efficiency in harbour porpoise, and to learn more about the physiology of this species.

METHODS Monitoring the growth: Parameters of total body length, body weight, and blubber thickness have been measured at least every two weeks for both harbour porpoises. For weighing, the animals are removed from the water by means of a special stretcher, and brought to an examination table for measuring and weighing, which is performed on a large platform balance with an accuracy to 0.01 kg. Length (taken in a straight line from jaw tip to tail fluke notch, parallel to the body) and six girths (see Lockyer, 1995a) are measured manually by means of a soft tape measure. The blubber thicknesses are measured dorsally, laterally and ventrally in three positions along the body (positions along girth lines behind the pectoral flippers, in front of the dorsal fin and posterior to the dorsal fin) by means of a portable ultra-sonic sub-dermal fat scanner. We use the Lean Meter, designed for use in pig husbandry.

Food intake: The main dietary species have been herring (*Clupea harengus*), some mackerel (*Scomber scombrus*), and a little cod (*Gadus morhua*), plus a few others. All fish have been weighed and recorded daily as food intake and by species. Fish fed are freshly thawed from frozen. A sample of fish from each new food batch has been retained for biochemical analysis.

RESULTS Body weight and length: The initial period in captivity resulted in major weight losses, especially in the dorsal thoracic and trunk regions because of refusal to feed. Such losses were sudden and dramatic in just the first few days – with about 5 kg being lost by Freja (female) and 4 kg by Eigil (male) who continued to lose a further 2.5 kg until day 60 (Figs 1a, b). Initial body weights were 40.5 kg for Freja and 37.5 kg for Eigil. Once feeding was established, weight stabilised within the first 60 days, but noticeable weight increase and growth in length did not take place until the animals were transferred from the initial indoor holding pool to the outside pool, and finally freed into the entire pool space. A stable period in body weight continued up to about 180 days (about 6 months) after capture, and then increased steadily over the next few months during winter, reaching a peak of 51.6 kg for Freja and 44.75 kg for Eigil in late January/early February 1998. Body weight then diminished to 47.2 kg for Freja and 43.85 kg for Eigil in July 1998. Thereafter, weight remained rather stable and in mid-October, weights were 47.75 kg for Freja and 38.1 kg for Eigil. During the winter months, weight increased to a peak of 55.5 kg in Freja and 44.5 kg in Eigil, and then decreased again in the same manner as the previous winter, to a new level of 52.5 kg in Freja and 43 kg in Eigil during February 1999 (Figs 1a, b).

During the 22 months since capture, length increased steadily from 127.5 cm to approximately 148 cm in Freja, and from 130.5 cm to approximately 138 cm in Eigil (Figs 2a, b).

Girth and blubber thickness: The measurements of girth and blubber thickness correlate well with observations on weight. The measurements taken in mid-girth (anterior to the dorsal fin) demonstrate the fluctuations in fat deposition that are reflected in body weight changes throughout the captive period (Figs 3a, b). Blubber thickness taken at the mid-dorsal position also mirrors the changes in girth and body weight observed (Figs 4a, b).

Food intake: All fish have been weighed and recorded daily as food intake and by species. A sample of fish from each new food batch has been retained for biochemical analysis. Food intake has varied from as little as 1.5 kg daily in the early months to about 5.5 kg in July 1997 when the animals were established. In general, intake has averaged 3.5 kg daily. The diet comprises mainly herring with some mackerel. A variety of fish *e.g.* cod, has been introduced into the diet to get the animals to readily accept other species than herring. This has been part of the plan for the experimental feeding of different fish species to determine the likely effect on growth efficiency. During feeding trials, body weights, girth, and blubber thickness were measured on alternate days. The potential problem of entry of «unscheduled» fish into the pool that could be consumed as undocumented supplements, were limited by placing additional small mesh nets over the existing ones at each end of the pool during the experimental periods.

The first scheduled dietary trials started in mid-October 1998, but the animals would not accept a sufficiently varied fish diet at that time. In the trial, the food intake (herring) was reduced by 20% of average food intake during the previous month for Freja, but maintained at previous levels for Eigil. In this situation, Eigil was used as a kind of control against which to measure any effects of dietary change on Freja. The trial lasted two weeks. This trial went well, although no significant change was observed in body weight of either animal. During a similar trial in February 1999, the same criteria were applied. Again, neither animal showed loss in body weight. At this time, it is not possible to predict how quickly the effects of a new diet may be manifested in terms of body mass, and we must consider the possibility of an increased efficiency of energy utilisation when energy intake is reduced.

DISCUSSION The estimated ages at first capture were about 2-3 yr for each animal. The current lengths of the animals are as estimated for a wild animal from the eastern North Atlantic region and of about age 3-4 yr (Lockyer 1995b, c). This is the estimated age at first sexual maturation for this species in this region. The body weight also compares favourably with expected weights determined from bycaught porpoises in this region. The initial weight loss is not unexpected because of the lack of feeding at first. However, the losses were not expected to be so sudden. This suggests that the energy reserves of the animals may only have been short term.

The large weight increase in the 1997-98 and subsequent 1998-99 winter months with the cold water temperatures also suggests that energy reserves and blubber fat in terms of insulation may be important. Studies on body weight composition of wild porpoises have shown that immature animals have the thickest and relatively largest amount of blubber reserves (Lockyer, 1995a, c), so that these increases are in line with predictions. The subsequent loss of weight for Freja and Eigil in the spring supports the possible role of blubber fat as insulation.

The results so far indicate that the animals are growing as predicted for wild porpoises in the region of inner Danish waters.

REFERENCES

Lockyer, C. 1995a. Aspects of the morphology, body fat condition and biology of the harbour porpoise, *Phocoena phocoena*, in British waters. *Rep.int.Whal.Commn* (Special Issue 16):199-209.

Lockyer, C. 1995b. Investigation of aspects of the life history of the harbour porpoise, *Phocoena phocoena*, in *British waters. Rep. int. Whal. Commn* (Special Issue 16):190-197.

Lockyer, C. 1995c. Aspects of the biology of harbour porpoise, *Phocoena phocoena*, from British waters, Pp.443-457. In, *Whales, seals, fish and men*, eds A.S.Blix, L.Walløe and Ø.Ulltang, Elsevier, 720pp.

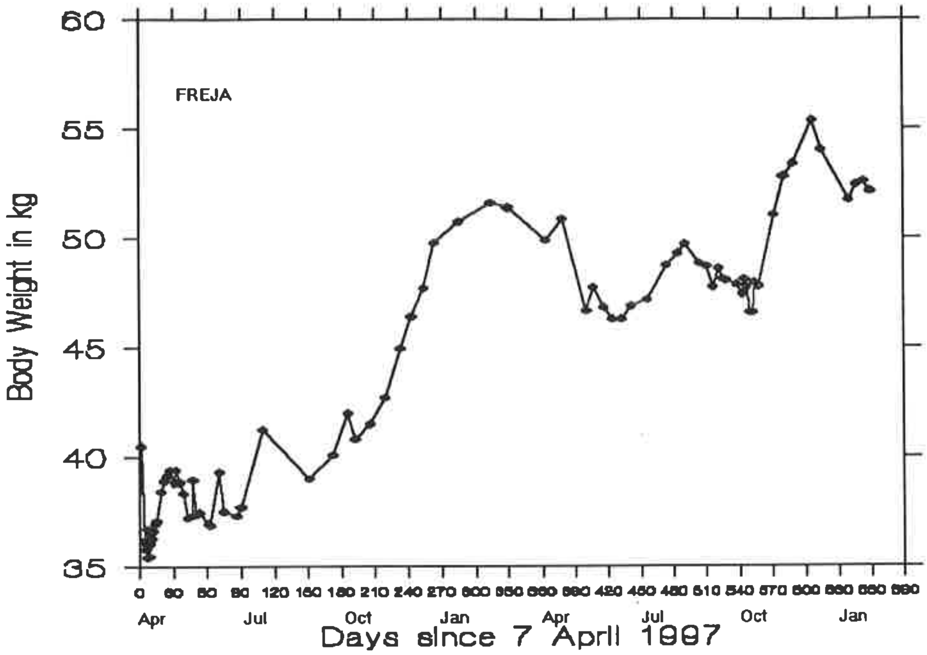

Fig. 1a - Growth in body weight in Freja

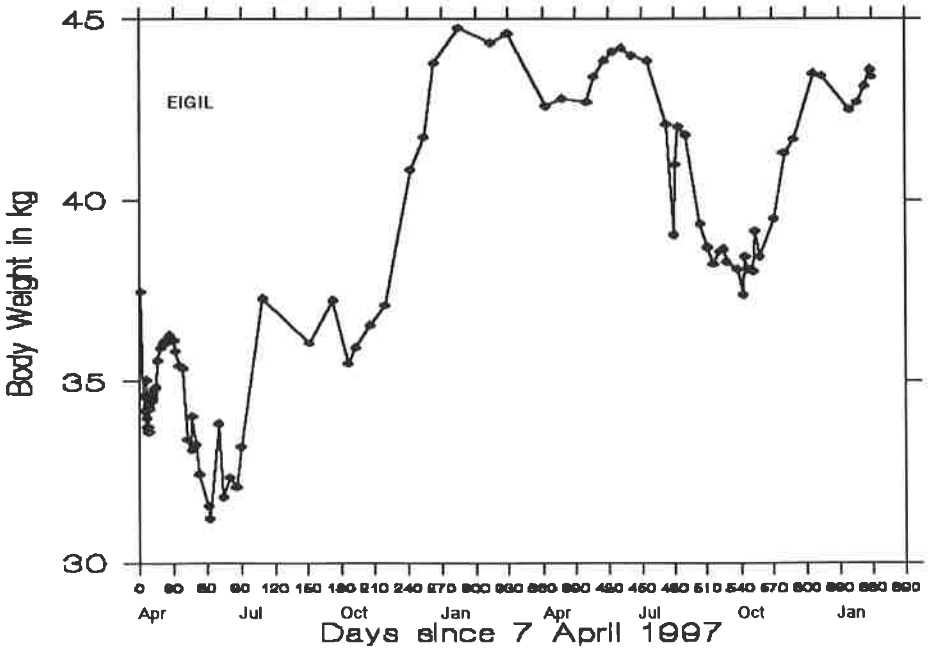

Fig. 1b - Growth in body weight in Eigil

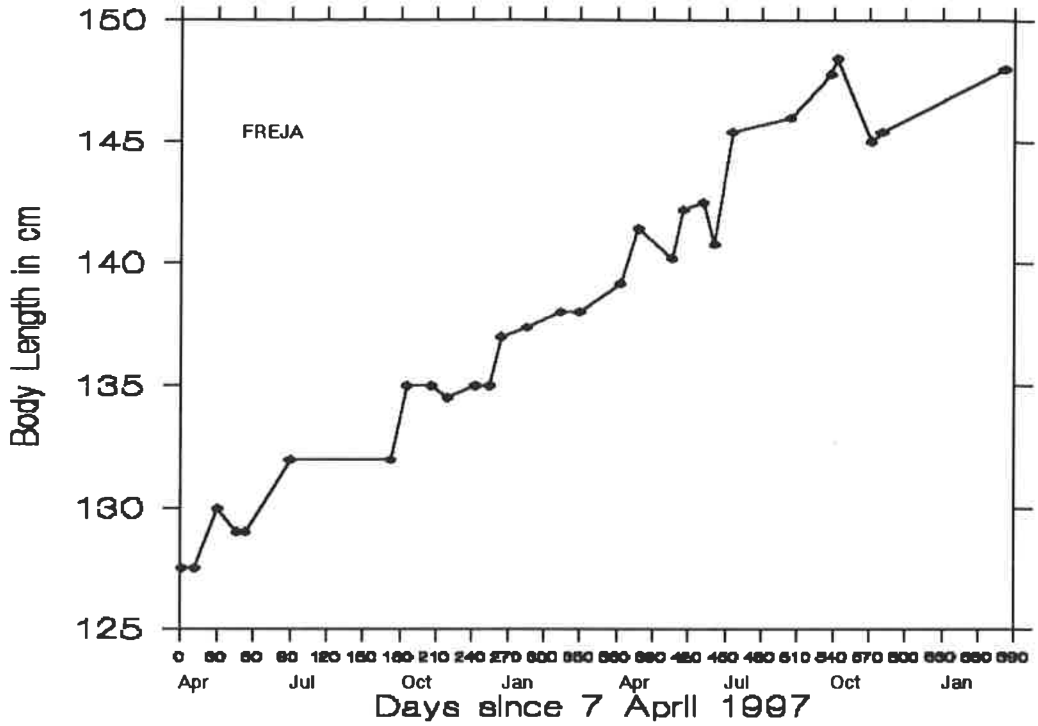

Fig. 2a - Growth in body length in Freja

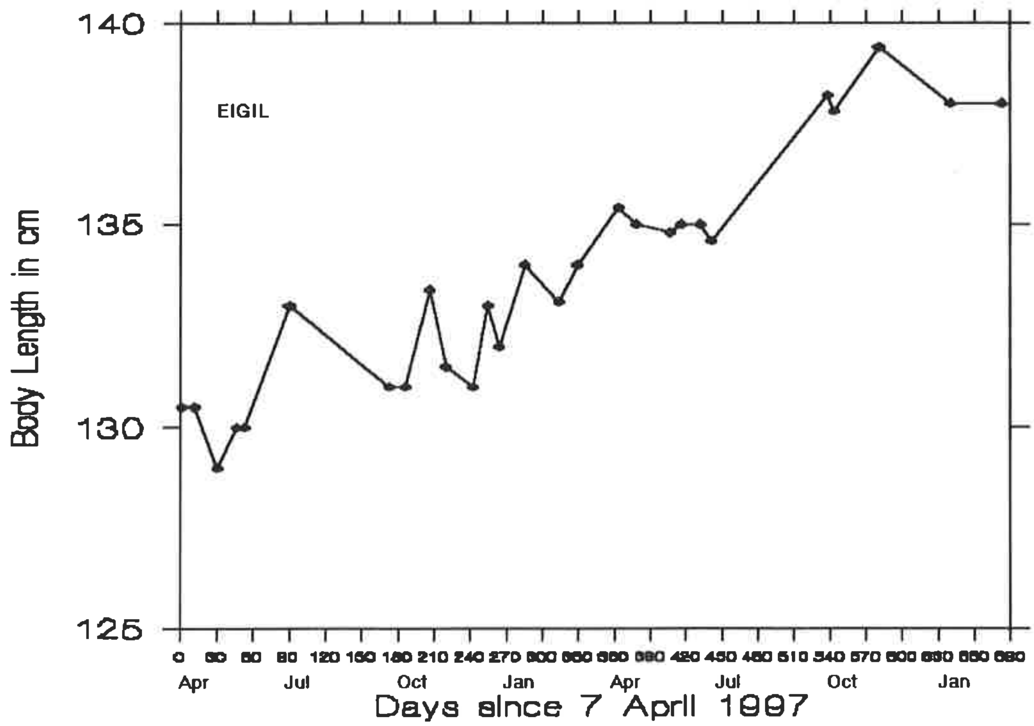

Fig. 2b - Growth in body length in Eigil

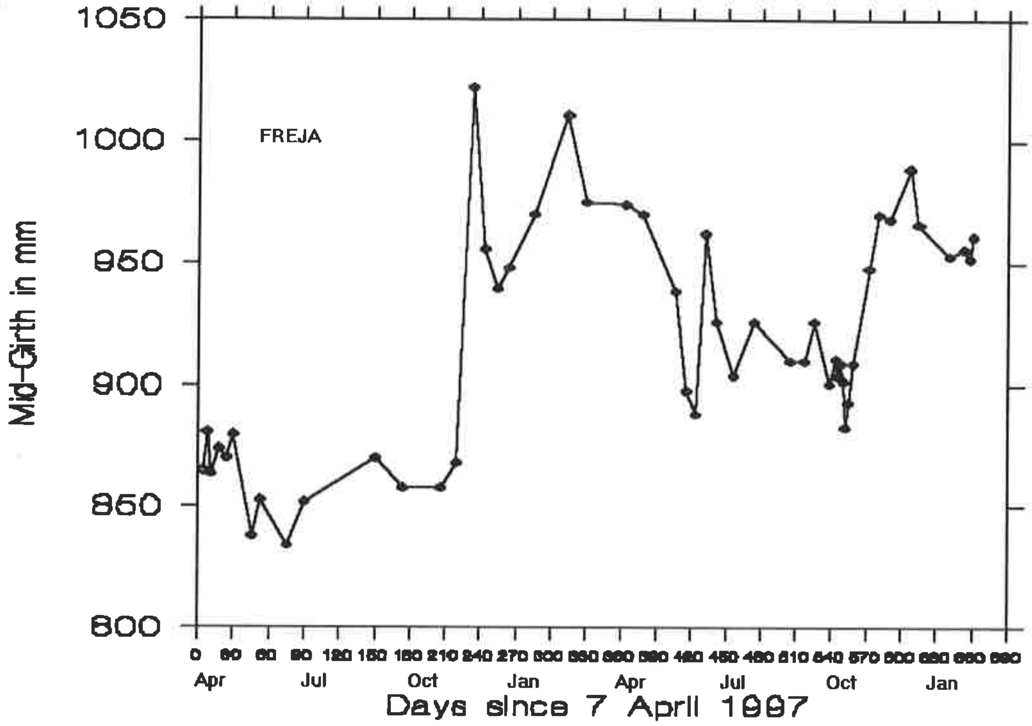

Fig. 3a - Changes in mid-girth over time in Freja

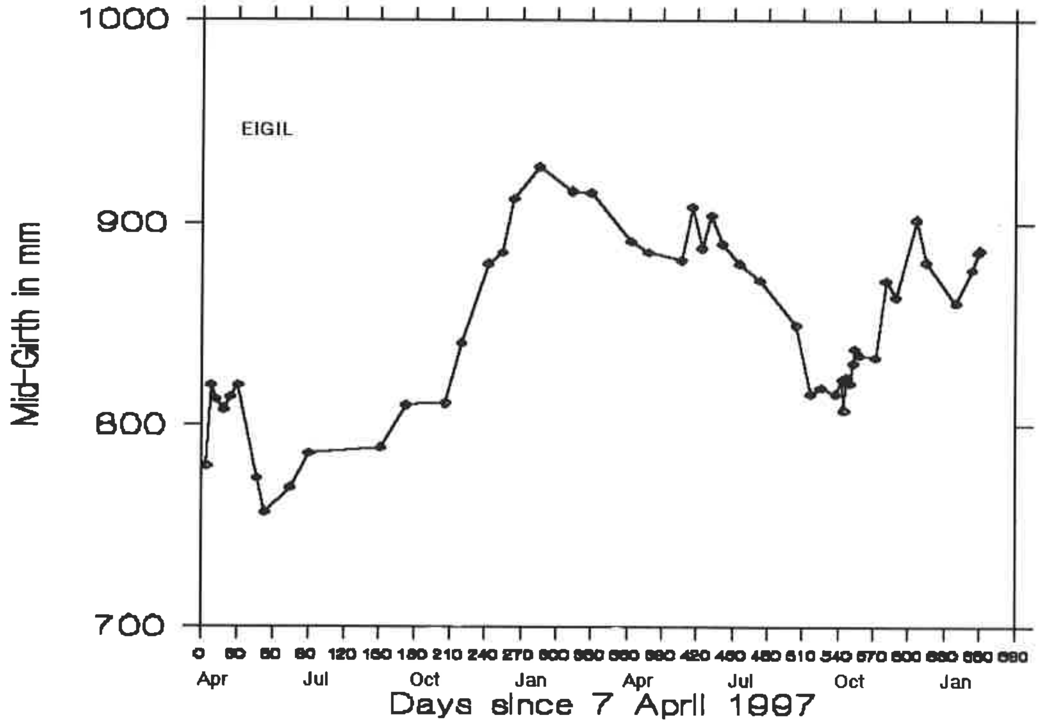

Fig. 3b - Changes in mid-girth over time in Eigil.

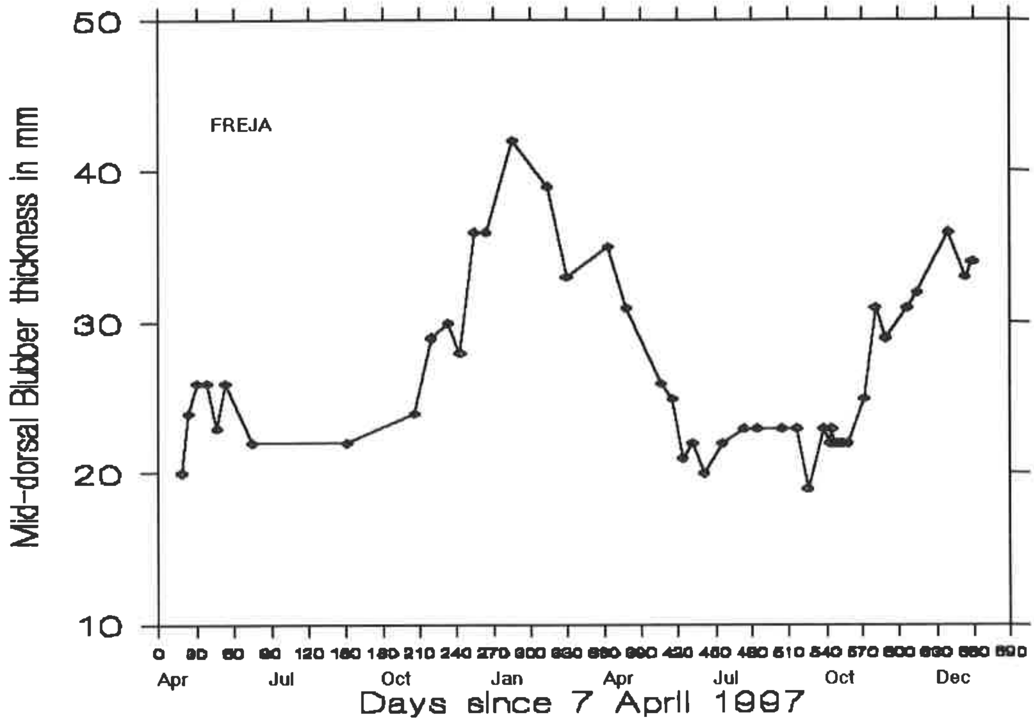

Fig. 4a - Changes in mid-dorsal blubber thickness over time in Freja

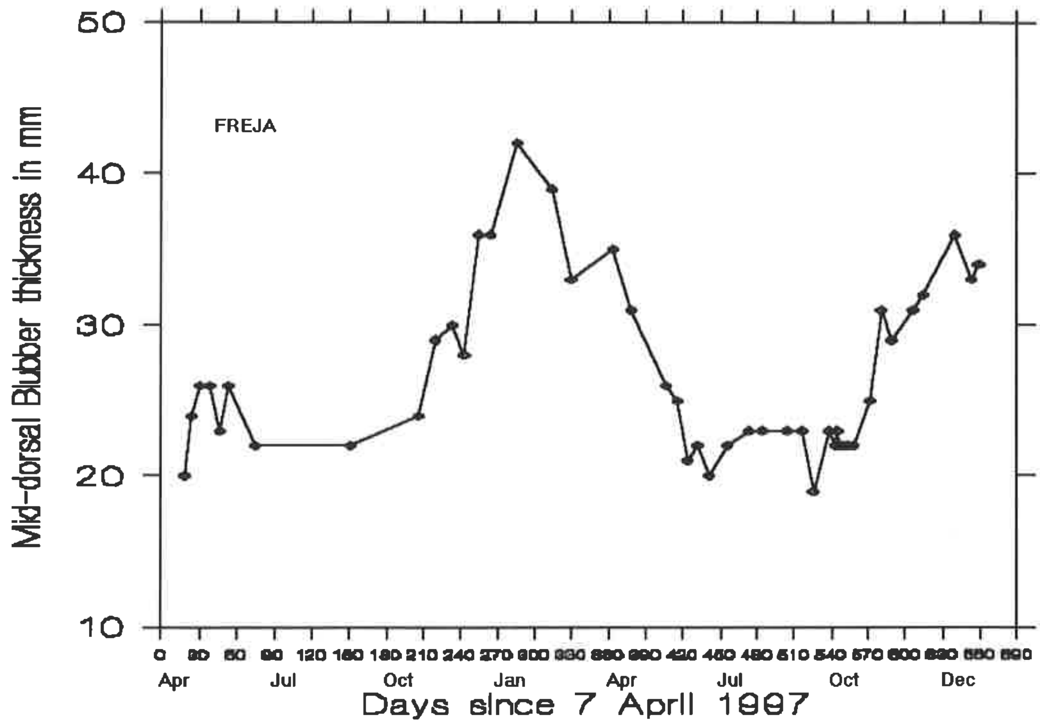

Fig. 4b - Changes in mid-dorsal blubber thickness over time in Eigil

A NEW APPROACH TO THE COLORATION PATTERNS OF THE CUVIER'S BEAKED WHALE

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The study of cetacean coloration shows some problems due to the fact that it quickly fades following the death of the animal. Most authors agree that the coloration pattern of the Cuvier's beaked whale is extremely variable. During the present work, several Cuvier's beaked whales stranded on the coast of the Canary Archipelago were examined up to 1998, and the coloration of recently dead animals studied either *in situ* or through good quality photographs. According to the material examined, it seems clear that there are different stages in the coloration pattern of the species, although subjected to slight alterations: a) immature animals, b) animals close to puberty, and c) adult animals. The immature ones with a length of 440 cm had a uniform grey coloration in the dorsal and lateral areas, becoming lighter on the underside, showing a notorious eye patch.

In animals with lengths ranging between 440 and 500 cm, that is those who are close to puberty or at it, the previously described pattern becomes darker so that it is no longer possible to distinguish the lighter coloration of the underside from the darker one of the upper body, the head and throat both showing a slightly clearer coloration. In the adult males, the contrast is even more marked so that the throat, head, and dorsal region up to the dorsal fin show a characteristic white or creamy tone. The only calf examined was exceptionally fresh, showing a brown coloration in the dorsal and lateral areas which melted with a bright white on the belly. The coloration of this animal was very interesting, specially on the head, showing a similar pattern to that described by several authors for the calves of *Mesoplodon*. In all specimens, the dark colour ranged from toasted to a chocolate brown colour, turning into grey a few hours after the stranding.

COMPARED DEVELOPMENT OF THREE NEWBORN CALVES REGARDING MOTHER-CHILD BEHAVIOUR OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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For intelligent mammals, learning and playing is a very important component for preparation to live in social structures, and to survive as an adult animal. This mother-child bond plays a very important role in the raising and development of a calf. In the summer of 1997, three bottlenose dolphins were born within a few weeks in the Dolphin Reef at Eilat. This provided a perfect opportunity to gain insight into the development of different calves of the same age. Here, it was possible to collect data with continuous recording: video recording underwater and above the waterline, photo-ID and hydrophone recordings, to compare the development of the three newborn calves. Remarkable was not only the fact that the development of the three calves was different, but also that this seemed to depend on the knowledge of their mothers - the knowledge and experience she had in being a mother (a mother has also to learn to be a mother). Furthermore, there seemed to be different disciplinary behaviours of the mother towards her child, depending on the behaviour the calf showed on what it had to learn. The three calves showed great individuality in the speed of learning, playing, and their individual preferences for different behaviours, as well as their different relationships to other dolphins and the whole business of being taken care of. In addition, one may note that in all highly specialised species of mammals, there seems to exist, to a large extent, similarities in learning and in mother-child relationships.

DOLPHIN 56 – A TWENTY YEAR HISTORY OF A WILD 'BUT SOCIABLE', MALE BOTTLENOSE DOLPHIN

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Wild, 'but sociable', solitary male and female bottlenose dolphins (*Tursiops truncatus*) have been reported from many locations around the world. However, the history of these animals prior to their 'sudden appearance' is largely unknown.

Dolphin 56 was captured, freeze-branded, and released in the Indian River Lagoon, Florida, on 28 August, 1979. At capture, he measured 238 cm, weighed 145 kg, and was estimated to be 12 years old based on tooth GLG counts. From that time through late 1996, he remained in the general area where he was captured and was sighted over 40 times. We do not know when he developed the habit of approaching boats and 'begging' for food. He was well-known to boaters and fishermen in the IRL area. Sometime late in 1996 or early 1997, he moved north out of Florida with reported sightings over the next 2.5 years as far north as New York State (1,600 km from the IRL). The last sighting of 1997 was in September in North Carolina. He re-appeared in February 1998 in North Carolina, and moved north as far as New York. The most recent sighting as of 19 November 1998, was in the State of Maryland on 10 October 1998. He has been observed at least 34 times since he left Florida.

Why did dolphin 56 leave the Indian River Lagoon after three decades, to assume a 'new' life hundreds of kilometres away? Did he make unobserved long-distance trips? Is he a social outcast? Is he post-reproductive? Is his longterm behaviour pattern typical of other wild 'but sociable', male bottlenose dolphins?

WEANING IN HARBOUR PORPOISE: A PILOT STUDY INVESTIGATING STABLE ISOTOPES IN MOTHERS, FOETUSES AND CALVES

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Harbour porpoise (*Phocoena phocoena*) start to eat solid food at four to five months of age, and weaning is believed to be completed after nine months. Milk has been found in stomachs from older calves, but how common this is has not been possible to investigate owing to the scarcity of suitable samples.

In the present study, we have investigated the usefulness of stable isotope analyses for studying duration of lactation and age at weaning. We measured stable isotopes of nitrogen (15N/14N) in muscle tissue from mature females (n=12), foetuses (n=6), and calves (n=6), collected from the Skagerrak and Kattegatt Seas between 1988 and 1997. To ensure that values obtained mainly would reflect milk ingestion, all calves examined were between three to six months old, assuming they were born in the middle of June. Females showed a seasonal variation in 15N, with a peak in early spring (mean=15.29‰) and low values in the autumn (mean=13.85‰), which probably reflects a switch in diet. Foetuses were significantly enriched in 15N compared with their mothers (mean = 2.63‰, $p<0.05$), but there was no significant difference between females and calves (15N = 14.53‰ and 14.88‰ respectively, $p>0.05$).

To explore the results further, we compared our data to models assuming an initial difference of 2.63‰ between the calves and females (the foetus effect), a lactation effect, and a seasonal change in diet and growth. Our calves had lower 15N values than expected from a model including all the factors above. It is premature to conclude precisely what is causing these low values, but our results indicate that calves start to take solid food earlier than previously reported. In conclusion, our study shows that stable isotope analyses can provide valuable information on calf diet, and, if applied on a larger sample including specimens from all seasons, it could greatly improve our understanding of weaning in harbour porpoises.

A CONTRIBUTION TO THE KNOWLEDGE OF THE HEPATIC PORTAL SYSTEM IN THE STRIPED DOLPHIN, *STENELLA COERULEOALBA* (MEYEN, 1833)

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In the liver of a few cetacean species, the branches of the portal vein show thickenings of the vascular wall, made by smooth muscle fibres. They sometimes form sphincter-like structures, possibly aimed at both the storage of a huge volume of blood during deep diving, and reducing the possibility of ventricular obstruction during the induced bradycardia. The aim of this study was to verify the presence of these structures in the branches of the portal vein in the striped dolphin,*Stenella coeruleoalba*.

All the samples were fixed in 10% formalin, dehydrated through a scale of ethanol, embedded in paraffin, sectioned at 5-10 µm, and coloured with hematoxylin-eosin or Masson's trichromic modified stain. This analysis shows the presence of these structures in the liver of the striped dolphin. This description is the first in the literature for this species. We suggest that its presence could be linked to the species' diving behaviour, and may be additional support for its taxonomic position within Cetacea.

PATHOLOGY, MEDICINE & TOXICOLOGY

STRIPED DOLPHIN *STENELLA COERULEOALBA* STRANDINGS ON THE NORTH-WESTERN MEDITERRANEAN COAST: A CLINICAL APROACH

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INTRODUCTION The striped dolphin (*Stenella coeruleoalba*) is the most frequent cetacean stranded on the north-western Mediterranean coast (Spain and France) after the 1990-91 die-off (Alonso *et al.*, 1996, Oliver *et al.*, 1994, 1995, 1996).

Although postmortem data are extensively described in the literature, there are only a few notes about the clinical description of the symptoms observed during the epidemic (Piza, 1992, Domingo *et al.*, 1992, Dhermain *et al.*, 1994).

This paper presents the common symptoms shown by seven striped dolphins that were found stranded alive in this area, betwen 1993 and 1998. Therefore, this is the first clinical description for the species after the mass die-off.

MATERIALS AND METHODS In the period described, the Catalan stranding network received seven calls of alert related to striped dolphins beaching alive. Six of them were on the Spanish coast and one on the French coast. Sex and length of every dolphin, and the date of stranding are shown in Figure 1.

Four dolphins were found stranded on sandy beaches and the rest on rocky shores. Only dolphin n° 3 died at the stranding site. The other six were carried from the stranding site by means of a stretcher. One dolphin was moved to a particular pool, and the rest were placed in a conditioned van for transport to the recuperation facilities. Dolphins n° 5 and 6 died during the transport. Dolphins n° 1, 2, 4, and 7 were finally placed into a recuperation pool. Times from the stranding to death of the dolphins are shown in Figure 1.

All the observations of the symptoms described, were made during the rescue operations. Heart beats per min. were measured by putting a hand ventrally between the insertion of the pectoral flippers (Geraci *et al.*, 1993). Body condition was determined by the degree of concavity of the lumbar musculature (Barnett, 1998).

RESULTS All dolphins were conscious and alert. Clinical descriptions of the dolphins beached during the 1990-91 die-off, divided them into two types: alert and listless dolphins (Piza 1992, Dhermain *et al.*, 1994). We observed both clinical descriptions in every dolphin, the alert phase being followed by a listless one.

The cardiac rate oscillated betwen 100-120 b.p.m., and the respiratory frequency was 3-4 b.p.m., with strong exhalations and no abnormal respiratory noises. The eyes were open in only two dolphins and these were the only ones to emit sounds. All the dolphins were in a good body condition.

During transport operations (with the stretcher and afterwards in the transporter van to the recuperation facilities), apneas of more than a minute followed by 3 or 4 fast breaths were observed. Every apnea was accompanied by a contraction of the dolphin's dorsal musculature, which produced the typical curved posture of the body with the caudal fin and the head looking upwards.

The two dolphins who died during transport in the van, had contractions which increased in frequency, but they seemed to be less intense. Both dolphins died after one of the contractions.

The common trait in the four dolphins placed into the recuperation facilities was the presence of the following nervous symptoms:

- Tremor of the dorsal fin, and contractions (mioclonia) of the body's caudal portion (also observed in the dolphins who died during transport in the van).

- Swimming in circles.

- Confusion and autodestructive behaviours (hitting their nose or rubbing their side against the sides of the pool). At least two dolphins were observed hitting their nose against rocks or boats, before the stranding.

- Vomiting (at least in two dolphins) and diarrhoea (at least in four dolphins). Dolphins were active until the listless phase which was characterised by the next symptom; the length of the listless phase could not be determined, but it always appeared at the end.

- Searching for less deep zones to lay the caudal fin on the bottom of the pool, in order to support the body weight.

- Ataxy, lateral rotation, and impossibility to maintain itself at the surface.

The death of the dolphins placed in the recuperation pool was preceded by a typical sequence of hypermotility. The animals increased progressively their movements energetically moving their tail, and swimming very fast along the pool. Suddenly, the dolphins stopped their movements and died.

CONCLUSIONS From 1993 to 1998, all the striped dolphins that stranded alive on the Catalonian coast had the clinical symptoms presented here. This clinical description is very similar to the clinical reports of live dolphins beached during the 1990-91 die-off.

These data support the hypothesis of a chronic morbillivirus infection in this species, (Domingo *et al.*, 1995). The symptoms described may be useful as a clinical pattern to diagnose striped dolphins with this central nervous system infection.

ACKNOWLEDGEMENTS All the observation data included in this paper were collected by the author, during his work on the veterinary staff of the Foundation for the Conservation of the Marine Animals (Barcelona, Spain).

REFERENCES

Alonso, J. M., Alegre, A. and López, A. 1996. Registro de varamientos de cetáceos en la costa catalana 1993-1996. Pp. 2-12. In: *Proceedings del curso Casos de Patología en cetáceos, 13-15 Dic., Bellaterra (Barcelona), Spain.*

Dherman, F., Bompar, J. M., Chappuis, G., Folacci, M. and Poitevin, F. 1994. Épizootie à morbillivirus chez les dauphins blue-et-blanc Stenella coeruleoalba en Méditerranée. *Rec. Méd. Vét.*, 2/3: 85-92.

Domingo, M., Visa, J., Pumarola, M., Marco, A. and Ferrer, L. 1992. Infección por Morbillivirus en el delfín listado (*Stenella coeruleoalba*) del Mar Mediterráneo. Pp. 85-90. In: *Proceedings of the Mediterranean striped dolphin mortality, 4-5 Nov, Palma de Mallorca, Spain.*

Domingo, M., Vilafranca, M., Visa, J., Prats, N., Trudgett, A., and Visser, I. 1995. Evidence for chronic morbillivirus infection in the Mediterranean striped dolphin (*Stenella coeruleoalba*). *Vet. Microbiology*, 44: 229-239.

Geraci, J. R., and Lounsbury, V. J. 1993. Cetacean single strandings. Pp. 71-132. In: *Marine Mammals Ashore: A Field Guide for Strandings.* Texas A&M. Sea Grant Publication.

Oliver, G., Bompar, J. M., Dhermain, F., Petit, H., and Cornil, L. 1994, 1995, 1996, 1997. *Recensement des échourages de cétacés (Cetacea Brisson,1762) sur les côtes françaises de Méditerranée.* Annual reports. Montpellier, GECEM, Commission "Échouages".

Piza, J. 1992. Striped dolphin mortality in the Mediterranean. Pp. 93-103. In: *Proceedings of the Mediterranean Striped Dolphin Mortality, 4-5 Nov, Palma de Mallorca, Spain.*

Table 1 - Data recorded during the observations

N°	DATE	MALE / FEMALE	LENGTH	TIME FROM STRANDING TO DEATH
1	August 1993	Female	185 cm	36 hours
2	May 1995	Male	176 cm	54 hours
3	August 1995	Male	178 cm	5 hours
4	May 1996	Male	194 cm	8 hours (euthanased)
5	February 1997	-	181 cm	3 hours
6	May 1997	Male	210 cm	1 hour
7	September 1998	Female	180 cm	18 hours

ONE WEEK MAINTENANCE OF A JUVENILE RISSO'S DOLPHIN (*GRAMPUS GRISEUS)* DURING A REHABILITATION ATTEMPT ON THE NORTH-WESTERN IBERIAN PENINSULA

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INTRODUCTION An average of 135 cetaceans beach every year on the Galician Coast (north-west of Spain). Of these, around 10% are stranded alive (López, 1998). There is a stranding network (CEMMA) operating in this area, although its work is related basically to post-mortem studies. Until now, the rescue operations consisted of the immediate return of the animals to open sea, due to the lack of a rehabilitation infrastructure.

This paper describes the first cetacean rehabilitation attempt on this coast handled under clinical procedures.

MATERIALS AND METHODS (clinical procedures) In the morning of the 17 October 1998, a juvenile female (165 cm) of Risso's dolphin (*Grampus griseus*) was found stranded alive in the mouth of the river Minor (Atlantic coast). The dolphin was transported to the Acquarium-Galicia facilities, where she was placed in a 15 x 5 x 1.5 m. pool.

All the observations of symptoms described were recorded during the rescue operations. Heart beats per min. were measured putting a hand ventrally betwen the insertion of the pectoral flippers (Geraci *et al*, 1993). Body condition was determined by the degree of concavity of the lumbar musculature (Barnett, 1998).

The rehabilitation attempt started with a milk replacer formula prepared with 2 kg. of sardine, 100 g. of vegetal oil, 250 g. of yoghurt with lactophilus, 125 g. of fresh cream, 1 l. of serum glucosed, and a polyvitamin complex with lecithin (Spotte, 1990; Fernández, 1997; Gili, 1998). The formula was administered with a 250 ml baby's bottle placed in the labial commissure at the rate of 300 ml every 3 hrs.

Antibiotics (Penicillin 40.000 U.I. intramuscular S.I.D.) (Stoskopf, 1990) and antiparasitic drugs (Praziquant (Droncit) 6 mg/kg), (Lacave, 1993) were administered from the first day.

Blood samples were obtained from the ventral surface of the fluke (Sweeney, 1995) for complete haematology and blood chemistry analyses. Head skin wounds and blowhole samples were obtained (Bossart *et al.*, 1990) for microbiological and fungal culture.

Necropsy and tissue sample collection (Kuiken *et al.*, 1991) were made immediately after the dolphin's death. Histological cuts were stained with haematoxilin/eosin.

RESULTS The initial examination indicated an unweaned dolphin with some loss of body condition noted by a depression of the lumbar musculature zone. Seven superficial circular wounds (from 1 to 3.5 cm length) were present on the dorsal skin of the head. No other abnormal signs were observed.

The dolphin hungrily suckled the formula. However, from the third day, she became progressively less hungry.

Results of the blood analyses were in the normal range described for this species (Nachtigall, 1990, except for lower levels of total proteins and glucose.

A polymicrobial fauna grew in the culture medium of the skin samples, dominated by motile Gram-negative *bacillus* (Proteus). Skin wounds were treated with a 10% povidone-iodine solution (Swaim, 1987).

The animal showed normal activity (swimming and diving) with short periods of calm till the last 48 hours when she started to spin 180° showing inability to return and maintain the normal position.

Unfortunately, the weight loss was continuous despite the increase in the formula intake, and the animal died six days after the stranding. Necropsy and histopathological analysis did not provide conclusive information.

CONCLUSIONS The cause of the dolphin's death remains unclear because the symptoms, complementary analyses, necropsy and post-mortem studies did not provide conclusive information. It seems that a severe catabolic metabolism was established, and this could not be reversed by the clinical procedures.

In spite of the dolphin's death, all the experience and information collected in this case represents a first step for the Galician stranding network toward guidelines on the best methods to handle live stranded cetaceans under clear clinical protocols.

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REFERENCES

Barnett, J. 1998. Treatment of sick and injured marine mammals. *Veterinary Practice*, (April 1998): 200-211.

Bossart, G. D. and Dierauf, L. A. 1990. Marine Mammal Clinical Laboratory Medicine. Pp. 1-52. In: *CRC Handbook of Marine Mammal Medicine.* CRC Press, Boca Raton FL, USA.

Fernández, E. 1996. *Clinical report on Grampus griseus calf rehabilitation.* Unpubl. Report.

Geraci, J. R. and Lounsbury, V. J. 1993. Cetaceans Single strandings. Pp. 71-132. In: *Marine Mammals Ashore: A Field Guide for Strandings.* Texas A&M Sea Grant Publication.

Gili, C. 1998. *Relazione complessiva dell'intervento effettuato su un esemplare di Grampus griseus cucciolo.* Unpubl. Clinical Report.

Kuiken, T. and García Hartmann, M. 1991. *Dissection Techniques and Tissue Sampling*. Pp. 1-39. Proceedings of the first ECS workshop on cetacean pathology, Leiden, the Netherlands, 13-14 September 1991. *ECS Newsletter* Special Issue No.17., 41pp.

Lacave, G. 1993. Diagnostic and Therapeutic methods. In: *Marine Mammals*, Zoo Duisburg, Dec. 4-5.

López, A. 1998. *Report on Cetacean strandings on the Galician Coast.* Unpubl. Report.

Nachtigall, P. E, Pawloski, J. L, Schroeder, J. P, and Sinclair, S. 1990. Successful maintenance and research with a formerly stranded Risso's dolphin (*Grampus griseus*). *Aquatic Mammals*, 16, 1: 8-13.

Spotte, S. 1990. Artificial Milk for Unweaned Marine Mammals. Pp. 521-532. In: *CRC Handbook of Marine Mammal Medicine,* CRC Press, Boca Raton FL, USA.

Stoskopf, M. K. 1990. Marine Mammal Pharmacology. Pp.139-162. In: *CRC Handbook of Marine Mammal Medicine,* CRC Press, Boca Raton FL, USA.

Swaim, S. F. and Lee, A. H. 1987 Topical wound medications: a review. *J. Am. Vet. Med. Assoc.*, 190, 12: 1588-1593.

Sweeney, J. C. 1995. Blood sampling and other collection techniques in marine mammals. Pp 425-428. In: *Fowler Zoo & Wild Animal Medicine, Current Therapy 3.* WB Saunders, Philadelphia, USA.

INFECTIOUS DISEASE MORTALITY IS ASSOCIATED WITH EXPOSURE TO MERCURY IN HARBOUR PORPOISES FROM ENGLAND AND WALES

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We investigate whether long-term exposure to heavy metals, including immunosuppressive metals like mercury, is associated with infectious disease in a wild cetacean.

Post mortem investigations on 86 harbour porpoises, *Phocoena phocoena*, found dead along the coasts of England and Wales revealed that 49 of the porpoises were healthy when they died, as a consequence of physical trauma (most frequently entrapment in fishing gear). By contrast, 37 porpoises died of infectious diseases caused by parasitic, bacterial, fungal and viral pathogens (most frequently pneumonia caused by lungworm and bacterial infections).

We found that mean liver concentrations of Hg, Se and Zn in the porpoises that died of infectious disease, were significantly higher than in those that died from physical trauma. Liver concentrations of Pb, Cd, Cu and Cr did not differ between the two groups. Furthermore, the Hg to Se molar ratio was significantly higher in the livers of porpoises that died of infectious disease, which may suggest a reduced capacity for the Se-dependent binding of highly toxic methylmercury in these individuals.

We discuss whether chronic exposure to Hg may have presented a toxic challenge and caused immunosuppression in the porpoises that succumbed to infectious disease mortality.

GASTROINTESTINAL HELMINTHS OF COMMERSON´S DOLPHINS (*CEPHALORHYNCHUS COMMERSONII*) FROM CENTRAL PATAGONIA AND TIERRA DEL FUEGO

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The Commerson´s dolphin is distributed along the coasts of Patagonia from Península Valdés to Tierra del Fuego, and it is incidentally caught in different types of fishing gear. This paper is the first reporting of results on gastrointestinal helminths, analysed in onnection with studies of stock differentiation.

The sample analysed consisted of eighteen individuals: nine from Central Patagonia (CP), and nine from Tierra del Fuego (TF). The former were caught incidentally in trawl nets; the latter were collected on beaches, presumably killed incidentally in coastal gillnets. Parasites were removed from stomachs and intestines, and were fixed and preserved in 70% ethanol.

Prevalence values for dolphins of the central Patagonian were: *Anisakis* sp.: 100% (presumably one species); *Braunina cordiformis*: 55.5%; *Pholeter gastrophilus*: 66.6%; *Hadwenius* sp.: 55.5%. Prevalences for Tierra del Fuego dolphins were: *Anisakis* sp.: 100%; *Hadwenius* sp.: 22.2% and *Strobilocephalus triangularis*: 11.1%.

Anisakis sp. was found in CP and TF hosts only in the third and fourth larval stages, despite the fact that the Commerson´s dolphin is a potential final host for the species in the area. Only one TF individual host carried adult forms of *Anisakis simplex*. *B. cordiforms* and *P. gastrophilus* were found in CP dolphins, while *S. triangularis* only appeared in one TF host. Despite the sample size, the differences in the helminth fauna between the two areas could be related to differences in feeding habits. The CP dolphins were found in open pelagic areas while those from TF were inhabiting coastal areas.

The presence of *P. gastrophilus*, *S. triangularis*, and *Hadwenius* sp. in Commerson´s dolphin represent new host records.

TROPHIC POSITION AND CADMIUM CONTENT OF DOLPHINS AND TUNAS FROM THE NORTHEAST ATLANTIC

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INTRODUCTION Small pelagic dolphins are commonly found associated with tunas in mixed-species aggregations. In general, these polyspecific aggregations seem to form when social species with similar foraging methods join to form larger groups to increase feeding success and to better avoid predators (Evans, 1982; Au, 1991; Scott and Cattanach, 1998). In the North-east Atlantic, three predators are often caught together in the same nets during tuna seining operations: the striped dolphin (*Stenella coeruleoalba*), the common dolphin (*Delphinus delphis*) and the albacore tuna (*Thunnus alalunga*). The question arises how predators requiring a similar diet in the same habitat share their environmental resources.

Dietary studies are often performed from field observations or analysis of stomach contents. Such information may also be obtained by isotopic analysis of stable carbon and nitrogen since isotope ratios of a consumer are related to those of their prey. Moreover, isotopic ratios, determined in both muscle and liver, allow a comparison of both short- and long-term diets; muscle is considered to have a longer turnover ($weeks^{-1}$ to $months^{-1}$), than the liver ($days^{-1}$).

Dolphins occupy the top of the trophic web, and therefore tend to accumulate high level of chemicals such as cadmium. However, heavy metal levels found in marine organisms depend not only on environment contamination but also on several other ecological or physiological factors, including the diet and position in the trophic network. Cephalopods, which are often preferential prey of dolphins, have been shown to concentrate cadmium (Law *et al.*, 1997).

This paper deals with some of the results relating to three marine predators from the North-east Atlantic (Das *et al.*, submitted): the striped dolphin, the common dolphin, and the albacore tuna, and focuses on a comparison of the trophic positions of the three species through both stable isotopic ratios, and cadmium levels.

MATERIALS AND METHODS Twenty-three striped dolphins, ten common dolphins, and twenty tunas, used in this study, originated from the Bay of Biscay in the North-east Atlantic. They were collected during commercial tuna seining operations during summer 1993 by IFREMER (Brest, France). Cadmium concentrations after tissue mineralisation in nitric and hydrochloric acid have been determined by atomic absorption spectrophotometry. $d^{13}C$ and $d^{15}N$ were analysed by mass spectrophotometry after lipid extraction from samples using chloroform and methanol rinses.

RESULTS AND DISCUSSION A stomach content analysis has been previously performed on these three predators by Hassani *et al.* (1997). In the two dolphin species, squids represent the most important prey group both in frequency and in abundance, while fish are predominant in the diet of the tuna. Very few squids are found in the stomach of tunas. Crustaceans are found significantly in the three species.

Our isotopic data performed in muscles also suggest a specific diet: Albacore tuna muscles display higher $d^{15}N$ than common and striped dolphins (mean: $11.4^0/_{00}$ *vs.* $10.3^0/_{00}$ and $10.4^0/_{00}$, respectively) which suggests a higher trophic level. Higher $d^{13}C$ are found in common ($-18.4^0/_{00}$) and striped dolphin ($-18.1^0/_{00}$) muscles than in albacore tuna ($-19.3^0/_{00}$). These isotopic data in muscles suggest a long-term substantial contribution of higher trophic level prey in the diet of tuna than in dolphin diet, and a more oceanic nutrition related to the tuna's migratory habit. There are no significant differences between common and striped dolphins. The trophic position of the tuna is rather unusual because generally in stable isotopes studies, marine mammals always display the higher d^{15}N compared with other species like fish.

However, in the livers which indicate recent feeds, no such specific re-grouping between individuals from the same species appears, indicating that the three species had a similar short-term food intake, and that some potential competition may exist between the three species.

Marine mammals that feed on cephalopods are known to concentrate high amounts of cadmium in their kidney and livers compared with animals that do not feed on squid (Bouquegneau and Joiris, 1992). The increase in hepatic cadmium levels of both dolphin species with length reflects a constant intake of cadmium-contaminated prey associated with a long half-time of elimination of the pollutant (Wagemann *et al.*; 1990). No correlation between size and cadmium levels was found in the livers of tuna, suggesting that the high hepatic cadmium content may be not chronic. The most striking feature was the presence of two groups, one heavily contaminated by cadmium (mean: 32±4 mg/kg dry weight), and another one displaying lower cadmium levels (mean: 5±1 mg/kg dry weight)

Tunas contaminated by cadmium display higher d^{15}N (mean: 11.5) and d^{13}C (mean: -18.1) than others (d^{15}N mean: 10.2 and d^{13}C mean: -18.7), suggesting that this cadmium discrepancy may be diet related as a result of a possible ingestion of cephalopods. These observations are supported by stomach analyses studies carried out by Hassani *et al.* (1997) which suggested that the diet of tuna differs in the presence of striped dolphins, with a higher squid content in the tuna stomach. When tuna was captured alone or in the same nets as common dolphins, fish was the predominant tuna prey. This is confirmed by our isotopic data in livers *vs.* muscles, which suggest two feeding behaviours in the recent past of the tunas.

CONCLUSIONS To conclude, combined stable isotopes and heavy metal analysis appears to be a powerful tool for tracing trophic relationships within these mixed-species aggregations. Further research on other organisms from this area will help to provide a better understanding of heavy metal transfer and different feeding relationships within high trophic levels.

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REFERENCES

Au, D. W. 1991. Polyspecific nature of tuna schools: shark, dolphin, and seabird associates. *Fishery Bulletin*, 89: 343-354

Bouquegneau, J. M. and Joiris, C. 1992. Ecotoxicology of stable pollutants in cetaceans: organochlorines and heavy metals. Pp. 247-250. In: *Whales: Biology - Threats - Conservation*. (Ed. J. J. Symoens). Symposium Proceeding, Brussels, 5-7 June 1991. Royal Academy of Overseas Sciences, Brussels.

Das, K., Lepoint, G., Loizeau, V., Debacker, V., Dauby, P., and Bouquegneau, J. M. (In press). Tuna and dolphin associations in the Northeast Atlantic: evidence of different ecological niches from stable isotope and heavy metal measurements.*Marine Pollution Bulletin.*

Evans, P. G. H. 1982. Associations between Seabirds and Cetaceans - a review. *Mammal Review*, 12: 187-206.

Hassani, S. Antoine, L. and Ridoux, V. 1997. Diet of Alabacore, *Thunnus alalunga*, and dolphins, *Delphinus delphis* and *Stenella coeruleoalba*, caught in the Northeast Atlantic albacore drift-net fishery: A progress report. *J. Northw. Atl. Fish. Sci.* 22: 119-123.

Law, R. J., Morris, R. J., Allchin, C. R., and Jones, B. R. 1997. Metals and chlorobiphenyls in tissues of spermwhales (*Physeter macrocephalus*) and other cetacean species exploiting similar diets. Pp. 79-89. In: *Sperm whale deaths in the North Sea: Science and Management.* (Eds. T. G. Jacques and R. H. Lambertsen). Bull. Inst. Roy. Sci. Nat. Belgium, 67, supplement.

Scott, M. D. and Cattanach, K. L. 1998. Diel pattern aggregations of pelagic dolphins and tunas in the eastern Pacific. *Marine Mammal Science*, 14(3): 401-428

Wagemann R., Stewart R. E., Béland P., and Desjardins, C. 1990. Heavy metals and selenium in tissues of beluga whales, *Delphinapterus leucas*, from the Canadian Arctic and the St. Lawrence estuary. *Can. Bull. Fish. Aquat.Sci.*, 224: 191-206.

FREQUENCY AND DOMINANCE OF BACTERIOLOGICAL PATHOGENS IN COMMON DOLPHINS (*DELPHINUS DELPHIS*) STRANDED ALONG THE COAST OF ANDALUSIA

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From May to October 1998, our laboratory received 12 samples from necropsies carried out on stranded individuals of the species common dolphin, *Delphinus delphis*. In all twelve cases, the dolphins were found in perfect condition for carrying out microbiological analysis.

The results of these microbiological studies reflect a positive culture for 66.6% of the samples (eight individuals). All isolations were carried out for samples obtained from different organs (liver, lung, kidney, spleen, brain and intestine), for which a diagnosis of septic systemic processes resulting in death was obtained. The infectious agents involved in these processes were identified as: *Pasteurella multocida*(2), *Pasteurella haemolytica* (2), *Pseudomonas aeruginosa* (2), *Candida albicans* (1), and *Nocardia asteoides* (1). These fungal and bacterial species are contained in the category of so called opportunistic and secondary pathogens, leading us to think of a previous state of severe immune deficiency of the animals, which could be associated with a toxic and/or viral agent. In order to clarify this situation, future research will involve toxicological and viral analysis of the tissues.

RENAL NEMATODOSIS IN CUVIER'S BEAKED WHALES (*ZIPHIUS CAVIROSTRIS*)

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INTRODUCTION Since 1995, the Centre for the Recuperation of Endangered Marine Species (C.R.E.M.A.), has been working on strandings of cetaceans along the coast of southern Spain. Among the twelve species of cetaceans recorded during this period, Cuvier's beaked whale (*Ziphius cavirostris*) strandings are considered of special interest, not so much for their frequency as for their peculiarity and the current lack of information on this species. There is still much to learn about this species, which belongs to the almost unknown family of cetaceans, Ziphiidae. This lack of knowledge is due to these animals' habits. The strandings records indicate that this species is distributed over all oceans and most seas, with the exception of the high polar waters (Moore, 1963), and it is most frequent in waters deeper than 1,000 metres (Nishiwaki and Oguro, 1972). Strandings constitute the current main source of valuable information about these animals.

METHODS C.R.E.M.A. tries to obtain the maximum information from every stranding. Data regarding date, location, taxonomic identification, sex, morphological measurements, external signs, and possible cause of stranding is recorded. Whenever possible, detailed necropsies are performed and biological samples are taken by C.R.E.M.A. for analysis (osteological material and tissue samples to study toxicology, stomach contents, external and internal parasites, etc.). The inspections are supported by video and photographic material. The records are inputted in a database. One of the most interesting points studied in Cuvier´s beaked whales has been the determination of pigmentation and general external appearance patterns of the specimens.

RESULTS Six Cuvier's beaked whale strandings have been recorded in 1997 and 1998 (see Table 1). Two of these strandings were found alive, occurring at different seasons of the year and under different meteorological conditions. Both animals showed similar symptoms, with blood analysis reflecting an important renal deficiency (see Table 2). In the first case, the animal died after 15 hours, and the second was euthanised, as its recovery was considered impossible. Necropsies of these two animals as well as of one of the two dead individuals, reflected an important renal parasitism by a nematode of the genus *Crassicauda*. The presence of this parasite and the organic response, were found to be responsible for originating a nephritic process as a result of the calcareous deposition which caused the atrophy of the renal lobulli. This, together with the obstruction of the urinary conducts produced by the same parasite, resulted in the acceleration of the renal failure process.

Pigmentation patterns of Cuvier's beaked whales: The pigmentation pattern for *Z. cavirostris* is poorly known due to the limited number of specimens examined that were fresh enough to be useful, and the fact that pigmentation patterns appear to be sexually dimorphic and change ontogenetically (Heyning, 1989). Colouring in adult males is described as dark grey over most of their bodies, with a distinctively white head. This white colouring contrasts with the rest of the body, and continues slightly posterior over the dorsal surface. The colouring described for adult females tends to vary from a dark grey to a reddish brown, with a slight lightening of the skin on the head. This colour contrast is not as dramatic as in males and does not appear to extend posteriorly on the dorsal part of the body.

In Cuvier´s beaked whale strandings recorded by C.R.E.M.A., different pigmentation patterns have been observed, even for animals of the same size, sex, and conservation status (fresh and very fresh), stranded on the same date and a few kilometres away from each other (see Table 1). Thus, the animal stranded in La Línea de la Concepción (Cádiz) was dark grey with a white head. The one stranded in Marbella (Málaga) did not have this white head and its general colour was lighter - a pinkish-brown. Another female specimen, smaller than this last one, which stranded alive in Estepona in May 1998, had a similar colouring to this one, slightly greyer and without the distinctive white colour on its head.

All the stranded animals had signs and marks on the skin, quite common in this species. These marks are attributed to interactions, both with other species (such as sharks and cephalopods), and with the same species. Lesions of ectoparasites of *Pennella sp.* are common.

Some characteristics of the parasite *Crassicauda* spp.: The nematodes (*Crassicauda* spp.) found in the collector urine channels usually range in size from 25 cm to 100 cm. They are variable in number; in the different cases we have studied, we have found from two or three (ZCA-121/98-M) to a maximum number of c. 40 specimens (ZCA120-/98-M). Differences in parasitic load between the right and left kidney have not been found, although they do seem to show a preference for the small lobes in the tercium anterior of the kidney.

Pathology: The parasite settles itself in one of the small renal lobes and begins to develop. A necrotic nephritis is caused by this strange body which results in the total dysfunctioning of the affected small lobe. Nevertheless, depending on the parasitic load and upon the immune response, higher or lower number of small lobes will be affected.So long as its development continues, the parasite will occupy the excretory vessels until it reaches the main excretory vessel, which communicates with the ureter. Then, and always depending on the parasitic load and on the extent to which one or both kidneys are affected, this process can provoke severe renal failure, due to an obstructive process which, according to our observations, is of a partial type.

CONCLUSIONS According to our studies, and the lack of confirmation of certain aspects, these nematodes can sometimes cause the animal's death. This is not due to a nephritis that leads to renal failure in itself, since there are functional small lobes still remaining, and each one is able to act as a little kidney. It is more likely to be due to a partial obstructive process which determines a sequence of metabolic alterations by multisystemic auto-intoxication.

Efforts to recuperate individuals of this species encounter serious problems because of their great size, the application of methods of diagnosis and treatment, and the poor knowledge of this species. Perhaps the diagnosis of the renal obstructive processes caused by *Crassicauda spp.* is simple and something to consider as a possible cause of stranding.

REFERENCES

Heyning, J. E. 1989. Cuvier's beaked whale, *Ziphius cavirostris* G. Cuvier, 1823. Pp. 289-307. In: *Handbook of Marine Mammals.* Volume 4. (Eds. S. H. Ridgway & R. Harrison). Academic Press, London & San Diego. 442pp.

Moore, J. C. 1963. The goose-beaked whale, where in the world? *Bull. Chicago. Nat. Hist. Mus.* 34: 2-3, 8.

Nishiwaki, N. and Oguro, N. 1972. Catch of Cuvier´s beaked whales off Japan in recent years. *Sci. Rep. Whales Res. Inst.* 24: 35-21.

Table 1 - Cuvier's beaked whales stranded on the Andalusian coast since 1995 and recorded by C.R.E.M.A.

CODE	DATE	PLACE	LENGTH	SEX	NECROPSY	OBSERVATIONS
-	3/3/95	Motril (Granada)	6m. (approx)	?	No	Diving in the port during 26 days
ZCA-025/97-M	27/3/97	Los Álamos (Malaga)	485 cm.	?	No	Only skeletal remains.
ZCA-027/97-M	11/4/97	Mijas (Malaga)	490 cm.	Male	Yes	It had shark bites. Tail missing. In decomposition. Renal parasitation.
ZCA-049/97-V	26/9/97	Guadalmar (Malaga)	475 cm.	Female	Yes	Stranded alive. Blood analysis and symptoms show obstruction in the urinary tubes. Ectoparasites *Pennella* sp.
ZCA-057/98-V	17/5/98	Estepona (Malaga)	475 cm.	Female	Yes	Stranded alive. Blood analysis and symptoms show an obstructive process of urinary tubes. Euthanasia was carried out.
ZCA-120/98-M	26/11/98	Marbella (Malaga)	540 cm.	Female	Yes	Ectoparasites *Pennella* sp. and *Xenobalanus*. No external lesions. Severe renal parasitism by *Crassicauda* spp.
ZCA-121/98-M	26/11/98	La Alcaidesa (Cadiz)	540 cm.	Female	Yes	Many ectoparasites *Pennella sp.* Renal parasitism by *Crassicauda* spp.

Table 2 - Blood analysis results of two living stranded specimens of *Z. cavirostris*

	ZCA-049/97-V	**ZCA-057/98-V**
RBC (10/mm3)	1'25	1'5
HT (%)	22%	60%
HB (g/dl)	19'8	
WBC (mm3)	4,100	4,200
CRETININE (mg/dl)	**8'2**	**4.6**
BUN (mg/dl)	189	67.65
ASAT (U/L)	540	
ALAT(U/L)	64	
URIC ACID (mg/dl)		1.4
PLATELETS (mm3)	83,000	

CETACEANS LIVING IN THE NORTH ADRIATIC SEA (GULF OF TRIESTE - GRADO LAGOON) - INTERVENTION PROTOCOL FOR HEALTHY AND DISTRESSED ANIMALS

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INTRODUCTION The Gulf of Trieste is one of the northernmost areas of the Mediterranean Sea, with a peculiar environment: the depth never exceeds 25 metres, water temperature can range from 7°C to 26°, salinity can range from 23‰ to 39‰, and the water is almost cloudy because of rivers and there is very strong tide. In the western part of the gulf there are lagoons and all the strandings of diseased animals occur in this shallow-water area. Dolphin and whales have been found in the middle and northern Adriatic Sea since Roman times. Biological reports of the last century, collected in the archives of the Natural History Museum of Trieste, note that fin whale *Balaenoptera physalus*, sperm whale *Physeter macrocephalus*, Risso's dolphin *Grampus griseus*, bottlenose dolphin *Tursiops truncatus*, striped dolphin *Stenella coeruleoalba*, and common dolphin *Delphinus delphis* were present and caught in this sea (Odoardi, 1791; Parona, 1897; Trois, 1894; Ninni, 1901; Spoto and Lapini, 1995). Bottlenose dolphin and striped dolphin are currently more common species, while Risso's dolphin is rare; common dolphin was the main resident cetacean in the northern Adriatic Sea until 40 years ago, but has since disappeared (Bearzi and Notarbartolo di Sciara, 1995), as have whales including the sperm whale. Current behaviour and social ecological studies focus on the bottlenose dolphin population of the Croatian Sea (Bearzi, 1997, 1999) and on groups moving in the middle of the Northern Adriatic Sea (Venice Dolphin Project, *pers. comm.*).

The Miramare Marine Reserve was actually created in the Gulf of Trieste in Italy in 1973, although it was officially established by the Ministry of Environment and Merchant Navy only on 12th November, 1986. It was created by the WWF, with the support of State grants, and is now a modern marine reserve, that conducts scientific research work (focused also upon the conservation of "large marine vertebrates"), and educational activities.

MATERIALS AND METHODS All available data have been collected with an old sightings form, completed by researchers or people who met mammals during their work or spare-time. Although not involved directly in dolphin research programmes, the Miramare Reserve acts as a reference centre for dolphins in the Gulf of Trieste, and is recognised as such by the Ministry of the Environment, the Coast Guard, the WWF, the CSC (Centro Studi Cetacei), and the ECS (European Cetacean Society). After ten years of activity, almost all potential "dolphin watchers" know that they should communicate any sighting to the Reserve, as do ordinary people, members of sailing and rowing clubs, nautical organisations, fishermen, and the police. Almost eight years ago, a group of marine biologists created the GPI (Gruppo di Pronto Intervento), which has now become EST (Emergency Service Team). This is a team which is always ready to act in the north-eastern part of the Adriatic Sea, when a cetacean is stranded, injured, or endangered by fishing equipment. All members of the EST are scuba divers who have experience in handling large marine vertebrates, like cetaceans, sea-turtles and sharks; a veterinarian co-operates for clinical and post-mortem examinations.

RESULTS Sightings: Data collected in the Gulf of Trieste up to this year mostly report sightings of bottlenose dolphin and striped dolphin, and rare visits of Risso's dolphin (Table 1). The highest frequency is found during spring and summer (Fig. 1), but dolphins move through the gulf throughout the year. It seems that no single individual ever tends to stay in this area for more than 4-5 months, and we have no evidence of periodical visits by any individually identified dolphin.

Strandings: Data related to dead animals demonstrate that lagoons function as traps for diseased dolphins (ST in Table 1). Moreover, they show the effects of the putative*Morbillivirus* epidemic of 1992 (Fig. 2). The greatest success of the GPI team was the release of a stranded young female Risso's dolphin in December 1996 (Zucca *et al.*, in press). In that instance the whole experimental aid protocol ran smoothly, thus confirming that it could be used as a standard procedure.

Preliminary photo-identification and behaviour studies: A preliminary analysis was conducted in 1996 to assess the frequency of the presence of cetaceans. In April 1996, the presence of a bottlenose dolphin was easily detected in the Bay of Muggia, where the animal remained for a few days. For the first time in this area, it was possible to identify the animal by photo-ID, and to collect evidence of its behaviour and respiration patterns (Fig. 3) (Bearzi *et al.*, 1997; Fortuna *et al.*, 1996).

Veterinary aspects: The aim of the veterinary protocol was to investigate the health status of the cetaceans living in the northern Adriatic sea. Standard post-mortem examinations were carried out on all stranded animals, with tissues/organs sampled for bacteriology (swabs, organs), virology, contaminants (heavy metals and PCB), and parasitology. Pathological findings included skin lesions, malnutrition, gastric ulcers, parasites (Nematodes, Trematodes), high mercury levels in liver and kidney.

CONCLUSIONS **Basis for new research:** The presence of dolphins in our sea is frequently considered non-significant, and there is a communication gap between observers and experts. Therefore, further involvement of the local population is necessary, e.g. with an easier-to-use, comprehensive cetacean sighting form. At the same time, the sighting form would be used for experimental research on dolphin-watching, performed by marine biologists in the Miramare Reserve along a transect in the Gulf of Trieste. The first part of the new sighting form focuses on the identification of the species of marine mammal sighted, the second part on the place of sighting, local environmental conditions, the number of cetaceans, and arrangement of the school; the third part is used to collect some easily identifiable behavioural data (Fig. 4). This will be supported by the photo-ID method, that allows researchers to assess the duration that these animals stay in the area using non-invasive methods of investigation, and by behaviour and respiration pattern sampling that could help to assess both the local environmental resources used by the animals and their physical state. Moreover, samples of animal, stranded or not, will be collected and submitted to the pathologists (Istituti Zooprofilattici delle Venezie, Universities) as soon as possible, according to the new wildlife health protocol of the Friuli Venezia Giulia Region.

Since more extensive research is in progress in the neighbouring areas of Croatia, Slovenia and the Venice lagoon (Italy), the use of photo-ID in the Gulf of Trieste allows us to obtain a comprehensive picture of cetacean movements in the northern Adriatic Sea.

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REFERENCES

Bearzi, G. and Notarbartolo di Sciara, G. 1995. A comparison of the present occurrence of bottlenose dolphin, *Tursiops truncatus*, and common dolphin, *Delphinus delphis*, in the Kvarneric (Northern Adriatic Sea). *Annales* (Annals for Istrian and Mediterranean Studies), 7: 61-68

Bearzi, G., Notarbartolo di Sciara, G. and Politi, E. 1997. Social ecology of bottlenose dolphin in the Kvarneric (Northern Adriatic Sea). *Marine Mammals Science*, 13, 4: 650 - 668.

Bearzi, G., Politi, E. and Notarbartolo di Sciara, G. (In press). Diurnal behaviour of free-ranging bottlenose dolphin in the Kvarneric (Northern Adriatic Sea). *Marine Mammal Science*, 15, 4.

Fortuna, C. M. 1996. Analisi dei modelli respiratori di tursiopi (*Tursiops truncatus* Montagu, 1821) osservati in Adriatico Settentrionale. Tesi di Laurea in Scienze Biologiche, Univ. Firenze. 105 pp.

Fortuna, C. M., Bearzi, G. and Delfino, G. 1996. Surfacing pattern of bottlenose dolphins following bottom trawlers in the Kvarneric (Northern Adriatic Sea). P. 244. In: *European Research on Cetaceans - 10*: Proc. 10th Ann. Conf. ECS, Lisbon, Portugal, 11-13 Mar 1996. (Ed. P. G. H. Evans). European Cetacean Society, Kiel, Germany. 334pp.

Fortuna, C. M., Bearzi, G. and Notarbartolo di Sciara, G. 1999. Analysis of respiration patterns of bottlenose dolphins observed in the Kvarneric (Northern Adriatic Sea, Croatia). Pp. 151-155. In: *European Research on Cetaceans -12*. Proc. 12th Ann. Conf. ECS, Monaco, 20-24 Jan 1998. (Eds. P. G. H. Evans & E. C. M. Parsons). European Cetacean Society, Valencia, Spain. 436pp.

Ninni, E., 1901. Sulle catture di alcuni Cetacei nel Mare Adriatico ed in particolare *Delphinus tursio*. *Neptunia*, XVI, 8, Venezia: 67–68.

Odoardi, J., 1791. De corpi marini che nel Feltrese distretto si trovano. *Nuova raccolta d'opusc. scientif. e filologici del Calogierà*. Tomo VIII, Venezia. 190pp.

Parona, 1897. Notizie storiche sopra i grandi cetacei nei mari italiani. *Atti Soc. Nat. e Museo Civ. St. Nat. Milano*, 36: 297-393.

Spoto, M. and Lapini, 1995. Cetacei. In: Materiali per una teriofauna dell'Italia Nord-Orientale (Mammalia, Friuli Venezia Giulia). Gortania - Atti del Museo Friulano di Storia Naturale, 17: 213-217.

Trois, F., 1894. Elenco dei Cetacei dell'Adriatico. *Riv. Ital. Sc. Nat. e Boll. Del Naturalista*. Anno 14, 10, Siena: 112-114 in Ninni 1901.

Zucca P., Francese, M., Spoto, M., Zuppa, F., and Oberosler, R. (In press). Intervento medico veterinario su di un esemplare di Grampo (*Grampus griseus*) spiaggiato a Grado. Fauna, Bollettino degli Osservatori Faunistici della Regione Friuli V.G.

Table 1 - Sighting and strandings data

Year	Species	Sight. (SI)/Strand. (ST) place
1990		
19th June 1990:	*Stenella ceruleoalba*	SI -Duino, Rilke, Sistiana (TS).
23rd August 1990:	*Tursiops truncatus*	SI -Barcola - Miramare (TS).
7th September 1990:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
6th October 1990:	*Stenella ceruleoalba*	SI- Marine Reserve (Miramare) (TS).
11th October 1990:	*Stenella ceruleoalba*	SI- coast of Trieste (Barcola) (TS).
12th -16th Nov 1990:	*Stenella ceruleoalba*	SI- Marine Reserve (Miramare) (TS).
11th December 1990:	*Tursiops truncatus*	SI- Port of Trieste (TS).
1991		
13th February 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
16th March 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
17th March 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
20th-25th March 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
16th April 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
16th April 1991:	5 *Tursiops truncatus*	SI- Port of Trieste (TS).
21th April 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
21th May 1991:	*Tursiops truncatus*	SI- Coast of Trieste (Barcola) (TS).
14th July 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
26th Jul-5th Aug 1991:	*Tursiops truncatus*	SI- Coast of Trieste (Barcola) (TS).
28th August 1991:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
1st October 1991:	*Tursiops truncatus*	ST- Grado Pineta (GO).
1992		
10th April 1992:	*Tursiops truncatus*	ST- Fossalon (GO).
15th April 1992:	*Stenella ceruleoalba*	ST- Fossalon di Grado (GO).
10th May 1992:	*Stenella ceruleoalba*	ST- Grado (GO).
10th June 1992:	2 *Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
6th October 1992:	*Tursiops truncatus*	ST- Lignano (UD).
12th October 1992:	*Tursiops truncatus*	ST- Grado (GO).
7th December 1992:	*Tursiops truncatus*	ST- Grado (GO).
1993		
18th May 1993:	3 *Grampus griseus*	SI- Marano Lagoon and Port (UD).
8th June 1993:	*Tursiops truncatus*	ST- Grado (GO).
1994		
June - September 1994:	*Tursiops truncatus*	SI- Duino, Rilke, Sistiana (TS).
1995		
9th January 1995:	2*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
10th January 1995:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
25th January 1995:	*Tursiops truncatus*	SI- Marine Reserve (Miramare) (TS).
3rd May 1995:	*Tursiops truncatus*	SI -Duino, Rilke, Sistiana (TS).
June - Sept 1995:	*Tursiops truncatus*	SI -Duino, Rilke, Sistiana (TS).
10th June 1995:	2 *Stenella ceruleoalba*	SI- Barcola, Miramare (TS).
1st December 1995:	*Stenella ceruleoalba*	ST- Grado (GO).
1996		
29th March 1996:	*Tursiops truncatus*	ST AND RELEASE Marano (UD).
16th April 1996:	*Tursiops truncatus*	SI- Port of Trieste (Channel) (TS).
18th August 1996:	*Tursiops truncatus*	SI- Barcola, Miramare (TS).
18th November 1996:	*Stenella ceruleoalba*	ST- Grado (GO).
21st December 1996:	*Grampus griseus*	ST AND RELEASE Grado (GO).
1997		
10th January 1997:	*Tursiops truncatus*	SI- Barcola (TS).
8th May 1997:	*Tursiops truncatus*	SI- Ginestre (TS).
11th August 1997:	*Tursiops truncatus*	SI- Grignano (TS).
1998		
11th May 1998:	*Stenella ceruleoalba*	SI- Muggia Bay (TS).
Aug- Sept 1998:	*Tursiops truncatus*	SI- Lignano e Grado (UD & GO).
2nd August 1998:	*Tursiops truncatus*	SI- Port of Trieste (TS).
9th August 1998:	*Tursiops truncatus*	SI- Port of Trieste (TS).

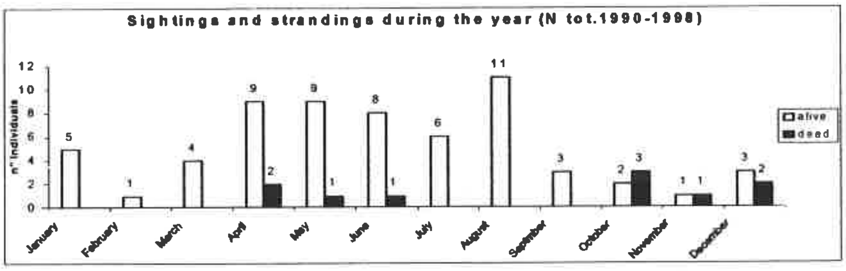

Fig. 1

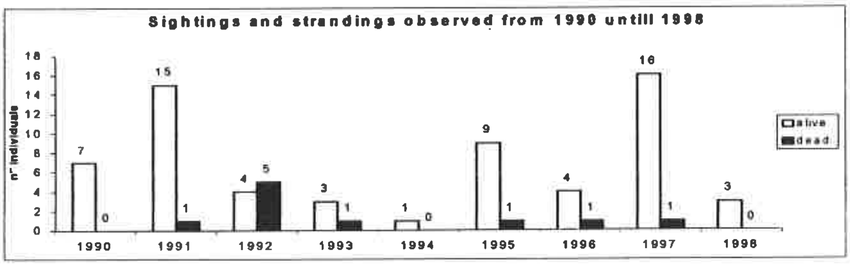

Fig. 2

Figs. 1 and 2 - Sighting and strandings in the Gulf of Trieste

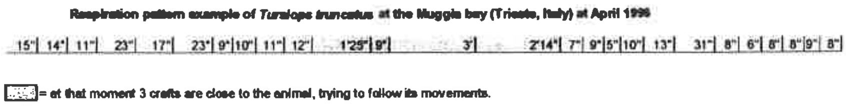

Fig. 3 - Example of the effect of a boat's noise

CETACEA SIGHTING FORM

Give it back to: ***NATURAL MARINE RESERVE OF MIRAMARE***
viale Miramare 349 34014 TRIESTE tel-fax 040/224147
E-MAIL: WWFMIRAM@UTSAX3.UNIV.TRIESTE.IT

WHAT'S THIS ?	If you have a marine mammal guide with you, write here the name of the species you have in front: ....; otherwise try to recognize it, crossing the following squares:

THE ANIMAL HAS A BEAK and:	yes	no
a dorsal fin at about midback, tall and sharply	D	
a squat tail with a normal caudal fin	T	
a slim tail with a wide caudal fin	ST CO	
a gray body on back and white below	TU ST	
some white stripes continue from eyes to the back	ST	
a white 'eight' form in the middle of the body side	CO	

THE ANIMAL DOESN'T HAVE A BEAK and:	yes	no
	D	
a big body, a dorsal fin sited on 2/3 back on body	ZI CA	
a gray body with white scratches on the back	GR	
a black body	GL PS	

THE ANIMAL HAS A CONSIDERABLE SIZE -WHALE- and:	yes	no
a big body, a dorsal fin sited on 2/3 back on body	B	
a white 'V' on the side and spots on the fins	MI	
the animal dives without to show its caudal fin and blows up	CO MI	
the animal dives showing its caudal fin and blows forward	CA	

WHERE IT IS ? WHAT IT IS DOING ?	Observe the animals carefully, use binoculars, compass or GPS system; if it is possible, try to do some pictures of them or film them.

Date, time and place of sighting	d/m/y: ....../....../......	h:........	place:..........................			
Position at the beginn of the sighting:		Lat:......	Long:.......			
Position at the end of the sighting:		Lat:......	Long:.......			
Environmental conditions:	smooth sea	rough sea	heavy sea	clear sky	overcast	wind
Number of animals:	1	2-5	5-10	10-20	others:	
Size of the animal/animals	0.5-1 m	1-2 m	2-5 m	5-10 m	10-20 m	
Animal conditions:	free ranging	fished	catched by a nest		in a lagoon or channel	
Do you film the animals or have you some picture of them ?					yes	no

N.B.: The personal dates are strictly private; they will be use onlyin case of gadgets posting or to improve the previous datas...

FIRST NAME:	......
FAMILY NAME:	......
ADDRESS:	....
TELEPHON NUMEBER/ FAX or E-MAIL:	

ETHOLOGICAL SIGHTING FORM

This is a short questionary to help us to collect some datas on the behaviour of our friends dolphins: try the emotion to be a marine researcher and test your investigative abilities !!!

At the sighting place you could notice:		feeding behaviour	
	.. some fishes jumping out of the water or moving at the surface of it ...	yes	no
	.. a high concentration of sea gulls flying above the sighting area ..	yes	no
	.. the dolphins diving longer than 30 sec between two consecutive respirations without moving from a limited area ..	yes	no
	.. the dolphins come out from the water carrying some fishes in the mouth or playing at the surface with needlefishes ..	yes	no
The dolphins are moving from the original sighting place:		cruising behaviou	
	.. following a definite course ..	yes	no
	.. diving shorter than 30 sec between two consecutive respirations ..	yes	no
The dolphins come out of the water surface with the whole body:		social behaviour	
	.. performing some jumps separated by a lapse of time ..	yes	no
	.. performing some consecutive jumps in succession ..	yes	no
	.. producing a loud sound by a part of the body (beak, lateral fin, caudal fin) knocking against the water surface ..	yes	no
	.. playing and jumping in pairs, rubbing and running after each other ..	yes	no
The dolphins are social towards the human people:		human interactions	
	.. approaching the craft ..	yes	no
	.. swimming on the wave made by the craft ..	yes	no
You notice some troubles for the dolphins caused by human people:		human impact	
	.. by the presence of crabs following the animals, during their travel, in the sighting area ..	yes	no
	.. how many they are ? Count them at once !	number:	
	.. by other causes such as .. write in the following lines the causes and the number of them (if possible) ..	yes	no
	.. the disturbance is signaled by prolonged dives of the animals which emerge far from the immersion point ..	yes	no
Some dolphins appear to be in trouble:		pathology	
	.. they stay motionless at the water surface, they look tired and dont react to external stimuli ..	yes	no
	.. they present clear wound signs	yes	no
	.. they present clear parasite signs (bubos or white scabs) ..	yes	no

FIRST NAME:	......
FAMILY NAME:	......
ADDRESS:	......
TELEPHON NUMEBER/ FAX or E-MAIL	

Fig. 4 – New cetacean sighting form

LIPID PEROXIDES IN INTERNAL TISSUES OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) AS BIOMARKER OF ENVIRONMENTAL EXPOSURE TO HEAVY METALS AND ORGANOCLORINE RESIDUES

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INTRODUCTION Although direct measurement of pollutant levels in marine organisms is necessary, there is an increasing need to develop methods for the identification of the actual effects of the pollutants upon the organisms. Recently, the use of biomarkers has been proposed as sensitive early warning tools for biological effect measurement in environmental quality assessment (Blasco and Bebianno, 1998; Cajaraville *et al.*, 1998; McCarthy and Shugart, 1990). Several toxic compounds, such as heavy metals and organochlorine compounds, tend to be bio-magnified in the marine food-chain, so that top predators such as marine mammals may accumulate high concentrations of these contaminants, and are consequently subjected to toxicological risks (Fossi, 1998). In humans and terrestrial animals, it has been considered that lipid peroxidation damage is involved in ageing and pathological disorders including some poisonings. Recently, the measurement of levels of lipid peroxides in tissues has been used as a biomarker of environmental exposure to heavy metals and organochlorine compounds. The reaction of lipid peroxides with thiobarbituric acid has been widely adopted as a sensitive assay method for lipid peroxidation in animal tissues. We have not found references in the literature concerning levels of lipid peroxides in tissues of dolphins. Heavy metals (lead and cadmium), organochlorine residues, and lipid peroxides have been analysed in several tissues of common dolphins (*Delphinus delphis*) found stranded on the Spanish southern Mediterranean coast.

MATERIALS AND METHODS Eleven common dolphins (*Delphinus delphis*) were found stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998. Samples of liver, kidney and brain were obtained by the staff of the C.R.E.M.A. (Málaga, Andalusia, Spain) and were frozen as soon as field conditions permitted. Sex, age, and nutritional status are detailed in the Table 1.

The levels of lipid peroxides found in this study have been correlated with the levels of the pollutants and biological factors, such as age, sex, and nutritional status of the dolphins.

Determination of lipid peroxides: We used the method described by Ohkawa *et al.* (1979), but with slight modifications. Samples of tissues were introduced in ice-cold 0.9% NaCl. 0.5 g. of wet tissue was prepared for homogenisation, and transferred to a Teflon Potter homogeniser. After addition of 5 ml of 1.15% KCl and 5 ml of 8.1% SDS, the sample was homogenised. The homogenised sample underwent an ultrasonic bath for 15 min.; 0.4 ml of this extract was transferred to a centrifugal tube, and 1.5 ml of 10% acetic acid was added. Then 1.5 ml of 0.8% TBA, and 0.6 ml of distilled water were added. After agitation, the sample was treated at 95ºC for one hour. Finally, total lipids were extracted with 5 ml of butanol : piridina (15:1) and, after centrifugation, the upper layer was measured using a ultraviolet-visible spectrophotometer to a wavelength of 535 nm. Blanks and standards were prepared using the same procedure.

Determination of heavy metals: Anodic Stripping Voltametry (ASV) analytic method has been used to determine concentrations of lead and cadmium. Firstly, all samples suffered dehydration in order to obtain results on dry weight. Our procedure has been previously published (García-Fernández *et al.*, 1995). It consists of wet digestion of samples using 0.5 ml of an acid mixture (nitric/perchloric/sulphuric acids, 8/8/1). The sample was then submitted to a progressive thermal treatment. A voltameter with a VA-646 processor and a VA-647 workstation (Metrohm, Switzerland) were used for analytical determination of lead and cadmium.

Determination of organochlorine compounds: The method employed to extract organochlorine compounds from tissues was described by Luna *et al.* (1993). A small tissue sample (0.2 g) was mixed at high speed using benzene as an extractant. The extract was purified by passing it through a Florisil microcolumn (Sep-Pak, Waters). The eluate was concentrated and redissolved to a volume of 5 ml of n-hexane. One ml of this extract was analysed by gas chromatography with an electron capture detector (ECD). The capillary column used was a 30 m x 0.25 mm ID fused silica SPB-5 (Supelco). Inlet and detector temperatures were 200° and 300° C respectively; a column temperature program was started at 90° C/min., and increased 5° C/min. up to 240° C, 30° C/min. up to 270° C. Helium was used as a carrier gas at about 1ml/min. Quantification was done using external standards (Supelco) which were assayed for repeatibility and recovery by preparing consecutive dilutions. The standard contained the following organochlorine compounds: a-HCH, b-HCH, lindane, d-HCH, aldrin, dieldrin, endrin, edrin-aldheyde, endosulphane I, endosulphane II, *p-p'*-DDT, heptachlor, heptachlor epoxide, *p-p'*-DDE, and *p-p´*-DDD. Limit of detection for every compound was 0.001 mg/kg.

Statistical studies: Data were grouped by lipid peroxides in each tissue, sex, age, and nutritional status. They were expressed as mean ± standard error, minimum and maximum values, median, and standard deviation. T tests for independent samples were used to examine differences both between species, and between males and females. To examine differences among groups by age and nutritional status, we used one-way analysis of variance (ANOVA) test. All statements of significance were based on the 0.05 level of probability.

RESULTS AND DISCUSSION It is well known that after the death of a living being, important biochemical changes are produced in the tissues. In spite of that, the concentrations of some elements, such as heavy metals and organochlorine compounds, do not suffer great changes. For this reason, the measurement of these compounds can be useful as an "indicator of exposure", although the animal died several hours before. However, the parameters proposed as "biomarkers of effect" have a biochemical origin and therefore they are rapidly discomposed after the death. This is the reason why the study of biochemical biomarkers must be conducted on tissues from animals in a good state of conservation. Fossi (1998) reported that some stranded cetaceans could be used for analysis of biomarkers, provided that the samples could be taken immediately after the death. We have analysed tissues from stranded dolphins. However, we could not obtain precise information about the time elapsed between the death of the dolphins and the sampling of their tissues, although we believe this time period was small in the cases studied. Taking into account this fact, it is difficult to obtain definitive conclusions about the usefulness of the lipid peroxides as a biomarker of exposure and effect on dolphins. However, because this is the first information about lipid peroxide levels in dolphins in the literature, we believe these results can be useful for new studies in the future, which will confirm them or not.

The detection and measurement of lipid peroxidation is the evidence most frequently cited to support the involvement of free radical reactions in toxicology (Halliwell and Gutteridge, 1990), and it is considered as a well established mechanism of cellular injury. Malondialdehyde (MDA) is in many instances the most abundant individual aldehyde resulting from lipid peroxidation, and its determination by thiobarbituric acid (TBA) is one of the most common assays in lipid peroxidation studies (Esterbauer and Cheeseman, 1990). It has been observed in *in vitro* studies that MDA can alter proteins, DNA, RNA, and many other biomolecules (Schauenstein *et al.*, 1977). We have used the measurement of MDA as a biomarker of lipid peroxidation, and we have provided the results expressed as nmol of MDA per g. of wet tissue. The average lipid peroxide levels were 150.1 ± 60.9 nmol brain, 133.1 ± 19.0 nmol in liver, and 108.4 ± 28.1 nmol in kidney. We have not found references to lipid peroxide levels in tissues of dolphins; for comparison, however, Ohkawa *et al.* (1979) obtained results slightly higher on tissues of male rats: 351 nmol MDA/g in liver, 234.6 nmol in kidney, and 211.5 nmol in brain. In our study, there were no differences between males and females except in brain lipid peroxide levels. Only one sample of brain of a female was analysed and its result was excessively high by comparison with the results obtained in brains of males. If we exclude this controversial result, the average lipid peroxide level in the brain was 90.2 nmol MDA/g. and then the arrangement of tissues should be the same as reported by Ohkawa: liver > kidney > brain. No statistical differences were found when organochlorine levels in tissues were compared by age and nutritional status.

A positive correlation was found between lipid peroxide levels in the liver and organochlorine concentrations in liver and fat. Lipid peroxide levels in the brain were positively correlated with cadmium, endosulphane and HCH concentrations in brain. The levels of lipid peroxides in kidney were only correlated with the levels of lead in this tissue. We believe that it is necessary to analyse more samples of dolphins and other cetaceans in order to conclude if this assay is useful as a biomarker of environmental exposure to pollutants in marine mammals.

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REFERENCES

Blasco, J. and Bebianno, M. J. 1998. Biomarkers. *Cuad. Invest. Biol.* 20: 541.

Cajaraville, M. P., Cancio, I., Orbea, A., Lekube, X. and Marigómez, I. 1998. Detection, control and monitoring of pollution using early warning cellular biomarkers: conventional and innovate approaches based on biotechnology. *Cuad. Invest. Biol.*, 20: 545-548.

Esterbauer, H. and Cheeseman, K. H. 1990. Determination of aldehydic lipid peroxidation products: malonaldehyde and 4-hydroxynonenal. *Meth. Enzimol.*, 186: 407-421.

Fossi, M. C. 1998. Environmental toxicology of sea mammals and other endangered wildlife species. *Cuad. Invest. Biol.*, 20: 347-350.

García-Fernández, A. J., Sánchez, J. A., Jiménez, P. and Luna, A. 1995. Lead and Cadmium in wild birds in Southeastern Spain. Environ. *Toxicol. Chem.*, 14, 12: 2049-2058.

Halliwell, B. and Gutteridge, J. M. C. 1990. Role of free radicals and catalytic metal ions in human disease: an overview. *Meth. Enzimol.*, 186: 1-85.

Luna, A., Molina, C., Barba, A., Navarro-García, S. and Cámara, M. A. 1993. Determinación de residuos de insecticidas organoclorados en grasa humana. Comparación de métodos analíticos. *Rev. Toxicol.*, 10:47-49.

McCarthy, J. F. and Shugart, L. R. 1990. Biological markers of environmental contamination. Pp. 3-14. In: *Biomarkers of environmental contamination* (Eds. J. F. MaCarthy and L. R. Shugart). Lewis Publishers, Boca Ratón, Florida.

Ohkawa, H., Ohishi, N. and Yagi, K. 1979. Asay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Anal. Biochem.*, 95: 351-358.

Schauenstein, E., Esterbauer, H. and Zollner, H. 1977. *Aldehydes in biological systems: Their natural occurence and biological activities.* Pion Press, London.

Table 1 - Individual characteristics and pathological findings in common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

Dolphin	Sex	Age	Nutritional Status
1	Male	Sub-adult	High
2	Male	Adult	High
3	Female	Adult	Medium
4	Male	Sub-adult	High
5	Female	Sub-adult	High
6	Female	Sub-adult	Medium
7	Female	Young	High
8	Male	Adult	Low
9	Male	Sub-adult	Medium
10	Male	Young	High
11	Male	Sub-adult	Low

Table 2 - Lipid peroxide levels in liver, kidney and brain of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

Tissue	Sample	Mean	S.E. Mean	Std. Dev.	Minimum	Maximum
Liver	10	133.1	19.0	60.2	67.4	249.9
Kidney	9	108.4	28.1	84.2	17.4	243.5
Brain	5	150.1	60.9	136.2	64.8	389.6

Table 3 - Lipid peroxide levels in internal tissues of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998, grouping by sex

Tissue	Sample	Mean	S.E. Mean	Std. Dev.	Minimum	Maximum
MALES						
Liver	6	136.7	24.6	60.3	81.9	249.9
Kidney	6	101.0	32.5	79.5	40.8	243.5
Brain	4	90.2	14.5	29.0	64.8	121
FEMALES						
Liver	4	127.6	34.4	68.9	67.4	194.7
Kidney	3	123.3	63.4	109.8	17.4	236.6
Brain	1	389.6	---	---	---	---

Table 4 - Lead and cadmium concentrations in internal tissues of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

Metal	Tissue	Mean	S.E. Mean	Std. Dev.	Median	Min.	Max.
Cadmium	Liver	0.58	0.23	0.77	0.32	0.05	2.78
	Kidney	1.99	0.53	1.77	1.42	0.25	6.25
	Bone	0.07	0.04	0.14	0.01	0.01	0.48
	Brain	0.03	0.01	0.03	0.02	0.01	0.07
Lead	Liver	1.36	0.72	2.39	0.47	0.22	8.27
	Kidney	0.53	0.10	0.34	0.42	0.24	1.49
	Bone	1.18	0.21	0.70	0.97	0.59	3.05
	Brain	0.44	0.09	0.22	0.44	0.13	0.72

Table 5. Organochlorine concentrations (mg/kg) in internal tissues of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

OCl	Tissue	Sample	Mean	S.E. Mean	Std. Dev.	Min.	Max.
Total OCl	Brain	6	0.233	0.090	0.219	0.04	0.60
	Fat	9	1.999	0.416	1.247	0.44	4.32
	Liver	11	0.364	0.123	0.407	0.05	1.13
Ciclodienes	Brain	6	0.032	0.013	0.032	n.d.	0.08
	Fat	9	0.383	0.074	0.223	0.11	0.74
	Liver	11	0.091	0.035	0.115	n.d.	0.31
DDT & derivs.	Brain	6	0.077	0.029	0.072	n.d.	0.20
	Fat	9	1.324	0.313	0.938	0.29	3.06
	Liver	11	0.093	0.044	0.145	n.d.	0.51
Endosulphane	Brain	6	0.018	0.008	0.020	n.d.	0.04
	Fat	9	0.243	0.059	0.176	0.02	0.62
	Liver	11	0.050	0.024	0.080	n.d.	0.22
HCH	Brain	6	0.077	0.035	0.085	0.01	0.23
	Fat	9	0.028	0.006	0.019	0.01	0.06
	Liver	11	0.075	0.022	0.074	n.d.	0.22
Heptachlor	Brain	6	0.030	0.016	0.039	n.d.	0.09
	Fat	9	0.021	0.004	0.012	0.01	0.04
	Liver	11	0.048	0.023	0.075	n.d.	0.23

LEAD AND CADMIUM IN INTERNAL TISSUES OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) STRANDED ON THE COAST OF ANDALUSIA (SW MEDITERRANEAN): INFLUENCE OF BIOLOGICAL FACTORS

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INTRODUCTION Lead and cadmium are industrial poisons which may have important consequences for human beings and for domestic and wild animals, either through acute or chronic exposure, since these heavy metals are accumulated in the organism, mainly in liver and kidney. This work presents the results of an investigation into the levels of lead and cadmium found in the liver, kidney, bone and brain of common dolphins stranded on the coast of Andalusia (SW Mediterranean, Spain). The accumulation of heavy metals in marine organisms has increasingly drawn attention because of heavy metal pollution in the marine environment. Some studies have been published about levels of heavy metals in internal tissues of dolphins and other marine mammal. However, they are few in comparison with similar studies in other species of wild and domestic animals. On the other hand, few studies have tried to correlate the heavy metal levels in tissues of dolphins with the pathological changes observed in them, in other words, the toxicological risk assessment as a consequence of the exposure to these metals.

MATERIALS AND METHODS Eleven common dolphins (*Delphinus delphis*) were found stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998. Samples of liver, kidney, brain, and bone were obtained by the staff of the C.R.E.M.A. (Málaga, Andalusia, Spain) and they were frozen as soon as field conditions permitted. Sex, age, nutritional status, and pathological findings are detailed in Table 1.

Anodic Stripping Voltametry (ASV) analytic method has been used to determine the concentrations of lead and cadmium. Firstly, all samples suffered dehydration in order to obtain results on dry weight. Our procedure has been previously published (García-Fernández *et al.*, 1995). It consists of wet digestion of samples using 0.5 ml of an acid mixture (nitric/perchloric/sulphuric acid, 8/8/1). The detection limits were 0.25 ppb for cadmium and 0.5 ppb for lead. The repeatability, determined by analysing ten identical samples of reconstituted lyophilised blood (European Union Reference Standards) CRM195, was 96.5 ± 1.2% for lead, and 94.2 ± 3.2% for cadmium. The means of the recoveries were 101.2-102.3% (blank), 103.2-100.6% (liver) and 101.9-103.4% (kidney), respectively.

Data were grouped by metal concentrations in each tissue, sex, age, and nutritional status. They were expressed as mean ± standard error, minimum and maximum values, median, and standard deviation. T tests for independent samples were used to examine differences both between species, and between males and females. To examine differences among groups of age and nutritional status, we used one-way analysis of variance (ANOVA) test. All statements of significance were based on the 0.05 level of probability.

RESULTS AND DISCUSSION Results of the cadmium and lead concentrations are shown in Table 2, and Figs. 1 and 2. Lead and cadmium are important industrial poisons for human beings and also for domestic and wild animals, not only in acute but also in chronic exposure, because these heavy metals are accumulated in the organism, mainly in liver and kidney. This paper presents the results of an investigation on lead and cadmium levels in internal tissues of common dolphins as a useful tool to evaluate the marine environmental contamination on the Mediterranean coast of Andalusia (southern Spain). The health risk assessment in the dolphins has also been considered.

Tissues analysed and levels of heavy metals: In the kidney, the mean concentration of cadmium was significantly higher than the mean concentration of lead. In the rest of tissues analysed (liver, bone and brain), the mean concentrations of lead were higher than those of cadmium, although the highest difference was observed in bone where lead is more accumulated than cadmium, this difference being statistically significant. Similar results have been reported by Leonzio *et al.* (1992) in striped and bottlenose dolphins. These results confirmed the distribution pattern of these heavy metals described in other wild animal species of mammals (Santiago *et al.*, 1998) and birds (García-Fernández *et al.*, 1996; 1997). However, it is noteworthy that the mean concentration of lead in brain was relatively high, and similar to the mean concentrations of lead found in kidney and liver. This aspect differs from the typical distribution pattern of lead, and it is possible that a correlation exists with the alterations in the central nervous system observed in the anatomo-pathological studies.

Cadmium is principally accumulated in the kidney, and the average ratio hepatic-cadmium/renal-cadmium was 0.29. Environmental exposure to cadmium determines a distribution pattern in which the ratio between cadmium concentration in liver and kidney increases with the intensity of exposure (Friberg *et al.*, 1974). In previous papers, we have studied this ratio in mammals and birds, and, following Scheuhammer (1987), when this ratio is lower than one we may conclude that the animals are exposed chronically to environmental cadmium.

Sex: The mean concentrations of cadmium and lead in males were higher than those found in females in all tissues analysed, except cadmium in the brain and lead in bone, which were higher in females than in males. However, these differences were not statistically significant. Honda *et al.* (1983) found differences in hepatic lead concentrations between mature males and mature females, and they thought that were due to the effects of parturition and lactation. In our study, we have only analysed one mature female and the tissue lead levels found were lower than in males.

Age: Renal cadmium concentrations increased with age of the dolphins ($r=0.78$). However, only a negative relationship was found between age of the dolphins and lead concentration in the brain ($r=-0.45$), in other words, brain lead concentrations decreased with age. Dietz *et al.* (1996) found an increase of cadmium with age, whereas lead concentrations are not correlated with age. Similar results, although without statistical significance, were found by Holsbeek *et al.* (1998). However Honda *et al.* (1983) found significant positive correlation with age of lead and cadmium concentrations in liver. Honda *et al.* (1983) also reported that a rapid change of metal concentration from birth up to one year indicates that lead and cadmium are transferred via milk from the mother to her pup. Due to the small number of samples, we cannot confirm this finding, but we have observed that the highest brain lead and cadmium concentrations were found in suckling calves, and the highest bone lead concentration was found in one of these also, this difference being statistically significant.

Nutritional status: The nutritional status of the dolphins was negatively correlated with renal cadmium concentration, so that those with low nutritional status had high concentrations of cadmium in the kidney. On the other hand, dolphins with high nutritional status showed a positive correlation with hepatic lead concentration.

Health status: Chronic exposure to environmental lead and cadmium can produce many toxic effects. These elements can alter the functioning of the kidney tubules and also have toxic effects on the male reproductive system, leading to a decrease in spermatogenesis and testicular atrophy (Lu, 1991). In a calf showing nervous symptoms, Seimiya *et al.* (1991) found 1.3 and 3.9 mg/kg of lead in liver and kidney respectively. Shlosberg *et al.* (1997) diagnosed a case of lead poisoning in a bottlenose dolphin that had ingested 55 airgun pellets of lead. This dolphin showed signs of anorexia and weight loss, and died four weeks later. They observed anatomo-pathological alterations in brain, optic nerve, liver and kidney, and they found 3.6 and 4.2 mg/kg of lead in liver and kidney, respectively. Two dolphins studied here (number 1 and 4) had levels of lead close to those cited above, and cadmium levels higher than the rest of the dolphins. We think it is possible that exposure to these metals is partly responsible for the changes observed in the kidneys and in the brain of the dolphins.

Several studies have demonstrated the relationship between heavy metal exposure and immunotoxicological effects in animals. Koller (1980) confirmed that evidence existed for lead exposure increasing the susceptibility of animals to infectious diseases. In mallard ducks (*Anas platyrhynchos*) exposed chronically to lead, Rocke and Samuel (1991) observed a decrease in the number of spleen cells, for example. The analytical results of lead and cadmium, and the histopathological changes of this study, suggest that environmental exposure to these metals in dolphins could explain some pathological effects due to immunosuppression.

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REFERENCES

Dietz, R., Riget, F. and Johansen, P. 1996. Lead, cadmium, mercury and selenium in Greenland marine animals. *Sci. Total Environ.*, 186, 1-2: 67-93.

Friberg, L., Piscator, M., Nordberg, G. F. and Kjellström, T. 1974. *Cadmium in the environment.* CRC Press, Cleveland, Ohio. 2nd edition.

García-Fernández, A. J., Motas, M., Navas, I., María-Mojica, P., Luna, A. and Sánchez-García, J. A. 1997. Environmental exposure and distribution of lead in four species of raptors in southeastern Spain. *Arch. Environ. Contam. Toxicol.*, 33: 76-82.

García-Fernández, A. J., Sánchez, J. A., Gómez, M. and Luna, A. 1996. Distribution of cadmium in blood and tissues of wild birds. *Arch. Environ. Contam. Toxicol.*, 30, 2: 252-258.

García-Fernández, A. J., Sánchez, J. A., Jiménez, P. and Luna, A. 1995. Lead and Cadmium in wild birds in Southeastern Spain. *Environ. Toxicol. Chem.*, 14, 12: 2049-2058.

Holsbeek, L., Siebert, U. and Joiris, C. R. 1998. Heavy metals in dolphins stranded on the French Atlantic coast. *Sci. Total Environ.*, 217, 3: 241-249.

Honda, K., Tatsukawa, R., Itano, K., Miyazaki, N. and Fujiyama, T. 1983. Heavy metal concentrations in muscle, liver and kidney tissue of striped dolphin, *Stenella coeruleoalba*, and their variations with body length, weight, age and sex. *Agric. Biol. Chem.*, 47, 6: 1219-1228.

Koller, L. D. 1980. Immunotoxicology of heavy metals. *Int. J. Immunopharm.*, 2: 269-279.

Leonzio, C., Focardi, S. and Fossi, C. 1992. Heavy metals and selenium in stranded dolphins of the northern Tyrrhenian (NW Mediterranean). *Sci. Total Environ.*, 119: 77-84.

Lu, F. C. 1991. *Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment.* Taylor and Francis, New York, 248pp.

Rocke, T. E. and Samuel, M. D. 1991. Effects of lead shot ingestion on selected cells of the mallard immune system. *J. Wildl. Dis.*, 27: 1-9.

Santiago, D., Motas, M., Reja, A., María-Mojica, P., Rodero, B. and García-Fernández, A. J. 1998. Lead and Cadmium in red deer and wild boar from Sierra Morena (Andalusia). *Bull. Environ. Contam. Toxicol.*, 61: 730-737.

Scheuhammer, A. M. 1987. The chronic toxicity of alumminium, cadmium, mercury and lead in birds: a review. *Environ. Poll.*, 46: 263-295.

Seimiya, Y.; Itoh, H. and Ohshima, K. 1991. Brain lesions of lead poisoning in a calf. *J. Vet. Med. Sci.*, 53: 117-119.

Shlosberg, A., Bellaiche, M., Regev, S., Gal, R., Brizzi, M., Hanji, V., Zaidel, L. and Nyska, A. 1997. Lead toxicosis in a captive bottlenose dolphin (*Tursiops truncatus)* consequent to ingestion of air gun pellets. *J. Wildl. Dis.*, 33, 1: 135-139.

Table 1 - Individual characteristics and pathological findings in common dolphins stranded on the coast of Andalusia (Southwestern Mediterranean) between November 1997 and May 1998

Dolphin	Sex	Age	Nutritional Status	Pathological findings
1	Male	Sub-adult	High	Congestion in brain. Degeneration in CNS. Renal failure. Lymphoid depletion.
2	Male	Adult	High	Congestion in brain and lungs. Oedema in lymphatic ganglia. Edema in subcutaneous tissue.
3	Female	Adult	Medium	Widespread congestion (including in brain). Pulmonary oedema and pneumonia. Hepatic fibrosis. Nephrosis. Congestion and hemorrhagies in lymphatic ganglia.
4	Male	Sub-adult	High	Edema and congestion in lungs. Interstitial fibrosis in renal medulla. Degenerative alterations and congestion in brain. Congestion in lymphatic ganglia
5	Female	Sub-adult	High	Brain congestion. Eedema in lungs. Degenerative alterations in brain.
6	Female	Sub-adult	Medium	General congestion. Pulmonary edema. Lymphoid depletion.
7	Female	Young	High	Congestion in brain, meninges and lungs. Degenerative alterations in brain.
8	Male	Adult	Low	Congestion in brain. Lymphatic ganglia congestion. Pulmonary oedema. Hepatic congestion. Degenerative alterations in brain.
9	Male	Sub-adult	Medium	Congestion in brain. Congestion and edema in lungs. Hepatic esteatosis. Lymphoid depletion. Degenerative alterations in CNS
10	Male	Young	High	Congestion in brain and in pulmonary epithelial cells.
11	Male	Sub-adult	Low	Congestion in lymphatic ganglia. Pulmonary oedema and congestion. Hepatic degeneration. Renal failure. Degenerative alterations in CNS

Table 2 - Lead and cadmium concentrations in internal tissues of common dolphins stranded on the coast of Andalusia (Southwestern Mediterranean) between November 1997 and May 1998

Metal	Tissue	Mean	S.E. Mean	Std. Dev.	Median	Min.	Max.
Cadmium	Liver	0.58	0.23	0.77	0.32	0.05	2.78
	Kidney	1.99	0.53	1.77	1.42	0.25	6.25
	Bone	0.07	0.04	0.14	0.01	0.01	0.48
	Brain	0.03	0.01	0.03	0.02	0.01	0.07
Lead	Liver	1.36	0.72	2.39	0.47	0.22	8.27
	Kidney	0.53	0.10	0.34	0.42	0.24	1.49
	Bone	1.18	0.21	0.70	0.97	0.59	3.05
	Brain	0.44	0.09	0.22	0.44	0.13	0.72

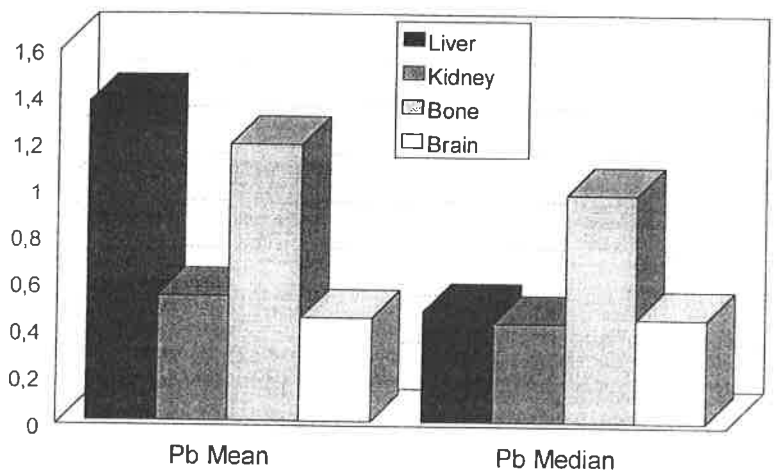

Fig. 1 - Lead concentrations (mg/kg, dw) in internal tissues of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

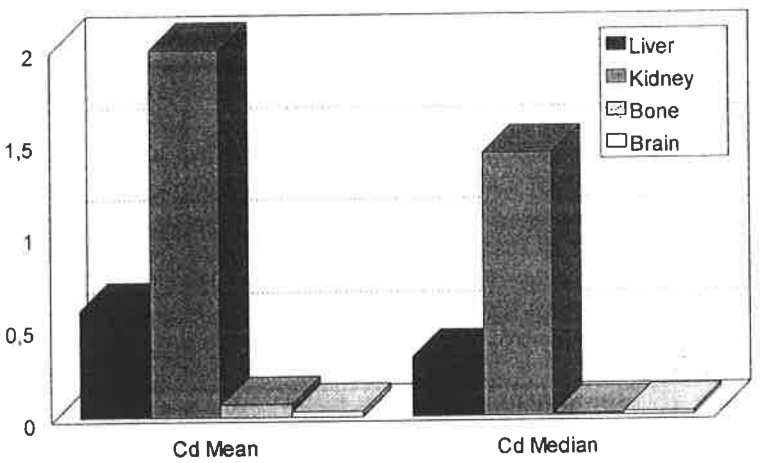

Fig. 2 - Cadmium concentrations (mg/kg, dw) in internal tissues of common dolphins stranded on the coast of Andalusia (Southwestern Mediterranean) between November 1997 and May 1998

MICROPHYTIC ALGAL-VEGETATION OF LITTLE UTRISH DOLPHINARIUM

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The microalgal community of Little Utrish dolphinarium (North Caucasus, Russia) was investigated during 1989-91. More than 105 algal samples, including scrapings and smears from skin surface of 30 bottlenose dolphins *Tursiops truncatus ponticus*, and planktonic and benthonic samples, were collected in June and September.

Isolated material was fixed or sown in Gol'dberg medium and then identified. There was strong predominance of diatoms among 37 registered algal species: so *Bacillariophyceae* were presented by *Navicula* and *Amphora* (four species each), *Achnantes* (three species), *Grammatophora, Nitzschia, Melosira, Pleurosigma* and *Synedra* (in twos), *Amphiprora, Donkinia, Entomoneis, Fragilaria, Hyalodiscus, Rhizosolenia, Skeletonema, Striatella* and *Thalassionema*.

In dolphin skin samples, 15 diatoms (*Achnantes brevipes* Ag., *A. longipes* Ag., *Amphora hyalina* Ktz., *A. turgida* Greg., *Grammatophora marina* (Lyngb.), *Licmophora* sp., *L. Ehrenbergii* (Ktz.) Grun., *Melosira moniliformis* (O.Mll.), *Navicula cancellata* Donk., *N. grevillei* W.Sm., *N. pennata* var. *pontica* Mer., *Nitzschia closterium* (Ehr.) W.Sm., *Pleurosigma rigidum* W.Sm., *Striatella unipunctata* (Lyngb.) Ag. and *Synedra tabulata* (Ag.) Ktz.) and *Ulothrix* sp. were identified.

At the same time wild animals caught in the adjoining sea area were free of microalgal overgrowing. Marine species dominated in algal community (11) in comparison with saltish water inhabitants (3) and mixed forms - marine-saltish (8) and saltish-marine (3).

THE FIRST MASS STRANDING OF *GLOBICEPHALA MACRORHYNCHUS* (CETACEA, ODONTOCETI) ON THE NORTH-WEST SPANISH COAST

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INTRODUCTION The short-finned pilot whale, *Globicephala macrorhynchus* Gray, 1846, is distributed in the tropical and warm temperate waters of the Atlantic, Pacific, and Indian Oceans. The species rarely moves towards latitudes higher than 35° N in the eastern Atlantic (Leatherwood and Reeves 1982). The complete absence of sightings or strandings of short-finned pilot whales in this area among the 1,200 pilot whale records for the period 1990-99 strongly suggests its absence from Galician waters. Mass strandings of cetaceans are infrequent on the Galician coast and only three have been reported during the last fifteen years: 25 striped dolphins *Stenella coeruleoalba*, 20 common dolphins *Delphinus delphis*, and five Risso's dolphins *Grampus griseus*. On the other hand, the long-finned pilot whale, *Globicephala melas*, is a common cetacean species inhabiting Galician waters and thus, thirty-three strandings were reported since 1990. However, in the past, only one mass stranding of 20 specimens of this species is known to have occurred in the early 1930's.

MATERIALS AND METHODS Observation and rescue: Twelve animals belonging to the species *Globicephala macrorhynchus* were observed in the Ría of O Barqueiro (43°45' N - 7°40' W) on 9th September, 1998. Video recording of the entire operation and pictures were made while the animals stayed in the proximity of the Ría. Two zodiacs belonging to Civil Protection, a 15 m, rescue boat of the Xunta de Galicia Government, and several particular small boats were used to take the surviving animals offshore.

Measurements: Thirty measurements, whenever possible, were made from eleven animals (six females and five males). Measurements were made to the nearest cm. Ten animals were sexed, and dissections were made of the dead ones. Ecto- and endoparasites were removed.

RESULTS Reconstruction of the mass stranding: The location of the strandings is summarised in Fig. 1.

9th September – Four short-finned pilot whales, three females (370, 380 and 391 cm total length, TL) one male (415 cm TL) were found stranded dead on a beach located in the inner part of the Ría (Fig. 1/1). Another eight specimens swam nearby, trying to enter the innermost part of the Ría and stranded repeatedly (Fig. 1/2). The whole group of surviving animals were taken to the mouth of the Ría where apparently they reached offshore waters.

10th September – One animal disappeared during the night and since the animal was not located in the interior of the Ría, we assumed that this specimen finally reached open waters. The remaining seven specimens stranded once during the evening. One animal died (male 427 cm TL, Fig. 1/3) and five specimens were released unharmed (Fig. 1/4). The last one was also released.

11th September – The animals were observed swimming near to the port of O Vicedo. Another three specimens were found stranded dead (males 270, 276 and 345 TL) close to the mouth of the Ría (Fig. 1/5).

12th September – The surviving animals of the group were located in the interior of the Ría, close to the beach where most animals stranded the previous days.

13th-19th September – The behaviour of the animals was still active, and they were located in the mouth of the Ría. The sightings confirmed that the animals swam actively in the area.

20th September – The three surviving animals penetrated the Ría and they tried to strand but were released during the evening.

21st-22nd September – The animals disappeared from the area and it seems that they were finally able to reach open waters.

24th October – Two females (384 cm and 375 cm TL) that apparently did not belong to the group, were found stranded dead (Fig. 1/6).

2nd November - One female (450 cm TL) was found stranded dead (Fig. 1/7).

Necropsies: Once the animals were dissected, it was noteworthy that all of them were parasitised, in different degrees of infection, by plerocercoid larvae of *Phyllobotrium delphini* encysted in the fat of the genital area, and the nematode *Anisakis* sp and *Stenurus* sp in the aerial sinus. One specimen was infected by *Monorygma grimaldii* and another one by *Xeobalanus* sp. It is noteworthy that the female of 391 cm TL lacked teeth and had a tumour in the uterus and an ulcerative gingivitis. All the stomachs studied were empty and most of them had ulcers. The female of 370 cm TL was pregnant with a foetus of 135 cm TL.

DISCUSSION The present study represents the first sighting and stranding of a group of short-finned pilot whales in the north-eastern Atlantic. What is clear in the mass stranding of this species that occurred in the Ría of O Barqueiro is that it has no human link because, among other reasons, we did not find any sign of interaction with gear, signs of ropes, etc. The stranding of a whale of social importance due to pathological or navigational problems, may induce others in the group to strand, and they may be unable to remain off the beach due to a secondary social or epimeletic response. Furthermore, the rough conditions of the sea, the effect of the tide, and ignorance of the topography may also have exerted a negative influence on the group. The combination of these factors seems to be the most plausible explanation for the first mass stranding of short-finned pilot whales in the north-eastern Atlantic.

It is likely that a combination of several of the possible causes of mass strandings leads to such an event. This fact seems to be the case in the mass stranding studied in the present paper. The group might be conducted towards the coast due to the bad condition of the oldest specimens. Thus the severe infestation by *Xeobalanus* sp. of the largest female clearly suggests difficulty of that individual swimming. Furthermore, the shallow waters of the Ría, the slope of the littoral shelf, and the influence of the tide, also complicated the possibility of escape for the surviving members of the group.

ACKNOWLEDGEMENTS We thank the Galician Government, and particularly the crew of the vessel JTYJH for their co-operation in rescuing the surviving animals. We are indebted to the members of Civil Protection, CEMMA (Coordinadora para el Estudio de Mamíferos Marinos), Sociedade Galega de Historia Natural, and some other volunteers for their assistance during the mass stranding and, afterwards, tracking the animals for about ten days. We also thank Dr Angel Guerra for correcting the manuscript. This study forms part of the Project "Impacts of fisheries on small cetaceans in coastal waters of Northwest Spain and Scotland" (Ref. # PC97/0089).

REFERENCE

Leatherwood, S. and Reeves, R. R. 1983. *The Sierra Club handbook of whales and dolphins.* Sierra Club Books, San Francisco. 302pp.

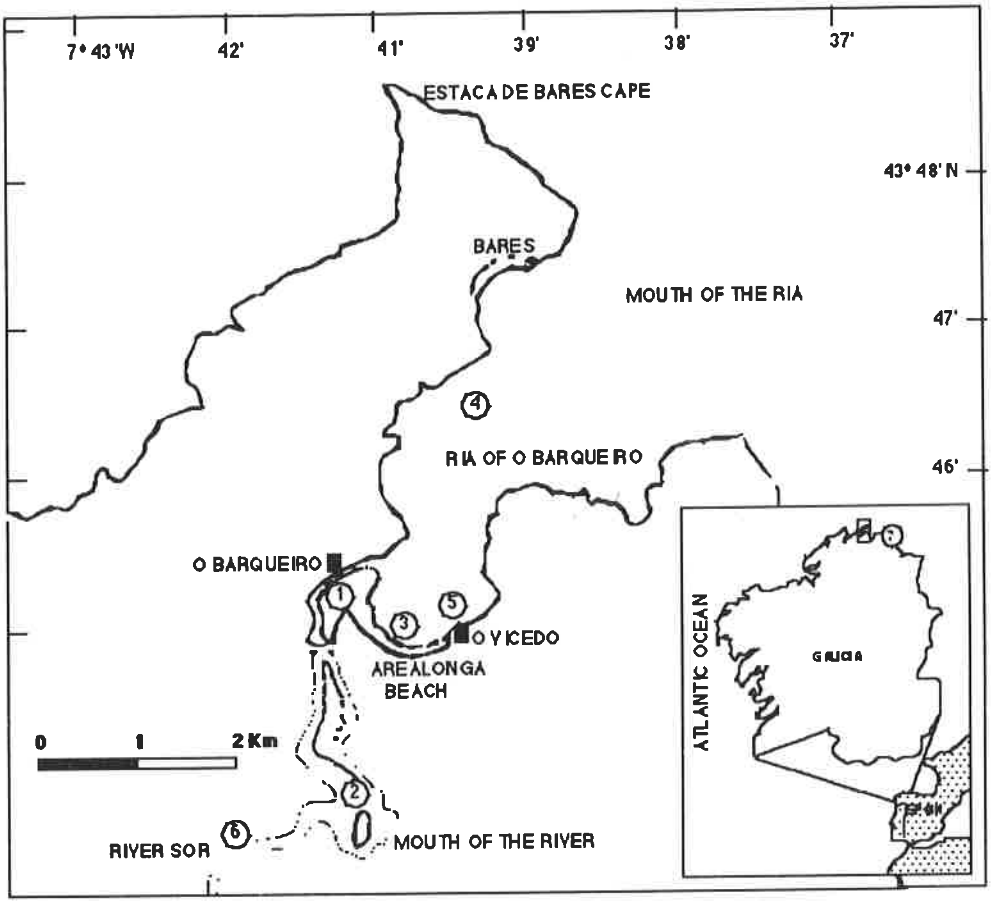

Fig. 1 - Location of the mass stranding in the north-western Iberian Peninsula and description of the event for the period 9 September to 21 September, 1998. 1) Situation of the dead animals (A, B, C and H) in September 9th; 2) Location reached by the surviving animals; 3) situation of the stranding of the animal D; 4) Area where the animals I, J and K were situated in September 10th; 5) Location where the animals E, F and G were found stranded dead; 6) Location where animals M and N were found stranded dead; 7) Situation where animal O was found stranded dead (Burela).

POST MORTEM INVESTIGATIONS ON A FIN WHALE, *BALAENOPTERA PHYSALUS*, STRANDED ALONG THE BELGIAN COAST

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On 1st November, 1997, a fin whale *Balaenoptera physalus* stranded along the Belgian coastline. Main necropsy findings were a chronic thrombus in the portal vein, massive parasitic infestation, and severe debilitation (emaciation, anaemia). The thrombus core was filled with nematodes, probably *Crassicauda* sp.

Microscopic investigations revealed multinucleated syncytia with large intranuclear inclusion bodies in mesenteric and mammary gland lymph nodes, skin and kidney. Immunoperoxidase staining using monoclonal antibodies against canine distemper virus (CDV) and against phocine distemper virus (PDV) were positive in lymph nodes, skin and kidney. Anti-CDV neutralising antibodies were found in the blood (titre 1/64) and aggregates of viral nucleocapsids were detected by electron microscopy in syncytia.

To the best of our knowledge, the case described here is the first direct evidence of a disease due to a morbillivirus in a baleen whale and a first description of a thrombus of the portal vein associated with nematodes in a fin whale.

Morbillivirus is known to be responsible for fatal epizootics among marine mammals. Its involvement in a disease of a fin whale should be considered as a potential threat for the species.

STENURUS MINOR INFECTION IN BLACK SEA HARBOUR PORPOISES

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Seventy-eight stranded harbour porpoises (*Phocoena phocoena*) from the Black Sea and the Sea of Azov were investigated in 1989-96. 100% of the extent of cranial air sinuses had been invaded by *Stenurus minor* (Nematoda: Pseudaliidae) was recorded. The intensity of invasion, including parasites in supracranial airways of up to 11,328 worms per porpoise, was described. Sometimes these nematodes have been found in the trachea, bronchi and stomach (up to 161 specimens). Cranial air sinuses of two animals (2.6%) were co-infected by *S. minor* and 1-3 specimens of *Crassicauda* sp. (Nematoda: Crassicaudidae). Young porpoises were infected by *S. minor* as well as the adults. The presence of larvae of Pseudaliidae in intestines and blood vessels showed possible routes of parasite distribution and host reinvasion.

The finding of these larvae in Black Sea fishes is unknown. Nevertheless, the possibility of prenatal infection in harbour porpoises was not confirmed: in two foetuses (49 and 83.5 cm long), the placental blood and amniotic fluid were free from any helminths.

MEDITERRANEAN STRIPED AND BOTTLENOSE DOLPHIN DIE-OFF OF SPRING 1998: FISHING RESPONSIBILITIES

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During spring of 1998, more than twenty striped dolphins *Stenella coeruleoalba* and two bottlenose dolphins *Tursiops truncatus* were found dead on French catalan coasts over an interval of two weeks.

Ten of them (9 *S. c.* and 1 *T. t.*) were macroscopically necropsied, and we performed histopathological studies on six of these (5 vs 1).

Macroscopically, most prominent lesions were: on all striped dolphins, round lacerative lesions on one side of the head, congestion in the lung (in all specimens studied) and *retia mirabilia* (in the five *Stenella* specimens). The round tegumental lesions did show various degrees of ulceration, and its form suggested that it was caused by a fisherman's hook gaff. On two dolphins, one *Tursiops* and one *Stenella*, we found sero-haemorrhagic effusion in the peritoneal cavity. No external signs of entanglement were found.

The microscopic analysis indicated the passive nature of thoracic congestion, and did not show any characteristics of septicaemia. Moreover, the tegumental wounds were found to be postmortem lesions. We therefore concluded that death was caused by drowning.

Given the repetitive nature of the strandings, and the evident signs of human-caused death, we questioned local fisheries services, and learned that this coincided with the start of a large-scale trawl net fishery for anchovy and sardine.

In conclusion, in the absence of evident external lesions of entanglement, one might have discarded this cause before considering specific pathology.

INFLUENCE OF THE AGE, SEX AND NUTRITIONAL STATUS ON ORGANOCHLORINE LEVELS IN TISSUES OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) FROM SOUTH-WESTERN MEDITERRANEAN

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INTRODUCTION Organochlorine compounds have been extensively used in agriculture worldwide. Even today, these substances are still used in developing countries. The high persistence of these compounds in the environment, their accumulation in the trophic chain, and their toxicity in humans and animals, were the main factors that pushed their prohibition in the mid-1980's. The monitoring of organochlorine residues in dolphins has recently been used by several authors as a useful indicator of the degree of marine environmental contamination (Kuehl and Haebler, 1996; O'Shea *et al.*, 1980; Vetter *et al.*, 1996; Wells *et al.*, 1994). Special mention must be made in this study of the research undertaken on dolphins from the Mediterranean (Guitart *et al.*, 1996; Kannan *et al.*, 1993). It is noteworthy that biological factors such as sex, age, nutritional status, and others affect the interpretation of the analytical results. On the other hand, reproductive failure, behavioural changes, and immunosuppressive effects in terrestrial mammals and birds have recently been associated with the exposure to organochlorine compounds (Kevin *et al.*, 1996), and it is reasonable to believe that similar effects could be present in the marine mammals.

MATERIALS AND METHODS Eleven common dolphins (*Delphinus delphis*) were found stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998. Samples of liver, kidney and brain were obtained by the staff of the C.R.E.M.A. (Málaga, Andalusia, Spain) and they were frozen as soon as field conditions permitted. Sex, age, nutritional status, and pathological findings are detailed in Table 1.

The method described by Luna *et al.* (1993) was used to extract organochlorine compounds from tissues. A small sample of tissue (0.2 g.) was mixed at high speed using benzene as an extractant. The extract was purified using a Florisil microcolumn (Sep-Pak, Waters). This new extract was concentrated and dissolved to a final volume of 5 ml. of n-hexane. One ml. of this solution was analysed by gas chromatography with an electron capture detector (ECD). The capillary column used was SPB-5 (Supelco). The temperatures of the inlet and detector were 200° and 300° C, respectively. A programme of progressive temperatures was started at 90°C/min., with a first increase of 5° C/min. up to 240° C and a second increase of 30° C/min. up to 270° C. Helium was used as carrier gas. Quantification was done using external standards (Supelco) which were assayed for repeatability and recovery. The standard contained the following organochlorine compounds: *α*-HCH, *β*-HCH, lindane, *d*-HCH, aldrin, dieldrin, endrin, edrin-aldheyde, endosulphane I, endosulphane II, *p-p'*-DDT, heptachlor, heptachlor epoxide, *p-p'*-DDE, and *p-p'*-DDD. The limit of detection for every compound was 0.001 mg/kg.

T tests for independent samples were used to examine differences both between species and between males and females. To examine differences among groups by age and nutritional status we used the one-way analysis of variance (ANOVA) test. All statements of significance were based on the 0.05 level of probability.

RESULTS AND DISCUSSION Results of organochlorine levels obtained after the analysis of tissues are shown in Table 2.

Detection, quantifying and distribution of organochlorine compounds in dolphins: Assuming the total body burden of organochlorine compounds to be the sum of the concentrations found in the liver, fat and brain, we found that the fat accumulated 77% of the total (mean=2 mg/kg), the liver 14% (mean=0.36 mg/kg), and the brain 9% (mean=0.23 mg/kg). All compounds analysed were detected in the three kinds of samples, although adipose tissue accumulated more organochlorine compounds than other tissues. The average of compounds detected in fat was 13, and in liver and brain, 7. DDE was the organochlorine most frequently detected and with the highest concentrations in all animals and in all tissues, with the highest concentrations present in adipose tissue. We also studied the body burden by groups of organochlorine according to the chemical structure. DDT and derivatives (DDT, DDE and DDD) was the group with the highest concentrations in fat (66% of the total), followed by cyclodienes (aldrin, endrin, dieldrin, endrin-aldehyde) (19%), endosulphane (I, II and sulphate) (12%), and, finally, the lowest concentrations were of heptachlor (2%) and isomers of HCH (lindane, a, b, d) (1%). Similar results have been described by other authors in cetaceans including dolphins (Guitart *et al.*, 1996; Kuehl and Haebler, 1995; O'Shea *et al.*, 1980; Wells *et al.*, 1994). The concentrations of DDT in blubber of striped dolphins obtained by Kannan *et al.* (1993) were lower than those obtained in this study.

Influence of the biological factors (sex, age and nutritional status): With respect to sex, no statistical differences were found; however, the organochlorine concentrations in brain and fat were higher in males, and the hepatic concentrations were higher in females. The adult specimens accumulated the highest organochlorine concentrations, this difference being statistically significant. Vetter *et al.* (1996) reported that the influence of sex and age on organochlorine concentrations was minimal. However, Wells *et al.* (1994) found a positive correlation between organochlorine concentrations in blubber and the sex and age of the animals.

Because the number of animals studied was low, and many factors were involved (age, sex, nutritional status, diseases, etc), we could not establish a definitive criteria for the influence of age and sex on organochlorine concentrations. However, studying individual cases, we have observed some important facts influenced by age and sex of the animals. Three dolphins (#2, #3 and #8, Table 1) had the highest hepatic concentrations of organochlorine compounds (>1 mg/kg), and another two dolphins (#10 and #11) had the highest brain concentrations. We consider that, except in dolphin #10, in all cases cited, there was an important mobilisation of organochlorine compounds from their accumulation site, the fat, towards the soft tissues, liver and brain. And this mobilisation was produced by different causes.

Dolphins #2 and #3: They showed a similar distribution pattern in liver that was different from the other dolphins studied. These animals had relatively high levels in liver of DDE, endrin, endosulphane, HCH, heptachlor and aldrin. The other dolphins only had high levels of DDE, endrin and endosulphane. We believe that the mobilisation of organochlorine was massive in these dolphins although for different physiological reasons. Dolphin #2 was suffering physiological mobilisation of adipose tissue because it was an old animal (2 m. in length and 68 kg weight). However, dolphin #3 physiologically mobilised fat because it was a female in lactation. In both cases, the organochlorine compounds accumulated in adipose tissue, were mobilised with the fat and distributed to the rest of the tissues, so that it would be logical to find high concentrations of organochlorines in the liver.

Dolphins #8 and #11: They were the only dolphins of low nutritional status. Their adipose reserves were finished due to a mobilisation probably as a consequence of malnutrition. In these cases, the organochlorine compounds were also mobilised and distributed towards soft tissues. In dolphin #8, the hepatic concentrations of several organochlorine compounds, and the brain levels of DDE, were high. Dolphin #11 had the highest brain concentrations of organochlorine compounds, mainly DDT and HCH.

Dolphin #10: This is a special case because it was a suckling specimen (1 m. in length and 12 kg of weight), and probably it was the offspring of dolphin #3, referred to above. This is not a case of mobilisation of adipose tissue. The organochlorine compounds in this animal followed a normal distribution pattern with high accumulation in adipose tissue. However, brain levels of organochlorine residues were very high. We believe that can be explained by the fact that in the early stages of growth, the hematoencephalic barrier is not completely formed, and these compounds may easily pass through it.

Influence of pathological signs: The analytic results and the distribution pattern of these substances suggest a chronic exposure to high levels of organochlorine compounds present in the marine environment. In this study, we could not diagnose acute exposures to organochlorines, and therefore we could not assume that the pathological findings were due to the direct toxic effects of those compounds. However, we believe that the pathological signs described in these dolphins could have been influenced by chronic exposure to organochlorines. The relationship between these compounds and several morphological and functional alterations of the immune, reproductive, and nervous systems, have recently been described and well documented. It is believed that these compounds can act as endocrine disruptors (Fig. 1) and, as a consequence, alter the systems cited above (Kevin *et al.*, 1997). The pathological findings and the diseases diagnosed on several dolphins in this study (#4, #5, #6, #8, #11,...) could be explained by this theory. Lymphoid depletion, degeneration of the central nervous system, nephrosis, hepatosis and high incidence of parasitism and infectious diseases, are easily correlated with the action of endocrine disruptors.

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REFERENCES

Guitart, R., Guerrero, X., Silvestre, A. M., Gutiérrez, J. M. and Mateo, R. 1996. Organochlorine residues in tissues of striped dolphins affected by the 1990 Mediterranean epizootic: relationships with the fatty acid composition. *Arch. Environ. Contam. Toxicol.*, 30, 1: 79-83.

Kannan, K., Tanabe, S., Borrell, A., Aguilar, A., Focardi, S. and Tatsukawa, R. 1993. Isomer-specific analysis and toxic evaluation of polychlorinated biphenyls in striped dolphins affected by an epizootic in the western Mediterranean sea. *Arch. Environ. Contam. Toxicol.*, 25, 2: 227-233.

Kevin, G., Osteen, P. D. and Sierra-Rivera, E. 1997. *Does diruption of inmune and endocrine systems by environmental toxins contribute to development of endometriosis?* Thieme Medical Publishers, New York.

Kuehl, D. W. and Haebler, R. 1996. Organochlorine, organobromine, metal, and selenium residues in bottlenose dolphins (*Tursiups truncatus*) collected during an unusual mortality event in the Gulf of Mexico, 1990. *Sci. Total Environ.*, 186, 1-2: 25-7.

Luna, A., Molina, C., Barba, A., Navarro-García, S. and Cámara, M. A. 1993. Determinación de residuos de insecticidas organoclorados en grasa humana. Comparación de métodos analíticos. *Rev. Toxicol.*, 10: 47-49.

O'Shea, T. J., Brownell, R. L. Jr., Clark, D. R. Jr., Walker, W. A., Gay, M. L. and Lamont, T. G. 1980. Organochlorine pollutants in small cetaceans from the Pacific and south Atlantic Oceans, November 1968-June 1976. *Pestic. Monit. J.*, 14 , 2: 35-46.

Vetter, W., Luckas, B., Heidemann, G. and Skírnisson, K. 1996. Organochlorine residues in marine mammals from the northern hemisphere a consideration of the composition of organochlorine residues in the blubber of marine mammals. *Sci Total Environ.*, 186, 1-2: 29-39.

Wells, D. E., Campbell, L. A., Ross, H. M., Thompson, P. M. and Lockyer, C. H. 1994. Organochlorine residues in harbour porpoise and bottlenose dolphins stranded on the coast of Scotland, 1988-1991. *Sci. Total. Environ.*, 151, 1: 77-99.

Table 1 - Individual characteristics and pathological findings in common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

Dolphin	Sex	Age	Nutritional Status	Pathological findings
1	Male	Sub-adult	High	Congestion in brain. Degeneration in CNS. Renal failure. Lymphoid depletion.
2	Male	Adult	High	Congestion in brain and lungs. Oedema in lymphatic ganglia. Oedema in subcutaneous tissue.
3	Female	Adult	Medium	Widespread congestion (including in brain). Pulmonary oedema and pneumonia. Hepatic fibrosis. Nephrosis. Congestion and hemorrhagies in lymphatic ganglia.
4	Male	Sub-adult	High	Oedema and congestion in lungs. Interstitial fibrosis in renal medulla. Degenerative changes and congestion in brain. Congestion in lymphatic ganglia
5	Female	Sub-adult	High	Brain congestion. Oedema in lungs. Degenerative changes in brain.
6	Female	Sub-adult	Medium	Generalised congestion. Pulmonary oedema. Lymphoid depletion.
7	Female	Young	High	Congestion in brain, meninges and lungs. Degenerative alterations in brain.
8	Male	Adult	Low	Congestion in brain. Lymphatic ganglia congestion. Pulmonary oedema. Hepatic congestion. Degenerative changes in brain.
9	Male	Sub-adult	Medium	Congestion in brain. Congestion and oedema in lungs. Hepatic esteatosis. Lymphoid depletion. Degenerative alterations in CNS
10	Male	Young	High	Congestion in brain and in pulmonary epithelial cells.
11	Male	Sub-adult	Low	Congestion in lymphatic ganglia. Pulmonary oedema and congestion. Hepatic degeneration. Renal failure. Degenerative alterations in CNS

Table 2 - Organochlorine concentrations (mg/kg) in internal tissues of common dolphins stranded on the coast of Andalusia (southwestern Mediterranean) between November 1997 and May 1998

OCl	Tissue	Sample	Mean	S.E. Mean	Std. Dev.	Min.	Max.
Total OCl	Brain	6	0.233	0.090	0.219	0.04	0.60
	Fat	9	1.999	0.416	1.247	0.44	4.32
	Liver	11	0.364	0.123	0.407	0.05	1.13
Cyclodienes	Brain	6	0.032	0.013	0.032	n.d.	0.08
	Fat	9	0.383	0.074	0.223	0.11	0.74
	Liver	11	0.091	0.035	0.115	n.d.	0.31
DDT & deriv.	Brain	6	0.077	0.029	0.072	n.d.	0.20
	Fat	9	1.324	0.313	0.938	0.29	3.06
	Liver	11	0.093	0.044	0.145	n.d.	0.51
Endosulphane	Brain	6	0.018	0.008	0.020	n.d.	0.04
	Fat	9	0.243	0.059	0.176	0.02	0.62
	Liver	11	0.050	0.024	0.080	n.d.	0.22
HCH	Brain	6	0.077	0.035	0.085	0.01	0.23
	Fat	9	0.028	0.006	0.019	0.01	0.06
	Liver	11	0.075	0.022	0.074	n.d.	0.22
Heptachlor	Brain	6	0.030	0.016	0.039	n.d.	0.09
	Fat	9	0.021	0.004	0.012	0.01	0.04
	Liver	11	0.048	0.023	0.075	n.d.	0.23

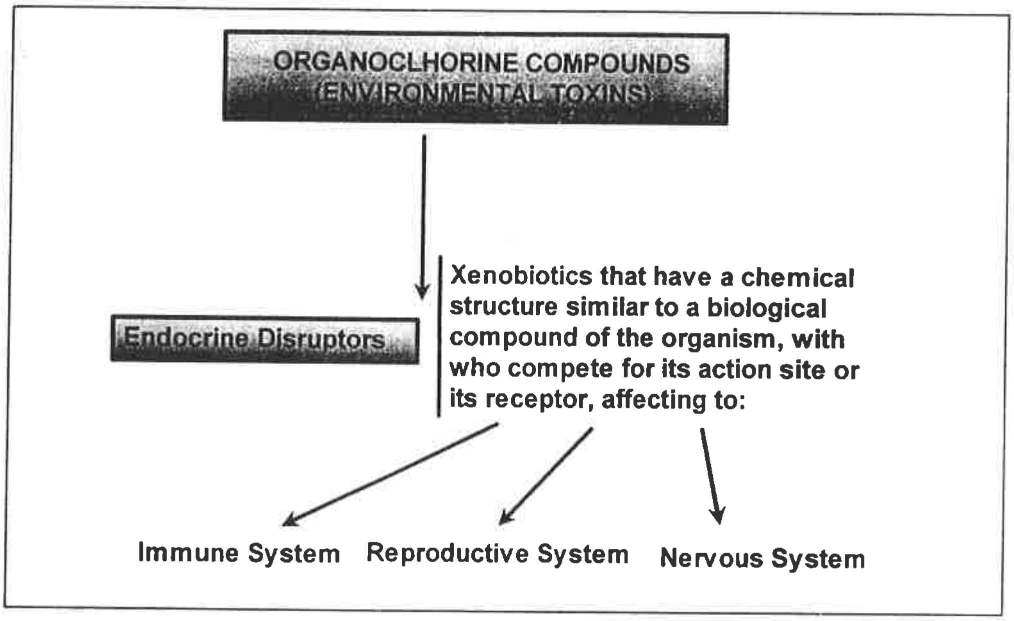

Fig. 1 - Diagram of the action of endocrine disruptors on immune, reproductive and nervous systems

INCIDENCE OF THE COOKIECUTTER SHARK *ISISTIUS BRASILIENSIS* (QUOY & GAIMARD,1824) IN THE CUVIER´S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*)

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The Cookiecutter shark *Isistius brasiliensis* (Quoy & Gaimard, 1824) is a small selaceous fish which generally lives at depths between 85 and 3,500 m., although at night it can be found on the surface. *I.brasiliensis* adheres itself by suction to big teleosts, chondricthyes, as well as several cetacean species, drilling and ripping off a portion of fat and muscle when coming off, thus producing a typical suboval scar on its prey of approximately 5 cm diameter. In the present study, approximately 22 Cuvier's beaked whales stranded on the coasts of the Canary Archipelago were examined during the period 1980-98. The cetacean body was divided into four sections, and the total number of bites from *I. brasiliensis* were counted on each of them.

Most of the bites were located in the posterior region of the belly. Although the sample size is limited, the study concludes that bites from the cookiecutter shark are rarely present in immature whales, but increase significantly in mature specimens, particularly in males. The results suggest that the Cuvier's beaked whale shows a differential exposure to this shark which is still poorly understood. It is likely that the behaviour of Cuvier's beaked whale during diving, or the distribution of the adults makes them more susceptible to interactions with this selaceous fish. In addition, the effect of the bites on the health of the Cuvier beaked whale is discussed.

SOME HELMINTH PARASITES FROM SMALL CETACEANS IN ALGERIAN WATERS

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As a part of a research programme on the natural history of cetaceans from Algerian coasts, a study of the parasitic fauna of dolphins was carried out. Nine common dolphins, *Dephinus delphis*, (7 females and 2 males; total length 176-214 cm) and three bottlenose dolphins, *Tursiops truncatus*, (2 females and 1 male; total length 200-314 cm), stranded or by-caught in fishing nets between 1995 and 1997, were examined for external and internal parasites.

Adult and larval stages of the nematode species, *Anisakis simplex*, were found in the fore-stomach and intestine of common dolphins, with a prevalence of only 44%.

Two cestode species were collected as plerocercoid larval stages in the blubber and mesenteries, respectively. The first species, *Phyllobothrium delphini*, was found in 55% of common dolphins and 67% of bottlenose dolphins. The second species, *Monorygma grimaldii*, was recorded in 55% of common dolphins and 67% of bottlenose dolphins.

The crustacean phoront species *Xenobalanus globicipitis*, appeared attached to the skin of the caudal fin in 33% of common dolphins, and 67% of bottlenose dolphins.

A. simplex was the only parasitic species related to pathological lesions. Larval stages 3 and 4, and adults, all appeared in stomach ulcers.

EVIDENCE FOR A DEFINED SHIFT IN THE FATTY ACID COMPOSITION ALONG THE BLUBBER-PROFILE OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*): THE PHYSIOLOGICAL SIGNIFICANCE

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A six-year-old by-caught female harbour porpoise was analysed for fatty acid composition along blubber cross-sections using a One-Step extraction and trans-esterification method. Analyses included twelve defined body sites, and were performed on 2 mm layers going from the epidermis towards the muscle. A total of 47 fatty acids were identified and made up 90-95% of total fatty acids.

A well-defined shift in the fatty acid composition occurred at all body sites 8-10 mm from the epidermis, and a high degree of stratification was apparent between the outer superficial layer and the inner deep layer, with the exception of the dorsal caudal position. For the remaining eleven sites, the outer superficial layer was characterised by high amounts of short-chained SFA and short-chained MUFA, low amounts of PUFA and a low n-3/n-6 ratio. By comparison, the inner deep layer was characterised by high amounts of long-chained SFA and MUFA, high amounts of PUFA, and a high n-3/n-6 ratio.

These findings revealed a shift in anti-freeze components between the superficial and the deep layer, and suggest that the deep layer is the most metabolically active region where diet-related lipids are stored and that the main function of the superficial layer is insulation. Based on the extremely low energetic and nutritional value of the superficial layer, and the presence of potential toxic fatty acids (VSFA, iso-C4:0 and iso-C5:0), a critical blubber thickness for harbour porpoise in the North Sea of 8-10 mm is suggested. The dorsal tail position (D5) functions mainly as a structural support optimising the animal's hydrodynamic shape.

PNEUMONIA IN TWO HARBOUR PORPOISES BY METASTRONGYLOID NEMATODES

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INTRODUCTION In July 1998, two harbour porpoises (*Phocoena phocoena*) were incidentally caught in a purse seine net in the northern coast of Portugal. This paper describes the gross and microscopic lesions found on the lungs of these porpoises.

MATERIALS AND METHODS A complete necropsy was performed according to the European Cetacean Society dissection protocol (Kuiken and García Hartmann, 1993). Both individuals were adult males and were sexually active at the time, with seminal fluid present in the testes. Although the examination of the stomach content was not yet performed, both porpoises had full stomachs. Blubber thickness was 2.90 cm for the individual A (143 cm body length), and 1.85 cm for individual B (157 cm body length).

RESULTS Gross examination of the two carcasses showed that the upper respiratory tract and bronchial tree were filled with blood-tinged foam, and lungs were congested with a high density of subpleural and intrapulmonary greyish nodules throughout the pulmonary lobes.

Histological findings included diffuse and intense pulmonary congestion with intra-alveolar oedema and haemorrhaging. Observations of the bronchi revealed a large number of adult worms, which caused a chronic catarrhal bronchitis. There was a large number of lymphocytes, macrophages and eosinophilis present in the wall and lumina of the bronchi and hyperplastic bronchus-associated lymphoid tissue. Histologically, there was extensive interstitial pneumonia associated with the presence of a large number of adult worms and larvae; alveolar walls were thickened by infiltration with inflammatory cells; and macrophages, giant cells and eosinophils were observed in the collapsed alveoli. There were also some granulomatous lesions surrounding dead worms, with many lymphocytes, eosinophils and multinucleated histiocytes.

Parasites collected from the lungs of the two porpoises were identified as nematodes of the genus *Pseudalius*. Male and female parasites were found.

CONCLUSIONS In spite of the severe lesions caused by the parasite, both porpoises were apparently in a good nutritional condition. The presence of these lungworms has been already associated with severe and extensive catarrhal pneumonia in harbour porpoises (Siebert *et al.*, 1996). However, some of the gross and histological findings – blood-tinged froth in the airways and pulmonary oedema – were most probably caused by the by-catch situation (Kuiken, 1996).

REFERENCES

Kuiken, T. 1996. Review of the criteria for the diagnosis of by-catch in cetaceans. Pp. 38-43. In: *Proceedings of the second European Cetacean Society workshop on cetacean pathology: diagnosis of by-catch in cetaceans* (Ed. Thijs Kuiken). ECS Newsletter 26, special issue, 43pp.

Kuiken, T. and García Hartmann, M. (eds). 1991. *Proceedings of the first European Cetacean Society workshop on cetacean pathology: dissection techniques and tissue sampling*. ECS Newsletter 17, special issue, 39pp.

Siebert, U.; Benke, H.; Frese, K.; Pirro, F. and Lick, R. 1996. Postmortem examination of by-catches from German fisheries and of suspected by-catches found on the coast of Germany. Pp. 27-30. In: *Proceedings of the second European Cetacean Society workshop on cetacean pathology: diagnosis of by-catch in cetaceans* (Ed. Thijs Kuiken). ECS Newsletter 26, special issue, 43pp.

PRELIMINARY DATA ON BUTYLTIN RESIDUES IN DOLPHINS FROM MEDITERRANEAN COASTAL AREAS

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Since 1987, many stranding events of cetaceans have occurred along the Mediterranean coast. These specimens presented bacterial and viral infections indicative of immune dysfunction. In an attempt to explain the susceptibility of these cetaceans to pathogenic agents, high concentrations of polychlorinated biphenyls (PCBs) and DDT have been determined in stranded cetaceans. Other studies have suggested that the occurrence of tributyltin (TBT) residues in stranded cetaceans may be another determinant for immunosuppression. Since 1960, TBT has been widely used as a potential biocide to prevent the attachment of marine organisms on boat hulls; its toxic effects on non-target organisms have been demonstrated. In mammals, TBT causes thymal atrophy and consequent immune suppression.

The aim of this study was to determine the TBT and its breakdown products in stranded dolphins along the Mediterranean coastal areas between 1992 and 1993. Samples of liver and kidney from striped dolphin, *Stenella coeruleoalba*, and bottlenose dolphin, *Tursiops truncatus*, found stranded in the Tyrrhenian coast, and from a foetus of common dolphin, *Delphinus delphis*, found in 1997 on the Greece coast, were analysed for butyltins (BTs). Mean concentrations of butyltins (TBT + DBT + MBT) in liver and kidney of striped dolphin ranged from 4 to 592 ng/g wet wt, and from 783 to 6,596 ng/g wet wt, respectively; in bottlenose dolphin, BTs ranged from 4 to 63 ng/g wet wt in liver and from 1,024 to 3,215 ng/g wet wt in kidney. A BTs concentration of 4,352 and 3,215 ng/g wet wt were found in liver and kidney, respectively, in the foetus of a common dolphin. These BT concentrations are in the same range or even higher than those reported by other authors in the same dolphin species from other industrialised areas.

Our preliminary results hypothesise that placenta can play an important role in the transference of BTs to the foetus. Moreover, the high levels of BTs could support the hypothesis of an immune suppression of dolphins.

FIRST DOCUMENTED SIGHTING OF A WOUNDED HARBOUR PORPOISE IN MEDITERRANEAN SEA. A UNIQUE CASE OF SUCCESSFUL REHABILITATION

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On 26th June, 1997, an adult female harbour porpoise (*Phocoena phocoena L.*) stranded wounded in the shallows of Panagia's Bay, at Halkidiki, northern Aegean Sea, Greece. The animal had a deep wound on the missing right eye and many smaller external wounds scattered all over her body. Immediately after the harbour porpoise's rescue and diagnosis of her critical condition, she was treated between 26th-29th June, *in situ* (in the sea), with antibiotics from DELPHIS's scientific advisor and veterinarian, Dr. Natasa Komninou from Aristoteles University of Thessaloniki, veterinary students and volunteers. Along with the macroscopic data which were also collected, the rescue and rehabilitation operation of the harbour porpoise was documented by photographs and video. The animal was surprisingly very co-operative to human contact, herself swam inshore to receive treatment at a 'self-programmed' time, and recovered from her wounds in four days. At the end of the fourth day, the animal started, day after day, to swim offshore and finally disappeared, never to be observed inshore again.

This case is unique because: 1) it is the first documented sighting of a harbour porpoise in Greece and in the entire Mediterranean Sea. So far, there are scarce unconfirmed data with no evidence of recorded sightings, for the distribution of this endangered species in the Mediterranean Sea (see, for example, Leatherwood & Reeves, 1983; Evans, 1987; Martin, 1990); 2) it has enriched our knowledge and experience on an exceptional and unknown behaviour of a normally timid species while it is in a critical condition, in the wild; and 3) it was an amazingly successful treatment *in situ*, of a relatively sensitive species that is known to be easily stressed in captivity. Following this incident, during 1998, DELPHIS extended the ongoing Cetacean Sighting Data Collection and Monitoring Project in the Ionian Sea to the northern Aegean Sea, with emphasis on obtaining harbour porpoise sightings.

FIRST REPORT OF PLASTIC INGESTION BY STRIPED DOLPHIN (*STENELLA COERULEOALBA*) IN THE CROATIAN PART OF THE ADRIATIC SEA

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INTRODUCTION On 12th June, 1998, a dead female striped dolphin was found near the SW coast of the island Krk, in the North Adriatic Sea. The cause of death was ingestion of foreign plastic objects, which is the first report of that kind for the Croatian part of the Adriatic Sea.

Striped dolphins are uncommon here, and only occasional sightings were reported in the deeper southern Adriatic. The first well documented sighting of striped dolphin in the North Adriatic Sea was in 1996 by Bearzi *et al.* (1998). However, Notarbartolo di Sciara & Demma (1994) and Bearzi *et al.* (1998) reported changes in the home range of striped dolphins in other parts of the Mediterranean, which might explain their recently more frequent occurrences.

In recent years, several reports referred to plastic debris ingestion and entanglement in various marine species (Barros, 1990; Beck, 1991; Kastelein, 1992; Tarpley, 1993; Whitaker, 1994). Unlike chemical pollution which affects immune reactions, reproduction and longevity of marine mammals (Addison, 1989; Aguilar & Borrell, 1994; Parsons, 1998), plastic ingestion often has immediate lethal consequences.

This finding highlights the increasing concern regarding man-made debris and its impact on the marine environment. Moreover, it questions the law enforcement for the protection of the marine environment.

MATERIALS AND METHODS The animal was transported to the Croatian Natural History Museum where basic *post mortem* analysis was carried out (Kuiken & Hartman, 1991). Parasites found all over dolphin's body surface were given to the Veterinarian Institute in Zagreb for further examination. Stomach content was analysed and stored in 70% ethanol.

Tissue samples (blubber, liver, kidney, muscle) were taken to the Institute for Medical Research and Occupational Health for organochlorine compounds and heavy metals (Hg & Cd) analysis. Organochlorine compounds were extracted with hexane; qualitative and quantitative analyses were conducted by HRGC/ECD. Atomic absorption spectroscopy was used for heavy metal analysis.

Age was determined by counting GLGs in dentine. Both the scanning electron microscopy (SEM) technique (Hohn, 1980; Perrin & Myrick, 1980 and decalcified haematoxilyn stained thin sections (Lockyer, 1995), were used.

RESULTS The animal was 203 cm long and weighed approximately 100 kg. According to Calzada & Aguilar (1995) and Notarbartolo di Sciara & Demma (1994), who suggested that striped dolphins in the Mediterranean attain sexual maturity at a length of about 190 cm, and at about 9 years of age, this specimen was a mature female. Combining age determination analysis and a growth curve plotted for striped dolphins from the Mediterranean Sea (Marsili *et al.*, 1997), the animal was aged at 23 years.

During necropsy, we found that the entire volume of the stomach was occluded by different kinds of plastic material (approximately 1.5 L of plastic and garbage bags, rubber glove, cellophane wrapping). Parts of sea grass *Posidonia oceanica* were also found, but no food remains. The blubber layer was extraordinarily thin, indicating starvation. No inner deformities were noticed. Parasites found on the body surface included the copepods, *Sphyrion* sp. Determination was carried out by Dr. R. Rajkoviæ (Veterinarian Institute, Department of Parasitology).

Results of mercury and cadmium analysis compared with the same analysis done for striped dolphins in the Mediterranean Sea (Leonizio *et al.*, 1992) and the French Atlantic (Holsbeek *et al.*, 1998) are shown in Figure 1. Comparison of results of organochlorine compound analysis between North Adriatic and Mediterranean striped dolphins (Marsili *et al.*, 1997) are presented in Figure 2.

DISCUSSION Although this animal was found in the Adriatic Sea, we cannot establish where ingestion and intoxication took place.

The North Adriatic is already recognised as one of the most degraded parts of the Mediterranean, and, therefore, some ecotoxicological implications on the health status of its already declining cetacean fauna can be expected. On the basis of heavy metal analysis, total mercury concentrations found in liver and kidney were higher than those measured for the French Atlantic and northern Tyrrhenian Sea, whereas cadmium concentrations were lower (Fig. 1). Nevertheless, levels of cadmium were 16 times higher in the liver, and 12 times higher in the kidney, than those found for bottlenose dolphins from the same area (Miokoviæ, 1997), although Leonicio *et al.* (1992) explained this in terms of differences in diet.

Total PCBs and DDTs concentrations found in blubber, liver and muscle were lower than those measured by Marsili & Focardi (1996) and Marsili *et al.* (1997) (Fig. 2). Similar concentrations were also found in tissue samples of bottlenose dolphins from the same area (Miokoviæ, 1997).

Plastic debris discharged into the sea probably have a greater impact on cetaceans and are more worrying than previously reported. Combined with other aspects of environmental degradation, they increase the vulnerability and threaten the survival of cetaceans and other marine animals.

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REFERENCES

Addison, R. F. 1989. Organochlorines and marine mammal reproduction. *Can. J. Fish. Aquat. Sci.*, 46, 2: 360-368.

Aguilar, A. and Borrell, A. 1994. Abnormally high polychlorinated biphenyl levels in striped dolphins (*Stenella coeruleoalba*) affected by the 1990-1992 Mediterranean epizootic. *Sci. Total. Environ.*, 154: 237-247.

Barros, N. B., Odell, D. K. and Patton, G. W. 1990. Ingestion of plastic debris by stranded marine mammals from Florida. In: Proceedings of the second international conference on marine debris, 2-7 April 1989, (Eds. R. S. Shomura & M. R. Godfrey) Honolulu, Hawaii. 746pp.

Bearzi, G., Fortuna, C. M. and Notarbartolo di Sciara, G. 1998. Unusual sighting of a striped dolphin (*Stenella coeruleoalba*) in the Kvarneriæ, Northern Adriatic Sea. *Nat. Croat.*, 7, 3: 169-177.

Beck, C. A. and Barros, N. B. 1991. The impact of debris on the Florida manatee. *Marine Pollution Bulletin*, 22, 10: 508-510.

Calzada, N. and Aguilar, A. 1995. Geographical variation of body size in Western Mediterranean striped dolphins (*Stenella coeruleoalba*). *Z. Saugetierkunde*, 60: 257-264.

Hohn, A. A. 1980. Analysis of growth layers in the teeth of *Tursiops truncatus*, using light microscopy, microradiography, and SEM. In: *Age determination of toothed whales and sirenians,* (Eds. W. F. Perrin & A. C. Myrick Jr). *Rep. Int. Whal. Commn.*, 3: 155-161.

Holsbeek, L., Siebert, U. and Joiris, C. R. 1998. Heavy metals in dolphins stranded on the French Atlantic coast. *Sci. Total. Environ.*, 217: 241-249.

Kastelein, R. A. and Lavaleije, M. S. S. 1992. Foreign bodies in the stomach of a female harbour porpoise (*Phocoena phocoena*) from the North Sea. *Aquat. Mammal.*, 18, 2: 40-46.

Kuiken, T. and Hartmann, M. G. (Eds.) 1991. Proceedings of the first European Cetacean Society workshop on cetacean pathology: dissection techniques and tissue sampling. *ECS Newsletter 17* (Special Edition).

Leonizio, C., Focardi, S. and Fossi, C. 1992. Heavy metals and selenium in stranded dolphins of the Northern Tyrrhenian (NW Mediterranean). *Sci. Total. Environ.*, 119: 77-84.

Lockyer, C. 1995. A review of factors involved in zonations in odontocete teeth, and an investigation of the likely impact of environmental factors and major life events on harbour porpoise tooth structure. *Rep. Int. Whal. Commn.*, 16: 511-529.

Marsili, L. and Focardi, S. 1996. Organochlorine levels in subcutaneous blubber biopsies of fin whales (*Balaenoptera physalus*) and striped dolphins (*Stenella coeruleoalba*) from the Mediterranean Sea. *Environ.Pollut.*, 91, 1: 1-9.

Marsili, L., Casini, C., Marini, L., Regoli, A. and Focardi, S. 1997. Age, growth and organochlorines (HCB, DDTs and PCBs) in Mediterranean striped dolphins *Stenella coeruleoalba* stranded in 1988-1994 on the coasts of Italy. *Mar. Ecol. Prog. Ser.*, 151: 273-282.

Miokoviæ, D. 1997. *Histological and toxicological analysis of the bottlenose dolphin (Tursiops truncatus, Montagu 1821) from the Adriatic Sea.* BSc thesis, Faculty of Natural Science, University of Zagreb, Croatia.

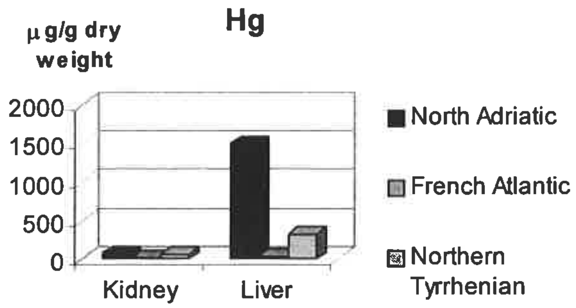
Notarbartolo di Sciara, G. and Demma, M. 1994. *Guida dei mammiferi marini del Mediterraneo.* Franco Muzzio Editore, Padova. 262pp.

Parsons, E. C. M. 1998. Trace metal pollution in Hong Kong: Implications for the health of Hong Kong's Indo-Pacific hump-backed dolphins (*Sousa chinensis*). *Sci. Total. Environ.*, 214: 175-184.

Perrin, W. F. and Myrick, A. C. Jr (Eds). *Age determination of toothed whales and sirenians.* Rep. Int. Whal. Commn. (Special Issue 3). 495pp.

Tarpley, R. J. and Marwitz, S. 1993. Plastic debris ingestion by cetaceans along the Texas coast: two case reports. *Aquat. Mammal.*, 19, 2: 93-98.

Whitaker, B. R., Geraci, J. R. and Stamper, A. 1994. The near fatal ingestion of plastic by pygmy sperm whale, *Kogia breviceps*. In: Proceedings of 25th Annual IAAAM conference, Marine World Africa USA, Vallejo, CA. 108.



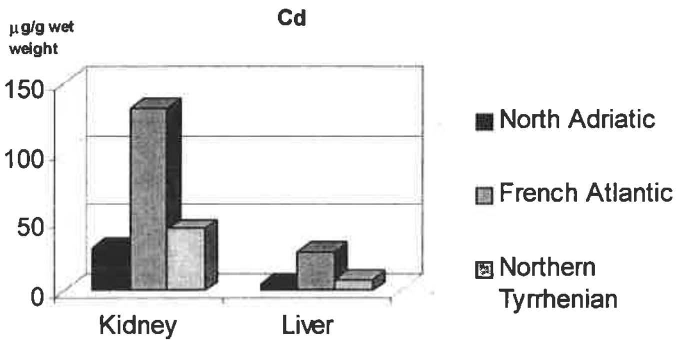


Fig. 1. Comparison of total Hg and Cd concentrations in striped dolphins from the North Adriatic (this paper), Northern Tyrrhenian Sea (Leonizio *et al.*, 1992) and French Atlantic (Holsbeek *et al.*, 1998). Analyses were done by Dr. M. Blanusa, Institute for Medical Research and Occupational Health, Mineral Metabolism Unit.

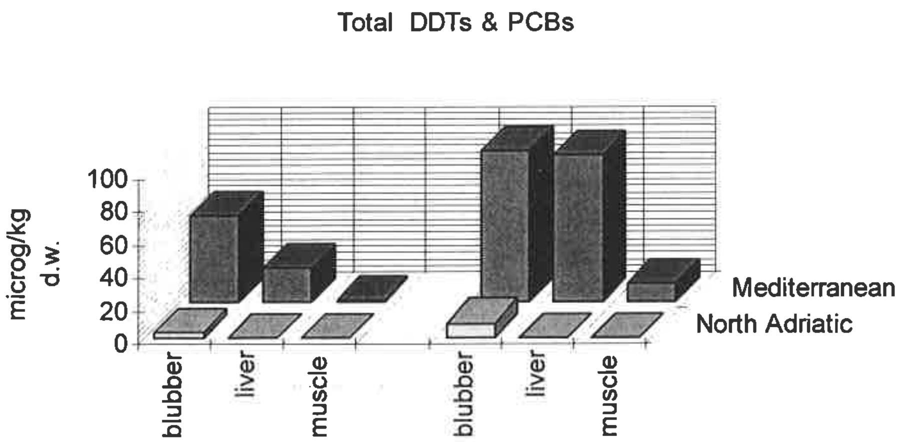


Fig. 2. Total PCB and DDT concentrations found in striped dolphins from the North Adriatic (this paper) and the Mediterranean (Marsili *et al.*, 1997). Total PCBs were determined as compared to Aroclor 1260; Total DDTs = DDT + DDD + DDE; d.w. = dry weight. Analyses were done by Dr. B. Krauthaker, Institute for Medical Research and Occupational Health, Biochemistry and Organic Analytical Chemistry Unit.

HEPATIC SARCOCYSTOSIS IN A STRIPED DOLPHIN (*STENELLA COERULEOALBA*) STRANDED ON THE SPANISH MEDITERRANEAN COAST

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Diseases caused by coccidian parasites of the genus *Sarcocystis* in animals are increasingly reported. There are few reports of hepatic sarcocystosis in animals, including a sea lion (*Zalophus californianus*) (Mense 1992), two polar bears (*Ursus maritimus*) (Garner 1997), a black bear (*Ursus americanus*) (Zeman 1993), a chinchilla (Rakich 1992), and a congenitally-infected dog (Dubey 1992). There are no reports of sarcocystosis in cetaceans other than the incidental finding of muscular sarcocysts in a striped dolphin (*Stenella coeruleoalba*) (Dailey 1978), a pilot whale (*Globicephala melas*) (Cowen 1966), and a sperm whale (*Physeter macrocephalus*) (Owen 1967). To our knowledge, this is the first report of hepatic sarcocystosis in the striped dolphin and any other wild marine mammal.

An 80-kg adult female striped dolphin was stranded on the north-eastern Spanish Mediaterranean coast in March 1997. Tissue samples were fixed in 10% neutral buffered formalin, embedded and stained with H&E and special stains. At necropsy, the most prominent finding was icterus and hemorrhages in the dorsolateral subcutaneous tissue, hepatic congestion, an enlarged mesenteric lymph node, and gastric nodular parasitic lesions, as well as a 4-cm bullous cavity in the left lung. Microscopically, the most prominent lesions affected the liver and pancreas. There was an acute severe necrotising hepatitis characterised by foci of lytic hepatocellular necrosis associated with diffuse and portal, and intense mixed inflammatory infiltrates composed mainly of plasma cells, macrophages and fewer eosinophils and lymphocytes. There was a marked intracanalicular and hepatocellular cholestasis.

Numerous protozoan parasites in different developing asexual stages could be found in association with the hepatic lesions. These protozoa failed to react with a *Toxoplasma gondii* antiserum by immunohistochemistry. There was also a mild focal pyogranulomatous and necrotising adrenalitis without intra-lesional protozoa. The acinar pancreatic tissue was degenerated and atrophic, and diffusely dissociated. There was also periductular and interlobular fibrosis with focal infiltrates of macrophages, plasma cells and lymphocytes, and occasional intraductular flukes. Trematode ova were also found admixed with pancreatic secretion debris within distended ducts. There were foci of granulomatous panniculitis with foamy macrophages and multinucleate giant cells surrounding necrotic adipocytes, and a pale yellow to grey, PAS- and ZN-positive material, consistent with ceroid.

The death of this dolphin was attributed to the *Sarcocystis*-associated hepatitis, that apparently caused hepatic insufficiency. The presence of panniculitis with ceroid, systemic lipofuscinosis, and degenerative myopathy of the tongue in this animal, is strongly suggestive of vitamin E deficiency.

UTERINE ADENOCARCINOMA IN A FEMALE BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS*, STRANDED IN NORTHERN PATAGONIA

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An adult female bottlenose dolphin was stranded at Playa Unión in northern Patagonia in July 1997. The size of the specimen was 3.2 m, its weight was 296 kg, and the age estimated by tooth sectioning was 29 years old. The specimen was sexually mature and showed 43 ovarian scars with a recent corpus albicans. The specimen showed an endometrial adenocarcinoma in its final stages with epidermoid differentiation. It was locally and regionally invasive affecting the abdominal organs with distant metastasis. The organs involved included liver, kidneys, spleen, diaphragm, lungs and pericardium, and they showed nodules of sizes from 5 to 8 mm, whitish to yellowish in colour and without cavity or internal structure. The walls of the uterus were thick and showed a lumen. The left horn was larger. The walls of the bladder were also thick and showed a greasy appearance. The mesenterium of the portal system was full of nodules as well as the external walls of the intestine all along its length. Some portions of the intestine and the rectum showed folds in places where one side of the wall was thickened by numerous nodules. Histological sections confirmed the macroscopic metastasis of the abdominal organs. The lungs, which did not indicate metastasis during the macroscopic inspection, showed histological evidence of infiltration. Another case of uterine adenocarcinoma was reported for the beluga whale by Martineau *et al.* (1998). Geraci (1987) reported leiomiomas in uterus for other cetacean species, and Howard (1983) reported two adenocarcinomas in the uterus of California sea lions.

SEROLOGICAL AND IMMUNOHISTOLOGICAL INVESTIGATION OF MORBILLIVIRUS INFECTION IN HARBOUR PORPOISES FROM THE GERMAN BALTIC AND NORTH SEA

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Morbilliviruses have caused epizootics in different species of marine mammals, and serology for morbillivirus specific antibodies disclosed a global distribution of the disease-causing pathogens. To further investigate the role of morbilliviruses as a cause of disease and death, blood and tissue samples from 77 stranded or by-caught harbour porpoises from the German Baltic and North Sea, collected between 1991 and 1997, were investigated for morbillivirus infection. A virus neutralisation assay for detection of canine distemper virus (CDV, Onderstepoort) and porpoise morbillivirus (PMV) specific antibodies was performed. Routine histology was carried out on different organs including brain, lung and lymph nodes, and immunohistology for morbillivirus antigen by means of the avidin biotin peroxidase technique, using a cross reactive, polyclonal antibody against CDV was performed on lung. Neutralising CDV and PMV antibody titres were found in 41 (53%) and 65 (84%) animals, respectively. The highest titres for CDV were 1:226 and for PMV >1:761; titres were always highest against cetacean mobilliviruses. No histological lesions specific for morbillivirus infection were detected and, by immunohistology, all cases investigated so far were negative for morbillivirus antigen. The absence of morbillivirus antigen and the lack of characteristic morbillivirus-specific lesions shows that morbillivirus infection was not a major cause of death or illness in the investigated population. However, the high incidence of morbillivirus specific antibodies indicates a continous spread and infection of morbillivirus among harbour porpoises from the German Baltic and North Sea.

ORGANOCHLORINE COMPOUNDS: A THREAT TO THE CETACEA OF ALGERIAN WATERS

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Oganochlorine compounds such as PCB, DDT and HCH are synthetic chemical products which have largely been used since 1940 as pesticides in agriculture and in different industrial applications, owing to their physico-chemical characteristics. The realisation of the risk and heavy damage that these halogenous hydrocarbons can cause on the ecosystem and human health, and in view of their large chemical stability and weak biodegradability, has led many countries, notably Algeria, to take legal measures that totally forbids their utilisation. Nevertheless, the illegal usage of these organic products and their persistence, made them the most xenobiotic pollutants commonly studied in living organisms, and particularly in marine mammals. For this purpose, a detailed study on the distibution of the organochlorinated compounds (PCB, DDT, HCH) in odontocete cetaceans frequenting Algerian waters (common dolphin, *Delphinus delphis*, bottlenose dolphin, *Tursiops truncatus*, sperm whale, *Physeter macrocephalus*, and Cuvier's beaked whale, *Ziphius cavirostris*) has revealed marked intraspecific and interspecific variation in contamination levels.

The small delphinids, common and bottlenose dolphins, seem to be the species most threatened by this kind of pollution in the region. This can be attributed, on one hand, to their respective habitat, and on the other, to their diet. Thus, the comparison of concentrations of organochlorine compounds between these odontocetes and two fish species (*Boops boops*, *Sardina pilchardus*) caught in the west Algerian littoral, has confirmed the role that cetaceans, notably Delphinidae, can play in the biomagnification of these pollutants. Such reports highlight the harmful impact of these chemical products, brought about by the processes of bioamplification, on the reproductive potential and thus the population dynamics of cetacean populations along the coasts of Algeria.

CUTANEOUS PAPILLOMAVIRUS INFECTION IN A HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) FROM THE NORTH SEA

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Papillomaviruses (PVs) cause epithelial and fibroepithelial benign tumours of the skin and mucous membranes (wart, papilloma, condyloma or fibropapilloma) in a variety of vertebrate species including humans. PV infection was recently demonstrated in dusky dolphins (*Lagenorhynchus obscurus*) and Burmeister's porpoises (*Phocoena spinipinnis*) from Peru.

The genus-specific PV antigen, borne by the major capsid protein, was detected in genital warts from both species, and two PV genotypes were identified in genital tumours from Burmeister's porpoises. Here, we report on PV infection in a male harbour porpoise (*Phocoena phocoena*) stranded alive in Nessmersiel, Germany, in December 1993. The animal presented several warts on the left side and on the dorsal portion of the tail fluke. It died after four days of intensive care at the Harderwijk Rehabilitation Centre (The Netherlands). A wart specimen was processed for routine histological examination. Microscopically, it presented features typical of a squamous cell papilloma with thin elongated dermal papillae, a marked epidermal hyperplasia, and an abnormal terminal cell differentiation. The latter was characterised by an absence of the thick and parakeratotic superficial layer observed in the contiguous unaffected epidermis. Immunohistochemical staining to detect the genus-specific PV capsid antigen was performed using a polyclonal rabbit antiserum against disrupted particles of bovine papillomavirus-1 and goat antirabbit IgG conjugated to phosphatase alkaline. PV capsid antigen was detected in the nucleus of superficial cells of the warts, but not in cells of the adjacent normal epidermis. This demonstrates a productive PV infection, and indicates that a PV was the causative agent of the cutaneous warts affecting the porpoise.

VIRUSES OF CETACEANS: A REVIEW WITH AN INSIGHT ON THEIR POTENTIAL IMPACT AT THE POPULATION LEVEL

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Viruses belonging to at least eight families have been detected in cetaceans. Viruses of the family Paramyxoviridae, Poxviridae and Papovaviridae have the potential to exert a negative impact on the dynamics of cetacean populations by increasing natural mortality and/or by affecting reproduction.

Cetacean morbillivirus (family Paramyxoviridae) causes a systemic disease, often lethal, and persists in several populations. It may have long-term effects on the dynamics of cetacean populations either as enzootic infections or recurrent epizootics. The latter presumably have the more profound impact due to the absence of herd immunity and removal of sexually mature individuals.

Members of the Poxviridae infect several species of odontocetes, resulting in ring and tattoo skin lesions. Although poxviruses apparently do not induce a high mortality rate, circumstantial evidence suggests they may be lethal in young animals lacking protective immunity, and thus may negatively affect recruitment.

Papillomaviruses (family Papovaviridae) cause genital warts in at least three species of cetaceans. In 10% of male Burmeister's porpoises (*Phocoena spinipinnis*) from Peru, lesions were sufficiently severe to at least hamper, if not impede, copulation.

Members of the families Herpesviridae, Orthomyxoviridae and Rhabdoviridae were demonstrated in cetaceans suffering serious illnesses, but, with the probable exception of herpesviruses, their causative role is still tentative. Herpes-like viruses and caliciviruses (Caliciviridae) caused cutaneous diseases in Monodontidae and/or Delphinidae. Antibodies to several serotypes of caliciviruses were found in cetaceans, but for two bottlenose dolphins (*Tursiops truncatus*), no calicivirus-related disease was reported. Adenoviruses (Adenoviridae) were isolated from the intestinal tracts of a sei whale (*Balaenoptera borealis*) and two bowhead whales (*Balaena mysticetus*), but were not associated with any pathologies.

TECHNIQUES

FIELD TRIALS OF THE POD – A SELF-CONTAINED, SUBMERSIBLE, ACOUSTIC DATA-LOGGER

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POD ESSENTIALS The POD is a self-contained, submersible, acoustic data-logger designed to detect the sonar clicks emitted by harbour porpoises and other odontocetes.

The POD is housed in a robust cylindrical container approximately 40 cm long by 13 cm wide, capable of withstanding water pressure at 150 m. depth. The POD does not store sounds; it logs the number of clicks detected in each logging interval. A logging interval of 1 min. was used throughout these trials. The POD distinguishes different categories of biosonar clicks according to the relative levels of energy in each of four frequency bands (Table 1).

POD data files were downloaded by connection to a PC, using the computer programme 'QuickPOD', written by Nick Tregenza. The data were then exported to Excel spreadsheets for further analyses.

The trials: We carried out trials in south-west Wales to test the ability of the POD to detect porpoises and distinguish their clicks from other sources of underwater noise.

Initial trials were carried out from a drifting boat. A hydrophone and wide-band click detector was used to listen to underwater sounds while a POD was suspended from the boat.

We tested the POD in the proximity of biological and other sources of underwater sound, including harbour porpoises and "snapping shrimps" at Strumble Head, common and Risso's dolphins at the Smalls, and bottlenose dolphins, power-boats and echo-sounders in Cardigan Bay.

For longer term trials, a lobster pot was used to hold a POD between a pair of outlying mooring blocks, each with a buoy on the surface (Figure 1). The mooring gear was left permanently in place at a study site in Newport Bay. The buoys were used as position markers during visual observations from land.

RESULTS Results indicated that the POD reliably identified harbour porpoise sonar clicks, and did not falsely detect porpoise type clicks when exposed to other sources of sound. By setting the detection criteria appropriately, it was also possible to detect bottlenose dolphin and Risso's dolphin sonar clicks.

Potential applications of the POD include surveys of the harbour porpoise and possibly other odontocete species; long-term monitoring of habitat use at sites of specific interest; and investigation of the behaviour of porpoises in the vicinity of fishing nets.

ACKNOWLEDGEMENTS These trials were carried out by Nekton, with funding from the Countryside Council for Wales and the Joint Marine Partnership of the Wildlife Trusts and WWF-UK. Detailed methods and results were provided in a report to the funding organisations (Pierpoint *et al.*, 1999).

REFERENCES

Pierpoint, C. J. L., Baines, M. E. and Earl, S. J. 1999. *Field trials of the POD - an acoustic data logger – to monitor harbour porpoise activity in Newport Bay, Pembrokeshire.* Unpublished Report to The Wildlife Trusts and WWF-UK.

Table 1 – Centre frequency and bandwidth of the four frequency bands sampled by the POD

Band	Centre Frequency, kHz	3dB Bandwidth kHz
Hi	132	36
Mid	93	25
Lo	50	10
Sub	25	4

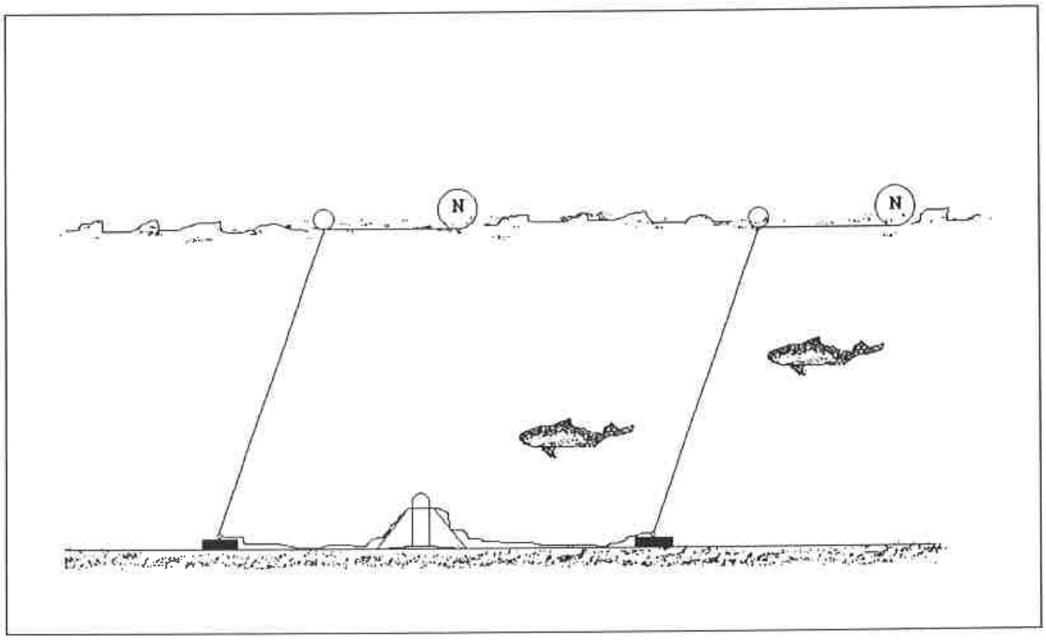

Fig. 1 - Method of deploying the POD in a lobster pot, set between two outlying mooring blocks, each with a surface marker-buoy.

TOOTH AGE DETERMINATION IN THE STRIPED DOLPHIN BY SCANNING ELECTRON MICROSCOPY

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Light microscopy is the method most normally used to determine the age of dolphins using growth layer groups (GLG) counts in teeth. Scanning electron microscopy (SEM) has also been used due to its convenience when interpreting results. Because of the lack of satisfactory results following the SEM methods described in literature, we opted to study possible variations in order to improve the results.

The teeth were taken from the striped dolphin, *Stenella coeruleoalba*, stranded on the north-east coast of the Iberian Peninsula. Teeth from the middle of the hemi-mandible were routinely extracted. After macerating in water and boiling in a phosphate buffer, they were cut, decalcified, and processed for observation by SEM. Results were not obtained from teeth that were previously fixed in formalin. Only transverse cuts gave positive results and, at the same time, the decalcification period needed to be for a minimum of 12 hrs and with a long final drying period. Age determination has been possible with this method, reducing difficulty and need for technical knowledge. No results for determining alterations in growth were achieved.

BASELINE RETINOL CONCENTRATIONS IN THE BLUBBER OF HARBOUR PORPOISES AND THEIR APPLICATION AS A BIOMARKER

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An unresolved central issue in ecotoxicology is the establishment of cause-effect relationships of pollutant concentrations. Odontocete cetaceans are the living vertebrates in which the highest concentrations of organochlorines (OC) have been found, but their actual effect and pathways of action have yet to be determined. However, adverse effects of these pollutants on the reproduction and immune competence of cetaceans have been suggested. Organochlorines are known to induce deficiency of retinol (Vitamin A) in mammals. The effects of retinol deficiency include decreased resistance to infection, reproductive impairment, and growth retardation. However, the use of retinol as a biomarker of organochlorine contamination in cetaceans requires baseline data on its variability patterns in populations from unpolluted environments.

We investigated these patterns in a nearly pristine cetacean population. 103 harbour porpoises from West Greenland taken mainly during hunting, were sampled in 1996. Sex, age, morphometrics, nutritive condition, and retinol and OC levels in blubber were determined for each individual. OC levels found in these samples were extremely low for an odontocete: mean blubber concentrations were 2.04 (SD=1.1) ppm for PCBs and 2.76 (SD=1.66) ppm for tDDT. These levels are not considered to affect the population. The mean retinol concentration for the overall population was 41.76 (SD=31.68) mg/g, which is in the normal range of values found in other marine mammals. No significant differences were found between sexes or geographical regions. Retinol levels were significantly ($p<0.001$) correlated with age, length and weight but not with blubber lipid content ($p=0.16$), suggesting little or no influence of body condition. These results show that biological information is critical for the use of retinol as a biomarker in cetaceans.

A FIELD TEST OF ACOUSTIC ALARMS TO REDUCE HARBOUR PORPOISE BY-CATCH IN BOTTOM SET GILL-NETS

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A field test to evaluate the effectiveness of pingers to reduce incidental catches of harbour porpoises (*Phocoena phocoena*) was conducted in the Swedish Skagerrak Sea from March to May 1997.

In the study, five observers accompanied five professional fishermen using bottom set gill-nets for cod. All strings of net were identical and set at least 300 m. apart. Every 100 m. of a string, a Dukane Netmark™ 1000 pinger was attached to the float line. On control strings, the pingers were inactivated by reversing the battery pack.

The field test was based on results from observer programmes conducted on the same fishery in 1995 and 1996. In the observer programmes, the event of a by-catch followed a Poisson distribution. The by-catch rates were shown to be equal between the years and were therefore pooled. The pooled by-catch rate was 1 porpoise per 28 hauls, or 35 porpoises per 10,000 km/hrs.

We had designed the pinger test to get 650 sets, but due to unfavourable weather conditions and fishing regulations, only 373 sets were conducted. Of these sets, 189 were active and 184 were control. No porpoise was observed by-caught. There was no difference in fishing effort per set or catch of fish per set between active and control strings.

Given the by-catch rate from the observer programmes, seven porpoises (95% CI=3–14) should have been caught in the 184 control strings. The zero by-catch was not caused by a change in fishing effort per set, because no difference was found among the years. Furthermore, no difference was found in catch of fish per effort and fishing day among the years. This indicates that the pingers did not change the distribution of porpoises by changing the distribution of their prey. Possible explanations for the zero by-catch could either be unknown variation in porpoise distribution or that pingers affected porpoises in the entire study area.

COMPUTER SIMULATION OF INTERACTIONS BETWEEN THE NORTH ATLANTIC RIGHT WHALE (*EUBALAENA GLACIALIS*) AND SHIPPING

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Computer simulation and modelling techniques can be important investigative tools in situations where the complexities of interactions within a biological system are under scrutiny. The intention of this simulation is to reproduce a system in such a way that many years can be simulated in a matter of hours. In the case of this simulation, the real value in the use of computer modelling is that it then becomes possible to investigate situations which relatively rarely occur in reality, possibly in single figures over an entire year. It is intended to simulate around 1,000 years of interactions, since in reality, right whale/ship encounters are a rare event.

It is proposed that this computer simulation of the interactions between whales and shipping, based upon assumptions on right whale behaviours, should attempt to draw conclusions as to the most effective advice to be offered to ships moving through an area where right whales are known to be present.

APPLICATION OF GRAPHICAL DIGITAL TOOLS TO STRANDING INFORMATION MAPPING OF STRANDINGS OFF THE ITALIAN COAST, 1986-1996

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An interdisciplinary approach was demonstrated to be an effective way to gain a complete understanding about cetaceans and their environment. Strandings are an important means of studying the distribution and presence of different species of cetaceans. Unfortunately, this information is often incomplete and not widely available.

Since 1986, the Italian "Centro Studi Cetacei" has systematically recorded all the relevant stranding data on the Italian coast, and this is published annually by the "Società Italiana di Scienze Naturali".

These data have been digitised in a collaboration between SACLANTCEN and CIBRA, which has made possible the creation of a geographic based system which allows one to explore the geographic distribution of stranding locations coupled with biological factors and/or other relevant information found in the database. The intention was to produce a fast method of consulting this enormous mass of recorded data collected during ten years of monitoring. With this database, it is possible to research specific geographic areas, time periods, as well as other keys such as species, interaction with human activities, pathology, etc. This database has established a framework in which all available stranding data for the Italian coast can be obtained in a complete and up to date format for easy consultation.

This work should be the basis for more complete data integration from all European and Mediterranean countries.

CETACEAN DISTRIBUTION IN THE ALBORAN SEA: USE OF GENERALISED LINEAR MODELS (GLMs) AS PREDICTIVE TOOL

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INTRODUCTION The development of easily interpretable models predicting the distribution and abundance of wildlife is needed for decision makers regarding the management of natural resources (Morrison *et al.*, 1987). Within exploratory models that search for general animal-habitat relationships, those seeking only presence-absence resolution are far less costly and are adequate enough in many situations (Morrison *et al.*, 1987). Recent attention has turned to Generalised Linear Models (GLMs) (Smith, 1994) in ecological studies. Because GLMs provide a mathematical description of wildlife species distribution *versus* environmental variables, they permit a wider range of relationships between the response and the explanatory variables (linear and non linear) (McCullagh & Nelder, 1989), and, likewise, the use of other error formulations when the normal error of traditional regression is not applicable (McCullagh & Nelder, 1989; Sanchez-Zapata & Calvo, in press). In this context, a particular case of GLMs, that of logistic regression, provides a convenient alternative by examining the relationships between the logistic transformations of the proportions (presence-absence) and linear combinations of the predictor variables. The combined use of GLMs with a Geographical Information System could be highly effective for management, because they describe species-environmental relationships and could be used as a predictive tool.

So far as we know, only a few studies (e.g. Fiedler & Reilly, 1994; Reilly & Fiedler, 1994) have been conducted to elucidate which are the more important variables to determine the cetacean community structure. Detailed analysis of oceanographic conditions and animal distribution relationships will be necessary to understand fully the habitat requirements of this pelagic fauna.

MATERIALS AND METHODS During the last week of each summer month of 1998, oceanographic and cetacean (common dolphin, *Delphinus delphis*, striped dolphin,*Stenella coeruleoalba*, bottlenose dolphin,*Tursiops truncatus*, long-finned pilot whale,*Globicephala melas*, Risso's dolphin, *Grampus griseus*) data on presence or absence, were collected every fifteen minutes, from vessel surveys conducted in the north-eastern Alborán Sea (Almería, SE of Spain). The number of stations sampled was 297, and all of them were positioned with GPS. Depth (D) data were added from a Digital Elevation Model (1 km^2 grid) derived from Spanish Navy nautical charts. Surface temperature (T) was measured with an analogue thermometer (0.1° C precision) and salinity (S) with a refractometer (1‰ precision). Chlorophyll *a* (Chl *a*) content was assessed by the spectrophotometric method (Parsons *et al.*, 1984).

The study area was located from 40°23.000' to 40°77.500' UTM north co-ordinates and from 5°09.500' to 6°20.000' east co-ordinates in the North-eastern Alborán Sea, including depths between 0 and 1,700 m. The bottom has steeper zones in the western and eastern sectors compared with the middle ones. The Alborán Sea is a zone of extraordinary interest, not only from a hydrodynamic (Almería-Orán Front) point of view but also an ecological one. The ecological effects of this circulation pattern mark an important difference between the occidental part of the Cape of Gata (Alborán Sea) and the oriental zone (Levante Sea). The high productivity of the Front is reflected by the presence of nekton fauna such as predatory fishes and many cetacean species which have been observed feeding along it (Viale & Frontier, in Powell, 1997).

During the sample period, temperatures ranged from 22.2° to 28.7° C, salinity varies between 35 and 39‰, and chlorophyll *a* content from undetectable values (<0.052) to 0.56 $\mu g \cdot L^{-1}$.

We made a mathematical description of cetacean species presence, using Generalised Linear Models (GLMs) (McCullagh & Nelder, 1989). Logistic regression examines the relationships between presence-absence data and linear combinations of the environmental variables (which can include its second order term) as follows:

$$\ln [p/(1-p)] = b_0 + b_1 \cdot X_1 + b_2 \cdot X_2 + \ldots$$

where p is the species encounter probability; b_0, b_1, b_2, ... are the parameters to be estimated from the observed data; and X_1, X_2, ... are the explanatory variables. We fitted each explanatory variable to the observed data using the "Forward stepwise" procedure, choosing 5% level of significance ($p<0.05$) to include a variable in the model. "Forward stepwise" procedure uses as model-seed, the variables that explained most deviance (data inertia) in univariate regressions. The variables are added to the first one by successive steps looking for decreasing on absorbed deviance. All these calculations were performed using STATISTIX v. 4.1 (Analytical Software, 1992).

RESULTS AND DISCUSSION We used not only environmental variables in a strict sense, but parameters such as longitude and latitude, which can detect spatial habitat variations in the study area that were not measured in this study (e.g. water mass movements, bottom topography, etc.). This situation implies that the resulting models are applicable only in our study area. In addition, latitude and longitude correlates with some environmental variables; in this case, for example, latitude correlates with depth (0.56). On the other hand, the encounter probability of the models is low, as a result of cetacean behaviour, being pelagic fauna with a great mobility yielding a reduced number of samples.

We obtained the following multivariate models as a result of the Fordward stepwise procedure (Table 1). The explained variance for the common dolphin model (Table 1, Fig 1) was 19.5%. Longitude and Chlorophyll *a* were the primary variables explaining most of the variation. The importance of this parameter for the species has been recognised by several authors (Selzer & Payne, 1988; Reilly & Fiedler, 1994). On the other hand, the explained variance for striped dolphin (Table 1, Fig. 2) was 9.27%. The primary variables explaining most of the variation were temperature and depth. Although striped dolphin has been shown to have a higher probability of appearance in warmer waters (Reilly, 1990; Reilly & Fiedler, 1994; Davis *et al.*, 1998), recent studies have shown an opposite situation. Our model describes the two different situations.

In the case of Risso's dolphin (Table 1), the explained variance was 44.24% and the variables explaing most variation were longitude and temperature. The model agrees with the results obtained in the Gulf of Mexico by Davis *et al.* (1998), where Risso's dolphin prefers areas with no extreme temperatures (on the edge between cooler and warmer waters), and the depth zone is at its steepest gradient, which are the western and eastern sectors in our study area.

For bottlenose dolphin and long-finned pilot whale models (Table 1) the explained variance was 44.8 and 38.46% respectively, with latitude, temperature, and Chlorophyll *a* as the most important variables. The behaviour of both bottlenose dolphin and long-finned pilot whale were apparently differently related to latitude and temperature. Since latitude and depth have a significant correlation (–0.56) with one another, the different response to latitude is probably related to water depth

The univariate models (Table 2, Fig. 3) are interesting because they allow comparisons between each species probability encounters with respect to the same variable. This is due to multivariate models of the different species rarely having the same explanatory variables: The temperature models (Fig. 3) for bottlenose dolphin, long-finned pilot whale, and striped dolphin (15.58, 12.7 and 4.8% of explained variance respectively) have maximum encounter probabilities at the lowest sea temperatures; it is interesting to note that striped dolphin and long-finned pilot whale have no probability (0) in the range of temperatures studied here, while bottlenose dolphin moved to zero probability from 27° C. In the salinity model, for bottlenose dolphin (11.01% e. d.), the probability is maximum at the highest values of salinity, in contrast to the Risso's dolphin (8.65% d. e.), which has maximum probability at the lowest salinity. Depth models for long-finned pilot whale (18.77% e. d.), Risso's dolphin (25.02% e. d.), and striped dolphin (2.98% d. e.) have maximum probabilities at the highest depth, but these declined fast in the first two species whilst in the third one they declined slowly; in spite of its small size, the striped dolphin is able to live in a wider range of depths.

The longitude model: For common dolphin (8.84% e. d.), the maximum probability is located westward of the study area, whilst for striped dolphin (4.55% e. d.) and Risso's dolphin (12.82% e. d.), the maximum is located eastward. The latitude model for long-finned pilot whale (21.24% d. e.) shows the maximum probability (p=0.26) in the southern part of the study area in contrast to bottlenose dolphin (9.08% d. e.) which has its maximum (p=0.1) in the north; this parameter is significantly correlated (-0.56) with depth, reflecting the orientation of the coast in this area, so that depth increases southwards. Chlorophyll *a* in the common dolphin model (8.71% d. e.) shows a Gaussian distribution; the concentration of Chlorophyll *a* is an important parameter for common dolphin, as previously recognised by Selzer & Payne (1988), and Reilly & Fiedler (1994).

REFERENCES

Analytical Software. 1992. *Statistix v. 4.1* Users Manual. Analytical Software. St.Paul. 330pp.

Davis, R. W., Fargion, G. S., May, N., Leming, T. D., Baumgartner, M., Evans, W. E., Hansen, L. J. and Mullin, K. 1998. Physical habitat of cetaceans along the continental slope in the Northcentral and Western Gulf of Mexico. *Marine Mammal Science*, 14, 3: 490–507.

Fiedler, P. C. and Reilly, S. B. 1994. Interannual variability of dolphin habitats in the Eastern Tropical Pacific. II: Effects on abundances estimated from tuna vessel sightings; 1975-1990. *Fishery Bulletin*, 92: 451-463.

McCullagh, P. and Nelder, J. A. 1989. *Generalized Linear Models*. Chapman and Hall. Cambridge. 511pp.

Morrison, M. L., Timossi, I. C. and With, K. A. 1987. Development and testing of Linear Regression Models predicting bird-habitat relationship. *J. Wildl. Manage.*, 51, 1: 247–253.

Parsons, T. R., Maita, Y. and Lalli, C. M. 1984. *A manual of chemical and biological methods for seawater analysis*. Pergamon Press, Oxford. 173pp.

Powell, D. K. 1997. *The horizontal distribution of pelagic fauna across the Almeria-Oran Front, SW Mediterranean Sea*. MSc. Thesis, University of Southampton. 107pp.

Reilly, S. B. 1990. Seasonal changes in distribution and habitat differences among dolphins in the Eastern Tropical Pacific. *Marine Ecology Progress Series*, 66: 1–11.

Reilly, S. B. and Fiedler, P. C. 1994. Interannual variability of dolphin habitats in the Eastern Tropical Pacific. I: Research vessel surveys; 1986-1990. *Fishery Bulletin*, 92: 434–450.

Sánchez-Zapata, J. A. and Calvo, J. (In press). Habitat structure and forest raptor abundance in semiarid Mediterranean landscapes. *J. Appl. Ecol.*

Selzer, L. A. and Payne, M. P. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphin (*Delphinus delphis*) vs. environmental features of the continental shelf of the Northeastern United States. *Marine Mammal Science*, 4, 2:141–153.

Smith, P. A. 1994. Autocorrelation in logistic regression modelling of species distribution. *Global Ecol. Biogeography Letters*, 4: 47–61.

Table 1. Multivariate models after "Forward stepwise" selection. ($p<0.05$).

Species	Model ($y = \ln[p/(1-p)]$)	Deviance (%)
Stripped dolphin	$y= 141.55+11.75*T+0.2*T^2+59.9*D-390*D^2$	9.27
Common dolphin	$y= 24.35-5.3\cdot10^{-5}*Lo+60.105*Chl-346.961*Chl^2$	19.5
Long finned pilot whale	$y= 1653.17-3.22\cdot10^{-4}*La-28.21*T+0.56*T^2-37.63*Chl$	38.46
Bottlenose dolphin	$y= -855.47-3.44*T+2.31\cdot10^{-4}*La-40.042*Chl$	44.86
Risso's dolphin	$y= -7058.43-4.67\cdot10^{-3}*Lo+4\cdot10^{-9}*Lo^2+632.87*T-12*T^2$	44.24

Table 2. Univariate models ($p<0.05$).

Variables	Species	Model ($y = \ln[p/(1-p)]$)	Deviance (%)
Temperature	Stripped dolphin	$y= 131.629-10.8*T+0.2*T^2$	4.8
	Risso's dolphin	$y= 185.512-14.75*T+0.3*T^2$	12.69
	Bottlenose dolphin	$y= 8.458-2.09\cdot10^{-2}*T^2$	15.58
Depth	Stripped dolphin	$y= -3.448+11.9*D$	2.98
	Risso's dolphin	$y= -8.312+44.5*D$	25.02
	Long finned pilot whale	$y= -6.243+29.8*D$	18.77
Salinity	Bottlenose dolphin	$y= -36.246+2.22\cdot10^{-2}*S^2$	11.01
	Risso's dolphin	$y= 30.56-0.94*S$	8.65
Chl *a*	Common dolphin	$y= -4.2+55.35*Chl-308.832*Chl^2$	8.71
Longitude	Common dolphin	$y= 11.672-4.92\cdot10^{-11}*Lo^2$	8.84
	Stripped dolphin	$y= -8.145+1.78\cdot10^{-11}*Lo^2$	4.55
	Risso's dolphin	$y= 3382.422-1.384\cdot10^{-3}*Lo+10^{-9}*Lo^2$	12.85
Latitude	Long finned pilot whale	$y= 303.685-1.88\cdot10^{-11}*La^2$	21.24
	Bottlenose dolphin	$y= -212.95+1.27\cdot10^{-11}*La^2$	9.08

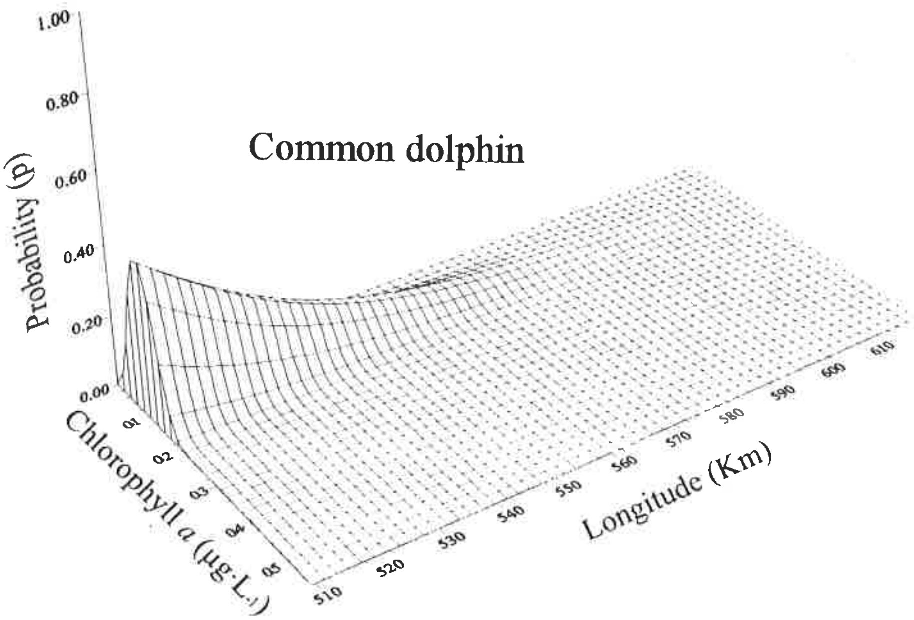

Fig. 1 Multivariate model

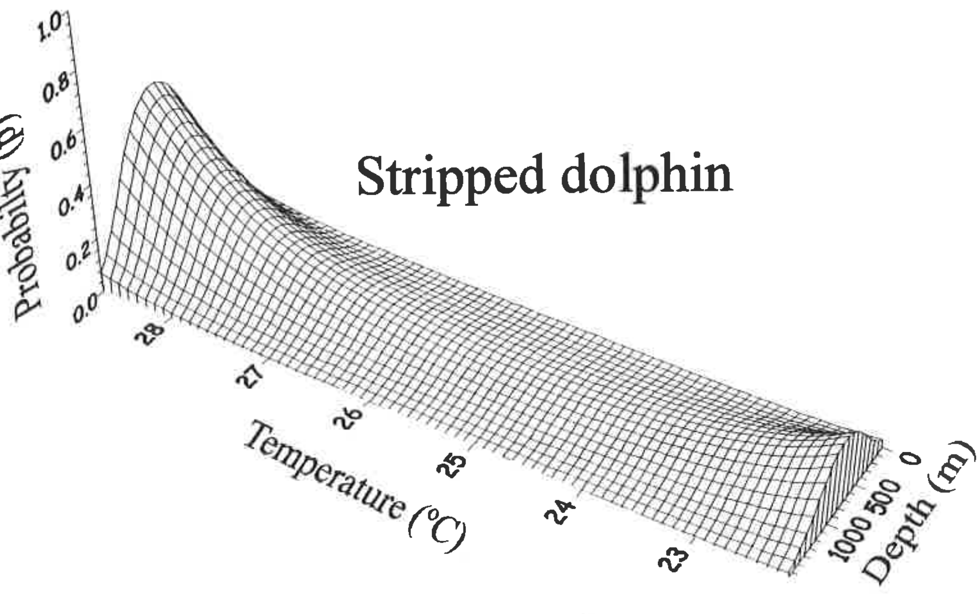

Fig. 2. Multivariate model

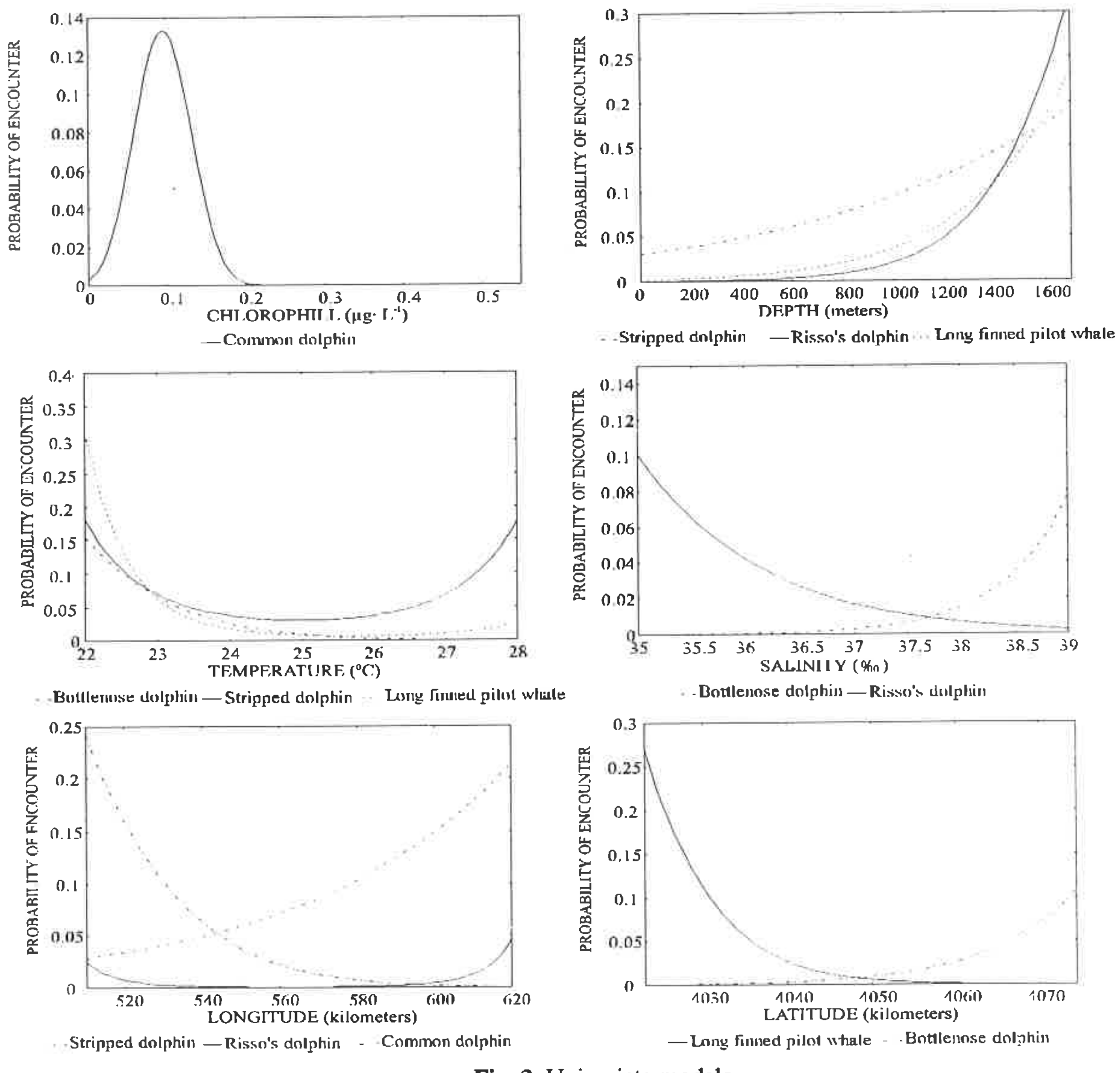

Fig. 3. Univariate models

APPLICATION OF GRAPHICAL DIGITAL TOOLS TO STRANDING INFORMATION: AN OPEN INFORMATION SYSTEM FOR MARINE MAMMAL STUDIES IN THE MEDITERRANEAN SEA

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Strandings data provide the opportunity to study the distribution and presence of different species of cetaceans as well as a means to better understand the causes of death in relation to the impact of human activities. Unfortunately, this information is often not widely accessible and its collection may take a long time. However, once the stranding database is established, it is beneficial to examine the data using multi-level data retrieval and geographic mapping capabilities. This interdisciplinary approach has been demonstrated as an effective way to gain a complete understanding about cetaceans and their environment. The application of this methodology to an 11-year stranding database demonstrates the first step in the development of a centralised, widely accessible, archive of oceanographic and biological data sets for the Mediterranean Sea. The database, named Sound Oceanography and Living Marine Resources (SOLMR), will be published on the World Wide Web to allow easy and free consultation on the Internet.

Relevant information on cetacean standings along the Italian coasts has been published on a yearly basis by the Italian Centro Studi Cetacei (CSC) since 1986 (Borri, 1997). Data contained in these publications during the time period of 1986-96 (CSC, 1997) were chosen in the concept development of the SOLMR database. The data were digitised and transferred to a GIS (Geographical Information System) for data retrieval and mapping (Fig. 1). ESRI ArcView 3, a widely used software available on different computing platforms was chosen for the baseline application. Each record in the database provides information about the date of the event, its position, and the characteristics of the specimen such as the species, sex, dimensions, and any other relevant data. The records also provide information about toxicological and parasitological investigations, and references to related bibliographic sources, when available. This collection of multilevel information enables research on cetacean populations, presence, distribution, diseases, temporal trends, and interaction with human activities. The final goal is to make the database easily and freely accessible by everyone through the web, using different spatial or temporal search keys. A notification of database publications will be posted on mailing lists related to cetaceans (MARMAM and ECS e-mail lists).

Subsequent SOLMR database development will incorporate data concerned with cetaceans and marine biology for the entire Mediterranean Sea. This will include zoological (strandings, sightings, acoustic detections, behavioural studies), and biological (productivity, biodiversity) information coupled with geophysical, oceanographical and climatological (remote sensing images to show chlorophyll concentration, water currents, sea surface temperature, weather conditions) (Fig. 2). Additionally, pictures (photographic documentation, including photo-ID), videos and audio files (acoustic signatures of species) will be included when available. All the information stored in the database will include references to the data sources and to the organisations or researchers responsible for the data collection. This will allow dissemination of relevant information to facilitate contacts and cooperation among the organisations providing information for the database. The SOLMR data base will provide a multi-national, multi-disciplinary open information system for the entire Mediterranean Sea. This centralised database will provide a planning tool for biological and oceanographic research that incorporates the use of new technologies applied to enhance biological survey data. Ultimately, it will provide a tool for evaluating the impact of human activities and for setting up and tuning conservation strategies.

ACKNOWLEDGEMENTS We thank Centro Studi Cetacei, Antonio Di Natale, Valeria Teloni, Marco Priano, Simonetta Galli, and Michele Manghi for their help at various stages.

REFERENCES

Borri, M., Cagnolaro, L., Podestà, M. and Renieri, T. 1997. Il Centro Studi Cetacei: dieci anni di attività 1986–1995. *Milano giugno* 1997, 88, 1: 93pp.

CSC (Centro Studi Cetacei) 1997. Cetacei spiaggiati lungo le coste italiane. XI. Rendiconto 1996. *Atti Soc. It. Sci. nat. Museo Civ. Stor. Nat.*

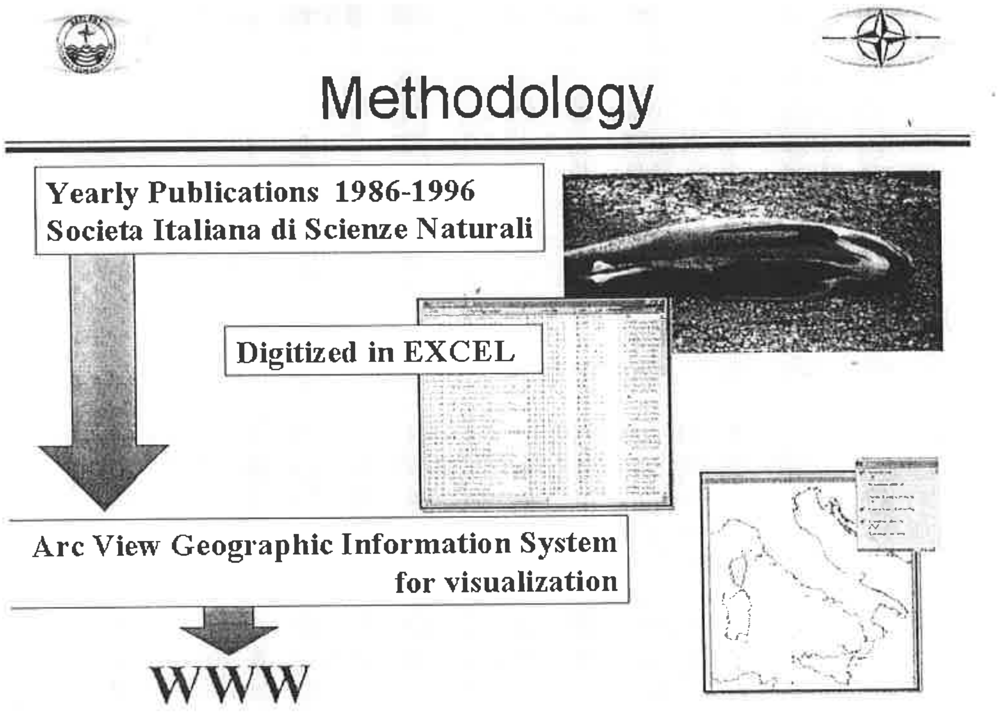

Fig. 1 Methodology applied.

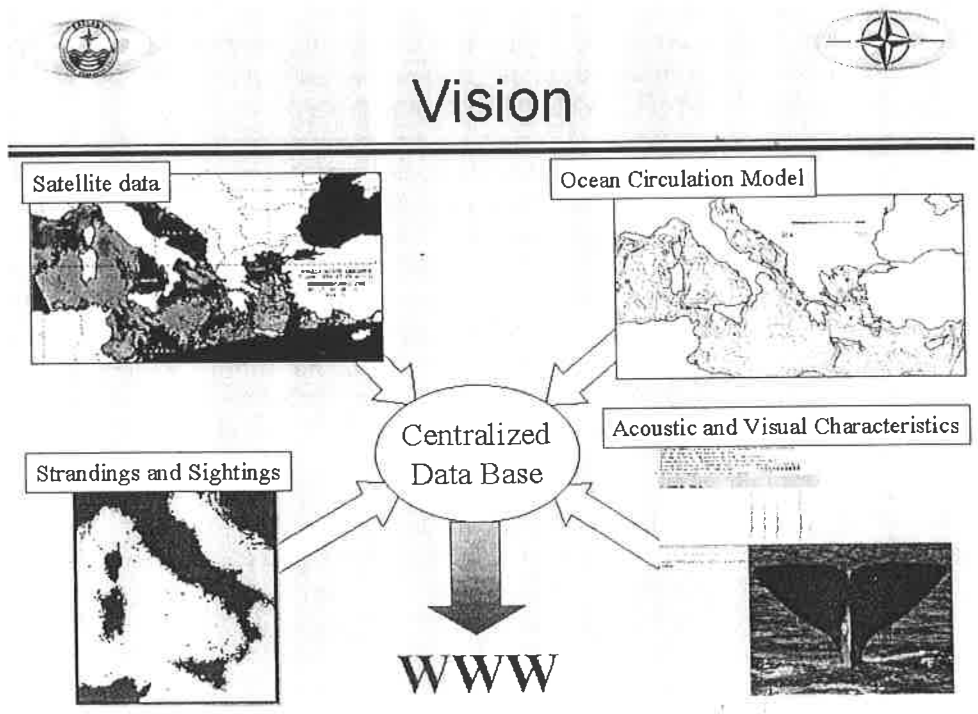

Fig. 2 Interdisciplinary data included in the database.

AUTOMATIC ACOUSTIC CETACEAN DETECTION IN THE VICINITY OF SEISMIC SURVEY VESSELS: A TOOL FOR MITIGATION

D. Gillespie[1, 2], O. Chappell[1, 2], J. Gordon[2], T. Lewis[1, 2] and R. Swift[1, 2]

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In recent years, there has been increased concern amongst academics and NGOs about the potential threats to marine mammals posed by high energy sound sources, such as air-gun arrays, which are used by the oil industry in its search for fossil fuels. UK government guidelines now prohibit the starting of air-guns if marine mammals are known to be within 500 m. However, many species of cetacean are difficult to spot, particularly in the weather conditions prevalent in the North Sea and the North-east Atlantic. The guidelines therefore recommend that acoustic detection techniques be used, in addition to visual searching, to detect cetaceans whenever possible.

In response to this, an automatic acoustic detection system has been developed, which is sensitive to cetacean vocalisations and can give operators advanced warning of cetacean presence. The system uses signals from a passive hydrophone array deployed from a guard vessel positioned approximately one nautical mile ahead of the seismic source.

The detection systems are principally software based and are designed to run on a single high-performance PC. The complete system comprises three different detectors each of which is sensitive to a different class of tonal or click-like sound. Data from the three detectors are collected and displayed by a fourth programme which makes a final decision on the likely presence of cetaceans using data from all three detectors. A permanent record of detections is also stored in a database for later analysis of cetacean abundance in the survey area.

A brief description of seismic operations and the way in which sound may affect marine mammals is presented, followed by a description of the equipment and procedures employed during sea trials in 1996, 1997, and 1998. Analysis of data from these trials shows that the acoustic detection system gives at least an eight-fold increase in the number of cetaceans detected when compared with visual methods alone. Systems of this type, which can detect and log cetacean vocalisations automatically, should also find many applications in population monitoring and behavioural research.

AN OBJECTIVE TECHNIQUE FOR MATCHING MOTHERS TO KNOWN CALVES

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For researchers working on free-ranging social odontocetes, information on which individuals are the mothers of known calves is valuable but inherently difficult to obtain. In the absence of genetic data, or by choosing to take a non-invasive approach, many researchers have used repeated field observations to assign mothers to known calves. However, this approach is subjective, and is not useful for animals that are rarely seen, or for those seen in large groups.

In this paper, we use eight years of photo-identification data from a coastal bottlenose dolphin population in a new approach designed to objectively assign mothers to known calves. We use association analyses and compare these results to those obtained by the more traditional field-based method. Analyses were carried out for 40 calves in their first two years of life, and associations were quantified in two ways. First, we carried out analyses on data from *groups* that included the known calf, and secondly on data from photo-identification *pictures* which contained the known calf.

Using association analyses on data from *groups* provides more objective information on mothers of calves than the traditional approach, whilst analyses carried out using *pictures* as the sampling unit allows more information to be extracted from small data sets – useful for individuals that are rarely seen.

USE OF A COMBINED VIDEO AND COMPASS BINOCULAR SYSTEM TO TRACK THE MOVEMENTS OF NORTHERN RIGHT WHALES (*EUBALAENA GLACIALIS*) FROM A MOVING VESSEL

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A combined system using a digital video camera mounted on a frame with compass binoculars was used to track the movements of right whales and record behavioural data from *Song of the Whale*, a 14 m. research vessel. Video images were taken from a known height and analysed on a PC using specially written software to measure the angle of dip from the horizon to the whale, thus allowing the range to be calculated. The system was operated by a single person, with bearings to whales and behavioural observations recorded verbally on the video soundtrack. These data were combined with data on the position of the vessel recorded from GPS to calculate whale movements. A number of calibration tests using radar and laser range-finding binoculars were conducted to ascertain the accuracy of the system under different conditions.

The data gathered on small scale movements were analysed to investigate the response of right whales to vessels. The same methods could also be used during sightings surveys to measure and track the location of whales relative to the survey vessel.

MEASURING OF INDIVIDUAL BOTTLENOSE DOLPHINS, *TURSIOPS TRUNCATUS*, USING STEREO-PHOTOGRAPHY

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INTRODUCTION At present, there are few non-invasive techniques to measure free-ranging bottlenose dolphins. Aerial photography, as used by Perryman and Lynn (1994) to measure striped dolphins,*Stenella coeruleoalba*, allows measurements to be made of animals within a group, but does not allow the identification of individual dolphins. In addition, aerial photography is expensive and beyond the budget of many researchers. This presentation outlines a technique using stereophotography to measure bottlenose dolphins, *Tursiops truncatus*, from boats. This technique is cheap, flexible, easy to use, and allows the identification of individual animals.

The accuracy of the technique has been assessed using photographs of objects of known size and captive bottlenose dolphins. It has been applied in two very different research situations, for the study of bottlenose dolphins in the Moray Firth, Scotland, and in the Sea of Abaco, The Bahamas.

The technique: Calculation of body length from photographs:

Using the apparatus shown in Figure 1, photographs were taken of bottlenose dolphins. On development, the negatives were examined using a magnification loupe and a light table. Any photographs where the animal was not parallel to the camera, or too far away, were discarded. From each suitable stereopair of photographs, the measurements shown in Figure 2 were taken. The total body length was then calculated using the following formulae:

$$L = lX/((X2-X1)+C)$$

$$TBL = L \times Mf$$

Where:

L = the length of the body section being measured (e.g. blowhole dorsal fin distance).
l = the length obtained from the photograph,
X = Separation distance between the centre of the lenses of the two cameras
X2 and **X1** are the appropriate measurements shown in Figure 2,
C = Correction factor calculated using photographs of an object of known length to account for any convergence in the camera
TBL = Total body length
Mf = Appropriate multiplication factor to convert **L** to **TBL**, obtained from regression analysis of morphometric measurements with total body length.

TBL is given in the same units as **X**

Finally, the dolphin being measured was compared to the appropriate catalogue and identified by nicks and marks on the dorsal fin to allow the total body length to be assigned to a specific known individual.

Level of accuracy of this technique: Measurements made from photographs of known sized objects indicated that there was no bias to under or over estimate the object size, and 95% of all measurements were within 2% of the actual object size.

Measurements of captive dolphins of known size indicated that the measurement of living animals did not result in any additional bias or greatly increase the level of error (see Table 1).

Benefits of this technique:

1. **Individual animals can be identified** from photographs used to calculate body length. This allows measurements to be allotted to photo-identified animals and allows the re-measurement of individuals.

2. **The apparatus is cheap to construct and use**. It can be constructed for as little as £300 and the only analytic costs are the development of the film and purchase of magnification loupe with a scale bar in it.

3. **It is simple to use**. Photographs of dolphins are as easy to obtain as photo-identification photographs, and can be taken at the same time. The mathematics involved in the calculation of total body length is relatively simple, and no specialist training is needed to analyse the photographs.

4. **It is flexible**. With different lens and separation distance combinations, this technique can be tailored to the specific needs of individual research projects and local conditions (e.g. how approachable the dolphins are, or the size of the research vessel). In addition, the apparatus is easily portable and can be quickly moved from one boat to another. It can also be used from non-research vessels, such as dolphin watching boats.

ACKNOWLEDGEMENTS This project was undertaken by CDM and JAL to fulfil the thesis requirements for an M.Sc. We would like to thank Kate Grellier for assistance with analyses, and Patrick Berry and other staff at the Dolphin Experience, Freeport, Grand Bahama for providing body measurements for and access to captive dolphins. Special thanks go to Diane Claridge of Bahamas Marine Mammal Survey (BMMS) for her advice and support for fieldwork in Bahamas. CDM would like to thank the Society for Marine Mammalogy for their Emily B. Shane Award, and the Whale and Dolphin Conservation Society for supporting fieldwork in the Bahamas. Thanks also to Earthwatch for supporting work undertaken by BMMS.

REFERENCES

Perryman, W. L. and Lynn, M. S. 1993. Identification of geographic forms of common dolphin (*Delphinus delphis*) from aerial photogrammetry. *Marine Mammal Science*, 9: 119-137.

Table 1: Comparison of actual measurements and stereophotographic measurements for 11 stereopairs of five different animals. BHDF = Blowhole dorsal fin measurement.

Individual	Actual Length BHDF (cm)	Stereophotographic length BHDF (cm)	Error (cm)
Bimini	79	75	-4
		80	1
		81	2
Caribe	71	70	-1
		70	-1
Indy	62	60	-2
		62	0
Kaholo	71	69	-2
		69	-2
Stripe	82	78	-4
		86	4
Average	73.5	72.7	-0.8

Table 2: Measurements of individual dolphins from the Moray Firth.

I.D. Number	Age Class	Sex	Total Body Length (cm)
79	Adult	Female	230.53
22	Adult	Male	240.37
474	Juvenile	Unknown	252.34
631	Sub-Adult	Unknown	278.82
210	Adult	Presumed Male	284.50
27	Adult	Female	286.69
107	Adult	Female	298.90
116	Adult	Presumed Male	304.76
7	Adult	Presumed Male	312.67
30	Adult	Female	313.01
64	Adult	Female	315.98
23	Adult	Presumed Male	316.92

Table 3: Measurements of individual dolphins from the Sea of Abaco:

I.D. Number	Age Class	Sex	Total Body Length (cm)
Tt15	Sub-Adult	Male	227.7
Tt46	Adult	Male	200.2
Tt??	?	?	214.2

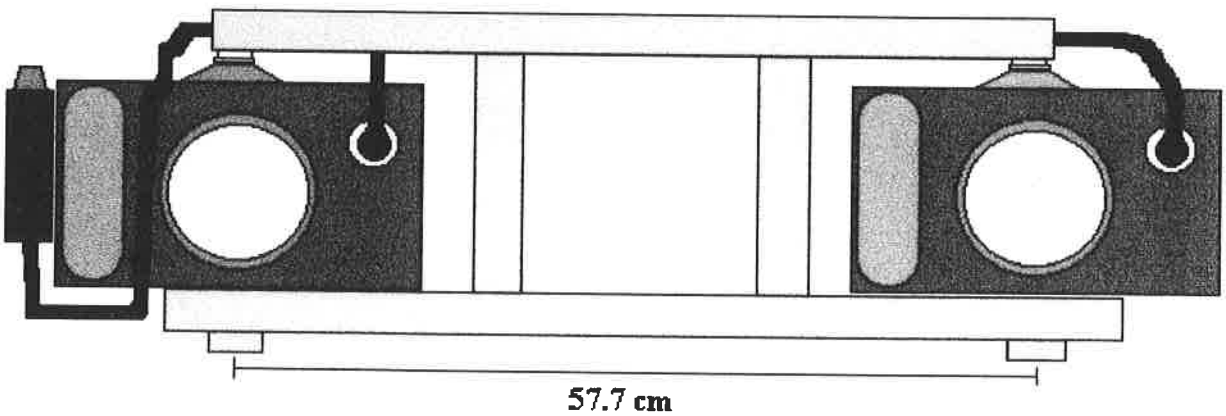

Figure 1: The apparatus developed to measure bottlenose dolphins using stereophotography. The cameras are two identical 35mm SLRs fitted with identical lenses. Focal lengths of both lenses were set at infinity and held in place with tape to ensure settings were identical. Shutters are triggered by a duel electronic cable release. Cameras are attached at the top by the hotshoe (flash mount) and at the bottom by the tripod mount. The bracket which fits into the hotshoe is flush against the edges of the hotshoe, so preventing the cameras moving and therefore keeping them parallel.

a).

b).

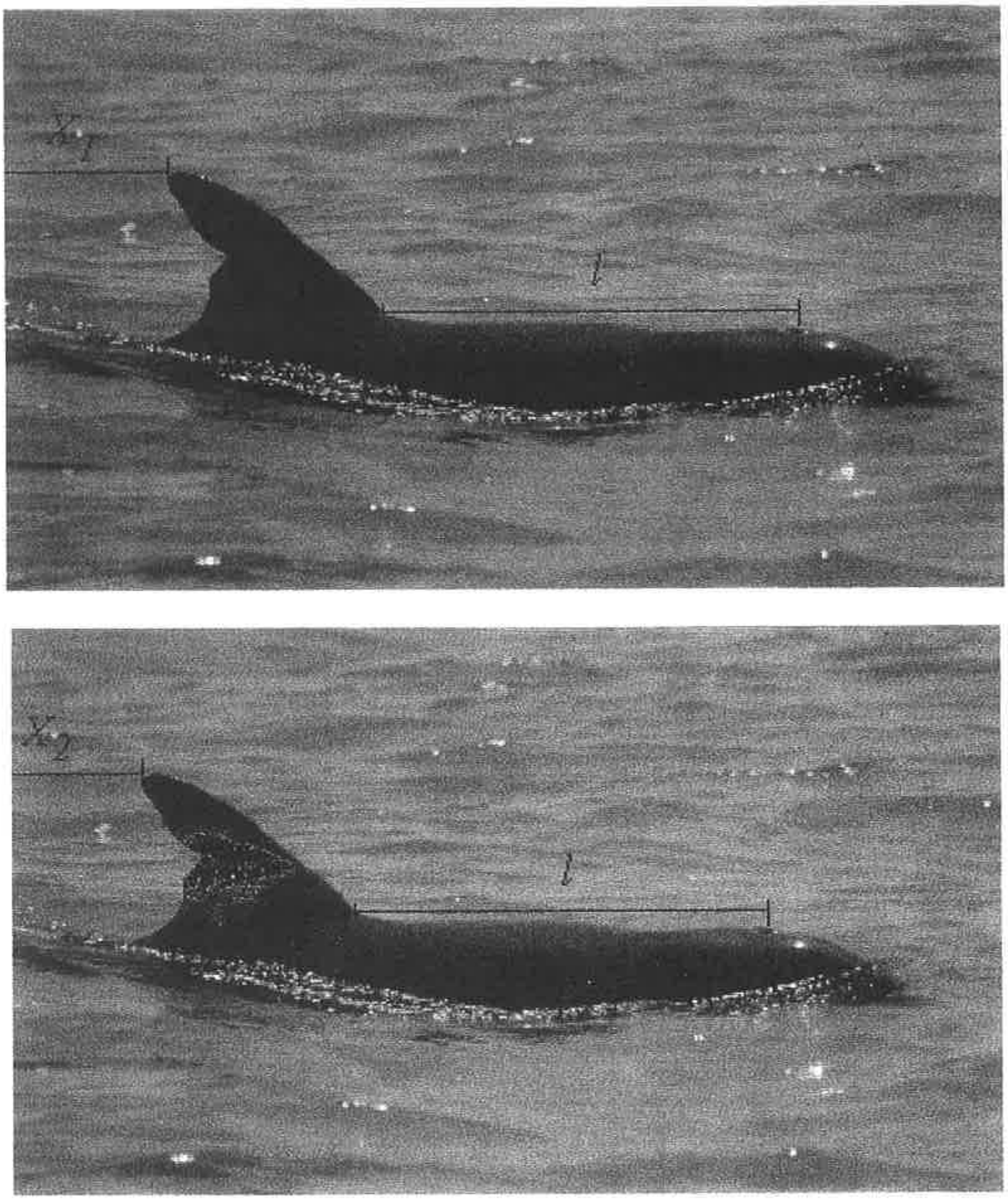

Figure 2:
fin length, l is the blowhole dorsal fin length of the animal, X_2 is the greater of the two measurements from the dorsal fin to the edge of the frame and X_1 is the smaller of these two measurements. a). is the image from the left-hand camera and b). is the image from the right-hand camera.

RETINAL VASCULAR PATTERN AS A SOLUTION FOR LOW TEMPERATURE, IN LONG-FINNED PILOT WHALE

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The cetacean eye has not shed its terrestrial modification but has faced several environmental problems. The neural tissue of the eye is probably the most exposed of tissues with an information-processing function to the environment. The nervous system may be irreversibly damaged by ion leakage when its temperature begins dropping below 15° to 20° C. And at the surface, and even more in deep dives, the temperature outside drops below these limits. The solution to eye temperature as a problem for the marine mammalian eye is not so clear.

Twenty eyes of long-finned pilot whales,*Globicephala melas*, were fixed in 10% formalin. In the twenty eyecups, the retinal vascular pattern was described and drawn *in situ*, and the retinas were photographed and video recorded. In another four eyecups, the retinas were dissected and were flat mounted on a slide, described and drawn, to study the possible differences between the vascular pattern *in situ* and flat mounted ones. Also, we have studied the vascular maps and the vein-artery pattern with histological techniques.

The retina is in accordance with the holangeotic vascular pattern following Leder's classification (1903). The pattern of vessels is essentially radial and homogeneous in vascular density. The main arteries and veins are arranged alternately. They are located at the nerve fibre and ganglion cell layers, and they dip into the plexiform and inner nuclear layer which derives numerous capillaries. The uniform vascular distribution and the geometry of the pattern with its dichotomous branching of similar diameter, suggest an equal blood supply, and level of pressure and temperature in the whole retina. The total and radial vascularisation with veins-arteries alternating, implies that the blood supply acts a radiator circuit. This is important for the vital temperature maintenance of the retina. This work is supported by GV-2521/94 and DGICYT PB 96 0414.

A NEW TOOL FOR CETACEAN RESEARCH – A FULLY SUBMERSIBLE CLICK DETECTOR

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The structure, function, and first results of this apparatus are presented. The click detector is a completely self-contained, battery powered, system capable of submersion to 200 m. and requiring no technical expertise at the place of deployment other than tying secure knots. It uses a predominantly analogue signal processing system which compares energy levels from four bands of the acoustic spectrum, to identify clicks by their relative levels and duration. Click counts, temperature, and ambient noise data are logged in sequential intervals of one or more secs over four days. Data are downloaded to a PC and can be viewed graphically, or as a spreadsheet file. Harbour porpoise, *Phocoena phocoena*, click identification is robust with very few false identifications from all possible sources of false clicks tested. Dolphin click detection is inherently less specific and has been less tested but appears to have a useful level of reliability. Among early results is evidence for the frequent presence of porpoises in the vicinity of gillnets in a known area of bycatch without porpoise capture in those nets, suggesting that the often supposed inability of porpoises to detect gillnets at a useful range may be incorrect. Deployment of arrays of click detectors on nets - a relatively simple task, will be of value in building up an understanding of cetacean acoustic behaviour and interactions with nets.

TWELFTH ANNUAL REPORT OF THE EUROPEAN CETACEAN SOCIETY: 1998

Paid-up members of the European Cetacean Society for the year 1998 numbered 457 (including 10 institutional members), from 26 European and 16 non-European countries. The highest representation came from Italy (93), Germany (75), United Kingdom (49), France (46), Spain (31), USA (22), Portugal (21), Switzerland (16), the Netherlands (15), Belgium (9), Sweden (9), and Denmark (8). Other member countries include Czechoslovakia, Croatia, Finland, Greece, Hungary, Iceland, Ireland, Israel, Malta, Monaco, Poland, Slovenia, Sweden, the Czech Republic, Turkey and Ukraine within Europe, and Australia, Brazil, Canada, China, Hong Kong, India, Japan, Malaysia, Maldives, Morocco, New Caledonia, New Zealand, Taiwan, and Zaire elsewhere.

For the first time in their histories, the European Cetacean Society and the Society for Marine Mammalogy joined forces to organise the First World Marine Mammal Science Conference, in Monaco between 20th and 24th January 1998. This represented the Twelfth Annual Conference of the ECS and was attended by around 1,200 persons from 55 countries. Its success was largely due to the efforts of Anne Collet (ably supported by Isabelle Deval and Bellou Kuhn in France and Terry Odell in the United States) who devoted much of the previous two years to ensuring that the conference ran smoothly. Many others also played a crucial role: the SMM board particularly Ian Stirling, Roger Gentry and Dan Odell; the ECS board particularly Christina Lockyer, Peter Evans, Greg Donovan and Ursula Siebert; the chairs and members of abstract review committees; and a large band of willing ECS & SMM student volunteers led by Paula Moreno and Leah Gerber. A plenary session on the subject of "Hot Topics in Marine Mammal Science" was held, along with five symposia ("Mysticetes: why migrate?"; "Scale Issues in Marine Mammals: Concepts and Applications"; "Recent Advances in Marine Mammal Acoustics: Noise pollution, Habitat Degradation, and Policy Making"; Marine Mammals and Oceanographic Processes"; and "Managing Marine Mammals in an Uncertain World: Application of the Precautionary Principle"). A total of 134 talks and 416 posters were presented at the conference.

Alongside the conference was a student meeting and seven workshops on "Marine Mammal Reproduction: Morphology and Physiology", "Assessing Behavioural Impacts of Human Activities on Marine Mammals", "Reducing Cetacean Bycatches: Progress with Acoustic Deterrents", "Discussion on the Biology and Conservation of the World's Endangered Monk Seals", "Whalewatch Research", and "Bio-acoustic Signal Processing: Directions for Future Research".

For the first time, all summaries contributed to the Proceedings were peer reviewed. An enormous amount of effort has gone into the editing and production of these Proceedings, and the editor thanks in particular Chris Parsons, along with Anna Colbert and Rachel King for their invaluable help in typing, editing, and lay-out, ably supported by Martin Rosen and Jim Boran. Toni Raga has been responsible for organising its printing in Valencia.

Three newsletters were produced during the year, reviewing 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 in the capable hands of Jan-Willem Broekema.

Between 14th and 17th September, the Second European Seminar on Marine Mammals: Biology and Conservation, was held at Universidad Internacional Menéndez Pelayo in Valencia, Spain, organised by Toni Raga, with help from Peter Evans. Ten lectures were given along with two round-table discussions (on marine mammal mass mortalities and marine mammal sanctuaries). The course was attended by about 120 students. The papers that were presented, along with some other invited contributions, will form a book entitled "Marine Mammals: biology and conservation", to be published by Plenum Press/Kluwer Academic.

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.

Finally, the European Cetacean Society has continued to provide information or advice to government departments and non-governmental organisations in European countries, with representation at both ASCOBANS and ACCOBAMS.

Beatrice Jann
(Hon. Secretary)

FINANCIAL REPORT FOR THE YEAR UP TO 1 APRIL 1999

	German account DM	British account £
Balance as of 15 January 1998	34,809.44	815.22
INCOME		
ECS account savings from 1997	34,809.44	815.22
Membership fees during the year 1998	20,222.00	59.20
Profit, Conference in Monaco	21,570.60	
Other payments (sale of Proceedings, T-shirts, etc)	5,365.50	600.00
Interest on Savings account		30.85
Total Income	**81,968.04**	**1,505.57**
EXPENSES		
Travel expenses: board meetings	4,791.71	
ECS-Newsletters (printing)	5,009.81	
ECS Proceedings Stralsund (typing and production)	11,109.64	
Editorial expenses (incl. typing, postage, printing)		514.53
Secretarial expenses (Address List)	570.00	
Postage (Newsletters, Proceedings, E-mail subscription, etc)	1,604.70	312.41
Bank account and credit card expenses	629.02	
Computer Support Group	987.56	
Total Expenses	**24,702.44**	**826.94**
Balance as of 1 April 1999	**57,265.60**	**678.63**

Total DM 59,233.63
EURO 30,285.67

Roland Lick
(Hon. Treasurer)

EUROPEAN CETACEAN SOCIETY - 1999

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 covering the Mediterranean Sea) 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.

A newsletter is produced three times a year for members, reporting current research in Europe, recent publications & abstracts, reports of working groups, conservation issues, legislation & regional agreements, local news, and cetacean news from around the world.

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, ten 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, and Stralsund (Germany) in 1997. In January 1998, the ECS joined with the Society of Marine Mammalogy (SMM) to hold the first World Marine Mammal Science Conference, held in Monaco. In April 1999, the annual conference was held in Valencia, Spain.

At intervals, workshops are held on particular topics, and the results published as special issues of the newsletter: 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; and no. 26 - a workshop for the diagnosis of by-catches in cetaceans held in Lugano (Switzerland), 1995.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **DM 60** for full and institutional members, or **DM 35** for those who are 25 years of age or younger, full-time students or unwaged. Payment may be made at the Annual Conference in German Marks or the currency of the host country. During the year, payment must be in German Marks by **Eurocheque** or any other cheque drawn to a German bank, payable to the *European Cetacean Society* (you are advised not to send cash). Send cheques together with membership details to:

European Cetacean Society, Mrs Ines Westphal, Deutsches Museum für Meereskunde und Fischerei, Katharinenberg 14-20, D-18439 Stralsund, Germany.

Membership fees can also be paid by **credit card** or **transferred directly** to the following ECS-account: Dr Roland Lick, Treasurer, ECS, Postbank Hamburg (FRG), Account No. 789584-205, Bank Code 200 100 20 (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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Please use the format given below. If you depart substantially from this, your contribution may be rejected.

(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.

(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, and on separate pages to the text. DO NOT INCLUDE THEM WITHIN THE MAIN BODY OF THE TEXT. Figure captions should be placed underneath each one and Table captions above, with Fig. 1, Table 1, etc. in bold type, lower case, and the caption itself in ordinary type, lower case and centred. Use Times font throughout.

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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. Harrison). Academic Press, London. 430pp.

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