EUROPEAN RESEARCH ON CETACEANS - 16

PROCEEDINGS OF THE SIXTEENTH ANNUAL CONFERENCE

OF THE EUROPEAN CETACEAN SOCIETY,

LIEGE, BELGIUM

7-11 APRIL 2002

EDITORS: P. G. H. EVANS, C.H. LOCKYER,

L. BUCKINGHAM & T. JAUNIAUX

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European Cetacean Society, Kiel, Germany

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INTRODUCTION

The Sixteenth Annual Conference of the European Cetacean Society was held at L'Amphithéâtre de l'Europe, University of Liège, Belgium between 7th and 11th April 2001. It was attended by 300 people.

The theme this year was 'Marine Mammal Health: from individuals to populations', and speakers invited to give keynote addresses to this theme included: Seamus Kennedy on "Mass Mortalities in Marine Mammals", Lance Barrett-Lennard on "Extreme Population Segregation in Killer Whales: The Roles of Inbreeding Avoidance, Song and Traditions", and Michel Miliinkovitch on "From the Management of Natural Populations to the Origin of Whales: The Efficiency of Molecular Approaches in Evolutionary Biology". In addition to these, there were 38 other talks and 148 posters. Associated with the Conference, there were workshops on the following themes: Morbilliviruses organised by the Pathology Working Group, Seal Rehabilitation organised by the Seals Working Group, and a Photo-ID workshop on the EU Europhlukes Project, and there was a meeting for students.

The Society is very grateful to the Conference Organisers Thierry Jauniaux and Krishna Das, along with other members of the Organising Committee: Jean-Marie Bouquegneau, Insa Cassens, Freddy Coignoul, Cathy Debier, Yvan Larondelle, and Michel Milinkovitch. Special thanks also go to their team of volunteers and student helpers: Anne Françoise Basset, Christina Beans, Myrianne Bolognin, Martin Boye, Renaud Berlemont, Cécile Brenez, Campos Claudia, Jean-Loup Castaigne, Arnaud Degroof, Wouter de Loor, Nadège Domi, Mostafa E. Bouyousfi, Nadia El Mjiyad, Lea Faure, Michael Fontaine, Carine Garot, Sylvie Gobert, Susann Kotzian, Elisabeth Jantsky, Stéphane Jeremie, Marie-Eve Lechanteur, Monika Lechermeier, Sandro Mazzariol, Negro Sandra, Eric Parmentier, Denise Risch, Antonella Servidio, Virginie Sterpinich, and Martine Vanherck. Valuable support was provided by the ECS Treasurer, Roland Lick, who played an important role in the organising of registration and membership fees.

We also gratefully acknowledge the following bodies for their generous sponsorship of the conference: Services Fédéraux des Affaires Scientifiques, Techniques et Culturelles, SMAP, Fonds National de la Recherche Scientifique, Patrimoine de l'Université de Liège, Communauté Française-de-Belgique, Aquarium de Liège, Faculté des Sciences de l'Université de Liège, Faculté de Médecuine Vétérinaire de l'Université de Liège, Interbrew, Boehringer Ingelheim, Bayer, Le Pain Quotidien, Omnilabo, Derouaux, Dako Diagnostic, Geographic Café, Chimay, and Ciney.
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A Conference Scientific Committee was chaired by Krishna Das and Thierry Janiaux, and also comprised Greg Donovan, Peter Evans, Jaume Forcada, Christina Lockyer, Toni Raga, Emer Rogan and Ursula Siebert. The following persons have reviewed abstracts: Alex Aguilar, Michel Andre, John Bannister, Lance Barrett-Lennard, Giovanni Bearzi, Simon Berrow, Peter Best, Arne Bjørge, David Borchers, Fabrizio Borsani, Mark Bravington, Doug Butterworth, Abigail Caudron, Florence Caurant, Phil Clapham, Anne Collet, Enrique Crespo, Krishna Das, Cathy Debier, Greg Donovan, Peter Evans, Jaume Forcada, Christina Fossi, Manuel Garcia Hartmann, Christophe Guinet, Phil Hammond, Sarah Heimlich, Rus Hoelzel, Ludo Holsbeek, Thierry Jauniaux, Paul Jepson, Ron Kastelein, Toshio Kasuya, Seamus Kennedy, Thijs Kuiken, Yvan Larondelle, Finn Larsen, Christina Lockyer, Tony Martin, David Mattila, Michel Milinkovitch, Simon Northridge, Dan Odell, Bill Perrin, Graham Pierce, Toni Raga, Andy Read, Randy Reeves, Peter Reijnders, Vincent Ridoux, Emer Rogan, Ursula Siebert, Paul Thompson, Nick Tregenza, and Marie-Françoise Van Bressem..

Contributions have been arranged broadly by subjects, and within subjects, they are arranged alphabetically. All abstracts were subject to a review process and represent all those submissions that were accepted for the conference. Extended summaries have been edited to improve clarity and to maintain a uniformity of presentation. 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 Christina Lockyer and Lucy Buckingham for their invaluable help at various stages of its production, and Roland Lick for all his help with the final production of the Proceedings.

Peter G.H. Evans

ACOUSTICS

CETACEANS AND SEISMIC ACTIVITY ON IRELAND'S ATLANTIC MARGIN

N. Aguilar[1], E. Rogan[1], and J. Gordon[2]

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Five cetacean acoustic surveys were carried out on Ireland's Atlantic Margin from July 2000 to July 2001 using a stereo hydrophone streamer towed on 300m of cable. Specialized software was provided by IFAW for the automated recording and detection of cetacean vocalizations from 200 Hz to 22kHz. Commercial acoustic software, Arc View GSI and SPSS statistical package were used for the data analysis. During surveys 20 second recordings were made automatically every 20 seconds. A total of 238.42 hours were recorded in this way during 85 days (1,190 survey hours) at sea. Approximately 22% of the 14,479 km of acoustic transects were also covered visually. Acoustic monitoring continued up to sea state Beaufort 9 with an average survey speed of 8.5 knots. Higher levels of cetacean acoustic activity were located in the Porcupine Seabight (67% of 3,286 samples with cetacean vocalisations), the NW slope of the Porcupine Bank (45% of 736 samples and 35.7% of 1,112 samples in 2 separate surveys), areas of the continental slope (up to 43.81% of 194 samples) and a deep open canyon on the SW Rockall Trough (40.3% of 479 samples). Vocalisations from a minimum of eight species of odontocetes were recorded, with sperm whales, pilot whales, common dolphins and Atlantic white-sided dolphins being the most frequently detected. Airgun pulses from seismic surveys were recorded on the Feni Ridge, more than 500km away from the source (NW Ireland shelf), confirming long range propagation of these signals. The expansion of hydrocarbon exploration into deeper waters where low frequency sound propagates readily may represent an important threat to deep-water species such as sperm whales and beaked whales.

ONLY SQUAWKING AT FACTUAL PORPOISES: IS THAT POSSIBLE?

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"Beacon-mode" pingers have proven effective in reducing harbour porpoises bycatch, but have some negative side-effects. "Interactive" pingers, which are triggered by porpoise sonar clicks, address some of these side effects, e.g. reducing "noise pollution" and delaying habituation. "Enticing" sounds must be transmitted independently to ensure that the porpoises aim their sonar towards the device, even interrupting "bottom grubbing", i.e. foraging in a vertical orientation with the sonar focused on the seabed. These enticing sounds may eventually act as an alerting signal, enough to keep the porpoises away from the nets without the deterrent sounds. This concept was explored at the Fjord&Bælt centre (Denmark), on two harbour porpoises held in a sea pen. During experiments, computer controlled test sounds were transmitted by two broadband transducers or two converted AquaMark100 units. The porpoises' sonar clicks, used to trigger the system, were picked up by a broadband hydrophone. 59 trials (5 min test, and 10-15 min pre and post baseline) were carried out, using continuous focal sampling of the porpoises' responses. Nine different enticing sounds, based on trains of 70 or 130 kHz porpoise-like clicks, were tested. The deterrent sounds were eight standard, broadband AquaMark100 sounds. All enticing sounds increased significantly the echolocation activity aimed at the device. When triggering the deterrent sounds, the porpoises appeared to be puzzled by the unusually strong, and strange "echo", returning from the transducer, and backed away from it. Their avoidance was similar to that seen in ealier "beacon-mode" pinger trials, although at the end of the study, extended over several years, one porpoise showed signs of habituation, most likely an enclosure effect. Randomly inserted periods, with the trigger function deactivated, was a promising battery saving test. Further testing with wild, naïve porpoises are planned for the summer of 2002.

ACOUSTIC AND SOCIAL REACTIONS OF AN ARTIFICIAL COMMUNITY OF *TURSIOPS TRUNCATUS* TO EVENTS THAT OCCURRED IN THE COMMUNITY

M. Azzali, S. Manoukian, A. Ruggeri , R. Simoni , S. Catacchio, and J. Baldacci

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INTRODUCTION Which is the transient acoustic and social behaviour of dolphins, coming from different places and forced to live together in a new tank? How much time need they to adjust to changes in the physical and social environment, to form a group, to find a social harmony and to develop at the same time a common sonar language that allows them a shared knowledge of echolocation's information? Are dolphins able to realize some crucial events that occur in their community, either positive such as the arrivals of new dolphins and births or negative such as the death of a member? The subject of the present study is the community of bottlenose dolphins (*Tursiops truncatus*) of Palablu, the new Gardaland delphinarium created in the March 1997. Palablu offered an unique opportunity to study the evolution of sonar communication and the relationships with the social behaviour between dolphins that at beginning did not form an acoustic and social group.

Since June 1997, the community, composed initially of three dolphins, has been in a highly dynamical state:

- the arrival (1999) in quick succession of an adult female first (January) and an entire family of three individuals later (June);
- the death of three community members in the space of six months (May-October 2000);
- finally, the birth in captivity of a calf (October 2001).

The acoustic and social behaviour of the community has been monitored regularly during these five years and intensively during those events. It seems that dolphins react differently to positive and negative events and that they show their reactions mostly acoustically.

MATERIALS AND METHODS The observations were conducted during a period of 41months (from June 1997 to October 2000) in Gardaland delphinarium (Fig.1). In the first 19 months of the research the community of animals was composed of a male, Robin, a two females, Violetta and Betty, coming from a different pool. In the following 5 months (January - May 1999) the community was composed of 4 dolphins, due to the arrival of another female, Amada. Then (June - September 1999) the community increased to seven members for the arrival of a small family: Squeak, the mother, Hector, the father and their male offspring, Teide. Subsequently three deaths characterized the community: first the death of Hector and Violetta (October 1999) and about one year later the death of Amada (August 2000).

Audio and video recordings were carried out in sessions of three consecutive days per month. Generally in each session two hours of acoustic and video data were acquired. Dolphin signals were recorded using a hydrophone (Bruel Kjaer 8105); charge amplifier (Bruel Kjaer 2635); tape recorder (0-500 kHz; dynamic – 55 dB), for broadband signals; sub water camera and video recorder; digital oscilloscope (HP 54520A). For signal registration the B&K 8105 has a flat frequency response up to 160 kHz, the sensitivity drops after 160 kHz at approximately -60 dB/decade (-18 dB/octave). Sounds were recorded simultaneously with a detailed comment of the operator and with the video images of the dolphins. Recordings were made regularly (two hours of recording collected randomly in a session of three days every month). The acoustic signals were digitalized at a sampling frequency of 5 MHz (512 samples in 100 m). The first and the second moments in time and frequency, the Gabor time width T_G and bandwidth B_G, the peak frequency f_p and the Q parameter (B_G/f_p) were calculated on a MATLAB platform.

Ethological observations were carried out in a session of three hours every week. They were based on "Focal Animal Sampling" method. The data presented in this paper are the interactions between the members of the community and their duration.

RESULTS The 41 months of study have been divided in nine periods during which particular events occurred within the community. The acoustic activity and social interactions of each dolphin both as a single individual and as a member of a community have been analysed. Table 1 shows: the number of clicks as total and per hour emitted by the entire community; the acoustic integration (%), i.e. the overlapping of the mean sonograms of each dolphin referred with the whole community mean sonogram; the social interaction (%).

These set of data are indicated then in Fig. 2 as histograms, where are visualized also the nine period signed by particular events. The acoustic activity among the first three dolphins is neither a natural not a progressive process but has the form of an outburst, which occurs after 18 months of life in common (I and II period). The creation of a common nucleus in the spectrograms seems to have been the necessary condition (acoustic integration) to allow social interactions. The socialisation began only two months after the acoustic activity. Arrivals of new dolphins tend to widen the acoustic integration and to favour the socialization of the community in the medium term (III and IV periods). This type of event seems to have had positive effects on our community. On the other hand, the death of a dolphin within the community seems to destroy the common acoustic nucleus whilst it increases the social interactions in the short term (V, VI and VII, VIII periods). After some months from this negative event, the acoustic nucleus is recreated (IX period).

Fig. 3 shows how the small community has acoustically reacted to the events: when the acoustic nucleus (i.e. acoustic group) remains, the event is considered positive (+); when the acoustic nucleus disappears even for a brief period (i.e. the acoustic group disaggregates), the event is considered negative. The arrival of a dolphin causes an increment of the acoustic activity without destroying the acoustic nucleus (positive event); on the other hand, the death of a community member causes the disaggregation of the acoustic nucleus (negative event). In Fig. 4 are showed some examples of how the acoustic nucleus of the community can change in the time in response to external short-term events.

CONCLUSIONS

- Both positive and negative events increase the acoustic (number of clicks per hour) and social (number of contacts) activity of the members of the community.
- Positive events (arrivals and mostly birth) widen the acoustic integration among the members of the community (i.e. reinforce the unity of the acoustic group), while deaths seem to destroy the acoustic integration (i.e. the acoustic group) temporally (for some months).

These results suggest that dolphins are able to realize the positive or negative events that occur within their community and show their consciousness mostly through acoustic activity.

ACKNOWLEDGEMENTS Authors acknowledge the support provided by the staff of gardaland delphinarium.

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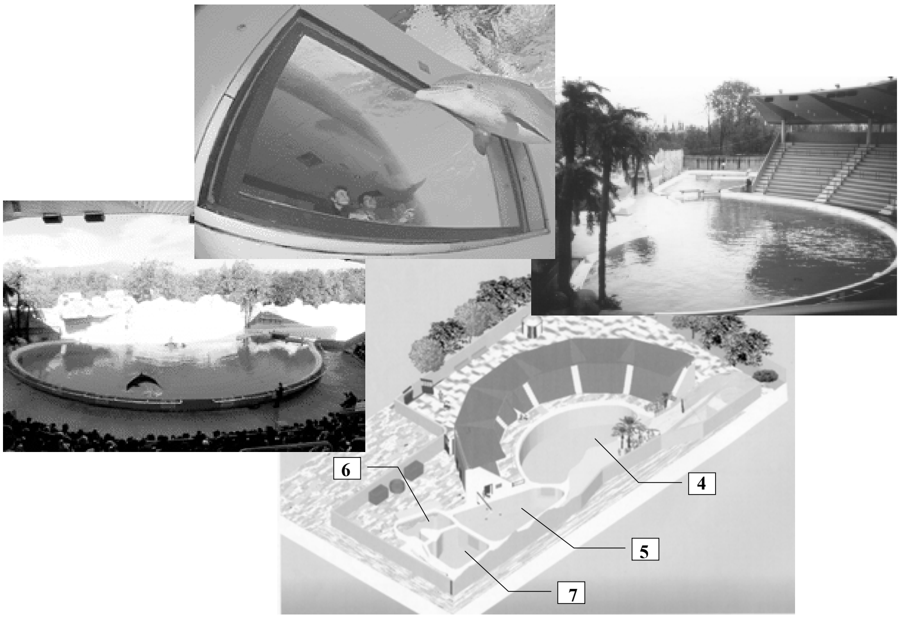

Fig. 1 – Delphinarium Palablu of Gardaland, built in 1997. It is structured in four intercommunicating pools covered in PVC to reduce the echoing. The larger pool (n°4) is adapted to shows, the mean one (n°5) to acoustic recordings, one of the smaller (n°7) is a nursery and the other (n°6) is destined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

Table 1 - Trend of the acoustic integration and social interactions level of the Palablu community from June 1997 to October 2000

Session	Month	N° of dolphins	Total n° of click	Mean n° of click per hour	Acoustic integration (%)	Social integration (%)	note
27 sessions June'97 – Oct.'98 (1° period)	1-17	3	250	4.63	0	2	Period of unnatural silence and no socialization
4 sessions Nov. – Dec.'98 (2° period)	18-19	3	500	62.5	29.4	5.3	Acoustic activity explosion
8 sessions Jan – Feb.'99 (3° period)	20-23	4	700	43.75	6.87	47.7	Arrival of Amada
4 sessions July – Sep.'99 (4° period)	24-28	7	1800	225	3.58	26.5	Arrival of Hector, Squeak and Teide
2 sessions Oct.'99 (5° period)	29	5	1420	335	2.34	51	Death of Violetta and Hector
2 sessions Dec.'99 (5° period)	30-31	5	1570	392.5	15.34		
4 sessions April - May'99 (6° period)	32-36	5	750	93.75	0	34	After-death period of Violetta and Hector
1 session June'00 (7° period)	37	5	851	425.5	26	24	Isolation of Amada
1 session August'00 (8° period)	38-39	5/4	1518	759	16.8	60	Death of Amada
1 session September'98 (9° period)	40	4	866	433	0	29	After-death period of Amada
1 session Octber'00 (9° period)	41	4	196	98	14.98		

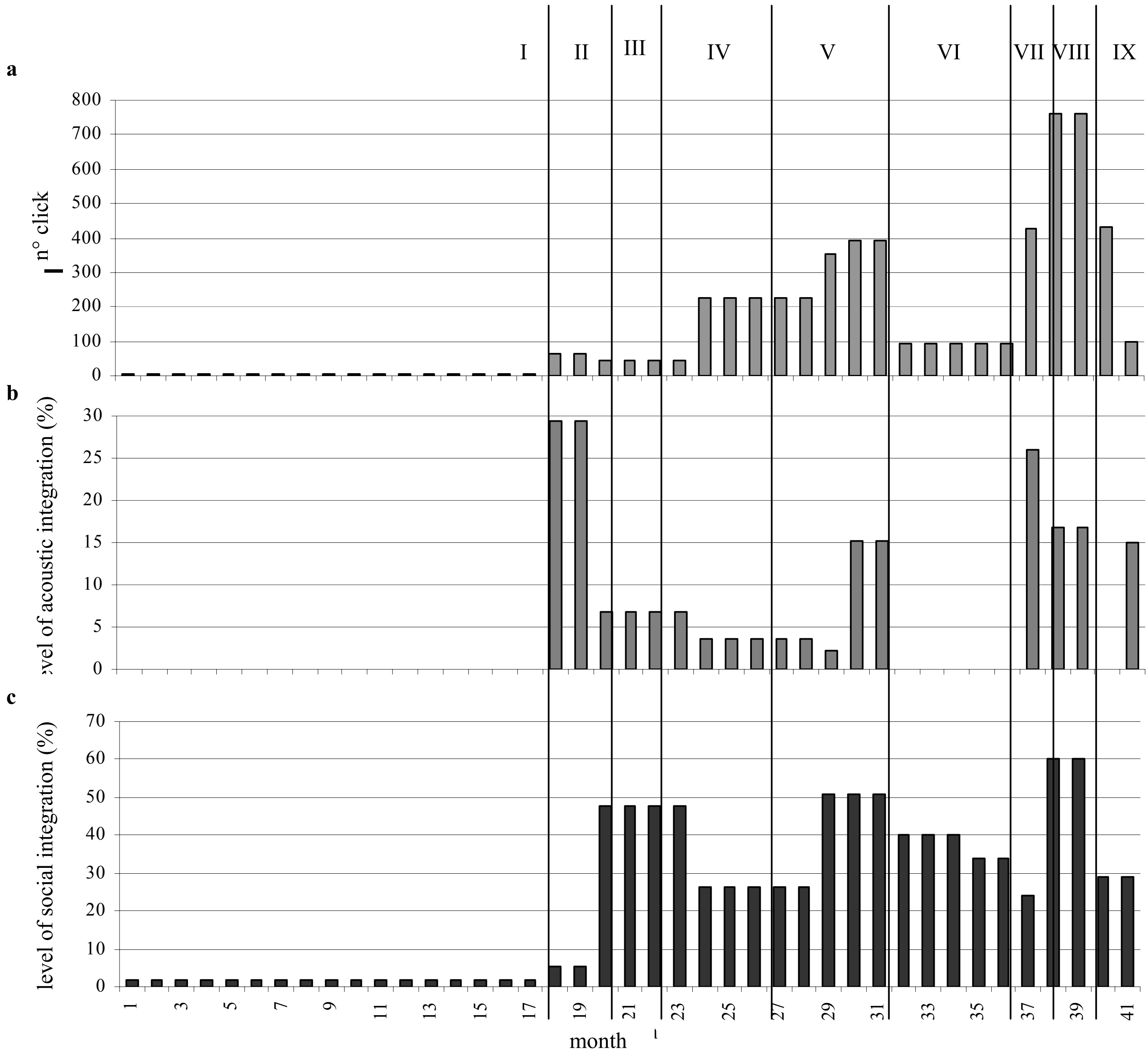

Fig. 2 - Histograms of the click mean number per hour (a), acoustic integration level (b) and social integration level (c) during the 41 months of study. The nine periods signed by particular events are also visualized.

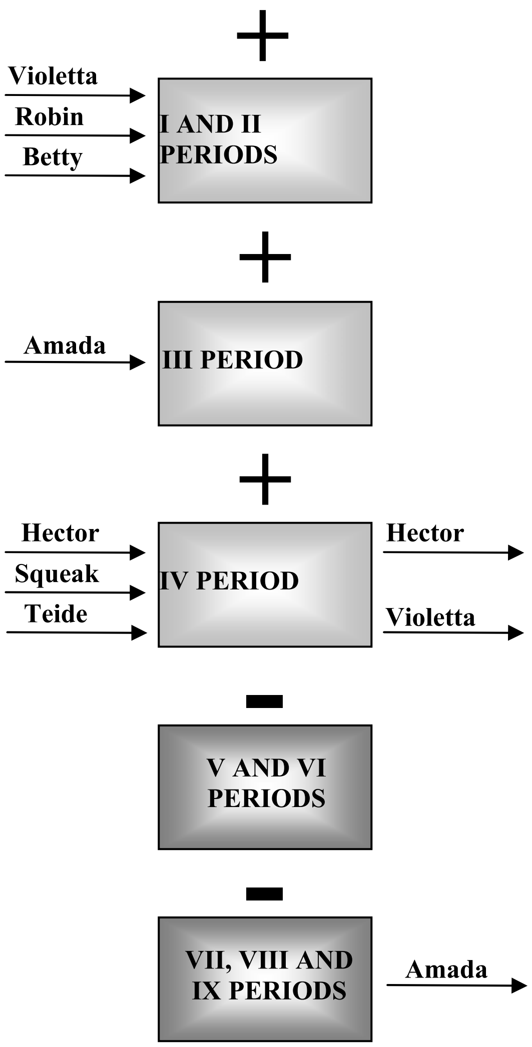

Fig. 3 - Short-term effects of events on the acoustic activity of the Palablu community that occur within the community itself. The arrival of a dolphin causes an increment of the acoustic activity without destroying the acoustic nucleus (positive event); on the other hand, the death of a community member causes the disaggregation of the acoustic nucleus (negative event).

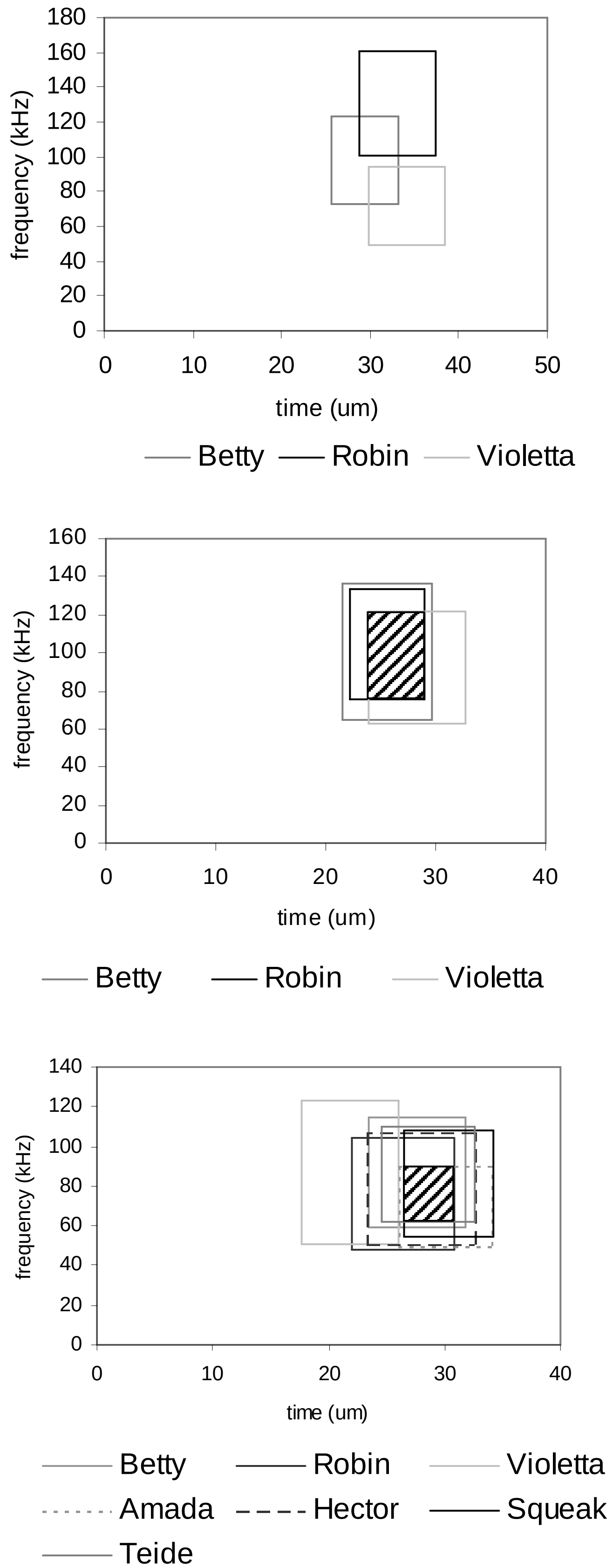

Fig. 4 – Examples of how can change the acoustic nucleus in the time in response to external short-term events.

ABILITY OF A DOLPHIN COMMUNITY TO RECOGNISE ITS OWN SONAR SIGNALS

J. Baldacci [1], M. Azzali [1], R. Tizzi [1-2], S. Manoukian [1], and S. Catacchio[1]

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INTRODUCTION Echolocating dolphins have demonstrated a keen capability to discriminate, recognise and classify underwater targets, using the clicks as a form of "autocommunication" (Nachtigall, 1980; Au, 1993; Helweg, 1995). However there is still uncertainty if dolphins can use clicks also to transmit information to other individuals (intercommunication). Variations in click rate, intensity or shape probably reflect underlying changes in motivation which may be transmitted to other members of the group and affect their behaviour. Sometimes clicks at particularly high intensity seem motivated by aggressiveness rather than by echolocation (Azzali *et al*, 1998). The shape of the clicks contains features concerning the specific context in which they are produced, the echolocating individual and its behaviour during the emission and probably the group (Baldacci, 2001), which the individual belongs to. In particular calves have their own special clicks (Azzali *et al*., 1998; 1999). All these features may have immediate effect upon the behaviour the dolphins, which perceive the signals. The purpose of this study is to provide a useful start point to investigate on these effects. It presents the responses of a captive community of dolphins to their own clicks and to clicks produced by a different community, using playback experiments.

MATERIAL AND METHODS The study, carried out from November 2000 to February 2001, investigates the ability of a community of bottlenose dolphins (*Tursiops truncatus*) to recognise its own clicks and to discriminate them from clicks emitted by a another group resident in an different aquarium. Subjects of study were three adult wild-born bottlenose dolphins and their three captive born calves housed in the Rimini Delfinario (Table 1). Four bottlenose dolphins resident in the Palablu of Gardaland (Table 2) were the alternative colony.

In November 2000 clicks of both community were collected on a broad band recorder from free swimming dolphins, using only the hydrophone as target. In laboratory one set of data (10 min. long) for each community was selected for the experiments, that were carried out about three months after. The data set of Rimini community consisted of 235 clicks and the data set of Palablu community of 90 clicks.

Three experiments, delayed each other one week, took place in February 2001.
The equipment used in the experiments consisted of:

- A cylindrical net cage (20 cm diam.; 40 cm height) containing an hydrophone (B&K type 8105) to capture the signals emitted by the dolphins, and a projector (Reson TC4034) to propagate back the sequences of the recorded sonar signals (Fig.1). It was the stimulus object exposed to the dolphins of Rimini community during the three experiments.
- A digital oscilloscope (HP54520A), an amplifier (B&K type 2626) and a wide band (20-300000 Hz) analogue recorder for monitoring and storing the sonar signals produced by dolphins.
- A wide band recorder (20 Hz-300000 Hz) and a wide band power amplifier (1501) to play back the sets of the recorded signals.
- A camera located near the porthole of the pool in front of the cage. Comments about the behaviour of the animals were recorded on the audio channel of the camera and on the audio channel of the wide band recorder.

In the experiment 1 the stimulus object, completely new to dolphins, was passive. The experiment lasted around 30 min. The experiment 2 was divided in three consecutive phases, each 10 min. long. In the first phase the object remained passive, exactly as in the exp.1. In the second phase the projector played back the sequence of sonar signals (235) produced by Rimini community 3 months before. In the third phase the projector ceased emitting. The experiment 3 followed the same procedure than the experiment 2, except that in the second phase played back the sequence of sonar signals (90) recorded in Palablu delphinarium.

RESULTS Experiment 1. The primary objective of the first experiment was to allow Rimini community to get accustomed to the object. A second objective was to have a reference to test the change of acoustic and swimming behaviour between a passive object and an active object that maintained the same visual aspect. Figure 2a shows that the acoustic activity of the community (number of click per minute) increased abruptly and considerably as soon as the object was lowered into water (from 6.8 click /min to 90 click/min). However after the first 10 minutes the acoustic activity decreased and returned to the normal values (5-8 click/min). The swimming activity was not disturbed by the presence of the object. During the experiment the dolphins, swimming slowly, approached the object separately. Therefore identifying the dolphin that was echolocating was pretty easy (only 4% of the clicks was unidentified, see Fig. 2b).

Experiment 2. The objective of this experiment was to study the change of the acoustic activity and swimming behaviour of the Rimini dolphins, when the object played back the sonar signals of their own community. As long as the object, lowered into water, remained passive (first phase), the acoustic activity of the community remained at a normal level (6.8 click/min, see Fig. 3a) and the swimming behaviour was regular. As soon as the projector played back the sequence of 235 clicks recorded in the Rimini Delphinarium, the acoustic activity increased more than twice (15.8 clicks/min), but it remained about 6 times lower than in the experiment 1 (90 click/min). In the last phase, when the projector ceased playing back, the acoustic activity decreased slightly (12.9 click/min), however did not returned to the level of the first phase (5-8 click/min). During the second and third phase of the experiment, dolphins swam quickly, in groups of two-three individuals, towards the object (Table 3). Therefore identifying the dolphin emitting signals was difficult (46% of clicks in the second phase and 40% of clicks in the third phase remained unidentified, see Fig.3b).

Experiment 3. The objective of this experiment was to investigate if Rimini dolphins could recognize that the sonar signals presented to them were produced by another uknow community. In the first phase the acoustic and swimming behaviour of the community was quite similar to that of experiment 2. When the projector played back the sequence of 90 signals recorded from the Palablu community (second phase), the acoustic activity of the Rimini community increased up to 17.2 clicks/min (about 9% more than in the experiment 2, see Fig. 4a). When the projector ceased playing back (third phase), the acoustic activity raised further (17.9 clicks/min, about 39% more than in the experiment 2). In the experiment 3 the dolphin produced sonar signals similar in shape and spectrum but with an average intensity dozens times higher (adults) or 3-4 times lower (calves) than in the experiment 2. In the experiment 3 (phase two and three) dolphins remained aggregated in an unique group and kept far from the object. Therefore it was very difficult identifying the dolphin emitting signals and about 66% of the click remained unidentified (Fig.4b).

Figures 5a, 6a and 7a compare the mean characteristics of sonar signals produced by Speedy, the adult male, in the two experiments. The average signal intensity of Speedy during the experiment 3 (phase two and three) was 40 times or 16 dB stronger than in the same phases of experiment 2 Figures 5b, 6b and 7b compare the mean characteristics of sonar signals produced by Blue, the youngest calf, in the two experiments. The average signal intensity of Blue during the experiment 3 (phase two and three) was 4 times or 6 dB weaker than in the experiment 2.

DISCUSSION AND CONCLUSIONS This paper tackled the problem: can dolphins recognise the sonar signals produced by members of their own community? Although the investigation presented here is far to be conclusive, some interesting results seem to validate a positive answer.

The first experiment used a passive object and the dolphins responded to it with typical echo locating signals and behaviour. They produced a very high number of pulses when the new object was lowered into the water but reduced it more than ten times when they got accustomed to the object. The rhythm of emission was different when the dolphins were confronted with the same object but playing back sequences of signals (Fig. 8). That is:

1) When the object played back the sequence of sonar pulses of their own community, groups of two-three dolphins emitted signals towards the object with a rhythm as if they "duet" with or mimic it.

2) When the object played back the sequence of pulses of an unknown community, the dolphins aggregated in an unique group that remained far from the projector. The rhythm of the signals emitted by the dolphins as well as their average shape and spectrum seemed to by pretty similar to the previous experiment. However the adults, and mostly the adult male Speedy, produced sonar signals at unusually high intensities, that could be interpreted as alarm or aggressive or territorial sounds. The calves, and mostly Blue the youngest between them, produced sonar signals at very low intensity that could be interpreted as distress sonar signals.

3) When the projector ceased playing back, the acoustic activity of the whole community decrease only slightly in the experiment 2 and increased in the experiment 3 as if the dolphins still tried to examine the object and perhaps to establish again the communication.

These results suggest that: clicks of a dolphin community contain features concerning the identity of the group; dolphins use these features to recognise its group and probably to enhance the group effectiveness and to defend its unity.

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Table 1. Rimini community

NAME	AGE	SEX	NOTE
SPEEDY	ADULT	M	FREE BORN (1970)
ALFA	ADULT	F	FREE BORN (1979)
BETA	ADULT	F	FREE BORN (1981)
SOLE	JUVENILE	M	BORN IN CAPTIVITY (1993)
LUNA	JUVENILE	F	BORN IN CAPTIVITY (1995)
BLUE	JUVENILE	F	BORN IN CAPTIVITY (1997)

Table 2. Gardaland community

NAME	AGE	SEX	NOTE
BETTY	ADULT	F	FREE BORN (1979)
SQUEAK	ADULT	F	FREE BORN (1972)
ROBIN	ADULT	M	FREE BORN (1980)
TEIDE	JUVENILE	M	BORN IN CAPTIVITY

Table 3. Rimini community behavior during two different acoustic stimulus

RIMINI COMMUNITY BEHAVIOR		ACOUSTIC STIMULUS FROM: RIMINI COMMUNITY	ACOUSTIC STIMULUS FROM: GARDALAND COMMUNITY
NEUTRAL	CIRCLE SWIM	√	
	RANDOM SWIM	√	
	GLIDE		
	STAND		
APPROACHING	SWIM AROUND THE STIMULUS	√	
	STAND BY IN FRONT OF THE STIMULUS		
AVOIDING	FAST SWIM EXTREME AGITATION	√	√
	AVOIDING		√

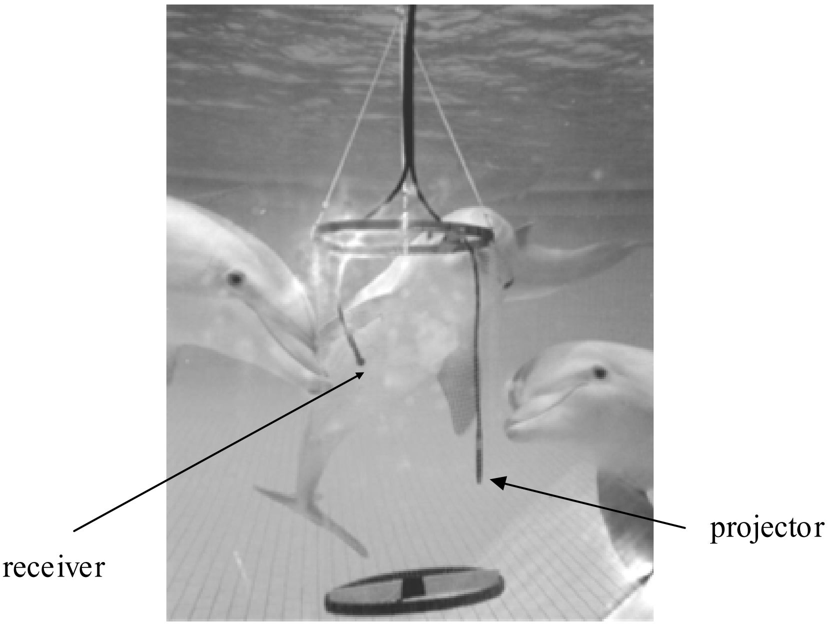

Fig. 1 Hydrophones cage

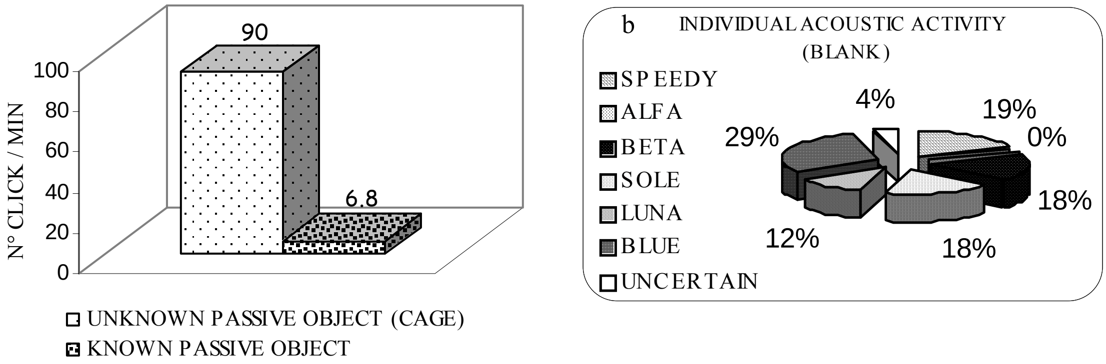

Fig. 2. Acoustic activity of the community before and after accustoming itself to the object (a), individual acoustic activity in presents of the known passive object (b)

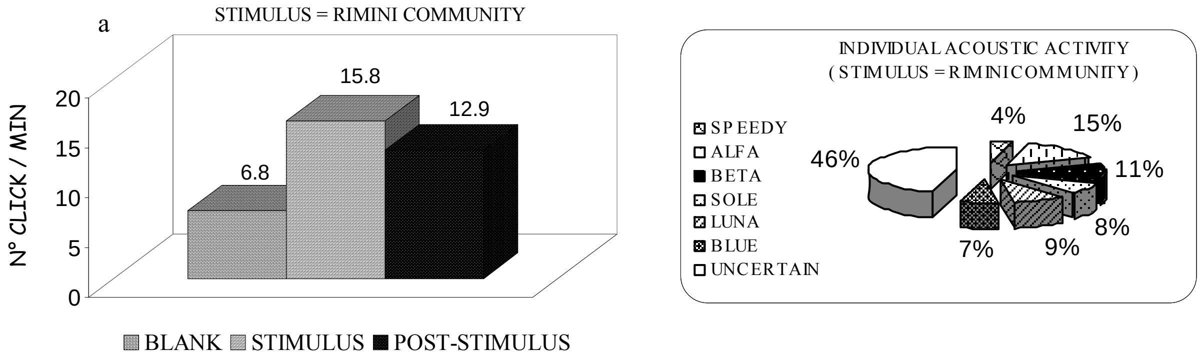

Fig. 3. Total (a) and individual (b) acoustic activity of the Rimini community during the second experiment

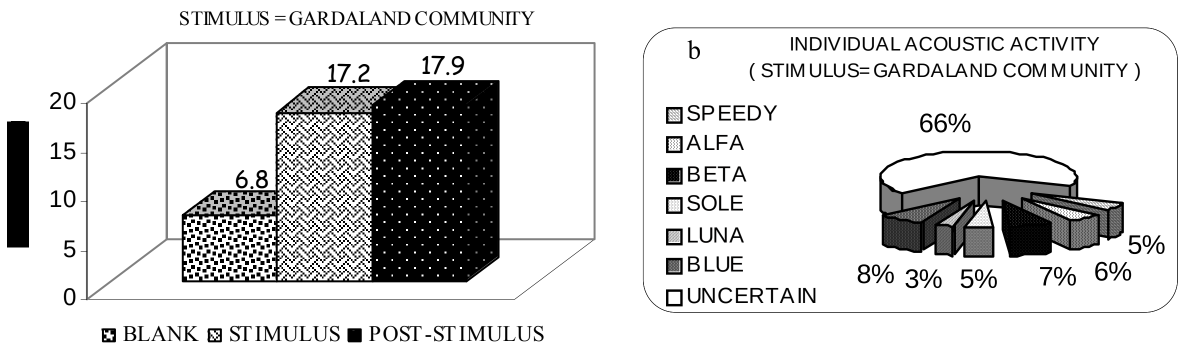

Fig. 4. Total (a) and individual (b) acoustic activity of the Rimini community during the third experiment

LEGENDA : ——— acoustic stimulus = Gardaland community - - - - - - - acoustic stim. = Rimini commun.

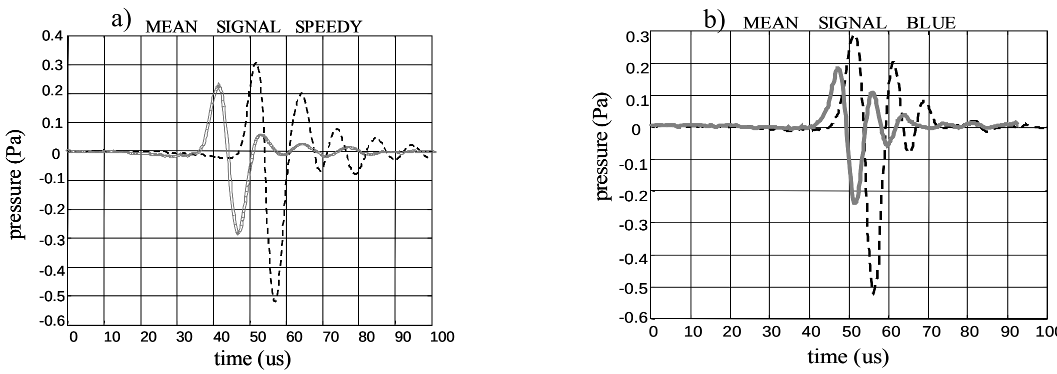

Fig. 5. Mean signal of speedy (a) and blue (b) in function of the different acoustic stimulus

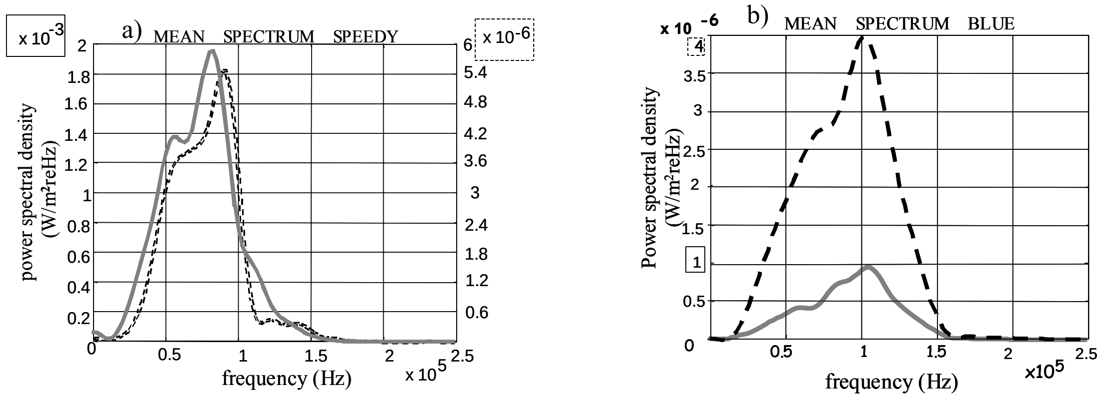

Fig. 6. Mean spectrum of Speedy (a) and Blue (b) in function of the different acoustic stimulus

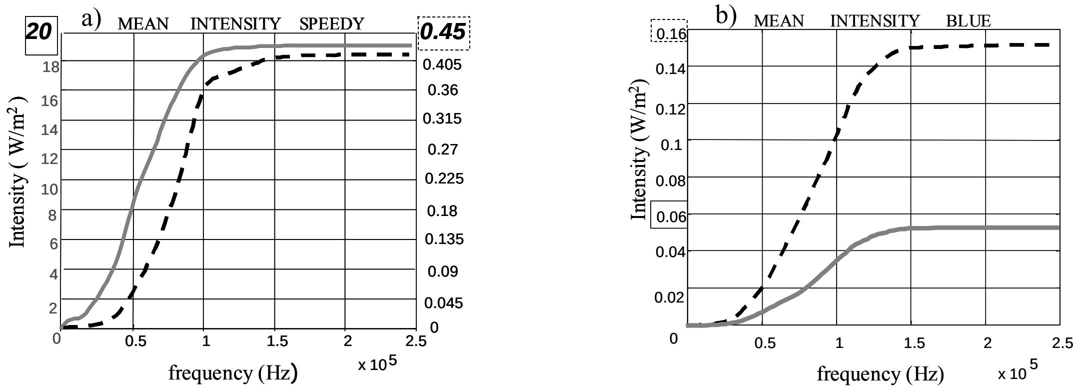

Fig. 7. Mean intensity of Speedy (a) and Blue (b) in function of the different acoustic stimulus

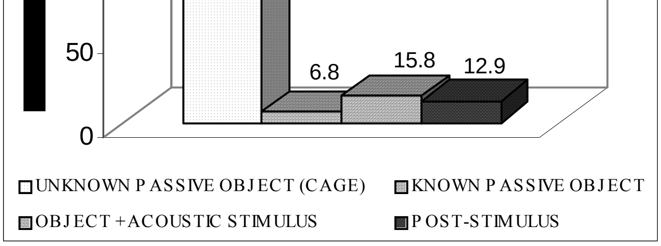

Fig. 8. Acoustic response of Rimini community to four different stimulus

THE UNDERWATER VOCALISATIONS AND BEHAVIOUR OF THE BELUGA WHALES (*DELPHINAPTERUS LEUCAS*) DURING A DISTURBANCE CAUSED BY HUMANS

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We studied the acoustical activity and behavior of the belugas from reproductive gathering off Cape Beluzjy, Solovetsky Island, the White Sea. The effect of five human disturbance factors on the whale vocal activity and behavior was analyzed: vessel noise, diver presence, musical playback, hydro-technical work, and transitions of the inflatable boat. We found that overall vocalization rate significantly decreases during the disturbance situations (except hydro-technical work). The hydro-technical work can be considered as the alarm situation. Three types of the signals may serve function of alarm calls. The white whales avoided swimmers and immediately left investigated area in cases of the operation with the underwater cable and the play of music. Our results point out to negative effect of noise pollution and especially of the attempts to swim with belugas on functioning of reproductive gathering.

CHARACTERIZATION OF VOCALISATIONS IN WEST INDIAN MANATEES (*TRICHECHUS MANATUS MANATUS*)

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Vocalizations in manatees have not been well studied in contrast to many other marine mammal groups. For seven weeks the group of four West Indian manatees (*Trichechus manatus manatus*) housed at Nürnberg zoo had to be split. Flora, a 23 year old female, had to be kept apart from the others for medical reasons leading to a separation between herself and her 3 year old offspring. Isolation was achieved by dividing the tank through a wooden gate allowing no sight contact. During this period we were able to record vocalizations by use of an underwater microphone. Sound recordings were kept on a computer for further analysis. A total of 800 calls was recorded. In order to investigate duration, frequencies (dominant and harmonics) and the interval between two sounds, we performed a spectrum analysis on each call. Examining structural sound characteristics we found two different categories: a short, pure modulated sound (A) and a longer pulsed sound (B). These calls were organized in sequence - one type of call was almost always followed by the other. Based on these acoustic data and on our observations we assume that the two different call types belong to two different animals. Although our data do not allow us to attribute individual calls to individual animals every time, it is most likely that type A calls belong to the calf and type B calls to the mother. We think that vocalizations analysed here present a good example of vocal interaction between a mother and her almost mature offspring.

RECOLONISATION RATE BY HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN AREAS SUBJECTED TO ACOUSTIC ALARMS

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Experiments and field trials have shown that acoustic alarms (pingers) can be effective as a mitigation measure to prevent bycatch of harbour porpoises (*Phocoena phocoena*) in gillnet fisheries. It has also been shown that pingers primarily work by deterring animals from the area of the sound source. In order to investigate the recolonisation rate by harbour porpoises in areas subjected to pingers, a field experiment was conducted in West Scotland, between April and August 2001. Two experimental arrays with Dukane NetMark 1000™ pingers and porpoises click detectors (PODs) were deployed in two sites. The pingers were programmed to be on during two different time cycles: A long cycle (pingers on for 24h and 50min then off for the same length of time) and a short cycle (pingers on for 4h, off 8h 25 min, on 4h, off 8h 25 min, then off for 24h 50 min). The presence of porpoises was measured as echolocation activity registered by the PODs. Two-hour periods following the use of pingers with short and long cycles were compared to control periods during the same tidal phase when pingers were not switched on. Non-parametric statistical analyses were used to compare the parameters; time to first click, occurrence of clicks, number of clicks, number of click trains, and number of clicks per train. When the pingers with the long cycle had been active, analyses of all parameters except number of clicks showed a significant reduction in echolocation activity for 2 hours after pingers had been turned off. Porpoise echolocation activity was not affected following the short cycle being turned off. No differences were found in comparisons between the two sites. The results from this study show that the effect of pinger sound on porpoise distribution appears to be sustained even after pingers have been turned off.

PINGERS AND PORPOISES: TAKING DETERRENCE TOO FAR?

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In order to investigate (i) the size of the area in which pingers reduce porpoise activity and (ii) whether porpoises attempt to swim through nets where malfunctioning pingers create an acoustic gap, a field experiment was carried out in the coastal waters of west Scotland. The experimental set-up consisted of eight Dukane pingers evenly distributed along a 700m long simulated bottom set gillnet. The two central pingers were always off while the three pingers on each side were programmed to be simultaneously either on or off during one 4h observation period every tidal cycle. Porpoise click detectors (PODs) were placed on the net and at distances of 250, 500 and 750m from the net. The area was visually monitored from an observation point 80m above sea level by observers using naked eye, binoculars and a theodolite. With pingers on, all PODs but the one placed 750m from the simulated net recorded a significant reduction in number of: observation periods containing clicks, clicks per observation period, or click trains per observation period. The visual data showed a significant reduction in the number porpoise groups observed within the first 250m interval from the net. Both the minimum and average distances of the tracks increased by approximately 300m and no increase was found in the number of tracks crossing the net by the silent pingers. In conclusion, acoustic monitoring was more efficient than visual monitoring in order to determine changes in porpoises activity. The area affected by pingers was found to be larger than in studies relying on only visual methods. Furthermore, pingers as a means to reduce bycatches is not sensitive to a few malfunctioning devices. However, with a great effective range, pingers may have a large negative impact if used in migration zones and in coastal waters where access is limited.

DOLPHIN EAR VASCULAR ANATOMY: AN ASSESSMENT OF HEARING DAMAGE

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The study of the ear has become a priority in the recent years because of the leading importance of this organ in the cetacean sensory systems. In addition, the growing concern about the increasing underwater man-made noise lead scientists to develop non invasive research tools to assess the negative effects of noise pollution on these mammals. Besides primarily disturbing their normal behaviour, it is also accepted that anthropogenic underwater noise may affect the cetacean inner ear structures. However, the strategic location of the ear as well as its complicated access make it difficult to study. Therefore, the development of techniques to improve our knowledge is needed. In particular, the vascular architecture of the dolphin ear and its morphophysiological and pathological implications are far for being completely understood. The vascular supply to the ear was studied by dissecting fresh and fixed heads of extremely fresh stranded animals belonging to different delphinid species, through plastic injection of the common carotid artery and posterior tissue corrosion techniques. Routine histology was performed in decalcified samples as well as scanning electron microscopy (S.E.M.) of fixed tissues and vascular plastic casts. The ear vascularization showed to proceed from the internal carotid artery, which in contrast with other mammals is not irrigating the brain. Actually, the internal carotid artery enters the middle ear from its lateral aspect branching and forming the middle ear cavity rete mirabile inside the tympanic bulla. The cochlea itself is supplied by a surrounding capillary network perforating the periotic bony wall through tiny holes. These branches supply the cochlear duct forming a fine mesh at the level of the stria vascularis. These results show that the vascular injection fixative techniques are efficient to bypass the difficult extraction of the ear and its consequent time delay to preserve the cochlea. Most important, the devotion of a specially large internal carotid artery for the ear region only confirms the evolutionary strategic importance of this organ and completes the picture to assess noise damage.

AN AMBIENT NOISE IMAGING SONAR TO DETECT NON-VOCALISING SPERM WHALES

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Near the sea surface, where danger of collision with maritime traffic is high, Sperm Whales (*Physeter macrocephalus*) are unfortunately known to remain silent. There is consequently no conventional passive acoustic way to detect them at their most vulnerable location. The active sonar solution is both fraught with difficulties (due to reverberation from the sea surface and disturbances associated with the vessel's forward motion) and in any case undesirable since the appropriate bandwidth overlaps those used by many marine mammals. Finally, visual detection is very limited in range, particularly at night and in bad weather. These factors currently preclude timely action by fast vessels to avoid collision. We propose a non-intrusive solution; an Ambient Noise Imaging (ANI) method that consists of using natural sources of opportunity in a bistatic sonar mode. We demonstrate that it is feasible to detect a silent sperm whale near the sea surface from the backscatter of known natural acoustic sources. This method differs appreciably from prior ANI techniques in that it treats the opportunistic sources as deterministic, rather than statistical. This requires the additional step of first localising the opportunistic sources, then searching for backscattered signals from silent targets. It appears that vocalising sperm-whale clicks emitted at depth may be suitable sources to perform such a task. We highlight the constraints on this method for the design of a permanent monitoring system such as the proposed Whale Anti-Collision System (WACS) between the islands of Gran-Canaria and Tenerife in the Canaries.

TESTING LOW-INTENSITY TRANSPONDERS TO MITIGATE BOTTLENOSE DOLPHIN DEPREDATION ON TRAMMEL NETS

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INTRODUCTION Mitigation of interactions between marine mammals and fishing activities has been attempted using Acoustic Harassment Devices (AHD) and Low-Intensity Transponders ('Pingers') (Reeves et al 2001). AHD produce ultrasounds that cause pain or discomfort to marine mammals. Although they keep animals away from nets, they are inappropriate in areas inhabited by endangered species. Pingers are less invasive and have been used to prevent net entanglement (Dawson et al 1998, Gearin et al 2000), but little experience is available on their use to reduce predation, particularly that produced by dolphins. The bottlenose dolphin (*Tursiops truncatus*) is the most common cetacean around the Balearic islands. Its coastal occurrence, together with the fact that the artisanal fleet operates near the coast, facilitate interactions between this cetacean and fishing activities (Silvani et al 1992). According to fishermen, such interactions are particularly severe during the trammel net fishing for the red mullet (*Mullus surmuletus*), which appears to be a preferred food item for bottlenose dolphins. The interaction produces abundant losses to the fishing and damage to the gear, which in turn elicit harassment and deliberate dolphin kills by fishermen. This report presents the results of a survey to test the use of pingers in discouraging bottlenose dolphins from predating fish catch in trammel nets.

MATERIAL AND METHODS Acoustic devices. The acoustic devices used for the study were "Aquamark 100©" pingers, distributed by Aquatec Subsea Limited (UK). When activated by submersion in water, the devices emit eight wide-band frequency signals between 20 kHz and 160 kHz band with mean source levels of 145 dB (re 1µPa@ 1 m) at 70 kHz . The Inter-pulse interval varies at random between 5 to 30 s. Pingers measured 150x45 cm and weighed 400 g. They were mounted inside a plastic hose for protection from physical damage, and attached to two floats to ensure neutral buoyancy.

Experimental design We conducted the study during September – October 2001, when, according to fishermen, dolphin attacks on nets are most frequent. Tests were made on the artisanal red mullet fishery in the bay of Alcudia, (Figure 1). The fishing vessels were based in the harbour of Alcudia (39º50'39''N – 003º08'25''E) and they made daily fishing trips throughout the bay. Table 1 details the characteristics of gear type and fishing practices.

Pingers were attached to the float line of trammel nets every 150 meters. In this way, the longest distance to a pinger from any section of the net was 75 m. Thus, we used 20 pingers for a 3000 m. net. To identify any potential incidence of the behavior of the fishermen on the outcome of the experiment, we also used a control set of nets that were equipped with fake, non-functional pingers. The crew of the fishing vessels did not know that one of the sets was indeed non-functional, nor were they informed of the type of pinger they were using. In addition, a third set of nets without pingers was used as control.

To establish the effectiveness of pingers, the following variables were measured: a) The catch per set of red mullet (the main target of the fishery), b) The occurrence of new holes in the nets or any other type of damage during each set, and c) The sighting of dolphins in the vicinity of the nets and, if so, the occurrence of predation.

During the study, all participating boats had an independent observer (a scientist) on board who collected the data. These observers were also personally responsible for the attachment and replacement of pingers.

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

RESULTS We monitored a total of 55 sets: 27 equipped with Aquamark 100© pingers, 16 equipped with non-functional pingers, and 12 equipped with no pingers. Figure 1 shows the locations of the fishing operations monitored along the bay of Alcudia. A total of 63.25 Km of nets were monitored, 30.5km equipped with Aquamark 100© pingers and 32.75 with non acoustic devices (19.4km with non-functional pingers and 13.35 with no pingers.) Table 1 summarizes the characteristics of the red mullet fishery in the area.

The use of pingers had no significant incidence on the catch of red mullet ($F=1.35$, $p=0.26$) (Figure 2 – A). When a dolphin interaction was recorded, the catch of red mullet in the involved set was smaller. Thus, the mean weight of the catch of the target species was significantly lower when dolphins were present in the vicinity of the net than when they were absent ($F=5.39$, $p=0.024$) (Figure 3). Overall, observers identified the occurrence of dolphin predation in 10.9% of the sets, nets equipped with functional pingers were less predated (7.4%) by dolphin interactions than sets equipped with non-functional pingers (12,5%) or without pingers (16.6%) (Figure 2 – C)

The daily count of new holes larger than 20cm after each fishing operation was used to asses damage to the nets. The average number of new holes in each stretch (50m) of net was 5.38 ± 4.3 (ranges: 1 – 26). A total of 357 new holes were counted in the 750 meters of nets monitored <u>for the three boats</u>. Only 24% of the holes observed in the nets were larger than 40 cm width. Nets equipped with pingers resulted less damaged that nets with non-functional devices or without pingers ($F=10.390$, $p<0.05$) (Figure 2 – B). Counts of more than 10 holes per stretch were observed only in 17 occasions. In 82,3% of these occasions dolphin predation was directly observed during the fishing operation.

CONCLUSIONS Although pingers are mainly applied to prevent entanglement of cetaceans, the results of this study indicate that they also reduce damage to the nets caused by dolphin predation, and are therefore an alternative and less invasive method than AHD. This study also indicates that:

- Pingers have no significant effect on the catch of targeted species and can therefore be considered as a passive element in the fishing gear. This is of particular relevance to persuade fishermen to use acoustic devices as a means to reduce dolphin predation, without reducing the catch of the target species.
- When dolphins were observed predating on the captured fish, or when spoiled fish was observed in the hauled net, the number of net holes was higher. Some of the new holes were not necessarily a consequence of dolphin interaction but were probably produced during the setting and hauling of the nets.
- Damage to the nets was smaller in nets equipped with functional pingers than in nets with no pingers or equipped with non-functional pingers.
- Fishermen were not consistent in the identification of new holes caused by dolphin interactions nor in the origin of the spoiled fish that remained entangled in the nets. The indirect techniques used by observers (counting the holes or weighing the catch) were more reliable but of little practicality. A reliable technique to assess dolphin interactions needs to be developed.
- Further research is needed to evaluate the extent of the damage caused by dolphins to nets.
- The population size of bottlenose dolphins in the area, and in particular of those predating on the nets, should be determined to assess the potential impact of incidental catches and deliberate kills on the population involved.

ACKNOWLEDGEMENTS This study would have not been possible without the collaboration of the fishermen, who readily accepted observers on board their vessels. We are also grateful to all the members of the fieldwork team that participated in the collection of data, especially Joan Gonzalvo, Carlos Carreras, Silvia Scali and Cati Bertran. Special thanks are due to Josep Maria Brotons and Antoni Grau, of the Conselleria d'Agricultura i Pesca, who assisted the research team in the design of the survey. Dave Goodson contributed in the earlier design of the study. This study was funded by the Spanish Ministry of the Environment (Directorate of Nature Conservation) and the Government of the Balearic Islands.

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Silvani, L., Raich, J. and Aguilar, A. 1992. Bottlenose dolphins, *Tursiops truncatus*, interacting with local fisheries in the Balearic Islands, Spain. Vol.6 *Proceedings of the Sixth Annual Conference of the European Cetacean Society.*

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Table 1 Characteristics of the red mullet fishery in the monitored harbour.

Fishery target species	Net mesh size	Average depth of fishing grounds	Average hours of nets in the water	Average meters of net /fishing boat
Red mullet (Mullus surmuletus)	25 mm	40,81 ± 9,4 meters	4,05± 0,5 Hours	2258 meters

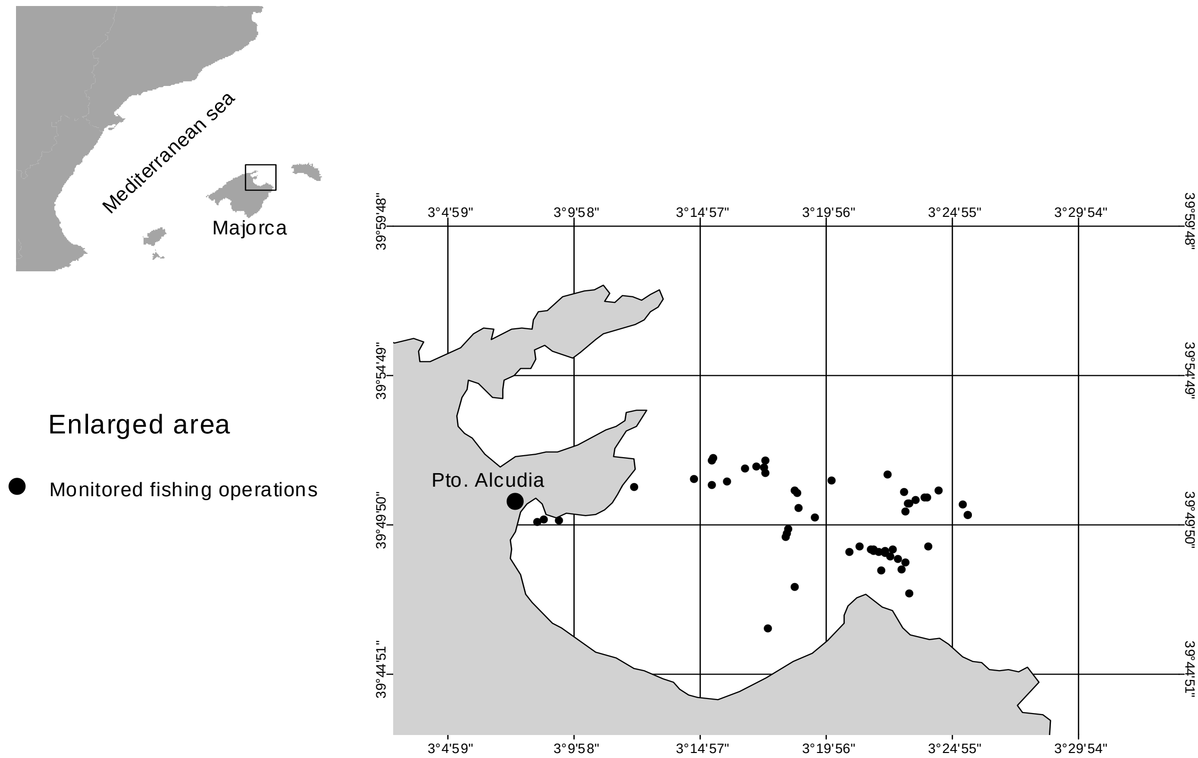

Fig. 1. Study area and locations of the monitored fishing operations

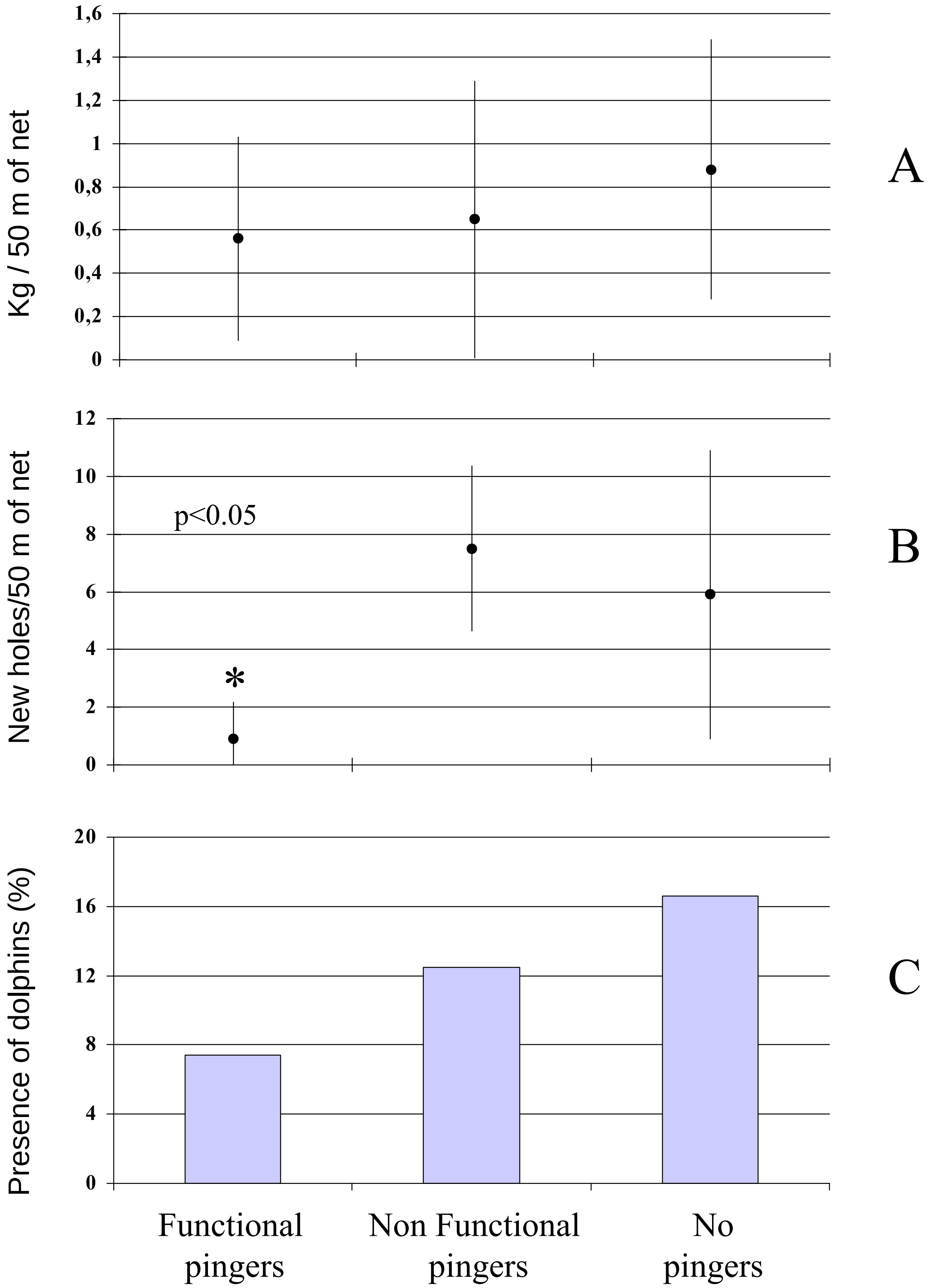

Fig. 2 Catches of target species (A), damage to the nets (B) and dolphin observations around the fishing nets (C) in the three experimental settings. (*) indicates significant differences

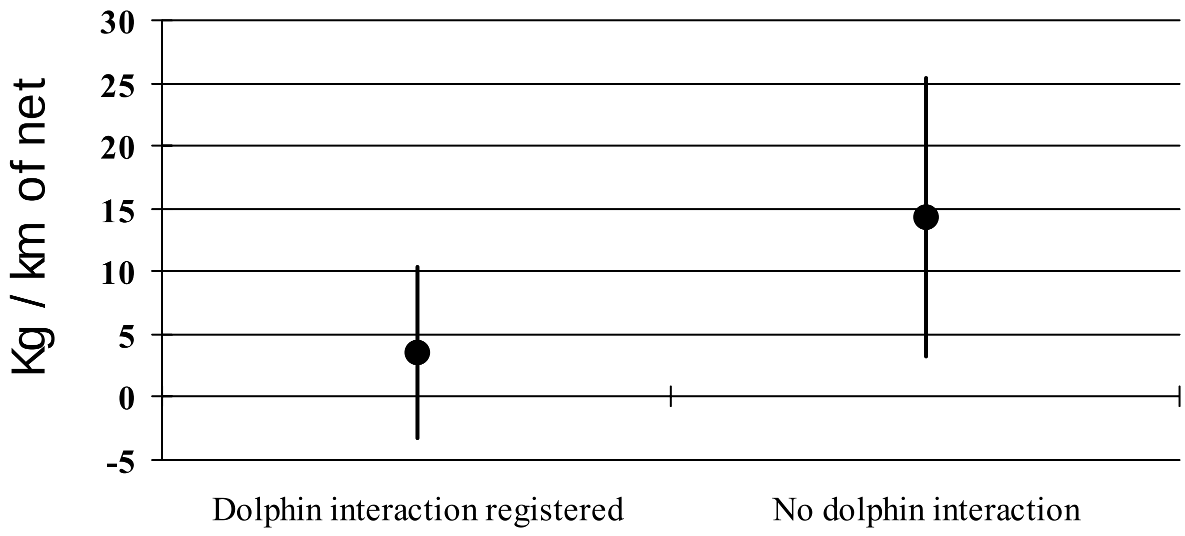

Fig. 3 Catches of target species in relation to dolphin interactions registered. (average value±SD)

REACTIONS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) AND HARBOUR SEALS (*PHOCA VITULINA*) TO UNDERWATER SOUND PRODUCED BY A SIMULATED 2 MW OFFSHORE WINDPOWER GENERATOR

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The behaviour of free-ranging harbour porpoises and seals was recorded under the influence of simulated offshore windpower sound by a combined method using theodolite tracking and a click detector on Vancouver Island / Canada. The hypothesis tested was that harbour porpoises and seals show distinct behavioural reactions to the sound of offshore windpower plants. In this experimental approach the sound was generated by a car CD-player and an underwater J-13 transducer. Minimum distances from the sound source increased from a median of 120 m and 239 m in harbour porpoises (380 groups) and seals (n = 141), respectively, during control periods, to 182 m and 284 m, respectively (375 porpoise groups, 157 seals) when the sound source was active. No distinct exclusion zones as compared to former pinger studies were observed around the sound source. The intervals during which porpoise echolocation clicks were detected increased by a factor of 2 from control periods to periods with windpower sound. The results show that (1) harbour porpoises and harbour seals were able to detect the low frequency sound generated during the experiment, (2) both species showed a significant reaction to the sound and (3) harbour porpoises showed exploratory behaviour instead of fear.

MAPPING AND ANALYZING ACOUSTIC SURVEYS' RESULTS: A GIS APPROACH

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INTRODUCTION C.I.B.R.A. is a research group whose main interest is in the study of underwater sounds related to marine mammals and in the development of acoustic detection and analysis technologies. The "acoustic" aspect in wide area studies, critical habitat identification and population distribution has become more and more popular. According to our experience it is a difficult task to integrate, in one scheme, acoustic evidences with other data sets like remote sensing or seasonal fluctuations models, and scientists often fail to provide one general clear picture of the study area. Nowadays, more than expanding scientific knowledge about acoustic communication and echolocation in marine mammals, researchers' interest is shifting to more comprehensive research topics. The methodology used to consolidate on a GIS acoustic data, historical data and measured or modeled parameters is hereafter described.

MATERIALS AND METHODS Starting from 1998, C.I.B.R.A. reasearch group has been involved in the NATO SACLANT Center SOLMaR research program (Sound Oceanography and Living Marine Resources). This program is aimed at evaluating and minimizing impact of human activities on marine life and marine mammals in particular. An extensive 24hrs/day acoustic detection classification is carried out by our team during 20 day/year periods spent at sea within this project (Fig. 1). The on-field periods are spent on the R/V Alliance, a large NATO Research Vessel offering unique facilities like large scientific labs, selected crew that supports uninterrupted cruising, state-of-the-art acoustic sensors towed by one of the most silent ships ever designed. During thess cruises, four or five people shift at an acoustic monitoring and recording equipment, performing a continuous recording and classification of the detected signals. Acoustic detections are categorized using a slotted time axis *vs.* abundance of simple sound categories. Each record in the database describes the events occurred in our time-slot, a one minute period. Events are described using simple acoustic categories. The researcher gives a quantitative value ranging from 0 (not present) to 3 (present and very abundant) to each of these categories. The same is made with a qualitative index (signal strength) for each category. The huge data amount resulting from continuous acoustic recordings and classification, together with navigation data, visual sightings, research effort indexes, acoustic and oceanographic parameters and satellite remote sensing, are flushed to and organized in a GIS database in order to perform further analysis and have area over-looks.

RESULTS AND DISCUSSION Time-slotting is indeed a useful strategy when trying to fill a database with events that stream uninterrupted along the time axis. This strategy throws a bridge among researches where continuous acoustic monitoring is chosen and those with acoustic samples taken at discrete stations. Along the continuous audio flow the researcher's "virtual" station will be the one delimited by the duration of the slot. Once filled with data, tables become a detailed index of detected signals. As all data are geographically referenced, by plotting tables on a map the researcher obtains in one step a view of his research effort and his detections. Acoustic categories must be as few as possible, directly deriving from a previous knowledge of the study area, and easy to spot for the operator. They must be meaningful for the research as well. Operators must be trained to reliably identify categories with their quality and quantity characteristics. Acoustic classification can be repeated in post-processing on tapes (or sound files), to check for missed events and to average classifications made by different researchers whose attitude could be to mis-estimate certain event categories. Data tables can be used to search for event sequences. They are the ultimate index of researcher's recordings. From tables it is easy to go to points of interest on recordings. Finally every table can be plotted on maps, and together with acoustics every other georeferenced parameter can be overlaid. Any record in the database or any sound cut can be thereon accessed starting from plots on maps.

CONCLUSIONS A GIS is basically a database that deals with georeferenced data, and it is able to geographically plot them or to plot results of mathematical, logical and statistical operations on those data. Our experience has shown us the feasibility of real-time recording, analysing and mapping acoustic data, together with slowly changing environmental parameters, on a GIS. Moreover detailed indexes of detections and recordings are shown along the ship's track on maps. As a GIS, performing operations, is able to look for relationships, it can be useful while testing hypothetical correlations among parameters. Good computer skills are required to obtain valuable results, but user interfaces are anyway rapidly evolving. Trained operators are still needed to classify acoustic signals, nevertheless this system is ready to be matched with automatic recognition routines as soon as reliable tools will be available. Plotting acoustic data together with other parameters gives researchers an excellent opportunity to spatially organize their findings, to check for correlations and to plan further researches.

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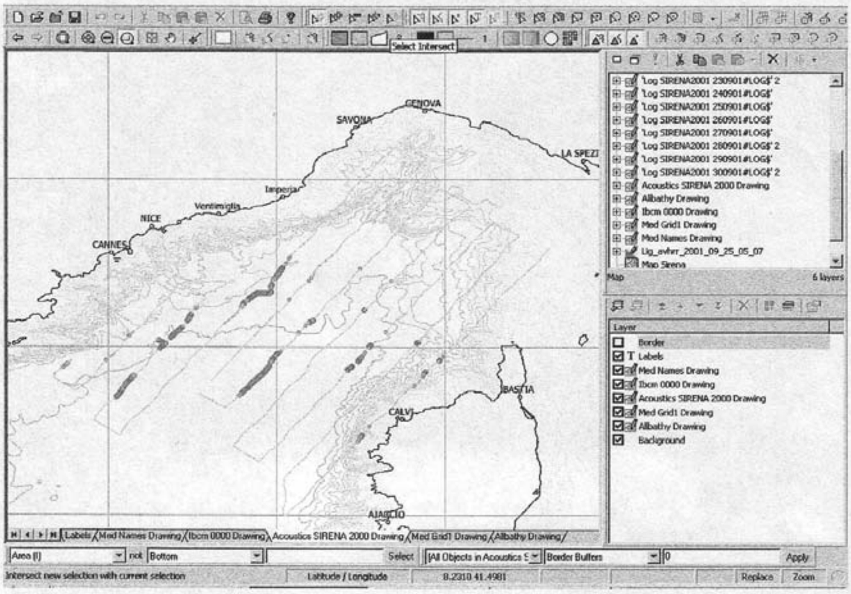
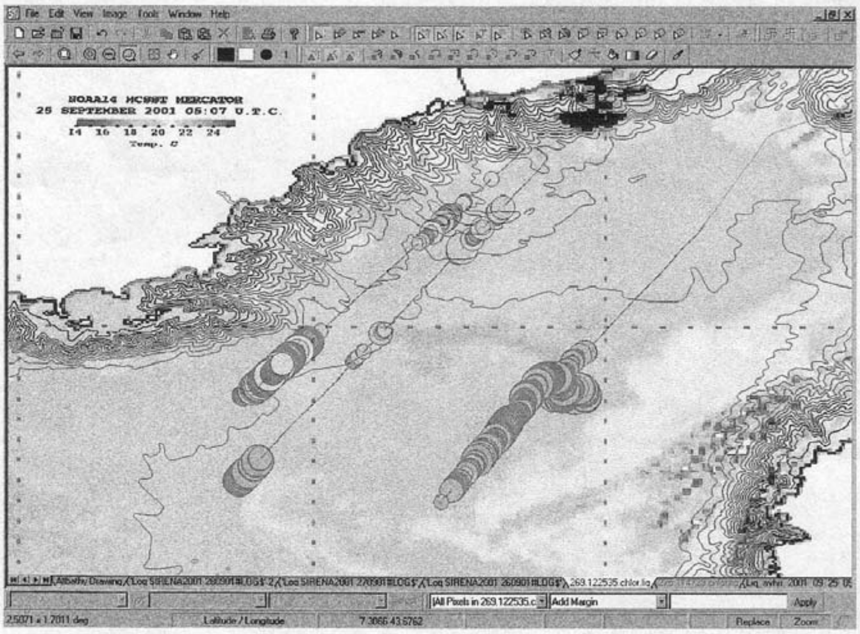


This simple map shows, for example, the occurrence of acoustic sperm whale detections along the ship's track.



All sorts of data can be overlaid (in this picture the sea surface temperature read by satellite) to get an area quickview and when meaningful correlations are tested.

Fig. 1. Study Area and Cruise Tracks

BEAM-PATTERN OF WHITE-BEAKED DOLPHIN CLICKS

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The aim of the study was to describe the beam-pattern of clicks recorded from free-ranging white-beaked dolphins. The recordings were made in Icelandic waters close to Keflavik. We used a four-hydrophone array, one center hydrophone and three other hydrophones at an angle of 120 between each. The distance from the inner to each of the outer hydrophones was either 0.5 m or 1 m. The hydrophones were connected to amplifiers and to a Racal Store 7. We used a tape-speed of 30 or 60 ips and had a frequency response up to either 150 or 300 kHz. In addition an underwater video camera was attached close to the center hydrophone. The under water video camera was used to check if the dolphins were aligned with the array. We calculated the range to the dolphin by using the difference in arrival time to the four hydrophones. Source levels of the clicks were also calculated. Preliminary results show a 3-dB beamwidth of 6-8 degrees, which can be compared to a 3-dB beamwidth of 10 degrees of bottlenose dolphin clicks.

ECHO-LOCATION LOGGERS (POD) TO ASSESS BOTTLENOSE DOLPHIN INTERACTIONS WITH TRAMMEL NETS

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INTRODUCTION In the Balearic Islands, bottlenose dolphins (*Tursiops truncatus*) adversely interact with the artisanal fishing, particularly when trammel nets are used. This results in economic loss to fishermen and in deliberate and incidental kills of dolphins. The extent and the frequency of such interactions is unknown. Within the framework of a project to assess the effectiveness of acoustic deterrent devices (pingers) to mitigate the conflict, we tested the utility of the POD, a submersible computerized hydrophone that logs dolphins echo-location clicks (Chelonia - T-POD, UK), to detect the presence of dolphins around trammel nets also when this is impossible to do visually (fishing activities are conducted mainly during dark hours).

MATHERIALS AND METHODS **The POD.** The POD is a computerized hydrophone able to recognize and log echo-location clicks from dolphins and porpoises. It has a cylindrical shape, a length of 64cm and a body diameter of 88cm. The transducer is a cylindrical piezo-electric ceramic with resonance at 130kHz. It has filters which select energy from different frequency bands of the sound spectrum. Every minute of logging, the POD runs 6 sets of filter frequencies for 9,3 seconds each. Via the software it is possible to decide, for each of these 6 "scans", which hardware setting to use in order to optimize the echo-location clicks detection.

Experimental design. The study was conducted in the bay of Alcudia (Majorca, Balearic Islands) during September-October 2001 during the red mullet (Mullus surmuletus) fishery. The POD was attached to the gear floating line, usually in the middle of the net, and remained in the water for the whole fishing operation. Nets were set at night and hauled at dawn. We tested different settings of the POD to improve noise avoidance, i.e. ultrasonic sounds other than dolphins clicks (boat sonar emissions, sounds of propellers, noise produced by sand movement, and unknown sources). In each test we counted the number of clicks and the number of clicks trains (clicks placed in series). We also estimated the number of clicks per hour and the number of trains per hour to measure dolphin echo-location activity independently from the time that the pod remained in the water. During the sets, an independent observer was onboard the boat to record any dolphin sighting or activity in the vicinity of the nets.

RESULTS 13 fishing operations were monitored using the POD (Table 1). Each set lasted about 4 hours(3:39±1:08); nets were deployed at about 3.30am and hauled at about 7:30am. The device was in the water during all the time the nets were set, resulting in a total of 47,45 hours of monitoring.

In seven of the monitored operations, bottlenose dolphins were sighted around the nets during the hauling out maneouvre, and in three cases observers recorded dolphin predation.

During the tests we used 4 different POD hardware settings that were in-build into the equipment.

Each of them varied in the central frequencies and sharpness of the two hydrophone filters, the minimum intensity of the higher filter, and the ratio energy between the two filters.

Post-collection data processing is used to reject 90% or more of logged clicks and retain those in trains, classifying them as resembling cetacean trains, boat sonar trains, or 'doubtful'. The data used here are clicks classified as being in cetacean trains. In some cases boat sonars were operating at the same frequency as bottlenose dolphins (50kHz).

The POD detected echo-location click trains, this is, the presence of dolphins, in seven of the monitored fishing operations. In 6 of these cases, dolphins were sighted in the vicinity of the nets, and in three of them damage to the net was observed once back in the harbour

The average number of echolocation clicks/hour was higher when dolphin predation on nets was observed (135.9±742) than when no attacks were registered (57.92±46).

The number of clicks registered in each train was similar in both situations: when dolphin predation was observed, the average number of clicks was 28.67±6.15; when predation was not observed, it was 26.67±6.50.

In 4 of the sets, dolphin activity around the net was observed within the first hour after the setting of nets, and in three occasions dolphins were observed after 2 and a half hours. Damage to the gear was independent of the time at which dolphins visited the nets.

CONCLUSIONS

- The POD is a useful and reliable indirect method to monitor dolphin presence around nets when visual observation is not possible.
- The number of clicks per hour were higher when dolphins were predating the nets than when they were swimming around the net without predating, but the mean number of clicks per train remained unchanged.
- All POD setting protocols registered echolocation's clicks. However, one of them produced better results because it more efficiently excluded non-dolphin ultrasonic sounds, like those produced by boat sonar and sand movement. In this protocol, the hardware was set to operate with the two filters, A (click frequency) and B (comparison frequency), the central frequencies were 50 and 80 Khz respectively, the sharpness (Q value) of the filter A was 5, and the sharpness of the filter B was 9.
- Dolphins arrived to the nets soon after they were set. This suggests that dolphins were already present in the fishing grounds or that they were readily attracted by the noise produced by the fishing boats during the maneuver of gear setting.
- Further research is needed to better characterize the relations between dolphins echo-location clicks patterns and predation on the nets.

ACKNOWLEDGEMENTS The authors acknowledge the fishermen of Alcudia for their collaboration. Joan Gonzalvo, Carlos Carreras, Josep Maria Brotons and Cati Bertran participated in the fieldwork and assisted in the collection of the POD data. We are also grateful to Antoni Grau, Conselleria d'Agricultura i Pesca, for his overall assistance in the operational aspects of the fieldwork and general support. This study was funded by the Spanish Ministry of the Environment (Directorate of Nature Conservation) and the Government of the Balearic Islands.

Table 1 Dolphins sightings and data collected by the POD in each trial

TRIAL NUMBER	DOLPHINS SIGHTINGS	DOLPHINS DETECTED BY POD	PREDATION OBSERVED ON THE NETS	CLICKS NUMBER	CLICKS/ HOUR	CLICKS TRAINS	CLICKS TRAINS /HOUR	TOTAL TIME IN THE WATER (min.)
1	YES	NO	NO	0	0	0	0	202
2	NO	YES	NO	264	104.21	9	3.55	152
3	YES	YES	NO	280	88.42	9	2.84	190
4	NO	NO	NO	0	0	0	0	242
5	YES	YES	YES	138	54.47	4	1.58	152
6	YES	YES	YES	615	155.04	21	5.29	238
7	NO	NO	NO	0	0	0	0	179
8	NO	NO	NO	0	0	0	0	153
9	YES	YES	YES	645	186.06	29	8.36	208
10	YES	YES	NO	17	3.91	1	0.23	261
11	YES	YES	NO	117	36.37	4	1.24	193
12	NO	NO	NO	0	0	0	0	314
13	NO	NO	NO	0	0	0	0	388

AN AUTOMATED PROCEDURE TO EXTRACT SPERM WHALE CLICK SEQUENCES FROM NOISY OBSERVATIONS

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From an acoustic recording of a diving male sperm whale off the coast of New Zealand a Pulse Repetition Frequency diagram (PRF) is constructed. The PRF is a common function in echolocation click sequence processing and plots the inverse of the Inter Click Interval as a functionof real time. An automated procedure based on amplitude thresholding and correlation methods on the click form is used. Contrary to what we expected from experience with other species of odontocetes, our analysis of the click train shows that it is not possible to designate one or more typical clicks as a reference set with a high correlation to all the other clicks in the data set. The consequence is that a real-time fully automatic detection method should take a large collection of clicks in consideration to identify the next click. Typically the use of such a method results in an error rate of about 10% . Different sizes ofreference sets of clicks are considered in this method.

COMPARING ECHOLOCATION BEHAVIOUR DURING ORIENTATION AND FORAGING OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

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This study concerns the echolocation behaviour of harbour porpoises (*Phocoena phocoena*) during fish capture and orientation. Synchronised video and high frequency sound recordings of porpoises during orientation and prey capture in mid water were made under controlled conditions. The behaviour was correlated with sound production. Two video cameras above water allowed the reconstruction of porpoise and target position (floating walkway or fish), enabling calculations of target distance. Two underwater video cameras allowed for three-dimensional reconstruction of the catch, showing predator/prey interaction. The experiments were conducted with two trained porpoises kept in a semi-natural environment at the Fjord&Baelt, Denmark. Click trains produced during catch show at least two different stages: a 'far stage', in which the porpoise approaches the fish to about 3 m, followed by a 'near stage', where the porpoise closes on the prey. During the 'far stage', the click interval decreases from ~80 ms to ~50 ms. The decrease is linear with distance, indicating range locking behaviour. During 'near stage' the click interval decreases rapidly to 1.5 ms, where it can be stable over more than one hundred clicks. Click trains produced during orientation (swimming from one site to another) show a click pattern comparable to the 'far stage', with range locking behaviour. We assume that landmarks are used for range locking during the 'far stage' of prey capture and orientation rather than the target or the fish. Focus on the prey starts in the 'near stage' - within the last few meters before capture. We thank following organisations and people for their co-operation, assistance, suggestions and financial support: Fjord&Baelt, Sabrina Labberté, Kirstin Anderson, Gwyneth Shepard, Dr. Geneviève Desportes, Dr. Mats Amundin, Deutscher Akademischer Austauschdienst e.V., Bundesamt für den Naturschutz, Stiftung Landesgirokasse Stuttgart, Gesellschaft zum Schutz der Meeressäugetiere e.V., Deutsche Umwelthilfe, the Danish National Research Foundation.

BEHAVIOUR

OBSERVATIONS OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE WATERS OF BARDSEY ISLAND, WALES

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The purpose of this study was to investigate the relationship between cetaceans and various habitats around Bardsey Island in the northern part of Cardigan Bay (Wales). In addition, we studied the influence of the tidal cycle upon porpoises. Land-based cetacean observations were conducted from Bardsey Island using a scan sampling methodology covering all waters around the island. The present study provided confirmation of the importance of Bardsey waters for porpoises. These waters form suitable feeding and possible breeding and/or nursery grounds. Bardsey Sound appeared to be the most preferred habitat for porpoises offering several locations, at different tidal states, that porpoises used primarily to feed. Porpoises are likely to benefit from an increased probability of finding prey during the ebb tide. We observed porpoises foraging in Bardsey Sound in front of the mainland (Lleyn Peninsula) and an area NE off Bardsey. Generally, as the tide began to flood, porpoises were seen traveling in a NW direction. They appeared to be 'hitch-hiking' the tide, towards the Lleyn Peninsula's headland 'Pen y Braich' and off the NW point of Bardsey, where foraging could again be observed.

DAYLIGHT BEHAVIOUR OF DUSKY DOLPHINS (*LAGENORHYNCHUS OBSCURUS*) IN GOLFO NUEVO, ARGENTINA

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The dusky dolphin is a commonly occurring cetaceans off Patagonian coasts, Argentina. During the last few years the occasional sighting of dusky dolphins has been discovered as an alternative for other tourism activities in the region. The objective of this study is to describe the general behaviour of dusky dolphin schools in Golfo Nuevo and to analyse the activity budget throughout the daylight hours. This information will be useful at the time of evaluating the potential impact of watching tours. Observations were made from a commercial boat and from a research boat from January to May, 2001. Once a group of dolphins was sighted, it was considered the focal group and followed as long as possible. Group size and composition were recorded at the time of the sighting. Behaviour and activity were recorded for each 2min intervals thereafter. During each interval, we recorded the number of clean leaps and noisy leaps. At the end of each interval, the predominant activity of the group was assigned as "feeding", "travelling, "resting", "socialising" and "milling". Dusky dolphins were observed for 95hs and behaviour was recorded for 95 focal groups. The daily activity pattern of dolphins was dominated by "travelling" (46% of the observation time). An increase in the time spent in "travelling" and a decrease in "resting" towards the afternoon was observed although the difference was not statistically significant. Mothers with calves were more frequently observed "resting", while "socialising" only appeared in adults-juveniles and in mixed groups. Higher number of noisy leaps happened when the activity was "socialising" (K-Wallis=25.18, $p<0.00001$) while higher number of clean leaps happened when "feeding" (K-Wallis=29.69, $p<0.00001$). Sequences of "travelling" and "feeding" were detected in which "travelling" periods were longer than "feeding" periods (=10 and 7 min respectively). Feeding periods lasted longer in larger groups ($r=0.525$, $p<0.0001$).

DISTRIBUTION OF KILLER WHALES (*ORCINUS ORCA*) IN WEST SCOTLAND AND THE MOVEMENTS OF IDENTIFIED INDIVIDUALS

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Analysis of cetacean sightings data collected since 1968 has shown killer whales (*Orcinus orca*) to be the fifth most common cetacean species reported in the nearshore waters of west Scotland. Furthermore, this analysis indicates that certain individuals have been seen for several consecutive years, indicating some degree of residency. Use of photo-id techniques has allowed several animals to be recognised in the region. Reports show two particular males; one with a distinctive notch at the base of the dorsal fin and another with a flopped/collapsed dorsal fin; to have been sighted repeatedly since 1987 and 1991, respectively. Both have also been sighted as recently as 2001. Preliminary sightings data also suggests that there is a high degree of mixing of animals between groups while they are in this area, since recognisable individuals, have been seen in groups ranging in size from two to twelve animals. To date, the largest group size reported was 40 animals; although the majority of groups constitute 8 animals or less. This information on killer whales in West Scotland waters, provides baseline data for an ongoing study which will permit a greater understanding of orca behaviour and movement on an individual and group level.

EYE DOMINANCE IN CAPTIVE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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The cognitive aspects of some peculiar behavioral patterns observed in captive dolphins are not yet completely clear. The counterclockwise swimming and the preference to use one eye looking toward the periphery of the pool still have not been explained using a systematic procedure. Given the anatomy of the dolphin's visual system, we decided to investigate the possible existence of an eye dominance in three captive bottlenose dolphins (*Tursiops truncatus*) at the Palablu' Dolphinarium inside Gardaland, Verona, Italy. We employed a behavioral approach to assess the eye preference. The dolphins watched for various stimuli outside the pool, while we video-recorded them for 5 minutes after the stimuli's presentations. The videotapes analysis consisted in counting the time spent inspecting the objects by each eye in each individual dolphin. Our data suggest a tendency of the three dolphins to prefer the right eye in watching stimuli especially when they are placed on the pool board. Whereas for hanging objects the difference between the two eyes is slight. We present preliminary results on cognitive aspects of the counterclockwise swimming and the eye-preference.

SYNCHRONOUS GROUP BEHAVIOUR: FACTORS AFFECTING THE SURFACING PATTERNS OF DOLPHINS

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Synchronous behaviour patterns within groups of free-living animals have been described for a wide range of species, including fish, birds, mammals and insects and its underlying function has been linked to a variety of behavioural contexts such as feeding, reproduction and predator avoidance. The majority of odontocetes are highly social and many of their locomotory behaviours are frequently described as synchronous. Most commonly, individuals within schools are reported to surface to breath in a co-ordinated fashion. This study investigates the surfacing behaviour of bottlenose dolphins (*Tursiops truncatus*), to determine the frequency of such behaviour. Individual schools of bottlenose dolphins were videoed from a cliff-top observation station. These data were then used to test whether the pattern of surfacings within each sample was synchronous. In addition, to elucidate some of the possible functions of surfacing synchrony, its occurrence in association with school size, presence of young calves and feeding behaviour were investigated. The majority of dolphin schools showed surfacing patterns that were not significantly different to those expected by random chance, but 33.3 % of schools did show synchronous surfacing behaviour. These were significantly positively related to the number of dolphins in the school (GLM: $F_1=11.825$, $P<0.001$) and when viewed alongside previous literature, suggest that synchronous surfacing is a form of social interaction between individuals. In contrast to observations in previous studies, there was no variation in this behaviour with respect to feeding patterns or with the number of calves in the school. This study provides an objective and quantifiable classification of synchrony in dolphin behaviour, and facilitates comparative studies required to understand the function behind synchronous behaviour in dolphins.

EFFECTS OF BOAT DISTURBANCE AND TIDE ON BEHAVIOUR AND OCCURRENCE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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INTRODUCTION Several studies have been conducted to investigate the effect of boat disturbance on the bottlenose dolphins (*Tursiops truncatus*) in the inner Moray Firth, Scotland (e.g. Janik & Thompson, 1996; Lüthebohle, 1997). These studies tend to find that boats disturb the dolphins in general and in particular, the commercial dolphin watching boats. Recent observations suggest that the dolphins in the later years have frequenting the inner parts of the Moray Firth than previously (Hammond *et al.*, 2002; Pers. Comm. Eleanor Dickson). This study addresses the behaviour and occurrence of the bottlenose dolphins in the outer Moray Firth in relation to boat occurrence and tide.

MATERIALS AND METHODS The study was shore-based and conducted from a cliff-vantage point in Cullen Bay (57° 42, 04' N; 02° 52, 00 W) (Fig. 1). This was done by *Ad libitum* surveys and 5 minute scans with binoculars during 39 days (202.5 hr.) in July and August, 2000. During the time span 0500-2200 the following features were logged: dolphin occurrence, behaviour (coded below), boat density within 3 miles of the bay, weather, wind force, visibility, other cetacean presence, tides and other possible influences. Tidal data (semidiurnal) was divided into four groups: 1) Inflow, 2) High tide, 3) Outflow and 4) Low tide. Chi-square was used for comparing frequencies and one-way ANOVA was used to compare means. Logistic Regression (LR) was used to test when the data was dichotomous.

Definition of the most frequent behaviour patterns of the bottlenose dolphins in this study:

- *Avoidance behaviour*: Avoidance of a boat can be seen as changes in direction, changes in swimming speed, as longer or deeper dives without any sign of feeding and in seldom cases as aggressive behaviour of the dolphins. In every case, the direction of movement is away from the object.
- *Feeding behaviour*: Dolphins perform mixed behaviour and are very active in a relatively little area. An obvious sign of a dolphin feeding is birds hovering above. Feeding is often associated with sharking, pursuing and aerial behaviour such as breaching (Fig. 2A).
- *Aerial displays*: Breach (Fig. 2A), porpoise (Fig. 2B), Spy Hop, and synchronised behaviour
- *Travelling*: Dolphins surfacing regularly in a constant direction. This usually occurs in groups
- *Milling*: Dolphins are swimming in various directions and are not making any progress in one direction. They are observed to be surfacing and often swimming gently into the current

RESULTS The dolphins occurred throughout the study period and used the area mainly for feeding. Aerial displays, milling and travelling was also frequently observed behaviours in the bay. The mean group size was 10.9 individuals (range 1-33) during the two months.

Significant avoidance behaviour towards boats within 50 metres of the dolphins was found (χ^2 = 19.33; 1 df; P < 0.01) and the dolphins avoided boats within 400 metres in three out of seven incidences. The avoidance behaviour was more pronounced in groups of more than 10 individuals than in smaller groups (χ^2 = 3.56; 1 df; P < 0.05) and the avoidance behaviour would increase with increased time spend in the area (χ^2 = 5,241; 1 df; P < 0.05). No correlations between boat density and dolphin occurrence was found and no bow riding was observed during the surveys.

The dolphins were seen significantly less in the area at outflow periods (LR: F = 6.31; 1 df; P = 0.012) (Fig. 3). No relations between group sizes, overall behaviours and tide were found. However, milling occurred less during high tides (LR: F = 6.92; 1 df; P = 0.009) and the avoidance behaviour in the high tide period was very close to the chosen level of significance (LR: F = 3.571; 1 df; P = 0,058). Both behaviours were observed to have a significant positive relationship with the time spent in the area (Milling: χ^2 = 5,241; 1 df; P < 0.05). It was found that the number of boats was highly significantly different within the tidal periods (ANOVA: F = 5.54; 3 df; P = 0.001). Most boats were observed during high tides and the lowest number of boats was observed during low tides (Fig. 4).

Harbour porpoises (*Phocoena phocoena*) were observed 21 times during 10 different days in the study period. All observations were in August except for one in July. The harbour porpoises were only observed in the area at the same time as the bottlenose dolphins once and this occurred with minimum distance of 2 miles (3.2 km) between the two species. The porpoises were most frequently seen in the area when no boats were present. In cases with boats nearby the porpoises would react with avoidance behaviour in all cases except for one. No statistical test is performed cause of too few data.

DISCUSSION This study contributes to the knowledge on the Moray Firth dolphins. In particular, it shows that boats do induce avoidance behaviour. The avoidance behaviour is not reflected in the occurrence of dolphins in the area though and this may be due to interactions of other factors such as tide.

Since the occurrence of both dolphins and boats was strongly correlated with the tidal periods and an increased number of boats were observed during high tide and outflow periods, it does seem to be likely that these observations may be interactions. The significant avoidance behaviour towards boats within 50 metres could have several causes. Primary effects such as noise and spatial arrangement of the boat could diminish the dolphin's advantage vocalisation both in terms of navigation, hunting and socialising (Janik, 2000). It has been shown that the dolphins' whistles often lie in the same acoustic frequency levels as the man-made noise surrounding the dolphins (Richardson *et. al.*, 1995). One secondary effect that would lead to behaviour being erroneously interpreted as avoidance, could be following prey that avoid the boats. Several studies show that schooling fish such as clupeoids (e.g. herring) avoid vessels by moving downwards at distances ranging from 5 to 7 metres from the boats (e.g. Gerlotto & Freón, 1992; Sonia *et al.*, 1996).

This study found that there were no relationship between boat density and occurrence of dolphins. This could mean that the dolphins were resigned to having boats in the area, and only got disturbed by them if they came within a certain range. Coastal species like bottlenose dolphins do appear to be able to adapt to intrusions into the coastal environment including quite high levels of disturbance (Thompson, 1992). It was found however, that the degree of avoidance behaviour would increase and the milling would decrease with the time the dolphins spend in the area frequented by boats. By staying in the area for longer time, the dolphins and the boats would have a higher encounter rate, which might lead to greater avoidance behaviour. The fact that the dolphins do stay in the area, despite increased avoidance behaviour, may also mean that there is prey nearby attracting them. The most observed behaviour was in fact feeding. When feeding the dolphins will only move on if disturbed and this study showed that boats did invoke avoidance.

Milling was also observed less in high tides. The behaviour is often associated with other behaviour such as travelling, food searching and social behaviours (e.g. Shane, 1990). This means that milling could be a social connector through vocalisation, a foraging strategy, a type of resting, a combination of behaviours or functions in an entirely different manner. Whatever the function of milling, it seems like that the dolphins may be disturbed when doing so at high tides, and the boat density is the highest. Other explanations such as differences in prey availability may also have an effect on milling. Whether the boats have any effect on the observed milling behaviour cannot be deduced from this study, but more research in this particular field would be advisable.

Several previous studies have reported an increased movement against current and increased feeding against a strong tidal current (e.g. Shane, 1980; Hanson & Defran, 1993). In particular, this phenomena is observed to occur in the inner Moray Firth, so feeding against a current is seen in the area. However, feeding did not seem to increase with the tidal flow and no movement against a current was obvious in this study of the Moray Firth dolphins. On the contrary, the dolphins were seldom present at the time of the out-flowing tides. This absence could be an effect of boat disturbance, but other factor such as a shift in favoured places to feed during outgoing tides may affect this behavioural pattern.

The mean group size in this study was almost twice as big as that observed for the inner Moray Firth in previous studies (Wilson, 1995; Wilson *et al.*, 1993), but lies within the expected group size of 2-15 individuals. This is the most frequently observed group size seen in coastal waters around the world (Shane *et al.*, 1986). The reason the dolphins are more affected by boat disturbance when being in larger groups, may be because of a possible increased socialisation, vocalization or more young in larger groups than in smaller. Previous studies have found socialising groups of dolphins to be larger than groups engaged in other behaviour (Shane *et al.*, 1986).

The porpoises were observed only once in July but 20 times during the last half of August. These observations suggest that the porpoises only came close to shore after calving or because a certain prey type was more abundant at the end of the study period. The porpoises and the bottlenose dolphins were only seen in the area at the same time once. This makes sense in the light of Ross & Wilson's article (1996) about attacks by bottlenose dolphins on porpoise in the Moray Firth. Observations from this study of porpoise reaction to boats support previous observations reported by Polacheck & Thorpe (1990). They found the porpoises in the Bay of Fundy would change swimming directions within 400 metres of the survey vessel.

More research in the field would be advisable; since energy expenditure over longer periods used up in escaping boats or diminished energy intake because of limited feeding opportunities may decrease the overall fitness in this bottlenose population.

ACKNOWLEDGEMENTS The Moray Firth Dolphin Trust, Tony Archer, Eleanor Dickson, Robin Young, Katherine Richardson, Lisa Groth, Karl Nielsen and the Benbola, Aarhus University, Peter Greenkjaer, Jørgen Grandfelt, Fiona McNie, Kerryn Wood & Rikke Frandsen.

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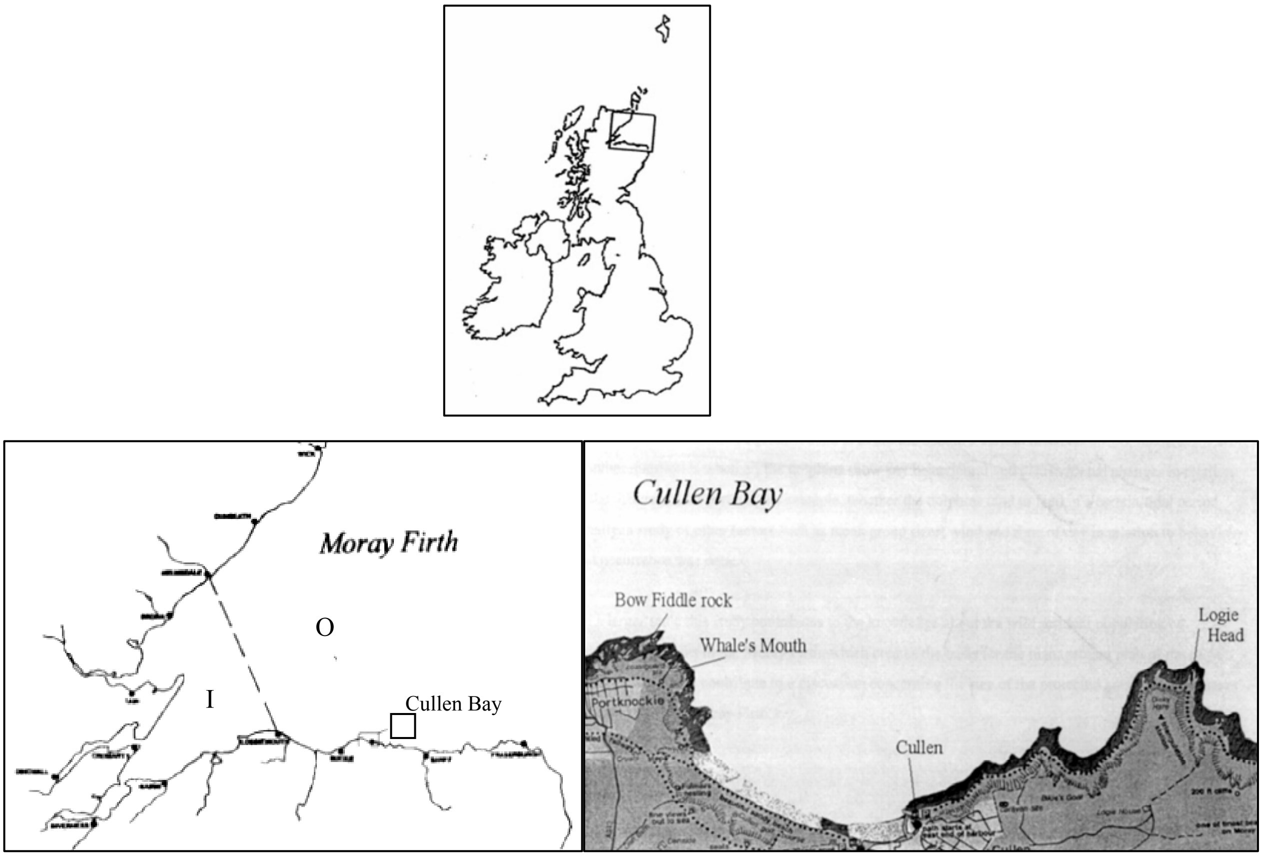

Fig. 1. Map of British Isles, Moray Firth (I = Inner part & O = Outer part) and Cullen Bay

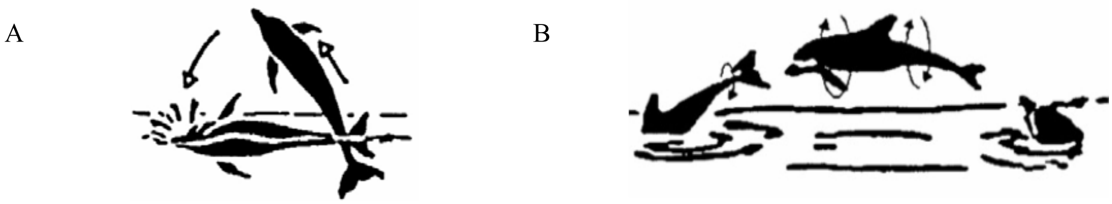

Fig. 2. A) Breaching & B) Porpoising The picture are borrowed and modified from Müller, 1998.

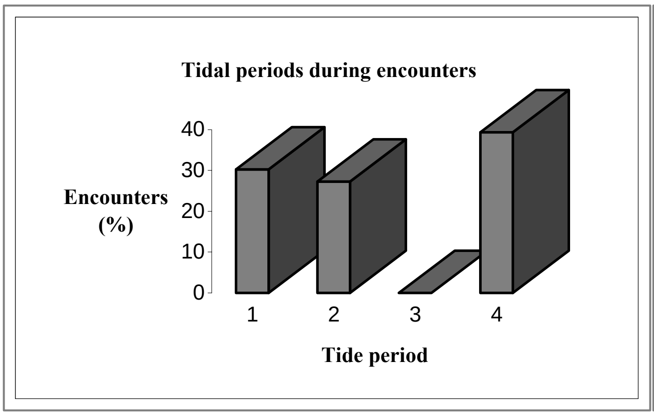

Fig. 3. The percentage of encounters observed in each tidal period (n = 26).

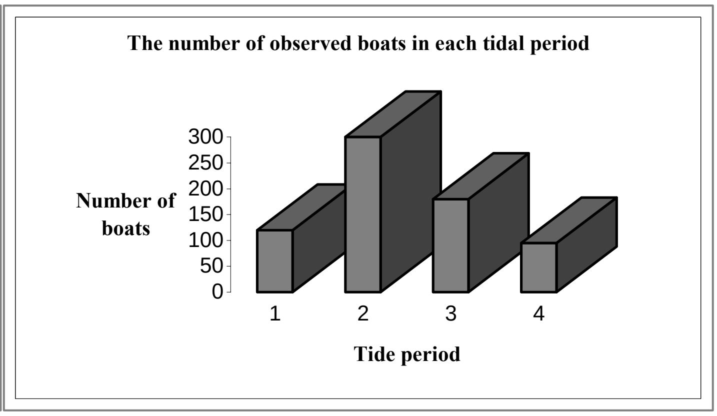

Fig. 4. Number of boats observed in each tidal period

BEHAVIOUR OF A SOLITARY COMMON DOLPHIN (*DELPHINUS DELPHIS*) IN NORTHERN FRANCE (STRAIT OF DOVER, ENGLISH CHANNEL)

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From June to October 2001, a solitary common dolphin (*Delphinus delphis*) has been resident in coastal waters near Calais (French side of the Strait of Dover), 2 miles away from the coast. It was a young female approximately 140 cm in length remaining close to a buoy (shipping repair). Observations of the animal were opportunistically conducted from small-motorized inflatable or sailing boat. Between July and October, daily sightings recorded from dedicated surveys or from "occasional observers" (fishermen, yachtsmen) permitted to investigate of the behaviour of the animal.

Three categories of behaviour were noted : 1) slow surfacing (considered as resting activity), 2) active behaviour and 3) boat interaction (only occurring around the buoy). The most frequently observed behaviour was the active one, characterised by many jumps around the buoy. We noted that the dolphin permanently rested around the buoy and did not move more than 40 – 50 meters far away. This case of a solitary common dolphin remaining within a small coastal area is relatively rare worldwide but very documented for bottlenose dolphin (*Tursiops truncatus*). The presence of this animal near this buoy could be interpreted as a missing social contact and 'resting around' might be a stereotypical behaviour.

MOTHER-INFANT SPATIAL RELATIONS IN FREE LIVING BELUGAS (*DELPHINAPTERUS LEUCAS*)

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The current study focused on reproductive gathering of belugas found off cape Beluzhii (Solovetzkii Island, White Sea) in 2001. We tried to determine the dependence of a calf on the mother and changes of such dependence with age. A criterion of dependence is the position of a calf relative to mother. Thus, 11 behavioral elements were outlined. We measured duration and frequency of occurrence of each behavioral element for each age group of calves. Three age groups of calves were identified based on combination of size and coloration: newly-born calves are brown in color and size of calf is 1/4 that of adult female, one month old calves are black and 1/3 of adult female, 1,5 month and older calves are dark gray and 1/2 of adult female. Newly born calf is following its mother everywhere. Its movements are not yet well coordinated and behavioral elements are short-termed. Movements, that require great efforts, are not recorded in newly born calves or are very short in duration (1-4 sec). Riding on the back or tail of a female, the behavior often found in older calves, is an example of such movements. With calves getting older, the proportion of behavioral elements, requiring maximum independence, is increasing. Such behavioral elements are the position of a calf "ahead", "behind" and "at a distance" from the female. It is established, that most biologically useful for all age groups of calves is the position "near the female's tail" (17 % for newly-born calves, 34 % for one month old calves and 22 % for two month old calves) and "near the side of a female" (newly born calves – 44,8 %, one month old calves – 24 %, two month old calves – 26 %). These positions, allow calves to overcome the drag in the water without significant efforts.

MANAGING OF SOLITARY AND SOCIABLE MALE DOLPHIN BEHAVIOUR OFF CHERBOURG IN NORMANDY, FRANCE, AND IN THE CHANNEL ISLANDS, UK

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INTRODUCTION **What do we mean by solitary and sociable dolphins?** The phenomenon of solitary dolphins being «sociable» by interacting with humans is today well known with about 70 solitary and sociable dolphins recorded world-wide. Nearly every year, some new wild solitary dolphins appear, allowing close contact with humans. (Fig.1.)

How do solitary and sociable dolphins behave during contact with humans? Solitary and sociable wild dolphins have many typical behaviour patterns in common:

- Closely following boats and approaching boat propellers within centimetres;
- Approaching when people make special noises (e.g. splashing on the water...);
- Investigating all kinds of objects (underwater cameras, masks, and torches…);
- Often allowing people to touch them;
- Swimming and diving with people, inviting swimmers to be drawn by the dorsal fin.

Do solitary and sociable dolphins perform «abnormal» behaviour? When solitary dolphins are observed closely interacting with humans, they «use», in particular, swimmers and divers as substitute for dolphin partners. Therefore, they try to interact with humans in a similar way as they do with conspecifics and just show «normal» dolphin behaviour but adapted to the special situation.

What are the dangers for wild sociable dolphins and for interacting humans? Nearly all known sociable dolphins have often been actively pursued and harassed by many people because no managing and protection of the animals has been assured.

Dangers for dolphins: to be harassed by boat drivers and swimmers, to get disturbed in the basic behaviour patterns as foraging and resting, to be injured or killed by people who are angry about the presence of the dolphin. (Fig.3.)

Dangers for humans: to be injured by the dolphin (biting, slapping with the tail), to be drawn out to the open sea and into dangerous currents with consequential risk to life, male dolphins often become aggressive and endanger swimmers because of dominant and sexual behaviour. (Fig.4.)

The case of Georges-Randy, the first solitary and sociable dolphin in normandy
History Georges-Randy is an adult male bottlenose dolphin (*Tursiops truncatus*), measuring 2.70 metres in length. He is sexually mature. Since the end of October 2001 until today, he has been observed several times on the French coast of Cotentin and in the Channel Islands (U.K.). Identification photographs have also confirmed that the same animal had been already observed on the coast of Vendée (Ile d'Yeu, Les Sables d'Olonne) during summer 2001 - data of the CRMM, La Rochelle. (Fig.5.)

Need of a highly performed survey network The movements and behaviour of Georges-Randy are followed up and the dolphin-human interactions are managed thanks to the highly performed survey network «Réseau Régional d'Observateurs de Mammifères Marins"(1) founded by the GECC / Normandy in 1997. Installations of military (e.g. "Semaphores de la Marine Nationale") and harbour authorities as well as fishermen and other sea users are actively participating at the dolphins survey and informing the GECC about all sightings they do. The Cetacean Section of La Société Guernesiaise and La Société Jersiaise survey the Channel Islands area.

Need of intelligent and very detailed information and education work In the case of Georges- Randy members of the survey network and media (newspaper, radio and television) are closely co-operating with the GECC and the Cetacean Section of La Société Guernesiaise (a similar study group in Guernsey, Channel Islands) to protect the dolphin from human harassment. To assure this protection, the most important task is to inform and educate people who encounter Georges-Randy about the rules to respect with this wild animal. (Fig.2.)

A few rules for interaction with Georges-Randy based on "Whale and Dolphin Conservation Society" Code of Conduct and "GECC Réseau Régional d'Observateurs de Mammifères Marins" recommendations

Marine mammals are protected by law: you are not allowed to disturb or pursue them:

- KEEP your distance. Never go closer than 100m (200m if another boat is present). Georges-Randy will come to you if he wants to.
- NEVER drive head on to the dolphin. If unsure of his movement, simply STOP and put the engine into NEUTRAL to prevent from any risk of accident.
- MAINTAIN a steady direction and NO WAKE speed. DO NOT steer erratically.
- PLEASE spend no longer than 15 minutes with the dolphin.
- NEVER try to touch or swim with the dolphin for your safety and his (you may be injured or contaminated, if he is carrying diseases).

ACKNOWLEDGEMENTS We gratefully acknowledge all the members of «réseau régional d'observateurs de mammifères marins de Normandie», the marine autorities and the fishermen for their collaboration. We also thank Keith Pyman and Nick Jouault of La Société Jersiaise, the Harbour Master, St. Peter Port Harbour, Guernsey, for their sightings and the CRMM, La Rochelle, for the data of "Georges-Randy" on the coast of Vendée.

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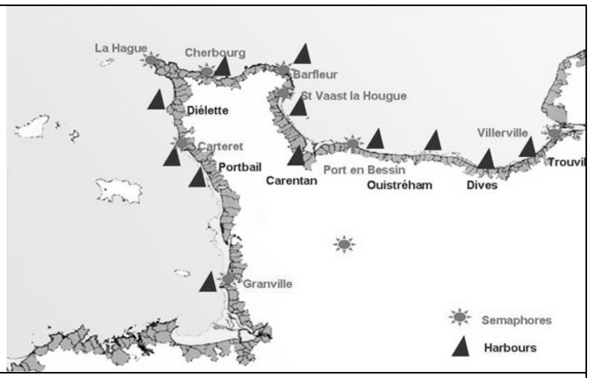

Fig. 1. "Georges-Randy" in Port-Chantereyne, Cherbourg (november 2001)

Fig. 2. Map of the GECC survey network

Fig. 3. "Georges-Randy" has been injured by a boat propeller.

Fig. 4. Sexual behaviour of "Georges-Randy".

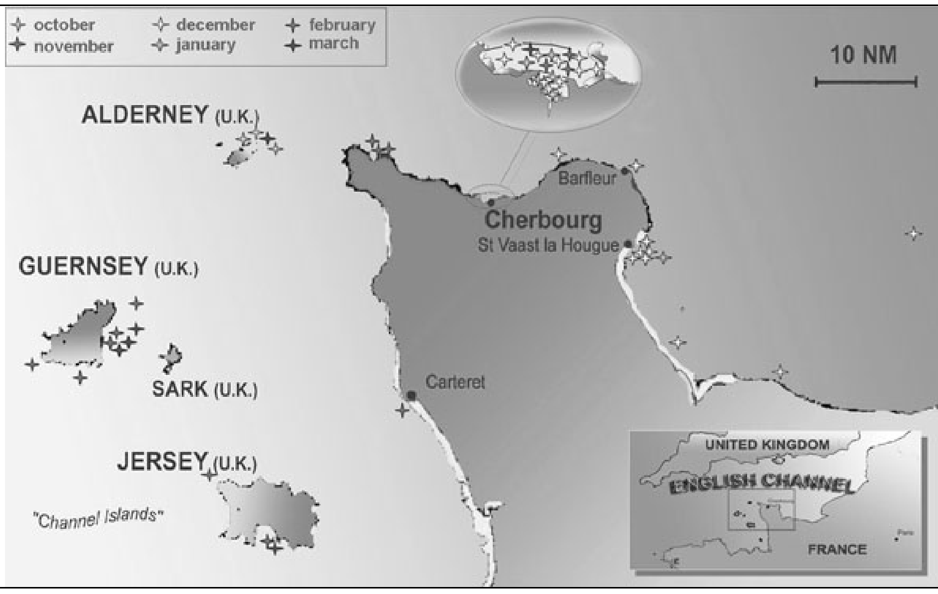

Fig. 5. Map of the geographic area used by "Georges-Randy" from 21th October, 2001 to 8th March, 2002 (n=50)

DIVING BEHAVIOUR OF MEDITERRANEAN FIN WHALES USING VELOCITY-TIME-DEPTH RECORDERS

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INTRODUCTION The fin whale is the most common mysticete inhabiting the Mediterranean Sea. During the summer, the population size has been estimated in 3500 individuals in the Western region (Forcada *et al*., 1996) and approximately 900 of these whales concentrate in the Corso-Ligurian-Provençal Basin (Forcada *et al*., 1995) which has been recently declared International Sanctuary for Marine Mammals. Many authors (among the others Forcada *et al*., 1995, Relini *et al*., 1992) agree that this area is probably the primary feeding ground of the Mediterranean fin whale.

This is due to the high productivity and the following massive presence of euphausiids, in particular *Meganyctiphanes norvegica* (Casanova, 1970), one of the main preys of the fin whale (Jonsgard, 1966).

Aim of this study was to describe the underwater activity of fin whales in this area by means of Velocity-Time-Depth Recorders.

MATERIALS AND METHODS Research cruises have been conducted during summers 1998 and 1999 aboard a 18m long sailing vessel. The study area was encompassed between the Western Ligurian coast and the North-Western Corsican coast.

During the study period seven fin whales have been tagged with Mk6 model V-TDRs (Wildlife Computers, Redmond, WA) that have been applied to the whales with a suction cup.

The V-TDRs used had a depth range of 0-500 m and of 0-750 m; their depth sensor accuracy was of 1% of the reading ± 2m and ± 3m, respectively.

The TDR collected environmental data, such as water temperature, light level, and data related to the whales'activity, such as velocity and depth of dives; they were sampled at 2s intervals.

The TDR was equipped with a VHF radio (Advanced Telemetry Systems, Isanti, MN); both the instruments have been fixed into an epoxy resin tag which weighed 375 g and measured 20 cm in length. The research vessel has been equipped with a VHF receiver and a directional antenna.

The tags have been applied to the fin whales by means of a 6 m long aluminium pole or by a modified spear-gun.

RESULTS 82 samples have been collected from 1998 to 1999, for a total of 13 hours and 28 minutes of diving activity. The maximum depth reached during each dive (dive depths) ranged between 54-474 m (mean 64.18, sd=94.22, N=82). Differences in mean rates of descent and ascent (1.18 m/s, sd = 0.58 and 0.87 m/s, sd = 0.384, respectively) among dives were significant ($p<0.01$). This indicated that fin whales swim faster at the beginning of the dive and decelerate when returning to the surface. Moreover the lower variability shown by the ascent with respect to descent rate (lower s.d.) suggests the existence of physiological constraints. Such s.d. value seems quite conservative also considering the subset of the supposed "foraging" dives (the dives to depths greater than 100 m). These dives were the 16.86% of the total sample and their descent/ascent mean rates were respectively of 2.21 and 1.44 m/s and s.d.=1.62 and 0.92. The tagged animals spent the 6.66% of their time performing these foraging dives and the 26.52% swimming on the surface. The speeds observed at the detachment of the instrument were always high (mean 3.74 m/s and sd=1.75) apart from one sample (speed observed=1.00 m/s).

CONCLUSIONS The diving activity of the Mediterranean fin whales has been related to the daylight vertical distribution of *M. norvegica* (Panigada *et al.,* 1999).

In a recent study conducted in the same area during summer season (Ricciardi *et al*., in press), a preliminary time budget, based on fin whale respiratory and surface behaviour, has been defined: 21% milling-rest, 6% travel, 41% dive-travel, 32% dive. The two last categories were associated to a foraging/feeding activity suggesting that these cetaceans during daylight spend lot of their time foraging. On the contrary, from the TDR data, the animals only spent 6.66% of their time foraging but this could be related to the fact that the TDR data are not balanced as a single sample provided the 62.5% of the total time.

The data presented here appear consistent with those reported for other deep diving cetacean species (*Hyperoodon ampullatus* and *Delphinapterus leucas*) (Hooker and Baird, 1999), suggesting that this lower ascent speed might serve a physiological function, reducing the rate at which gas bubbles appear in the blood or tissues. In fact the effects of pressure on diving mammals are most dangerous during ascent, when the decrease in pressure may cause either decompression sickness, or a reduced concentration of oxygen in the arteries resulting in a decrease in the amount of oxygen reaching the brain (Kooyman, 1988; Kooyman and Ponganis, 1997).

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FINBACK WHALE *BALAENOPTERA PHYSALUS*MATING: PRE AND POST COPULATION BEHAVIOUR, MAYBE (HE CHASES HER UNTIL SHE CAUGHT HIM, PROBABLY)

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I used an Olympus C-2100 Ultra Zoom digital for this Photo investigation of *Balaenoptera physalus*, Finback Whales. They were recorded in shallow, 30 meter water, an area used, off and on, by Fins June through mid-September. The pair of interest, first recorded August 1, with the male in the lead, were then in a mode common here August through September, described, elsewhere, as a diagnostic characteristic for Sei Whales, i.e. low with blow holes and dorsal fin out of water. September 2nd 2001, there were 5 whales in a 4 or 5 kilometre area, just off shore, two sets of pairs and one loner, all relatively small, i.e. under 20 metres. The pair of interest, had been several Kilometres off shore, before swapping positions with the inshore pair. Then began a chase. One whale remained low in the water doing a typical blow, often cutting a hard right or left, the other coming high out, cutting hard after it, occasionally not even blowing while up. The sequence ended with the male, the chaser, coming out high, but very slow. The female came in front low and at right angles to the male, turned toward the male. The male cut right and from the position of his tail, be seen to roll left. The female completed an S turn ventral surface up, parallel to and on his right as she rolled bringing her left side up, based on the angle of her tail. Her tail slid diagonally and down into the water with them ventral surface to ventral surface. Following this, the female continued her low blows, the male continued coming high out, beak somewhere near her dorsal fin, head canted 10 or 15 degrees, eye on her tail, maybe protecting his biological investment. She made no move to loose him.

BEHAVIOURS OF STRIPED DOLPHIN WITH ATTACHED SUCKERFISH IN THE GULF OF CATANIA, IONIAN SEA

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Groups of striped dolphins, *Stenella coeruleoalba*, are always sighted in the Gulf of Catania during the summer period. During the last few years, several sightings of striped dolphins with attached suckerfish or with sucker disc spots on their bodies have been made in the study area. Exceptionally, the 6th of June 2000 an individual has been photographed with two suckerfishes attached contemporaneously. The animals with attached suckerfish have been showed unusual behaviours and have been always observed far from the group. They travelled rapidly changing continuously their direction and often they performed fast surfacing and diving leaping as if they would tried to get ride of the suckerfish. More of one sucker disc spot has been photographed on the same dolphin and it is due to the changes of the suckerfish position on its body. Videotapes and photographs have been taken and accurately analysed to understand the observed behaviours and to try to identify the suckerfish species, which is probably the whale sucker (Remilegia australis), the reported host cetacean’s species.

BEHAVIOURAL PATTERNS AND GROUP SIZE OF DUSKY DOLPHINS (*LAGENORHYNCHUS OBSCURUS*) IN GOLFO NUEVO, ARGENTINA

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Activities of dusky dolphins (*Lagenorhynchus obscurus*) were observed in Golfo Nuevo, Península Valdés, Argentina between November 22, 1999 and March 16, 2000. Excursions were carried out using a tourist vessel (boat length: 11 m). During each dolphin sighting (n total=166 sightings), I recorded time, surface water temperature, position, swimming speed, group size and behaviour (incident- and focal group sampling) of the dolphins. The main activity of the dusky dolphins between 9:00 and 19:00 hs (total observation time: 45.9 hs) was socializing (31%), followed by feeding (22%) and social travel (20%). Other recorded behaviours were traveling (7%), resting (6%), feed travel (3%) and mixed behaviour (11%). Dusky dolphins rested mostly in the mornings. Pure socializing was proportional highest in the noon, decreasing during afternoon, whereas traveling, feed- and social travel increased to a maximum between 15:00 and 17:00 hs. This observation indicates a greater mobility of the dolphins in the afternoon, which is possibly caused by searching for prey. After 17:00 hs feeding behaviour increased considerably. Mean speed during all activities (except resting) was 2.47 m/s (SD=2.0; n=29). Group size of dusky dolphins varied between 4 and more than 100 animals. A large proportion (34% of n total=111 groups) of the groups consisted of 4 to 10 dolphins, suggesting that the smallest social unit of dusky dolphins represents a group of that size. However, 81% of feeding groups (n total=39 feeding groups) were greater than 10 dolphins, with the groupsize of 21 to 50 dolphins being most frequent (46%). Group sizes were highly related to activities (Kruskal-Wallis, $p<0.001$).

CONSERVATION/MANAGEMENT

LAUNCHING OF AN ENVIRONMENTAL TISSUE BANK FOR MEDITERRANEAN MARINE MAMMALS

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INTRODUCTION In the past, population reduction in marine mammals was mainly caused by kills, either deliberate or incidental. While this threat is still a source of concern, in the last few decades chemical pollution and genetic deterioration have been identified as main threats to many populations. Not only can they reduce or even eliminate populations, but they also decrease the capacity of the diminishing populations to recover their original abundance.

The availability of comprehensive, well-preserved tissue sample collections is of paramount importance to develop the baseline knowledge necessary for the management of marine mammal populations and also for the regulation of human activities, such as exploitation, incidental culls or environmental release of pollutants, which pose a threat to populations or species. In the Mediterranean Sea, an enclosed water mass whose coastline is densely populated and where, as a consequence, several marine mammal populations are heavily affected by urbanization, intensive fishing, tourism, and the chemical discharges produced by agriculture and industry, this need is particularly compelling.

Aim of the bank. The aim of the *Tissue Bank for Mediterranean Marine Mammal Tissues* is to provide researchers with geographically- and temporally-comprehensive collections of samples that may be used as a cost-effective diagnostic tool for the management of populations. Although these samples may eventually be of use for other types of research, the sampling priorities and conditions in which tissues will be preserved will be those appropriate for genetic studies and for the determination of pollutant levels and their biomarkers. If appropriate, the Bank may later extend to other regions. At present, there is no such bank in the region; indeed, comparable banks are extremely scarce worldwide and almost always restricted to the national level. Once in operation, the Bank has the potential to become a keystone for conservation-oriented research and, in this way, assist national and international organizations in the development of sound management policies for marine mammal populations and their habitats.

Operation The Bank was formally created at the end of 2001, and is expected to be operative by the end of 2002. It is to be located at facilities of the University of Barcelona and the Department of the Environment of the Catalonian Government. The collections will be managed under the guidance of an international committee. The sample collection will focus as a priority on species that are either at risk of extinction or have suffered severe reductions in abundance in the Mediterranean: Mediterranean monk seals, bottlenose dolphins, striped dolphins, and common dolphins. Tissues from other marine mammal species will also be collected and stored whenever possible.

Collaboration of research groups working in the region will be sought to obtain duplicates of existing collections, but specially designed fieldwork will be undertaken to ensure comprehensive geographical and taxonomic coverage. Samples will be obtained either from stranded cetaceans, from bycatches in fishing operations, or by means of biopsies collected from free-ranging cetaceans

Applications of the bank for pollutant analysis:

- To examine geographical patterns of variation in pollutant loads.
- To identify marine mammal populations in which tissue pollutant levels exceed those considered as safe.
- To undertake studies on pollutant cause-effect relationships by comparing populations of the same species subject to a gradient of pollutant exposure, as recommended by the IWC *Pollution 2000+* program.
- To monitor the temporal evolution of the pollutant load. This will permit researchers to assess future trends and successes of pollution control policies.
- To identify pollution "hot spots" where research and conservation efforts should focus and where anti-pollution efforts should concentrate as a priority.
- To alert agencies to the appearance of novel or previously unnoticed compounds in the region.
- To allow reanalysis of historical samples when new analytical techniques are developed.

Applications of the bank for genetic studies:

- To determine population identity, genetic isolation, and patterns of geographical variation.
- To assess the degree of fragmentation of currently declining populations.
- To identify populations in which loss of genetic diversity is severe.
- To examine temporal evolution of genetic profiles in populations.
- To investigate taxonomic relationships.
- To study reproductive behavior and paternity patterns.

- To allow reanalysis of historical samples when new analytical techniques are developed.
- To make available raw material to develop tools for both genetic research and assisted reproduction.

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CONSERVATION MEDICINE AND EMERGING DISEASES IN MARINE MAMMALS: A TRANSDISCIPLINARY APPROACH

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Conservation medicine is an emerging, transdisciplinary scientific field devoted to understanding the interactions among: (1) human-induced and natural changes in climate and habitat structure; (2) emergence of pathogens, parasites, and pollutants; (3) biodiversity and health within animal communities; and (4) health of humans. Conservation medicine has both basic and applied elements, and many endeavours in this field combine aspects of both. Simply stated, Conservation medicine is the practice of ecological health and is especially relevant in today's human-modified landscapes, including the marine environment where habitat destruction and degradation and episodes of emerging human and wildlife diseases are increasing. This discipline combines the pursuit of basic issues such as how destruction and alteration of natural habitats such as coral reefs influence community diversity and population size of marine species, with the pursuit of practical issues such as determining how Brucella or morbillivirus emerged in marine ecosystems or were transmitted among terrestrial and marine wildlife. Conservation medicine embraces participation by practitioners of ecology (terrestrial and marine), organismal, cellular, and molecular biology, veterinary medicine, and human medicine. In addition, perspectives from the social and political sciences are fundamental in understanding the underlying causes of human-induced changes in climate, habitat, and the use of coastal and marine ecosystems. Although Conservation medicine is a scientific discipline, it may provide the basis for political positions on the conservation and management of species or ecosystems. The hope is that once armed with the appropriate knowledge, public policymakers and marine biologists will proactively devise and implement epidemiological strategies to better ensure ecological health of the oceans. With these thoughts in mind, I will present the approach of Wildlife Trust to address the emergence of disease in marine mammals including threatened marine species such as La Plata dolphins, Hawaiian monk and manatees.

THE CREATION OF A TISSUE BANK FROM CETACEANS STRANDED IN THE MEDITERRANEAN SEA AND ADJACENT WATERS

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Exchange of tissues from stranded animals has become a paramount objective in cetacean research: samples from different species collected in the same or adjacent marine areas allow research in a variety of fields including anatomy, neurochemistry, toxicology and genetics. To overcame difficulties due to the causality of the stranding event, we decided to create a tissue bank with samples from cetaceans stranded along the Mediterranean coasts, and to distribute them to whoever works in the field. Samples from foreign researchers are also welcome. Tissues, sampled from volunteers belonging to the Italian Centro Studi Cetacei, have been fixed or frozen on the spot and sent to the bank sited in the Department of Experimental Veterinary Sciences of the University of Padua. Here, samples have been trimmed, classified and processed for histology or stored frozen. Tissues already stored belong to the following 5 species: *Delphinus delphis*, *Stenella coeruleoalba*, *Tursiops truncatus*, *Grampus griseus*, *Ziphius cavirostris*. The bank works at no charges (apart from postal fees) and offers sections of organs and tissues to whoever will write specifically for that purpose. In addition, an histopathological diagnostic service is available on request in co-operation with the anatomical pathology section of the Faculty. Interested parties could contact us on-line: http://digilander.iol.it/cetaceantissuebank and specify the nature of their research. At present, collection frozen tissue is limited due to storage space in the bank. Same tissues (as brain and spinal cord) are restricted to motivated researchers. A database will allow researcher a quick check of what (and how much) is available at any given moment. The creation of a tissue bank is a key action in the National Action Plan for cetaceans prepared by I.C.R.A.M. for the Italian Ministry of the Environment.

COMPARISON OF THE ABUNDANCE AND DISTRIBUTION OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) AND BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN CARDIGAN BAY, UK

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Fatal interactions between bottlenose dolphins and harbour porpoises have been reported from both the Moray Firth and Cardigan Bay. A better understanding of the comparative ecology of these species may contribute towards our understanding of this phenomenon. Sightings of both species were recorded during a line-transect survey of the Cardigan Bay Special Area of Conservation (SAC) between May and September 2001. In addition, photo-identification data were collected for bottlenose dolphins. Harbour porpoise sightings were distributed throughout the SAC, whereas bottlenose dolphins were seen only in the inshore half. At no time were both species seen together. When a sighting of one species was made, the next sighting was three times more likely to be of the same species, than of the other. The density and abundance of each species were estimated using program DISTANCE, both for the entire SAC and for offshore and inshore sub-strata. When the periods May-July and August-September were compared, there was an increase in abundance of dolphins from 128 (95% CI: 67 – 245) to 152 (95% CI: 80 – 287), and of porpoises from 62 (95% CI: 29 - 133) to 152 (95% CI: 78 - 297), in the inshore stratum. Analysis of photo-identification data using program CAPTURE suggested a population of 112 dolphins (95% CI: 82 – 186) for the period May-July, with an influx of further individuals during August-September, raising the population to an estimated 213 (95% CI: 183 – 279). There was evidence to suggest this influx may have been associated with the exploitation of seasonally available coastal prey, particularly sea trout, Salmo trutta, and herring, Clupea harengus. These findings predict that interactions between the two coastal cetacean species are more likely in the period August–September than May-July, and may be associated with competition for prey.

WILDLIFE TOURISTS IN THE MORAY FIRTH, SCOTLAND-DO DOLPHINS CHANGE LIVES?

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This ongoing project aims to assess the impact of wildlife tourism in the Moray Firth, focusing on bottlenose dolphins. The Moray Firth Wildlife Centre (MFWC), the Whale and Dolphin Conservation Society (WDCS) and Nottingham University are collaborating in this research. Questionnaires were distributed at MFWC and on the local dolphin watch boat and followed up one month later. Criteria assessed included: type of visitor, educational value, environmental attitudes/involvement and factors contributing to satisfaction e.g. seeing dolphins/ other wildlife, scenery, information available and naturalist guide. Local businesses were asked how important tourism was to their business and how important the dolphins were to the local tourist industry. Results: 90% of visitors did not think the government did enough for the environment, 60% did not think they themselves did. 79% on the boat answered educational questions correctly, compared to 55% at the MFWC. 75% on the boat and 53% at the MFWC showed further interest in conservation. In follow up questionnaires, 89.5% had told their friends, 75.8% said they had become more interested in environmental issues, 59.7% sought further information and 65.3% had either become more actively involved or joined/donated to environmental organisations. Both the MFWC and boat trips have great education potential and can encourage further involvement in conservation. At both sites the overall satisfaction was high. This included days with no dolphins. The most important factor to satisfaction was the responsibility of the boat operator around wildlife, followed by encountering dolphins and the presence of a naturalist guide. Seeing other wildlife and pleasant scenery were also important. The majority of local business people cited tourists as quite important to their businesses and the dolphins as important to the tourism industry generally. There was an overall consensus that more publicity on the dolphins and the Moray Firth area was needed.

LOCAL CONFLICT WITH BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) REPERCUSSIONS ON ARTISANAL FISHERIES OF THE BALEARIC ISLANDS

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The interaction between bottlenose dolphin and artesanal fishery activity is known for ages in the Balearic Islands. Nevertheless, fishers complaints received by Fishing Authorities (Direcció General de Pesca) became more frequent since 1990. Independently of problems as by-catch or direct attacks on dolphins that has been already documented in literature, their parasitic role implicates, since an exploitation point of view, a direct economical lose by predated fish and an indirect lose by damaging fishing gears and diminishing their efficiency. The first stage to solve the conflict is the evaluation of its nature, extension and economy lose. This is the basic objective of the project initiated in October 2000. Its main goal is to evaluate the real interaction by means of continue control of fishery boats. All participating boats had an independent observer on board for the duration of the study. These observers collected information about location of net sets and catches. Back in the harbour, observers counted and marked each new hole and/or other damage on randomly selected 250 meters of net. The red mullet (*Mullus surmulletus*) and the cuttlefish (*Sepia officinalis*) fisheries survey was the principal activity in this first year of the project because these fisheries were identified as the most problematic ones in a preliminary study. At the moment 305 fishing operation have been surveyed (433.150 meters of net). Only 26 (near 8%) attacks were registered. This percentage is very low but its intensity and temporally concentration produced locally severe damage on the artesanal fisheries.

DEPREDATION BY BOTTLENOSE DOLPHINS ON SOLE CAUGHT IN TRAMMEL NETS: REPORT OF AN ONGOING CONFLICT IN NORTHERN ADRIATIC SEA, ITALY

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INTRODUCTION The damaging of the fishing gears and the removal of the fish from the nets caused by marine mammals is a world-wide phenomenon and it involves various types of fishery, both with fixed nets and with trawl nets (Corkeron *et al.*, 1990; Silvani *et al.*, 1992; Broadhurst, 1998). In Italy, as well as in many countries of the Mediterranean, the phenomenon has been reported from some time (Marini *et al.*, 1995; 1995; Tringali *et al.*, in press). In the northern Adriatic Sea, the small number of dolphins has for a long time kept the scientists away from investigating the problem in the area. However, in the last few years, thanks to various reports from Italian, Croatian and Slovenian fishermen, even the northern Adriatic Sea has started to draw the attention of the researchers (Casale, 2001; Casale *et al.*, 2001). In particular, the Italian fishermen's co-operatives, present in the Gulf of Venice, have induced to an investigative action on the phenomenon of the interaction existing between artisanal sole (*Solea vulgaris*) fishery and *Tursiops truncatus*, a cetacean which is almost exclusive in this area (Bearzi *et al.*, 2000). Artisanal sole fishery takes place by trammel nets between the end of September and January exploiting the natural concentration of this kind of fish in the Gulf of Venice during the autumn-winter period, since it comes here to spawn (Piccinetti and Giovanardi, 1984). The inner netting panel mesh size is 38-45 mm; nets on the average 2 nm long are lowered at sea and are composed by the assembling of more net pieces each of around 25 m long and 80-110 cm high. The nets extend from the sea bottom in all their height, staying in place from 13 to 24 hours. Sole represents an average of around 70% in weight of the total catches made by trammel nets. The annual earnings of fishermen who carry out this activity are greatly concentrated in this period, because the cost of soles on the market is on average higher than other fishing products (wholesale price: 9.3-20.1 €/kg). Except from sole fishery, in Caorle none of the artisanal fishery are interested in interaction with dolphins.

MATERIALS AND METHODS A two years survey was carried out in the soles fishery period (Oct. '00–Jan. '01 and Oct. '01–Jan. '02). The port of Caorle was chosen for this purpose, since small artisanal fishery is practised by nearly 40% of the local fishing fleet. The aim of the survey was to get information about the quantity of sole caught by trammel nets in the absence/presence of clear damages on the fishing gear caused by the feeding behaviour of bottlenose dolphins. The data come from different fishing boats and were collected both by the fishermen themselves at the end of each fishing session (who filled in specific forms) and by a researcher who went aboard together with the fishermen. Mann-Whitney's test has been used for statistical considerations. In this study we also tried to estimate the economical damage (ED) suffered by fishermen due to dolphins, a damage which was intended as: (*i*) soles removed from the nets; (*b*) soles frightened away from nets by dolphins feeding in the area. To this end we used the mathematical model of Lauriano *et al.* (in press).

RESULTS The results regard the separated observations for two different years (2000-'01 and 2001-'02). In the first year the data were collected from 4 fishing boats, in the second one from 2. The Mann-Whitney's test has highlighted how there is no statistic difference between the quantity of sole caught (kg/km) reported by the boats with just fishermen aboard and the boat with the researcher aboard, in absence (YEAR 1st: U= 19; z= 1.31; p>0.05 - YEAR 2nd: U= 29; z= 1.33; p>0.05) and in presence (YEAR 1st: U= 126; z= 1.01; p>0.05 - YEAR 2nd: U= 47; z= 0.15; p>0.05) of damages caused by dolphin. In accordance with the above analogy, and with the fact that the fishermen used the same kind of nets, the same area and the same fishing period, the data on the sole caught have been treated homogeneously for each year.

Differences between the quantities of catch. The fishing-days carried out by boats during each year are similar; nevertheless the percentage of interaction frequency with dolphins (days presence of damages / total fishing-days) is different (YEAR 1st =52% - YEAR 2nd =37%) (Figure 2). During the survey, the total amount of soles caught by trammel nets are increased about 180 kg, but in presence of damages on the gears always there are the lowest catches (YEAR 1st =27 % - YEAR 2nd =19 %) (Figure 3). As reported in Figure 4 and in Tables 1-2, the averages of catches (kg/km) made by trammels show a net difference for each year between the presence and the absence of damages. At last, the Mann-Whitney's test highlights how highly significant is the difference between the quantity of sole caught during the two different events: *kg/k*m presence vs kg/kmabsence (YEAR 1st) U =65.5, z =5.35 (p <0.001); (YEAR 2nd) U =135, z =4.02 (p <0.001).

Assessment of economical damages. A research similar to ours has been made by Lauriano *et al.* (in press) in Sardinia (Italy). The mathematical model they used has the aim of quantifying the economical damage (ED) due to the loss of *Mullus surmuletus* (striped red mullet) from trammel nets by bottlenose dolphins. On the basis of the analogy of the phenomenon, we have adopted the same model as follows:

ED = L * l * F * days * P

		YEAR 1ST	YEAR 2ND
L = fish average loss (*kg/km* absence - *kg/km* presence)	=	8.82	8.16
l = average net length used daily by fishermen (*km*)	=	3.76	3.62
F = interaction frequency (*days* presence of damages / *total fishing-days*)	=	0.52	0.37
days = real fishing days made by trammel nets each year	=	35	41
P = fish commercial average price (*€/kg*)	=	14.70	14.70

ED (YEAR 1^{st}) = 8,872.48 € (YEAR 2^{nd}) = 6,587.21 €

Predation techniques and typology of damage. During the day the soles stay hidden at the sandy bottom of the sea; at night these fishes increase their movements searching for the prey. Therefore it happens during the night that the nets make their biggest catches and the dolphins swim near the fishing gears to feed on the entangled soles. The gear damaged by dolphins usually presents a long ripped piece of net (Figures 5-6-7) with at the end a little entanglement of the net itself, the remaining of the small sack formed by the sole when entangled in the net. Sometimes you can even see mutilated soles, usually without the head. The fishermen rarely repair the holes, but, awaiting for the time when they will change the entire piece (a segment of 25 m), they only tie to the float line (rope on which numbers of floats are mounted to keep the gear vertically spread) the piece of net ripped at the end of each fishing session. This operation allows therefore to distinguish a "freshly" rip from an older one. The rips to the nets are not caused at all by rocky bottom, because sole fishing is carried out exclusively on flat sea bottoms with fine deposits. The dolphins which interacts with the nets have never got entangled.

CONCLUSIONS The observation carried out after this first survey allows us to justify the complaints forwarded by the fishermen. The statistical analysis carried out on the quantity of sole caught by trammel nets, in the absence/presence of damages, highlights a difference in catches. The ED calculation has estimated for each fishermen a not negligible yearly loss by removal (or frighten away) of the soles from the nets. To this sum, we should add the cost of the damages on the gears during the entire fishing season. The cost of a segment of 25 m completely rigged is around 34 €. Therefore, for a net 2 nm long (average lenght), the cost of entire gear replacement (every 1-2 years) at present is over 5000 €. It should be born in mind that it exists a "missed catch cost", caused by a choice of less optimal areas, in order not to incur in the presence of dolphins. Indeed, the "optimal areas" for sole fishery are situated especially offshore the Istrian coasts of Croatia. Here one can find the "big breeders" (size > 25 cm; age ≥ 3-4 years), on "dirty" or residual sandy bottoms, while the young specimen (mean size: 16 cm; age: 0+, 1+) can be found in particular on the sandy or silty bottoms of the Italian coast (Giovanardi, 1983). The Italian fishermen try therefore to set out their nets at the border of the Croatian territorial waters (15-20 nm from the Port of Caorle) to catch the breeding specimen of big size. Nevertheless, when the predation by dolphins on the gear is higher, it happens that the Italian fishermen have to fish nearer to their own coasts, where soles with non favourable commercial sizes are present; in such a way they reduce their travels and thus their consume of fuel, partly balancing the lower profit due to the no exploitation of more favourable fishing areas. However, bottlenose dolphins seem to be very mobile, interacting also with the nets set out few miles off the Italian coasts. When this occurs, the fishermen can decide not to fish at all.

Ecological and behavioural considerations. In the northern Adriatic Sea, the interaction between artisanal fishery and dolphins existed also in the past, but the entity of the phenomenon is quite unknown (Anonymous, 1901 cited by Ballarin *et al.*, 1989). According to the information given by the fishermen, during the eighties it seems that dolphins were rarely present on fishing gears. An increasing of interference with fishery started again by the middle of the nineties. It seems that interacting with the fishing activity is for bottlenose dolphin a real adaptation of his feeding behaviour. Indeed, a better result of the predatory activity can lead dolphins to increment opportunistic behaviours, in this way it would be possible for them to feed, reducing energy consumption usually spent searching for preys dispersed in the sea. Also, the concentration of soles in the Gulf of Venice in the autumn-winter period can mean the chance for dolphins to build up fat stores, useful to compensate the energy losses caused to the lower water temperatures in this part of the year (Shane, 1990*b*). However, one must underline how the northern Adriatic Sea presents highest fishing pressures in Italy (Ardizzone, 1994), caused especially by trawl systems. This is certainly a reason of alteration for the ecosystems (Williams, 1998) and an impoverishment of the fish fauna. In the last twenty years in the Adriatic Sea there has been a general decrease of the demersal and small pelagic stocks due to the combination of antropogenic, climatic and ecological reasons (Bombace, 1992). The increase of the phenomenon of interaction between fishery and small cetaceans of the latest years can be put into relation with the decrease of the Adriatic Sea fish stocks, and also interpreted as an ecological index which highlights the state of over-exploitation of the marine environment. A possible conclusion is that a natural feeding strategy carried out by dolphins, who have access to resources also through the interaction with the fishing activities, is amplified as the answer to a general impoverishment of the fish stocks, thus exasperating the competition with the most vulnerable fishery (artisanal fishery). The danger that can derive is that the deterioration of the situation could also transform itself into a open hostility towards the cetaceans.

The limits of this research. The problems researched in Caorle require deeper studies, which will verify in time the constancy of the phenomenon and will quantify over few years the amount of fish losses and the damages to the fishing gears. Moreover, the preliminary feature of this research does not allow us, for example, to explain the absence of interaction with other types of fishing by fixed nets or to have a complete vision of the phenomenon of interaction between fishery and dolphins considering also the trawl nets.

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Tables 1-2 - Descriptive statistics for sole caught by trammel.

Damages on the gears	YEAR 1ST N obs.	Mean (kg/km)	Median (kg/km)	Min. (kg/km)	Max. (kg/km)	St. dev.	St. err.
ABSENCE	27	**13.49**	13.50	3.76	31.26	6.44	1.24
PRESENCE	29	**4.67**	4.32	1.03	12.70	2.85	0.53

Damages on the gears	YEAR 2ND N obs.	Mean (kg/km)	Median (kg/km)	Min. (kg/km)	Max. (kg/km)	St. dev.	St. err.
ABSENCE	36	**12.87**	9.83	1.54	44.47	10.29	1.72
PRESENCE	21	**4.71**	3.37	0.43	15.88	4.14	0.90

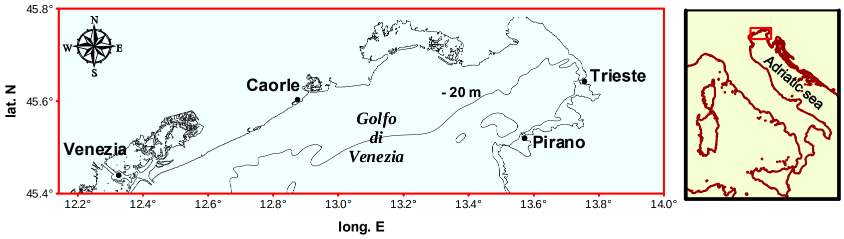

Fig. 1. Map of study area.

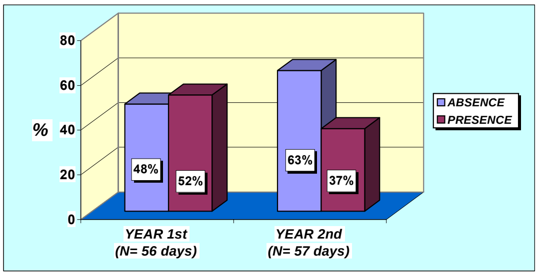

Fig. 2. % of fishing-days in absence/presence of damages.

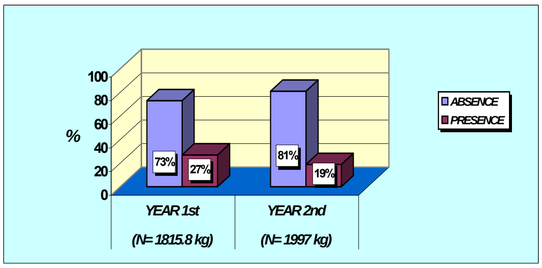

Fig. 3. % of the catches of *S. vulgaris* (kg) in absence/presence of damages.

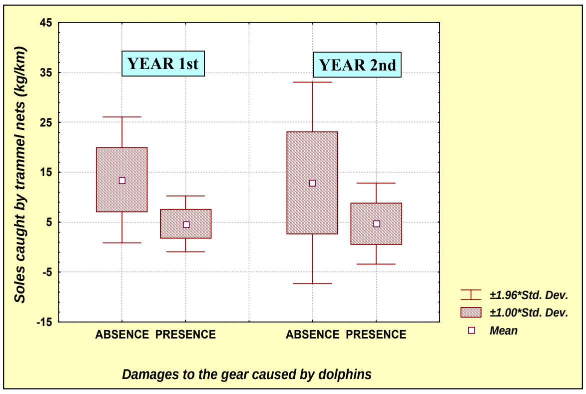

Fig. 4. Average quantity of sole caught in absence and in presence of damages.

Figs. 5-7 Gears damaged by dolphins.

CONSERVATION ISSUES CONCERNING BOTTLENOSE DOLPHINS IN AN ESTUARINE ENVIRONMENT

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The resident bottlenose dolphins (*Tursiops truncatus*) in the Sado estuary and adjacent coastal waters (Portugal) face increasing competition and disturbance from humans using their habitat. A number of studies have focussed on the use of this habitat by the dolphins, their preferential areas for the different activities, their sound production and the noise levels in the estuary, and the major conservation problems these animals face. This presentation summarizes our present knowledge concerning the importance of the different geographical areas, identifies some environmental threats we consider relevant (e.g. industrial and agricultural contaminants, increasing boat traffic) and discusses our current views and efforts on the necessary and viable conservation measures.

SHORT-TERM RESPONSES AND POTENTIAL IMPACT OF TOURISM ACTIVITIES ON DUSKY DOLPHINS, IN GOLFO NUEVO, ARGENTINA

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Dusky dolphins became a target for tourism activities off Patagonian coast, Argentina. Several low-scale studies have been conducted during the last year in order to assess natural patterns in occurrence and behaviour and to evaluate short-term responses of dusky dolphins to boats. First, we analysed which is the main activity in which dolphins are engaged when approached, second in which circumstances dolphins do change or not their behaviour, and at last, how much time they need to resume the initial conditions. Ship-based surveys were done in summer-fall, 2001, through random transects by a research boat and by tourism trips. When a group of dolphins was detected, the predominant activity was assigned before the boat approached the dolphins, at 200mts or more, and it was reassigned when the research boat was at 100mts and the commercial boat was at 50mts or less. Group size and composition were recorded at this moment and the activity was recorded for each 2min interval thereafter. Among seventy-four groups, the main activity before the commercial vessel approached was feeding, followed by travelling and socialising, while feeding, travelling and resting were the main categories from the research vessel. Feeding decreased and travelling decreased after the approach. Feeding is the most affected activity (c2=14.44; $p<0.0007$) and there were no differences between boats (c2=0.07; $p>0.05$). Mother with calves seemed to be more susceptible. Time spent feeding decreased during the first 48min of the encounter (c2=8.55; $p<0.03$). By observing dolphins from the research boat, feeding decreased and travelling increased while the commercial boat was close to the dolphins. Once the commercial boat abandoned dolphins, travelling decreased and feeding slightly increased, although differences were not significant. The time that the boat stays with the dolphins as well as the effect of the boat on the aggregation of dolphins may preclude longer feeding bouts.

STUDYING BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) ABUNDANCE, DISTRIBUTION, HABITAT USE AND HOME RANGE SIZE IN CARDIGAN BAY: IMPLICATIONS FOR SAC MANAGEMENT

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A Special Area of Conservation (SAC) was recently established in West Wales to protect what is believed to be a resident population of bottlenose dolphins. Thirty days of systematic boat surveys sampled the SAC and environs between May and October. Two independent abundance estimates were obtained, one with DISTANCE sampling from line transects (135 individuals, 95% CI: 85-214), and the other using "mark-recapture" by photo-ID, and measuring the size of the population using the SAC during the study (215 individuals, 95% CI: 179-290). Bottlenose dolphins were concentrated in the coastal sector with particular sites favoured. GIS was used to compare dolphin distributions with five environmental parameters (substrate type, bathymetry – depth and gradient, water temperature, and chlorophyll 'a'), derived from remote sensing or by direct sampling. Abundance was greatest close to the entrance to the main river catchment in the region (river Teifi), and declined with distance away from here, although the decline appeared to be affected by the local flow of tidal streams. Range analysis of individual animals shows that part of the population spends at least some time outside the SAC whilst the offshore zone of the SAC is relatively unimportant. This suggests that conservation of the species might be better served with different boundaries to those which presently exist. Proposals are outlined for zoning human activities such as recreation within and adjacent to the SAC, and a degree of flexibility for this highly mobile species is recommended for its long term management in the region.

INTERACTIONS BETWEEN CETACEANS AND FISHING ACTIVITIES IN THE BALEARIC ISLANDS

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INTRODUCTION Interactions between the bottlenose dolphin (*Tursiops truncatus*) and artisanal fisheries in the Balearic Islands have occurred for decades (Silvani *et al.*, 1992). Dolphins visit trammel nets to obtain food, and this behaviour produces damage to the gear and net entanglements that may eventually result in the dolphin's death. The reaction of fishermen to gear damage is on many occasions the deliberate aggression to dolphins. During the years 2000 and 2001 we conducted a study on these interactions to determine current extent of interactions and associated dolphin mortality.

MATERIALS AND METHODS Study area (Fig. 1). To determine the extent of the dolphin interactions, we interviewed 289 fishermen from the three islands, 80% of whom work in artisanal fishery, 7% in bottom trawlers, 12% in long liners, and 1% in purse seiners. Data collected included:

- Type of fishing craft.
- Fisherman's perception about the population of bottlenose dolphins: Abundance and frequency of observation.
- Incidental catches of dolphin and entanglement.
- Damage caused by dolphins: Type, frequency and economic cost.
- Methods used to prevent such interaction.

RESULTS **Interactions with fishing gear.** The gear most abundantly employed on the three islands are trammel nets: the 83mm net mesh size is used for fishing lobster *(Palinurus elephas)*, the 50mm for capturing cuttlefish *(Sepia officinalis)*, and the 25mm for fishing red mullet *(Mullus surmuletus).* 66% of the fishermen interviewed claim to suffer net damages due to interactions with dolphins (Figure 2). Of these, 59% state that these damages occur on a daily to weekly basis.

The fishing nets which the fishermen claim to suffer the largest damages are the ones most frequently used: 92.37% (of total interaction) in trammel nets for red mullet and 72.35% in trammel nets for cuttlefish. 100% of interaction observed in purse seine is based only in 10 interviews, this fact has to be taken into account in order to consider final results (Fig 3).

The most frequent damages deriving from the interaction with dolphins are:
- Damages caused to the nets (28%)
- Damages caused to the catch (51%): consumed by the dolphins (27%) or spoiled by the dolphins (24%).

When we requested fishermen to quantify the economic loss caused by dolphins, the answers varied according to the island. (Figure 4).

- In Majorca, 55% of those interviewed estimate at least 1200 EUR, and 22% of them estimate the losses to be above 3000 EUR per year.

- In Minorca, the majority (40% of all responses) estimate between 1200 and 3000 EUR per annum.

- In Ibiza, 73% of the fishermen interviewed did not answer the question, so no robust estimates could be derived from the interviews.

The losses fishermen suffer due to the dolphins lead to the adoption of two types of dissuasive measures: i) methods that affect the fishing activity, such as varying the setting time, the zone, or the way how nets are deployed, and ii) methods that affect the dolphin, such as the use of a variety of harassing systems, i. e. homemade fireworks or poisons, spreading of fuel on the sea water, or other aggressive actions, including shooting to the dolphins.

Only 106 fishermen (38.4% of the total) responded when asked which dissuasive method they employed. Of these, 10.4% admitted using dissuasive methods that affect the dolphins, i.e., direct aggressions toward them. This aggressive attitude seems to be especially acute in Majorca, where 25% of fishermen who responded the interview admitted to employ such methods. In Minorca, 81.52% responded the question, and all admitted using dissuasive methods that affect the gear. In Ibiza, slightly more of the half of those interviewed (57.4%) denied that they used any methods against the dolphins. Only 4 admitted the practice of measures that affect the net, and the rest appears not to do anything to solve the conflict, in spite of the high incidence of complaints.

Dolphin incidental catches. The 289 interviews reported a total of 13 dolphins incidentally caught in the last year (11 in trammel nets and 2 in trawling nets). It is unknown which fraction of the actual toll these reported cases represent.

CONCLUSIONS Although the number of dolphin deaths caused by fishing interactions and their impact on the population could not be reliably established, given the critical situation of the species in the western Mediterranean and the fact that the Balearic population is most likely the largest of the Spanish Mediterranean, such interactions are considered to be a sensible conservation issue for the species. Further research is needed to deepen into this conflict. It is also necesary to intensify the awareness campaigns among the conflictive fishing collectives, especially in Majorca, where it seems that the level of deliberate aggressions is higher.

ACKNOWLEDGEMENTS Thanks are due to the fishermen of the Balearic Islands for their collaboration in this study. Carles Carreras and Vicente Sempere participated in the fieldwork. This study was funded by the Spanish Ministry of the Environment, the Autonomous Government of the Balearic Islands and EU-LIFE project NAT/E/7303.

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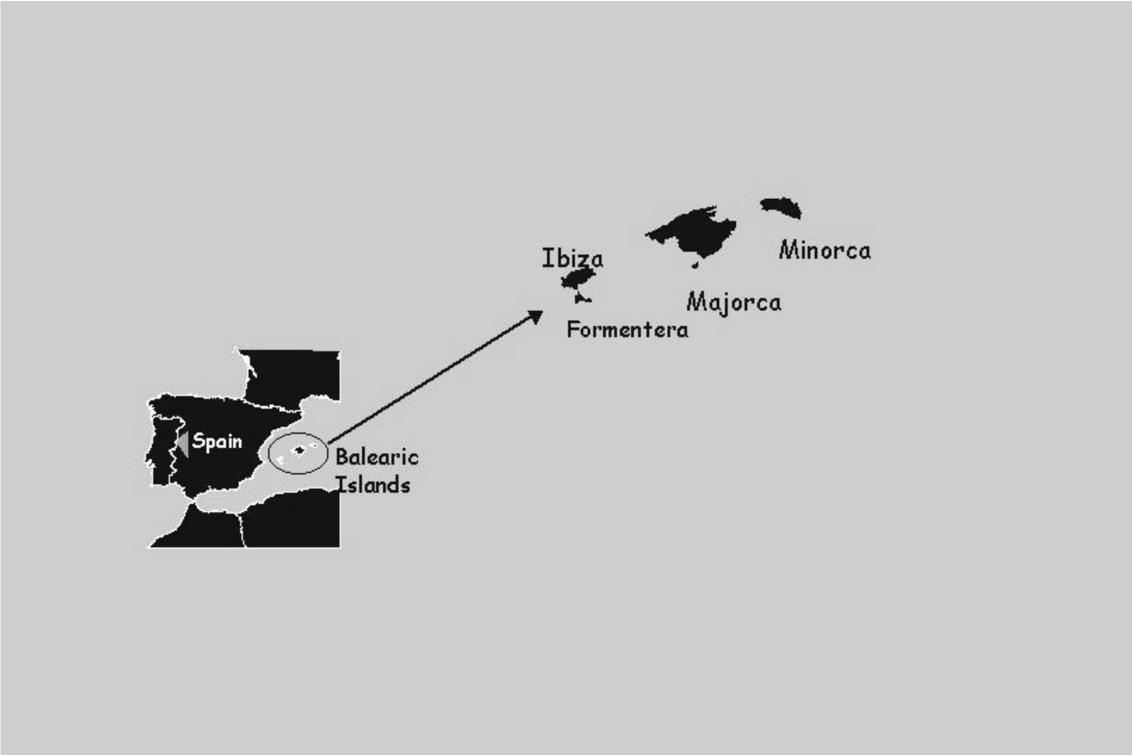

Fig. 1. Study area

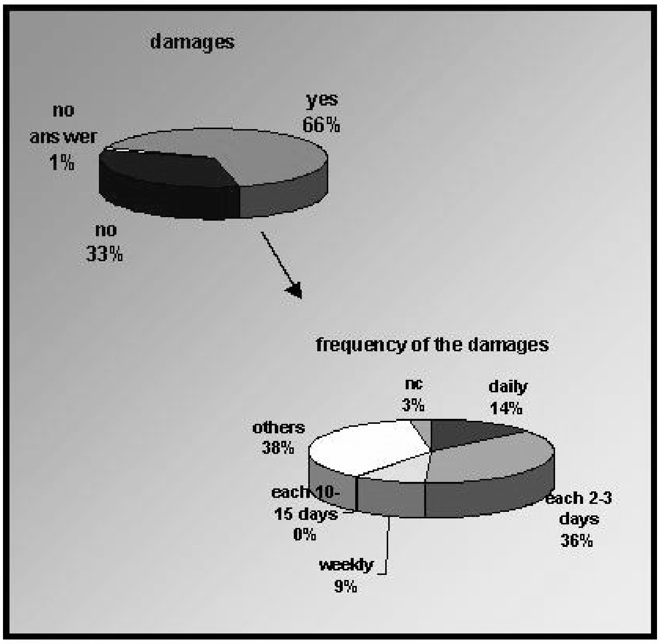

Fig. 2. Frequency of net damages due to interactions with dolphins.

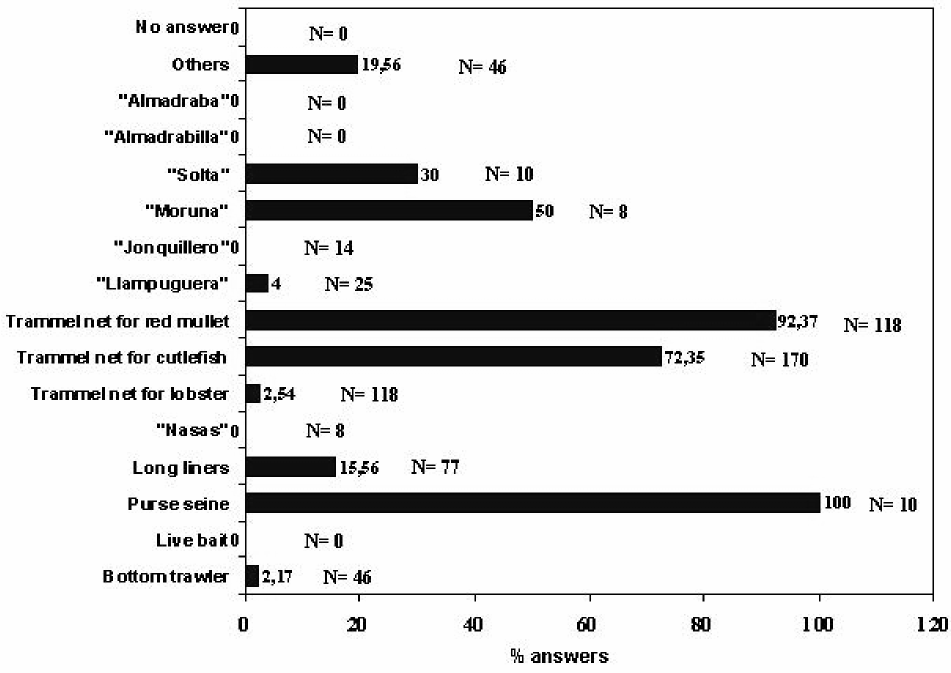

Fig. 3. Degree of interaction, expressed as % of positive answers, for each fishing gear.

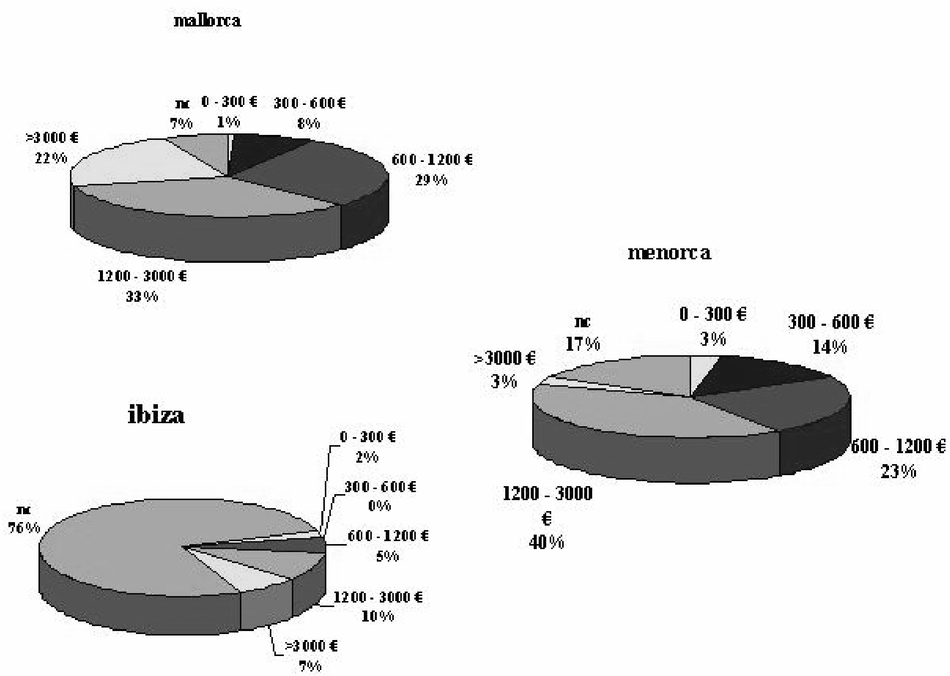

Fig. 4. Economic loss caused by dolphin interaction

THE COST OF A VIABLE ENDANGERED SEAL

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The cost of reproduction for a marine mammal female can be divided into the energy requirements for gestation and for lactation. Research on eutherians indicates that the cost of producing a fetus is insignificant relative to the costs associated with lactation. In agreement, marine mammals have adaptive strategies to minimize lactation costs. Each strategy entails different fitness consequences depending on the mass, age and survival of pups at weaning. We provide quantitative evidence that explicitly links pup survival, lactation duration and future reproductive costs in the Mediterranean monk seal in the western Sahara. Pup survival from birth to weaning determines the duration of lactation and a long lactation implies reduced female survival and breeding propensity. These limitations, never quantified in an endangered mammal, have critical consequences for the conservation of highly reduced populations. A dynamic stochastic model indicates that the expected monk seal natality rates that maximize fitness are higher on average than those observed. Thus, optimal recruitment rates for recovery of this population are affected by a reduced allocation in reproduction to increase future female survival.

IDENTIFICATION OF AREAS OF SPECIAL INTEREST FOR CETACEAN CONSERVATION IN THE WATERS OF EAST SPAIN BY AERIAL SURVEYS

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INTRODUCTION More than 6 cetacean species occur in the western Mediterranean waters, and most of them have apparently suffered a severe regression over the last decades. Particularly, the bottlenose dolphin (*Tursiops truncatus*) is classified as "priority species" by the so-called Habitats Directive of the European Union. However, scarce information exits about abundance and distribution of these species in the western Mediterranean. Such information is essential to implement the international policies of the Habitat Directive, the Barcelona Convention and ACCOBAMS agreement as well as the National Biodiversity Strategy. For this reason, the Spanish Ministry of the Environment initiated in 2000 a 3 year research programme for the identification of special interest areas for cetacean conservation in the Spanish Mediterranean waters. This programme involves various Spanish research teams. In particular, the University of Valencia covers the waters of the Spanish Mediterranean regions of Valencia and Murcia (Fig.1.). This has been carried out by seasonal line transect aerial surveys during 2000 and 2001. This method is the most adequate to survey certain animals over extensive areas, such as cetaceans, since aerial sampling can cover homogeneously large areas in short time allowing the distribution and abundance to be measured at precise points in time (Bayliss, 1986). Aerial surveys have been proved successful for these objectives in other areas (Hain *et al*., 1992; Kenney & Winn, 1986; Shoop & Kenney, 1992; Hammond *et al*., 1995).

The present study summaries the results of aerial surveys performed by the University of Valencia team in the past two years. Based on the cetacean sightings, we propose preliminary areas for the conservation of these species; areas that will be sited and sized with precision after the completion of the surveys in 2002, and the integration of additional biological and socio-economical information of the region.

MATERIALS AND METHODS Nineteen aerial surveys were performed in coastal waters, from Delta de Ebro (40º41'N- 0º53'E) to Aguilas (Murcia, 37º22'N- 1º38'W) from June 2000 to October 2001. Date and effort of each flight are given in Table 1. The study area comprised a strip of between 16.8 to 56 nautical miles (nm) in width from the coastline (an overall area 6,886 nm^2). We used a push-pull aircraft (CESSNA-337) for the surveys, flying at an airspeed of 85-90 knots and at an altitude of 150m. Flat windows limited the observation vertically down the aircraft. Surveys were undertaken following the transect line methodology (Buckland *et al*., 2001). Line transects were designed in a zig-zag pattern. The standard crew consisted of the pilot and a recorder with two observers positioned behind them on each side of the plane. The following data were reported: species, number of animals, location (obtained from a GPS) and environmental conditions, including Beaufort sea state, sun glare, percent cloud cover and visibility. Data on human activity, marine debris aggregations and pollution were also collected. Surveys were flown only with Beaufort sea state lower than 3 to reduce visibility bias.

Quantification of the abundance of cetaceans on the whole area is based on the number of sightings and individuals per navigated nm (relative density).

In order to determine the areas for conservation we partitioned the study area into blocks of 20 minutes of latitude by 20 minutes of longitude. To decide which blocks are the most interesting for conservation we considered 2 parameters: (1)Relative density: we calculated a value for cetaceans per unit effort (CPUE), expressed as the number of individuals sighted per nm of trackline surveyed for each block (James, *et al*., 1992; Kenney & Winn, 1986; Kenney & Shoop, 1991). In order to visualise the results, CPUE values were divided in 4 categories; CPUE = 0, 0<CPUE<0.1, 0.1≤CPUE<1 and CPUE≥1.

(2) Diversity: we calculated two diversity indices, the number of species (S) and the Shannon Index (H) for each block (Begon *et al*., 1996). The Shannon Index was calculated as: $H= -\sum Pi\ 1n\ Pi$. Where Pi is the proportion of the i^{th} species (number of individual of the i^{th} species/total number of individuals). In order to visualise this parameter, the H values were divided in to 3 categories; $0 \leq H< 0.3$, $0.3 \leq H < 0.6$, $H \geq 0.6$. Furthermore, we also bore in mind the presence or absence of bottlenose dolphin because this species is the most threatened according to the Habitats Directive.

RESULTS Six surveys, 2 of them uncompleted, have been performed in 19 flights, with a total of 5,157.8 nm navigated. A total of 97 sightings (2, 456 individuals) of 6 cetacean species have been recorded (Table 1). Mean relative density (± SD) of cetaceans based on 4 complete surveys of the whole area was 0.0175 ± 0.0097 sightings/navigated nm, and 0.4 ± 0.282 individuals/navigated nm. From most to less frequent, the species observed were: striped dolphin

(*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*) common dolphin (*Delphinus delphis*), Risso's dolphin (*Grampus griseus*), fin whale (*Balenoptera physalus*), and long-finned pilot whale (*Globicephala melas*) (Table 1.)

Figure 1 shows the values of CPUE of each block. The highest values of relative density correspond to the quadrats F9, L5, G9, E8, I8, L2, and F8.

Figure 2 shows the values of the Shannon diversity index (H), the number of species (in brackets) and the presence of bottlenose dolphin (*). The quadrats with the highest values of H were J6, K5 and L3, and the quadrats with the highest number of species were E8 and J6. Bottlenose dolphin is present in the Castellon Province waters (around Columbretes Islands) and in front of Cabo de Palos (Murcia).

DISCUSSION This is the first time in which the distribution and density patterns of cetaceans have been studied in the waters of Valencia and Murcia region. Our results show that cetaceans are present throughout the study area all over the year, with the stripped dolphin being the most abundant and widespread species. Furthermore, other 5 species occur in the study area indicating that this is a high diversity area for cetaceans needed to be conserved. In addition, this diversity is higher because other species, such as sperm whale (*Physter catodon*) and false killer whale (*pseudorca crassidens*) have been detected stranded or in opportunist sightings (unpublished data, University of Valencia). We may suppose that the quadrats F9, L5, G9, E8, I8, L2, and F8 in Figure 2 are very interesting for cetacean conservation, due to the high density values observed. However, these quadrats, do not coincide with those of a high diversity in figure 3 because in the quadrats with higher CPUE values, most of the sightings correspond to large groups of only one species (stripped dolphin). In fact, this species is the most abundant in the area (85% of the individuals observed were stripped dolphin).

Analysing Figures 1 and 2 together, we propose 3 areas of special value, namely, the western part pf the Columbretes Island marine reserve (around D7), an area situated in from of Cabo de Palos (around K5), and the south-western waters of Murcia (around L3). Furthermore, we suggest to pay attention on the area at the north of the Ibiza channel (around F9) because of the permanent presence of cetaceans there, although most of them belong to the same species (stripped dolphin). These areas are preliminary. Aerial surveys will continue until winter of 2002, and will allow to obtain precise estimations of cetacean abundance, as well as the identification of areas to be protected with more precision.

ACKNOWLEDGEMENTS This study was performed within the project: "Programa de Identificatión de las Áreas de Especial Interés para la Conservatión de los Cetáceos en al Mediterráneo Español", funded by the Environment Spanish Ministry.

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Table 1. Cetacean species observed on effort in the flights carried out in the study area in 2000 and 2001. The table includes date, length, number of sightings and number of individuals of each flight.

Date	Survey effort	Sc		Tt		Dd		Gg		Gm		Bp		Und		Total	
	(in nm)	N° S	N° I	N° S	N° I	N° S	N° I	N° S	N° I	N° S	N° I	N° S	N° I	N° S	N° I	N° S	N° I
02/06/2000	175	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3	3
13/06/2000	183.5	-	-	1	3	3	77	-	-	-	-	1	1	1	1	6	82
18/07/2000	313	-	-	1	3	-	-	-	-	-	-	-	-	-	-	1	3
19/07/2000	175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20/07/2000	368.5	17	688	-	-	-	-	1	1	-	-	-	-	4	16	22	705
07/09/2000	307.5	1	130	-	-	1	75	1	4	-	-	-	-			3	209
22/02/2001	200	2	402	3	73	-	-	-	-	-	-	-	-	1	5	6	480
03/05/2001	284.5	1	33	-	-	-	-	-	-	-	-	1	2	-	-	2	35
04/05/2001	200	1	10	-	-	-	-	-	-	1	4	1	2	-	-	3	16
23/05/2001	356.5	3	141	-	-	-	-	-	-	-	-	-	-	-	-	3	141
24/05/2001	333	1	9	1	20	-	-	1	7	-	-	-	-	-	-	4	36
26/07/2001	280	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2
25/07/2001	200	-	-	1	15	-	-	-	-	-	-	-	-	-	-	1	15
27/07/2001	325	2	75	-	-	-	-	-	-	-	-	-	-	1	1	3	76
28/07/2001	295.5	3	79	-	-	1	6	-	-	-	-	-	-	1	10	5	90
23/10/2001	223.5	2	100	1	7			-	-	-	-	-	-	-	-	3	107
24/10/2001	256.5	6	17	1	30	-	-	-	-	-	-	-	-	-	-	7	47
27/10/2001	246	14	213	-	-	-	-	1	2	-	-	1	2	1	1	17	218
28/10/2001	255.8	4	156	-	-	-	-	1	12	-	-	-	-	1	3	6	171
28/10/2001	179	1	20	-	-	-	-	-	-	-	-	-	-	-	-	1	20
Total	**5157.8**	**58**	**2073**	**13**	**156**	**5**	**158**	**5**	**26**	**1**	**4**	**4**	**7**	**10**	**37**	**97**	**2456**

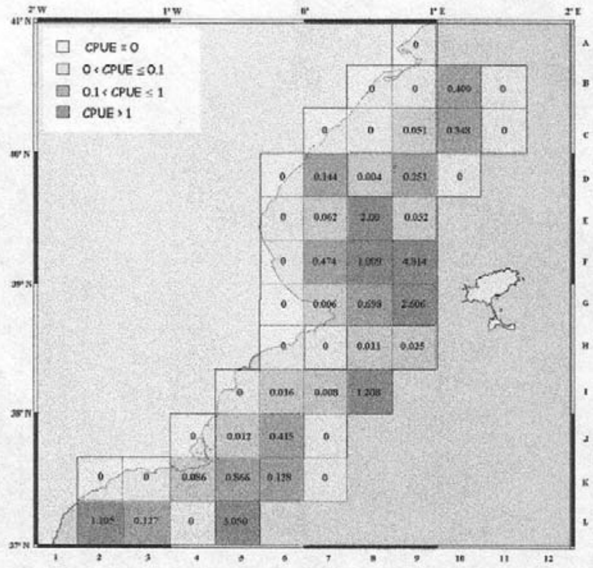

Fig. 1. Overall pattern of cetacean relative density (CPUE) in20-minute quadrats from aerial surveys.

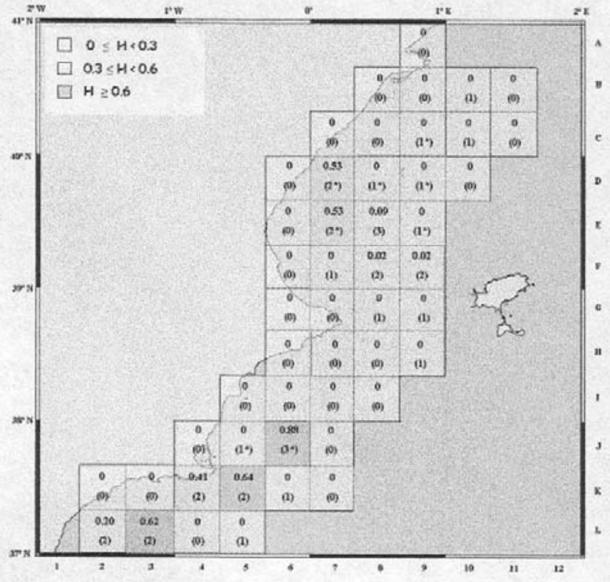

Fig. 2. Diversity of cetacean species in the blocks forming the study area. Up numbers: Shannon diversity index, ( ): number of species, (*): Presence of *Tursiops truncatus.*

INCREASING NUMBERS OF HARBOUR PORPOISES IN BELGIUM BETWEEN 1990 AND 2001

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The harbour porpoise in Belgian waters. The harbour porpoise (*Phocoena phocoena*) is not common in Belgian waters. Anecdotal evidence suggests that it was more common in the first half of the 20th century than it is today. In Belgium, De Smet (1974, 1981) collected a large number of historical stranding data of cetaceans. However, stranding records were only systematically gathered from the late 1970ies by Van Gompel (1991, 1996), while the Royal Belgian Institute of Natural Sciences (RBINS) coordinated technical interventions and collected specimens. From the late 1980ies data were collected by Van Gompel, the RBINS and the Management Unit of the North Sea Mathematical Models (MUMM). Whereas strandings data prior to the 1980ies can be considered incomplete, today most strandings are recorded.

Possible reasons for the decline of the harbour porpoise during the second half of the 20th century in Belgian waters, and in at least part of the southern North Sea, are overfishing, bycatch, pollution, disturbance, and environmental factors.

Increased number of strandings and sightings. Data from 1990 to 2001 indicate an increase in the number of strandings since 1998. From 1990 to 1997, 3 to 6 strandings were reported each year, while 8 strandings were reported in 1998 and 2000, 18 in 1999 and 21 in 2001. Strandings were most common in November and especially from February to July (figure 1). The majority of porpoises were immature. During the last years some new-born and stillborn calves stranded. In 2001 the first pregnant female reported in Belgium washed ashore. Addink and Smeenk (1999) also reported a small proportional increase in stranded neonates and calves in the Netherlands.

Necropsies performed on the stranded porpoises made it clear that most of the animals had been in a poor health condition. The most common findings were lung problems, parasite infestation and emaciation. Approximately 20 % of the animals showed evidence of bycatch in fishing gear.

From 1997 onwards, also sightings have increased in Belgian waters (MUMM data, unpublished). Numbers of harbour porpoises seem to have increased recently in Dutch coastal waters, as reported by Camphuysen and Leopold (1993), Camphuysen (1994) and Witte *et al* (1998).

DISCUSSION Porpoises are present in Belgian waters at least from December until July. However, the number of animals probably remains relatively low compared to the first half of the 20th century. The recently increased number of porpoise strandings may partially be the result of a better reporting, but certainly numbers have (seasonally) increased in the southern North Sea. This could be due to a growing population size and/or a dispersion of part of the population towards the southern North Sea, possibly caused by altered food availability or by changing environmental conditions. However, more research is needed, and the data should be compared with other data from the North Sea. Next to gathering stranding data, there is a need for research on the actual abundance of porpoises throughout the year.

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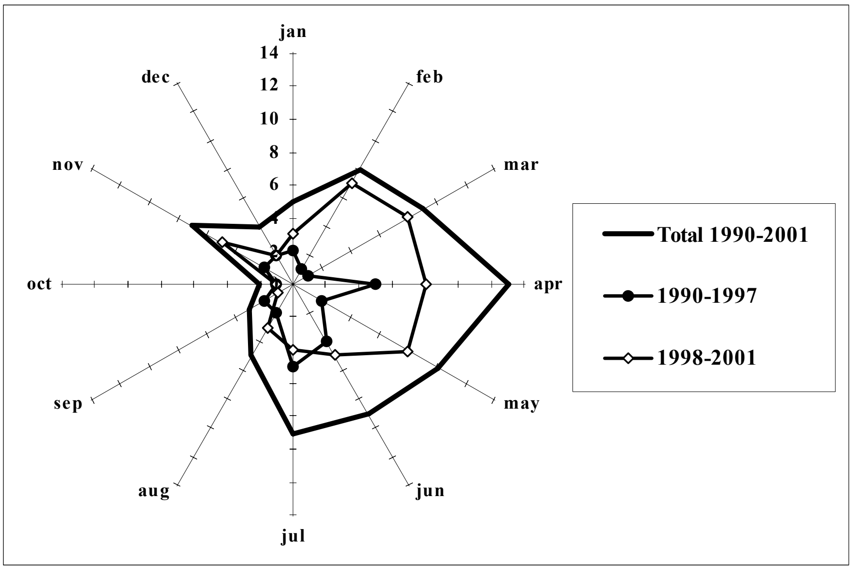

Fig. 1. Number of stranded harbour porpoises per month (1990-2001)

RECENT RANGE EXPANSION IN NORTH SEA BOTTLENOSE DOLPHINS: EVIDENCE AND MANAGEMENT IMPLICATIONS

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Management of European marine species has increasingly focused on the protection of key sites. One pioneering venture for bottlenose dolphins is the designation of the candidate Special Area of Conservation (cSAC) in the Moray Firth, Scotland and an associated management scheme. The cSAC boundary encompasses the population's core range based on data collected in the 1980s and early 1990s. However, anecdotal sightings outside the cSAC have increased in recent years. Here we examine photo-identification and strandings data from 1990 to 2000 to determine whether this trend reflects elevated public awareness or a real change in the dolphins' distribution, and discuss the implications for management. Photo-identification studies carried out in areas previously thought to be outside the population's range confirmed that all animals belonged to the same population. Of a set of well-marked animals first identified within the cSAC, 26% were only ever identified within the area whilst 74% ranged widely elsewhere. During the study, the wide-ranging animals became a progressively smaller fraction of the total identified each year within the cSAC. Bottlenose dolphins off Scotland attack and kill harbour porpoises. Unlike porpoises that died of other causes, carcasses from these interactions became significantly more frequent outside the cSAC during the late 1990s compared with previous years. These results indicate that the distribution of this coastal dolphin population expanded during the 1990s. In consequence, the cSAC will afford less protection than previously believed to the population as a whole, and the heterogeneous ranging behaviour means that individuals will receive differing levels of protection. We recommend that (a) monitoring and management not be restricted to within the cSAC alone, (b) priority be given to identifying the factors that drive dolphin distribution to better inform the placement of management boundaries and help prioritise conservation efforts.

BOTTLENOSE DOLPHINS ON THE WEST COAST OF IRELAND: RESULTS OF PRELIMINARY EXTENSIVE PHOTO-IDENTIFICATION SURVEYS

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At present detailed knowledge of the ecology and distribution of bottlenose dolphins in Irish waters is limited to the Shannon estuary where dedicated survey effort by UCC has been ongoing since 1996. However, bottlenose dolphins using the Shannon are not fully resident within the estuary and it is likely that their ranging patterns extend to other coastal areas. Limited survey data and anecdotal reports suggested that a few specific locations on the west coast of Ireland are frequently visited by bottlenose dolphins. This study aimed to photograph and identify animals using these coastal areas and examine matches with a catalogue of dolphins known to use the Shannon estuary. The distribution of individually identified bottlenose dolphins on the west coast of Ireland was examined by conducting 12 boat-based surveys at four selected coastal areas. During these surveys six schools of bottlenose dolphins were encountered. School sizes ranged from 3 to 35 dolphins and a total of 80 individuals were identified using photographs of their natural markings. Resightings of identified individuals were made in subsequent surveys at one coastal site suggesting a degree of site fidelity in this location. Sightings of 8 dolphins previously identified in the Shannon were made in Brandon Bay, the nearest survey site to the Shannon estuary. However, all other animals encountered during this study were previously unidentified. A digitised catalogue of animals identified during this work was created and these images will be useful for matching photographs of bottlenose dolphins encountered around Irish coasts during future surveys. The results of this study identify potentially important habitat areas for bottlenose dolphins outside of the Shannon estuary and provide useful information regarding future potential conservation designations.

OBSERVATIONS OF DRIFTNETTING OFF THE ISLAND OF ISCHIA, ITALY, WITH INDIRECT EVIDENCE OF DOLPHIN BYCATCH

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INTRODUCTION Driftnets are known for their high bycatch rates affecting cetaceans and other marine species (Di Natale and Notarbartolo di Sciara, 1994; IWC, 1994; Silvani *et al.*, 1999). This peculiar fishing technique represents a great danger to the pelagic fauna of our sea, with an immediate and devastating impact. Its list of victims includs especially small Odontocetes and large whales such as sperm whale, as well as other marine animals from moon fish, mantas, sharks, sea turtles over to some species of seabird.

During the fishing season, from the island of Ponza to the island of Ischia (about 120 km), fishermen set two distinct barrages (exactly along the 1000 m and 700 m depth lines. Drift nets are set at 20:30 and retrieved at 03:00, placed one after another to create an unbreakable wall (Mussi *et al.*, 1998). Boats are co-ordinated by an efficient radio system that prevents any possible collision between them and assures best results.

METHODS Between 2000 and 2001 data on driftnet fisheries operating around the island of Ischia, Italy, were collected through direct observations. In the May-August fishing season, boats carrying driftnets were monitored in the harbour at distance by means of binoculars and video cameras, totalling 145 observation days.

RESULTS Forty different boats (mean length 14 m, range 10-20 m) operating driftnets remained consistently in the area to fish in the waters off Ischia. According to their registration plates, 26 boats were from Calabria and 12 from Sicily, while 2 exhibited no registration code.

Based on the volume of visible coils on the deck - a measuring means routinely used by fishermen and authorities - all boats carried driftnets exceeding by at least a factor of four the EU limit of 2.5 km/boat, and in some cases perhaps up to one order of magnitude greater.

Over seven observations a total of 282 swordfish (*Xiphias gladius*) weighing between 20-120 kg were landed, totalling 17,880 kg. The catch also included tuna (*Thunnus thynnus, Thunnus alalonga*) and moonfish (*Mola mola*).

Between 28 - 29 July 2001, three striped dolphins (*Stenella coeruleoalba*) were found stranded or adrift around Ischia with body mutilations and lesions indicative of bycatch in driftnets. One specimen had had its flukes and dorsal fin cut off, and had been tied with a rope around its pectoral fins and head.

DISCUSSION These observations suggest that cetacean bycatch in driftnets is still an issue in southern Italy, and that illegal driftnetting may still occur, irrespective of current driftnet length limits. The waters around Ischia represent an important feeding and breeding ground for several cetacean species, including the endangered short-beaked common dolphin (*Delphinus delphis*; Mussi *et al*. 2004).

Urgent management measures are clearly needed to monitor illegal fisheries and protect cetaceans as well as other species from bycatch.

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Fig. 1. A fishing boat carrying driftnets exceeding the EU limit

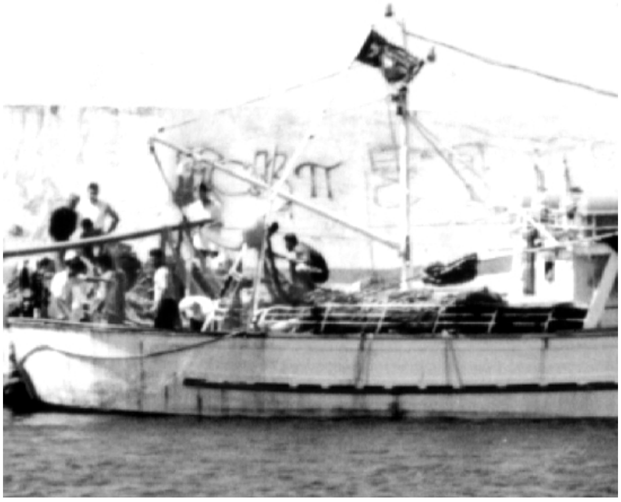

Fig. 2. Fishermen working on the net in the harbour

Fig. 4. A specimen of striped dolphin tied with a rope around its pectoral fins and head.

Fig. 5. Mutilation of the dorsal fin

Fig. 6 . A tail cut off

A MULTIDISCIPLINARY CONSERVATION APPROACH INVOLVING MARINE MAMMALS IN THE MARINE PROTECTED AREA OF CAPO CARBONARA (ITALY)

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INTRODUCTION Marine Protected Areas (MPAs) are designed with the scope of conserving marine biodiversity, maintaining productivity, and contributing to economic and social welfare (Tunesi L., 2001). The Marine Protected Area of Capo Carbonara is amongst one of the 16 italian MPAs to have been established to date in Italy. The MPA was established in 1999 and is situated in the southeastern coast of the island of Sardinia and houses a port with a 750 boat-holding capacity. The area represents an important site for a number of marine mammals such as the bottlenose dolphin (*Tursiops truncatus),* and the Risso's dolphin *(Grampus griseus),* while the adjacent waters are also inhabited by other Cetacean species like the sperm whale (*Physeter macrocephalus*), the striped dolphin (*Stenella coeruleoalba*), the pilot whale (*Globicephala melas*) and the fin whale (*Balaenoptera physalus*) (Arcangeli and Marini, 1999). Moreover the area was characterised by several Mediterranean monk seal (*Monachus monachus*) sightings occuring during the summer 2000. A conservation programme was undertaken in 2001 in the MPA of Capo Carbonara, as a cross-collaboration scheme between the Central Institute for Applied Marine Research (ICRAM) and the MPA's management body. The programme represents a multidisciplinary conservation approach involving research on protected species distribution and habitat, assessment of recreational boat traffic pressure, the capacity building of personnel involved in monitoring the MPA and public awareness activities.

MATERIALS AND METHODS **Bottlenose dolphin distribution and assessment.** Surveys were conducted from a 6-m rigid-hulled inflatable boat, following a pre-defined route and according to the weather conditions. Photo-identification methods were used in order to apply mark-recapture analysis. Surveys were conducted in weather conditions of Beaufort ≤ 4 but the analysis was carried out only on data collected in appropriate conditions (Beaufort 0, 1 or 2 and good visibility).

Monk seal monitoring and habitat assessment. Monitoring rounds at sea were incorporated into the normal patrolling activities of the MPA personnel and were planned in such a way as to enable the collection of sightings of the various mammal species. Patrolling occurred along stretches of rocky coast as well as areas with deeper waters (see Fig.1). The 6 units of personnel involved in monitoring the MPA conducted patrols on land and at sea for a total of 9 hours per day 7 days on 7 from May to September 2001, and 4 hours per day 6 days on 7 from October to December 2001. Patrols occurred during hour periods starting at 8 am until dusk. Given the difficulty to monitor sporadic sightings of monk seals moving along stretches of the Sardinian coast a fieldwork investigation was planned to assess monk seal habitat suitability in the MPA of Capo Carbonara and the adjacent coast stretching north until the town of Arbatax. The coast was investigated by snorkelling along the coast contour and inspecting all openings with snorkelling gear and with scuba gear. All crevices occurring at the surface level as well as underwater up to a 5-meter depth were inspected with free dives. Each possible haul-out site was measured, mapped, and drawn (i.e. entrance dimensions; shape, size and slope of beach; evaluation of exposure to sea conditions). Whenever possible photographs were taken of the internal beach area, the pool and passageway and of the external opening to the cave along the coast.

Assessment of recreational boat traffic pressure. The study of recreational boat traffic pressure was carried out during July and August 2001, within a broader research project regarding nautical activities in the MPA (Di Nora *et al.*, in press). In particular, the purpose for monitoring vessel spatial distribution was to identify the zones with the highest presence of boats. Data was collected through visual census from selected look-out points on land supplemented by observations carried out by MPA personnel carrying out normal patrolling routes at sea. Part of the MPA marine area was divided into fifteen main sectors with distinct coastal subsectors extending 500 meters from the coastline (see Fig. 1). The following information was collected for every sector: number of boats present; typology of boat (engine, sail etc); dimension (big, medium, small), activity (anchored, in movement etc.); position (if near the coast or not); weather conditions. The data collected was gathered in alphanumeric databases created with Access© software. A Geographic Information System (GIS) was set up to store, analyse and represent spatial data and basic cartographic information was obtained by digitising the nautical map of the area (I.I.M., 1993) using ArcInfo© and ArcView© software.

RESULTS **Bottlenose dolphin distribution and assessment.** Field work was carried out from 27th of April 2001 to 4th of November 2001, during 41 different days (only 3 of which were characterised by Beaufort 3 or 4). In total 1,985 Km were covered and 25 groups of bottlenose dolphins were encountered (for a total of 95 individuals, see Fig. 2). A summary of the results derived from data collected during "appropriate conditions" is given in Table 1.

Monk seal habitat assessment. The coast investigations were carried out for a total period of 25 days. Despite the fact that most of the south-eastern portion of the Sardinian coastline is characterised by a granite and basalt geomorphology, cavities were found distributed throughout all the stretches of coast investigated for a total of 16 coastal caves and cavities. The MPA is characterised by the presence of 10 coastal cavities, 3 of which are best suited as monk seal haul-out areas due to the following characteristics: visually hidden entrance, short underwater passageway, long and narrow water corridor, haul-out area sufficient for at least one individual (see Fig.3).

Assessment of recreational boat traffic pressure. Monitoring from land and sea effort amounts to 115 hours for a total of 3,407 recorded observations. The preliminary results indicate that major nautical pressure is located in the coastal sectors. Nautical presence is highest in the coastal subsectors B, C, D, E, F, G, H, I, and it is more reduced at distances greater than 500 m from the coastline (see Fig.2). One of the highest concentrations of vessels was recorded around the "Isola dei Cavoli" and in particular in its NW and SE sectors.

CONCLUSIONS Preliminary elaboration of bottlenose dolphin data indicates that:

- Either the low density and the low number of individuals (preliminarily photo-identified) frequenting the MPA can be due to the size of the study area (about 100 Km^2) and its very coastal position.
- As in other areas (Bearzi *et al.*, 1997) bottlenose dolphins seemed to prefer the area between the isobath of 50 and 100 m.
- The photo-identified dolphins in 2001 are the same individuals identified during the previous research (Arcangeli, 2001).
- In order to help the MPA management body to define critical habitats a more extensive research effort is needed, in a wider area. This would allow to better define this segment of bottlenose dolphin population and its habitat use.

No further monk seal sightings were observed during the study period. This could be due to the fact that previous sightings involved transiting individuals whose return in the area is fortuitous. Moreover, the occurrence of noticeable coastal nautical pressure recorded during the summer months is a likely deterrent for the stopover of transiting monk seal individuals. However, the presence of suitable shelters provides adequate conditions for monk seal stop over during other months of the year when nautical pressure may be reduced. Given the small surface area of the MPA and the large movement capacity of monk seal individuals (Adamantopoulou *et al.*, 1999) such a possibility should be investigated through future monitoring of the caves identified in the present study.

The individual research projects, included in a most comprehensive management plan of the MPA, supported a multidisciplinary conservation approach through several initiatives. The personnel involved in MPA monitoring activities was appropriately trained to guarantee adequate data collection for the bottlenose dolphin, monk seal and boat traffic pressure studies. Special meetings were carried out so as to inform the local community and tourists, in particular boaters, of the collaborative efforts occurring in the area. In addition, a special educational four- day module was programmed within the academic program of the local school of the municipality of Villasimius that would stimulate the collection of historical data on the presence of the investigated species involved, and at the same time bringing together old and new generations while introducing the students to a more in depth knowledge on the theme of marine mammal conservation and their interactions with nautical traffic.

ACKNOWLEDGEMENTS The authors wish to thank the MPA management and staff and in particular the Cooperative Eolosimius and the office for the management of the Port of Villasimius.

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Table 1. Bottlenose dolphin distribution and assessment - data collected in "appropriate conditions"

km covered	1,254
Area scanned (km^2)	1,254
Number of sighting (or groups encountered)	21 (one sighting occurred out of the MPA)
Total number of dolphins encountered	78
Mean group size	4 (SD=2)
Density (per km^2)	0.06
Number of individuals photo-identified (preliminary)	15

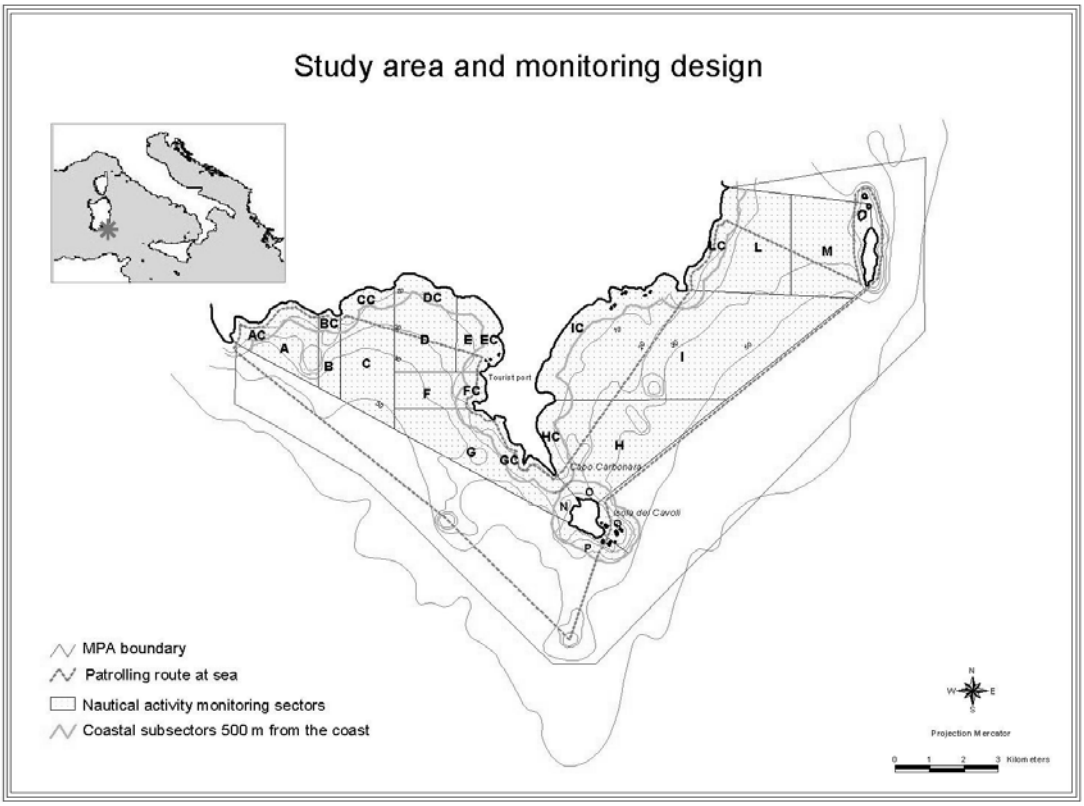

Fig. 1. Study area and monitoring design

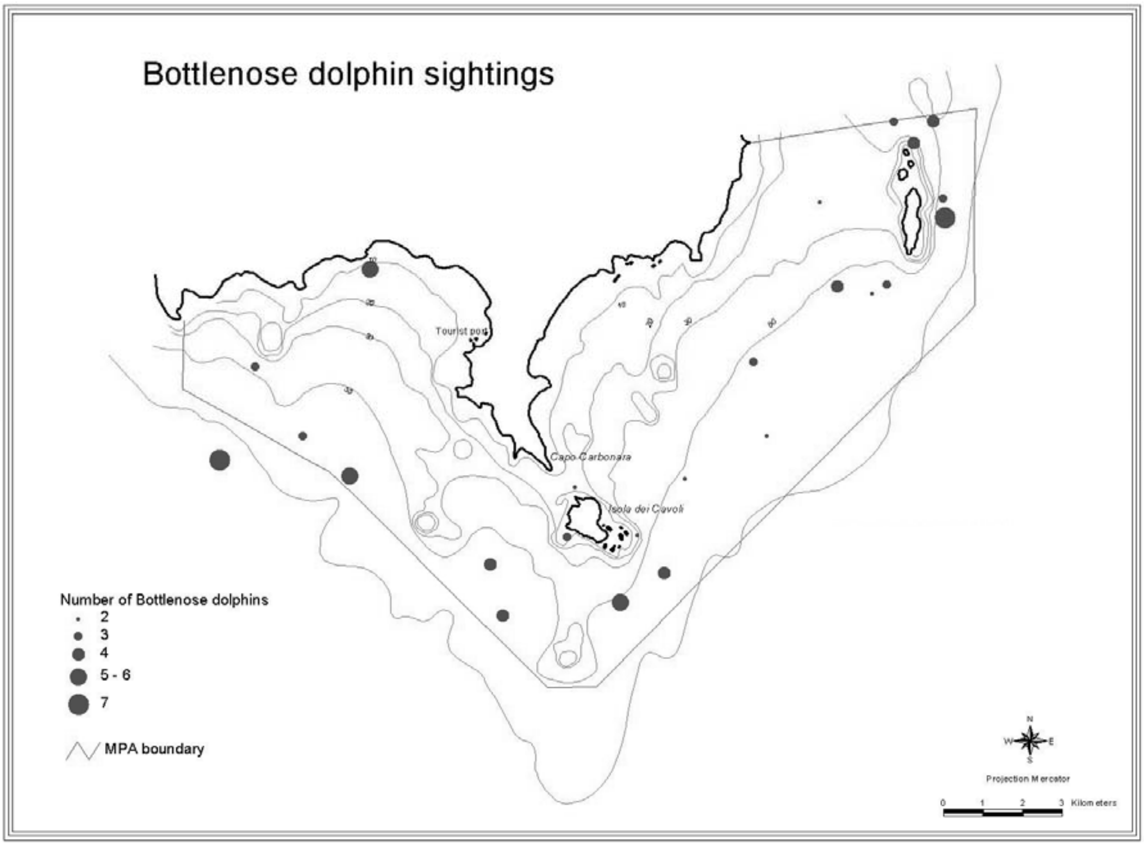

Fig. 2. Areas of dolphin sightings and densities

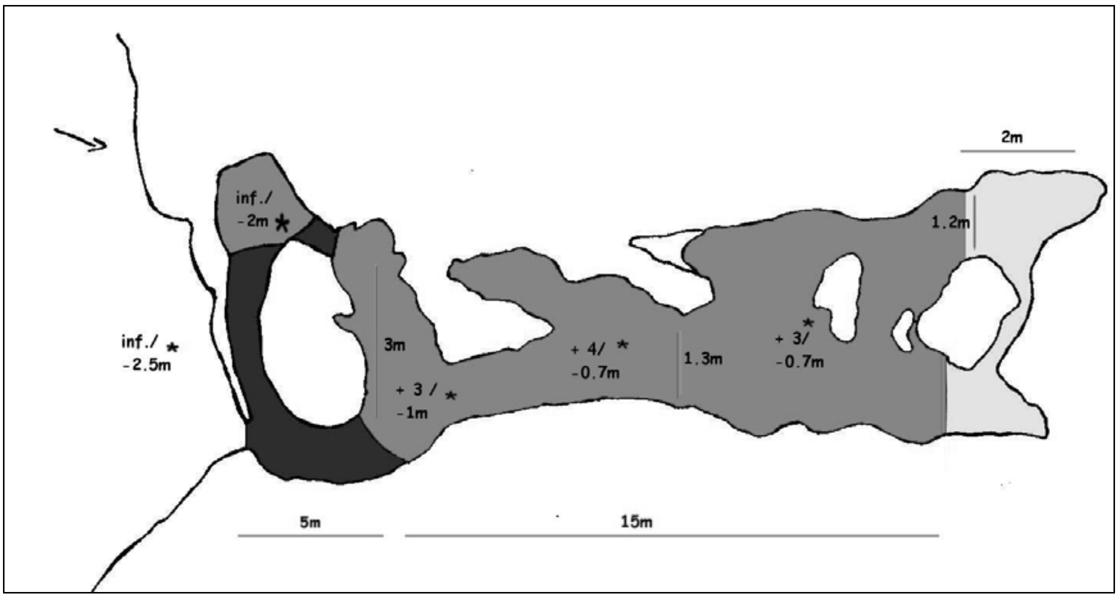

Fig.3. Cross-section drawing of a suitable monk seal haul-out area (light grey = haul-out space, grey = water corridor, black = underwater passageway leading into the cave)

CONSERVATION ISSUES CONCERNING MEDITERRANEAN FIN WHALES

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This work summarizes nine years (1991-1999) of effort-weighed sightings in western Ligurian Sea offshore waters. The area plays a key role for the ecology of cetaceans, particularly for fin whales (*Balaenoptera physalus*), representing an important feeding ground in the Mediterranean Basin. On 25 November 1999 Italy, France and Monaco signed an Agreement to create an International Sanctuary for Cetaceans, which has recently come into force following the ratification process by the three signatory Parties. Other conservation bodies are active in the Basin, including the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) which entered into force on June 1st 2001. Mediterranean fin whales are exposed to threats including direct human disturbance, anthropogenic noise, pollution and collisions with vessels. The latter threat represents a primary source of concern, due to the large number of ferries and commercial ships crossing the waters of the Sanctuary. Evidence of collisions has been reported both on stranded and free-ranging fin whales. To provide information on whale distribution and abundance useful for future management measures, a portion of the Sanctuary area was subdivided in squares measuring 10 minutes of latitude by 10 minutes of longitude and the number of sightings-per-unit-effort (SPUE) was computed. Unexpected distribution patterns and yearly trends were obtained. The north-eastern portion of the study area shows lower values of SPUE, and the overall yearly mean SPUE values showed a significant threefold decrease, from 0.449 sightings per 100 km in 1995 to 0.131 sightings per 100 km in 1999. These data may help identifying "low fin whale density" routes that – if adopted by ship companies - may reduce the probability of collisions. The steady decrease in the SPUE from 1995 to 1999 is particularly worrisome, and stresses the need for urgent management measures.

INCIDENTAL DOLPHIN-FISHERY INTERACTION ALONG ITALIAN COASTS: DATA REVIEW THROUGH REPORTS ON STRANDING. DOES THIS PROBLEM EXIST?

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INTRODUCTION Incidental dolphin catch in fishing gear has been well documented worldwide (Northridge, 1991). Data available show that pelagic driftnets are the major cause of dolphin by-catch (Di Natale *et al*., 1992; Richards, 1994; Di Natale and Notarbartolo di Sciara, 1994).

MATERIALS AND METHODS This paper reviews stranding reports from 1986 to 1999 published by the Centro Studi Cetacei. Strandings were divided into nine categories, defined by post-mortem lesions or injuries believed to be the cause of stranding, according to the report on differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations (Angliss and DeMaster, 1997).

1. Fishing Nets: marks consistent to fishing interaction, divided into two sub-categories: a) Body marks (skin lesions caused by the action of a net on the body); b) Entangled (specimens discovered entangled in nets or stranded with net fragments around the body or in the mouth).
2. Fin cuts: bodies showing post-mortem cuts to the fins and/or tail fluke and/or dorsal fin.
3. Deep wounds: deep cuts caused by sharp objects such as a hook or knife, or made by a firearm.
4. Tissue removal: dorsal and/or abdominal muscles removed for consumption.
5. Ship collision: specimens having post-mortem propeller cuts or injuries consistent with ship impact.
6. Superficial wounds*:* minor lesions to the skin.
7. Pollution: death caused by xenobiotic or toxic element ingestion, or body contamination. Divided into two sub-categories: a) Plastic (plastic elements ingested); b) Hydrocarbons (body contaminated).
8. Decomposed*:* specimens that are in a state of advanced decomposition which exclude any type of post-mortem investigation.
9. Other: other strandings not fitting the categories above.

Specimens recorded with multiple post-mortem lesions were catalogued according to the most serious injury. Categories 1 to 4 can be considered as consistent with dolphin fishery interaction (Angliss and DeMaster, 1997). Fishermen typically remove fins or make other body lesions whilst trying to preserve their nets. In the other hand they may kill cetaceans found alive in nets and remove muscle tissue for consumption (Di Natale and Notarbartolo di Sciara, 1994).

RESULTS A total of 2,389 specimens were recorded stranded between 1986-1999 (Table 1). Figure 1 shows taxonomic group strandings by percentage during years 1986-1999. Percentage amounts concerning each post-mortem lesion's category were calculated (Figure 2). Categories reflecting fishery interaction (Body marks, Entangled, Fin cuts, Deep wounds, Tissue removal) reach all together 23% of total. Seasonal incidental catch rates show that the summer is the season with highest total value (320 animals), followed respectively by autumn (94 animals), spring (86 animals) and winter (53 animals). Moreover in summer the category Fin cuts is the most represented (180 specimens) decreasing in spring (39 specimens), autumn (34 specimens) and winter (15 specimens) (Table 2).

Total taken into account for regional analyses amounts to 2,385 specimens because in the year 1989 four unidentified cetaceans were recorded entangled in pelagic waters. Regional comparison reveals that highest number of strandings, consistent with fishery interaction, were recorded in Liguria (137 specimens), Sicily (120 specimens), Calabria (87), Sardinia (68 specimens), Apulia (44 specimens), Latium (34 specimens), Tuscany (31 specimens) and Campania (7 specimens) decreasing respectively (Table 3). Regional rates of each category consistent with fishery interaction and decomposed category were investigated as showed in Figure 3. The figure 4 shows annual stranding trend analyses for total categories consistent with fishery interaction and decomposed category. Comparison reveals that, while the catches due to fishery interaction reached a peak in 1989 and then decreased to a consistent annual level, decomposed specimens peaked in 1991 decreasing gradually until 1996 then reaching a consistent level in the following years. Analysis of incidental catch data reveals that the impact of drift netting on cetaceans living along Italian coasts is very high. Species most affected are the small cetaceans such as striped dolphin (*Stenella coeruleoalba*) and bottlenose dolphin (*Tursiops truncatus*). Annual, seasonal and regional analyses reveal that striped dolphin is the most abundant species found dead along Italian coasts, 45% of total strandings. Striped dolphin is also the most commonly found species with in the Fin cuts category, particularly in the summer and autumn seasons when the use of driftnets was extensive. Lesions consistent with net interaction also affect other species such as bottlenose dolphin, sperm whale (*Physeter macrocephalus*), cuvier's beaked whale (*Ziphius cavirostris*), long-finned pilot whale (*Globicephala melas*) and Risso's dolphin (*Grampus griseus*). Fin cuts category is recorded in all species except in minke whale

(*Balaenoptera acutorostrata*), dwarf sperm whale (*Kogia simus*), false killer whale (*Pseudorca crassidens*) and common dolphin (*Delphinus delphis*) stranded in a few account during these investigated years .

CONCLUSIONS Although stranding reports provide some information on cetacean by-catch in driftnets, many data from decomposed specimens are lost due to an inability to ascertain cause of death as marks on the specimen become less distinguished through time and dehydration (Schmidt and Hussel, 1994).

Differences in regional stranded specimens' rates were revealed. Indicating that some regions may be more affected by incidental catch or that other regions may be not properly monitored due to cost and/ or to inaccessible coasts.

In 1989 incidental catches were very high and then decreased to a consistent annual level. The highest record of decomposed specimens in 1991 may be related to Mediterranean striped dolphin *morbillivirus* diseases. This could imply that the reduction of strandings fitting the categories consistent with fishery interaction recorded in the following years may not reflect a decreased fishing impact on small cetaceans but be due to reduced number of individuals available to interact with nets.

It is fair to assume that some records of the Decomposed category were due to fishery interaction. The increase in decomposed specimens recorded since 1996 should be better investigated. In some cases small cetaceans entangled in nets will die from stress, free of signs of fishing interaction. In this case it can be assumed that records from the Decomposed category could be due to incidental catch.

Since January 2002 drift nets are banned from EU waters. In Italian waters will incidental catch decrease thank to law?

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Table 1. All specimens stranded along Italian coasts between 1986-1999 with lesion category.

	Categories consistent with fishery interaction											
	FISHING NETS							POLLUTION				Total 1986-99
SPECIES	Body Marks	Entangled	Fin Cuts	Deep Wounds	Tissue Removal	Ship Collision	Superficial Wounds	Plastic	Hydrocarbons	Decomposed	Other	
Balaenoptera physalus	0	2	3	0	0	13	0	0	0	15	12	**45**
Balaenoptera acutorostrata	0	0	0	0	0	1	0	0	0	1	2	**4**
Balaenoptera sp.	0	0	0	0	0	0	0	0	0	1	0	**1**
Physeter macrocephalus	2	31	4	3	0	6	0	0	0	18	39	**103**
Kogia simus	0	0	0	0	0	0	0	0	0	1	0	**1**
Pseudorca crassidens	0	0	0	0	0	1	0	0	0	1	1	**3**
Ziphius cavirostris	1	8	3	0	0	0	0	0	0	5	24	**41**
Globicephala melas	0	7	5	1	0	2	0	0	0	11	10	**36**
Grampus griseus	4	6	3	4	0	2	0	2	0	25	54	**100**
Tursiops truncatus	5	18	27	18	3	7	0	0	0	164	180	**422**
Delphinus delphis	1	0	0	1	1	0	0	0	0	5	16	**24**
Stenella coeruleoalba	34	35	153	46	12	34	2	3	1	241	524	**1085**
Unidentified cetaceans	1	24	70	15	2	16	0	1	0	175	220	**524**
TOTAL 1986-99	**48**	**131**	**268**	**88**	**18**	**82**	**2**	**6**	**1**	**663**	**1082**	**2389**

Table 2. Seasonal strandings between 1986-1999 for each post-mortem lesion category.
Seasons' key: Spring= March, April, May; Summer= June; July; August; Autumn= September, October, November; Winter= December, January, February.

	Categories consistent with fishery interaction											
	Fishing Nets							Pollution				Total 1986-99
SPECIES	Body Marks	Entangled	Fin Cuts	Deep Wounds	Tissue Removal	Ship Collision	Superficial Wounds	Plastic	Hydrocarbons	Decomposed	Other	
Spring	11	10	39	21	5	23	2	3	0	167	261	**542**
Summer	20	79	180	36	5	30	0	0	0	246	384	**980**
Autumn	10	36	34	13	1	15	0	0	0	162	254	**525**
Winter	7	6	15	18	7	14	0	3	1	88	183	**342**
TOTAL 1986-99	**48**	**131**	**268**	**88**	**18**	**82**	**2**	**6**	**1**	**663**	**1082**	**2389**

Table 3. Regional strandings from 1986 to 1999 for each post-mortem lesion category.

	Categories consistent with fishery interaction											
	Fishing Nets							Pollution				Total
SPECIES	Body Marks	Entangled	Fin Cuts	Deep Wounds	Tissue Removal	Ship Collision	Superficial Wounds	Plastic	Hydrocarbons	Decomposed	Other	1986-99
Liguria	10	52	57	14	4	17	0	1	0	72	150	**377**
Tuscany	1	5	13	11	1	15	0	0	0	60	88	**194**
Latium	5	4	18	6	1	4	0	2	0	52	85	**177**
Campania	0	0	6	1	0	2	0	2	0	23	22	**56**
Calabria	8	16	51	11	1	8	2	0	0	45	77	**219**
Sicily	17	28	67	7	1	12	0	0	0	107	193	**432**
Sardinia	5	9	32	20	2	10	0	0	0	84	155	**317**
Apulia	1	6	17	13	7	12	0	1	1	138	197	**390**
Abruzzo	0	2	0	1	0	1	0	0	0	19	31	**54**
The Marches	0	1	1	2	1	0	0	0	0	12	20	**37**
Emilia-Romagna	0	1	5	1	0	0	0	0	0	18	28	**53**
Venetia	0	3	1	0	0	1	0	0	0	18	22	**45**
Friuli Venetia Giulia	0	0	0	0	0	0	0	0	0	7	4	**11**
Molise	1	0	0	1	0	0	0	0	0	5	4	**11**
Basilicata	0	0	0	0	0	0	0	0	0	2	7	**9**
TOTAL 1986-99	**48**	**127**	**268**	**88**	**18**	**82**	**2**	**6**	**1**	**662**	**1083**	**2385**

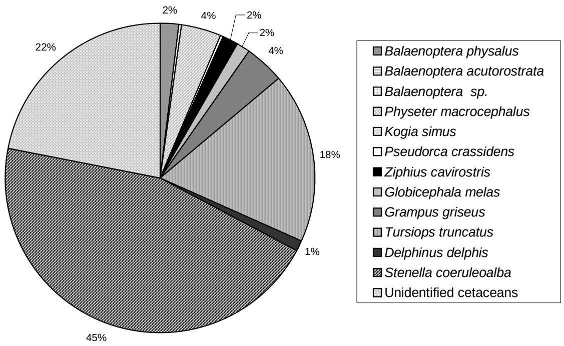

Fig. 1. Taxonomic group strandings, by percentage (1986-1999)

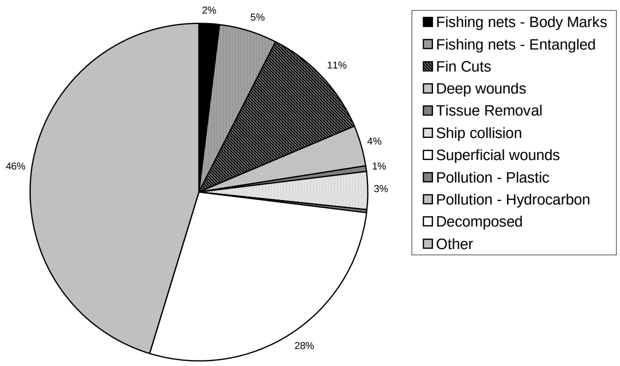

Fig. 2. Post-mortem lesions' categories (1986-1999)

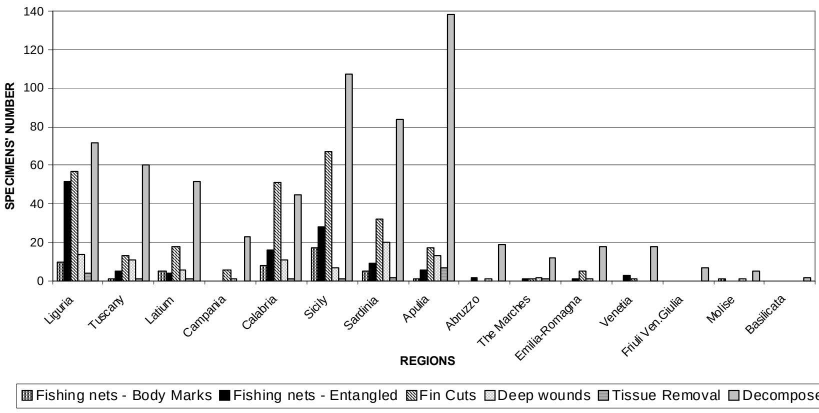

Fig. 3. Regional total of each category consistent with fishery interaction and decomposed category (1986-1999)

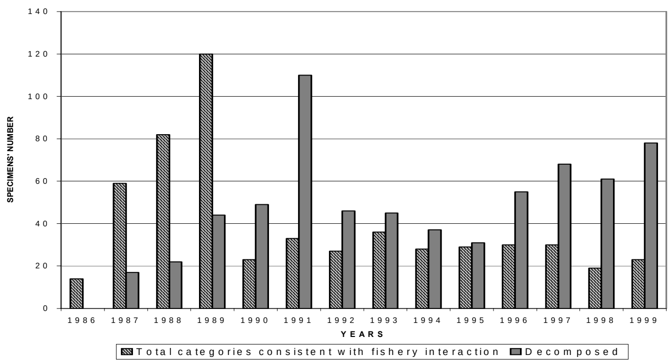

Fig. 4. Total categories consistent with fishery interaction and decomposed category (1986-1999)

A GIS AND ASSOCIATED DATABASE FOR THE ITALIAN STRANDING NETWORK. A COOPERATIVE PROJECT BASED ON GIS TECHNOLOGIES.

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INTRODUCTION The "Centro Studi Cetacei" (CSC) is a research group established in 1985 at the Natural History Museum of Milan as part of the Italian Society for Natural Sciences. One of the most important projects of CSC was to create a national network (Italian Stranding Network) to collect data about stranded Cetaceans along the Italian coasts, or entangled in fishing nets, or found dead in open waters.

The Centro Studi Cetacei is recognized by the Italian Ministry of Agricultural, Food and Forest Resources, by the C.I.T.E.S. Office and by the Ministry of Environment (Nature Conservation Service). Since 1986 the Italian Stranding Network has been collecting data on more than 2600 strandings (>2700 animals), concerning 12 cetacean species, and has published regular annual reports. The dataset also includes 164 events recorded in the former project "Progetto Cetacei" as well as historical data found on literature and newspapers.

As it represents one the most comprehensive dataset available for the Mediterranean Sea, the Italian Stranding Network archive has been chosen as a case study of a Cetacean GIS application.

Stranding Networks in the Mediterranean Sea. Some of the Countries of the Mediterranean area have national cetacean stranding networks and keep databases encompassing either all or part of the coast. Other Countries have little or no coverage at all on stranding events.

The Italian stranding network is based on the cooperation of many subjects and Authorities. The Italian coastline (more than 8000 km) is divided into sixteen areas, each assigned to a member of the CSC who is in charge of the data collection related to the stranding and/or animal recovery.

The notice of the stranding is usually first reported to an urgency call-centre in Milan (sponsored by the insurance company Europ Assistance Italia). This information is promptly forwarded to the researcher in charge of the area in which the stranding has occurred. For each stranding event, basic data (species, number of animals, sex, location, etc.) and biological samples are collected to carry out biological and environmental researches. The main subjects analysed are: cause of death, levels of organo-chlorines and heavy metals in different tissues; accumulation and detoxification systems of mercury; bacterial and viral infections; enzymatic systems; parasites; age determination; diet; histo-physiology of the digestive apparatus; histology of the lungs and of the liver; osteology. Whenever possible, tissue samples are forwarded to the Cetacean Tissue Bank at the University of Padova.

SOLMAR Databases. Data collected by CSC and by Progetto Cetacei, related to events from 1972 to nowadays, have been geographically referenced and organized in a database. This database is the core of a Mediterranean and Black Sea Cetacean GIS. This GIS is being developed within the NATO Saclantcen SOLMAR (Sound Oceanography and Living Marine Resources) Project.

SOLMAR is an international interdisciplinary programme that investigates underwater noise and its effects on marine environment. This program is sponsored and developed by NATO Saclant Undersea Research Center based in La Spezia, Italy. It includes the development of a whole set of databases containing oceanography, ecosystem dynamics and marine organisms of the Mediterranean Sea. The program is aimed at developing models for predicting presence of marine mammals according to environmental parameters.

To comply with SOLMAR objectives, datasets were expanded to include strandings from other areas of the Mediterranean Sea, Black Sea and adjacent waters, when available. This was made by browsing literature and contacting researchers involved in other stranding networks, though it is clear that the coverage of the Mediterranean Sea made by stranding networks is incomplete and many unpublished partial datasets may still exist.

The GIS for the Italian Stranding Network SOLMAR databases were first organized by entering data reported by CSC and other older records. The records were cross-checked with the original documentation kept at the Natural History Museum of Milan. By browsing through the original documents it was also possible to add unpublished details.

The database includes information about the number of animals, the species (or the genus when identification was impossible), size and sex, the status observed when the animals were found (alive, dead, decay status), the injures observed on bodies, the hypothetical or proved cause of death, the treatment and release condition in case of animals found alive. Together with the described fields, information to track the biological samples (tissue, skeletons, etc.) and the final disposition of the bodies were included.

The position of each stranding was then searched on detailed maps to be accurately georeferenced. As most of the records reported local names only, it was often difficult to associate them to precise locations and official place-names. In some cases, the coordinates were assigned according to the central point of the coast pertaining to the municipality in which the event was reported.

Datasets were transferred to ArcView 3.1 for plotting and for a further phase of cross checks. Recently, to provide CSC researchers with a low cost solution for data archiving, display and analysis, data were transferred from ESRI ArcView to a less expensive GIS (Manifold 5) also. To further improve the analysis potential of Manifold 5, custom scripts and VBA modules have been developed to make data analysis quicker. Basic queries allow plots of the distribution of events by region, year, species, number of animals, cause of death, data source, etc. To satisfy specific requests, advanced queries and reporting can be easily added.

To set up the physical oceanographic part of this GIS, the IBCM bathymetric contours distributed by British Oceanographic Data Center (BODC, UK) were used. Contours were transformed into suitable formats using a custom developed software.

A broader approach. Mediterranean sea life is heavily endangered by habitat degradation deriving from human activities. Fishing, heavy ship traffic, biochemical and noise pollution, coastal anthropization are constants in the Mediterranean area.

The GIS approach not only helps for data visualization, but it also helps understanding spatial and temporal distribution of stranding events, their causes and their relationship with other oceanographic, environmental and population parameters. By integrating sightings, acoustic contacts and stranding data in the GIS, it will become an important tool for cetacean distribution studies in relation with environmental parameters, for identifying critical habitats, for evidencing critical environmental issues, and for defining conservation and management guidelines.

ACKNOWLEDGEMENTS The work presented here is the result of the activity of a large number of persons who participated in the CSC ISN data collection and of the continuous support provided by the Natural History Museum of Milan.

The creation of the databases and of the GIS is mainly due to the joint efforts of Saclantcen, CSC and CIBRA. Funding to CIBRA was provided by ONR Grants N00014-99-1-0709 and N00014-02-1-0333; the GIS work of the first Author was also supported by funding from IUAV. Thanks to the Manifold staff and to Nauta-rcs for their technical support.

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Web References

Cetacean Tissue Bank	http://digilander.iol.it/cetaceantissuebank/
CIBRA	http://www.unipv.it/cibra
CSC	http://www.centrostudicetacei.org
ESRI	http://www.esri.com
GEBCO	http://www.bodc.ac.uk
Manifold	http://www.manifold.net
Museo di Storia Naturale di Milano	http://www.rcs.it/mimu/musei/musei.htm
ONR	http://www.onr.navy.mil
SOLMAR	http://solmar.saclantc.nato.int

Table 1. Table showing the contents of the database: stranding data earlier than 1986 represent less than 10% of the dataset.

	Whole database	Italian waters and coast	Italian waters and coast by CSC
N. of stranding events			
1840-1985	264	200	-
1986-1998	2379	2335	2322
1999-2000	292	292	292
total	**2935**	**2827**	**2614**
N. of animals			
1840-1985	321	246	-
1986-1998	2511	2452	2438
1999-2000	294	294	294
total	**3126**	**2992**	**2732**

Table 2. Amount of data now available in the database/GIS, species by species. At present only data about Cuvier's beaked whales cover the whole Mediterranean basin. Undetermined species (>600 cases) are not reported in table. The numbers related to striped dolphins are influenced by a morbillivirus infection happened in 1991; in that year the strandings doubled the values of previous years.

LIST OF SPECIES RECORDED (1840-2000)	Number of strandings		*Number of animals*	
	Other seas	Italy	Other seas	Italy
Physeteridae				
Physeter macrocephalus	-	144	-	167
Kogia simus	-	1	-	1
* *Kogia breviceps*	1	-	2	-
BALAENOPTERIDAE	-	8	-	10
Balaenoptera acutorostrata	2	65	2	65
Balaenoptera physalus				
DELPHINIDAE	-	43	-	43
Delphinus delphis	-	44	-	51
Globicephala melas	-	112	-	120
Grampus griseus	-	1	-	1
Orcinus orca	-	4	-	5
Pseudorca crassidens	2	1223	5	1280
Stenella coeruleoalba	-	497	-	502
Tursiops truncatus				
ZIPHIIDAE	92	75	117	87
Ziphius cavirostris	1	-	1	-
* *Hyperoodon ampullatus*	10	-	10	-
* *Mesoplodon* spp.				
* Canary Islands *Mesoplodon* spp. include *M.europaeus, M.bidens, M. densirostris*				

WHALEWATCHING IN THE STRAIT OF GIBRALTAR

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The whalewatching activities in the South of Spain, especially in the Strait of Gibraltar, have been occurring since 1982. However, an increase of this activity in the Straits has happened in the last nineteen years from 1 boat in 1982 to 13 boats in 2001. Beside this, the boats are increasing the number of passenger seats from 12 in 1982 to 600 seats in 2001, increasing this number by 109 % from 2000. The Strait of Gibraltar offers the possibility to see dolphins and pilot whales all year around, sperm whales in winter, spring and summer, and killer whales in summer. Although the weather conditions make difficult the every day trip, the success rate of sighting is about 96% for dolphins and pilot whales. This is possible because the dolphin species are widely distributed and pilot whales are concentrated in the centre of the Strait. This success rate of sighting cetaceans has changed from 1999, when the success rate of sighting was 85%, this has been due to the collaboration of the several platforms which tell each other the position of the animals. Operators from Tarifa, one of the main whalewatching villages, have created a local pact to fill the administrative hole in whalewatching regulations in order to protect the animals and also as a commercial strategy. The future will bring more development of this activity, and although the Spanish government is currently drafting a law in order to regulate whalewatching in Spain, immediate local action and good whalewatching practices are needed.

FAST FERRIES INFLUENCE ON THE BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS* (MONTAGU, 1821), PRESENCE AND SOCIAL STRUCTURE IN WATERS OF NORTH-EASTERN SARDINIA

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The developing of human population is linked to an increasing of the potential disturb in wild animals. To manage the protected marine areas it could be really useful to know the marine traffic effects on bottlenose dolphin coast populations. The clue of this study is to describe in which way the fast ferries activity can influence a bottlenose dolphin population, regarding to the spatial distribution, to the social structure and to the size of the school. The observations have been carried out from October 1999 to October 2001 along the north-eastern coast of Sardinia. The collecting data has been organised in:-two periods of absence and presence of fast ferries; two zones: low and high fast ferries influence and two day times: absence and presence of fast ferries. The group size and the social structure of each school have been considered. 358 bottlenose dolphin schools have been sighted during 1360 observation hours. 0,33 has been the presence index (sighting per hour) during the fast ferries absence and 0,30 (lightly inferior) the one during their presence. Sighting duration didn't show significant differences in periods, zones and day times (Median test P>0,05). When fast ferries are present the schools are smaller respect to when ferries are absent, while the school structure doesn't change in any case. By further studies it could be interesting to know the stress caused on these animals by fast ferries; stress that could be the reason of long term problems, hard to detect.

CETACEAN AND TOUR BOAT INTERACTIONS IN KENAI FJORDS NATIONAL PARK, ALASKA

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INTRODUCTION Kenai Fjords National Park (fig. 1), in close proximity to Alaska's largest city, Anchorage, is an increasingly popular tourist destination. In the past decade a young tour boat industry has developed serving nearly 100,000 clients annually (fig. 2). Viewing cetaceans has become one focus of this growing industry which could potentially have a negative impact on sensitive cetacean populations, if it were to interfere with vital activities such as feeding and reproduction. Of special concern are the endangered humpback whale (*Megaptera novaeangliae*) which regularly uses the area as a northern feeding ground and the mammal-eating ("transient") killer whale (*Orcinus orca*) which shows high levels of PCBs and DDTs (Ylitalo *et al.*, 2001). Moreover, the genetically discrete transient killer whale group "AT1" has declined by over 50% (Matkin *et al.*, 2000). The situation is acerbated by the severe decline of the primary prey of transient killer whales, harbour seals (*Phoca vitulina*), as well as the decline of another prey, the Steller sea lion (*Eumetopias jubatus*). In 2000, considering these factors and with support from the National Marine Fisheries Service, we initiated a program to educate tour boat operators on the biology and status of local marine mammal stocks, and demonstrate negative effects of aggressive/intrusive whale-watching. We assisted the operators in creating and adopting their own code of conduct. They developed an association and a code that actually exceed the government regulations and guidelines (table 1). The present study was conducted to assess the way operators complied to the guidelines they developed, by observing their conduct around whales.

METHOD The field work took place between 16 May and 18 September 2000 and between 14 May and 3 September 2001. Data were collected from a 10 m vessel and included date and time, whale species, location, type and name of the tour boat, the operator's name if known, duration of interaction with the whales, estimated distance of the vessel from the whales, and manner of approach. An interaction was considered to occur when a tour boat took notice of whales and altered either course or speed to view the whales. The viewing time included the time the boats spent viewing whales within an estimated 500 m distance. The closest distance of active approach was defined as the closest distance that the vessel actively moved toward the whales. Distances were estimated based on the known lengths of the vessels under observation.

RESULTS We observed 139 and 178 interactions respectively in 2000 and 2001. Viewing times and closest distances of active approach to whales could not be documented for all interactions. For this presentation, only the main results are exposed. In 2000, 68.3% (N=139) of the tour boats did not watch whales longer than 20 min against 66.7% (N=168) in 2001. The difference was not significant (χ^2=0.0976, df=1, p=0.755). As for the closest distance of active approach to whales, 89.8% (N=128) of the boats did not actively approach closer than 100 m in 2000 against 75.2% (N=165) in 2001. The difference was highly significant (χ^2=10.35, df=1, p=0.001).

DISCUSSION Although the presence of the research vessel may have influenced the behaviour of tour boat operators, we believe the data collected does give a good general picture of the interaction between tour boats and whales in the Kenai Fjords region. Operators complied with the self-developed guidelines most often, however some relaxation of discipline was observed from 2000 to 2001 and this may justify annual refresher workshops to review and update the guidelines. We also suggest occasional visits by enforcement personnel. Observations indicated an educational effort should also be directed at the sport/charter/pleasure boat fleet that increasingly views cetaceans and has not had the benefit of educational programs. Operators' associations have been created in other regions of the world (e.g., Washington State and New England, U.S.A., British Columbia, Canada, Scotland, Vesteralen, Norway, Tarifa and Islas Canarias, Spain, South Africa, New South Wales, Australia, Kaikoura, New Zealand) but remain rare and, in some cases, not efficient enough because some operators do not comply with the guidelines or do not join the associations to maintain their independent behaviour.

ACKNOWLEDGEMENTS We thank Kaja Brix and the NMFS, Regional Headquarters, Juneau, Alaska for supporting the program, the Kenai Fjords Tour Boat Operators Association for its participation and the Kenai Fjords National Park for providing statistics on the local whale-watching industry. We also thank individuals who provided information about operators' associations in their areas, and Christophe Guinet for his useful comments.

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Ylitalo, G.M., Matkin, C.O., Buztis, J., Krahn, M.M., Jones, L.L., Rowles, T. and Stein, J.E. 2001. Influence of life-history parameters on organochlorine concentrations in free-ranging killer whales (*Orcinus orca*) from Prince William Sound, AK. *The Science of the Total Environment*, 281(1-3): 183-203.

Table 1. U.S.A. federal laws and main guidelines developed by the operators' association

Federal laws (MMPA and ESA)	Main guidelines developed by the Kenai Fjords Tour Vessel Operators Association in 2000
In U.S.A. waters, the Marine Mammal Protection Act and the Endangered Species Act prohibit harassment, hunting, capture, killing or feeding of marine mammals in the wild. In addition to these regulations, guidelines are recommended.	✓ No active approach closer than 100 m ✓ No observation longer than 20 min ✓ Keep noise levels down around animals ✓ No corralling of animals ✓ Minimise contact with resting whales ✓ Minimise contact with transient killer whales ✓ Exercise caution around cow and calf pairs ✓ Avoid re-viewing the same group of whales more than once in a trip ✓ Do not approach killer whales when they are beach-rubbing

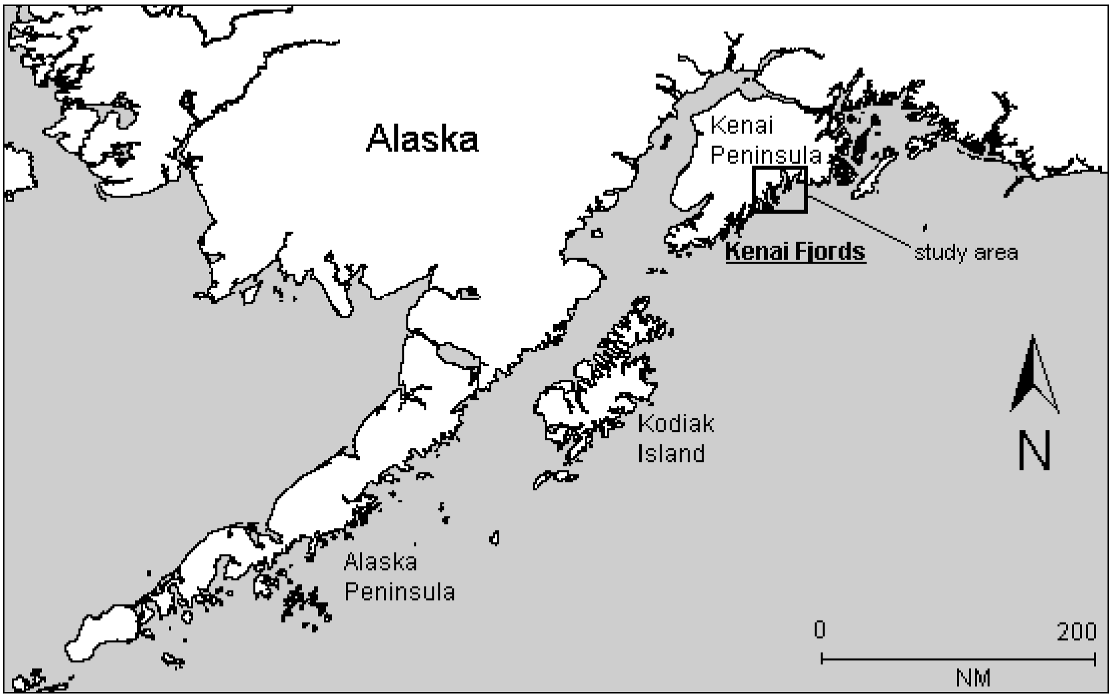

Fig. 1. Location of the study area

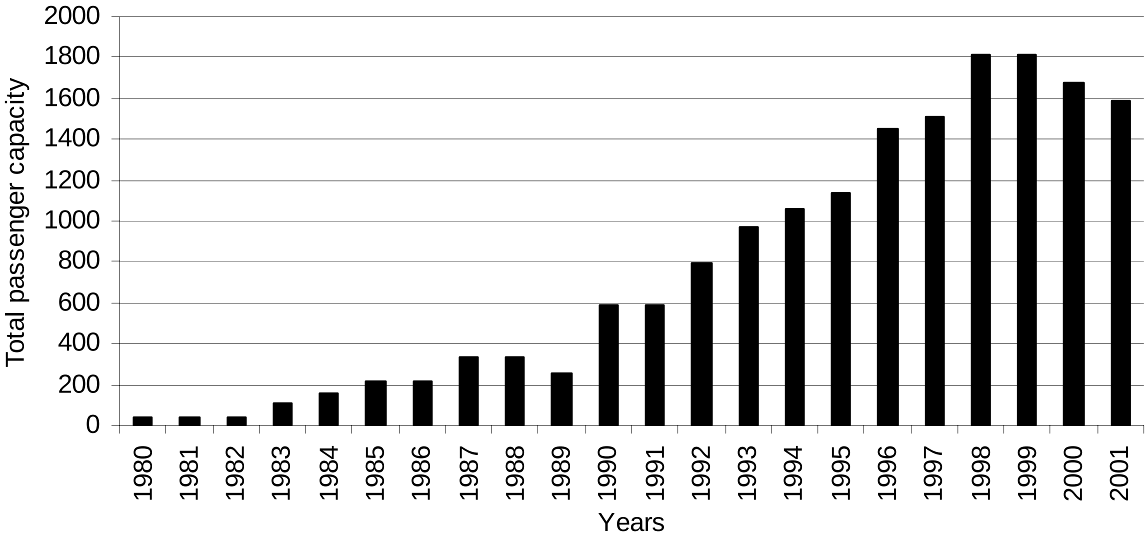

Fig. 2. Evolution of the total passenger capacity of the tour vessels in the Kenai Fjords National Park from 1980 to 2001

SPATIAL DISTRIBUTION OF CETACEANS IN RELATION TO OBSERVED OCEANOGRAPHIC FACTORS IN WESTERN IRISH WATERS AND THE ROCKALL TROUGH

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A line-transect survey of the waters off western Ireland was conducted during the summer of 2000 to determine the distribution, abundance and habitat use of oceanic species. A total of 2,681 km was surveyed and included a variety of habitat types, including continental shelf (< 500m), contintental slope (500 - 2000m), and the deeper waters (>2000m) of the Rockall Trough. Measurements of along track sea surface temperature (SST) and depth were collected. As an index of gradient, the difference in water depth was calculated every 30 minutes along a transect line. To obtain a relative index of abundance, encounter rate was calculated by dividing the number of groups encountered in each habitat type by the kilometers travelled on effort. A total of 126 cetacean sightings were made of 15 identified species and six categories of unidentified cetaceans. Most of the sightings (54.7%) and the highest encounter rate were made on the continental shelf area (<500m). This area received 38.9% of the survey effort. In comparison, the continental slope received 27.9% of the survey effort, had a lower number of sightings but a comparable sightings rate (n = 26 encounters, 4.26 sightings/100km). In the deep waters, the encounter rate was lower (2.9 sightings/100km) with 27 individual sightings. Common and Atlantic white-sided dolphins were the most frequently sighted species in terms of number of schools and number of individuals and were seen throughout the study area. Both species appear to overlap in their distribution and showed no clear habitat or temperature preferences. Among the larger cetaceans, sperm whales, fin whales and minke whales were the most frequently encountered. Sperm whales were sighted exclusively along the northern margin of the trough, in waters >1000m associated with colder water (14.5 C). In contrast, minke whales were predominantly found in shelf waters, along with harbour porpoise and bottlenose dolphins.

INTERACTION BETWEEN CETACEANS AND THE AZOREAN TUNA–FISHERY: IS THIS A REAL PROBLEM?

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Information on the interaction between cetaceans and the tuna-fishery in the Azores was collected by observers placed onboard tuna fishing vessels. Between 1998 and 2000, 617 fishing trips and 6554 fishing events were monitored by the observers. Cetaceans were present in less than 10% of the observed fishing events. Common dolphins (*Delphinus delphis*), spotted dolphins (*Stenella frontalis*) and bottlenose dolphins (*Tursiops truncatus*), accounted for 97% of the occurrences. Cetaceans interfered in only 5% of the total number of fishing events, by sinking the tuna school (in 140 occasions), feeding on the live bait thus competing with tunas (n=130), or doing both (n=41). However, cetacean interference did not result in a significantly lower tuna catch (in weight) per fishing event. During the three years, the observers reported a total of 49 dolphins caught during the fishing activity. Thirty-nine common dolphins, nine striped dolphins (*Stenella coeruleoalba*) and one bottlenose dolphin were caught in the fishing line, but were released alive. In spite of the general opinion that small dolphins are detrimental to the tuna-fishery activity in the Azores, results on cetacean presence and interference reported in this study are not in fully agreement with that notion.

MONITORING THE PRESENCE AND OCCURRENCE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN COASTAL ABERDEENSHIRE WATERS, NORTH EAST SCOTLAND

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INTRODUCTION The resident population of bottlenose dolphins (*Tursiops truncatus*) in the Moray Firth, Scotland is considered to be of international importance. Indeed, an area of the inner Moray Firth was recently designated as a candidate Marine Special Area of Conservation (mSAC) specifically for the conservation of this species. However, data collected during the present study suggests that the range of bottlenose dolphins from the Moray Firth population extends considerably beyond the boundaries of such protected waters.

The Sea Watch Foundation conducted land- and vessel-based cetacean surveys in the coastal waters of Aberdeenshire over a 3 year period (1999-2001) in order to collect data on the occurrence and abundance of bottlenose dolphins in North East Scotland. Although bottlenose dolphins were the primary focus of these surveys, several other cetacean species were additionally recorded during the survey work, in particular, the harbour porpoise, *Phocoena phocoena* and the white-beaked dolphin, *Lagenorhynchus albirostris* (Weir & Stockin, 2001)

This paper presents the first systematic study of bottlenose dolphins within the Aberdeenshire waters of North East Scotland.

METHODS The study area was located along the coast of Aberdeenshire, North East Scotland (Fig. 1) in a shallow region of the North Sea. Data presented here were collected using a combination of land-based surveys carried out along the coastline throughout the year, and a series of vessel-based transects between March and October.

Both land- and vessel-based surveys utilised trained observers to conduct effort related sighting surveys. A continuous scanning methodology (Altmann, 1984) was implemented primarily with the naked eye, but supplemented with regular binocular scans (8-10x magnification) where appropriate. Relevant environmental data e.g. sea state and visibility were collected at 15 min intervals throughout the survey, and cetacean data including the species, number of animals and behaviour were recorded during each encounter.

During vessel-based surveys, a 15 m motor vessel at 3 m eye height was utilised to survey the region between Stonehaven and Aberdeen, a return journey of approximately 24 km. On two occasions, the vessel route ran southwards between Stonehaven and Inverbervie. A Global Positioning System (GPS) was used to record the vessel track and the position of cetaceans encountered.

During vessel-based surveys in 2001 (n = 17) photo-identification of individual animals was conducted using a Nikon F80 SLR camera fitted with Nikon-AF Nikkor 75-300 mm zoom lens. Photographic methodologies employed during this process were similar to those described by Wilson *et al.* (1997a).

RESULTS **Survey Effort.** A total of 18,896 min survey effort was collected during timed sighting surveys at 15 land-based sites during the course of this study. Over 92% of land-based survey effort was collected from five key sites (Collieston, Girdle Ness, Souter Head, Aberdeen Harbour and Stonehaven Bay). Land-based survey effort was collected in all months of the year, but predominantly over the summer months between March and August.

Vessel-based surveys (n = 26) were completed in sea state 3 or less, resulting in 5,774 min of dedicated survey effort. These surveys occurred only between March and October due to winter weather constraints, with most coverage achieved during May and August.

Bottlenose dolphin occurrence. A total of 299 individual sightings of bottlenose dolphins were made during between 1999 and 2001. The majority of these encounters (n = 276) were land-based observations made during timed surveys (n = 86) and opportunistic sightings (n = 190). Bottlenose dolphins were recorded along the entire coast of the study area (Fig. 2a) suggesting a continuous distribution along the of Aberdeenshire coast. Aberdeen Harbour recorded the highest level of bottlenose dolphin encounters, with a rate of 1 sighting every 122 min of survey effort. Bottlenose dolphins were additionally sighted during most vessel-based surveys (n = 23) and were the most numerous cetacean species recorded with a total of 180 animals. Dolphins were most often encountered transiting along the coast presumably between feeding areas, and also while feeding off Girdleness and the harbour area. All sightings occurred within 1 km of the coastline, and most were within a few hundred metres from land. The location of vessel survey effort is shown in Fig. 2b.

Land-based sightings data revealed that group size ranged from 1 to 60 animals, with data being positively skewed towards smaller schools of 1 to 6 animals (mean = 8; median = 6.0). Further, group size increased to 10.9 animals in schools where juveniles and/or calves were present. When analysed over a temporal scale, this trend remained consistent, resulting in a higher mean group size for schools with immature animals present, as shown in Fig. 3. Calves and juveniles were observed throughout the year and were present in more than a third (35%) of total bottlenose sightings. This proportionally high presence of immature animals suggests that Aberdeenshire waters may be important for various age groups.

Despite adequate survey effort throughout the summer, bottlenose dolphins exhibited a marked seasonal occurrence within Aberdeenshire waters, with over 95% of vessel-based sightings occurring between March and June. A similar trend appears evident in land-based survey data, where both the number of sightings and the number of animals per unit effort sharply decreased throughout the late summer, as shown in Fig. 4. Interestingly, white-beaked dolphins were recorded close to the coast of Aberdeenshire during the summer months only (June to August), suggesting a distinct seasonal occurrence of animals in this coastal region to that of the bottlenose dolphin. However, unlike the white-beaked dolphin, bottlenose dolphins were observed to be strictly coastal in nature, only observed in shallow bays and travelling parallel along the coast.

Photo-identification. Approximately 1,200 photographic frames were taken during 17 vessel-based surveys in 2001, with a total of 17 animals being identified. Of these, 41.2 % (n = 7) were re-encountered during different vessel surveys throughout the 15-week photo-identification period. Over 70% of animals (n = 12) were distinguished by more than one type of identifiable feature. Permanent features e.g. nicks, certain types of pigmentation and dorsal fin shape accounted for 82.4 % of identifications (n = 14). The remainder (n = 3) were distinguished by semi-permanent features alone, e.g. skin lesions.

The number of marked individuals identified in each encounter ranged from 1 to 7 animals (mean = 2.8, median = 2.5). A third of individuals (29.5%) were identified using both left and right hand side photographs (n = 5), whilst 70.5% of animals were identified from either left hand side (n = 10) or right hand side (n = 2) images only, accounting for 58.6% and 11.9% of identified animals respectively.

During the present study, photo-identification was used to successfully confirm the presence of Moray Firth dolphins in Aberdeenshire waters. Although majority of the animals present in the study area are yet to be identified, the authors suggest that a continuous distribution of bottlenose dolphins exists along the Moray-Aberdeenshire coast and that majority of animals present in Aberdeenshire waters form part of the recognised Moray Firth population.

CONCLUSIONS Despite strong evidence of seasonality, results of the present study reflect a year-round presence of bottlenose dolphins along the coast of Aberdeenshire. This may be an important issue given the numerous potential sources of disturbance within this region e.g. heavy shipping traffic, oil and gas development and dredging activities. An increased presence of bottlenose dolphins in Aberdeenshire waters may have important conservation implications for a population whose numbers are already reported to be in decline (Sanders-Reed, 1999). Wilson *et al.* (1997b) showed bottlenose dolphin sightings peak between June and August in the Moray Firth. In the present study, sightings of bottlenose dolphins in Aberdeenshire waters declined dramatically during this period. This in conjunction with the high frequency and regularity with which dolphins were observed during the present study, suggests that the Aberdeenshire coast is currently part of the normal range for at least a proportion of the Moray Firth bottlenose dolphin population. Conclusions about long-term trends in abundance of this population may also need revision in light of the present Aberdeenshire data, which undoubtedly indicate more than the 'occasional' extension to home range, as reported by Wilson *et al.* (1999).

ACKNOWLEDGEMENTS Shell U.K. Exploration and Production kindly sponsored this study. The survey vessel '*Tranquility*' was skippered by Brian Bartlett. Dr. Peter Evans (Sea Watch Foundation), Ciarán Cronin and David Simmons helped to establish the present study. Special thanks are owed to Dr. Graham Pierce (Aberdeen University) for commenting on earlier drafts of this report. The authors also wish to thank the volunteers who contributed their time and effort to this project.

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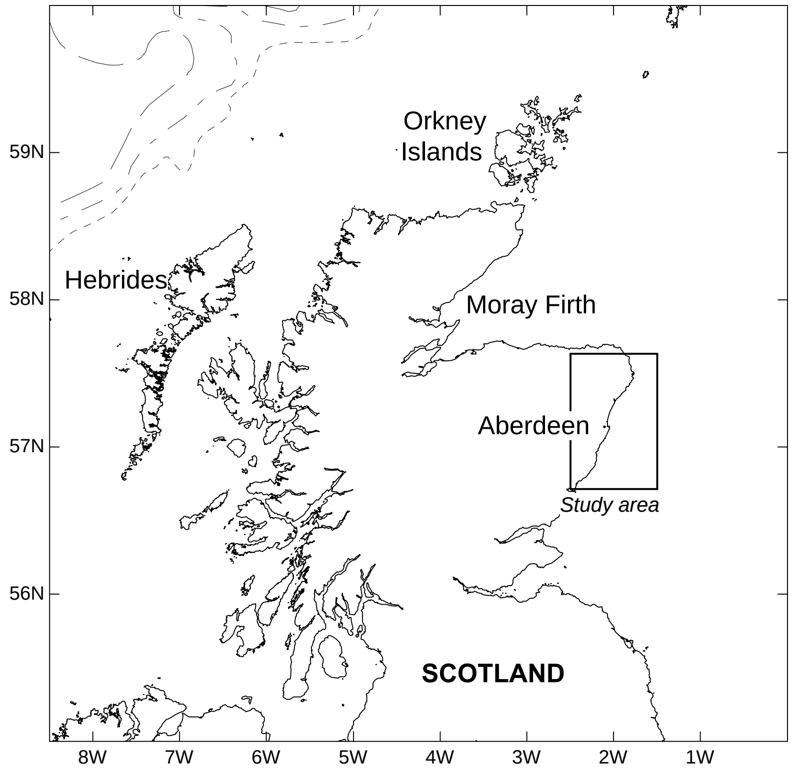

Fig. 1 Location of the study area
Bathymetry: dot (200m isobath); dotdash (500m isobath); dash (1000m isobath)

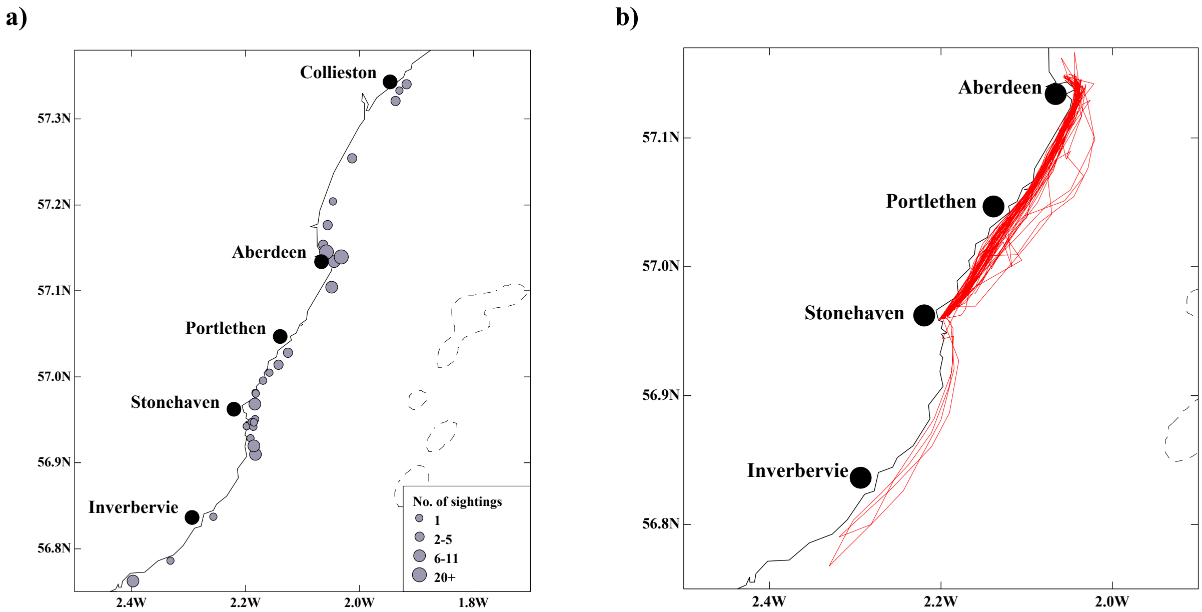

Fig. 2. (a) Distribution of land-based bottlenose dolphin sightings (1999-2001) (b) Route plot of vessel-based surveys (1999-2001)

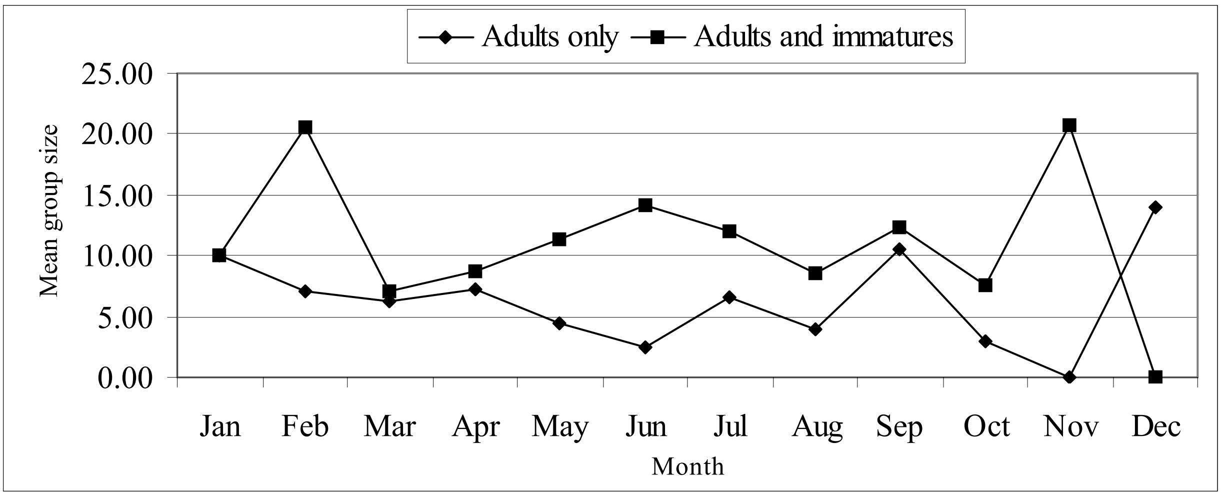

Fig 3. Monthly mean group sizes for bottlenose dolphin groups containing adults only and groups including immatures

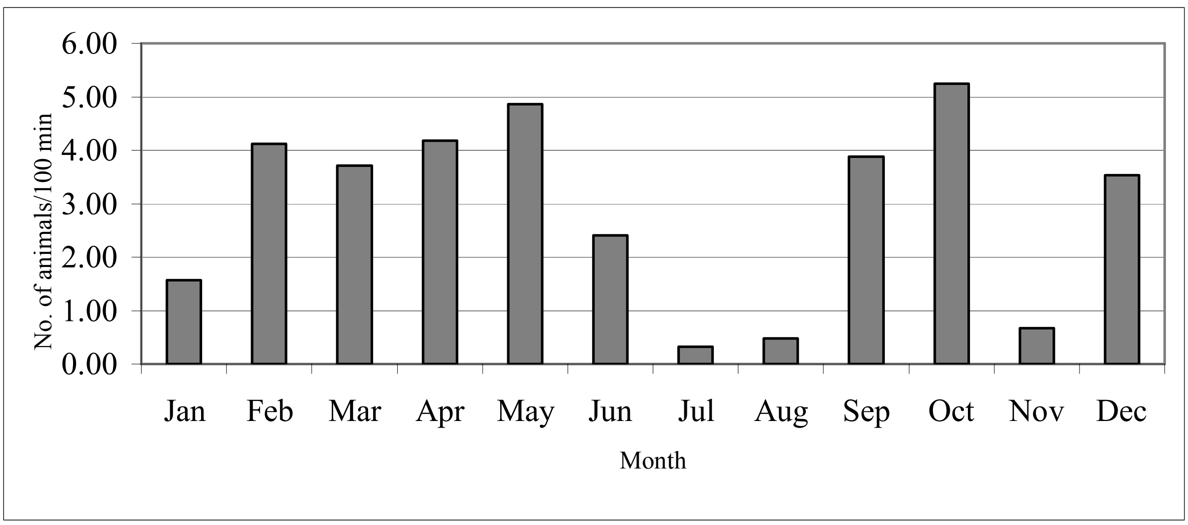

Fig 4. Monthly number of bottlenose dolphins per 100 min. survey effort

THE COME-BACK OF THE HARBOUR SEAL (*PHOCA VITULINA*) IN THE ESTUARY OF SOMME (FRANCE) : RECENT EVOLUTION OF THE POPULATION AND IMPLICATIONS FOR CONSERVATION

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INTRODUCTION The presence of several hundred harbour seals (*Phoca vitulina*) has been noticed in the estuary of Somme (France) since the 19th Century. However, strong hunting pressure caused the decline of this population (Labitte, 1858). Production of pups was considered as ceased in the 1960's (Duguy, 1990). In 1972, the site benefited from the introduction of a hunting ban. A small group of 8 – 10 individuals recolonized the site in 1980. In this estuary, where there are considerable human activities, a survey and conservation programme has been developed by the association 'Picardie Nature' since 1985 (Thiery *et al.*, 1996). This paper discusses some aspects of study and conservation implications, the population development and the course of the population size parameters and reproductive rate of harbour seals in the area.

MATERIAL AND METHOD The Bay of Somme is a tidal estuary of 70 square – km situated on the eastern Channel coast of France (Fig. 1). Seals successively use different haul-out sites within the estuary (Thiery *et al.*, 1996). The bay is also an important area for tourists throughout the summer. In 1989, persistent human disturbances were noted during the seal's breeding and pupping season (De Heij, 1989) and this gave rise to the implementation of a protection and study programme of the colony. Despite the designation of the estuary of Somme as a Nature Reserve in 1992, covering the area where the majority of seals are present, study and conservation measures were considered as necessary to ensure the maintenance of the colony.

Since 1986, the number of animals is calculated on a ten days period basis and on a daily basis during July and August with a summer observation and protection programme. The number of pregnant females is estimated every June. Each summer, mother-pup pairs are located to organise disturbance prevention. Age and sex determination is evaluated in August. During the summer, two expositions are presented. One on the beach to enable tourists to observe seals with binoculars and another site in Saint-Valery-sur-Somme (nearest town from the estuary), very frequented by tourists, with posters, video and oral presentations.

RESULTS Between 1989 and 2001, the colony grew from 9 to 76 seals, i.e. an average inter-annual ratio of 1,21 ± 0,25 (Fig. 2). Between 1994 and 2000, annual maximum number of seals were observed during the first, second and third ten days period of August, on the first ten days period of September (two years) and on the third ten days period of September (one year) (Fig. 3). Sex ratio was normal all year round and especially in summer. Between 1989 and 2001, we observed a significant intra-annual variability of seals number within the site (Fig. 3). Pregnant females have been observed since 1989 but observations of mother-pup pairs has been observed since 1992. Annual pup number increased between 1992 and 2000 (Fig. 2). Between 1992 to 2000, pups production (percentage of pups born from the annual maximum number of seals, including pups), is on average 12% ± 0,06% and the mean date of birth (n=40) is day 197 (16 July) ± 6,59 and the mean whelping period (n= 13) was 28 ± 6,4 days. Fertility of adult females was estimated from 1996 to 2001 (Table 1). During this period, adult females fertility increased respectively from 24% to 81%. Mortality of pups during the first six weeks should be 46% (considering none intervention), but rehabilitation limits it to 11%. However, we remarked a logical increase of pup strandings between 1992 and 2001 probably because of the population development.

CONCLUSION Implications for conservation and population development of the harbour seal in the Somme estuary are not negligible. The protection and study program seem impact positively on the colony (increase and stabilisation of the colony). Nevertheless, this operation should continue due to increasing human pressure in the area.

ACKNOWLEDGEMENTS We would like to thank the Réserve Naturelle de la Baie de Somme (financial partner), and also all surveyors having helped Picardie-Nature for more than 10 years each summer to protect and study the seals of the estuary of Somme. Special thanks to Graeme CRESSWELL (ORgasisation CetaceA) for improving the English of the manuscript.

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Table 1. Number of females harbour seals, pregnant females, pups born in the Somme estuary from 1996 to 2001. Evaluation of females fertility (Percentage of pups born / Females > 5 years).

	1996	1997	1998	1999	2000	2001
Total Females	27	23	22	32	25	32
Total pregnant Females	4	4	6	8	9	16
Total Females > 5 years	17	15	14	22	15	21
Total pups born	4	4	6	8	11	17
Percentage pups born / Females > 5 years	24%	27%	43%	36%	73%	81%

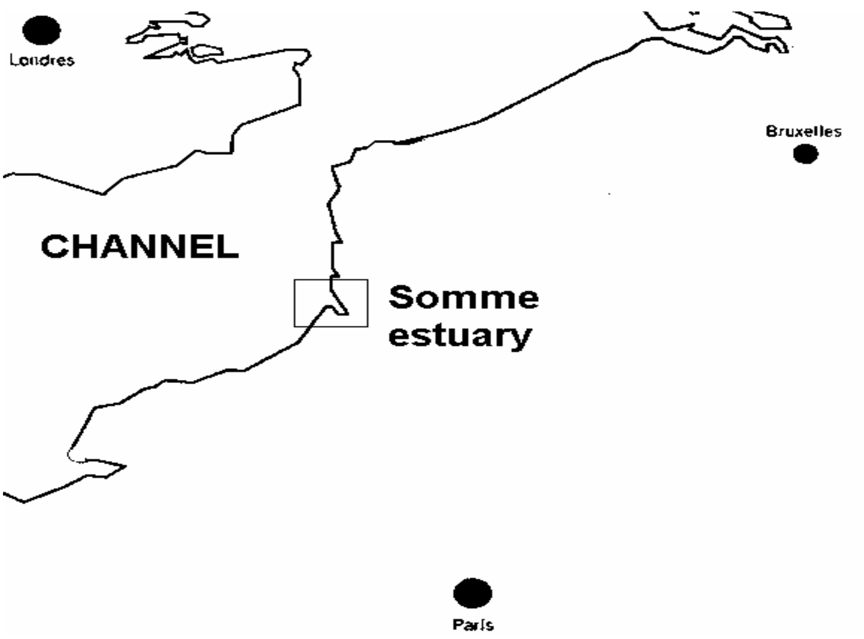

Fig. 1. Map on the location of the Somme estuary (France)

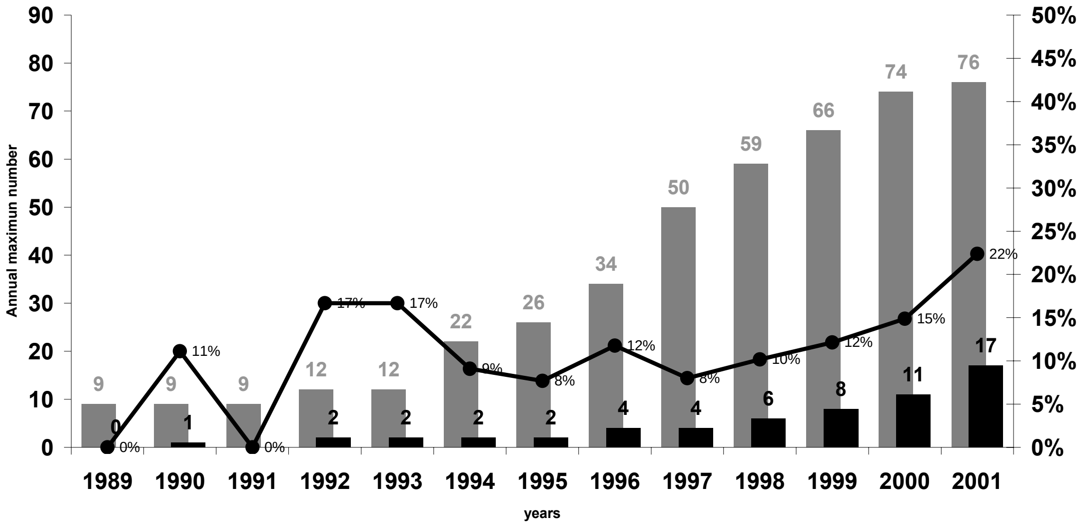

Figure. 2. Inter-annual evolution of maximum seal numbers (grey bars), pup numbers (black bars) and pup production (annual pups number / annual maximum seals number) (black curve) in the Somme estuary between 1989 and 2001

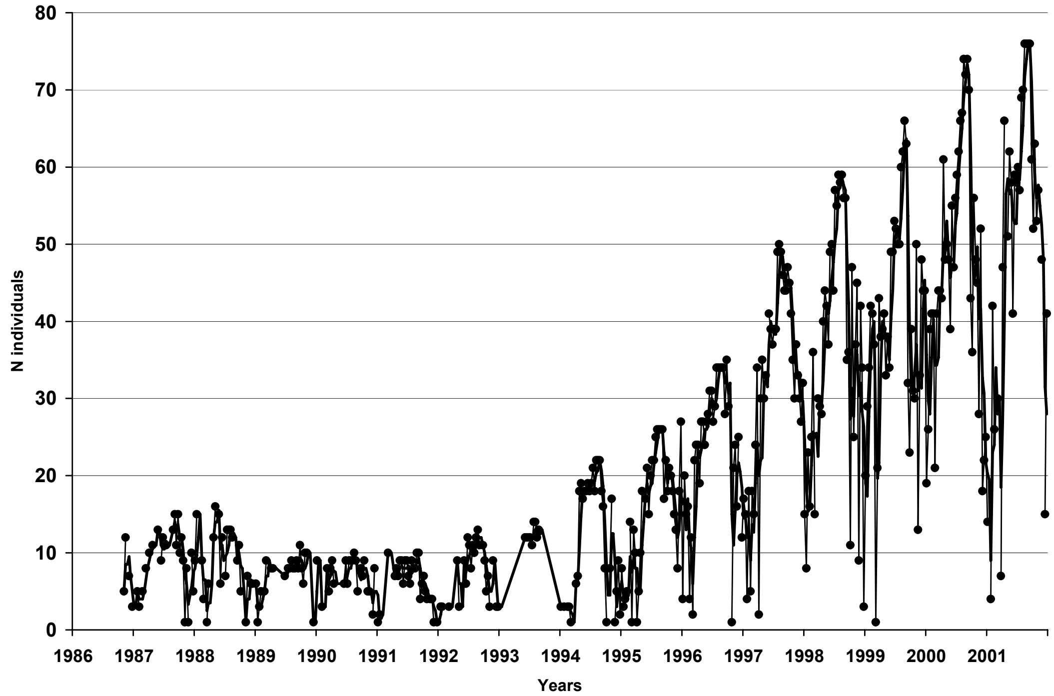

Fig. 3. Ten day period maximum numbers of harbour seals counted on haul-out sites in the Somme estuary between 1986 and 2001

INCIDENTAL CAPTURES OF MARINE MAMMALS BY DRIFTING LONGLINE FISHERIES AT WESTERN MEDITERRANEAN SEA

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INTRODUCTION There is poor information on Spanish fisheries and interactions with marine mammals in the Mediterranean. Silvani et al (1999) detected marine mammal incidental captures in driftnets close to Gibraltar Straits in the past. Pelagic drifting nets were prohibited by EU and Spanish authorities and the fishery closed in 1994. A report of the Spanish Cetacean Society showed an important number of marine mammals stranded along the Spanish Mediterranean coast, but details on direct relations between mortality and fisheries are uncertain (Cañadas *et al*, 1999). Western Mediterranean Sea is an important fishing area for the Spanish drifting longline fleet, targeting swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore (*T. alalunga*) but data on pelagic fisheries effects on marine mammals are scarce (Camiñas and Valeiras, 2001).

MATERIAL AND METHODS Some species of marine mammals can be captured incidentally in longlines by entangling and hooking. Marine mammal incidental captures by drifting longliners were monitored in 1999 and 2000. This study was partially carried out within two European projects funded by EU DGXIV-Fisheries and IEO. The studied area included all fishing grounds at the western Mediterranean where the Spanish drifting longline fleet works targeting swordfish and tuna. The surveys were carried out by scientific observers onboard 22 longline fishing vessels working from the Gulf of Lyon to Gibraltar Strait. From May 1999 and December 2000 fishing data including commercial catch and bycatch were recorded during 798 sets. Fifteen marine mammal captures were recorded.

RESULTS The Spanish fleet is made up of 72 vessels between 4 and 22 m length. The fishing area is the Western Mediterranean Sea, mainly the Spanish waters. The fleet is versatile, and changes fishing grounds, gears and strategy depending on the season, target species abundance, prices, etc. The fleet use four types of surface fishing gears with some differences on structure and components: longline for swordfish (SWO), longline for bluefin tuna (BFT), longline for albacore tuna (ALB) and a semipelagic longline for swordfish. The fishing gear is made up for a main line (from 19 to 60 km length) equipped with 1500-4000 branch lines. Floats keep the main line near to the surface. The hooks are baited with fish (mackerel, sardine, scabbard fish) and squids (*Illex* spp.). Semipelagic longline is set with weights which maintain the gear deeper.

Fifteen cetaceans of three species have been incidentally captured by drifting longlines set by the Spanish fleet al the Western Mediterranean targeting tuna and swordfish: 7 Striped dolphin (*Stenella coeruleoalba*), 7 Risso´s dolphin (*Grampus griseus*) and an unidentified beaked whale (*Ziphiidae* sp.).

Total captures and catch rates (cetaceans by 1000 hooks) are showed in table 1 and 2. Catch rates range between 0.001 and 0.008 individuals by 1000 hooks according to the fishing gear. The drifting longline targeting swordfish showed interaction with three different species, reaching 11 captures an rates of 0.004. The bluefin longline affected to one single species, the Risso's dolphin but the bycatch rates was 0.008. The albacore longline caught one stripped dolphin. There was not incidental captures during the observed semipelagic longline sets. Most of the cetaceans were captured by accidental entanglement in the lines (main and branch lines) and were liberated alive by the crew (n=9). Two dolphins were found dead, possibly by asphyxia (mortality rate: 0.0009). Three dolphins were captured by hooking on baited hooks. Taking into account data on fishing effort from Spanish official fishing statistics, preliminary estimation of the annual total catch indicated 167 cetaceans incidentally captured between 1999 and 2000.

During onboard works the following species were observed close to the vessels during fishing activities but incidental captured did not occur: Fin whale (*Balaenoptera physalus*), Sperm whale (*Physeter macrocephalus*), Long-finned pilot whale (*Globicephala melas*), Common dolphin (*Delphinus delphis*) and Bottlenose dolphin (*Tursiops truncatus*).

The geographic distribution of captures occurred at several important fishing grounds located at pelagic areas from 500 to more than 2000 meters depth. From our data, the incidental catches occur more often at an area between Iberian Península, Balearic Islands and Alboran Sea.

ACKNOWLEDGEMENTS This work was carried out under the framework of several fisheries projects. We are grateful to 'cofradías', fishermen and collaborative people at the Spanish ports. Our thanks to our colleagues of Big Pelagics scientist team of IEO-Málaga and the Spanish onboard observers team.

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Table 1. Marine mammal incidental catch rates (number of captures by 1000 hooks) and estimated total catch (99-00). (SWO: longline for swordfish, BFT: longline for bluefin tuna, ALB: longline for albacore tuna).

Gear	Species	N	Catch rate N/1000 hooks	Estimated total catch 99-00
SWO	*Stenella coeruleoalba*	6	0,004	75
	Grampus griseus	5	0,003	63
	Ziphiidae sp.	1	0,001	13
	Observed Fishing Effort (x1000 hooks)	1629,0		
	Total Fishing Efffort (x1000 hooks)	20479,3		
BFT	*Stenella coeruleoalba*	0	0	0
	Grampus griseus	2	0,008	25
	Ziphiidae sp.	0	0	0
	Observed Fishing Effort (x1000 hooks)	238,5		
	Total Fishing Efffort (x1000 hooks)	2986,0		
ALB	*Stenella coeruleoalba*	1	0,003	2
	Grampus griseus	0	0	0
	Ziphiidae sp.	0	0	0
	Observed Fishing Effort (x1000 hooks)	299,0		
	Total Fishing Efffort (x1000 hooks)	614,4		
TOTAL 99-00	*Stenella coeruleoalba*	7	0,003	78
	Grampus griseus	7	0,003	78
	Ziphiidae sp.	1	0,000	11
	Observed Fishing Effort (x1000 hooks)	2166,5		
	Total Fishing Efffort (x1000 hooks)	24079,7		

Table 2. Characteristics of observed incidental captures. (Sco: *Stenella coeruleoalba*, Ggr: *Grampus griseus*, Zsp: Unidentified beaked whale).

Species	Gear	Date	Fishing area	Observations
Sco	SWO	24/08/99	3701W	Entangled. Liberated alive.
Sco	SWO	22/09/99	3800E	Entangled. Liberated alive.
Sco	ALB	29/09/99	4003E	Entangled. Liberated alive. Young.
Sco	SWO	26/03/00	3903E	Entangled. Liberated alive.
Sco	SWO	27/07/00	3700E	Hooked. Liberated alive.
Sco	SWO	07/10/00	3700W	Entangled. 1 young dead.
Sco	SWO	19/10/00	3801E	Entangled. Liberated alive.
Ggr	BFT	09/05/00	3800E	
Ggr	BFT	27/05/00	3801E	Hooked. Liberated alive.
Ggr	SWO	07/07/00	3700E	Entangled in a branch line. Liberated alive.
Ggr	SWO	29/07/00	3700E	Entangled in a branch line. Liberated alive.
Ggr	SWO	21/08/00	3700W	Entangled by the caudal fin. Dead
Ggr	SWO	07/09/00	3700W	Hooked. Liberated alive.
Ggr	SWO	23/09/00	3900W	Entangled in the main line. Liberated alive.
Zsp.	SWO	02/08/00	3801E	Entangled and hooked. Possibly a Ziphius spp.

POPULATION CHARACTERISTICS OF THE COMMON DOLPHIN, DELPHINUS DELPHIS, DURING MULTIPLE STRANDING EVENTS IN THE NORTH-EAST ATLANTIC : EVIDENCE FOR BY-CATCH AND POTENTIAL DEMOGRAPHIC EFFECTS

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INTRODUCTION Major anthropogenic threats to cetacean population health include pollution, noise, habitat destruction, depletion of food resources and incidental catch in fishing gears. Since the late 80's, major mortality events recurrently affect the small delphinids of the bay of Biscay and are expressed as sharp peaks in stranding time series data. Natural mortality in delphinids is known to affect preferentially the younger age classes, corresponding to individuals still being nursed, and the older senescent animals (Ralls *et al*. 1980) ; in between the dolphins classically enjoy a long period of steadily high annual survival. In the case of incidental mortality, the pattern of selectivity according to age classes can be drastically different (Goujon, 1996). Therefore, if the peaks of mortality resulted from incidental catches and if chronic stranding from non-peak period would mostly result from natural mortality, one would expect contrasted population characteristics when comparing multiple stranding events with standard periods of chronic stranding.

MATERIALS AND METHODS Since 1972, the stranding database for all coasts of France is managed by the *Centre de Recherche sur les Mammifères Marins* (CRMM). We selected the set of stranding data for the Atlantic sector during the period 1980 to 2000. The information used were stranding date and location, species, sex, length and the presence of external marks of by-catch as listed by Kuiken (1996).

We compared, spatial distribution, species composition, external evidence of by-catch, sex-ratio and body length distributions of small delphinids found during acute peaks of multiple strandings *vs* out of these peaks. We identified major peaks (P) and compared them, firstly, with the same winters immediately prior to and after the peak (Out of Peak Periods, OPP) and, secondly, with Non-Peak Years (NPY). To compare spatial distribution, the coast was divided in 3 parts : northern area (south of Brittany to the river Loire estuary), central area (from the river Loire to the river Gironde estuary) and southern area (from the river Gironde estuary to the Spanish border).

Structures and distributions were tested by using Chi-Square test, Kolmogorov-Smirnov test and Wilcoxon-Mann-Witney two-sample test (Scherrer, 1984).

RESULTS The threshold between chronic stranding and multiple strandings was set at 30 individuals per winter decade from the examination of the distribution of winter decades ranked according to the number of small delphinids found stranded (Fig. 1). Nine peaks were identified between 1988 and 2000 (Table 1 and Fig. 2). Peak period were constituted of a higher proportion of common dolphins, *Delphinus delphis*, than non-peak periods (94.4% *vs* 75.9-83.9%) (Table 2). Comparing peak year (P) to periods of chronic stranding (OPP-NPY), spatial distributions of strandings are significantly different (P *vs* OPP : $\chi^2=96.26$, df=2, $p<0.05$; P *vs* NPY : $\chi^2=85.11$, df=2, $p<0.05$). Peaks of multiple stranding were more abundant in the southern bay of Biscay (Table 3). Peak periods showed more external evidences of incidental catches (31.3% *vs* 18.6-20.8%) (Table 3). The percentage of animals showing evidence of by-catch increases since 1990 and can exceed 70 %, as observed in 1997 and 2000.

We are interested in the bio-demographic parameters of common dolphin. The sex-ratio differs significantly between the peak and non-peak periods (P *vs* OPP : $\chi^2=24.04$, df=1, $p<0.05$; P *vs* NPY : $\chi^2=16.14$, df=1, $p<0.05$), being in favour of males during peaks (on average 2.2 males for 1.1-1.3 females). When the two types of chronic stranding are compared (OPP *vs* NPY), there is no difference in sex-ratio ($\chi^2=1.01$, df=1, $p>0.05$) (Table 2).

Body length distributions (Fig. 3 and 4), are significantly different for males (KS test : D=0.146, p=0.002), whereas no significant difference was detected in females (KS test : D=0.101, p=0.17). In males, the smaller length classes were less represented during peaks of multiple strandings and larger ones were slightly more numerous (WMW test : Z=2.5, p=0.006).

CONCLUSIONS These patterns suggest that the peaks are largely associated to events of exacerbated incidental mortality, but that incidental mortality also occurs out of these peaks. The fact that males of common dolphins are more heavily exposed than females and that longer males are more impacted than smaller ones may be a result of differential habitat and food utilisation by groups of different social composition (adult males and/or immature of both sexes *vs* females with young; Evans, 1994). This may have important consequences as to the impact of this additional mortality on social structure and reproductive potential. More parameters (age, reproductive status and diet) will be compared in the future between peaks and non-peak periods in the aim of better understanding the circumstances of this incidental mortality, identifying the segments of the population most exposed and eventually assessing its impact on the population.

ACKNOWLEDGEMENTS We would like to thank all the participants of the French national stranding network (RNE) for their everyday help on the field. The monitoring of cetaceans stranding is funded by the French Ministry of the Environment.

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Table 1. Description of the 9 identified peaks

ID Peak	Year	Period	Duration (days)	N delphinids
1	1988	Feb-Mar	30	215
2	1989	Feb-Mar	20	625
3	1990	Jan-Feb	20	118
4	1991	Jan-Mar	40	355
5	1992	Feb	10	74
6	1996	Janv	10	35
7	1997	Feb-Mar	30	630
8	1999	Feb-Mar	40	303
9	2000	Feb-Mar	40	481

Table 2. Specific composition in peaks *vs* non-peak period (* P = peak ; NPY = non peak year ; OPP = out of peak periods - ** Dd = common dolphin ; Sc = striped dolphin ; Tt = bottlenose dolphin ; Gm = long-finned pilot whale ; Oth. = other species)

		Species composition**				
		Dd	*Sc*	*Tt*	*Gm*	Oth.
N ind. - *%*	P*	1681-*94.4*	65-*3.7*	17-*1.0*	16-*0.9*	1-*0.1*
	NPY*	368-*75.9*	36-*7.4*	20-*4.1*	50-*10.3*	11-*2.3*
	OPP*	303-*83.9*	33-*9.1*	4-*1.1*	16-*4.4*	5-*1.4*
χ^2 value	P/NPY	201.12, df=4, P<0.05				
	P/OPP	67.38, df=4, P<0.05				
	NPY/OPP	19.09, df=4, P<0.05				
Conclusion	P/NPP	Different				
	P/OPP	Different				
	NPY/OPP	Different				

Table 3. Spatial distribution, sex-ratio and prevalence of external marks of incidental catch in peaks *vs* non-peak period (* P = peak ; NPY = non peak year ; OPP = out of peak periods)

		Spatial distribution			Sex-ratio		Marks of by-catch	
		North	Centre	South	M	F	Y	N
N ind. - *%*	P*	206-*12.3*	513-*30.5*	962-*57.2*	870-*68.2*	405-*31.8*	518-*31.3*	1135-*68.7*
	NPY*	108-*29.3*	128-*34.8*	132-*35.9*	165-*51.5*	130-*48.5*	58-*18.6*	254-*81.4*
	OPP*	100-*33.0*	98-*32.3*	105-*34.7*	118-*55.9*	111-*44.1*	64-*20.8*	243-*79.2*
χ^2 value	P/NPY	85.11, df=2, P<0.05			16.14, df=1, P<0.05		20.58, df=1, P<0.05	
	P/OPP	96.26, df=2, P<0.05			24.04, df=1, P<0.05		13.64, df=1, P<0.05	
	NPY/OPP	1.08, df=2, P<0.05			1.01, df=1, P>0.05		0.49, df=1, P>0.05	
Conclusion	P/NPP	Different			Different		Different	
	P/OPP	Different			Different		Different	
	NPY/OPP	Not Different			Not Different		Not Different	

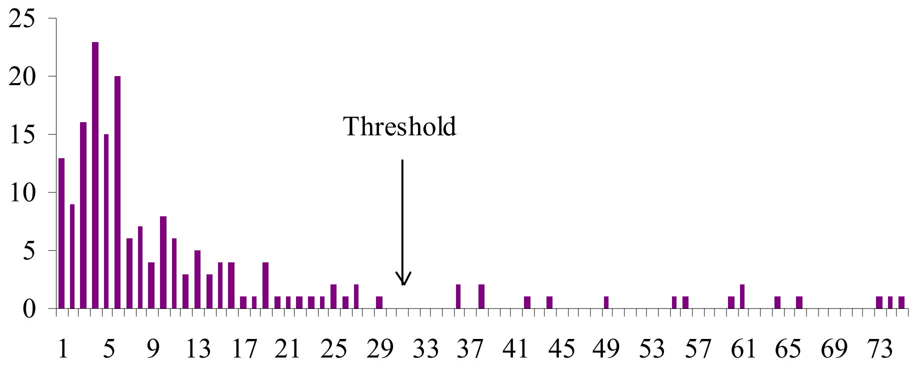

Fig. 1. Distribution of winter decades ranked according to the number of small delphinids recorded stranded along the Atlantic coast (n=5525)

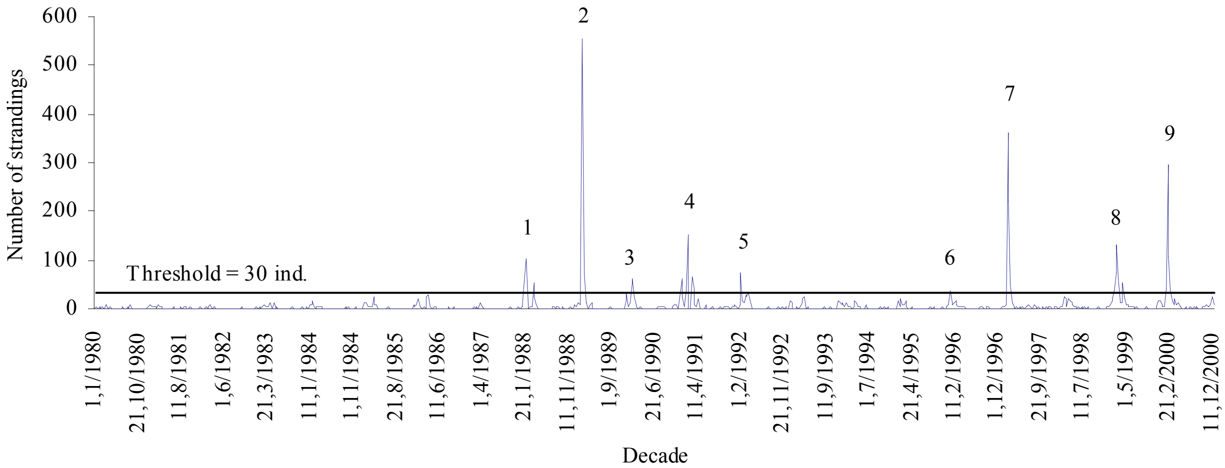

Fig. 2. Temporal changes of delphinids stranding per decade (period of ten days) since 1980 (n=5525)

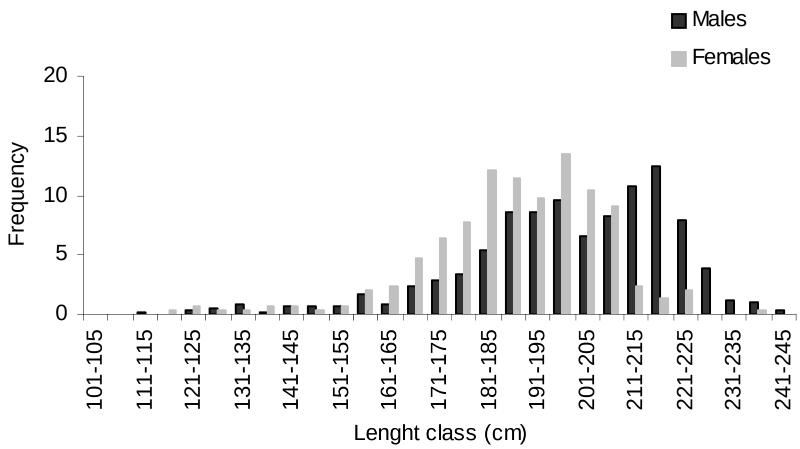

Fig. 3. Length distribution of stranded common dolphins during peak period

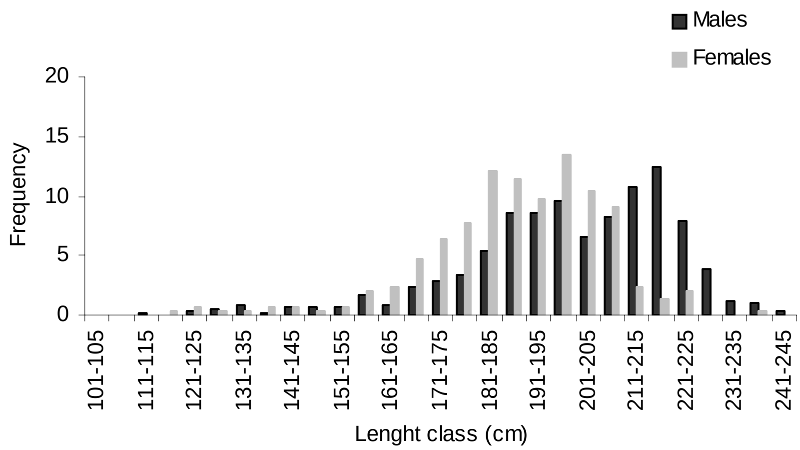

Fig. 4. Length distribution of stranded common dolphins during period of chronic stranding

DELPHINUS DELPHIS ABUNDANCE AND DISTRIBUTION AROUND THE MALTESE ISLANDS 1997-2001: ARE THESE DOLPHINS STILL COMMON IN MALTESE WATERS?

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A long-term conservation research project running since 1997 has focused on the study of cetacean species in an area of 85,000km2 around and South of the Maltese Islands. The boats and plane surveys have allowed for detailed observations to be taken during all seasons of each year and encompassing both coastal and offshore marine habitats. Among the species observed the results on *Delphinus delphis* abundance and distribution is considered here to highlight its habitat preference, travelling and seasonal behaviours (mating, young rearing, migrations), anthropogenic and fisheries associations and survival problems in this area of the Mediterranean. This study has also observed and documented the recent encounters of two separate cases of lone *Delphinus delphis* (common dolphins) close to the Maltese Islands. *Delphinus delphis* strandings between 1997 and 2001 have been recorded as well. Local abundance data is compared to other observed and recorded abundance values in the Mediterranean in order to consider the extent to which the drop in abundance of this species observed in certain regions of the Mediterranean is observable in this area under study and to seek ways of promoting proper protection measures for this species. The group size for this species in this area for the period of study was found to range between 25 to 200. However the spread of some of these dolphin groups' sightings were noted to be so large that the best estimates would have been obtained only during plane surveys.

COMMON DOLPHINS (*DELPHINUS DELPHIS*) STATUS IN THE CENTRAL AND SOUTHERN MEDITERRANEAN AROUND THE MALTESE ISLANDS

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INTRODUCTION: Since 1997, the scientific conservation research project focusing on cetaceans in the Central and Southern Mediterranean Sea around the Maltese Islands has managed to increase accurate information of the various species inhabiting these waters (Vella 1998, Vella 2000). Among the species studied, this research considers the common dolphin, *Delphinus delphis,* that is particularly necessary for its conservation assessment, monitoring and management planning requirements in the Mediterranean and due to the need of contributing to international agreements such as ACCOBAMS (Accobams Bulletin 2000). Though Mediterranean Cetaceans are legally protected in the Maltese Islands, this scientific field conservation research project is the only local effort that may furnish the required details for effective conservation measures. Common dolphin distribution, abundance, habitat preference, behaviours, and associations with fisheries that are exploited in the same area are among the parameters studied. Marine habitat degradation and resource over-exploitation are considerations that need to be addressed since both may affect cetacean survival in the region. The cetacean research area is shown in part in the Map provided (Fig.1) and includes most of the fishing area also utilised by Maltese fishermen.

Outside the 25 mile zone around the Maltese Islands, Maltese fishermen share the area with numerous other fishermen from other Mediterranean and Non-Mediterranean countries, particularly during the Blue fin tuna fishing season but also during the dolphin fish/pilot fish fishing season. These activities are of particular importance to species such as the common dolphins that may be increasingly disturbed by the rising fishing effort in this Mediterranean region. Fisheries' statistics show declines in catch amounts for most exploited fish species in recent years. Knowledge of the impacts of these trends on common dolphin, is necessary for both sustainable resource utilisation and effective preservation of legally protected species such as Common dolphins.

METHODS: Field research around the Maltese Islands included both boat (N=255) and aerial (N=36) surveys undertaken between 1997 and 2002 year round. Results and observations were obtained after a total strip transect of 23,000km^2 was covered using boat and aerial surveys method described in Vella 1998. During these field observations the following parameters are recorded: number, sizes, behaviours (feeding, mating, young rearing, diving-time sequence, etc.), and association with fishing activities and fish stocks in area. Photo-identification studies are also in progress for common dolphins in the research area. Land surveying is another aspect of this research work, it is not the best method to study common dolphins, however some groups have been observed from land with powerful binoculars. This method however has proved important in monitoring the behaviour of the lone young common dolphin case in B'Bugia port/bay in October 2001.

The field research is compared to the inflow of sea-user sighting records which are forwarded in structured manner to support this cetacean project from various entities, including the Armed Forces of Malta, fishermen, yachtsmen, sailing boat crew members, and ferry boat observers of the Gozo Channel. Maltese fishermen's activities and problems out at sea have been considered as well (Vella 1998), and another questionnaire was undertaken in 1999.

A record of common dolphin strandings and possible causes of death is noted, with a particular follow-up on what is seen out at sea during field trips and considerations of the problems these species may be facing in their environment. These methods allow for the assessment of seasonal variation in the both the cetacean parameters and the possible associations between different cetacean species and the different fisheries exploited.

DISCUSSION: Through this research project, the abundance of Common dolphins species in this region of the Mediterranean is found (Tables 1 & 2) to compare well with the higher densities and abundance estimates in certain Southern parts of the Mediterranean. Indeed several authors have indicated that this species seems to increase in abundance as one goes Southward below the 38^{o}00'N latitude (Politi *et al.*1992; 1994; Notarbartolo di Sciara 1993; Frantzis, 1996; Pulcini & Pace 1998; Sagarminaga & Canadas 1998). Since few studies however were undertaken year round in the Mediterranean it is also important to consider possible differences in abundance and distributions due to seasonal changes. This research may thus aid in considering this important variable as well. Especially in planning conservation areas or conservation management programmes for long-term effectiveness for common dolphins, it is vital to establish the locations and sizes of home-ranges, the extent of seasonality in home range use and the extent of fidelity in migration paths taken by the species between areas used. The common dolphin species observed in this region appear to show large home ranges with drastic increase in group sizes and abundance closer to the Maltese Islands during the September and October period. During this period common dolphins are also observed to travel closer to land than is typical of this species at other times of the year in this region (Table 3). Thus the Maltese Islands may be positioned in an important travel path during these months.

The greater exploitative competition for natural resources in the Central/Southern Region of the Mediterranean may be seriously jeopardising the survival of this species (Table 4) as may be noted by the number of strandings and increasing incidences of lone dolphins in this region (Tables 5 & 6) especially during peaks in the fishing effort offshore between May and December. The strandings of common dolphin species in June and October, together with the incidences of lone individuals in June and October may be pointing further to serious conflicts and distress between fishing activities and this species during these periods. The fact that Blue fin tuna and dolphin fish fishing activities peak in these two months may need to be considered in the near future for the survival of this species in this region of the Mediterranean. It is hoped that with the ACCOBAMS coming into force in 2001 (ACCOBAMS 2000) support for monitoring and management programs will come into practice, so as to reinforce environmentally sustainable fishing practices and promote areas for common dolphin survival in the Mediterranean. As the Maltese Islands seem to be situated in an area of the Mediterranean where common dolphins are more abundant it is essential that plans to effectively protect this species in this area be given critical consideration.

ACKNOWLEDGEMENTS My thanks for making all the above work possible go to:

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Table 1. Group size of *Delphinus delphis* (Common dolphins)

From field sessions with Common dolphin observations:

Average Group Size**: 26 (N=85)** St. Dev.: **33** Groups Size Range: **1 to 250**
Average Group Sighting frequency per hour in research area: **0.015/hr**

Largest Group sizes (150-250) were observed in September and October months, indicating seasonality and migrations in a South-East or Eastern direction in this region at this time. Very often the only way of obtaining the group size in these cases is through aerial surveys, due to the spread of numerous groups of 25 to 50 individuals travelling together.

Table 2. Density of common dolphins in Central-Southern Mediterranean

Combined distance strip transect estimates of the parameters used to obtain an overall estimate of the number of Common dolphins in the research area around the Maltese Islands.

PARAMETER	ESTIMATE	%CV	%95 CONF. INTERVAL
Group density/km^2	0.005	11.2	0.002 - 0.015
Dolphin density/km^2	0.135	28.4	0.066 - 0.290

Table 3. Distance (kms) from the nearest coast for sightings of Common dolphins in this region

Descriptive statistics of distance (km) from the nearest coast for sightings of Common dolphins *(surveys undertaken between 1997 and 2001)*

N	MEAN	ST.DEV	ST.ER	RANGE
85	11.9km	12.2	4.9	1-115km

Table 4. Associations of Common dolphins with fisheries of economic importance in this region

The following interactions are noted to be seasonal in the research area.

Blue fin tuna are in the research area between May and July: 35% of common dolphins sightings during this period were in association with this species.

Dolphin fish are in the research area between August and January: 40% of common dolphins sightings during this period were in association with this species.

Table 5. Lone cases of *Common dolphins* close to the Maltese coasts

In the 2001 two cases of lone common dolphins have been recorded for the first time in this region, since prior to these two cases the smallest group size was of two individuals. Both lone individuals were observed close to the Maltese coasts.

First case in 27th June 2001 the individual was an adult. It was observed in the same area for two days.

Second case observed from the 11th to the 23rd of October 2001: the dolphin was young observed in the polluted B'Bugia port/bay area. The individual remained in the area until it was found dead and in advanced stage of decomposition. No evidence of infections or parasitic infestation was detected in the examinations undertaken by Dr. A. Casha (Vet) asked to undertake a post-mortem autopsy by the Environment Protection Department in Malta. The autopsy showed that the animal had no food in its stomach and intestines and that water may have penetrated part of her lungs. Vital organs were found to be in functional order. The animal's teeth were very small, nearly transparent and hollow, aging this young female dolphin to less than one year.

Table 6. Stranding records of *Common dolphins* between 1997 and 2001 in the Maltese Islands

1. October 1997	Young dolphin with tail wound (nearly cut off)
2. June 1999	Adult decomposed - DNA identification
3. June 1999	Adult with wound in head
4. October 2001	Young lone dolphin found dead after observed alive for days in the harbour

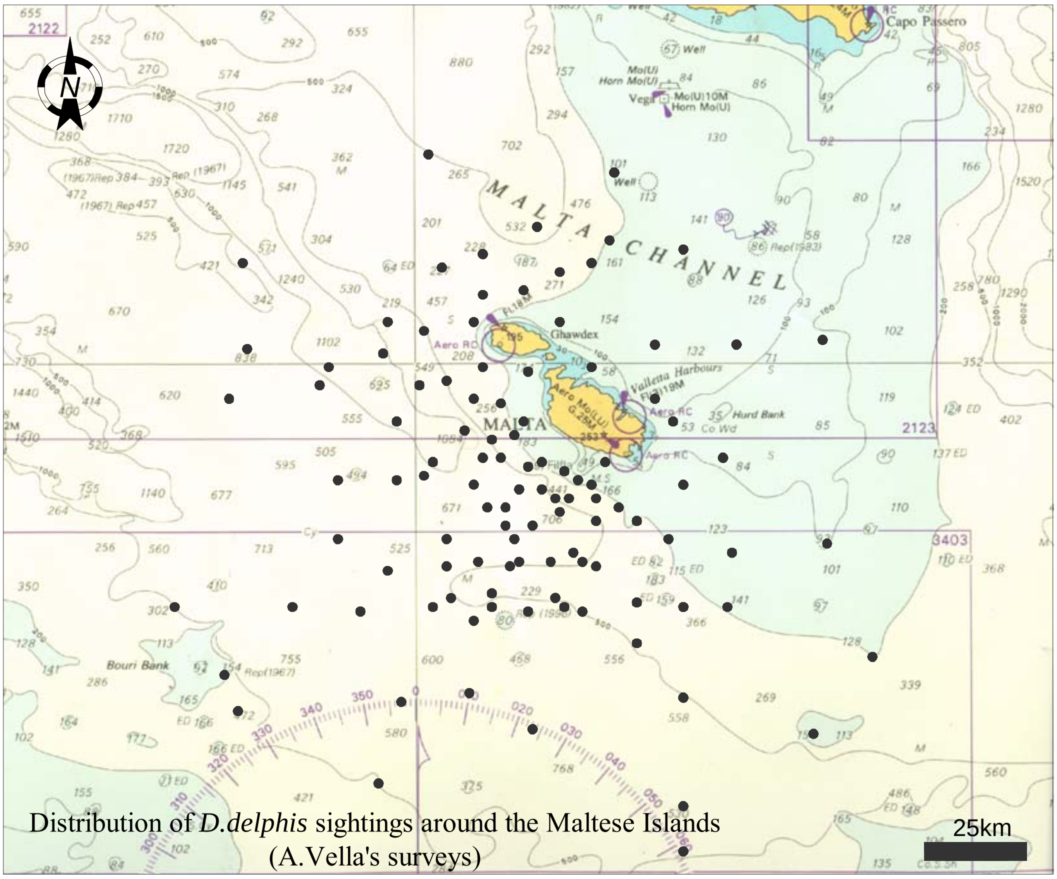

Fig. 1. Map of the Sighting Distribution of Common dolphins *(this map is a subset of the whole research area, focusing on the area closer to the Maltese Islands)*

CAUSES AND EFFECTS OF DISTURBANCE ON HARBOUR SEALS (*PHOCA VITULINA*) BEHAVIOUR IN THE ESTUARY OF SOMME (FRANCE) DURING THE SUMMER

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The Bay of Somme is a 70 square km-wide tide estuary situated on the coast of the eastern French Channel. For 20 years, this site has been the largest harbour seal (*Phoca vitulina*) colony in France. The highest number of individuals occurs in August and then decreases in autumn and winter. The seals haul-out on intertidal sandbanks and reach their maximum number every low-tide period. Since 1990, summer watching operations (July – August) have allowed us to determine the factors and effects of disturbance on seal's behaviour and hauling out rates.

The summer period is characterised by the growing number of users present within the estuary and especially tourists. Between 1995 and 2000, we noted that disturbances from the sea were the most prejudicial, and notably jet-skiing, fishing activities and other boaters (54%). The remaining sources of disturbance are in order of importance : walkers on sandbanks and aircraft (planes and helicopters). These have led seals to move towards water and leave the sandbanks. Mother and calf pairs were more sensible than larger and older seals. As a result, the strandings of precocious pups are amplified, and suckling as well as moulting rates are disturbed. At long term, extension of tourist and boat activities may impact the presence of seals in this area.

INTERACTIONS BETWEEN A RESIDENT POPULATION OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) AND FISHING ACTIVITY AROUND THE ISLAND OF LAMPEDUSA, ARCHIPELAGO OF THE PELAGIAN ISLANDS (SICILY, ITALY)

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The Bottlenose dolphin (*Tursiops truncatus*) is impacted at various degree by several human activities throughout its range. In many areas, Bottlenose dolphins have adapted feeding strategies to human activities, probably because overfishing and destructive fishing caused a general state of degrade and depauperation. In 1996, the Nature Conservation Department of the CTS started a long term monitoring programme of the Bottlenose dolphin population in the Island of Lampedusa, Archipelago of the Pelagian Islands (Sicily – Italy), resulting in the foundation of a Dolphin Research Centre in summer 2001. Researches have been carried out through boat surveys, photo-identification techniques and bio-acoustics recording, and through land posting using binoculars and spyglasses. Researches results have increased the knowledge on the population size: a residential group has been photo-identified and has been studied since 1996; the group is composed of females, males, subadult and juveniles. The animals have been monitored for long time to determine variations in their behavior during the day and data have been collected to draft a specific ethogram. About the habitat use, the results are demonstrating that dolphins have adapted their feeding habits to take advantage of human activities. Following trawlers and other fishing boats they feed on the unwanted fish that are thrown overboard, eating netted or hooked fish, fish stirred up by nets and propeller washes and fish attracted to idle vessels, eating netted fish and fish discarded by fishermen. These activities are increasing every year more, bringing the local population of dolphins into conflict with fishermen interests. Since 2002 an integrated monitoring program collecting bio-acoustic recordings, by a fixed station, and monitoring the quantity of catch directly on the fishing boats, will provide additional information to achieve effective conservation of the species.

CRITICAL HABITAT

SHORT-BEAKED COMMON DOLPHINS AROUND ISCHIA, ITALY, AND KALAMOS, GREECE: RELIC POPULATION UNITS OF PRIMARY CONSERVATION IMPORTANCE IN THE MEDITERRANEAN SEA

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The decline of the Mediterranean population of short-beaked common dolphins (*Delphinus delphis*) has been the subject of controversy among scientists and indifference among managers, which has contributed to delaying research and conservation actions. Lack of population estimates and of consistent time-series data have prevented full understanding of historical and ongoing trends in most areas. However, literature, photographic documentation and osteological collections unambiguously indicate that short-beaked common dolphins were once frequent in the Mediterranean Sea. Today, the species remains relatively abundant in the Alboran Sea, while it is extremely rare or it has completely disappeared from other portions of the basin (uncertainty exists for unexplored portions of North African coasts and Aegean Sea). Areas containing critical habitat have been identified around the islands of Ischia, Italy, and Kalamos, Greece, where relic population units survive. Their fate, however, represents a source of concern. Longitudinal studies suggest that several factors may have converged to cause population decline, including: 1) a reduced availability of key prey caused by overfishing and habitat degradation, 2) habitat contamination by xenobiotic compounds that accumulate in dolphin tissues through biomagnification and cause in particular immune-suppression and reproductive failure, 3) bycatch in fishing gear, and possibly 4) disturbance by vessel traffic. The relative importance of these threats may vary among Mediterranean sub-areas. The Kalamos population unit has shown signs of dramatic decline within the past eigth years, possibly due to reduced prey availability, while animals around Ischia are exposed to threats including overfishing, illegal driftnetting and heavy boat traffic. Therefore, urgent conservation and management actions should be implemented, i.e. the immediate establishment of pilot protected areas accompanied by experimental management plans that include intensive dolphin monitoring, restrictions on fishing activity and vessel traffic, education efforts directed at the local fishing communities and recreational users, and research.

SHORT-BEAKED COMMON DOLPHINS AROUND THE ISLAND OF ISCHIA, ITALY (SOUTHERN TYRRHENIAN SEA)

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INTRODUCTION Short-beaked common dolphins (*Delphinus delphis*) in the Mediterranean have undergone a dramatic decline in abundance during the last few decades, and have almost completely disappeared from large portions of their former range. This study provides information about a relic population unit in the central Mediterranean Sea.

METHODS Observations, totalling 79h 45min, were carried out between July-September from a 18m sailing vessel. Most of the survey effort was concentrated north of the island of Ischia, within 11 km from the coast, during 256 daily surveys covering nearly 8,500 km.

RESULTS There were a total of 51 short-beaked common dolphin sightings between 1997-2001 (Fig. 1). Group size data presented here is based on a sub-sample of 41 sightings, for which best group size estimates were available. *Delphinus* groups were relatively large (mean=65.5 SD=23.94, N=41, range 35-100 individuals). In 18% (N=41) of the sightings, short-beaked common dolphins were in mixed groups with striped dolphins (*Stenella coeruleoalba*).

The animals were mostly sighted over the submarine canyon of Cuma, a highly productive marine area characterised by high pelagic biodiversity and multi-species associations. The area represents an important feeding site for other cetacean species, including striped dolphins, Risso's dolphins (*Grampus griseus*),and fin whales (*Balaenoptera physalus*; Mussi et al. 2001).

A total of 46 individuals could be photo-identified based on long-term natural marks on their dorsal fins (both nicks on the dorsal fin's trailing edge and fin pigmentation pattern where considered). Of these, 19 individuals were re-sighted in different years, suggesting high levels of site fidelity.

Breeding activities were often observed, and calves were always present in one or more of the group sub-units (Fig. 2). Surface feeding (Fig. 3) occurred frequently and appeared to focus on skippers, *Scomberesox saurus*, a seasonal fish that is highly valued on local markets. Local fishermen claim that co-operative fishing may occur in the area, with fishermen taking advantage of fish aggregations that are actively schooled by short-beaked common dolphins near the surface. In the past, fish rewards were offered to the dolphins in reciprocation. Based on interviews conducted locally, the skipper fishery fleet has decreased by one order of magnitude in the last two decades due to declined fish stocks.

DISCUSSION Observations took place in the busy summer seasons, when pleasure boats and ferries crowd these waters. Commercial and passenger traffic in the Gulf of Naples and nearby islands (Ischia, Procida and Vivara) reportedly exceeds 200,000 trips/year, and up to 2,000 pleasure boats may be moored during the summer in the ports of Ischia. Ship collisions in the area have been documented for cetacean species including striped dolphins, common bottlenose dolphins (*Tursiops truncatus*) and fin whales, while a dramatic harassment event on Risso's dolphins has been reported by Miragliuolo *et al.* (2001). Despite the relatively high abundance of vulnerable cetacean population units, the waters around Ischia are commonly used for extemporaneous offshore races, implementation of coastal speed limits being virtually null.

Another potential threat to short-beaked common dolphins and other cetaceans in the area is represented by the illegal driftnet fishery, sadly known for the heavy toll paid by Mediterranean cetaceans (Di Natale and Notarbartolo di Sciara, 1994; IWC, 1994; Silvani *et al*., 1999). This fishery is reportedly impacting local cetacean communities, with documented bycatch events involving striped dolphins, common bottlenose dolphins, sperm whales (*Physeter macrocephalus*) and fin whales.

The creation of a marine protected area has been proposed, with the intention of supporting conservation actions and ultimately protecting the local cetacean fauna against threats posed by human activities.

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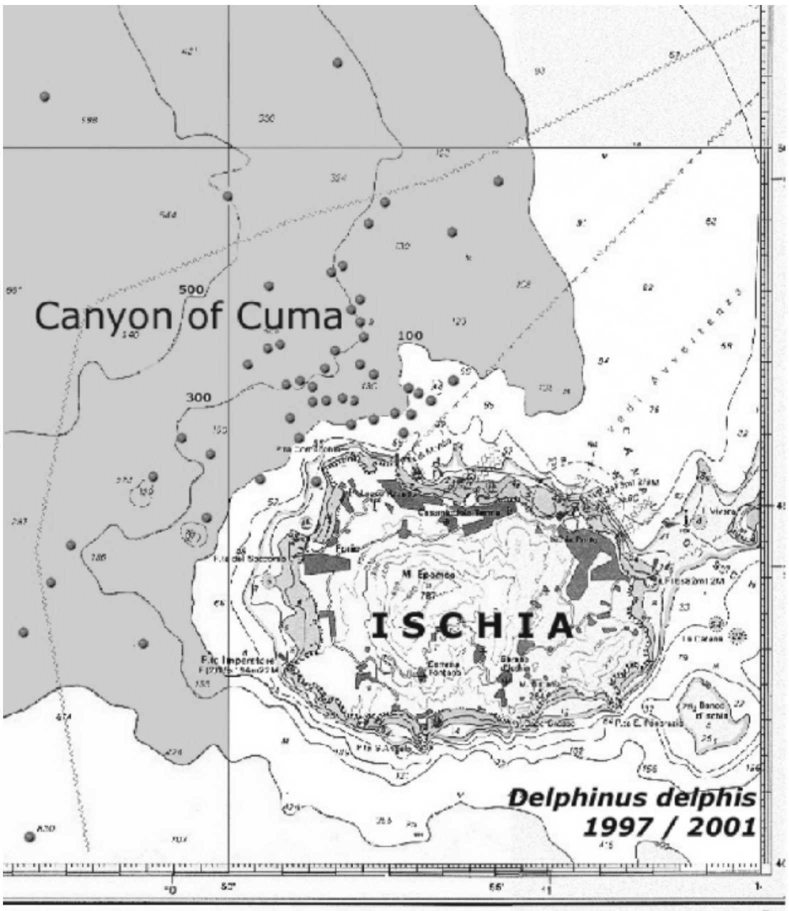

Fig. 1. Map of the sightings of short beaked common dolphin in the study area

Fig. 2. Photo-identified female short beaked common dolphin with calf

Fig. 3. Surface feeding

ECOLOGY

RELATIONSHIP OF MINKE WHALES (*BALAENOPTERA ACUTOROSTRATA*), HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) AND FEEDING-GROUPS OF SEABIRDS IN THE INNER HEBRIDES, SCOTLAND

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Whales and several seabirds are able to herd fish close to the surface and thus facilitate prey capture not only for themselves but also for other species. Seabirds could thereby take advantage of cetaceans, but a whale might also be acoustically attracted by feeding birds. The local and temporal distribution of each taxa might shed light on the direction of a potential dependence. During September 2001, the time, location, and composition of a total of 110 sightings of seabird aggregations were compared with 178 minke whale and 156 harbour porpoise sightings around the Isle of Eigg, West Scotland. Seabird aggregations ranged in size from 40 to 543 individuals and typically contained razorbills, common guillemots, kittiwakes, herring gulls, great black-backed gulls, and shags in changing compositions. 45% of the groups had a minke whale associated with them, whereas only 10% had harbour porpoises in their vicinity. The presence of a whale was independent of the overall group size and composition. However, all feeding-groups contained auks, which are able to herd shoals of fish (identified as herring and sprat) near the surface, thus making them accessible to other bird species and, as a compact ball, to minke whales. Significant correlations were found between the group size of several bird species. Since the seabird aggregations had always formed and were actively feeding before a minke whale arrived, we suggest that the whales took advantage of the bird groups driving fish together rather than vice versa. Feeding whales followed the same diurnal pattern as the birds, suggesting that both taxa adapted to the time pattern of the prey, whereas no common temporal distribution was found between harbour porpoises and birds. Although minke whales and harbour porpoises were thought to share the same prey in the area, niche differentiation by different feeding strategies seems plausible.

EXTREME POPULATION SEGREGATION IN KILLER WHALES: THE ROLES OF INBREEDING AVOIDANCE, SONG, AND TRADITIONS

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Coastal killer whales in the northeastern Pacific Ocean show a remarkable degree of sympatric and parapatric population segregation. Two dietary specialist ecotypes are well studied: fish-eating *residents* and mammal-eating *transients*. These overlap partially with a poorly known third ecotype referred to as *offshores*. The resident and transient ecotypes both consist of at least three genetically discrete regional populations which in turn are distinct from the offshores, thus a total of at least seven well-defined populations coexist within a single continuous environment. The populations are small relative to those of other species, containing an average of 130 individuals each. Here, I hypothesize that this extreme population segregation results from the combination of effective inbreeding avoidance, which decreases the genetic cost to individuals of remaining in their natal populations; the use of stereotyped calls, which allows the social cohesion of physically dispersed groups; and culturally-transmitted feeding traditions, which favour individuals that remain in their natal population. The following findings support the hypothesis: 1) In residents, most matings occur between individuals from pods that belong to the same population but have markedly dissimilar acoustic repertoires. Since relatedness and repertoire similarity are correlated, this mating preference results in lower inbreeding levels than would be expected in a same-sized random mating population. 2) Pods use unique calls to announce their identity over long distances (Ford 1991 Can. J. Zool. 69:1454). Pods hearing the calls of members of their own population often approach and intermingle with the callers. Mating occurs during these temporary associations which presumably promotes and helps maintain social ties within populations. In contrast, calls do not elicit social contact between members of different populations. 3) Cultural traditions that enhance survival are demonstrated by directed travel of both resident and transient killer whale pods between widely-dispersed but seasonally-consistent prey hotspots. The hypothesis implies that population maximum size is a function of the frequency with which pods associate, with fission occurring if the size and range of a population become such that some member pods fail to encounter others at a threshold rate. It also implies that killer whale populations are functional social units, vindicating Bigg's categorization of them as "communities" (1982 Rep. Int. Whal. Commn. 32:625).

CADMIUM AND MERCURY IN FOUR SPECIES OF MARINE MAMMALS FROM THE FAROE ISLANDS : FACTORS RESPONSIBLE FOR THE CONCENTRATIONS

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Numerous factors are responsible for the variability of cadmium and mercury concentrations in marine mammals species or even in segments of populations of the same species and it is necessary to identify the main factors leading to the exhibited concentrations. Diet is probably one of them, cephalopods and fish being the major vector of cadmium and mercury respectively. The northern sub-polar area appears to be a region of a great interest to study the processes of bioaccumulation, since there is a cadmium enrichment in the food web, which induces marine mammals to exhibit high cadmium concentrations in their tissues. Thus, cadmium concentrations in kidney and mercury concentrations in liver have been compared in four species of adult individuals of marine mammals from the Faroe Islands (north-east Atlantic Ocean), exhibiting different feeding habits : pilot whales (*Globicephala melas*) and northern bottlenose whales (*Hyperoodon ampullatus*) mainly squid eaters, Atlantic white-sided dolphins (*Lagenorhyncus acutus*), and grey seals (*Halichoerus grypus*), mainly fish eaters. Pattern of Cd in kidney appears to fall into 2 broad categories with high levels in Atlantic white-sided dolphins (25±5.4 µg.g-1 wet weight) and grey seals (34.4±13.6 µg.g-1) and very high levels in northern bottlenose dolphins (91.5±30.4 µg.g-1) and pilot whales (94.8±39.2 µg.g-1). Hence, feeding specialisation emerged as a major source of inter-species variation of cadmium levels among fish- and squid-eating marine mammals. Pattern of Hg in liver appears to fall into 3 broad categories, with very low levels in northern bottlenose whales (0.78±0.77 µg.g-1), high levels in Atlantic white-sided dolphins (52±26.2 µg.g-1) and pilot whales (79.3±43.5 µg.g-1), and very high levels in grey seals (126±57.2 µg.g-1). Besides diet other factors such as assimilation and excretion rates, body size must be considered to explain mercury concentrations.

DO MANIPULATIONS AND DEVICE ATTACHED ON LACTATING FEMALES ANTARCTIC FUR SEALS (*ARCTOCEPHALUS GAZELLA*) PLAY A ROLE ON THEIR PUP GROWTH ?

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We investigated pup growth in Antarctic fur seals (*Arctocephalus gazella*) on Heard Island during summer 2000-2001. From the beginning of December (birth period) to the beginning of March, the seal colony was visited at least twice a day and every pups encountered were weighed and lenghed. Some females were also manipulated : some were just weighed once, some had a PTT-TDR device attached and retreived and some others were weighed 3 times or more in order to monitor the milk transfer from mum to pup. These manipulations were not exclusive. We always presented the mother to her pup as soon as she was released to reduce the risk of a flying response to the sea. But this risk exist and we were then intersted in the effect these manipulations could have on pup growth. Correcting for female age, we compared the growth of pups with mums not manipulated at all and pups with mums manipulated on one hand and mums with a device attached on the other hand. The results are quite interesting and must play an important role in the way futur studies on fur seals should be conducted.

BOAT TRAFFIC AND SEAWEED GATHERING IN THE IROISE SEA. WHICH HAS A BIGGER IMPACT ON DOLPHIN DISTRIBUTION ?

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Many coastal bottlenose dolphin ranges include high boat traffic areas,especially during summer when the number of recreational boats is at its highest. What is the extent of this superposition? In the Iroise sea (westof Brittany), a bottlenose dolphin group considered as coastal is present in the Molene archipelago and another group has been resident in a restricted range around Ile de Sein and studied since 1992. Several small boat surveys were carried out in the Molene archipelago during summers 1992, 1995, 2000 and 2001 to describe distribution patterns of the group. The area can be divided in two parts : the south-western area which was mainly used by dolphins during 1992 and the south-eastern area corresponding to their core range during the following field studies. Boat traffic is mainly concentrated in the south-east area because of the closeness to mainland harbours and safe navigation compared to the south-west part with manyrocks. During the last decade, dolphins changed their range : they left an area with low traffic to move towards one with highest boat pressure. Moreover, the recreational traffic has increased during the last years. The south-east area is mainly used to forage. We could hypothesise that such an area could satisfy dolphins basic needs like energy requirements and that the potential disturbance from recreational boat has a lower influence on dolphins distribution than prey availability. The observed shift of range during the last decade may have been induced by seaweed gathering mainly occurring in the south-western area which may have significantly changed the habitat of dolphin prey species. This situation sets the difficult problem of managing an area with objectives to protect species and also to preserve human activities. The marine national park project of Iroise sea is confronted with this predicament.

DISTRIBUTION AND HABITAT USE OF BOTTLENOSE DOLPHINS OF KVARNERIC, CROATIA: IDENTIFICATION OF CRITICAL HABITATS

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As part of a long-term programme studying the ecology of bottlenose dolphins inhabiting the waters of the Kvarneric archipelago, Croatia, abundance was estimated, in 1997, at 113 dolphins (95% CI = 107-121, SE=6.967, proportion of highly marked 0.53), in an area of over 1000 km2. Recently part of the study area has been proposed as a Special Marine Reserve for dolphins. This zone experiences heavy human exploitation, seasonally by tourism and year-round by small-scale fisheries, that increases each year. This study analyses dolphin distribution and habitat use to provide insight for the management of possible critical habitats. The distribution of sightings and dolphin habitat use were investigated between March 1995 and September 2001. GIS was used to integrate a total of 298 sightings with sea-surface temperature, submarine slope, distance from the coast, number of dolphins present and the distance to sites affected by high intensity human use, such as harbours and shipping lanes. These parameters were considered within cells of 1000 m2 size. Correlation with environmental and others factors were analysed by using Generalised Linear Models and the spatial analysis tools of ArcView 3.2. The number of sightings varied greatly between years, without any apparent trend, except for a significant decrease of almost 50% in 1996. The distribution of sightings showed high seasonal and annual variability. The density of dolphins, number of dolphins per unit area (cell) weighted by the effort in each cell, was then used to look at the “critical” zones. Throughout the study period dolphins showed a particular preference for at least 4 sites that are suggested to be representative of critical habitats possibly due to underwater currents more than their submarine topography. These sites are of particular interest for management because they are correlated with areas of high human activity.

DISTRIBUTION PATTERNS OF BOTTLENOSE DOLPHINS *(TURSIOPS TRUNCATUS)* OFF THE BALEARIC ISLANDS.

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INTRODUCTION The bottlenose dolphin (*Tursiops truncatus*) is believed to occupy only coastal waters in the Western Mediterranean and is therefore most likely to be affected by human activities. It is considered the most endangered cetacean species in this area. Its Mediterranean population is catalogued in the Red Book of the Spanish Vertebrates as Vulnerable, and the Habitats Directive (EU) and the Bern Convention consider it in need of protection. Through the analysis and detailed review of the totality of sightings in Balearic waters recorded in the database of GRUMM (Group for the Study and Conservation of Marine Mammals, University of Barcelona), this study aims to highlight the importance of this area for the conservation of the species.

A total of 235 sightings of bottlenose dolphins off the Balearic Islands have been recorded since 1985 (Map 1). During this long-term study many different parameters have been considered. This study examines patterns of distribution, depth range, distance from coast, group size and the presence or absence or calves within a given group. Its main goal is to improve our understanding of the ecology of the species in Balearic waters, in order to identify the most relevant areas and develop a conservation action plan.

RESULTS **Distance from coast.** 30% of the sightings were recorded between 4 and 10 nm from coast and only 5% were beyond that. Most sightings (65%, n=142) were within the first 4 nm from shore at an average depth of 114.7 ±14.3 m. (Fig. 1)

Depth range. 11 % of the sightings were reported in waters no deeper than 30 m, 67 % in waters between 31 and 100 m, and 22 % in waters over 100 m deep. The highest mean group size was for those sightings in waters over 100 m deep, with a value of 4.49 ±6.25. (Fig. 2)

Group size 64.22 % of the sightings were composed of 1 – 4 individuals, 24.14 % of 5 –10 dolphins, and only 11.64 % had a group size greater than 10 (Fig. 3). From 1991 to 2001, the average group size decreased significantly ($p<0.05$) from 8.9 ±8.13 in 1991 to 3.7 ±2.43 in 2001 (Fig.4).

Schools with calves Precise information on the presence or absence of calves within the group was available only for 160 (68 %) sightings. Of those, 32 % (n=51) contained calves. Most (96%) of the sightings with calves were within the first 10 nm from coast. The highest percentage (43%) was detected at a distance of between 2 and 4 nm from coast at an average depth of 91.47 m (± 63.77) (Fig. 5). The average size of groups sighted with calves (7.48 ± 6.19) was significantly higher ($p<0.05$) than those without (4.11 ± 4.10).

CONCLUSIONS Bottlenose dolphins around the Balearic Islands are mainly found within the first four nm from the coast, in waters ranging from 30 to 150 m in depth.

Most sightings were of a maximum of four individuals. Larger groups (up to 25 individuals) were found in waters deeper than 100 m.

The number of individuals per group has decreased in the last decade.
Schools with calves are mainly observed between two and four miles from the coast, and only sporadically beyond 10nm.

The presence of calves correlates with group size. Groups with calves were almost double the size of groups without.
Future management of the species and design of Marine Protected Areas should take into account the presence of the species not only in coastal waters but also several miles off shore.

ACKNOWLEDGEMENTS Thanks are due to all persons, groups and institutions who supplied sighting data. Project funded by the Spanish Ministry of Environment and EU-LIFE project NAT/E/7303.

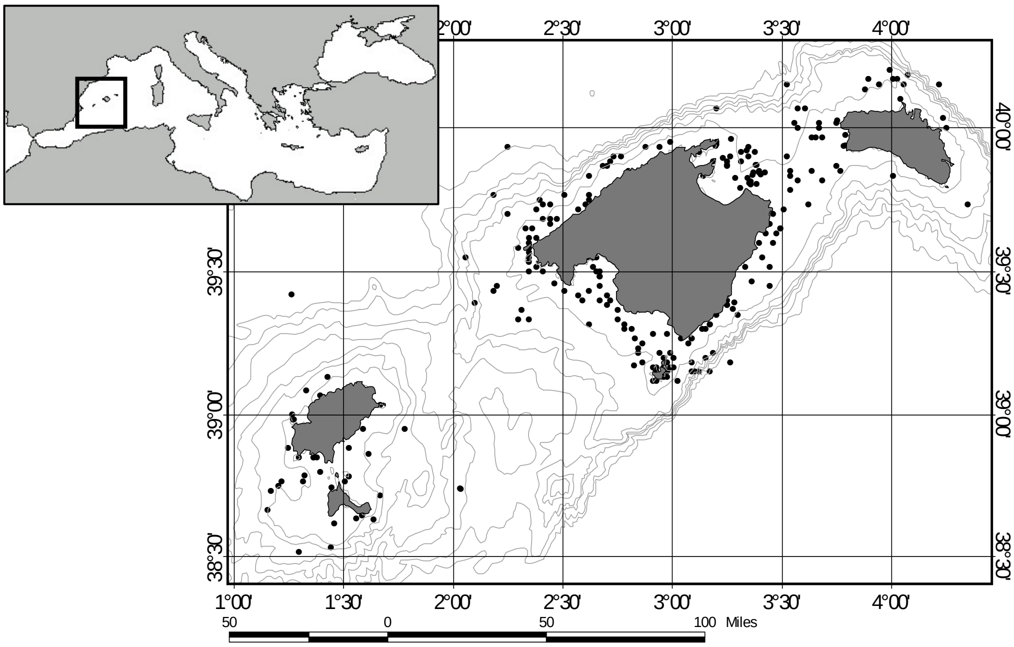

Fig. 1. Study area showing the sightings of bottlenose dolphins (•)

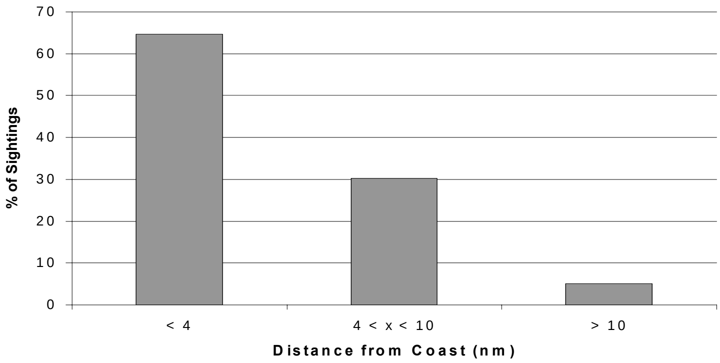

Fig. 2. Percentage of sightings in relation to distance from coast

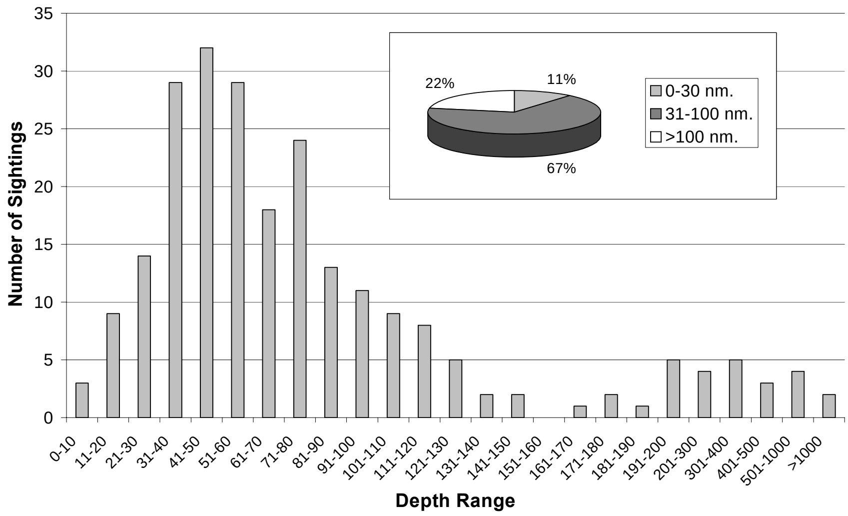

Fig. 3. Number of sightings for each depth range

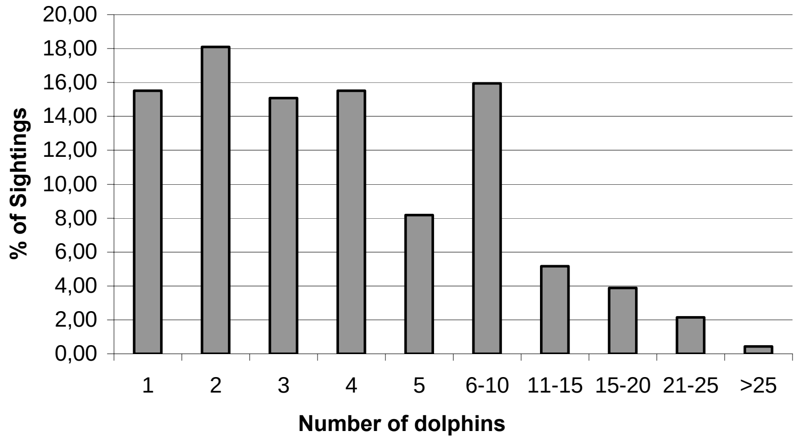

Fig. 4. Percentage of dolphins in relation to their group size

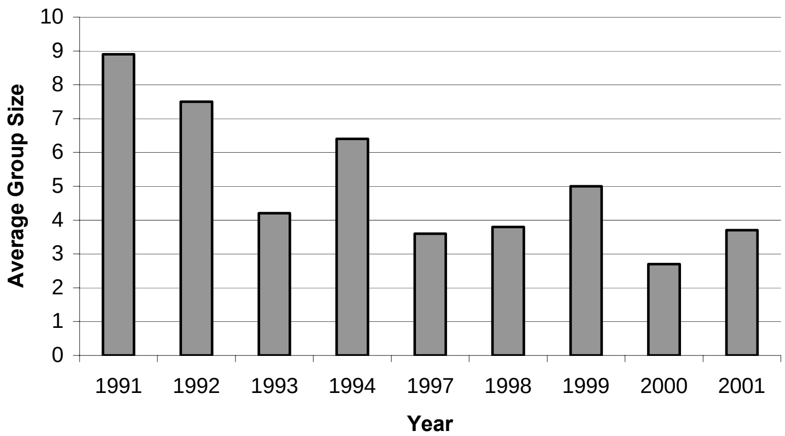

Fig. 5. Average group size per year

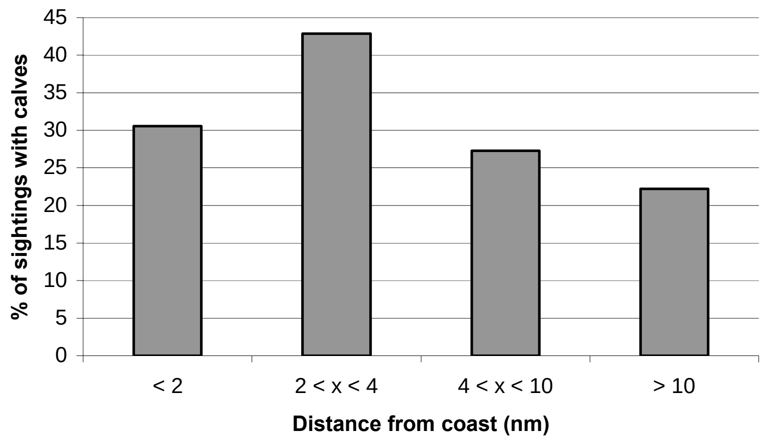

Fig. 6. Percentage of dolphins with calves at different distances from coast

THE ECOLOGY OF BLAINVILLE'S BEAKED WHALE (*MESOPLODON DENSIROSTRIS*) EAST OF GREAT ABACO, THE BAHAMAS

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This paper summarises data collected during a study into the ecology of Blainville's beaked whale (*Mesoplodon densirostris*) and investigates aspects of the biology, such as habitat preference, group size, social structure and reproductive biology. This study took place in the summer months between May 1998 and June 2001 to the east of Great Abaco Island in the northern Bahamas. Distribution of sightings through out the study area was not random and the majority of encounters occurred over the upper reaches of a marine canyon (the Little Abaco Canyon) in water depths of between 200 and 1000 meters. Analysis of photographs showed that individual animals were often resighted within and between years in the same area. Surface observations suggested that socialising and possibly foraging occur in this area. However, encounters which occurred away from this canyon area were most frequently found to be travelling. Group size varied from one to seven individuals, with the average group containing four individuals. Groups generally consisted of a number of adult females with or without associated calves and often accompanied by an adult male and/or maturing male. No groups were observed to contain more than one adult male. The observed sex ratio of adult males to adult females in this population was far from 1:1, and was closer to three or four adult females to every adult male. Heavy scarring observed on adult males indicate that adult males interact aggressively with one another. This coupled with the fact that two adult males were never sighted in the same group indicates that such aggressive interactions are probably over adult females and that males may aggressively exclude each other from social groups. This, along with the skewed sex ratio, suggests *M. densirostris* is polygamous and that males fight for access to receptive females.

RESTING AND BREEDING HABITS AND POTENTIAL HABITAT OF THE MEDITERRANEAN MONK SEAL (*MONACHUS MONACHUS*) IN THE ARCHIPELAGO OF MADEIRA

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The Mediterranean monk seal *Monachus monachus* is considered to be critically endangered and survives in small isolated subpopulations. The species seeks sea caves in order to rest and reproduce. Our knowledge of the habitat and the minimum requirements for resting and successful breeding has remained limited until now. In order to gain essential knowledge of the ecology and behaviour of the species in the area a project was initiated in 1989 aiming to: 1) Locate and chart the available monk seal shelters in the area, 2) Describe the caves used by the local monk seal population and identify the ecological parameters determining the selection of caves as resting or breeding sites and 3) Based on the knowledge of the habitat and the resting and breeding habits of the species in the area, identify which caves could be used in the future by the recovering monk seal population for resting and successful breeding. For this purpose the entire coastlines of the current species' distribution in the Archipelago was circumnavigated and all shelters located and charted. The results of a cluster analysis indicate the presence of eight cave types available to the species in the area. Almost the entire range of these cave types is used by the monk seals for resting. When breeding however, the species appears to prefer sea caves with beaches above sea level during high tide and long entrance corridors. The results of the study indicate furthermore the existence of a large number of caves suitable for resting. The number of suitable breeding caves in contrast appears to be limited. Latter caves have been located and are being closely monitored during the breeding season.

THE EXPLOITATION HISTORY OF THE PATAGONIAN MARINE COMMUNITY: A MULTISPECIES APPROACH TO THE DYNAMICS OF THE SOUTHERN SEA LION

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Since we still barely understand how communities are organised and regulated, it is not surprising to observe collapses in exploited populations. In marine fisheries, both over-fishing, and predation/competition involving marine mammals are among the arguments commonly raised in the quest for explanations. However, these questions usually do not have straightforward answers, largely due to the limitations imposed by the combination of complex dynamics, and incomplete and short-term databases. In the Patagonian case, an interesting historical process took place. The sea lion (Otaria flavescens) was heavily harvested between 1920 and 1960, the development of the hake (Merluccius hubbsi) fishery began in the 70's, whilst the squid (*Illex argentinus*) fishery developed in the 80's. These fisheries together represented in the 90's between 500-1,000 thousand tonnes per year. Also in this decade, the sea lion showed a clear recovery whilst the hake, most likely due to over-fishing, declined dramatically. The hake and the squid (together with the anchovy *Engraulis anchoita*) are key species of the Patagonian community. Since they also are important prey of the sea lion, we implemented a multispecies model to study this trophodynamic system. The model consisted of a set of ordinary differential equations, and is based on bioenergetics and allometric principles. Fisheries catches and the sea lion harvest are also included. Among other results, the model describes reasonably well the overall dynamics of the system, particularly the sea lion and hake populations. We also find that the squid fishery reduces the recovery of the hake population, and both fisheries promote the sea lion recovery.

RESPONSES TO FOOD-STRESS IN A FEEDING SUB-POPULATION

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We first observed food-stress among ichthyophagous minke and finback whales in 2000. Signs included subjects with visibly reduced back-blubber and prominent cervical vertebrae well beyond the mid-point of the feeding season. We know that these whales distribute themselves in the Laurentian Channel-head (LCH) relative to prey location and concentration (1994). So we asked the question: what happens to quantative aspects of spatial and numerical distributions when cyclical food-stress conditions pertain? We used photo-identification and GPS and GIS technologies to record, identify, locate, and track animals daily across the 2001 season, and applied log survivorship analysis to replicate samples of their feeding behaviours. Except for rare sightings, finback whales responded by leaving the study area, moving 30 to 40 km north and offshore, and switching target prey from fish to krill. Minke whales did not follow this pattern. Instead they made a major progressive shift in distribution across the season from the main feeding grounds at the LCH into the nearby Saguenay fjord, so that by October only one individual was sighted in the traditional feeding area. By comparison less than 5% of sightings were recorded in the Saguenay area during the entire 1999 season. Day-residence rates dropped from 10.5 to 8.1 animals in 2001 (n = 73 and 78 days), and estimated numbers from 154 to 90 individuals. We recorded structural changes in feeding techniques, including a move to shallower activity despite depth, and we documented the first observed use of bubbling strategies. There was a significant increase in the costs of foraging ($p < 0.01$, Mann-Whitney 'U') as measured by mean oxygen uptake (blow) rates of 90.7-h in 2001 compared with 80.5-h prior to 2000. In addition, we estimated a 23% lost in whale-food-days for the year versus 1999. These quantative responses have implications for population and reproduction estimates.

MODELLING PREY COMPETITION BETWEEN DOLPHINS AND TUNA IN THE NORTH-EAST ATLANTIC

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INTRODUCTION During the summer, the North-east Atlantic is a foraging area for juvenile albacores, *Thunnus alalunga*, which are exploited by the French drift-net fishery (Goujon, 1996). In the same area, large populations of small delphinids are known to occur : 62000 common dolphins, *Delphinus delphis*, and 74000 striped dolphins, *Stenella coeruleoalba* (Goujon, 1996). However until today, little is known of the trophic relationships between these three species of top predators and their impact on the oceanic ecosytem. We examined the diet of common and striped dolphins, as well as of the albacore, in order to assess their prey comsumption and investigate potential dietary competition between them by using the steady-state model ECOPATH.

MATERIALS AND METHODS Sampling. In 1992-93, the GERDAU programme was carried out by Ifremer (*Institut Français pour le Recherche et l'Exploitation de la Mer*) to study the ecological impact of this fishery on the populations of dolphins. Thanks to observers embarked onboard tuna drift-netters, stomachs of the three species were collected sympatrically (47°-50°N ; 12°-15°N) and simultaneously (June to August). The samples were frozen for later analysis in the laboratory.

Diet analysis Each stomach was weighted and its contents washed through a sieve of 0.2 mm mesh-size. Intact prey were immediately identified, measured and weighted. Bones, otoliths, cephalopod beaks and exoskeletons of crustaceans were sorted and identified at the lowest taxonomic level. For identification, we used published guides (Harkönen, 1986 ; Clarke, 1986) and a reference collection from specimens caught by trawlers off the French coast. All prey remains were stored in 70% ethanol, except otoliths and bones.

The number of fish species was determined by the half number of otoliths rounded up to the integer, whereas the number of cephalopod species was estimated by the maximum number of upper or lower beaks (Pierce and Boyle, 1991). For crustaceans, individuals were counted from the carapace or from the telson.

To describe the diet, 3 standard indices were used : percentage by number, percentage by reconstructed mass and body size. For diet quantification, we only took into account the fresh part of the stomach content in order to avoid the biases due to differential passage rates amongst prey types (Fig. 1). Preys, which take a long time to pass through (*e.g.* Cephalopods) would tend to be over-represented if all the remains were counted (Bigg and Fawcet, 1985). In contrast, exoskeleton of shrimps are fragile and rapidly digested. In the absence of sufficient experimental data on digestion rates the main prey types, we defined a limit from our own experience: the fresh fraction of the stomach content was defined as all crustacean remains and fish or cephalopod remains with some flesh still attached (Fig. 1).

The reconstruction of the prey body length and body mass was based on the measurements of the hard diagnostic remains. When more than 30 fish otoliths or jaw bones or cephalopod beaks were present in a stomach, a random sub-sample of 30 was measured. Relationships from the literature (Clarke, 1986 ; Härkönen, 1986 ; Reid, 1996 ; Whitehead *et al.,* 1986) allowed length and mass to be back-calculated.

Modelling An ECOPATH ecosystem model was used to explore and quantify food transfers to top predators and competitive relationships. The ECOPATH approach uses mass-balance principles to estimate flows of biomass through a trophic web (Christensen and Pauly 1992). Functional groups are defined, which gather all organisms sharing a similar trophic niche. Each group is represented by one balanced equation (Eq 1) and requires 7 input parameters : biomass (B), production (P), consumption (Q), ecotrophic efficiency (EE), diet composition (DC), exports (Ex) and catch of each group by fisheries (Y).

Eqn 1 $$P_i = Y_i + \Sigma\, B_j\, (Q/B)_j\, DC_{j,i} + Ex_i + P_i\, (1\text{-}EE_i)$$

EE is the fraction of production that is passed up the food web. Of the four basic input parameters (B, P, Q, and EE), three must be entered. The exports were supposed to be nil because we made the assumption that the detritus sedimentation outside this pelagic ecosystem was made up by the input nutrients in the ecosystem.

The compartments were built from the model of the Pacific Ocean elaborated by Trites *et al.* (1997). Our oceanic ecosystem was formed of the following groups : the common dolphin, the striped dolphin, the albacore, myctophids, other mesopelagic fish, cephalopods, shrimps, macro-zooplankton, micro-zooplankton, phytoplankton and detritus.

The input parameters are given in table 1. The values in bold type came from the North-east Atlantic (Goujon, 1996) including our first results on the diet analysis, while the model of Trites *et al.* (1997) provided the majority of the other values.

RESULTS Sampling 20 stomachs of striped dolphins, 18 of common dolphins and 30 of albacores were analysed for this study. About 75% of the dolphins were juveniles with a mean length of 168 cm.

Diet analysis Thirty-two different prey taxa were found in the diet of the common and striped dolphins (Table 2).
In the common dolphin, fish was the most important prey group, with 14 species of 8 families accounting for 73% of the total number of prey items and 52 % by mass. By far, the lanternfish (*Myctophidae*) dominated the fish diet by number followed by the *Sternoptychidae Maurolicus muelleri*. In terms of biomass, the dominating fish families were the mesopelagic lanternfish and *Paralepididae* and the epipelagic *Bramidae* and *Scomberesocidae*. The cephalopods were represented by 5 taxa belonging to 6 distinct families. They contributed almost half the estimated diet by mass (46%) due to the larger individual body mass of the *Gonatidae* and the *Cranchidae*. Crustaceans of 5 distinct taxa were found, mostly shrimps (*Pasiphaeidae*, *Sergestidae*) and euphausiids (*Euphausiidae*). They were of rather low importance by number and because of their generally smaller body size than fish of cephalopod prey, they reached only to 2% of the estimated prey mass.

Sixteen out of 24 prey species identified in the common dolphin diets were also found in the striped dolphins. Cephalopods were the most important taxa making up more than 47% by number and more than 62% by reconstructed mass, the most important species being the cranchiid *Teuthowenia sp*., the brachiotheuthid *Brachioteuthis rissei* and the gonatid *Gonatus steenstrupi*. The fish part of the diet was constituted of 13 species, from 7 distinct families, and was dominated by myctophids and paralepidids either by number or by mass. Crustaceans represented as much as 19.6% of the diet by number, but less than 5% of the diet by mass ; the dominant species were the same as in the common dolphin.

The diet of the albacore was dominated by fish, with *M. muelleri* accounting for 78% of the diet by number. The mesopelagic paralepidid *Arctozenus risso* contributed to 55% of the diet by reconstructed mass (55%) whereas *M. muelleri* represented only 32%, due to its smaller size. Euphausiids and hyperids accounted for 18% by number and 4% by mass of the diet.

Modelling The first parameterisation estimated the biomass for cephalopods and shrimps and the ecotrophic efficiency for the other boxes (Table 1, Table 3). The EE, which is the part of the production used in the system, is expected to be close to 0 for cetaceans and close to 1 for the lowest trophic levels. However, the estimated EE showed several aberrant values. The EE for tuna (0.2) is too low for a commercial species (Schultz, 2001) ; the predation pressure on Myctophids and other mesopelagics was much too low (0.0 and 0.2 respectively) compared to EE values for compartment of similar trophic levels (cephalopods and shrimps from the litterature) ; lastly, EE was more than 1 for zooplankton, which is not possible, and close to 0 for phytoplankton, which is unrealistic. A second parameterisation was carried out by forcing more realistic values of EE ; in this case the biomasses were re-estimated (Table 3). The phytoplankton biomass is realistic with a production of 800 t/km^2/y, or 0.2 g C/m^2/d, corresponding to the range of 0.1 to 0.5 g C/m^2 given by Blackburn (1981) for oceanic areas.

From this second parameterisation, common dolphin, striped dolphins and albacore had a similar impact on the system, with a global consumption estimated at 88, 100, 126 kg /km^2/y respectively. A niche overlap index (i) was used to assess the competition for food between species and showed a high overlap between the two dolphin species (i=0.9) and to a lesser extent with the albacore (i=0.3 with common dolphin; i=0.4 with striped dolphin).

CONCLUSIONS On the whole, the two species of dolphins and the albacore are suggested to have a similar impact on the ecosystem, when one considers the annual consumption irrespective of the prey species actually exploited. Fish and Cephalopods contributed rather equally to the diet of the common dolphin, whereas cephalopods slightly dominated the diet of the striped dolphin. Consequently, these two species display high overlap of trophic niche but no so with the albacore. Mesopelagic species, particularly myctophids, are important forage species both for the common and the striped dolphins off the continental shelf of the Bay of Biscay. The preferred albacore forage food were *M. muelleri* and *A. risso*, two species of secondary importance to the dolphins.

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Table 1. Input parameters for the different compartments of the system

	B (kg/km^2/y)	P/B (/y)	Q/B (/y)	Y (kg/km^2/y)	EE	DC
Common dolphin	**5.6**	0.1	**15.7**	**0.03**	-	**Present diet analysis**
Striped dolphin	**6.4**	0.1	**15.7**	**0.11**	-	**Present diet analysis**
Albacore	**20.0**	1.2	**15**	**5.05**	-	**Present diet analysis**
Myctophids	1270	0.6	7	**0**	-	95% Lz, 5% Mi
Mesopelagics	1270	0.6	7	**0**	-	90% Lz, 10% Mi
Cephalopods	-	1.6	16.6	**0**	0.8	100% Lz
Shrimps	-	0.1	0.4	**0**	0.8	50% Mi,50% Ph
Large zooplankton	10000	0.5	2.5	**0**	-	50% Mi,50% Ph
Microzooplankton	2500	20	96	**0**	-	20% Mi, 40% Ph, 40% De
Phytoplankton	15000	150			-	
Detritus	58720					

Table 2. Diets of the common (Dd) and striped (Sc) dolphins in the NE Atlantic, off the Bay of Biscay

Prey taxa	Diet by number		Diet by mass		Prey size	
	Dd %	Sc %	Dd %	Sc %	Dd x ± σ	Sc x ± σ
MYCTOPHIDAE						
Diaphus sp	1,29	5,30	0,23	0,98	82.7± 0	44.8± 13.3
Myctophum punctatum	0,12	0,05	0,04	0,02	64.7± 7.4	65.9± 0
Benthosoma glaciale	0,06	0,10	0,01	0,00	44,1± 0.3	30,6± 6.6
Notoscopelus kroyeri	3,06	3,04	5,09	4,38	104.1± 9.4	103.3± 5.0
Ceratoscopelus maderensis	0,29	0,63	0,1	0,18	66.3± 8.1	64.4± 3.8
Unidentified mycto	38,5	10,99	15,1	3,59		
Paralelipididae						
Arctozenus risso	3,35	7,18	11,2	19,99	154.2± 7.2	153.3± 19.5
Macrolepis affinis?	0,35	0,14	1,18	0,40	153.1± 1.1	152.1± 0.4
STOMIATIDAE						
Stomias boa ferox	1,59	2,12	0,85	0,76	201.4± 30.8	133.6± 54.3
CHAULIODONTIDAE						
CHAULIODUS SLOANI	0,18	1,59	0,1	1,44	132.6± 0	85.9± 7.1
STERNOPTYCHIDAE						
Maurolicus muelleri	19,5	0,14	0,83	0,01	41.7± 4.7	51.5± 0
SCOMBERESOCIDAE						
Scomberesox saurus	2,94	0,05	6,96	0,10	202.8± 20.5	215.3± 0
BRAMIDAE						
Brama brama	0,47	0	9,57	0	243.5± 16.3	-
Alepocephalidae						
Xenodermichthys copei	0	0,29	0	0,34	-	141.2± 0
GADIDAE						
Micromesistius poutassou	0,06	0	0,1	0	184.2± 0	-
Unidentified fish	1	1,16	0,46	0,49		
TOTAL FISH	**72,8**	**32,79**	**51,8**	**32,68**		
HISTIOTEUTHIDAE						
Histioteuthis (A) sp	0,06	0,68	0	0,34	13.3± 5.1	14.4± 6.1
Histioteuthis (B) sp	0,94	3,33	1,14	3,18	25.8± 13.0	26.3± 16.5
BRACHIOTEUTHIDAE						
Brachioteuthis rissei	4,88	20,25	1,58	5,97	52.3± 9.8	49.8± 8.5
CRANCHIDAE						
Teuthowenia sp	8,23	15,09	21	27,96	134.8± 35.2	120.9± 33.5
ONYCHOTEUTHIDAE						
Ancistroteuthis lichtensteinii	0,71	1,59	0,67	0,92	60.7± 8.4	64.8± 14.8
GONATIDAE						
Gonatus steenstrupi	3,29	6,32	20,3	23,20	140.8± 43.3	120.7± 31.1
PHOLIDOTEUTHIDAE						
Pholidoteuthis sp	0	0,05	0	0,20	-	-
OCTOPOTEUTHIDAE						
Octopoteuthis sp	0	0,19	0	0,49	-	-
OMMASTREPHIDAE	0,12	0,05	1,43	0,32	176.5± 0	174.2± 0
SEPIOLIDAE	0	0,05	0	0,01	-	41.2± 0
TOTAL CEPHALOPODS	**18,2**	**47,59**	**46,1**	**62,58**		
PASIPHAEIDAE	1,7	3,95	1,13	0,95		
Pasiphaea multidentata	1,7	3,52	1,13	1,52	95.2± 3.2	110.0± 13.7
Pasiphaea sivado	0	0,39	0	0	-	72± 0
Pasiphaea sp	0	0,05	0	0,02	-	97± 0
SERGESTIDAE	2,88	12,68	0,42	3,57		
Sergestes arctica	2,88	12,49	0,42	3,82	39.1± 3.8	40.2 ± 3.8
Sergia robusta	0	0,19	0	0,04	-	63± 0
OPLOPHORIDAE						
Acantephyra purpurea	0,18	1,59	0,01	0,25	66.0± 3.0	66.0± 3.0
PENAEIDAE						
Funchalia woodwardi	0,65	0,77	0,25	0,15	76± 3.0	89.0± 8.0
Gennadas sp	0	0,05	0	-	-	-
EUPHAUSIIDAE						
Meganyctyphanes norvegica	3,58	0,58	0,29	0,03	29.7± 6.0	32± 0
TOTAL CRUSTACEANS	**8,99**	**19,62**	**2,09**	**4,73**		
TOTAL	**135**	**100**	**100**	**100**		

Table 3. Parameterisations with estimated and forced parameters

	1st parameterisation : estimated parameter		2nd parameterisation : forced parameter	2nd parameterisation : estimated parameter
	EE	B (kg/km^2/y)	EE	B
Common dolphins	0.1			
Striped dolphins	0.2			
Albacore	0.2		0.5	8.4
Myctophids	0.0		0.8	24.6
Mesopelagics	0.4		0.8	310.4
Cephalopods		53.82		
Shrimps		61.86		
Large zooplankton	3.5		0.8	9900.6
Microzooplankton	1.2		1	16000
Phytoplankton	0.0		1	4164.9
Detritus				

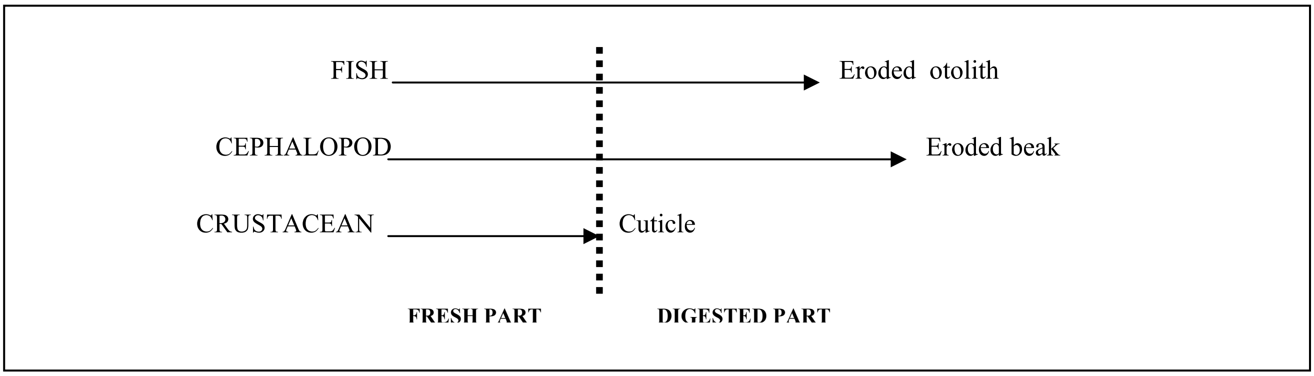

Fig.1. Schematic diagram of the fresh and digested fractions of a stomach content in relation to differential passage time of prey items through the gut. Arrows represent transit from fresh item to eroded diagnostic part. The dashed line separates the fresh part where all prey types are represented from the digested fraction in which some prey type are no longer present.

THE ECOLOGICAL CONSEQUENCES OF GROUP SIZE IN THE CARDIGAN BAY BOTTLENOSE DOLPHINS

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From May to September 2001 the ecology of a coastal population of bottlenose dolphins (*Tursiops truncatus*) in Cardigan Bay, West Wales, was studied using a combination of line transects and photo-identification methods. A total of 287 hours at sea was accumulated.

The mean group size of all encounters ($n = 138$) was 3.86 ± 0.37 (SE), the median was 3 and group size ranged from 1 to 40. No significant differences between the months could be found (one-way ANOVA, $df = 4$, $F = 1.030$, $p = 0.394$). Groups between 1 and 4 animals accounted for 71% of all sightings; more than ten dolphins were only encountered in 6%. Groups consisting of adults, juveniles and calves ($n = 8$) showed significantly bigger group sizes than groups of adults only ($n = 105$) as well as adults and either calves or juveniles ($n = 8$ and 19, respectively) (Tukey HSD, $p < 0.001$). The six most frequently seen dolphins were usually observed in bigger groups than the overall mean group size, but only one animal showed a statistically significant difference over the seasonal mean (Tukey HSD, $p < 0.001$).

Bigger groups showed a wider spectrum of behaviour types than smaller ones. 80% of single animals and 78% of groups of 2 to 4 dolphins observed were travelling, while bigger groups observed were travelling in less than half of the encounters. In larger groups aerial and socialising behaviour types increased. Of all behaviour types observed on more than five occasions, animals travelling showed the smallest group sizes (4.08 ± 0.42 SE), while those feeding had the biggest group sizes with 12.29 ± 4.89 SE). On two occasions groups of more than ten dolphins were observed feeding on shoaling fish, which could indicate an advantage of larger group sizes in co-operative foraging.

FOOD AND FORAGING BEHAVIOUR OF GREY SEALS : ARE THEY MORE OPPORTUNISTIC AT THE PERIPHERY OF THEIR RANGE?

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INTRODUCTION One often considers that organisms experiment less optimal environmental conditions and, therefore, express increasing ecological plasticity from the core to the edge of their range. If this applies to the food available to grey seals across their distribution, they should display more diversified diet and foraging strategies at the margin of their range. We tested this hypothesis at the Molène archipelago, north-west France, by investigating their diet and foraging behaviour in an approach which combined scat and stomach content analyses with satellite telemetry.

MATERIALS AND METHODS Diet 145 scats were collected at haul-out sites in the Molène archipelago from March 1998 to March 2000. Because haul-out sites located above the high tide level are only used by the seals during their moult, scats were mostly collected during the months of January to March. 14 stomach contents from seals by-caught in fishing gears were obtained from the vicinity of the archipelago. The samples were washed on 0.250 mm mesh size sieves. Prey remains were identified to species from the examination of otoliths, bones and mandibles and by using available keys and guides (Härkönen, 1986 ; Clarke, 1986) as well as unpublished reference materials. The composition of the diet was quantified by occurrence, relative abundance and reconstituted body mass.

Foraging behaviour Six individuals were fitted with Satellite Relay Data Loggers, which transmitted activity budgets and dive data. We used the satellite relay data loggers (SRDLs) built at the Sea Mammal Research Unit (SMRU, University of St-Andrews, Scotland, UK) which consisted of a data logger interfaced to an Argos transmitter unit (see McConnell *et al.* 1999 for details). Location fixes were filtered by an algorithm described by McConnell *et al.* (1992). A Time-At-Depth (TAD) index was used to classify dives as travel or foraging dives : TAD values close to 0.5 and 1.0 respectively (Fedak *et al.* 2001). The seals fitted with SRDLs were caught close to their haul-out sites of the Molène Archipelago, in early May 1999. Two females of 37 and 58 kg and 4 males (42, 99, 101 and 114 kg) were monitored.

RESULTS AND DISCUSSION Diet Of 155 otoliths and 9 cephalopod lower beaks found in scats and 93 prey found in stomachs, 18 fish, 5 cephalopod and 1 crustacean species were identified. From the prey remains found in the scats it appeared that the ballan wrasse, *Labrus bergylta*, three gadids (*Trisopterus luscus*, *Pollachius pollachius* and *Ciliata mustela*) and two flatfishes (*Pleuronectes platessa*, *Solea solea*) were the dominant taxa, amouting to 66.3, 11.9 and 5.0% respectively (Fig. 1). In contrast, from the stomach content analyses, it appeared that the bulk of the diet was accounted for by the cuttlefish, *Sepia officinalis* (68.1%), the common squid, *Loligo vulgaris* (10.4%), and two gadids, *P. pollachius* and *T. luscus* (11.4% together).

None of the major prey species found at the Molène Archipelago was previously reported to be of any importance in the food of the grey seals from core areas. Instead, cod, *Gadus morhua*, whiting, *Merlangius merlangus*, sandeels, *Ammodytes spp*., and plaice, *P. platessa*, are the commonest pivotal prey, often accounting for up to 50-90% by mass of the diet (Prime & Hammond 1990, Pierce *et al.* 1991, Thompson *et al.* 1996, Hammond *et al.* 1994a,b).

Part of this discrepancy may be accounted for by some methodological aspects. Indeed, scats were collected during the only period when seals use resting places located above high tide level. This corresponds to a season when the seal group is vastly dominated by adult males, congregating there for moulting (Vincent 2001). These animals are supposed to essentially fast at that time of the year ; as a consequence, the array of prey species obtained in their scats may be skewed towards more inshore species available during shorter trips at sea than at other seasons. In the case of the stomach samples, the present results represent the diet of yearlings, as this age group is supposed to be more vulnerable to by-catch than older, more experienced individuals ; consequently the difference with other analyses may partly express a possible ontogeny of prey choice. Finally, on a more methodological point of view, examining stomachs instead of scats may over-represent prey taxa with large digestion-resistant diagnostic parts which would be regurgitated rather than eliminated via the faeces ; here the prevalence of cuttlefish and squids in this set of samples may be at least partly related to this point.

Nonetheless, all other previous works were also exposed, to various extent, to these sources of biases. The differences in dietary composition between the marginal area of the Molène archipelago and the core area of the species are therefore considered to be at least partially the expression of the local availability of prey and more specifically of the relative rarity of the pivotal prey taxa which constitute elsewhere the bulk the species diet.

Foraging behaviour Foraging trips and patterns were highly variable across individuals (Fig. 2), unlike what was described for the grey seal in the North and the Baltic seas (McConnell *et al.* 1999, Sjöberg *et al.* 2000). These tracks are the results of a variety of foraging patterns. Seals **a** and **b** tended to concentrate their foraging effort in restricted areas located fairly close to their resting sites (**a** in St Ives Bay, Cornwall ; **b** off Ushant) and thus allowing the development of daily routines ; in addition, seal **b** visited Wales twice, doing strait line trips apparently not primarily aimed at foraging. Seal **c** was not tracked for long enough to display any clear pattern. Seal **e** typically made foraging trips in tidal estuaries either in Brittany or Cornwall ; when it was in Brittany it had a clear routine alternating 4-5 days resting in the Molène archipelago with 10 days foraging in the Bay of Brest. Seal **d** made an extended excursion throughout the English Channel up to the southern North Sea but never established any clear routine of foraging habitat use. Finally, seal **f** almost permanently made long foraging trips either loop trips or trips connecting different resting places in the western English Channel ; typically these trips were of several 100s km and 3-6 days long.

In all cases the foraging nature of these trips was ascertained by TAD index values close to 1. This index, combined with the comparison of maximum dive depth to available depth suggested that certain seals constantly made typical U-shaped bottom foraging dives during long travel, instead of using the classically described V-shaped travelling dive (Fig. 3).

Previous works investigating the foraging behaviour of the grey seal in the North Sea and in the Baltic Sea, two areas where a pivotal prey species – sand-eel and herring, *Clupea harengus*, respectively - does exist, showed much more inter-individual consistency in foraging trip location and characteristics (McConnell *et al.* 1999 ; Sjöberg *et al.* 2000)

CONCLUSIONS Although a larger sample size would be necessary to confirm these trends, we suggest that a broader foraging repertoire could help peripheral grey seals to cope with the relative lack of an adequate pivotal prey species in the ecosystem.

ACKNOWLEDGEMENTS Many thanks are due to the *Office National de la Chasse et de la Faune Sauvage*, who kindly provided accommodation and logistic during the field part of the satellite tracking experiment. Jean-Yves Le Gall, Laureline Meynier, Christelle Puibarault and Mathias Rouan are warmly acknowledged for helping in collecting scats and stomach contents. We are also very much indebted to Colin Hunter, Phil Lovell and Simon Moss for their invaluable help in the satellite tracking experiment. This work was part of a research and management project funded by the European Community (Feoga), the Regional Council of Brittany and the French Ministries of Education and Research and of the Environment.

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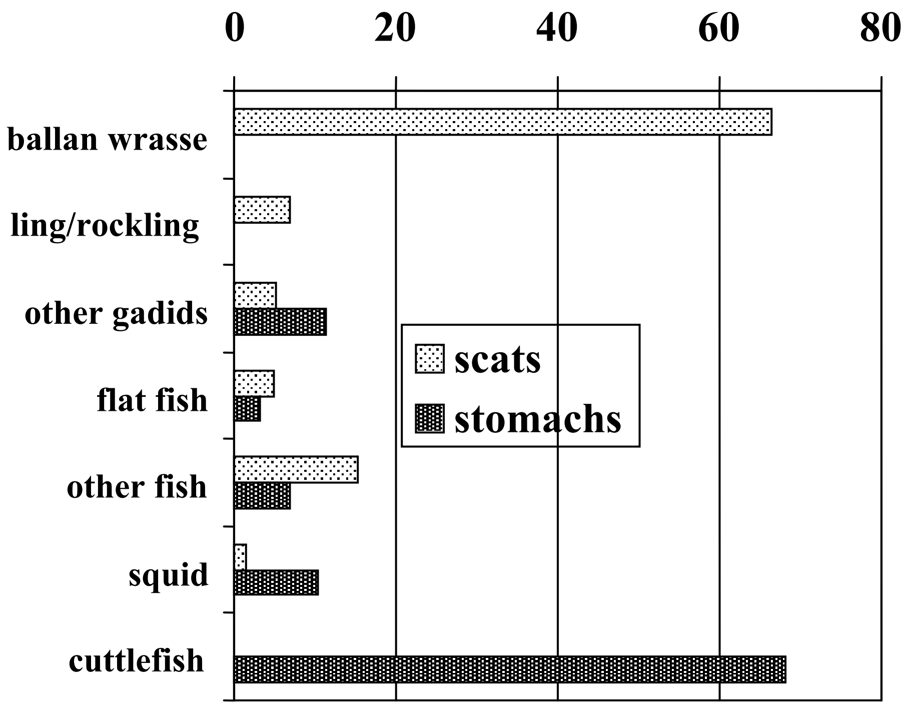

Fig. 1. Compositions by reconstituted biomass (in %) of the diet of the grey seal at the Molène Archipelago, from scat (N = 145) and from stomach content (N = 14) analyses.

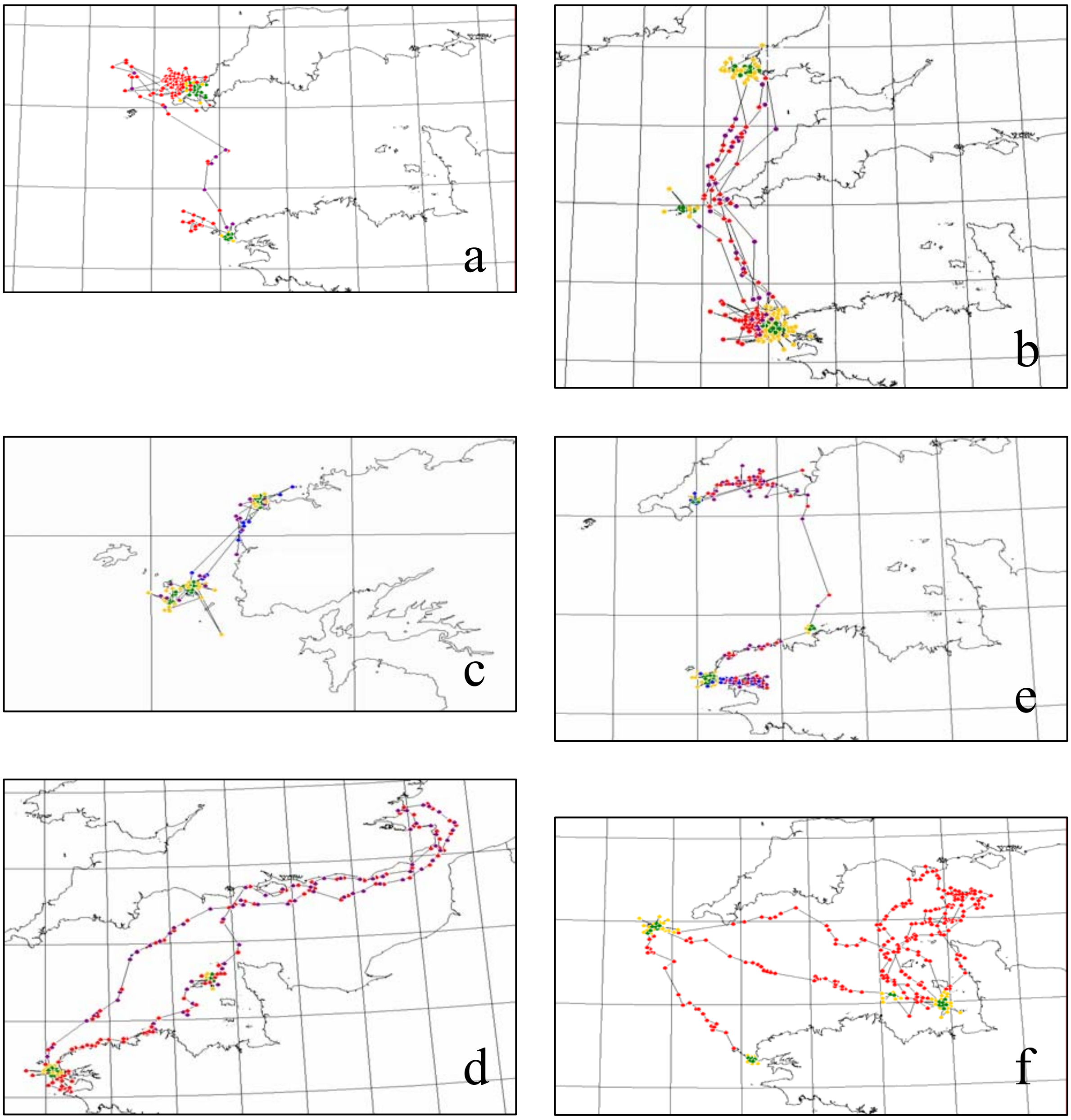

Fig. 2. Individual tracks of six grey seals of the Molène Archipelago fitted with SRDLs

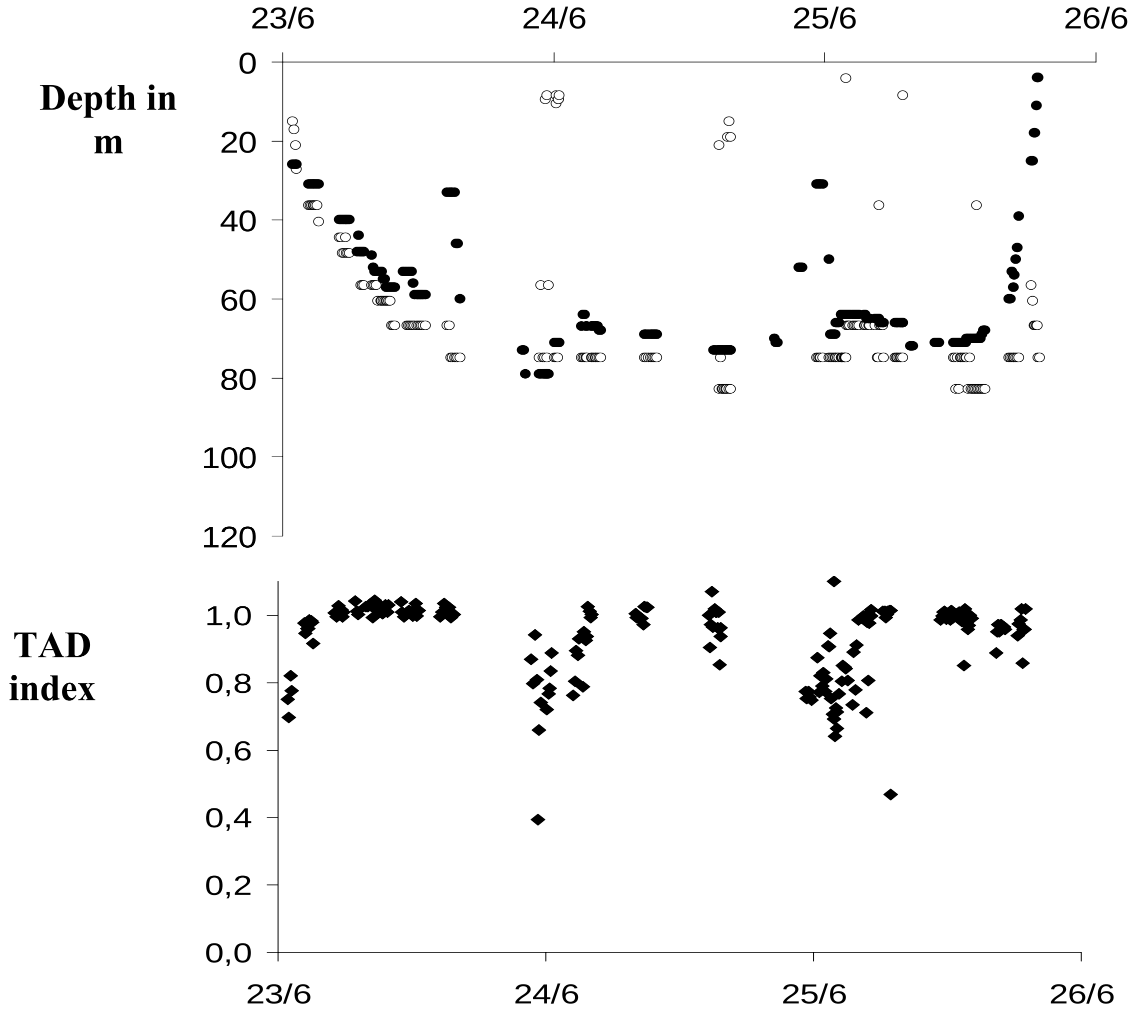

Fig. 3. Example of maximum dive depths (upper frame, open circle), available depths (upper frame, full circles) and TAD values (lower frame) profiles during a long foraging trip made by seal **f** through the western English Channel

SATELLITE TRACKING STUDY OF MOVEMENTS, RANGE AND DIVING BEHAVIOUR OF KILLER WHALES IN THE NORWEGIAN SEA

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Since 1983, the identity and behaviour of killer whales (*Orcinus orca*) has been studied in the wintering grounds of herring (*Clupea harengus*) in northern Norway from October to January. Little is known about their movements and behaviour for most of the year. This project aimed to study seasonal movements and diving behaviour of killer whales, focusing on interactions between herring and killer whales. In December 2000 two young killer whales of known pods were equipped with satellite linked dive recorders and VHF tags. Data was received from ”Mette” in the period 1 December to 28 February and from ”Linn” in the period 5 December to 9 May. Photoidentification work had indicated that killer whales were stationary in the wintering grounds of herring. This study revealed that killer whales undertake extensive migrations in and out of this area and their known range for this season has expanded from 11 000 km2 to 115 000km2. After herring left the wintering grounds, position data was received only from ”Linn”. Her pod followed the herring to the coastal spawning grounds (February-March) 750 km south and back north to the offshore feeding grounds (April-early May). The data show that killer whales follow the herring at least 7 months of the year and their minimum range is 215 000 km2 including both coastal and offshore waters. Although dives up to 352-400 m were recorded, the whales spent most of their time in the upper 28 meters. Majority of the deepest and longest dives occurred during daylight hours, when herring stays in deeper water. Both whales were resighted and VHF tracked after the tagging and the tags did not appear to affect their natural behaviour. This study demonstrates the importance of satellite tracking in understanding home range, habitat use and behaviour of killer whales.

FROM INDIVIDUAL TO POPULATION : STATUS AND FUNCTIONING OF A PERIPHERAL GREY SEAL (*HALICHOERUS GRYPUS*) GROUP IN BRITTANY

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INTRODUCTION The core population of grey seals *Halichoerus grypus* in the Northeast Atlantic is about 130000 seals, located primarily around the British Isles (Hiby *et al.*, 1996). About 100 seals haul out on the French coasts at the southern limit of their range. Very little is known on the distribution, behaviour and genetics of such peripheral groups. It was unclear whether these seals constitute a separate sedentary group or if they belong to the larger core population and opportunistically use this peripheral haul-out site. We monitored the main colony of this peripheral area, located at the Molène archipelago, Brittany, in order to estimate the group size, determine whether seals were isolated from the British population and describe their movement patterns.

MATERIALS AND METHODS An interdisciplinary programme was conducted from 1997 to 2000 in the Molène archipelago, combining regular censuses at haul-out sites, photo-identification, satellite tracking and genetics.

Censuses at haul-out sites. Regular censuses were conducted in the Molène archipelago from December 1991 to January 1994 and from December 1997 to August 2000. Provided sea state and weather condition allowed, censuses were conducted once every two weeks from a semi-rigid boat. All censuses were carried out from 2 hours prior to low tide to low tide time, when the number of seals hauled-out or resting in adjacent waters around haul-out sites was maximum (Y. Roger, unpublished data).

Photo-identification. Photo-identification sessions were carried out at low tide, usually twice a month, from March 1998 to August 2000. Photos were taken from rocks using a Canon EOS 500 camera, a Canon 500 mm lens and a Keiko 2X converter, using Ilford XP2 black and white films. Photos were matched visually and individuals were catalogued when both profiles were photographed. Mainly females have contrasted pelage patterns useful for identification. In males, the pelage usually becomes very dark with age, so that patterns are difficult to distinguish ; scars must then be used. As a consequence a higher proportion of females than of males shows pelage pattern suitable for photo-identification (100% *vs* 44% respectively ; Vincent *et al.*, 2001).

Satellite tracking. Ten grey seals were fitted with satellite tags, among which 4 rehabilitated juvenile seals in June 1997 and 6 juvenile and sub-adult wild seals in May 1999. We used SRDLs (*Satellite Relay Data Loggers*) built at the Sea Mammal Research Unit (University of Saint-Andrews, Scotland) consisting a data logger interfaced to an Argos RF transmitter unit (see McConnell *et al.* 1999 for details). Location fixes were filtered by an algorithm described by McConnell *et al.* (1992).
Genetics. Blood samples were taken from 54 grey seals stranded, captured or bycaught in France, and 100 grey seals captured in Scotland. Microsatellite analyses were conducted from 8 loci. Linkage disequilibrium, Hardy-Weinberg equilibrium, Population structure, and Pairwise F-statistics were tested using Genepop v 3.2 (Raymond & Rousset 1995). Here we only present results on the Pairwise F-statistics.

RESULTS Censuses at haul-out sites. 42 censuses were conducted from 1991 to 1994 and 49 from 1997 to 2000. Between the two periods the mean number of seals counted increased from 30.5 to 43.5, i.e. + 6% annually (Figure 1). However this increase varied seasonally. From 1997 to 2000, clear seasonal variations appeared, with a peak during the moulting season (February-March). The mean number of seals hauled out in the Archipelago was of 40 to 45 during the summer, and dropped to 35 or less during the breeding season, in November. The maximum abundance during the moult was mostly attributed to adult males, with a sex ratio reaching 5:1, while it was close to 1:1 the rest of the year.

Photo-identification. 88 different seals were photo-identified, from a total of 15000 photos. The discovery curve showed that most identifiable seals were photo-identified during the study (Figure 2). Few seals were observed in the archipelago at all seasons. There were important variations in the individual patterns of occurrence of photo-identified seals, but many adult males were only photographed during the moult while many females were mostly resighted during spring and summer. However, most seals showed a high inter-annual site fidelity. 95% of the 59 seals photo-identified in 1998 were resighted in 1999, and they were 67% in 2000 (field work ended in August 2000).

Satellite tracking. Tracking duration varied from 13 to 180 days, with an average duration of 1 month for rehabilitated seals in 1997 and 2.5 months for wild seals in 1999. Individual tracks extensively covered the western part of the Channel and outermost movements reached Ireland, Wales and the Southern North Sea (Figure 3). The most striking point in these tracks was the variety of individual movement patterns. The youngest seals showed exploratory movements while older ones often routinely used the same sites, but few seals hauled out on the same sites, apart from the Molène archipelago where they were caught. Only two seals, tracked for only two weeks, did not move away from the French coasts. The other seals travelled over hundreds of kilometres, at a mean rate of 90 Km/day (Table 1)

Genetics. Preliminary results showed that the genetic structure between the French groups was very low, as was the structure between Isle of May and North Rona seals (Table 2). Higher F(st) values between French and Scottish seals indicated that there was less gene flow between the two than there was within French and within Scottish samples.

CONCLUSIONS The interdisciplinary approach presented here allowed us to describe for the first time the abundance and the movements of grey seals in France. We observed seasonal variations in the number of seals hauled out in the Molène archipelago that could be related to the sex structure of the group. Similar results were described in Ireland (Kiely, 1998, Lidgard, 1999). Photo-identification confirmed this tendency, with seasonal patterns of occurrence of individual seals, but also brought an important and complementary information about the high inter-annual site fidelity of these photo-identified seals. These results combined suggest that the local grey seal group is not sedentary, and that individual seals use the site among others during the year. The movements suggested by these seasonal variations were confirmed by satellite telemetry, with 8 seals over 10 moving across the Channel during their tracking. These movements were frequent and fast, with a mean swimming speed of about 90 km/day. They definitely showed that French grey seals do not constitute a closed peripheral population. Lastly, preliminary results from genetics indicated that a significant although weak difference existed between French or Scottish samples. Further analyses including samples from seals hauling out in Ireland, Wales, England or the Channel islands would be necessary to better understand the population structure of the grey seals at a finer geographical scale.

We therefore reject the hypothesis of an isolated grey seal population or group in France. We rather suggest that seals alternatively and repeatedly haul out at this peripheral site and other sites around the Celtic sea and western Channel according to their sex during their biological cycle. These results have important consequences on the conservation of the species in France. Combined with similar studies conducted outside the British isles (Abt *et al.*, 2002), they may bring new insights in our understanding of peripheral populations of the grey seal in the North-east Atlantic.

ACKNOWLEDGEMENTS Many thanks are due to the *Office National de la Chasse et de la Faune Sauvage*, who kindly provided accommodation on the Reserve of Béniguet island, and Jean-Yves Le Gall for his help in the archipelago. Very special thanks are due to Simon Moss, Colin Hunter, Bernie McConnell and Phil Lovell (SMRU) for their help in the Argos trackings. Christelle Puibarault and Mathias Rouan helped in the photo-identification work and field assistance respectively. The programme was funded by the European Commission (Feoga), the Regional Council of Brittany and the French Ministry of Research.

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Table 1. Maximum extent of individual trips of seals tracked with satellite tags outside the Molène archipelago, and duration

Seal Number	Haul-out site visited	Distance (Km)	Trip Duration (days)
		Between too successive haul-out sites	
#97-01	English Cornwall	200	3
#97-01	Great Saltee (Ireland)	400	8
#97-02	Isle of White	400	11
#97-04	South-east England	200	3
#99-01	St-Ives bay	200	7
#99-02	Falmouth Bay	200	13
#99-03	Skomer (Wales)	370	5
#99-03	Skomer (Wales)	370	4
#99-05	Guernsey	220	3
#99-06	Isles of Scilly	270	3
#99-06	Les Minquiers (Channel Isles)	320	3

Table 2. Results of the Pairwise F-statistics, tested on the different groups of seals from France or Scotland

Population	R	BC	MO	PUP	N. Rona	I. of May
R	–					
BC	0.0029	–				
MO	0.0180	0.0177	–			
PUP	0.0177	0.0351	0.0095	–		
N. Rona	0.0501	0.0288	0.0572	0.0895	–	
I. of May	0.0430	0.0177	0.0479	0.0741	0.0037	–

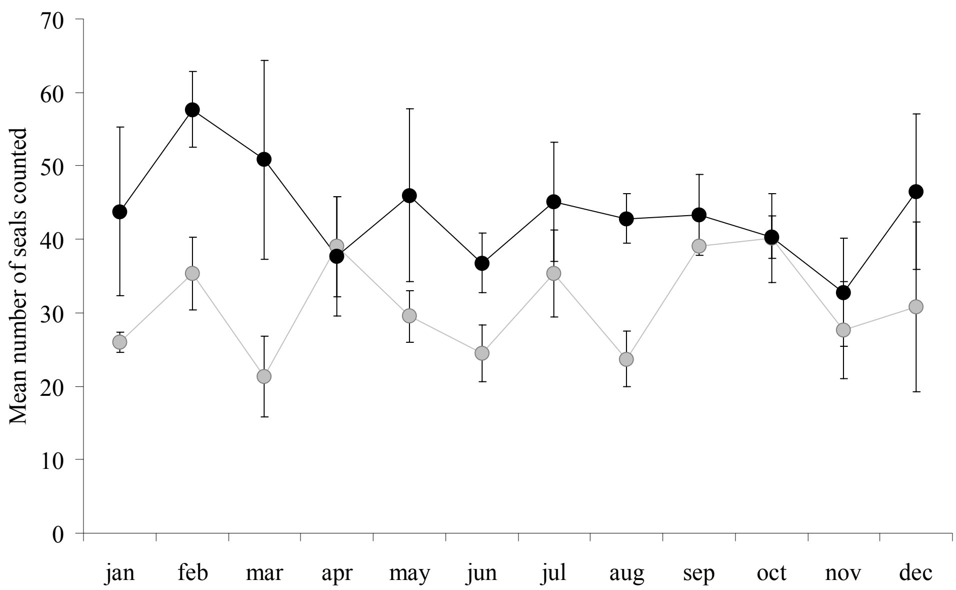

Fig. 1. Monthly variations of the mean number of seals counted on haul-out sites in the Molène archipelago, from 1991 to 1994 (in grey) and from 1997 to 2000 (in black), ± S.D

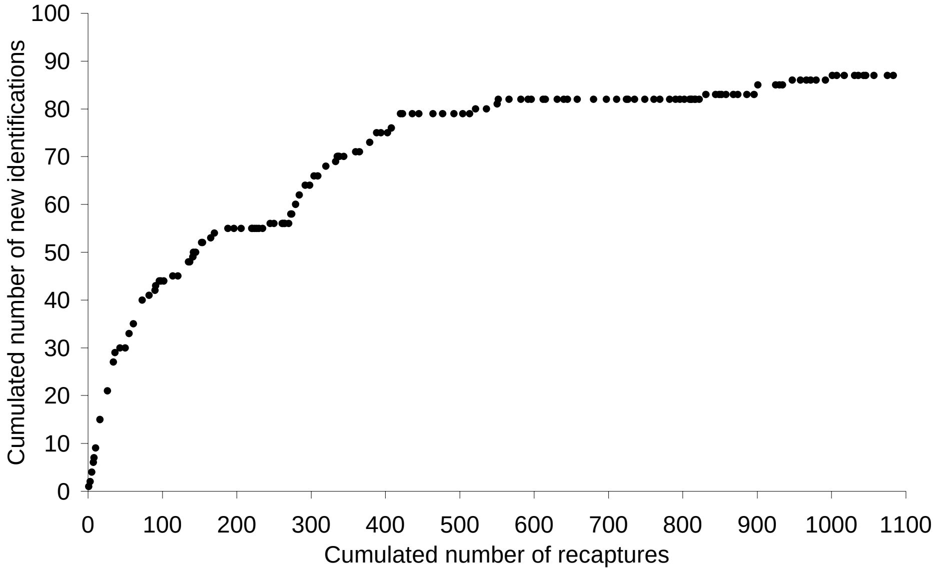

Fig.2. Discovery curve of photo-identified seals : changes in the number of new identifications in relation to the total number of recaptures

(a) (b)

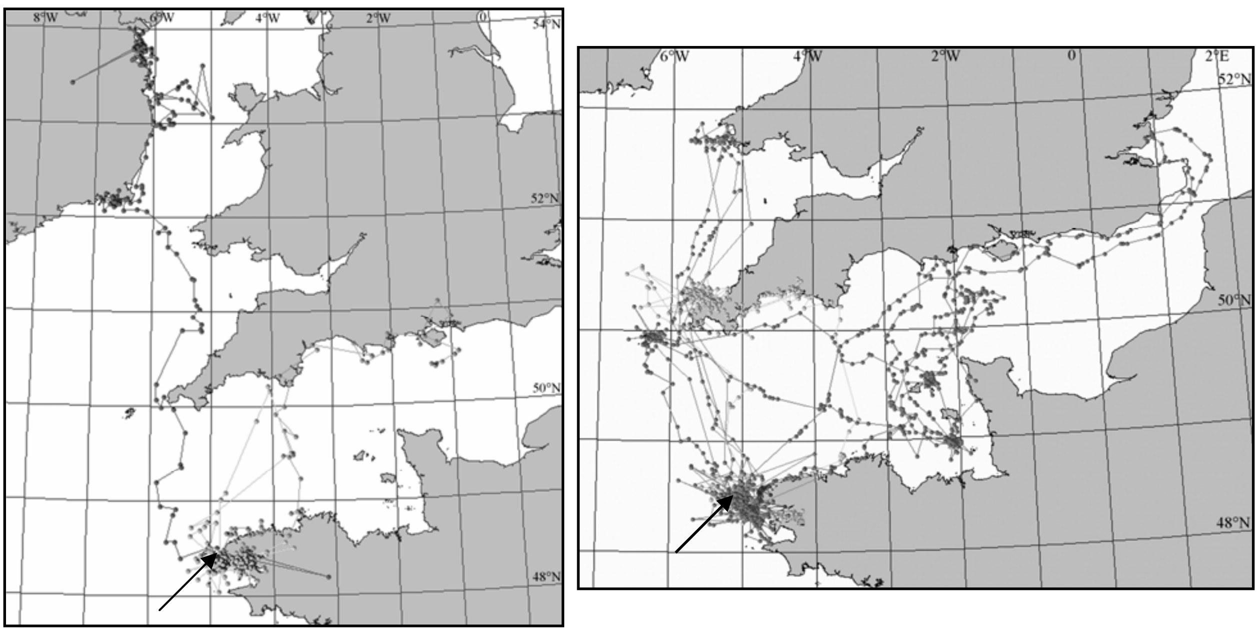

Figure 3. Satellite trackings of (a) 4 rehabilitated juvenile grey seals released in June 1997 at the western point of Brittany (arrow), and (b) 6 wild grey seals captured in May 1999 in the Molène archipelago (arrow)

SEASONAL OCCURRENCE OF THE WHITE-BEAKED DOLPHIN (*LAGENORHYNCHUS ALBIROSTRIS*) IN COASTAL ABERDEENSHIRE WATERS, NORTH-EAST SCOTLAND

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INTRODUCTION The Sea Watch Foundation has carried out land- and vessel-based cetacean surveys in the coastal waters of Aberdeenshire since April 1999. A semi-resident population of bottlenose dolphins (*Tursiops truncatus*) has been the primary focus of these studies (Weir & Stockin, 2001), but several other cetacean species have been additionally recorded during the survey work. In particular, the white-beaked dolphin (*Lagenorhynchus albirostris*) has been regularly encountered within this relatively small and coastal study area.

Within UK waters both the bottlenose dolphin and the white-beaked dolphin are species that typically inhabit continental shelf waters of less than 200 m depth (Pollock *et al*., 2000). However, the white-beaked dolphin has a much more pelagic nature than the bottlenose dolphin, and has received a relatively limited research focus. Although the white-beaked dolphin is generally considered to be the most numerous dolphin species in North Sea waters (Evans, 1992) details of its distribution, biology and ecology are little understood. The species is regularly reported during both dedicated sightings surveys (Hammond *et al*., 1995; Northridge *et al*., 1995), and during opportunistic observations (Weir, 2001; *pers. obs*.) in offshore North Sea waters, but its occurrence in coastal waters within the region has been poorly documented.

This paper reports on observations of white-beaked dolphins within a small study area along the coast of Aberdeenshire, Scotland.

METHODS The study area was located along the coast of Aberdeenshire, North-east Scotland (Fig. 1) in a shallow region of the North Sea. Data presented here were collected between 1999 and 2001, using a combination of land-based surveys carried out along the coastline throughout the year, and a series of vessel-based transects between March and October.

Both land- and vessel-based surveys utilised trained observers to carry out timed sea-watches. A continuous scanning methodology was implemented primarily with the naked eye, but supplemented with regular binocular scans (8-10x magnification), and occasionally with telescopes (20x). Relevant environmental data such as sea state and visibility were collected at 15 min periods throughout the survey, and cetacean data including the species, number of animals and behaviour were recorded whenever animals were observed.

During vessel-based surveys, a 15 m motor vessel at 3 m eye height was utilised to survey the region between Stonehaven and Aberdeen, a return journey of approximately 24 km (the vessel route twice ran southwards between Stonehaven and Inverbervie). A Global Positioning System (GPS) was used to record the vessel track and the position of any cetaceans encountered. A team of trained volunteers carried out vessel-based surveys, in addition to one or both of the authors.

Data were entered onto a computer database in a coded format, and were standardised as far as possible by the single person entering data to correct for variation in observer experience.

RESULTS **Survey coverage.** A total of 18,896 min survey effort was collected during timed sea watches at 15 land-based sites between 1999 and 2001. Over 92% of land-based survey effort was collected from five key sites (Collieston, Girdle Ness, Souter Head, Aberdeen Harbour and Stonehaven Bay). Land-based survey effort was collected in all months of the year, but predominantly over the summer months between March and August.

A total of 26 vessel-based surveys were completed in sea state 3 or less, resulting in a total of 5,774 min of dedicated survey effort. Vessel-based data were collected only between March and October (due to winter weather constraints), with most coverage achieved during May and August.

White-beaked dolphin occurrence. A total of 104 sightings of white-beaked dolphins was made during the survey between 1999 and 2001, involving 634 animals. Of these, 84 sightings (547 animals) were land-based observations, of which 39 were recorded during effort related surveys and 45 were opportunistic sightings. White-beaked dolphin sightings occurred predominantly along the cliffs between Stonehaven and Aberdeen, and from Collieston in the north of the study area (Fig. 2a). Sightings were absent from the gently-sloping, shallow waters between Aberdeen and Collieston. A total of 20 white-beaked dolphin sightings (87 animals) was recorded during vessel-based surveys. The location of vessel survey effort and white-beaked dolphin sightings is shown in Fig. 2b.

The distribution of white-beaked dolphin sightings during both land- and vessel-based surveys was centred primarily along the coast between Aberdeen and Stonehaven (Fig. 2). This stretch of coastline is comprised mostly of cliffs and the 50 m isobath occurs within 3,500 m of the coast, compared with the shallow, sloping beaches to the north of Aberdeen where the 50 m isobath is over 7,700 m from shore. Table 1 shows the relationship between depth and dolphin sightings; white-beaked dolphins were sighted more often where deeper water occurred closer to shore.

The Sightings Rate Per Unit Effort (SPUE) for white-beaked dolphins was slightly higher overall during vessel-based surveys (0.346 sightings/100 min) than in land-based surveys (0.206 sightings/100 min). This factor may probably be explained by the tendency of white-beaked dolphins to approach vessels for bow-riding, thereby increasing their detection rate. However, both survey types reveal a strong seasonal trend in white-beaked dolphin sightings; sightings clearly occurred only during the summer months between June and August (Fig. 3). Despite adequate levels of survey coverage, no sightings occurred during dedicated watches outside of the June to August period, and only single opportunistic sightings were made during May and September respectively. These data clearly suggest a distinct seasonal movement of this species into Aberdeenshire coastal waters.

Of the total 104 white-beaked dolphin sightings recorded between 1999 and 2001, group size ranged from 1 to 32 animals (mean=6.2, median=4.5, modal=2.0). In some groups, the age of dolphins was approximated according to the estimated/comparative size of the animals. Over 52% of such aged groups contained immature (juveniles and/or calves) animals, and the mean group size of 3.52 animals in adult only pods increased to 8.03 when immature animals were present. Young calves were recorded in all three months that dolphins were observed, with a peak of 13 calves recorded during August.

CONCLUSIONS White-beaked dolphins were recorded close to the coast of Aberdeenshire during the summer months only (June to August), suggesting a distinct seasonal occurrence of animals in this coastal region. Within the coastal water study area, white-beaked dolphins were sighted more often along areas of coastline where relatively deep water occurred near to shore. Both these trends suggest that white-beaked dolphins occupy a different niche/habitat from the more commonly observed bottlenose dolphins in the region. Bottlenose dolphins are generally absent from the area during June to August at the same time that white-beaked dolphins are observed, and the bottlenose dolphins are strictly coastal in nature being recorded in shallow bays and travelling parallel along the coast.

The movement of potential prey species most likely explains the seasonal occurrence of white-beaked dolphins in coastal waters off Aberdeenshire, since dolphins were engaged in feeding behaviour during many sightings. Mackerel (*Scomber scombrus*) also show an inshore movement along the coast of Aberdeenshire during the summer months (Coull *et al.* 1998), and the distribution of this prey species may explain the seasonal appearance of white-beaked dolphins.

The movement of white-beaked dolphins in relation to increased prey sources is especially relevant during the breeding season when dolphins may have higher energetic demands during calving and lactation. Immature white-beaked dolphins were recorded in over 52% of aged groups, suggesting that the species may utilise Aberdeenshire waters over their calving period.

Other possible reasons for the shift in distribution to inshore waters includes the reduced risk of predation to calves/juveniles in the shallower, coastal waters (from e.g. killer whales, *Orcinus orca*). However this is considered unlikely in this particular population of white-beaked dolphins, since killer whales and other large predators are rarely observed in the central North Sea.

ACKNOWLEDGEMENTS We would like to thank Shell U.K. Exploration and Production who have kindly sponsored this study since June 2000. The survey vessel '*Tranquility*' was skippered by Brian Bartlett. Dr Peter Evans of the Sea Watch Foundation, Ciarán Cronin and David Simmons helped to establish the project. Many thanks are owed to the volunteers who contributed cetacean sightings to this project.

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Table 1 White-beaked dolphin sightings in relation to depth isobath

Distance of isobath from shore (m)	Total min survey effort (n=no. of sites)	Sightings per unit survey effort (SPUE)	No. of casual sightings
10 m Isobath			
<500	6569 (n=5)	6.15	13
500–1000	2570 (n=5)	1.51	7
>1000	9757 (n=5)	0.00	3
30 m Isobath			
<2000	6479 (n=4)	5.04	13
2000-3000	8122 (n=4)	2.51	5
>3000	4295 (n=7)	0.12	5
50 m Isobath			
<4000	6569 (n=5)	6.15	13
4000-5500	8297 (n=4)	1.40	6
>5500	4030 (n=6)	0.12	4

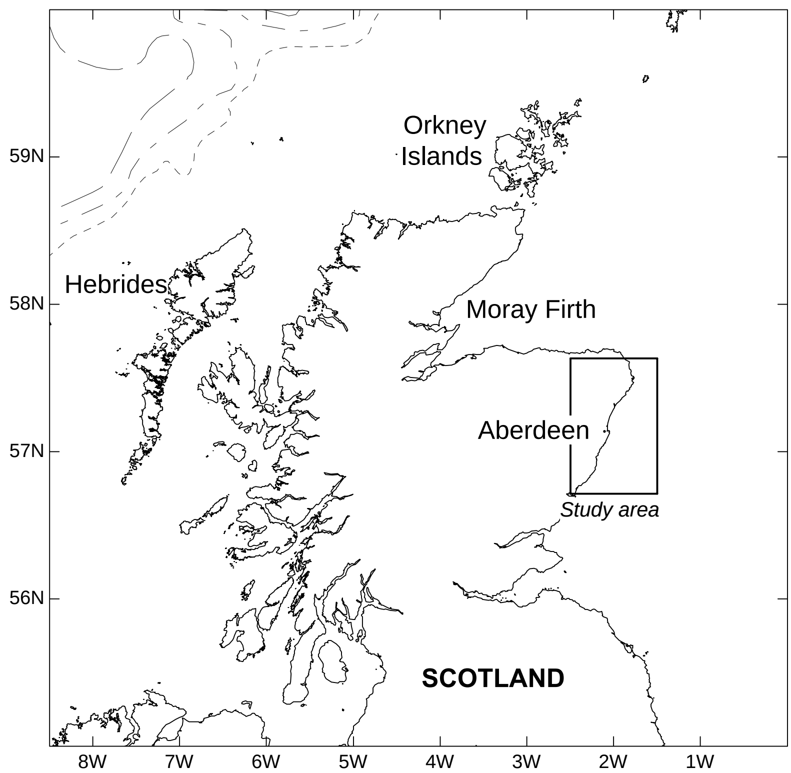
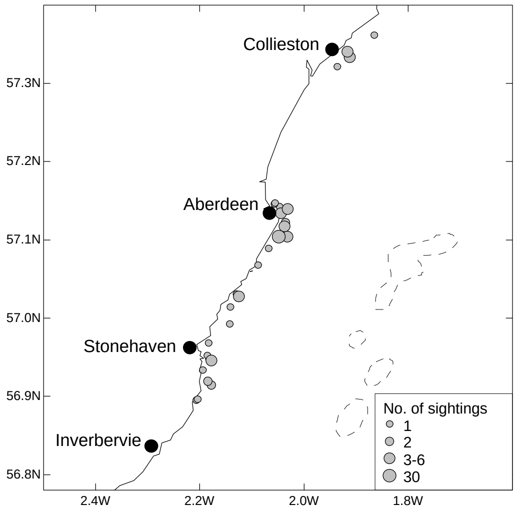


Fig. 1 Location of the study area
Bathymetry: dot (200m isobath); dotdash (500m isobath); dash (1000m isobath)

a) **b)**



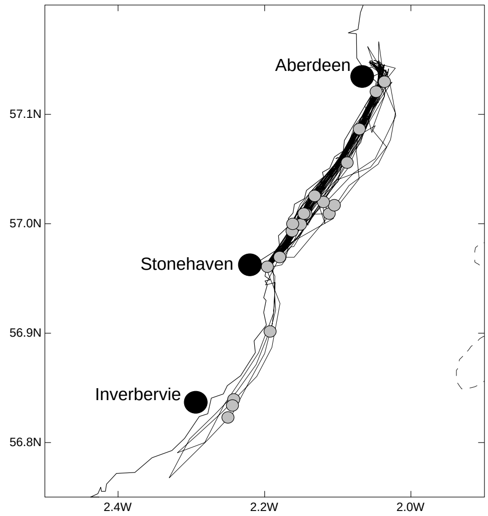
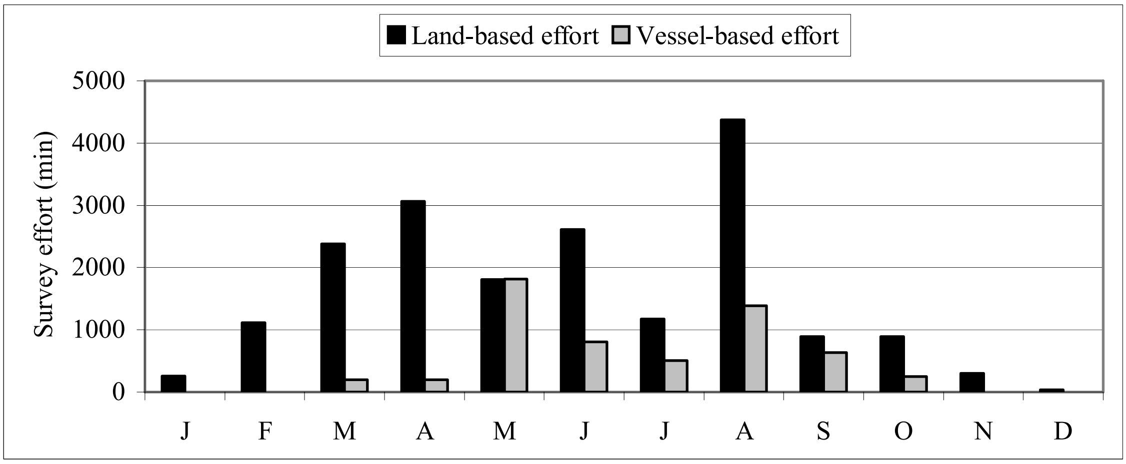


Fig. 2 Location of white-beaked dolphin sightings in a) land-based surveys and b) vessel-based surveys (showing vessel routes)

a)



b)

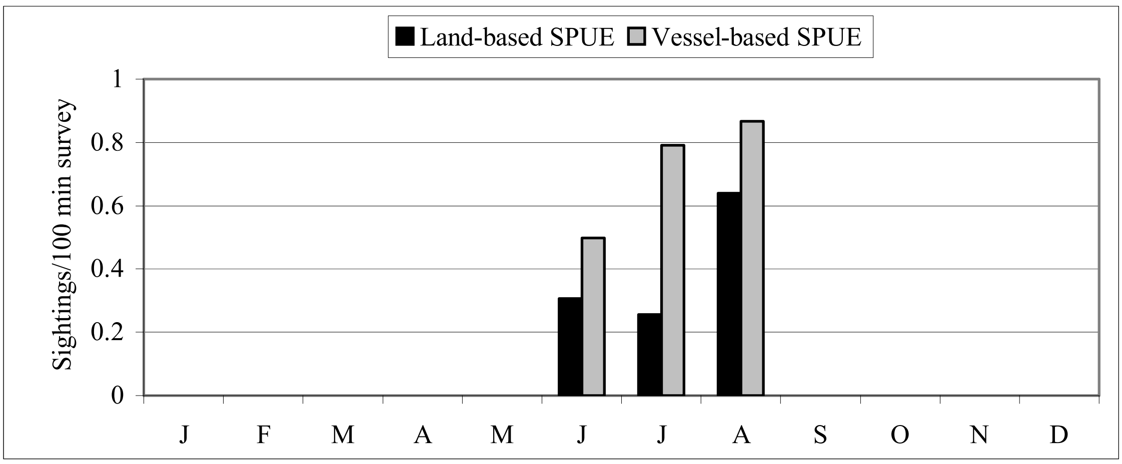


Fig. 3 Seasonal occurrence of a) survey effort and b) white-beaked dolphin sightings per unit effort

FEEDING

INTERACTIONS OF COMMON DOLPHIN *DELPHINUS DELPHIS* AND BOTTLENOSE DOLPHIN *TURSIOPS TRUNCATUS* WITH TRAWL AND PURSE SEINE FISHERIES IN THE ALBORAN SEA (WESTERN MEDITERRANEAN SEA)

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INTRODUCTION It is known that several species of dolphins attend fisheries operations to benefit from gear effects on the sea bottom and discarding. The information on interactions with fisheries such as trawling and purse seining is scarce in the Western Mediterranean. The information from strandings networks and sightings programs on the Spanish Mediterranean coast suggests interactions of cetaceans with several fisheries (Cañadas et al, 1999). This investigation presents data on fishing capture and discarding from studied fisheries and preliminary observed interactions with cetaceans.

A scientific observer program onboard bottom trawl and purse seine vessels was carried out monthly between August 2000 and October 2001 in the Alboran Sea. This work involved vessels from 5 fishing ports and it was coordinated by two research projects at the Oceanographic Centre of Málaga (Instituto Español de Oceanografía) and the Granada Provincial Council. Purse seining and bottom trawling are the most important commercial fisheries in the Alboran Sea. Characteristics of the fisheries and fleet can be found in Abad and Giráldez (1990) and Gil de Sola (1993).

METHODS Seventy bottom trawling hauls were observed onboard. Sampling area covered 5 depth strata, corresponding with the fishing grounds where the trawling fleet operates. These fishing grounds are called “la Terraira”, between 50 and 150 m, “el Cantillo”, between 150 and 275 m, “la Media Mar”, between 275 and 350 m, “el Canto”, between 350 and 460 m and “la Fonela”, between 460 and 640 m.

Forty one purse seine sets were observed onboard. All the fishing operations were at night and most of them with light-boats. The sets ranged between 10 m and 370 m in depth, although the fishery usually operates between 50 and 100 m.

Data recorded included fishing parameters (geographic position, fishing depth, meteorological data) and quantification and identification of commercial capture and discards by each fishing operation for 70 bottom trawling hauls and 41 purse seine sets. In addition, a single onboard day from August 1999 has been included. Discards are the part of the capture that are returned to the sea for a variety of reasons such as having physical damage, being a non-target species for the trip, and compliance with management regulations like minimum size limits or quotas. Size sampling for commercial species was made.

Cetacean sightings during fishing operations were recorded (see Fig. 1) and interactions with the fishery were noted down. Interviews with 33 skippers of different coastal fisheries (trawling, purse seine, drifting longline, bottom longline, fish traps and trammel nets) were carried out during the study period to get information on cetacean interactions.

RESULTS The data on commercial captures and discards are presented in tables. Table 1 shows the main species caught in trawlers, with fishing yields data (grams per trawling hour). Bottom trawlers caught a large variety of benthic and demersal species. The highest fishing yields corresponded to blue whiting (*Micromesistius poutassou*), hake (*Merluccius merluccius*), deep-water pink shrimp (*Parapenaeus longirostris*) and common octopus (*Octopus vulgaris*). Summarising fishing data results, the total capture obtained in the trawling fishery included (in weight) 75.3% fish, crustaceans (16.9%), molluscs (7.3%) and other invertebrates that represented only 0.5%. By taxonomic group, 39% of total fish weight was discarded, 17% of molluscs and 35% of crustaceans. The remaining invertebrates were totally discarded.

Table 2 presents main commercial species captured in purse-seines according to total weight. The purse seine fishery targeted small pelagic fish which comprised 99.9% of total capture (weight). The greatest catches were gilt sardine (*Sardinella aurita*), sardine (*Sardina pilchardus*), horse mackerel (*Trachurus spp*) and anchovy (*Engraulis encrasicolus*). By taxonomic group, 19% of total fish weight was discarded, 20% of molluscs and 31% of crustaceans. All remaining invertebrates were returned to the sea as in the trawl fleet.

The most important discarded species in the trawling fleet (see Table 3) were sablefish (*Lepidopus caudatus*), hollowsnout rat-tail (*Coelorinchus coelorinchus)*, silver pout (*Gadiculus argenteus*) and a large amount of other fish and invertebrate species. Main discarded species in the purse-seining fleet were sea breams (*Pagellus acarne*) and bogue (*Boops boops),* due to small size, and gilt sardine (*Sardinella aurita*) when the catch was not enough to be profitable.

A total of 22 sightings of common dolphin and bottlenose dolphin were recorded during fishing operations in this study (see Table 4). Feeding in the fishing gear area was observed during five trawl hauls and four purse seine sets.

CONCLUSIONS Interactions of common dolphin and bottlenose dolphin were observed with both fisheries. Bottlenose dolphin is a species with the capacity to adapt its feeding strategies to the available resources, and it is known that the dolphin usually follows trawlers in order to benefit from the trawl net effect on the seabed communities. The incidental catch and interactions between common dolphin and purse seine fisheries are known in other areas. In the Alboran Sea, scientific data on temporal and spatial interactions, distribution and feeding resources (commercial and discarded species) are scarce.

In the purse seine fisheries, common dolphins fed in surface waters, catching fish escaped from the gear and/or gill-snared fish. Summer feeding areas of common dolphin pods (5-50) could overlap with fishing grounds of small pelagic fishes. Groups of both bottlenose dolphins (1-12 individuals) and common dolphins (10-500 individuals) were observed feeding close to the trawl gear during fishing operations, making long submersions.

Information from interviews with fishermen indicated that both species of dolphin are periodically observed during the fishing operations, mainly during summer. Regarding purse seining, dolphins can feed directly over the gear, sometimes making difficulties for fishermen because the fish schools may subsequently disperse. On the other hand, a common dolphin "pond" can also bring the fish together and increase fishing yields for fishermen. No incidental catches were observed during the study but occasional dolphin captures were reported from interviews. Such incidental captures resulted in one or two dolphins being caught alive and then released over the floats.

Regarding trawling, both species can follow the gear for several hours, clearly feeding close to the fishing gear area. Fishermen indicate that bottlenose dolphin presence especially increases the hake yields. There are not enough data at the moment to assess this relationship, but in two hauls with bottlenose dolphins sightings, hake yields were higher than the rest of the hauls the same fishing day.

The existence of interactions between dolphins and traditional fisheries, could suggest an overlap between fish and cetaceans in exploitation of the fish resources. This study presents preliminary information, and shows the need to identify species required by cetaceans and assess the importance of their eating habits. This will help to establish temporal and spatial characteristics of interactions between common and bottlenose dolphin pods and local fisheries. Although other species (pilot whale, *Globicephala spp.*, Risso´s dolphin, *Grampus griseus*, striped dolphin, *Stenella coeruleoalba*, and fin whale, *Balaenoptera physalus*) have been recorded at the study area, there is no evidence for feeding interactions with fisheries.

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Table 1. Main fishing yields (grams per trawling hour) of commercial species caught in trawls

GLOBAL YIELDS (g/h)					
MAIN COMMERCIAL TRAWLING SPECIES					
FISH		CRUSTACEANS		MOLLUSCS	
Micromesistius poutassou	8388,2	*Parapenaeus longirostris*	1365,9	*Octopus vulgaris*	1009,8
Merluccius merluccius	2090,6	*Nephrops norvegicus*	1040,4	*Todarodes sagittatus*	356,0
Lophius spp	1796,0	*Plesionika heterocarpus*	910,8	*Illex coindetti*	337,7
Phycis blennoides	1169,0	*Plesionika martia*	500,1	*Todaropsis eblanae*	248,3
Scyliorhinus canicula	1166,6	*Liocarcinus depurator*	217,4	*Eledone cirrhosa*	205,1
Boops boops	971,3	*Plesionika edwarsii*	96,4	*Sepia orbignyana*	149,8
Pagellus acarne	429,4	*Calappa granulata*	35,5	Others	14,9
Conger conger	336,6	*Palinurus mauritanicus*	14,4		
Galeus melastomus	317,4				
Centrophorus granulosus	230,8				
Galeorhinus galeus	192,3				
Helicolenus dactylopterus	164,0				
Cepola rubescens	153,9				
Others	266,8				

Table 2. Main commercial species captured in purse-seines according to total weight

MAIN COMMERCIAL PURSE SEINING SPECIES	
FISH	CRUSTACEANS
Sardinella aurita	*Calappa granulata*
Sardina pilchardus	
Trachurus mediterraneus	
Engraulis encrasicolus	MOLLUSCS
Scomberesox saurus	
Scomber japonicus	*Octopus vulgaris*
Scomber scombrus	*Todaropsis eblanae*
Trachurus trachurus	*Illex coindetti*
Pagellus acarne	*Loligo vulgaris*
Spicara maena	*Sepia officinalis*

Table 3. Main fishing yields (grams per trawling hour) of discarded species in trawls

GLOBAL YIELDS (g/h)							
MAIN DISCARDED TRAWLING SPECIES							
FISH		CRUSTACEANS		MOLLUSCS		OTHER INVERTEBRATES	
Lepidopus caudatus	3233.4	*Solenocera membranacea*	877.4	*Neorosia caroli*	192.9	*Stichopus regalis*	162
Coelorhynchus coelorhynchus	2216.1	*Liocarcinus depurator*	696.2	*Bathypolipus sponsalis*	112.6	*Aphrodite aculeata*	30.6
Galeus melastomus	1995.7	*Plesionika heterocarpus*	341.3	*Rossia macrosoma*	56.8	*Astropecten spp*	15.3
Gadiculus argenteus	1311.5	*Pasiphea sivado*	185.2	*Sepietta oweniana*	44.9	*Alcyonum palmatum*	15
Conger conger	932.4	*Dardanus arrosor*	64.1	*Alloteuthis spp*	39	*Pennatula rubra*	9.1
Capros aper	515.1	*Munida iris*	62.9	*Pteroctopus tetracirrhus*	27.7	Others	8.6
Helicolenus dactylopterus	431	*Plesionika martia*	57	*Illex coindetti*	19		
Hoplostethus mediterraneus	397.2	*Xantho pilipes*	50.5	*Rondeletiola minor*	14.7		
Etmopterus spinax	276.6	*Pontophilus spinosus*	49.9	Others	41.1		
Antonogadus megalokinodon	211.9	*Processa canaliculata*	43.9				
Scyliorhinus canicula	200.9	*Pagurus prideauxi*	42.3				
Symphurus nigrescens	198.3	*Macropodia longipes*	37.7				
Nezumia aequalis	186.8	*Nephrops norvegicus*	37.1				
Others	1237.8	Others	208.1				

Table 4. Sightings of common dolphin (*Delphinus delphis*) and bottlenose dolphin (*Tursiops truncatus*). Numbers and feeding behaviour are shown

Date	Gear	Latitude N	Longitude W	Species	Number	Feeding
23/08/00	Trawl	36.6874	3.1311	*D. delphis*	9	no
20/10/00	Trawl	36.6210	2.9800	*T. truncatus*	10	no
20/10/00	Trawl	36.6856	3.1584	*T. truncatus*	8	no
20/10/00	Trawl	36.6840	3.1550	*T. truncatus*	4	no
20/10/00	Trawl	36.6826	3.2849	*T. truncatus*	8	no
2/02/01	Trawl	36.6778	3.7399	*T. truncatus*	2	no
22/06/01	Trawl	36.6597	3.9545	*T. truncatus*	5	no
22/06/01	Trawl	36.6575	3.9563	*D. delphis*	7	no
22/06/01	Trawl	36.6580	3.9723	*T. truncatus*	10	no
12/07/01	Trawl	36.5749	2.1299	*T. truncatus*	10-12	yes
12/07/01	Trawl	36.4833	2.2532	*T. truncatus*	8-10	no
27/07/01	Trawl	36.7223	2.2395	*D. delphis*	300-500	yes
27/07/01	Trawl	36.5572	2.2264	Unidentified	30-50	no
31/07/01	Trawl	36.4821	4.5075	*D. delphis*	10-15	yes
31/07/01	Trawl	36.5095	4.4722	*D. delphis*	20-30	no
29/08/01	Trawl	36.5004	4.8564	*T. truncatus*	1	yes
4/10/01	Trawl	36.4783	4.6588	*D. delphis*	20	no
25/10/01	Trawl	36.6280	4.2000	*T. truncatus*	5-8	yes
11/08/99	Purse seine	36.5500	4.5800	*D. delphis*	20-50	yes
22/08/01	Purse seine	36.7083	4.3810	*D. delphis*	5-6	yes
25/09/01	Purse seine	36.6773	4.3015	*D. delphis*	5-8	yes
30/10/01	Purse seine	36.6600	4.4300	*D. delphis*	5-6 (1 calf)	yes

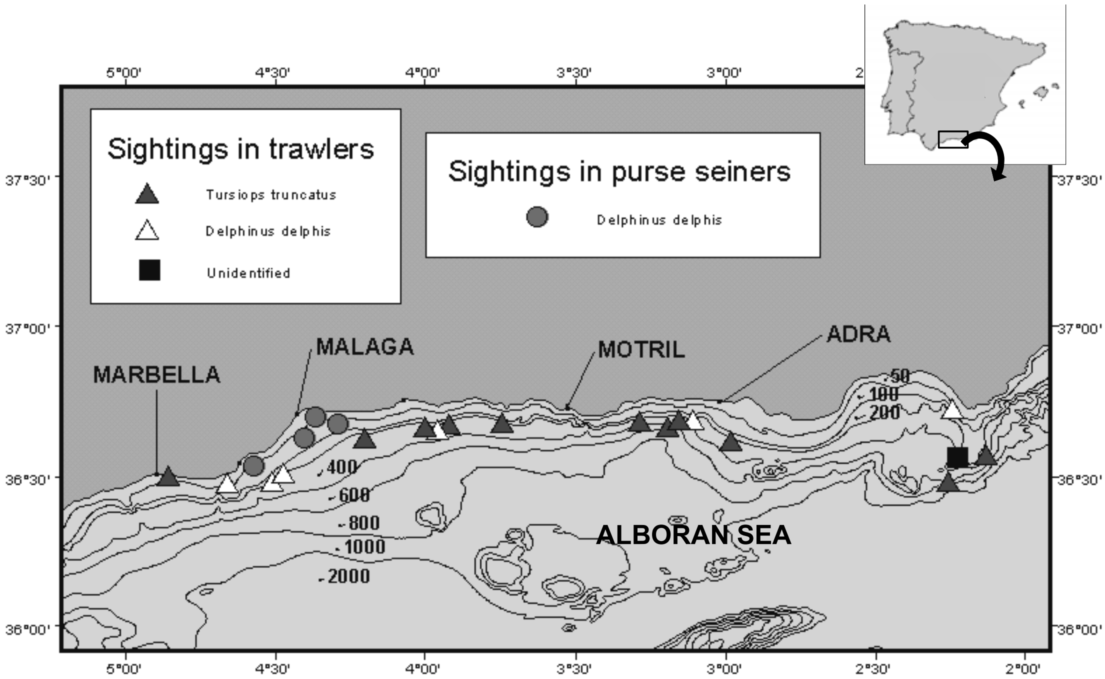

Fig 1. Sightings locations in the study area using a Geographic Information System (GIS)

DIET OF THE WHITE-BEAKED DOLPHIN (*LAGENORHYNCHUS ALBIROSTRIS*) IN DANISH WATERS

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The diet of white-beaked dolphin was studied based on stomach contents of 23 stranded or incidentally caught animals (14 females and 9 males) along the Danish coasts between 1984 and 2001. 2429 fish otoliths were identified representing six different fish families: Gadidae, Clupidae, Ammodytidae, Pleuronectidae and Scrombridae. Gadids were the most important prey item, mainly consisting of cod *Gadus morhua*. Cod otoliths found in white-beaked dolphins were on average larger than in a sample of harbour porpoise *Phocoena phocoena* stomachs from the same waters, indicating a preference for larger prey items. No sexual differences in diet were found.

DIET OF STRIPED DOLPHIN (*STENELLA COERULEOALBA)* IN THE WESTERN MEDITERRANEAN BASIN

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INTRODUCTION With more than 225 000 (CV 27.8%) individuals estimated in 1991 (Forcada *et al*., 1992), the striped dolphin, *Stenella coeruleoalba*, is the most abundant odontocete of the western Mediterranean species. Nevertheless its diet is still poorly known.

This study shows original data about striped dolphin diet in the Gulf of Lions on the basis of the analysis of stomach contents, and replaces it in a larger context by comparing it with four other areas of the western basin: the Spanish coasts (.Blanco *et al*,. 1995), the Algerian Basin (Boutiba, 1992) the Ligurian Sea (Würtz and Marrale, 1993) and the Tyrrhenian sea (Alessandrini and Affronte, 2001, Pulcini *et al*,. 1992).

MATERIALS AND METHODS Stomach contents of 94 striped dolphins from the Spanish coasts (27), Gulf of Lions (15), Ligurian Sea (23), Tyrrhenian Sea (23) and Algerian Basin (6) are taken here into account.

Fishes were identified from diagnostic remains, principally otoliths, vertebrae, and other skeletal structures, cephalopods by beaks (Clarke, 1986), and crustaceans by carapace, telson and mandibles, with the help of M. Wurtz.

For each species of cephalopods, fishes and crustaceans, we have calculated the frequency of occurrence, number, weight, and the index of relative importance (IRI) according to Pinkas *et al*. (1971).

IRI % = (N % + W %) * F %
(N = number of prey, W = mean weight of one prey, F = frequency of occurrence)

As in the literature weight of preys are not always indicated, we have calculated the mean weight of each prey with all of the weights data mentioned in the stomach contents of the whole basin. We then used this global mean in all IRI calculations in order to be more realistic and homogeneous, even if the precise weight of a species in a given stomach was available.

RESULTS By type of prey. A total of 4685 prey items belonging to 61 different species and 29 families were identified in the striped dolphins stomachs. The majority of dolphins showed a mixed diet of squid and fish.

Cephalopods are globally the most important food item, with 91.8% of frequency of occurrence, 32.4% of the total number of prey items ingested and 76.9% of the reconstituted weight (table 1). *Histioteuthis reversa* and *Todarodes sagittatus* are the main prey on a weight basis, totalling more than 34% of the weight of all prey items taken *(H. reversa* 18%, *T. sagittatus* 16%). 32 cephalopods species belonging to 12 families were identified in the stomachs contents. Many of them are present in several areas but in very variable proportions. For example, Loligonidae family is present in all of the five sectors (table 2), certainly related to a large geographic distribution of this kind of prey.Others are spatially limited to restricted areas, like Enoploteuthidae and Brachioteuthidae, only present along the Spanish coasts.

The Gulf of Lions shows the largest diversity of cephalopods species (18). Ocythoidae (*Ocytoe tuberculata*) and Cranchidae families are only present in stomachs from individuals found in this region, and in poor quantity (IRI<0.7%).

Fishes play a variable role in striped dolphin diet depending on the area : in stomach of individuals from Ligurian sea and Gulf of Lions, they are diversified (9 families) and found in regular frequency. Striped dolphins of the Algerian basin seem to consume fishes, at least in summer when Clupeidae (*Sardinella aurita* and *Sardina pilchardus*) are very abundant. Fishes play a secondary role in the Tyrrhenian Sea.

Crustaceans are present in stomachs coming from three of the five areas. They could be found in very high quantity (84 *Sergia robusta*) in one stomach of the Gulf of Lions but, as they have a low caloric value, they cannot be considered as major prey.

DISCUSSION (at geographic level) A general gradient appears from west to east concerning prey species level, and three separate sectors can be distinguished (Tables 2 and 3).

In the Tyrrhenian sea, the eastern part of the studied area, the Histioteuthidae family plays a very important role and fishes (Sparidae) are secondary prey.

The diet of the central part of the basin, composed from north to south of Ligurian Sea, Gulf of Lions and Algerian Basin, is dominated by three cephalopod species. *Sepia officinalis* is only present in the Algerian Basin, *Todarodes sagittatus* is an important item in the northern parts (Gulf of Lions and Ligurian Sea), and *Loligo vulgaris,* is present in the South (Algerian Basin) and the North (Gulf of Lions). In each of these three areas, cephalopods are accompanied by one particular fish: *Sardina pilchardus* in the south, *Merluccius merluccius* in the Gulf of Lions and *Micromesistius poutassou* in Liguria.

In the western sector (Spanish coasts), and according to the data available, *Todarodes sagittatus* predominates, but could be perhaps associated with three other species *(Abraliopsis pfefferi, Onychoteuthis banksii* and *Brachioteuthis riisei).*

These differences in stomach contents are likely to be due to the particular oceanographic patterns prevailing in each area, and preys observed are mainly zooplanktonophageous species. These species feed on phytoplankton, which is linked to oceanographic features. The northern part of the basin (Ligurian sea and Gulf of Lions) is characterized by a large continental shelf and is influenced by continental waters, upwellings, and by the Mediterranean North Current (MNC) and its associated thermohaline front, allowing a highly developed planktonic bloom in spring. All these reasons lead to a certain trophic richness, with a high diversity species (36 species in the Gulf of Lions, 32 in the Ligurian Sea). The southern part of the basin (Algerian Basin) is a poor productive sector, and the dolphin diet has a poor diversity species (5 species). The Tyrrhenian Sea occupies an intermediate position, with a moderate diversity of prey (15 species).

CONCLUSION Cephalopod species are a regular source of food for *Stenella coeruleoalba* in the Mediterranean Fishes and crustaceans are eaten more occasionally, but some times in very large quantities, so this dolphin appears to be above all a teutophagous species in the Mediterranean and is opportunely or localy ichtyophagous.

Most of the striped dolphins preys are benthopelagic or pelagic, living above the continental slope. Many of them are able to perform large nocturnal vertical migration from deep water to the surface, which might imply more active feeding at night.

At a global level, neither one particular species of fishes nor crustaceans is found in more than 6% of the total number of stomachs, according to the opportunistic diet of striped dolphins. On the other hand, 6 families of cephalopods (among 12 encountered) make up the dolphins diet of at least 4 regions (table 2). Among the representatives of these families, *Loligo vulgaris*, *Onychoteuthis banksii, Todarodes sagittatus* and *Todaropsis eblanae* are the most frequent.

Finally, the maintly teutophagous and opportunistic diet of the species is also prouved by considering the most important IRIs (> 25%) found in the different areas : Ommastrephidae in the Gulf of Lions and Ligurian Sea, Histioteuthidae in the Tyrrhenian sea, Loliginidae and Clupeidae in the Algerian basin.

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Table 1 Frequency of occurrence (F%), number of prey (N%), and weight of prey (W%)

	CEPHALOPODS			FISHES			CRUSTACEANS		
	F%	N%	W%	F%	N%	W%	F%	N%	W%
Tyrrhenian sea	66.6	93.4	98.3	87.5	1.2	0.9	29.2	4.2	0.5
Algerian basin	100	25.7	66.7	100	74.3	33.3	0	0	0
Gulf of Lions	100	29.76	62.8	56.25	48.3	33.4	18.7	22	2.8
Ligurian sea	88.5	7.4	48.3	61.5	91	50.8	19.2	1.6	0.9

Table 2 IRI % (Pinkas *et al*., 1971) of each families of cephalopods, fishes and crustaceans

	Tyrrhenian sea	**Algerian basin**	**Gulf of Lions**	**Ligurian sea**	**Spanish coasts**
CEPHALOPODS					
Lologinidae	1.18	**35.46**	**12.69**	0.08	0.06
Sepiidae	0.02	**24.52**			
Enoploteuthidae					**26.81**
Onychoteuthidae	3.26		**12.24**	6.39	**16.75**
Ommastrephidae	**11.6**		**26.12**	**36.88**	**29.21**
Brachioteuthidae					**12.95**
Octopoteuthidae	0.01		0.5	0.01	7.86
Sepiolidae	2.5		1.61	0.45	2.87
Chiroteuthidae	8.94		0.15		1.8
Histioteuthidae	**72.02**		5.92	4.83	1.7
Ocythoidae			0.04		
Cranchidae			0.68		
FISHES					
Clupeidae		**33.19**	5.35		
Engraulidae		6.81		0.83	
Merluccidae			**19.08**	5.01	
Gadidae			0.13	**24.82**	
Belonidae				0.33	
Sparidae	0.11		3.35	8.2	
Stomiatidae			1.26	3.17	
Chauliodontidae			0.29	0.14	
Gonostomiatidae				5.13	
Myctophidae			4.46	3.25	
Muraneidae			0.1		
Cepolidae			0.03		
CRUSTACEANS					
Pasiphaeidae	0.06		3.32	0.47	
Oplophoridae			0.14	0.02	
Sergestidae	0.04		2.38	0.004	
Penaeidae	0.2				
Pandalidae	0.07				

Table 3. In black, species of cephalopods, fishes and crustaceans which have an IRI>10%

	Tyrrhenian sea	**Algerian basin**	**Gulf of Lions**	**Ligurian sea**	**Spanish coasts**
CEPHALOPODS					
Histioteuthis bonnellii	■				
Histioteuthis reversa	■				
Sepia officinalis		■			
Loligo vulgaris		■	■		
Todarodes sagittatus			■	■	■
Abraliopsis pfefferi					■ **?**
Onychoteuthis banksii					■ **?**
Brachioteuthis riisei					■ **?**
TOTAL Nb of species	**13**	**2**	**18**	**14**	**15**
FISHES					
Sardina pilchardus		■			***unstudied***
Merluccius merluccius			■		***unstudied***
Micromesistius poutassou				■	***unstudied***
TOTAL Nb of species	**1**	**3**	**14**	**15**	***unstudied***
CRUSTACEANS					
TOTAL Nb of species	**1**	**0**	**4**	**3**	***not indicated***

RELATIVE TROPHIC LEVELS OF SEVERAL MARINE MAMMAL SPECIES FROM THE NORTHEASTERN ATLANTIC DETERMINED THROUGH STABLE ISOTOPE ANALYSIS

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INTRODUCTION In recent decades the study of differences in stable nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) isotope ratios have provided valuable insights into the trophic ecology and movements of many species (Hobson and Welch, 1992; Kelly, 2000; Lesage *et al.*, 2001). Their analysis has proven to be a useful complement to stomach content analysis in trophic studies in order to be able to relate diet information with other factors (such as pollutant levels, Das *et al.*, 2000) since precise information on the animals' diet is not abundant (stranded animals' stomachs are frequently empty) and stable isotope data gives quantifiable results which can be used for statistical analysis. The use of stable isotope ($\delta^{15}N$ and $\delta^{13}C$) analysis has shown to be of use in determining the trophic position of animals, as within a food web a trophic enrichment of about 3 $^0/_{00}$ for $\delta^{15}N$ and 1 $^0/_{00}$ for $\delta^{13}C$ is generally observed (reviewed by Kelly, 2000). $\delta^{13}C$ data has nevertheless proven more helpful in tracking carbon sources through a food chain: $\delta^{13}C$ values of organic matter are higher (less negative) in coastal food webs than in pelagic ones (Dauby *et al*., 1994).

This paper deals with the results of stable isotope analysis done on seven species of marine mammals (grey seal *Halichoerus grypus*, harbour porpoise *Phocoena phocoena*, white-beaked dolphin *Lagenorhynchus albirostris*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, striped dolphin *Stenella coeruleoalba*, common dolphin *Delphinus delphis* and bottlenose dolphin *Tursiops truncatus*) from the Northeast Atlantic Ocean in order to compare their trophic position (relative to each other) in two neighbouring regions (Irish coasts and French coasts of the English Channel), (Das *et al.,* submitted).

MATERIALS AND METHODS We analysed $\delta^{15}N$ and $\delta^{13}C$ in liver and muscle samples collected from 7 grey seals, 12 harbour porpoises, 3 white-beaked dolphins, 2 Atlantic white-sided dolphins, 6 striped dolphins, 19 common dolphins and 1 bottlenose dolphin found dead along the Irish (counties of Cork, Galway, Kerry, Meath, Clare and Waterford) and French (Cotentin region) coasts between 1989 - 1993 and between 1998 - 2000, respectively. Samples were stored until analysis at –20°C. Lipids were extracted from samples using 1:1 (v) chloroform : methanol rinses, as they are known to be depleted in $\delta^{13}C$ relative to diet. $\delta^{13}C$ and $\delta^{15}N$ measurements were performed with an isotopic ratio mass spectrometer (V.G. Optima, Micromass) coupled to an elemental C-N-S analyser (Carlo Erba).

RESULTS AND DISCUSSION In both ecosystems a significant relationship was observed between $\delta^{13}C$ and $\delta^{15}N$ in livers and muscles, all species considered, ($p < 0.001$ with $r_p = 0.8$ for Irish coasts and $r_p = 0.7$ for French coasts). When considering the species found in both Irish and French coasts, the same relative order in their distribution was observed, from top to bottom: white-beaked dolphin, harbour porpoise, common dolphin and striped dolphin (figure 1).

According to $\delta^{15}N$ measurements, the top trophic positions are occupied by grey seals (18.5 $^0/_{00}$ in liver and 18.3 $^0/_{00}$ in muscle, French coasts) and white-beaked dolphins, followed by harbour porpoises and bottlenose dolphins. These values are consistent with a piscivorous diet. Common dolphins and white-sided dolphins show very low $\delta^{15}N$ values (in striped dolphin, 13.2 $^0/_{00}$ for liver and 11 $^0/_{00}$ for muscle, French coasts; 11.9 $^0/_{00}$ and 10.8 $^0/_{00}$, Irish coasts). This concurs with a smaller proportion of fish (and an increasing proportion of invertebrates) in their diet, culminating with a minimum for striped dolphin which is principally a teuthophageous species (table 1). No significant differences were observed in $\delta^{15}N$ values between individuals of a same species from the Irish and French coasts ($p > 0.5$).

$\delta^{13}C$ values measured in liver and muscle in animals from the Irish coasts were systematically more negative than those from the French coasts. In the case of common dolphins this difference is statistically significant ($p < 0.02$ for liver and $p < 0.005$ for muscle), as well as for striped dolphins (muscle only, $p < 0.05$; hepatic values remain similar, $p> 0.5$), but not so for harbour porpoises ($p > 0.5$). The lowest $\delta^{13}C$ data is for striped dolphin (-16.5 $^0/_{00}$ in liver and –16.7 $^0/_{00}$ in muscle, French coasts; -17.1 $^0/_{00}$ and –17.5 $^0/_{00}$, Irish coasts) followed by common dolphin and white-sided dolphin. This presumably reflects a greater reliance on offshore food, as opposed to the other four species (harbour porpoise, white-beaked dolphin, bottlenose dolphin and grey seal) whose higher $\delta^{13}C$ values would correspond to their preference for a coastal habitat (table 2).

CONCLUSIONS It appears from this study that grey seals, white-beaked dolphins, bottlenose dolphins and harbour porpoises feed closer to shore and higher up in the food web than do the white-sided, common or striped dolphins. Some diet overlap probably occurs between bottlenose dolphins, white-beaked dolphins and harbour porpoises; as well as between common dolphins and white-sided dolphins.

White-beaked dolphins, harbour porpoises, common dolphins and striped dolphins display the same relative and decreasing trophic position along the Irish and French coasts, showing conservative habits in these Northeast Atlantic areas.

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Table 1: Diet of marine mammal species (Evans, 1987; Bonner, 1989)

SPECIES	**DIET**
Striped dolphin	Fish 40% (small), squid 60%
Common dolphin	Fish 85% (sardines, anchovies), squid15%
White-sided dolphin	Fish 90% (herring, cod, pout, mackerel, hake), squid 10%
Harbour porpoise	Fish (herring, mackerel, sandeel, cod), cephalopods (little), crustaceans
White-beaked dolphin	Mainly fish: mackerel, herring, cod, capelin + some squid
Grey seal	Wide variety fish, crustaceans, cephalopods; sand eels prefered food in some regions

Table 2: Marine mammal habitats (Evans, 1987; Bonner, 1989)

SPECIES	HABITAT
Striped dolphin	Oceanic
Common dolphin	Pelagic, offshore
White-sided dolphin	Pelagic, continental slope
White-beaked dolphin	Coastal, continental shelf
Harbour porpoise	Coastal, shallow bays
Grey seal	Coastal

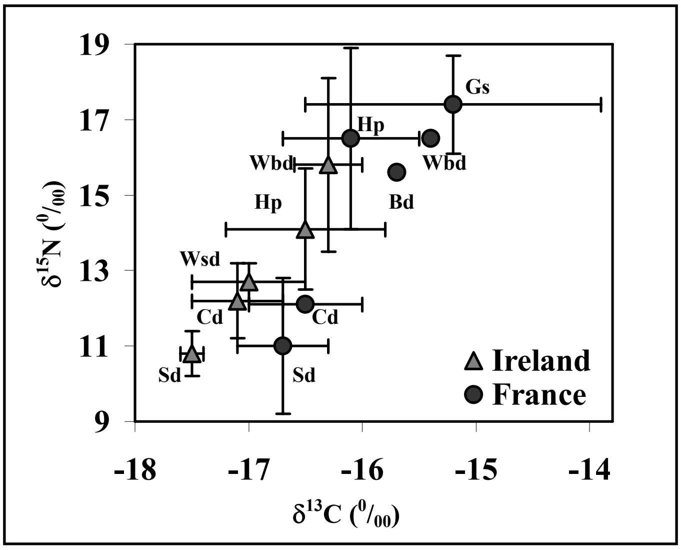

Fig. 1. Muscle isotopic composition of marine mammal species stranded on the French and Irish coasts. (Gs: Grey seal, Hp: Harbour porpoise, Wbd: White-beaked dolphin, Wsd: White-sided dolphin, Bd: Bottlenose dolphin, Sd: Striped dolphin, Cd: Common dolphin)

A SPATIALLY EXPLICIT MODEL OF MARINE MAMMAL FOOD CONSUMPTION IN THE NORTH ATLANTIC – INCORPORATION OF HABITAT PREFERENCES USING GIS

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Important information about the spatial distribution of food intake is often missing in current models estimating feeding requirements of marine mammals. We built a spatially explicit model of marine mammal biomass and consumption in the North Atlantic using high resolution modelling and mapping. A relatively simple base model was developed to estimate feeding requirements and population biomass of all North Atlantic marine mammal species. Maximum geographic ranges of species that are described in the literature were digitised using GIS tools and subsequently rasterized to grid cells measuring 0.5 longitude/latitude. Other cell attributes included depth information and ice coverage. Estimates of annual biomass and food consumption generated by the base model were linked to the associated species-specific distributional ranges. Spatially explicit biomass and food intake (expressed as a proportion of the global total in each cell) were further refined by incorporating information about known species' habitat preferences such as depth ranges and association with ice edges. Plausible probability distributions were superimposed to calculate the likelihood of a given species occurring in a given cell. This likelihood was subsequently used as a 'weighting factor' to modify the initial homogenous biomass and food consumption distributions. Our model predictions correspond well with reported sightings of marine mammals, and suggest that the ranges of marine mammals can be modelled using relatively few oceanographic parameters. We predicted the highest concentration of marine mammals (biomass) and the highest levels of food consumption (in the North Atlantic) to occur along the temperate continental shelves, with peaks off the East coast of Canada and West of Ireland. The visualization of geographic peaks in biomass and food intake may be a useful tool to investigate questions about anthropogenic impact on marine mammal populations, and competitive interactions between fisheries and marine mammals

CEPHALOPODS EATEN BY SPERMWHALES STRANDED IN DENMARK

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The cephalopod remains in the stomachs of ten stranded sperm whales (*Physeter macrocephalus*) were analysed. The sperm whales all stranded at the west coast of Denmark between 1991-2000. Cephalopod remains in the stomachs consisted of 1971 upper and 2313 lower beaks. Species identification was done based on the morphological features of the beaks. The species found were: *Gonatus fabricii, Todarodes sagittatus, Bathypolypus arcticus*, *Histioteuthis* sp., *Haliphron* sp. and *Cyclioteuthis* sp. The lower rostral length (LRL) on all the decapod beaks, and the hood length (h) on all the octopod lower beaks were measured using a calliper. For each lower beak, the estimated mantle length (ML) of the whole animal was calculated from species specific regression lines. *G. fabricii* made up 99.9% of all the lower beaks. 73% of the lower beaks of *G. fabricii* measured between 5.5mm-7.0mm (LRL), which corresponds to an estimated ML of 192-257mm. This means that these sperm whales mostly fed on mature *G. fabricii*. Mature *G. fabricii* females go through comprehensive morphological changes after mating. The muscles degenerate into gelatinous tissue, which results in loss of swimming ability. They drift in the water column carrying their eggs until these hatch. Through this period of their lifecycle *G. fabricii* females are extremely easy prey. The biomass of *G. fabricii* in the North East Atlantic is considerable, and we propose, based on the results here presented, that sperm whales take advantage of the easily catchable food that consists of onthogenically transformed *G. fabricii* mature females. Other predators, such as northern bottlenose whale (*Hyperoodon ampullatus*), who mainly prey on *G. fabricii* may use the same strategy.

GENETICS AND EVOLUTION

NOT SAMPLED, BUT INFLUENTIAL: MISSING HAPLOTYPES AND THE PHYLOGEOGRAPHY OF DUSKY DOLPHINS (*LAGENORHYNCHUS OBSCURUS*)

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We investigated the phylogeography and evolutionary history of dusky dolphins (*Lagenorhynchus obscurus*) using mtDNA sequences of the full cytochrome b gene in 130 individuals from the putative stocks off Peru, Argentina, and South Africa. While genetic differentiation within oceans is surprisingly low, there is no evidence for recent female gene flow between Atlantic and Pacific waters. Highest genetic variability in terms of sequence divergence and number of haplotypes is found in the Atlantic. Given the high level of mortality experienced by the Peruvian dusky dolphin in local fishery activities, our findings have important implications for the objective determination of management decisions. Sequence analyses indicate that the dusky and Pacific white-sided dolphins are sister species and that populations diverged under the "Westwind drift" hypothesis. However, other models of dispersion are conceivable and will be discussed. Finally, we analysed our mitochondrial sequence data set with several widely-used network estimation methods. The resulting intraspecific gene genealogies revealed substantial differences, pointing out shortcomings in some of the algorithms. Given that scientific hypotheses and management decisions strongly depend on a resulting tree or network topology there is a clear need for a systematic comparative analysis of available methods.

PATTERNS OF POPULATION SUBDIVISION, GENETIC VARIABILITY AND GROUP KIN STRUCTURE OF MEDITERRANEAN STRIPED DOLPHINS (*STENELLA COERULEOALBA*)

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The phylogeographic patterns of variation within the Mediterranean Sea was investigated on a total of 152 Striped dolphins from three different areas of the Mediterranean Sea (Adriatic, Tyrrhenian, and Spain), and were analysed at 8 microsatellite DNA loci. Samples were collected from 1990 to 2000 from stranded and free ranging animals in different locations. The number of alleles detected per locus varied from 4 to 22. The Tyrrhenian population had the highest average number of alleles per locus, whereas Spain had the lowest. In general the data suggest small but significant population structure over relatively small geographic scale. Assessment of kinship (based on estimates of R) showed high values both within and between groups, but on average values were higher for intra- than inter-group comparisons. Smaller groups also showed higher average kinship, but high pairwise values were also seen in large groups. Comparisons of relatedness among sexes showed a significant differences between males and females. We suggest a relatively fluid model of kin structure with a trend of female philopatry, and a pattern of male dispersal.

REDEFINITION OF STOCK STRUCTURE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) ALONG THE ATLANTIC COAST OF THE U.S.

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Following the 1987-88 mortality event of bottlenose dolphins along the Atlantic coast of the United States, it was assumed that there was a single stock of coastal bottlenose dolphins that migrated from northern areas (Virginia through New Jersey) in summer to southern areas (central Florida) in winter. A multi-disciplinary study to test the one-stock hypothesis was instigated in 1997. Preliminary results are available from four methods: genetics, stable isotope ratios, photo-identification, and telemetry. These results indicate that the one-stock hypothesis was incorrect. In preparation for a working group required to find ways to reduce the mortality of coastal bottlenose dolphins in commercial fishing gear, we needed to define stocks to the finest resolution possible with the existing data. For that purpose, we have defined seven management units of bottlenose dolphins from New Jersey to central Florida, with three sympatric stocks in North Carolina. It is notable that the contribution from each of the methodologies used in this study was complementary, such that the coast-wide definition of stock structure was contingent on having results from each method. Each individual method on its own would have resulted in a different stock definition. The new definitions allow for a more focused approach to reducing mortality of bottlenose dolphins, which will simultaneously reduce mortality while minimizing adverse effects on the fishermen and the communities that depend on the economic contribution of the fisheries. This study also illustrates the value of multi-disciplinary, integrated approaches to defining stock structure.

SPONGE CARRYING BY BOTTLENOSE DOLPHINS IN SHARK BAY, WESTERN AUSTRALIA: A PATTERN OF CULTURAL TRANSMISSION?

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During a long-term behavioural study on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia, eleven individuals were observed carrying marine sponges on their rostra multiple times (regular spongers), and seven other regularly observed individuals only once (anomalous spongers). Molecular sexing revealed that ten (90.9 %) of all regular spongers, and five (71.4 %) of the anomalous spongers, were female. A total of 106 dolphins of either sex were sampled in an area of about 120 km2 where sponging predominantly occurs, to test if animals that engage in sponging behaviour are more likely to have the same haplotype than expected by chance. Mitochondrial DNA (mtDNA) analysis of a 351 base pair fragment of the hypervariable d-loop region showed five different haplotypes. Haplotype H was found in 16 of all 18 spongers (88.9 %) and in ten (90.9 %) of the regular spongers. Remarkably, the haplotype frequency for H among all 106 animals was only 0.28, a highly significant difference between observed and expected haplotype frequencies, suggesting a very strong association between sponging and a particular haplotype. The fact that about 90 % of all spongers have the same haplotype suggests a pattern of mother-offspring similarity in a complex form of behaviour, indicating a vertical mother-offspring cultural transmission.

FROM THE MANAGEMENT OF NATURAL POPULATIONS TO THE ORIGIN OF WHALES: THE EFFICIENCY OF MOLECULAR APPROACHES IN EVOLUTIONARY BIOLOGY

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Morphological, physiological, and behavioural characters are of great interest in phylogenetic and population genetic analyses. However, the genetic basis is known for very few of these traits in only a small number of species, and the influence of environmental factors on the observed character variance is unknown in most cases. On the other hand, molecular methods open the entire biological world to evolutionary studies and give access to an enormous number of objective characters. Not only can molecular techniques provide a better understanding of character variation at the molecular level, it can also address questions in natural history and organismal evolution, from the determination of pedigrees to the inference of macro-evolutionary patterns. Molecular techniques are especially relevant for cetaceans because *(1)* they are very mobile and often inaccessible organisms for which morphological, physiological, and behavioural characters can be exceedingly difficult to score for population studies, and *(2)* their highly derived and specialised morphology greatly reduces the utility of phenotypic data for phylogeny inference. I will shortly discuss a couple of the major advances in evolutionary biology of cetaceans that molecular approaches have produced in this last decade. Finally, I will advocate that molecular techniques might efficiently assist management decisions at the species and population levels.

THE POPULATION STRUCTURE OF PYGMY (*KOGIA BREVICEPS*) AND DWARF (*KOGIA SIMA*) SPERM WHALES IN THE SOUTHERN HEMISPHERE

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Little is known about the biology of pygmy (*Kogia breviceps*) and dwarf (*Kogia sima*) sperm whales as these animals are rarely observed in the wild. However, strandings of both species occur frequently in the Southern Hemisphere along the South African, Australian and New Zealand coastlines and provide samples for two little known species. The use of conventional techniques as well as novel methods to extract DNA from "ancient" material, such as teeth and bone, now provide data, which allow a first analysis of the population structure of both species. A 279 base-pair consensus region of the mitochondrial cytochrome b gene was sequenced for 96 *K. breviceps* and *29 K. sima* and 26 and 12 unique haplotypes were identified, respectively. The phylogenetic reconstruction by means of a neighbour-joining tree indicated a strong division at the species level, which was in contrast to a lack of characteristic phylogeographic structure within the two species. Overall a lower nucleotide and haplotype diversity was found for *K. sima* than for *K. breviceps*, which, in comparison to other cetaceans, had a high nucleotide diversity. The amount of genetic variation between *K. breviceps* from Australia and New Zealand was extremely small (Fst=0.004), while it was larger between animals from South Africa and Australia (Fst=0.029). The largest amount of genetic variation was observed between animals from South Africa and New Zealand (Fst=0.042). A molecular analysis of variance (AMOVA) showed little genetic differentiation between locations and only the populations from South Africa and New Zealand were significantly different. The above results are in concordance with previous findings about the foraging ecology and distribution of both Kogia species. These data indicated a more opportunistic feeding behaviour and tolerance towards a larger range of water temperatures for *K. breviceps*, which may have evolved as a result of higher predation pressure.

SPERM WHALES IN S. MIGUEL (AZORES, PORTUGAL): NEW INDIVIDUALS, SAME MITOCHONDRIAL HAPLOTYPES

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Sperm whale (*Physeter macrocephalus*) groups found in the North Atlantic are known to be genetically distinct from North Pacific or Southern Ocean groups, even though their organization within the former is not clear. In spite of the frequent, year-round, sightings of sperm whales in Azorean waters, the genetic data on such animals is scarce. The relatively small number of animals (13) that has been studied, does not dismiss the hypothesis that sperm whales found in the area might be genetically distinct from other Atlantic populations. Interestingly, three animals are known to have revisited local waters, 2, 22 and 32 years after they had been harpooned, suggesting the existence of site fidelity, at least to some extent. In order to test if sperm whales sighted and stranded in S. Miguel constitute matrilineal groups distinct from the ones that have been found elsewhere, animals sighted in the Summer of 2000 were photographed and genetically characterized. Out of 44 sighted individuals, 9 flukes were successfully photographed, which had no match in the North Atlantic and Mediterranean Sperm Whale Catalogue. DNA was extracted from sloughed skins of a group with 6 sighted individuals and from two stranded individuals. Samples belonging to the same individual were detected using 5 microsatellites, revealing that the sloughed samples belonged to four individuals. The first 330 bases of mitochondrial control region of the DNAs were amplified and sequenced for a total of 6 animals. Alignment of the mtDNA sequences resulted in the identification of two distinct haplotypes, both described in the literature for North Atlantic and North Pacific animals. Therefore, sequence data does not support the existence of a distinct matrilineal lineage. Nevertheless, a higher number of animals must be analyzed until a decisive conclusion can be drawn on this issue.

LIFE HISTORY

NON-PARAMETRIC EVALUATION OF THE BIRTH DATE OF HARBOUR PORPOISES OF THE NORTH AND BALTIC SEAS

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Since 1990, a monitoring of stranded and by-caught marine mammals has been financed by the Federal State of Schleswig-Holstein and the Federal Ministries of Environment, Research and Technology, Germany. The program includes the collection of data of stranded harbor porpoises. Data collected over a period of ten years were used to evaluate a birth period that lies at the end of June for the North Sea and the end of July for the Baltic. By means of finding dates and body lengths of stranded young harbor porpoises (<1 year) of the North Sea it was possible to determine the birth period with a non-parametric procedure. The animals of the North Sea population, which were under 100 cm of length were put into different length catagories. The smallest category started with 65 cm, the largest ended with 85 cm. These lengths are randomize. The number of the previous was added to the following category. In a third column the appendant medians of the finding dates were entered. To calculate the total birth period of the North Sea population a normal distribution is assumed. Furthermore it is supposed that the porpoises died shortly after birth and were found soon afterwards. It was observed that the maximum of the distribution of the estimated birthdates of the found animals has its mean at 27 June. Therefore it is assumed that the birthdate of the harbor porpoises population of the North Sea of Schleswig-Holstein has its mean at 27. June. A similar proceedure was used in calculating the birth date of the Baltic Sea popualtion. The mean of this birth date was exactly one month later. According to literature the birth period of the North Sea population has roughly been estimated to be in June/July, for the Baltic population in July/August (Fisher & Harrison, 1970; Read ,1990b; Kinze, 1990; Polachek *et al*., 1995).

AN UNPREDICTABLE HORMONAL CYCLE: ARE FEMALE PORPOISES ALSO MOODY OR CAN THEY EXHIBIT OVARIAN DYSFUNCTION OR SOCIAL SUPPRESSION

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A female harbour porpoise, Freja, has been kept since April 1997 together with a male in a semi-natural environment at the Fjord&Bælt centre, Denmark. Progesterone and estradiol profiles, including 1-3 points per month, are available for the period April 1997 - March 2001. Sexual activity and succesful matings were monitored through systematic behavioural observations and occurence of spermatozoa on genital swabs. Hormonal values were obtained from wild females by-caught in pound nets. Until August 98, Freja’s estradiol baseline levels were close to 500 pg/ml, with peaks above 1400 pg/ml. Between November 98 and March 2000, they dropped to less than 300 pg/ml, with no peaks. From June 2000, estradiol raised dramatically to a baseline of 2000 pg/ml with peaks above 4000 pg/ml. Progesterone baseline values were about 4-5 ng/ml with peaks up to 11 ng/ml until July 5, 99, then dropped to 1ng/ml and remained inferieur to 2ng/ml, with no peak. In wild porpoises, progesterone values up to 40 ng/ml were observed while estradiol value remained inferior to 100 pg/ml. Successful matings occured every summer since 1998, but Freja did not get pregnant. The decrease in progesterone in July 99 occurred five weeks after a one-year female was introduced in the pool, the June estradiol surge followed her death in February. Interpretation is difficult since estradiol and progesterone peaks are short-lived event which can be missed under irregular sampling. Freja’s estradiol levels were noticeably higher than levels in wild porpoises and other cetacean and mammalian species. Cystic ovaries could produce high estradiol levels. The presence of the juvenile female may also have influenced hormonal secretion. Captivity can represent a suppressing factor in a species where mating bonds are short-lived. That successful matings have occured every summer, with or without high hormonal levels and peaks, is worth noting.

MEDICINE AND DISEASE

PATHOLOGICAL LESIONS ASSOCIATED WITH SCOLEX PLEURONECTIS (CESTODA) IN STRIPED DOLPHINS (*STENELLA COERULEOALBA*) FROM THE WESTERN MEDITERRANEAN

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Two morphotypes of Scolex pleuronectis, 'small' and 'large', occur in striped dolphins from the Western Mediterranean. These larval types differ only in size and have a scolex with an apical sucker, and 4 monocular bothridia with an anterior accessory sucker. Small *S. pleuronectis* are found within the lamina propria of the mucous layer of the pyloric stomach and terminal colon, whereas large *S. pleuronectis* occur within anal crypts. From these locations, these larvae apparently enter the lymphatic-circulatory system to reach the abdominal mesenteries and blubber, where *S. pleuronectis*would become *Monorygma grimaldii* and *Phyllobothrium delphini*, respectively. In this study, we describe the pathological effects associated with the presence of *S. pleuronectis*in the digestive tract. Samples collected from 4 dolphins were examined macroscopically, then fixed in 10% buffered formalin, embedded in paraffin, sectioned at 5 m m, and stained with hematoxylin and eosin. Small *S. pleuronectis*caused variable erosion of the mucous layer of the pyloric stomach and terminal colon. Microscopically, dilation of the crypts, necrosis of the epithelium, and diffuse infiltration of lymphocytes, plasma cells and eosinophils in the lamina propria were observed. Large *S. pleuronectis*caused inflammation of the openings of anal crypts. Microscopically, the epithelium of the crypts showed exocytosis of inflammatory cells, degeneration and focal necrosis (occasionally associated with the scolex), and desquamation of epithelial cells in the lumen. There was also a moderated to intense infiltration of eosinophils in the connective tissue surrounding the crypts with worms and, to a lesser degree, in the crypts without worms. In the submucosa of one dolphin, inflammatory granulomas with centres of necrosis surrounded by macrophages, syncitia and mononuclear cells were also observed. * This work has been supported by Valencian & Spanish Governments, FPI98-RN-14-218 & DGES PB96-0801.

AUDITORY EVOKED POTENTIALS OF A REHABILITATED STRIPED DOLPHIN, *STENELLA COERULEOALBA*: AN ASSESSMENT OF THE SONAR SYSTEM FUNCTIONALITY

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The odontocete bio-sonar processes constitute a primary information exchange mechanism for communication, food location and orientation in the marine habitat. In a healthy organism, the hearing system characteristics are directly and evolutively related with the habitat use, thus further characterises a cetacean species. Both the species related frequency resolving power and the hearing frequency sensitivity, HFS (i.e. hearing threshold) can be studied with electrophysiological methods, through the analysis of evoked potentials (EP) from the head surface. The analysis of the hearing frequency sensitivity is of particular interest in the case of a rehabilitated cetacean in order to assess the physiological and/or pathological status of the auditory system, estimate the bio-sonar performance and evaluate the survival probability of the animal after release. A female striped dolphin, *Stenella coruleoalba*, stranded alive in August 2001 on the West Mediterranean Coast (Alicante, Spain). After a 16 week rehabilitation period, HFS-EP analysis as well as experiments to stimulate the production of sonar click trains were conducted prior to the release. Although these experiments represent the first attempt to record EP responses from this species with the consecutive lack of reference about the striped dolphin audiogram (overcome by analogies with odontocete species for which audiograms are available), a severe hearing loss appeared in response to the whole frequency spectrum tested as well as a total absence of sonar click production. These results illustrate that, despite the vital parameters and the nutritional state of the animal were correct during the whole rehabilitation process, this dolphin would have very little chance to survive if released. Therefore, we recommend the introduction of EP measurements as a complementary clinical procedure and a necessary analysis in any cetacean rehabilitation process since it represents an objective parameter to assess the functionality of the cetacean most critical sensory systems.

GROWTH AND DEVELOPMENT OF MEDITERRANEAN MONK SEAL PUPS DURING REHABILITATION

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The critically endangered status of the Mediterranean monk seal, *Monachus monachus* has led to a series of conservation plans of action. One of the measures recommended has been the establishment of a rehabilitation programme for the Eastern Mediterranean range of the species. This programme was initiated in Greece in 1990, with the establishment of the Seal Treatment and Rehabilitation Centre, in Alonnissos, N.Sporades. The aim of this programme is to increase the survival possibilities of animals needing aid and to release them healthy into their natural environment. Here we present data on the growth, relative to the diet, and development of six Mediterranean monk seal pups rehabilitated in the Centre. During this period, apart from the veterinary care, the growth and development of each animal were monitored through the regular recording of data on dental eruption, moulting, weight and length. All pups, four males and two females, were admitted at the age of 1 - 3 weeks old. They were all orphans and exhibited symptoms of dehydration, starvation and in one case multiple infections. The rehabilitation lasted between 3-6 months, depending on their health status, growth and the potential to survive in the wild. Their weight upon admission ranged from 12.8 - 20 kg and increased gradually to 50 - 70 kg., at the time of release. The period of dental eruption lasted from 40-51 days, starting at the age of 2-3 weeks. Duration of moulting of the pup lanugo was found to be quite variable and lasted between 35-96 days, staring at the age of 4-5 weeks. These results form a previously unavailable basis for developmental parameters for this species in captivity. Comparing our observations with those measured in the wild, it is likely that malnourished animals exhibit a delayed development.

SEPTICAEMIC INFECTION CAUSED BY *ERYSIPELOTHRIX RHUSIOPATHIAE* IN A HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) STRANDED ON BELGIAN COAST

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An adult female harbour porpoise (*Phocoena phocoena*) has been found dead on a Belgian beach in october 2001. The body was in good condition. Pure and abundant growth of a small rod-shaped, Gram-labile bacterium was obtained aerobically and anaerobically on Columbia blood-agar from the heart blood, the mouth, the pharynx, the lungs, the intestine and the anus. The colonies were surrounded by a narrow zone of a-hemolysis. The catalase- and peroxydase-tests gave negative results. Rapid ID 32 Strepto (Biomérieux, France) sugar tests identified this isolate to *E. rhusiopathiae* in heart blood, lungs and intestine. *E. rhusiopathiae* is not reported as a common cause of infection and death in wild cetaceans in opposite to captive dolphins. Nevertheless, *E. rhusiopathiae* can be considered as the cause of death of this stranded harbour porpoise as it was present in heart blood and internal organs.

PARASITOSIS OF PORPOISES STRANDED ALONG THE BELGIAN AND NOTHERN FRENCH COASTS

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Between 1990 and 2001, 77 harbour porpoises were found stranded along the Belgian and French coasts. Among those, 47 were parasitized. The aim of the study was to determine the implication of the helminth endoparasites in the lesions and the mortality of porpoises. During necrospy, the helminths were sampled and preserved in 70 % ethanol containing glycerin 5 %. The asssociated lesions were examined macroscopically and were stored in 10% buffered formalin for histopathology. Two nematoda, *Torynurus convolutus* and *Pseudalius inflexus* were observed in the respiratory tract and caused an acute bronchopneumonia. A third one, *Halocercus invaginatus* was encysted in the pulmonary parenchym. In the stomach, the third stage of *Anisakis simplex* caused a chronic ulcerative gastritis, severe in some cases. *Pholeter gastrophilus*, a trematoda encysted in the mucosa of the second gastric compartment, caused a chronic nodular gastritis. A cestoda, *Diphyllobothrium stemmacephalum* observed in the intestine, was rare and caused an subacute enteritis. *Stenurus minor* observed in the peribullar sinuses caused no lesion. The main lesions in relation with the parasitism were the emaciation and the bronchopneumonia. The statistical analysis showed that these three pathologies influenced one another. We also studied the relation between the single or multiple (more of two infested organs) parasitism as well as the presence or absence of lesions with the host's biological data. The multiple parasitism was associated with the presence of lesions (parasitosis). In conclusion, the parasites could predispose to the death, often being associated with bronchopneumonia and emaciation.

EXCEPTIONAL RECORD OF A DOUBLE-FACED MONSTER OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) IN THE MEDITERRANEAN SEA, FRANCE

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INTRODUCTION Anatomists addressed the issue of monstrosity as a whole and considered that it was part of the evolution of the foetus. They depicted 'monstrosity' as part of a natural process, rather than as an independently produced phenomenon. The teratology is the division of embryology and pathology which deals with abnormal development and congenital malformations. It is well known that many types of teratological specimens have been found among mammals including man. Comparatively, such records in cetaceans remain scarce.

Discovery and preliminary examination. On June 24th 2001, two of the authors (Césarini and Clémenceau, GECEM) found a small and abnormally shaped bottlenose dolphin. First examination revealed that it was a stillborn female, 119cm body length, 22kg body mass, with 80 cm of umbilical cord. This female was in an advanced state of decomposition and showed two visible rostra. The discovery was done on the Borgo beach (10km south of Bastia), upper Corsica.

Necropsy. The carcass was kept frozen until further examination. The animal was X-rayed and necropsied on July 2nd in Marseille. The malformation mostly affected the face of the animal and to a much lesser extent the brain case (Fig. 1).
There were only one brain case with 2 tympanic bullae, but two beaks, 2 blow holes, 2 eyes located laterally and 2 others inserted between the two beaks. The skull was abnormally wide, had a single occipital hole as well as a single hyoid apparatus; however the tongue was bifid, each part corresponding to one of the two beaks.

Morphometric skull description. The skull was cleaned by using a non invasive method (fresh water maceration) in order to preserve bone sutures and allow the description and measurements of skull features (Fig. 2 and Table 1).

CONCLUSIONS Teratological specimens have long been documented in a diversity of mammals, mostly domestic species and man. Comparatively, such records in cetaceans remain scarce. To our knowledge, previous records of double-headed cetaceans only include one striped dolphin, *Stenella coeruleoalba*, found in Japan in 1981 and one bottlenose dolphin described in the Netherlands in 1920. This kind of abnormality must result from dysfunctionning during the early organogenesis of the embryo and no inference could be made of the initial cause from the examination of the carcass.

This kind of double-faced monster is not evenly distributed among mammals; instead, apart from the few cases known in cetaceans, it was only reported from Artiodactyla, the even-toed Ungulates, the closest terrestrial relatives to Cetacea within current mammalian fauna.

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Fig. 1. Skull of the double-faced bottlenose dolphin monster

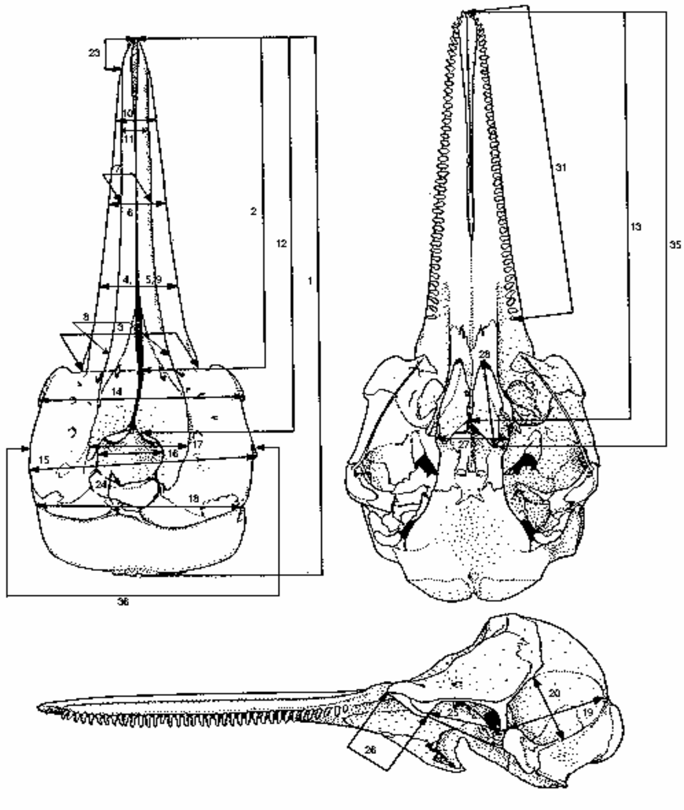

Fig. 2. Scheme of skull measurement (W.F. Perrin, 1975)

Table 1 : Skull measurements

N°	Standard measurements (mm)	Left side	RIGHT SIDE
1	Condylobasal length.	286	303
2	Length of rostrum.	134	142
3	Width of rostrum at base.	66	65
4	Width of rostrum at 60 mm anterior to line across hindmost limits of antorbital notches.	54	50
5	Width of rostrum at 60 mm from rostrum base.	51	47
6	Width of rostrum midlength.	54	52
7	Width of premaxillaries at midlength of rostrum.	25	23
8	Width of premaxillaries at rostrum base.	43	39
9	Width of premaxillaries at 60 mm from rostrum base.	27	24
10	Width of rostrum at 3/4 from posterior end.	36	36
11	Width of premaxillaries at 3/4 from posterior end.	26	25
12	Distance from tip of rostrum external nares.	160	166
13	Distance from tip of rostrum internal nares.	161	181
14	Greatest preorbital width.	116	114
15	Greatest postorbital width.	135	150
16	Greatest width of external nares.	31	32
17	Greatest width of premaxillaries.	61	70
18	Greatest parietal width.	147	145
19	Greatest length of left posttemporal fossa.	38	32
20	Greatest width of left posttemporal fossa.	44	24
21	Major diameter of left temporal fossa.	43	45
22	Minor diameter of left temporal fossa.	17	15
23	Projection of premaxillaries beyond maxillaries.	10	9
24	Distance from foremost end of junction between nasals to hindmost point of margin of occipital crest.	39	37
25	Length of left orbit.	45	48
26	Length of antorbital process to left lacrimal.	33	31
27	Greatest width of internal nares.	43	45
28	Greatest length of leftand right pterygoid.	45/39	47/38
29	Greatest length of left tympanic bulla.	41	40
30	Greatest width of left tympanic bulla.	20	23
31	Length of upper left and right tooth row.	124/104	123/111
32	Length of lower left and right tooth row.	138/118	96/63
33	Greatest length of left ramus	251	189
34	Greatest length of right ramus	165	121
35	Tip of rostrum to posterior end of pterygoids.	122	136

N°	*Specific measurements*	In mm
36	Bicephale cranial breadth.	189
37	Distance between the two rostrums at tip.	88
38	Distance between the two rostrums at midlength.	91
39	Distance between the two rostrums end.	102

A REVIEW OF POST-MORTEM INVESTIGATIONS OF CETACEAN STRANDINGS AROUND THE COASTLINE OF ENGLAND AND WALES BETWEEN 1991 AND 2001

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Between January 1991 and December 2001, 838 cetaceans found stranded around the coastline of England and Wales were examined at post-mortem using standardised methodology as part of a project initiated by the UK government in 1990. The animals examined comprised 488 harbour porpoises (*Phocoena phocoena*), 246 common dolphins (*Delphinus delphis*), 40 striped dolphins (*Stenella coeruleoalba*), 18 white-beaked dolphins (*Lagenorhynchus albirostris*), nine bottlenose dolphins (*Tursiops truncatus*), eight pilot whales (*Globicephala melas*), six Atlantic white-sided dolphins (*Lagenorhynchus acutus*), six Risso's dolphins (*Grampus griseus*), five minke whales (*Balaenoptera acutorostrata*), three fin whales (*Balaenoptera physalus*), two sperm whales (*Physeter macrocephalus*), two killer whales (*Orcinus orca*) and single strandings of a pygmy sperm whale (*Kogia breviceps*), a Sowerby's beaked whale (*Mesoplodon bidens*), a Blainsville's beaked whale (*Mesoplodon densirostris*), a humpback whale (*Megaptera novaeangliae*) and a northern bottlenose whale (*Hyperoodon ampullatus*). A cause of death was established for 665 of these animals (79.4%). The most common cause of mortality in porpoises (n=131) and in common dolphins (n=143) was entanglement in fishing gear. A range of samples were taken at post-mortem and form part of a substantial marine mammal tissue archive consisting of over 23 000 frozen and fixed samples cross referenced on a database specifically developed for this purpose. In addition a range of analyses have been performed on many animals in this study such as ageing (n=734), toxicology (n=289 where PCB burdens have been examined) and dietary analysis (n=337). The generation of samples and data from post mortem examinations resulting from this long term monitoring program has enabled a clearer understanding of cetacean biology, health and mortality to be gained. The project continues to provide a valuable resource for existing and future inter-disciplinary collaborative research.

CAPTIVE HARBOUR PORPOISES VERSUS WILD ONES: WHERE IS THE CHALLENGE?

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A regular long term monitoring of blood hematology and clinical chemistry of harbour porpoises kept in human care provided a unique background for interpreting values obtained from wild porpoises. An adult male, an adult female and a juvenile female were kept together for nearly five years and 10 months respectively, in a semi-natural outdoor enclosure (natural environmental conditions, sea water, tidal currents, fauna) at the Fjord&Bælt centre, Denmark. They were fed with frozen fish, but took also live fish and regularly received anti-parasite treatments. A medical check was carried out at least once a month. Similar medical checks were performed before the satelitte tagging of 30 harbour porpoises by-caught in pound nets. Hematology and serum chemistry values were determined by a commercial laboratory, using standard techniques. As expected, some parameters decreased with age (e.g. white cell count, alkaline phosphatase), while iron concentrations were higher in females. Wide individual variations were observed for some parameters (e.g. urea). Because of the inter-relation of blood parameters and the contradictory effect of different causes, interpretation of vertical data has to be cautious. Several results, however, could indicate a systematic difference between captive and wild porpoises. White blood cell counts and differential neutrophil counts were significantly higher, while differential lymphocytes and eosinophil counts were significantly lower in wild porpoises. These results suggest that wild porpoises are under higher bacterial and parasitic pressure than captive animals. Interestingly, the oldest (longest) wild females had significantly lower differential lymphocyte counts and higher differential neutrophil counts than the other wild porpoises. Higher differential eosinophil counts in conjunction with higher SPGT (alanine aminotransferase) values in wild porpoises could be indicative of higher parasitic liver burden. Absolute blood cell counts would facilitate the interpretation of the differences observed. This project is supported by the Danish Nature and Forest Agency.

CENTRAL NERVOUS SYSTEM T CELLS LYMPHOMA IN A COMMON DOLPHIN

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On the 13th of June 2000, a group of common dolphins (*Delphinus delphis*) were sighted next to Las Canteras beach (Gran Canaria). One of them, a male adult, showed an anomalous behaviour with the intention of beaching. The dolphin died before moving to the recuperation centre for its medical attendance. Then it was carried to the Veterinary School of Las Palmas University where a complete necropsy was performed, showing as main findings congestion of different systems and granulomata of different sizes on the lungs. The most significant change was found in the hypothalamic area where a nodular mass of 3 cm in diameter was detected. The histological examination of the nervous system showed the presence of different sized rounded cells and evidence of nuclear pleomorphism, with 1-2 mitotic figures per field of high magnification. Areas of necrosis associated with cells with lymphohistiocytic appearance were also noticed. Several layers of mature lymphoid cells with scarce cytoplasm were present on the Virchow-Robbin spaces. In order to determine the cellular inmunophenotype of the neoplasia, inmunohisthochemical methods were applying by using a panel of polyclonal and monoclonal antibodies. Inmunohisthological results showed reaction to the CD3 lymphocyte T antigen in the membrane of most neoplastic cells. The tumour was diagnosed as a primary round-cell neoplasm of the Central Nervous System on the basis of its growing pattern, organic location, and the cellular morphology. The immunohistochemical result confirmed the diagnosis of a Primary Lymphoma of T-Cell.

EPIPHYSAL ANKYLOSIS IN THE VERTEBRAL COLUMN AND FLIPPERS OF DANISH HARBOUR PORPOISES (*PHOCOENA PHOCOENA*): ONSET AND DEVELOPMENT

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ABSTRACT The onset and timing of epiphysal ankylosis was studied in 210 postcranial skeletons of the harbour porpoise (*Phocoena phocoena*) originating from Danish waters and held in the collections of the Zoological Museum, University of Copenhagen. Ankylosis in the vertebral column starts in the cervical region, then it proceeds from both ends, terminating in the thoracal vertebrae. Females have a delayed ankylosis compared to males. Ankylosis in the flippers begins at the distal end of the humerus and the proximal ends of the radius and ulna. The progression of ankylosis in the flippers was much more consistent across the specimens than the vertebral ankylosis, and might be used as a rough age estimation tool, based on x-ray photographs. Several characters of the skeleton were measured and their growth monitored, and the growth and development of males and females was registered independently and compared. A two-phase growth model for both sexes is proposed. The size of the scapula, humerus, radius, ulna, pelvic bone and the first rib all correlated strongly with the total length of the specimens. The scapula, 1st rib and pelvic bone showed positive allometry compared to the total length. The humerus, radius and ulna showed negative allometry. A strong tendency for larger right scapulae, humerii, radii and ulnae was detected.

INTRODUCTION The ankylosis of epiphyses and the fusion of other post cranial elements as a gross measure of age is well known, but very few papers have addressed this phenomenon in cetaceans, and in those cases mainly on mysticete species (Wheeler, 1930, Ohsumi et al., 1958). The only comparable studies on odontocete species, we could find were carried out by Ito & Miyazaki (1990) on the striped dolphin (*Stenella coeruelba*), and Yoshida et al. (1994) on the finless porpoise (*Neophocoena phocoenoides*). Ferrero & Walker (1999) investigated epiphysal ankylosis of three thoracal vertebrae as a measure of physical maturity in Dall's porpoise (*Phocoenoides dalli*). The general characteristics of the pattern of epiphysal ankylosis in the vertebral column of the investigated cetaceans can be described as a rapid and early ankylosis of the thoracal vertebrae, immediately followed by the ankylosis of posterior caudal vertebrae; ankylosis then progresses from both ends. Growth and allometry of external characters in harbour porpoises have been investigated by Read & Tolley (1996), finding negative allometric growth for the flippers and the anterior part of the body as related to the total length of the specimens. The asymmetry of the harbour porpoise skull has been addressed (Yurick & Gaskin, 1988), but we have not been able to find any studies of the asymmetries of the postcranial skeletons of cetaceans. Here, we describe the process of epiphysal ankylosis in the vertebral column and flipper bones and the growth, allometry and asymmetry of several characters of the postcranial skeleton.

MATERIALS AND METHODS A series of harbour porpoise skeletons of known age were examined at the Zoological Museum of Copenhagen originating from all Danish waters and collected during 1981-89. For investigation of ankylosis and growth specimens were selected to represent age classes from fetuses up to 14 years and above. Where possible, each age class consisted of 15 specimens of each sex. It was impossible to achieve full sample sizes for all age classes since older animals are rare in a sample originating from incidental catches. Because of the scarcity of specimens the following age classes were combined for both sexes for investigation of ankylosis: 6-7 year old animals, 8-9 year old, 10-13 year old and 14 years and above (only females were available in the latter age class).

Ankylosis. The degree of epiphysal ankylosis in the vertebral column was registered in each vertebra of each specimen, and described as states A, B, C and D (see table 1 and figure 1.). The mode of state of ankylosis of each vertebra in an average vertebral formula is presented in Fig. 1.

The degree of epiphysal ankylosis in the flipper bones was registered in the proximal and distal ends of the humerus, radius and ulna for each specimen, and described as states A, B, C and D (see table 2). The mode of state of ankylosis was determined for both ends of each bone in each age class. To examine if ankylosis in the flippers could be used as a quick, rough age estimate in harbour porpoises, x-ray photographs were taken of ten preserved flippers from the collection.

Age and size relationship. The age of each specimen was expressed as follows: For individuals with no deposited growth layer groups in the dentine (GLGs), the age was calculated as the count of days from the 1st of July to the date of collection / 365, regarding the 1st of July as the birth date, following Kinze (1994). The age of fetuses was likewise calculated by counting the days from the collection to the 1st of July, and subtracting the fraction of 365 from 0. Fetuses found after the 1st of July were considered as 0 years old. For all other specimens the age was calculated as 0,5 + number of GLGs.

For analysis of growth, allometry and symmetry, the total length (cm) of each specimen was obtained from the ZMUC database for harbour porpoise. The following measurements were made to the nearest mm using a caliper: greatest length of each scapula, greatest length of each humerus, greatest length of each radius, greatest length of each ulna, greatest length of 1st rib and the greatest length of each pelvic bone.

Allometry and correlates of the measured characters. For all the measured skeletal characters the average length (left+right/2) was correlated to the total length of the specimens. To determine the growth pattern in each specific character as related to total length, we used an allometric model taking the form:

$Y=aL^b$ (1)

Where Y is the measured character, L is the total length of the specimen, a is a constant determined by the value of Y when X is unity, and b is the growth coefficient. This model was fitted to the data using a least-squares approach. A growth coefficient significantly less than 1,0 indicates negative allometry, a coefficient significantly greater than 1,0 indicates positive allometry, and a coefficient not significantly different from 1,0 indicates isometry. Statistical analysis involving thegrowth coefficient tested the null hypothesis H_0: b=1, where the test statistic $t_s = (b-1)/SE_b$ with α=0,05.

Asymmetry. The asymmetry of the skeleton was examined by comparing all the measurements of the left and right bones, using a paired student's t-test.

RESULTS Complete ankylosis of all vertebral epiphyses occurs in the harbour porpoise. Sexual maturity is attained several years before physical maturity. Females seem to have a delayed ankylosis compared to males, for the flipper bones as well as the vertebrae, except for the cervical vertebrae. Ankylosis of the vertebral column commences in the anterior cervicals, then around the 25-30th caudals, proceeds posteriorly from the cervicals and in both directions from the first-fused caudal vertebrae. The youngest specimen to exhibit full fusion of all vertebrae was an 8-year old female. The oldest not to exhibit full fusion was a 14 year-old female still showing sutures in the thoracal and lumbal vertebrae. The average life-span of a harbour porpoise is 8-10 years (Kinze, 1994), so it seems that most harbour porpoises do not live long enough to attain physical maturity. Typical progressions of ankylosis in the vertebral columns of the respective age classes are presented in Fig. 1.

Ankylosis in the flippers. Ankylosis in the flippers begins at the joint of the humerus to the radius and ulna, proceeds at the proximal end of the humerus and ends with the ankylosis of the epiphyses at the distal ends of the radius and ulna. The oldest specimens not to show any ankylosis in the flippers were 0 years old for males as well as females, while the oldest female not to exhibit full ankylosis was 6 years old, while an 8 year-old male was not fully fused at the distal ends of the radius and ulna. The results for ankylosis in the flippers were much more consistent than the corresponding results for the vertebrae. X-ray photographs may provide a quick and easy, rough age estimate for cetaceans.

To examine if ankylosis in the flippers could be used as a quick, rough age estimate in harbour porpoises, x-ray photographs were taken of ten preserved flippers from the collection. Age estimations based on the photographs were identical to the results obtained from GLGs in six cases, and deviated with only a year in four cases. Typical ankylosis progression in the flippers of the respective age classes are presented in Fig. 2, and x-ray photographs of the flippers of two specimens are presented in Fig. 3.

Growth. Growth curves were fitted to the length at age data for males and females separately using a non-linear least-squares approach. One and two-phase Gompertz, Laird, van Bertalanffy, hyperbola and logarithmic models were tried, and the best fit for both sexes was attained with a two-phase Gompertz model, using the three parameter base model:

$L(t)=A(\exp(-b \exp(-kt)))$ (2)

Where L(t) is the length at age t, A is the asymptotic value, b is the constant of integration, k is the growth rate constant, and t is age.

Regressions for the two-phase model were tried using immature and mature specimens for the 1st and 2nd phases respectively, and also by using younger and older animals for the two phases.
For both sexes the best fit was achieved using the data from specimens from fetuses to 1,5 years old for the lower curve, and the remaining data for the upper curve.

The transition point between the upper and lower curves was marked by the intersection of the two curves. Note that the intersection point for the females was ultimately at a lower age than the transition between the younger and older animals used for the two regressions. This does, however, not mean that the fit was better for a model based on animals younger than 1 for the lower curve and older than 1 for the upper curve. The resulting equations for the growth curves are presented in table 3, the fitted curves are displayed in figures 4 and 5.

Harbour porpoises exhibit a two-phase growth pattern. For males the predicted asymptotic length of the upper curve was 143,4 cm. 95% of predicted asymptotic length was reached at an age of 3,8 years. Early post-natal growth was rapid, reaching a predicted length at the age of 1 of 120,1 cm. The transition point between the upper and the lower curves was 124,1 cm. at age 2,14.

The upper curve of the females predicted an asymptotic length of 163,0 cm. 95% of predicted asymptotic length was reached at an age of 8,6 years. As with males, post-natal growth was rapid, reaching a predicted length at the age of 1 of 124,2 cm. The transition point of the upper and lower curve was at a much younger age than in the males at length 125,5 cm and 1,28 years. The secondary growth phase was more pronounced, and of shorter duration for males than females, and the difference between the asymptotes of the two phases is greater for the females.

The lower curves are directly comparable between the sexes, and young females grow at a significantly ($p<0,01$) faster rate than young males.

Allometry and correlates. All the measured characters showed a strong correlation to the total length. The measurements in the flippers; the humerus, radius and ulna exhibited negative allometry in both sexes. The measurements of the scapula, the pelvic bone and the 1st rib all showed positive allometry for both sexes. For all the measurements, the except the 1st rib, the males are significantly more inclined to positive allometry. Correlates and allometric equations are presented in table 4.

Asymmetry. For all the measurements except the pelvic bones, significantly larger values were obtained from the right side bones compared to the left, for both sexes. The greatest differences were measured for the scapulae. The data are presented in table 5.

DISCUSSION Ankylosis in the harbour porpoise approximately follows the same pattern as noted for other cetacean species (Ito & Miyazaki, 1990; Ohsumi et al., 1958; Yoshida et al., 1994), the characteristics of this pattern being a rapid and early ankylosis in the cervical region, immediately followed by ankylosis of the caudal vertebrae. From our data we deduce that full ankylosis in the vertebral column is not mandatory for its optimal functioning, as it occurs at such an advanced age (first seen in an 8 year-old specimen).

Females exhibit a general tendency towards later ankylosis than males. The later ankylosis of the females corresponds well to their overall larger size, and the growth model proposed here. Females reach 95% of their total length at 8,6 years, while males do so 3,6 years old. A prolonged growth period for female harbour porpoises has also been proposed by Gaskin & Blair (1977); Gaskin et al. (1984), Kull & Berggreen (1995), Lockyer (1995), Miyazaki et al (1987), Stuart & Morejohn (1980), Van Utrecht (1978) and Read & Tolley (1997). The extensive period of growth may be viewed as a reproductive adaptation, since the newborn calf must be of a certain minimum size to withstand excessive energy-loss due to loss of body-heat to the surrounding water. This prerequisites that the sexually mature female must be of a certain size in order to accommodate a fetus of up to 50% of the mother's length (90 cm., Kinze (1994). It may be speculated that the larger the mother, the greater the calf's chances of survival, since our data suggest that most females will not stop growing before they die. The onset and the specific timing of ankylosis show a considerable variation within each age class.

The corresponding results for the flippers are much more consistent, and apart from the distal ends of the radius and ulna, ankylosis occurs at a younger age. This may mirror a greater importance of ankylosis for the proper functioning of the flippers compared to the vertebral column. Based on a limited survey of ten flippers, we believe that x-ray photographs of flippers can provide a quick and easy, rough age estimate in harbour porpoises, and most likely in other cetacean species as well. We are currently working on a more comprehensive study to investigate this.

Our data suggest a two-phase growth model for the harbour porpoise, akin to what has been suggested for other small odontocete species such as Dall's porpoise (Ferrero & Walker, 1999) and the spotted dolphin (*Stenella attenuata*) (Perrin et al. 1976). For all three species the data suggest a close link of the second growth phase to the age of sexual maturity, though the females in our study begin their second growth phase sooner than the males, and are known to attain sexual maturity later (Kinze, 1994).

Our data from the allometric analysis differ somewhat from Read and Tolley's (1996) findings on Bay of Fundy harbour porpoises. Like their study, our data show clear negative allometry for the flippers, whereas Read & Tolley report negative allometry in the growth of girth as well as length of the anterior region of the body. The scapula and 1st rib exhibited positive allometry in our study. The longitudinal measurements of Read & Tolley incorporate the head however, and cranial measurements (unpublished data) of our sample show strong negative allometric growth. The fact that the flipper bones show negative allometry, while the scapula shows positive allometry, indicates that the young harbour porpoise must drive a relatively large flipper with a smaller musclemass, giving them a potential deficit in maneuverability.

All our measurements are significantly larger for bones in the right side than the left, except the pelvic bones. The scapula, humerus, radius and ulna are all part of the appendicular skeleton, while the 1st rib could be thought to yield support to the flipper. The same asymetric pattern is found in humans (*Homo sapiens*), where it is attributed to right-handedness (Steele, 2000). A preference for the use of the right forelimb has also been observed in rats (*Rattus norvegicus*) by Mikliaeva et al. (1987). We deduce that the harbour porpoise is a right-flippered species, relying more on the use of the right flipper than the left for maneuvering. A planned study on the behaviour of captive harbour porpoises will further clarify this. To our knowledge, the asymmetry of the postcranial skeleton of cetaceans has not been addressed before, but may be a general pattern.

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Table 1. States of epiphysal ankylosis of the vertebral column.

A	No ankylosis. Both epiphysal plates free.
B	Initial ankylosis. At least one epiphysal plate loosely fused to centra
C	Progressing ankylosis. Both epiphysal plates fused to centra showing clear sutures.
D	Complete ankylosis. Both epiphysal plates fused to centra showing no sutures.

Table 2. States of epiphysal ankylosis of the flipper bones.

A	No ankylosis. Epiphysis free.
B	Initial ankylosis. Epiphysis loosely attached to the bone.
C	Progressing ankylosis. Epiphysis fused to the bone showing clear suture.
D	Complete ankylosis. Epiphysis fused to the bone showing no suture.

Table 3. Fitted growth curve equations for total length at age (L(t)) based on the Gompertz model.

Male lower curve	L(t)= 124,73(exp(-0,354 exp(-2,308t)
Male upper curve	L(t)= 143,42(exp(-0,544 exp(-0,617t)
Female lower curve	L(t)= 126,40(exp(-0,357 exp(-3,013t)
Female upper curve	L(t)= 162,96(exp(-0,348 exp(-0,223t)

Table 4. Correlation and allometry. Allometric equations for the characters based on the allometric model (Eq. 1). '+' indicates positive allometry, '-' indicates negative allometry. Significance: p<0,05; *, p<0,01; **, ns; not significant

Females	Correlation coefficient	Allometric equation	Significance of allometry	Intersexual growth coefficient (b) difference
Scapula	0,934	$0{,}217L^{1{,}28}$	+ **	F<M **
1st rib	0,924	$0{,}704L^{1{,}03}$	+ *	Ns
Pelvic bone	0,885	$0{,}004L^{1{,}98}$	+ **	F<M **
Humerus	0,850	$2{,}198L^{0{,}63}$	- **	F<M **
Radius	0,880	$1{,}120L^{0{,}80}$	- **	F<M **
Ulna	0,892	$0{,}888L^{0{,}81}$	- **	F<M **
Males				
Scapula	0,921	$0{,}108L^{1{,}43}$	+ **	M>F **
1st rib	0,868	$0{,}622L^{1{,}06}$	+ **	Ns
Pelvic bone	0,860	$0{,}001L^{2{,}26}$	+ **	M>F **
Humerus	0,884	$0{,}606L^{0{,}90}$	- **	M>F **
Radius	0,853	$0{,}555L^{0{,}94}$	- **	M>F **
Ulna	0,847	$0{,}563L^{0{,}91}$	- **	M>F **

Table 5. Differences in size between right and left bones. R refers to right bones, L to left.

Significance: P<0,05; *, P<0,01; **, P<0,001; ***, ns; not significant.

Females	Average of differences, R-L/n mm.	Average of differences in % of bone length	% R>L; R=L; R<L.	Significance of difference
Scapula	1,42	1,20%	76%; 14%; 10%	***
1st rib	0,85	0,77%	48%; 26%; 26%	*
Pelvic bone	0,73	0,54%	39%; 17%; 44%	Ns
Humerus	1,13	0,83%	43%; 53%; 4%	*
Radius	0,48	0,86%	35%; 59%; 6%	**
Ulna	0,23	0,48%	33%; 54%; 13%	**
Males				
Scapula	1,65	1,56%	72%; 21%; 7%	***
1st rib	0,85	0,77%	51%; 24%; 25%	*
Pelvic bone	1,13	1,29%	38%; 26%; 38%	Ns
Humerus	0,33	0,73%	40%; 52%; 8%	*
Radius	0,51	0,97%	33%; 60%; 7%	**
Ulna	0,33	0,74%	33%; 62%; 5%	***

Figure 1. **Ankylosis in the vertebral column.** Mode of state of ankylosis.

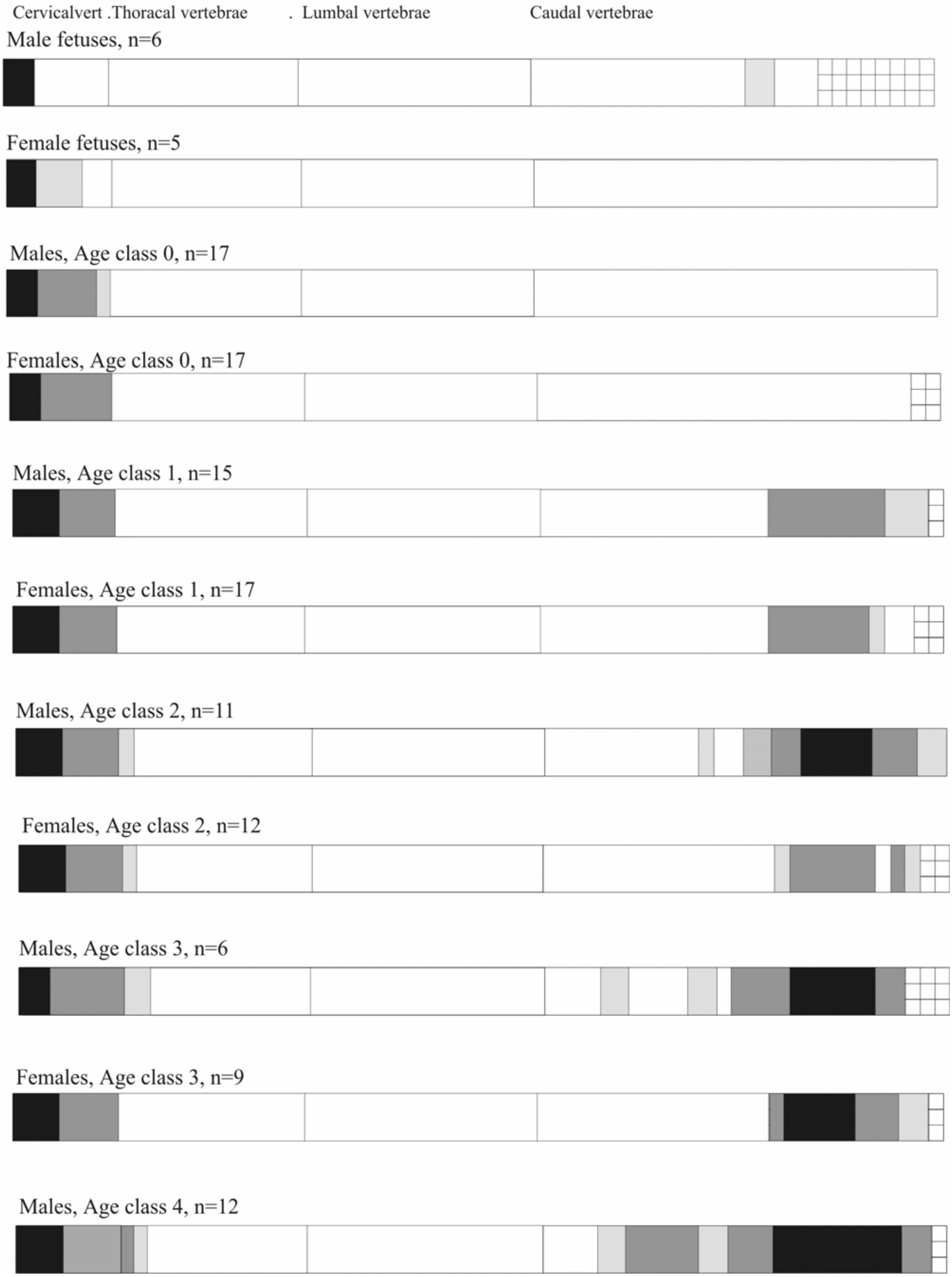
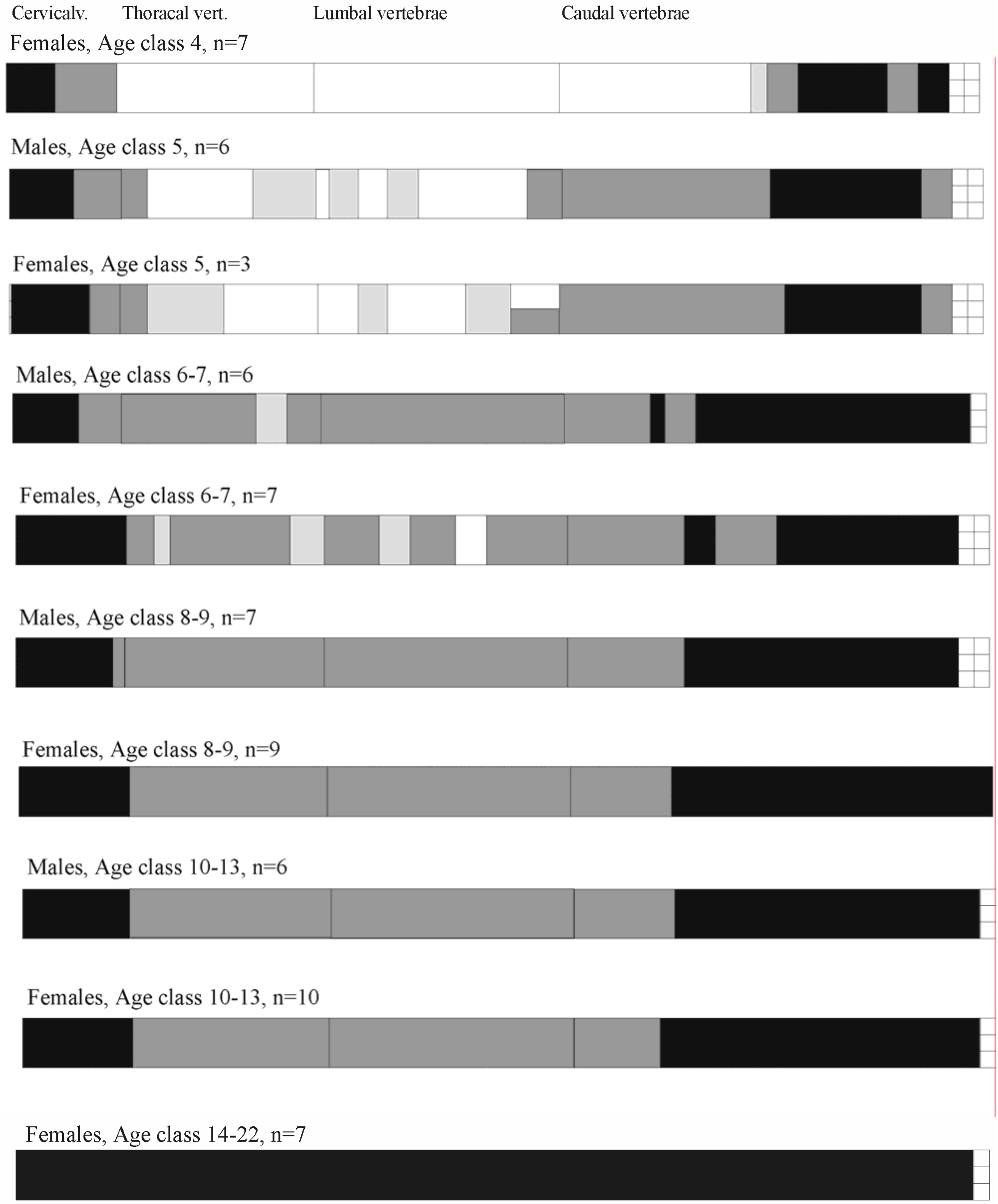
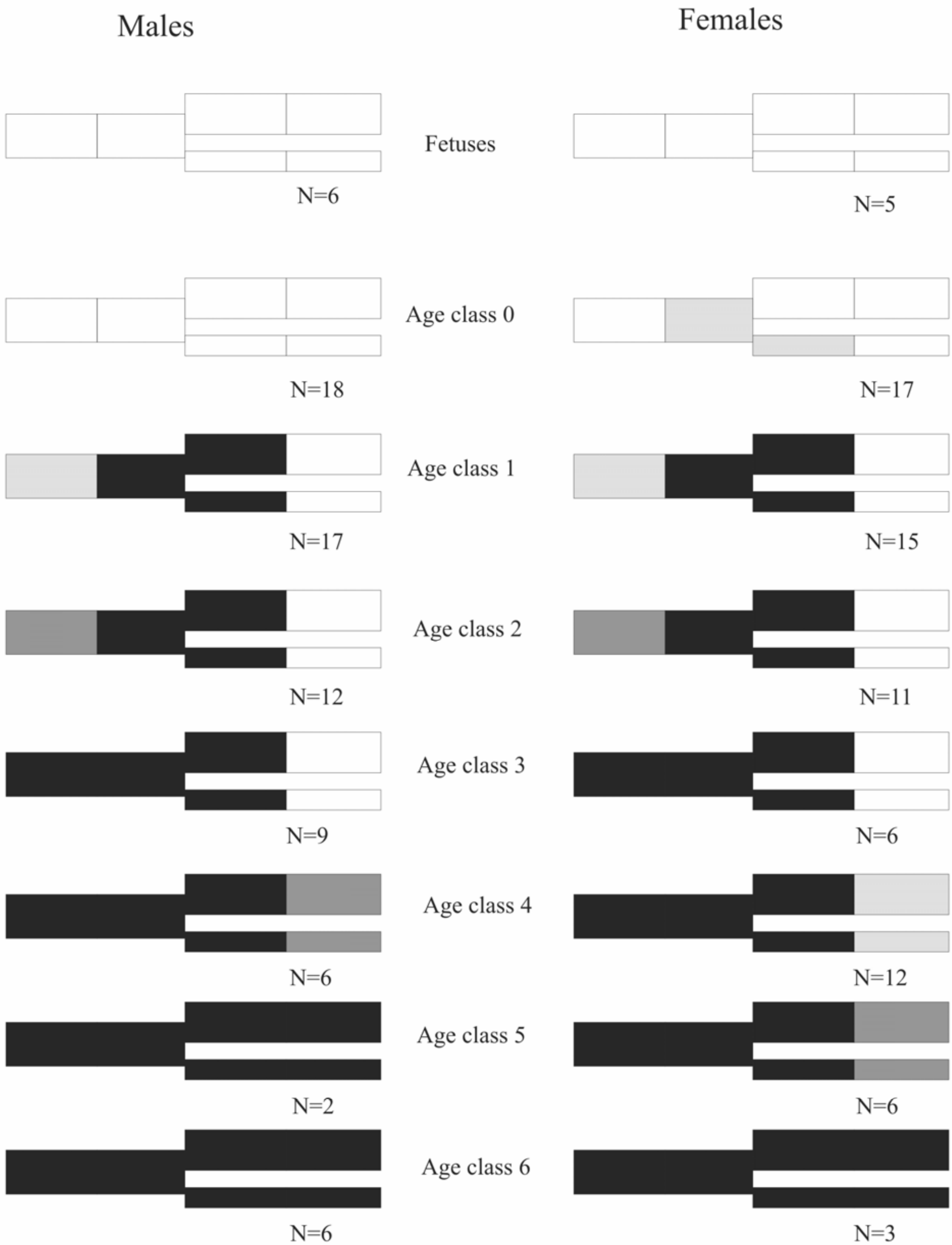


Fig. 1 contnd. **Ankylosis in the vertebral column.** Mode of state of ankylosis.



Typical vertebral columns of the respective age-classes. The modal state of ankylosis of each vertebra is indicated:
White= no fusion; Light grey= fusion commenced; Dark grey= sutures still apparent; Black= fusion complete; Squares= less than two vertebrae in the respective age-class available.

Figure 2. **Ankylosis in the flippers.** The mode of state of ankylosis in the flipper bones.



Humerus on the left, radius; top right, ulna; bottom right. The two boxes on each bone refer to the progression of apiphysal ankylosis at the respective end of the bone:
White: No ankylosis Light grey: Ankylosis commenced Dark grey: Sutures still apparent Black: Ankylosis complete

Fig. 3. X-ray photographs of two harbour porpoise flippers. Left, a 1-year old specimen. Notice the suture at the proximal end of the humerus, and the free epiphyses at the distal ends of the radius and ulna. The epiphyses at the joint of the humerus to the radius and ulna are already fused to the bones. Right, the flipper of an 8-year old specimen, with all the epiphyses fused to the bones.

Fig. 4. Two-phase Gompertz-plot of Total length / Age, Females

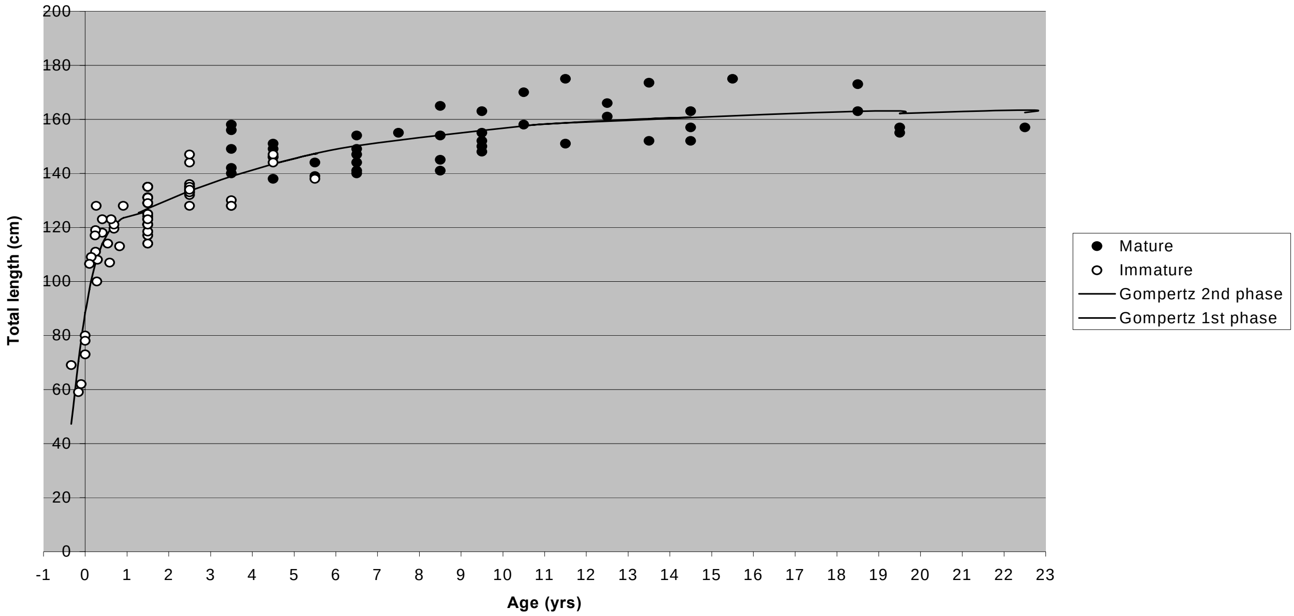
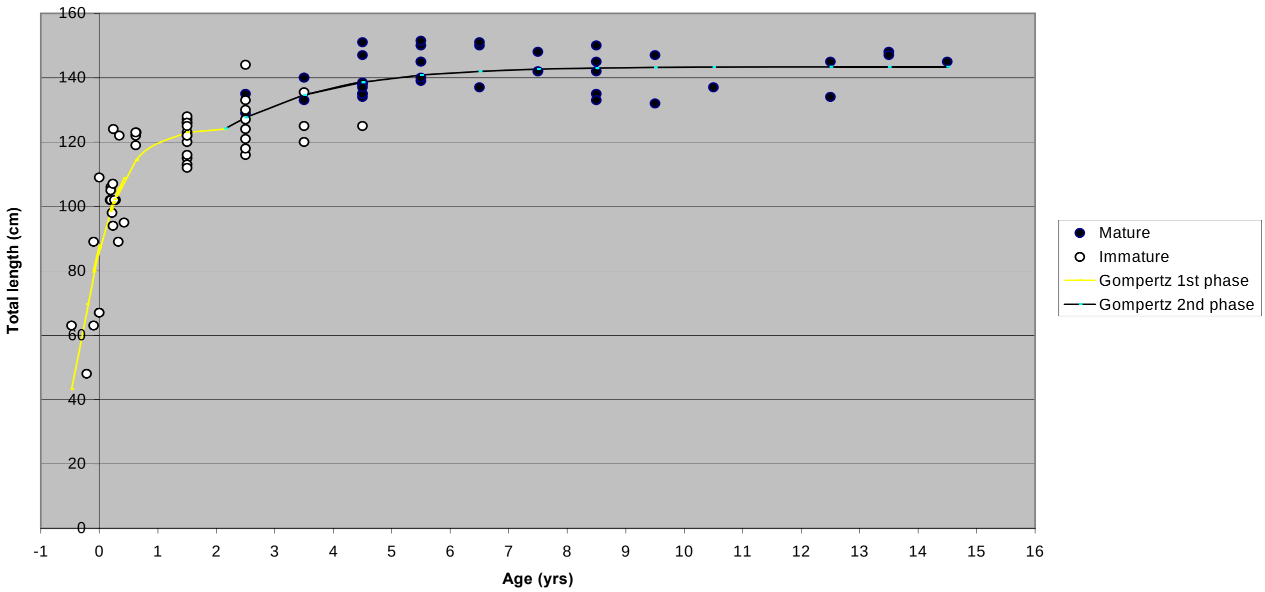


Fig. 5. Two-phase Gompertz plot of Total length / Age, Males



CLASSIFICATION OF *BRUCELLA* SPP. ISOLATED FROM MARINE MAMMALS BY DNA POLYMORPHISM AT THE OMP2 LOCUS

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These last years, Brucella strains have been isolates from seals, porpoises, dolphins, and a minke whale. However, their overall characteristics were not assimilable to those of any of the six recognized Brucella species and it was suggested that they comprise a new nomen species to be called *Brucella maris*. In this study we analyzed DNA polymorphism at the omp2 locus of 33 marine Brucella strains isolated from different marine mammals. The omp2 locus contains two gene copies (named omp2a and omp2b) coding for porin proteins and has been used for molecular identification and typing of Brucella at the species and biovar level. PCR-RFLP and DNA sequencing showed that strains isolated from the minke whale, dolphins and porpoises carry two omp2b gene copies instead of one omp2a and one omp2b gene copy or two similar omp2a gene copies reported in the currently recognized species. The otter and all seal isolates except one were shown to carry one omp2a and one omp2b gene copy as encountered in isolates from terrestrial mammals. By PCR-RFLP of the omp2b gene a specific marker was detected grouping the marine Brucella isolates. Although marine Brucella isolates may represent a separate group from terrestrial mammal isolates based on omp2b sequence constructed phylogenetic trees, the divergence found between their omp2b and also between their omp2a nucleotide sequences indicates that they form a more heterogeneous group than isolates from terrestrial mammals. Therefore, grouping the marine Brucella isolates into one species seems not appropriate. With respect to the current classification of brucellae according to the preferential host, brucellae isolated from such diverse marine mammal species as seals and dolphins could actually comprise more than one species and at least two new species, *B. pinnipediae* and *B. cetaceae*.

THE EFFECT OF TOTAL ANTIBODY LEVELS, MASS AND CONDITION ON THE FIRST-YEAR SURVIVAL OF GREY SEAL PUPS

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A joint live-recapture/live-resighting/dead-recovery mark recapture model was used to investigate the effect of serum antibodies (IgG) levels, gender, mass and condition (mass/length) at weaning on the probability of survival from weaning to age one, in grey seal pups born at two different breeding colonies (Isle of May and Farne Islands) in two different years (1997 and 1998). We found that increased mass or condition at weaning has a positive effect on the first year survival of grey seal pups born at both colonies. Also males had a lower probability of survival than females. Post-weaning circulating IgG concentrations also played a significant role in the probability of survival. We do not know if those pups with high IgG were individuals with naturally higher circulating concentrations or because titres were elevated due to antigenic challenge. If IgG titres were related to antigen exposure and pups were fighting an infection, to which they subsequently succumbed, we would have expected to observe time dependent mortality. However, this was not the case. There may therefore be an energetic conflict in grey seal pups between maintaining high IgG titres and the need for growth and development in the first months of life.

TRENDS IN CAUSES OF MORTALITY OF 492 HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) STRANDED ON THE COASTS OF ENGLAND AND WALES (1990-2001)

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Between Sept 1990 and Sept 2001 inclusive, 492 harbour porpoises (*Phocoena phocoena*) stranded on the coastline of England and Wales were necropsied using standardised methodology. The cause of death was established in 390 cases. Entanglement in fishing gear (by-catch) was the most common cause of death (n=134) comprising juveniles/subadults (n=87), adults (n=42) and neonates (n=5). The high proportion of by-caught juveniles suggests that a degree of learning may be involved in the avoidance of nets. The by-catches predominantly occurred in Wales, Cornwall/Devon and the North Sea coast from Northumberland to Humberside. The proportion of porpoises diagnosed as by-catches peaked in the mid-1990s, and has declined markedly since. Physical trauma (other than by-catch) accounted for the death of 61 porpoises, of which 22 (17 juveniles/subadults, 5 adults) had characteristic injuries consistent with fatal attack from bottlenose dolphin(s) (*Tursiops truncatus*). Twenty-one of these stranded in West Wales (Cardigan Bay) and one stranded in Devon. The first cases were diagnosed in 1995, and the number of cases increased during 2000 and 2001. The absence of neonates in this group, and the high proportion of these animals having recently ingested prey in their stomachs suggests that prey competition may be a causal factor in these violent interactions. Starvation was the apparent cause of death of 50 individuals, of which 33 were neonates. Infectious diseases of various aetiologies accounted for the death of 97 porpoises including pneumonias (mainly parasitic and/or bacterial)(n=60) and generalised bacterial infections (n=18). Only one case of fatal morbillivirus infection was identified which occurred in 1990. Between 1990-1996, significantly higher mean tissue levels of PCBs and Hg were found in subsets of porpoises dying due to infectious disease than those dying from physical trauma (mainly by-catch), suggesting that chronic exposure to PCBs and Hg may predispose harbour porpoises to infectious disease mortality.

MASS MORTALITIES IN MARINE MAMMALS

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Many incidents of mass mortality have been reported in marine mammals during the past 50 years. Several of these events have been caused by, or attributed to, infectious agents (eg influenza virus, morbillivirus and Leptospira), marine biotoxins or natural events such as El Niño. In other cases, no cause has been established. This presentation reviews some recent mortality events with emphasis on those caused by morbillivirus infections.

SUSPICION OF COLLISION IN A SOWERBY'S BEAKED WHALE (*MESOPLODON BIDENS*) STRANDED ON THE NORTHERN FRENCH COAST

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INTRODUCTION On 19 September 2001, a Sowerby's beaked whale (*Mesoplodon bidens*) was found stranded dead on the beach of Dunkerque (northern France), on the French southern North Sea coast. The specimen was a 405 cm long sub-adult male (the teeth were not erupted) and was in a state of advanced putrefaction. The animal was necropsied at the Faculty of Veterinary Medicine of Liege. *Post mortem* investigations are presented in the present paper.

The stranding and the necropsy. In France, the National Stranding Network (co-ordinated by the Centre de Recherche sur les Mammifères Marins, la Rochelle) intervenes on all marine mammals strandings occurring along the coastline of the country. On the 19 September 2001, regional correspondents were reached on a Sowerby's beaked whale stranding near Dunkerque. First, the location of the stranding was unusual. Sowerby's beaked whales like other beaked whales species (*Ziphiidae*) are known to occur in offshore and deep waters (Cresswell and Walker, 2001). They are consequently not present in the English Channel and in the southern/central parts of the North Sea. In conclusion, the present individual was probably an erratical animal or drifted dead on a long distance. This hypothesis is supported because of the advanced putrefaction state observed on the animal. The whale was transferred the next day to the Faculty of Veterinary Medicine, in Liege (Belgium) to investigate the cause of death of the animal.

Post mortem investigations revealed severe emaciation (absence of blubber), the body presented external lesions on all its surface and the epidermis was eroded. We noted also the presence of a large intramuscular haematoma on the lateral face of the thorax and an extended hemothorax. Both were associated with a fracture of the fifth right rib.

A collision with a ship responsible? The cause of lesions were considered as being traumatic, then a collision with a vessel was suspected. Collisions between cetaceans and vessels are not rare in several oceans and seas around the world. These involve especially large cetaceans like Fin whales (*Balaenoptera physalus*) in the Mediterranean Sea and Northern right whales (*Eubalaena glacialis*) in the western North Atlantic, for example. This phenomenon depend simultaneously of the ship traffic and its density in a precise area, the density of whales and of the speed of vessels (Laist *et al.*, 2001). Collisions on beaked whales are poorly reported (for example, see Aguilar *et al.*, 2000), probably due to their pelagic home range and low population densities.

CONCLUSIONS In the present case, we observed simultaneously traumatic injuries and severe emaciation, these elements can be correlated. Debilitated cetaceans are known to rest at the water surface probably most of the time than when they are healthy. Then we suppose collision risk increase on poorly conditioned cetaceans. However, it is impossible to know preciously the location of the suspected collision. Obviously the present individual was certainly an erratical individual stroke in the Strait of Dover or in adjacent waters but could also be stroke elsewhere and drifted on a very long distance during several weeks. Nevertheless, the presented report is, in our knowledge, the first on Sowerby's beaked whale.

ACKNOWLEDGMENTS We would like to thank Jan TAVERNIER, from the Museum of Natural History of Brussels, for his help and disponibility during the transport of the whale to the Faculty of Veterinary Medicine, in Liege. We thank also all members of the French Stranding Network helping us during the intervention and especially Nathalie MAYTAS and Jacky KARPOUZOPOULOS.

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DIAGNOSTIC INVESTIGATION OF A CANINE DISTEMPER OUTBREAK IN CASPIAN SEALS

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Unusually high mortality of Caspian seals (*Phoca caspica*), with more than 10,000 deaths reported, occurred in spring and summer 2000. Eighteen seal carcasses, found on the shore of the Caspian Sea between May and August 2000, were examined by necropsy to determine its cause. The primary diagnosis was canine distemper (CD) (n = 11). Histologically, CD was characterized by broncho-interstitial pneumonia, lymphocytic necrosis and depletion in lymphoid organs, and the presence of typical intra-cytoplasmic inclusion bodies in multiple epithelia. Canine distemper virus (CDV) was identified by phylogenetic analysis of reverse transcriptase-polymerase chain reaction products. The diagnosis of CD was made in 8 of 9 seals less than 1 year of age, compared to 2 of 6 older seals. All three seals greater than 1 year of age and without CD had antibody to CDV. This pattern of prevalence of mortality from CD skewed towards juveniles and high prevalence of older individuals with immunity indicates that CD either is endemic in the Caspian seal population, or is regularly introduced from adjacent populations of terrestrial carnivores. The mean organochlorine concentrations in the blubber of seals with CD were 6 to 11 times lower than in seals without CD. This indicates that organochlorine contamination did not affect mortality from CD, although it may have affected mortality from other causes. The mean monthly air temperature in the north Caspian Sea during the winter preceding the mortality event was up to 3.5 C higher than the 11-year average, and ice break-up occurred 16 days earlier than the 11-year average. This unusually mild weather may have affected mortality from CD due to increased haul-out behaviour, reduction of available haul-out area, and premature weaning of seal pups.

PARASITOLOGICAL INVESTIGATIONS ON HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM GERMAN AND NORWEGIAN WATERS AND HARBOUR SEALS (*PHOCA VITULINA*) FROM THE NORTH SEA

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As a part of monitoring programmes in Schleswig-Holstein harbour porpoises and harbour seals are investigated for their health status. Special attention is given to parasites as major infection agent. Samples included in this investigation originated from dead harbour porpoises and harbour seals collected along the coast of Schleswig-Holstein between 1997 and 2001. Furthermore samples of harbour porpoises from Norwegian waters were examined which were by-caught in the year 2000 in commercial fishery gill-nets. Parasites were collected during necropsies, preserved in 70% Ethanol and determined after preparation in Lactophenol according to scientific literature under the microscope. Special attention was paid to the respiratory tract. Pathological deviations of organs due to parasites were considered.12 species of parasites could be isolated from the investigated organs. Of the investigated organs, the respiratory tract was the most frequently and severely affected. Prevalence of lung nematodes was about 50% in investigated harbour porpoises from German waters from 1997 to 2001. Harbour seals showed increasing prevalence from 15 - 35% over the years. Harbour seals as well as harbour porpoises showed mixed infections with different species of lung nematodes, which often induced secondary bacterial infections and bronchiopneumonia. Frequently found lung nematode species in harbour porpoises were *Pseudalius inflexus, Torynurus convolutus* and *Halocercus invaginatus*. Harbour seals showed infections with *Otostrongylus circumlitus* and *Parafilaroides gymnurus*. There were differences in the intensity of infections of the organs between harbour porpoise-populations from different areas. The intensity of infection in the lungs of the animals by-caught or stranded differed as well. The intensity of the infection of the lungs of seals shot did not differ from those found dead. The intensity of infection with parasites in the lungs of seals decreased with growing age. The reasons for differences in parasitic lung infection between harbour porpoises from German and Norwegian waters remain unclear.

DEVELOPMENT AND EVALUATION OF A RECOMBINANT VACCINE FOR HARBOUR SEALS

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Phocid herpesvirus type 1 (PhHV-1) causes significant morbidity and mortality among young and immunocompromised harbour seals. Therefore the availability of an effective PhHV-1 vaccine is of importance for orphanages and seal rehabilitation centres. Since possibilities to test PhHV-1 candidate vaccines in the target species are limited, a suitable animal model is needed. Given the close genetic and antigenic relationships between PhHV-1 and feline herpesvirus (FHV), the FHV cat system was first evaluated to test candidate PhHV-1 vaccines. Cats were vaccinated thrice with iscom adjuvanted PhHV-1-, FHV-, and mock vaccines. One month after the last vaccination, all cats were challenged with a virulent FHV strain. All PhHV-1 and FHV vaccinated cats were protected from developing severe disease ($P = 0.03$ and $P = 0.01$ respectively) and excreted significantly less FHV than the mock vaccinated cats (throat: $P = 0.02$ and $P = 0.006$ respectively; nose: $P = 0.001$ and $P < 0.001$ respectively). A candidate vaccine for seal, based on the recombinant glycoproteins B and D of PhHV-1 was subsequently evaluated in the FHV cat model. Both vaccines (gB or a combination of gB +gD) prevented severe disease ($P=0.01$ and $P=0.02$ respectively) and reduced FHV excretion in cats ($P = 0.03$ and $P = 0.05$ respectively). The addition of gD to the gB iscom vaccine did not result in a significant improvement of the protective parameters. Consequently, the gB based iscom vaccine was tested for safety and immunogenicity in harbour seals rehabilitated at the seal centre in Pieterburen, The Netherlands. All seals that received the vaccine developed neutralising antibody titres (range 80-160) and proliferative responses to PhHV-1. The gB iscom vaccine can therefore be considered a candidate vaccine for protection of seals against PhHV-1 induced disease.

PATHOGEN POLLUTION IN THE GULF OF ST. LAWRENCE AND ESTUARY, CANADA

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Over the past 20 years there has been intense interest in diseases of marine mammals. Some pathogens are new to science or at least were unknown in marine mammals due to lack of study [phocine and cetacean distemper viruses (Morbillivirus), *Brucella pinnipediae, B. cetaceae*]. However, some well known terrestrial pathogens are now being found in marine mammals, some with an anthropogenic source. A research and monitoring program on diseases of Canadian marine mammals has been conducted since 1996 on the east coast of Canada. We found that 50% of harp seals, >60% hooded seals, 25% of harbour seals and grey seals are infected with *Giardia* sp. using a monoclonal antibody technique. Our analyses have identified this parasite as *Giardia duodenalis* using PCR analysis. We also found that 2% of hooded seals and 9% of harbour and grey seals are seropositive to *Toxoplasma gondii* using a MAT. Our experimental studies have confirmed the susceptibility of grey seals to small doses of *T. gondii* oocysts. The point source of these pathogens in the marine environment has yet to be determined but may include municipal wastewaters, agricultural runoff, ship ballast or septic reservoirs. A number of studies show that some of these pathogens are present in coastal marine shellfish, suggesting that infective stages are in the water column. It is unknown how marine mammals become infected - either directly through contamination of seawater or indirectly through the food chain. Given that anthropogenic chemical contamination of the marine environment and its biota has been documented for a number of years, it is perhaps not suprising that pathogen pollution of marine mammals also occurs. This suggests that human activities are more wide-reaching than previously believed and that such activities are of significance to animal (anthroponotic) and human (zoonotic) health.

ZOONOTIC THREATS ASSOCIATED WITH THE HUNTING OF MARINE MAMMALS IN ARCTIC CANADA

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It is the right of aboriginal Canadians to subsistence hunt marine mammals. Most of this food is consumed raw yet it undergoes no formal government inspection or certification. In the last few years a number of emerging bacterial, parasitic and viral agents have been identified from diseased marine mammals, some of which are pathogenic to humans. They include strains of influenza (A and B), Trichinella as well as the newly isolated strains of Brucella. The risk to humans who hunt marine mammals and are exposed to these pathogens is obvious; however, the only Canadian cases of human disease related to the consumption of these animals have been Trichinella infections linked to consumption of infected walrus meat. Serological evidence of Brucella infection has been found in six species of Canadian phocids, and two species of cetaceans. Positive animals were identified from sampling locations in the Pacific, Atlantic and Arctic Oceans. Since 1995 a total of eleven isolations of Brucella have been made from seals and beluga in Canada. All the isolates appear identical in biochemical and phage typing studies but differ slightly from European and American isolates. A clinical case of brucellosis has been reported in Britain from a researcher working with a marine mammal strain of Brucella; indicating that these strains are indeed human pathogens. Human brucellosis is often misdiagnosed, even in areas of the world where it is endemic. Unfortunately, the risk of handling and consuming meat from infected marine mammals has not been evaluated in Canada. The situation for influenza infection is less alarming. Though there is serological evidence of both ringed seals and beluga being infected with strains of influenza A. Infection is sporadic in Canada and not related to large die-offs of animals or disease in humans, though the possibility of both does theoretically exist.

NEOPLASIA IN CETACEANS FROM SCOTTISH WATERS

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Between 1992 and 2001, 359 harbour porpoises (*Phocoena phocoena*) stranded on the coastline of Scotland were necropsied using standardised methodology. In addition, 240 other cetaceans, comprising thirteen different species were examined. Tumours were found in four porpoises, but none were found in any of the other species. In three of the cases, reproductive system tumours were found in mature females. A 164 cm long porpoise in poor condition, weighing 49 kg, had multiple, discrete fibroleiomyoma tumours, up to 5 cm in diameter, in the uterine wall. The porpoise had been pregnant, but the tumours had prevented parturition leading to the porpoise's death from foetal masceration and toxaemia. In another case, there were two small (1-2 cm diameter) tumours in the wall of the cervix and uterus. This porpoise had not been pregnant or lactating and the tumours were an incidental finding. Another porpoise, 160 cm long, weighing 52.6 kg died after parturition. There was a tear in the cervix and uterus with secondary peritonitis. There was a squamous cell carcinoma around the tear with extensive necrosis and inflammation. The tumour invasion would have weakened the tissues allowing the tear to occur during parturition. There was also intra abdominal metastasis. An adult male porpoise, 151.5 cm long, weighing 39 kg was in moderate condition and had a heavy lungworm burden and associated pneumonia. However, a dramatic infiltrate involving choroid plexus, adrenal glands, spleen, liver and pulmonary associated lymph nodes was found. A myeloid leukaemia is proposed. Toxicological screens on selected tissues from these animals is being undertaken, though previous studies have shown that harbour porpoises from Scottish waters have relatively low pollutant burdens.

SEROLOGIC SURVEY OF MORBILLIVIRUS INFECTION IN MARINE MAMMALS AND TERRESTRIAL CARNIVORES FROM CANADA

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Canine distemper virus (CDV) is recognised as a worldwide problem affecting marine mammals and terrestrial carnivores, and has the second highest fatality rate after rabies in domestic dogs. Interspecies transmission, has resulted in a range of new wildlife diseases, and was responsible for the death of thousands of Baikal seals (*Phoca sibirica*) in Siberia in 1987 due to an infection by a CDV field strain which probably originated in terrestrial carnivores. Other morbillivirus infections have been responsible for a number of epizootics among global populations of marine mammals (bottlenosed dolphins, *Tursiops truncatus*; harbour seals, *phoca vitulina* and striped dolphins, *Stenella coeruleoalba*). To determine the extent of morbillivirus infections in Canadian wildlife we tested for the presence of specific antibodies to CDV in whole blood collected from 756 ringed seals (*Phoca hispida*), 507 beluga (*Delphinapterus leucas*) and 192 Narwhal (*Monodon monoceros*) during the period 1984-2000 from a number of locations in arctic Canada, using an ELISA. Over a similar time period serum was collected from 102 walruses (*Odobenus rosmanus*) and 52 beluga, as well as from nine species of terrestrial carnivores (american badger, black bear, grizzly bear, polar bear, cougar, lynx, wolf, and wolverine). In these sera the prevalence and antibody titres to three morbilliviruses (CDV, phocine distemper, and dolphin morbillivirus) were determined and compared by means of a virus neutralisation assay. The prevalence of CDV antibodies in ringed seals in Hudson Bay increases over time,suggesting a wetward expansion of virus infection. Antibodies against all three morbilliviruses were present in terrestrial carnivores, suggesting the infection by both PDV- and DMV (like) viruses.

SKIN LESIONS ASSOCIATED WITH AN UNIDENTIFIED VIRUS IN STRIPED DOLPHIN (*STENELLA COERULEOALBA*), FROM THE SPANISH MEDITERRANEAN COAST

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From a total of 9 viral families detected in cetaceans only the Poxviridae, Papovaviridae, Herpesviridae, and Caliciviridae were found associated with skin and/or genital mucosa lesions. We report a new unidentified virus associated with skin hyperplastic lesions in striped dolphins. A female calf was found dead in the spanish coast. Necropsy was performed and tissue samples collected into 10% formalin. Tissues were routinely processed for histopathological examination, and samples of epidermis processed for transmission electron microscopy (TEM). At necropsy the most prominent findings were a few skin ulcers, up to 5 mm in diameter, in the rostrum, melon and scattered throughout the body. Moreover, there was a depigmented and umbilicated plaque (approximately 1.5 cm in diameter) with a central crust. The tongue edges also presented multiple ulcers. Other findings consisted of subcutaneous edema, mild multifocal parasitic neumonia, and one parasitic nodule in the glandular stomach. Microscopically, no relevant lesions were found in most organs. Skin ulcers had focal subepidermic piogranulomatous inflammatory infiltrate, blood vessel trombosis, haemorrhage, and necrotic material. The epidermis of ulcer edges ocassionally had parakeratotic hyperkeratosis, and some keratinocytes from the spinous layer had intracytoplasmatic vacuoles. Depigmented plaque cut was characterized by the presence of focal epidermal hyperplasia with parakeratotic hyperkeratosis; the keratinocytes from the hyperplasic area appeard large and pale, and with a high number of intracytoplasmatic eosinophilic inclusion bodies surrounded by a pale halo. Ulcers in the tongue had similar lesional characteristics of skin ulcers. TEM examination revealed virions, scattered through or/and forming clusters in the cytoplasm of keratinocytes, from the basal layer of the epidermal hyperplastic area. Apparently, virions were naked, with 100 to 120 nm in diameter, and consisted of an outer capsid nearly spherical in outline, and a dense core with icosahedral symmetry (80 to100 nm in diameter). No virions were found in the nucleus of keratinocytes. These viral morphologic characteristics do not correspond to any cetacean described virus. Further studies are in course for viral characterization.

EPIDEMIOLOGY OF INTESTINAL VOLVULUS IN HARBOUR AND GREY SEALS

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Intestinal volvulus involves the rotation of the intestine on its mesenteric axis, and often results in death. Although this disease has been reported briefly in seals, its pathogenesis and epidemiology are poorly understood. Therefore, we reviewed necropsy reports of 437 harbour seals (*Phoca vitulina*), 67 grey seals (*Halichoerus grypus*) and 34 other phocid species examined at the Seal Rehabilitation and Research Centre (SRRC), Pieterburen, Netherlands, from 1975 to 2001. The overall incidence of intestinal volvulus was 5 % (21 cases) in harbour seals and 3 % (2 cases) in grey seals. One harbour seal developed clinical signs of intestinal volvulus 2 months after arrival at the centre; the other 23 animals were found with the disease. At necropsy, intestinal volvulus was characterized by rotation of 180 to 540 degrees of a large portion of the intestine, dark red to black discolouration of the affected intestinal wall, and the presence of abundant bloody fluid in the intestinal lumen. In harbour seals, the incidence was higher in adult (5 of 27, 19 %) and subadult (7 of 55, 13 %) males than in adult (5 of 46, 11 %) and subadult (3 of 48, 6 %) females. Only 1 of 131 (1 %) juvenile males and 0 of 140 (0 %) juvenile females had intestinal volvulus. In grey seals, intestinal volvulus was diagnosed in 1 of 10 (1 %) adult, 1 of 11 (9 %) subadult, and 0 of 19 (0 %) juvenile males, and 0 of 27 (0%) females. Why male seals are predisposed to intestinal volvulus is not clear, but the same predilection also has been observed in other species. Based on this retrospective study, intestinal volvulus is an important non-infectious mortality factor for the harbour seal population in the Dutch Wadden Sea.

PHYLOGENETIC ANALYSIS OF MORBILLIVIRUSES IN DIFFERENT MARINE MAMMAL SPECIES FROM 1990 TO 2000

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Since the isolation of a morbillivirus from harbour seals (*Phoca vitulina*) in 1988, which caused a disease outbreak killing 17000 seals, several new morbilliviruses have been detected in and isolated from different marine mammals including seals, dolphins and porpoises. To study the relationships between these newly detected morbilliviruses and the known morbilliviruses, Canine distemper virus (CDV), Rinderpest virus (RPV), Peste des petits ruminants virus (PPRV) and Measles virus (MV), regions from the Nucleoprotein and the Phosphoprotein were sequenced. Viruses of pinniped and cetacean origin used in this study were: Phocine distempervirus-1 (PDV-1) from harbour seals and Phocine distempervirus-2 (PDV-2) from Baikal seals (*Phoca sibirica*), CDV from Caspian seals (*Phoca caspica*), Dolphin morbillivirus (DMV) from common dolphins (*Delphinus delphis*) striped dolphins (*Stenella coeruleoalba*) and bottlenose dolphins (*Tursiops truncatus*) and monk seal morbillivirus (MSMV) from Mediteranean monk seals (*Monachus monachus*). The Nucleoprotein and Phosphoprotein gene fragments were amplified by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR), using pan-morbillivirus primers. Based on the identification of PDV-2 as a CDV strain, MSMV as a DMV like virus and CDV in Caspian seals, we concluded that interspecies transmission between species of different orders is not an uncommon event. For further phylogenetic analysis the variable carboxy-terminal 456 nucleotides that code for the Nucleoprotein were sequenced. DMV isolated from dolphins originating from the Mediterranean Sea over a four year period showed a remarkable stability in this region. Furthermore, DMV identified in 1998 in bottlenose dolphins had only a very limited number of mutations compared to the first isolates from striped dolphins in 1990. Overall, phylogenetic analysis has revealed only limited mutations in the viruses examined, indicating that morbilliviruses in marine mammals have remained relatively stable in the past decade.

EVIDENCE OF *BRUCELLA* SP. IN MARINE MAMMALS FROM GERMAN WATERS

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As part of national monitoring programmes in Germany living and dead marine mammals from the North and Baltic Seas are investigated for their health status. Furthermore, seals rescued in the seal station Friedrichskoog are examined constantly during their stay in the station. Investigations include blood status as well as pathological, microbiological, parasitological, serological and chemical tests. According to reports about Brucella infections in seas mammals, bacteriological and serological investigations in animals found in Germany were extended also to Brucella bacteria. Between 1997 and 2000 bacteriological investigations were performed on 165 common seals (*Phoca vitulina*), 80 harbour porpoises (*Phocoena phocoena*), 11 grey seals (*Halichoerus grypus*) and 3 other marine mammals. The organs examined were liver, spleen, kidney, lung, intestine, stomach, lung lymph nodes, mesenterial lymph nodes and others. For cultivation Brain-Heart-Infusion-agar and Brucella-agar were incubated at 37 Celsius in an CO2-enriched atmosphere. Furthermore, serum samples of 155 harbour seals were tested for Brucella-antibodies using a tube agglutination test with a stardardised *Brucella abortus* antigen. The investigations revealed that out of 259 animals 32 Brucella strains from a total of 20 animals were isolated. The majority of the strains was found in the lung of seals. 30 of the 155 animals (19,4%) tested serologically had antibodies ranging between 1:20 and 1:10240. So far, the Brucella isolates have been identified as *Brucella maris* but specific molecular biological investigations are currently under process. To our knwoledge, this is the first report about the evidence of Brucella bacteria in marine mammals from German waters. According to the pathological findings, no typical lesions were associated with the evidence of *Brucella* sp. in this material. Little is known about the pathogenic potential of *Brucella maris*, in particular in humans, therefore special precautions should be taken when handling living or dead marine mammals.

NATURAL HISTORY

PRESENT STATE OF UNDERSTANDING OF THE CETACEAN FAUNA OF THE CROATIAN ADRIATIC SEA

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Records of cetaceans in the Croatian Adriatic sea date back to the mid 1800's. Since then numerous species have been identified, described and published in different scientific literature. However a recent review of the species, taken from published literature, stranded carcasses and confirmed reports from this period reveal that only nine cetacean species have been recorded in the Croatian Adriatic Sea. These include; the fin whale, *Balaenoptera physalus*; sperm whale, Physeter catodon; Cuvier's beaked whale, *Ziphius cavirostris*; false killer whale, *Pseudorca crassidens*; long-finned pilot whale, *Globicephala melas*; Risso's dolphin, *Grampus griseus*; bottlenose dolphin, *Tursiops truncatus*; common dolphin, *Delphinus delphis*; and striped dolphin, *Stenella coeruleoalba*. All these species are known to be regularly present in the Mediterranean, so their appearance in the Croatian Adriatic sea is no surprise. All of these species, with the exception of the common and the bottlenose dolphin - species regularly present in the entire Adriatic during historic times, are very rare visitors, believed to have strayed from the Mediterranean. Current knowledge suggests that only bottlenose dolphins are distributed throughout the entire Adriatic sea. The common dolphin, once the most abundant cetacean species in the Adriatic sea, is now considered regionally extinct from northern section, and the status of the population in southern part is largely unknown. Regular sightings of the striped dolphin in the northern section during the past decade also suggest that this species is extending its range. The possible changes in range of the common and striped dolphins, together with the new findings of *Grampus griseus*, *Balaenoptera physalus*and *Ziphius cavirostris* (misidentified as *Hyperoodon ampullatus*) are presented and discussed.

NEW TECHNIQUES

DISTANCE MEASUREMENT IN POLAR WATERS

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In order to estimate abundance more accurately, distance to minke whales was measured using a pair of laser range finder binoculars Leica Geovid during the research cruise ANT XVIII/4 of AWI Bremerhaven in Antarctica. The indirect measuring method applied took advantage of ice floes and ice clumps drifting in the immediate vicinity of the animals sighted. Measurements to the edge of suitable ice particles could be obtained freehand in the first or second attempt up to a range of about 600m during periods of good visibility and moderate sea state. Steep faces of larger icebergs gave readings beyond the nominal range of 1000m. In contrast to binoculars with reticles, distances could also be measured if the horizon was obscured by clouds or icebergs. Measuring accuracy of the Leica Geovid is given as one meter.

TESTING T-PODS, A NEW AUTOMATED CETACEAN ECHO-LOCATION CLICK LOGGER, FOR ITS APPLICABILITY

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Porpoise detectors (T-PODs: http://www.chelonia.demon.co.uk/), new automated cetacean echo-location click logger with click timing, seem to be a promising tool for investigating the presence and echo-location activity of odontocetes. T-PODs consist of a hydrophone, analogue filters and memory. They detect brief narrow-band ultrasound events at chosen frequencies and store their arrival times and durations. Software on a PC subsequently searches for click trains within the data. T-PODs have not been evaluated as a research tool and it is not yet known to what extent boat noise, boat sonars or other sources may cause false detections, or the likelihood of detecting a porpoise. In this project the reliability, false alarm rate, applicability, and detection range of T-PODs set for harbour porpoises (*Phocoena phocoena*) are tested. Two Pods were anchored in the harbour waters of Stralsund, Germany, with heavy boat traffic but no porpoises. 10 hours of T-POD recordings were done registering many porpoise like clicks. The pattern recognition algorithm detected no high probability click trains, filtering false alarms created by boat noise/sonar. In 10 hours of T-POD recordings at the Fjord&Baelt, Kerteminde, Denmark, where two porpoises are held under semi-natural conditions, high probability click trains were identified. Both Pods recorded comparable data. Field experiments were carried out at Fyns Hoved, Denmark, to determine the detection range of 2 T-PODs, anchored 150m and 200m offshore, 5m below water surface. Visual observations from land were made using a theodolite and handheld computer to record sighting times of porpoises, their behaviour, group size, body orientation and position relative to the T-PODs. 6036 sightings including 221 tracks were recorded in 100 hours of observation over 15 days. The maximum distance of a porpoise detected by a T-POD was 273m.

SPATIAL DISTRIBUTION ANALYSIS OF THE BOTTLENOSE DOLPHIN AND ITS RELATIONS WITH THE EUROPEAN ANCHOVY FISHING IN THE GULF OF CATANIA, IONIAN SEA

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Geographical Information System (GIS) is a useful tool to analyse complex phenomena such as the dolphin's interference on the fishery activities and its relative spatial distribution. In this study, a GIS approach has been chosen to analyse the bottlenose dolphin spatial distribution in the Gulf of Catania and to understand their spatial relation with the positions of the gill-nets for the European anchovy, *Engrauilis encrasicolus*, fishing. The GIS analysis has been carried out using Arcview 3.2 software package and its extensions. In particular, the seasonal spatial distribution of the bottlenose dolphin has been detected in relation to the seasonal anchovy fishing distribution in the study area using the Spatial analyst extension. The Tracking analyst extension has been used for visualising the movements of the bottlenose dolphins and the relative gill-net and fishery boat positions and to better understand the bottlenose dolphin behaviour in the study area. From this analysis, it emerged that the bottlenose dolphin distribution is mainly influenced by the gill-net position during all year round and it is connected to the opportunistic feeding behaviour of this species in relation to the anchovy fishery activities.

PHYSIOLOGY AND ANATOMY

TWO-DIMENSIONAL TOPOGRAPHIC DESCRIPTION OF THE SMALL CETACEAN LIVER FOR ULTRASONOGRAPHIC EXAMINATION

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The importance of the real-time ultrasonography is increasing as a clinical protocol for veterinary patients examination, being considered a very useful method for detecting hepatic lesions in terrestrial mammals. The lack of specific examination protocols and two-dimensional topographic descriptions of small cetacean internal organs represents the main limitation for using ultrasonographic examination in these species. The aim of this presentation is the description of the small cetaceans liver location in a plane-section format for an easy application to the imaging diagnostic methods, specially real-time ultrasonography. For this purpose, three fresh carcasses of dead stranded common dolphins and one striped dolphin positioned in ventral recumbency were frozen in a box with water forming an ice block for a better parallel slicing. The dolphins were cut using an industrial saw in one centimetre thick transversal (two common dolphins), sagittal (one striped dolphin) and coronal sections (one common dolphin). Moreover, twenty-five animals, including dead and live dolphins pertaining to four different species, were examined using a real-time scanner with a 3’5 MHZ transducer. Transducer positioning was tested in live animals looking for best quality images: underwater keeping the animal in a natural position and out of the water after removing the dolphin from the pool. Finally, full computed axial tomography and magnetic resonance imaging was performed in a common dolphin. The description and comparison of the different imaging methods applied and the dolphin body sections becomes a very useful tool improving the knowledge of visceral topography. All these data represents a two-dimensional anatomic description of the dolphin’s liver and this is the first step towards using ultrasonographic examination of this main organ in the clinical guidelines of diagnosis in small cetaceans.

MORPHOMETRY AND SOME ASPECTS OF POSTNATAL DEVELOPMENT OF FORELIMB SKELETON IN HARBOUR PORPOISE (*PHOCOENA PHOCOENA RELICTA*)

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INTRODUCTION The cetacean flipper is a complicated mechanical system possessing a great degree of safety. The structure of the flipper skeleton consisting of a large number of discrete elements underlies these properties. However, the quantitative peculiarities of proportions and ontogenetic transformations in cetacean forelimb bones remain unknown. The present work discusses the preliminary results of observations in this field on the forelimb of Black Sea harbour porpoises.

MATERIALS AND METHODS Flippers from 15 harbour porpoises of different ages, sex and body size stranded at the southern coast of the Sea of Azov (Crimea, Ukraine) in July and August 2001 were examined. The sample included 6 males (2 animals aged less than 1 year, 2 -2 years, 1-3 years, 1- physically mature) and 10 females (2- aged less than 1 year, 1 -1 year, 1- 6year, 6- 8 years and more) Forelimb bones (including *humerus, radius, ulna, carpus, metacarpus* and *phalangae*) kept frozen were measured and weighted, X-ray images were done, and histological preparations stained by Erlich's haematoxylin and acid fushsine were examined. Linear measurements were made using the original scheme (table 1.). The term "length" is regarded as the measurement in parallel with the longitudinal axis of the flipper in *humerus radius* and *ulna,* but as the measurement perpendicular to the longitudinal axis of the flipper in *carpus* and *metacarpus*. "Width" is regarded as the measurement perpendicular to longitudinal axis of the flipper in all cases. "Height" is regarded as the measurement parallel to the longitudinal axis of the flipper in *carpus, metacarpus* and *phalangae.*

RESULTS AND DISCUSSION **Allometric growth of bones.** The linear size of the most part of the forelimb bones is highly variable (as it is seen in adult females- for example, the oblique length of intermedium varies between 13.3-19.3mm in animals of length 142-151cm), and the correlation with body growth is weak enough in many bones. However, the general growth patterns can be found (Fig.1.). The proximal skeletal links, *humerus* and forearm bones, are characterized by strong negative growth indices especially for longitudinal measurements (indices *b* in power formula are 0.28-0.35); but also for width measurements (indices are 0.30-0.87). Carpel elements have slightly positive growth (indices are 1.01-1.49). It is interesting that the *olecranon* of *ulna* belongs to "carpal type" of growth- its index reaches 1.28. The width parameters of this zone have the positive growth indices. The *metacarpus* and *phalangae* have the largest growth indices- respectively, 1.11-1.77 and 1.41-2.53.

The power function **$y= ax^2$** (the classic equation of allometry) is the most adequate formula to represent the allometric growth in forelimb bones. The logarithmic and Gompertz formulae fit for some cases but their application is rather limited.

Correlations in bone size. The measurements of the large part of flipper bones weakly correlate with each other; this especially concerns the basal departments. Besides the most part of them do not have strong correlation with the total body size; many indices observed above are only mean values describing the general tendency in growth. However, the total body size and associated flipper size are the main factors drawing together the proportions in different bones.

Total body length closely correlates with the length of flipper (r^2= 0.81 in power function). Body length is associated with measurements of *radiale*; the length of flipper correlates with the size of *ulnare*. The size of *olecranon* of *ulna* and proximal width of forearm are closely associated with both body and flipper length and each other; they form a sustainable clique with them. *Ulnare* is closely (unlike *radiale*) associated with the proportions of distral *carpus*, metacarpal bones and *phalangae*, which have a weak correlation with the measurements of the other limb departments; they are also closely connected into the complete subgraph with the correlation index r^2 exceeding 0.8. The third group of bones is represented by relatively independent bones: *humerus* (the best correlation with the flipper length – 0.54), *intermediale* (the best correlation with the *radiale* size – 0.69), *radius* and *ulna* (interconnected; related to the total body length - r^2 is about 0.5). So this group includes the largest bones (even *intermediale* is the largest carpal bone), and the factors affecting their size are unknown. The interesting fact is that the size of the *olecranon* is independent from that of the *radius* and *ulna* but related to the total flipper length.

Bone structure affected by age. The postnatal growth of particulare bones is relatively short-term, as well as all life history parameters it its characterized by biopiphyseal type (or proximal epiphyses in some *phalangae*); the growth in bones of *carpus* occurs dues to the secondary cores of ossification forming a ring around a bone, as in other cetaceans (Vokken, 1946). The rings are replaced by dense tissue resembling the samples of compact periosteal zone. Some of them are represented by layered tissues with laminae. These layers in mass can be regarded as the rows of typical marginal bone laminae, often seen in compact bone. However, sometimes these laminae have structure similar to that of "resting lines" in bone of terrestrial mammals and bullae tympani of whales. The question of their connection with growth layers in the other tissues is controversial and further study is required.

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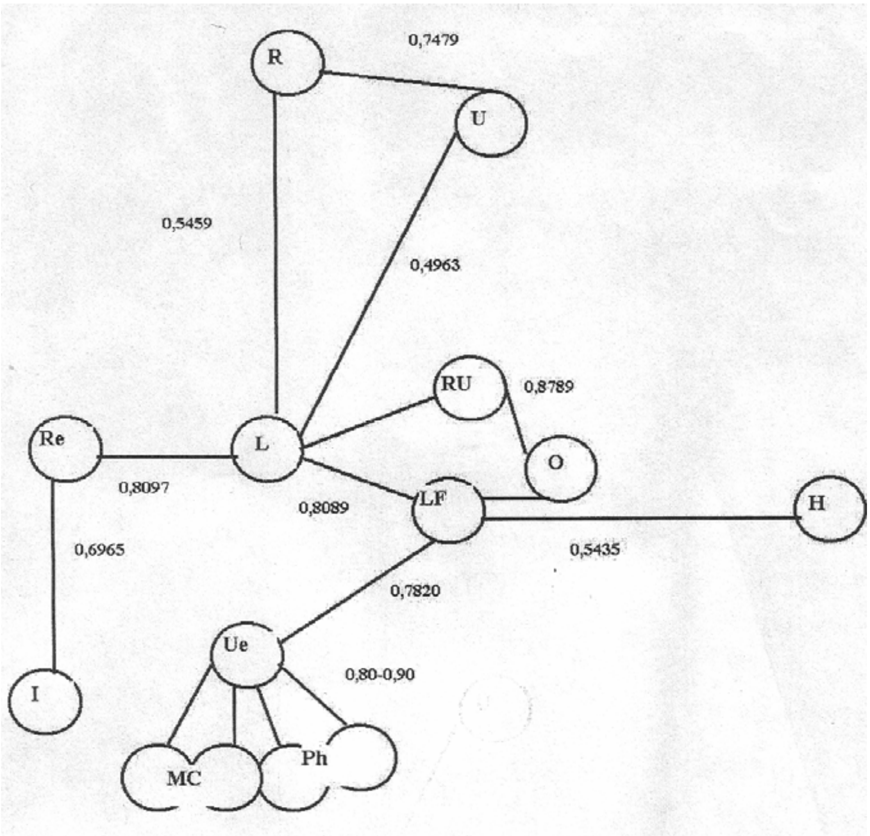
Table. 1. The Scheme of bone morphometric measurements

1. Length of *humerus*
2. Maximal width of proximal part of *humerus*
3. Width of neck of *humerus*
4. Maximal width of distral part of *humerus*
5. Width of *olecranon* of *ulna*
6. Length of *radius*
7. Maximal width of proximal part of *radius*
8. Medial width of *radius*
9. Maximal width of distral part of *ulna*
10. Length of *ulna*
11. Miximal width of proximal part of *ulna*
12. Medial width of *ulna*
13. Maximal width of distral part of *ulna*
14. Maximal width of forearm (*radius+ ulna*) at the proximal end
15. Maximal width of forearm (*radius+ ulna*) at the distral end
16. Height of *radiale*
17. Length of *radiale*
18. Oblique length of *radiale*
19. Height of *intermedium*
20. Length of *intermedium*
21. Oblique length of *intermedium*
22. Height of *Ulnare*
23. Length of *Ulnare*
24. Oblique length of *Ulnare*
25. Height of *metacarpale* V
26. Length of *metacarpale* V
27. Oblique length of *metacarpale* V
28. Height of *carpale+ metacarpale* I
29. Length of *carpale+ metacarpale* I
30. Height of *carpale* II+III
31. Length of *carpale* II+III
32. Oblique length of *carpale* II+III
33. Height of *carpale* IV
34. Length of *carpale* IV
35. Oblique length of of *carpale* IV
36. Height of *metacarpale* II
37. Width of *metacarpale* II
38. Oblique length of *metacarpale* II
39. Distral width of *metacarpale* II
40. Height of *metacarpale* III
41. Width of *metacarpale* III
42. Oblique length of *metacarpale* III
43. Distral width of *metacarpale* III
44. Height of *metacarpale* IV
45. Width of *metacarpale* IV
46. Oblique length of *metacarpale* IV
47. Height of *phalange* II-2 (regarding *metacarpale* as conditional *phalangaI)*
48. Width of *phalange II-2*
49. Height of *phalange* II-3
50. Width of *phalange* II-3
51. Height of *phalange* II-4
52. Width of *phalange* II-4
53. Height of *phalange* II-5
54. Width of *phalange* II-5
55. Height of *phalange* II-6
56. Width of *phalange* II-6
57. Height of *phalange* III-2
58. Width of *phalange* III-2
59. Height of *phalange* III-3
60. Width of *phalange* III-3
61. Height of *phalange* III-4
62. Width of *phalange* III-4



L- Body length

LF- Flipper length

H- Length of *humerus*

R- Length of *radius*

U- Length of *Ulna*

RU- Width of forearm (*radius* + *ulna*) at the proximal end

O- Length of *olecranon* of *ulna*

Re- oblique length of *radiale*

I- Oblique length of *intermediale*

Ue- Oblique length of *ulnare*

MC- measurements of metacarpal bones

Ph- measurements of *phalangae*

Numbers indicate the value of r^2 in formula $\mathbf{y= ax^b}$, where x and y- measurements, a and b- coefficients

Fig.1. Power correlations between measurements of forelimb bones

THE ANATOMY OF THE HARBOUR PORPOISE: COMPARISON OF SOME MORPHOLOGICAL METHODS

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INTRODUCTION AND METHODS The harbour porpoise (*Phocoena phocoena*) is a cetacean well documented in the scientific literature and the anatomy of this animal was documented by many different methods (e.g. Tyson, 1680; Slijper, 1936; Cranford et al., 1996; Kastelein et al., 1997). Macroscopic dissection of tissues and organs is a prerequisite for the identification of body structures, whereas x-ray computed tomography (CT) and magnet resonance imaging (MRI) data give an interpretation of the different tissues within scanned slices. The CT method converts tissue densities into digital values and images, respectively (Brouwers et al., 1990; Hartmann et al., 1992). In contrast, MRI uses the proton density in tissues to reconstruct corresponding digital images. To demonstrate the power of different morphological methods, an adult female harbour porpoise was documented by CT and MRI. Afterward it was sectioned frozen in the mediosagittal plane by means of a band saw. The animal was photographed and fixed using the "Kaiserling" method (Romeis 1989).

RESULTS AND DISSCUSSION CT and MRI are well-established diagnostic methods in life science. In anatomical research, dealing mostly with post-mortem specimens, these methods face some problems. One problem using MRI in dead animals is the recognition of artifacts (Figure 4). So, hematomas or fluid-filled spaces may be mistaken for parts of structures. X-ray methods are more robust against this kind of artifacts. But often soft tissues are not rendered good enough because of minor differences in tissue densities (Rauschning et al., 1983). On the other hand, invasive methods as macroscopic dissection for partial analysis may alter the topography of the target structures (Figures 1 and 2).

As non-invasive methods, CT and MRI demonstrate the topography of organ systems better than any other technique and 3-d computer reconstruction of the scans is a powerful tool to understand complicated structures (Figures 3 and 4). Our synthetic study is one of the few that present the topographic relation of the skeleton within the body, e.g., the pelvic bones in a porpoise (Knauff, 1905; Kastelein et al.; 1997; Figure 3). In conclusion, only the combination of modern imaging techniques and traditional gross anatomical methods (slice cryosectioning, dissection) including routine histology will show the complete picture of morphology and topography and help to interpret the functional implications of the tissues and structures in question. Nevertheless, CT and MRI scans even of high end systems cannot compete with the resolution and brilliance shown in photos of gross sections.

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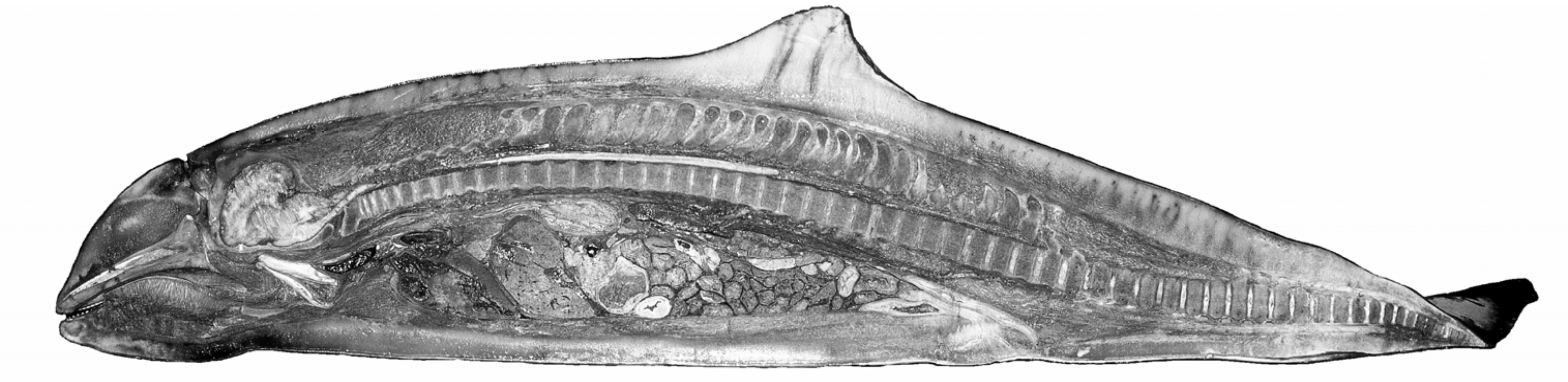

Fig. 1. Mediosagittal cryosection through a harbour porpoise.

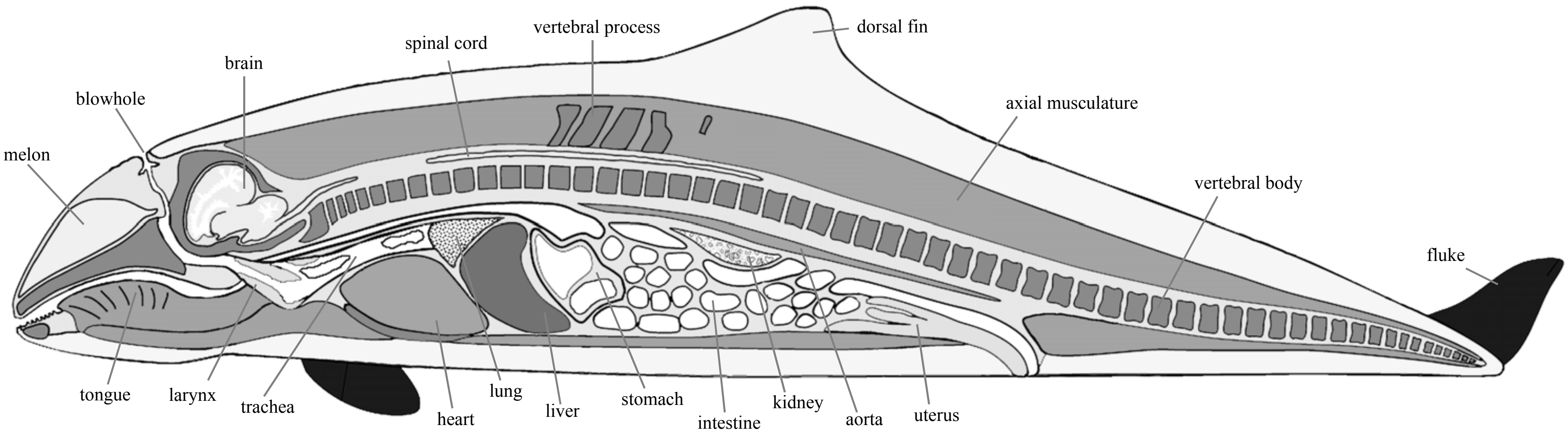

Fig.2. Mediosagittal schematic reconstruction of a harbour porpoise.

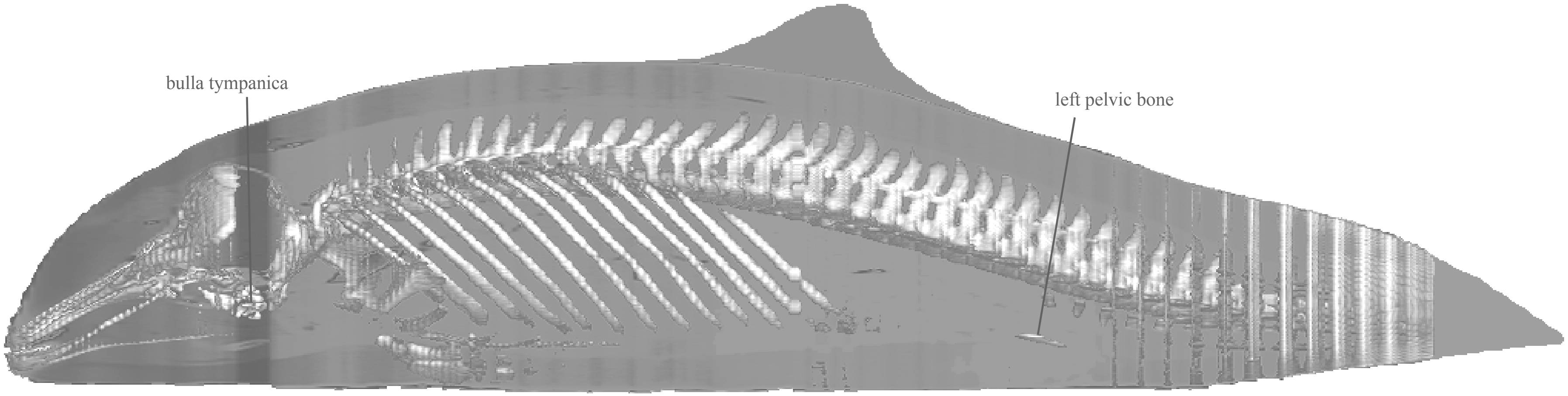

Fig. 3. 3-D reconstruction based on computed tomography scans of a harbour porpoise showing the mediosagittal plane and the skeleton of the left body part. The bulla tympanica and pelvic bones are high lighted.

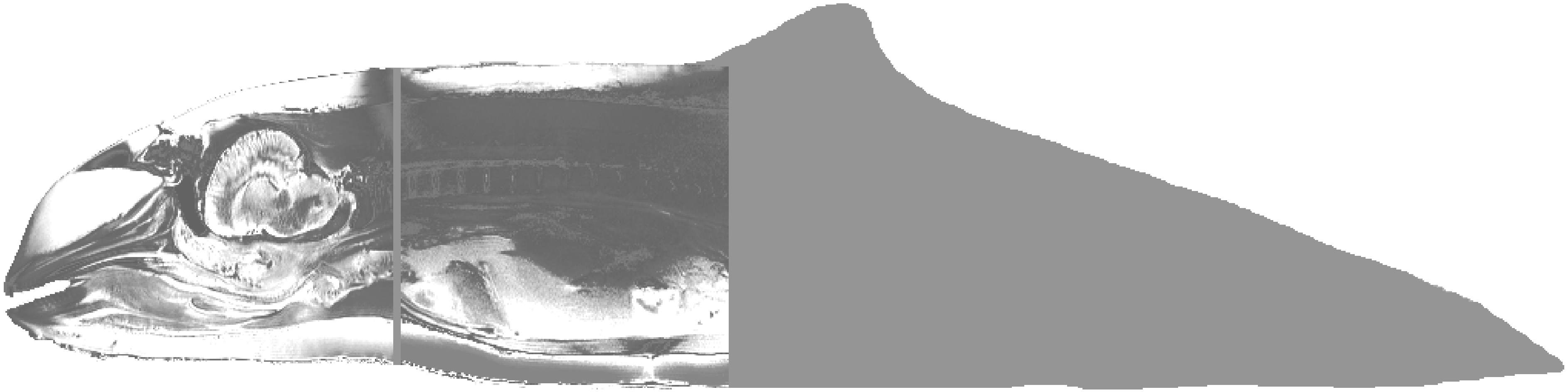

Fig. 4. Colour-mapped sagittal magnet resonance images of the harbour porpoise head and thorax region.

CRANIOMETRIC DISTINCTION BETWEEN BRYDE'S WHALE, *BALAENOPTERA EDENI*, AND SEI WHALE, *BALENOPTERA BOREALIS*, BY MEANS OF THE NEUROCRANIAL EXPOSURE

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The background for the study was an unusual stranding of a young baleen whale in Danish waters exhibiting external morphological features shared by Fin and Bryde's whales, and certain osteological features shared by Sei and Bryde's whales. It turned out to be a Bryde's whale (*Balaenoptera edeni*), the first ever recorded for Denmark. Two skulls of each species from the collection of the Zoological Museum, University of Copenhagen, were compared in order to reveal the most reliable mesurement for distinguishing between the two species. Among the position, size and shape of the nasal bone, and the width and length of the neurocranial exposure, only the width and length of the neurocranial exposure have reliable diagnostic value.

SKULL DEVELOPMENT IN NORTH ATLANTIC MINKE WHALE, WITH IMPLICATIONS FOR SPECIES IDENTIFICATION IN THE GENUS *BALAENOPTERA*

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Eleven Minke Whale (*Balaenoptera acuturostrata*, Lacepede 1804) skulls from the North Atlantic were examined to establish whether the development of the skull progresses isometrically or allometrically. The series consisted of animals spanning the entire size range in length and therefore presumable age. It was found that the growth of the single skull elements is proportional to the length of the skull with the exception of the *Os nasale. Os palatine*, the rostrum, as well as the neurocranial exposure were found to be consistent characters in both juvenile and physically mature animals suggesting diagnostic values for species identification of balaenopterids in general, as the members of the genus Balaenoptera resemble each other rather closely. The breadth of the skull and the height and length of the mandible also grew proportionally with the skull length. *Os palatine* should not be used in species determination of juvenile animals as the examination indicated an allometric growth. The examination was performed to evaluate the validity of skull characters to be used in identification of a juvenile balanoptera specimen stranded in Denmark, September 2000. As the morphology suggested three different species (*B. edeni, B. physalus and B. borealis*) it was essential to establish whether the included skull characteristics keep the same positions and proportions during development, to affirm whether skull characteristics could be used for identification or not.

CRANIAL ANALYSIS IN THE COMMON DOLPHIN *DELPHINUS DELPHIS* IN THE NORTHEAST ATLANTIC

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The common dolphin has a widespread distribution and is relatively abundant in the temperate to sub-tropical waters of the Northeast Atlantic. However, knowledge on whether one species, sub-species, or various populations occur in this region is deficient. Moreover, adequate information on stock structure and stock identies is necessary for management strategories. A total of 347 common dolphin skulls obtained from both stranded and by-caught individuals were examined. These were collected by Irish (58 specimens), English (130 specimens), Welsh (9 specimens) Scottish (24 specimens), Spanish (46 specimens) and Portuguese (81 specimens) marine mammal stranding projects. The sample included 141 female and 168 male common dolphins ranging in length from 93 cm to 227 cm and 105 cm to 244 cm respectively. The sample period ranged from 1901 to 2001, however the majority of the samples analysed were obtained in the last ten years due to an increase in effort by the local stranding projects. Forty eight characters were measured in order to ascertain the existence of a number of species, subspecies, populations and stocks within in the North East Atlantic. Sexual dimorphism, growth and cranial development in skull morphology were analysed by using additional information such as total body length, sex, and age obtained from each individual dolphin. Initial analysis indicates the presence of a single species, the short-beaked common dolphin (*Delphinus delphis*), with a significant level of divergence between the sample regions and the sexes. This work is part of an extensive study on the biology of the common dolphin in the Northeast Atlantic.

HARBOUR PORPOISE: A RELATION BETWEEN SKIN STRUCTURE AND THE HYDRODYNAMIC DESIGN OF THE DORSAL FIN

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INTRODUCTION The "dolphin's secret" as it was formulated by M. Kramer remains unresolved. It is generally accepted that the relatively high speed of dolphin is provided by the streamlined body shape, mode of swimming, and probably hypothetic dolphin skin dampening. According to this hypothesis, the dolphin skin is a compliant surface reducing friction drag by distracted viscous dampening of perturbations in a boundary layer (Kramer, 1960). While the recent progress in compliant walls is obvious (Carpenter *et al*., 2000) there are no direct evidences of the friction drag reducing by the dolphin skin. One of the reasons is the difficulty of experimental study of the flow-skin interface of swimming dolphin. On the other hand, the study of the relation between local skin structure and streamlined shape may give the indirect sign of dolphin skin adaptation to the flow.

MATERIALS AND METHODS Dorsal fins of three harbour porpoise (*Phocoena phocoena* Linnaeus, 1758) were cut off from the body and fixed in 10% neutral formalin. The skin sampling had been done in 33 points on the fin #2. Serial histological 10μm sections parallel to the skin surface were stained by iron hematein and photographed. Surface of dermis was reconstructed from the images of serial sections using disc-guided interpolation with IsoSurf software. A specific volume of dermis in a subpapillary layer was calculated as the total volume of dermal ridges and dermal papillae divided by the volume of epidermis. A specific surface of dermis in a subpapillary layer was calculated as the total surface area of dermal ridges and dermal papillae divided by the volume of epidermis. Eight cross-sections of the fins were made with equal intervals. Cross-sections of fin were analysed with DesignFOIL™ software. The velocity distribution and therefore pressure distribution, is derived using a panel method. Pressure distribution along with fin cross-sections as well as extent of the laminar, transition and turbulent region were calculated both for the cruising and burst speed of swimming. Due to the lack of documented reports of the harbour porpoise speed of swimming, the cruising speed was assumed 2m/sec while the burst speed was assumed 8m/sec (Rohr *et al*., 1998). All Calculations were made at zero angle of attack.

RESULTS AND DISCUSSION Three-dimensional structure of skin varies noticeably on the dorsal fin of harbour porpoise. The leading edge area is characterised by relatively high dermal papillae (Fig. 1a.). Long axis of dermal papillae is orthogonal to the skin surface there. Cross-sections of the dermal papillae at this place have almost round shape. Dermis does not form the ridges and dermal papillae are disconnected. The surface area of dermis is maximal there and it provides for the tight junction between epidermis and dermis.

At the fin planes the dermis relief keeps the common view inherent to the porpoise body (Sokolov *et al*., 1971). The dermis is organised in dermal ridges ending by the dermal papillae (Fig. 1b, c). Dermal ridges originate from the leading edge and pass to the trailing edge by arc-wise deflecting. Dermal papillae have a triangle form in plane and are flattened in orthogonal direction. Cross-sections of the dermal papillae on the fin planes have the elongated elliptical shape. The characteristic feature of the dermis located from the leading edge to the maximum thickness of the fin cross-section is the relatively high dermal papillae that are approximately equal to the height of dermal ridges (Fig. 1b). The height of dermal papillae decreases from maximum thickness of the cross-section to the trailing edge. Near the trailing edge, the dermal papillae almost disappear and merge with dermal ridges (Fig. 1d.). The specific volume of dermis, as well as the specific surface area of dermis, increase fluently from the leading to the trailing edge of the fin cross-sections.

The dorsal fin of the harbour porpoise is short and has a triangle platform. Cross-sections of the fin have a symmetric profile, blunt rounded leading edge, and thin tapered trailing edge. The cross-sections outlines were estimated using basic airfoil parameters: leading edge radius r, maximum thickness MT, and position of the maximum thickness PMT (Fig. 2.). Hydrodynamic analysis of the fin cross-sections has shown the pressure distribution along with a chord that is similar to the engineered airfoils under the same Reynolds number. The extent of the laminar, transition and turbulent region varies from the fin root to tip. The difference of the extent of laminar region at the cruising and burst speed of swimming decreases from fin root to the fin tip with an average value 7.1 ± 4.95% of the chord length. The difference of the extent of transition region is more variable at the same conditions with an average value 8.9 ± 11.47% of the chord length.

Morphology of the skin conforms to the hydrodynamics of the dorsal fin of the harbour porpoise. It appears as in the difference of skin thickness as in the difference of spatial structure of dermal-epidermal joint. It was found that laminar, transition and turbulent regions of the fin surface are characterised by the different spatial structure of the skin. The specific volume as well as the specific surface increase along with cross-sections according to chordwise modification of the boundary layer from laminar to turbulent mode.

Mechanical properties of dolphin skin depend on its structure (Babenko, 1971). Following the analogy with compliant walls that have a similar design to the dolphin skin (Carpenter *et al*., 1990; Yeo, 1990) it can be assumed that difference of skin thickness, specific volume of dermis as well as the angle between dermal papillae and normal to the skin surface reflects the difference of mechanical properties of dolphin skin. The point of such a difference becomes clearer by the assumption that each portion of the skin could have been optimized for the appropriate range of local Reynolds numbers (Gad-el-Hak, 1996).

CONCLUSIONS Founded variability of the spatial structure of dolphin skin can be considered as an indirect sign of the adaptation of skin to the local flow conditions.

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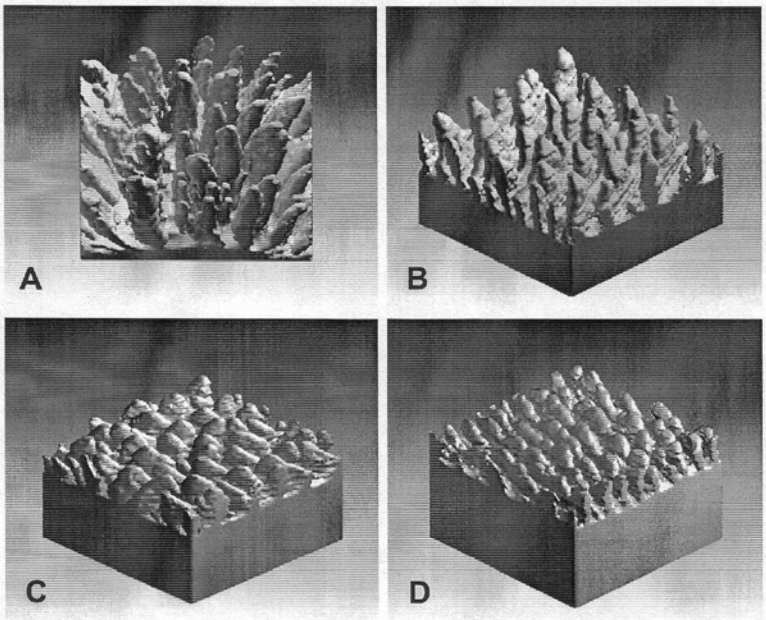

Fig. 1. Dermis relief on the harbour porpoise dorsal fin. A – leading edge, B – between leading edge and maximum thickness of the fin cross-section, C - maximum thickness of the fin cross-section, D – near the trailing edge.

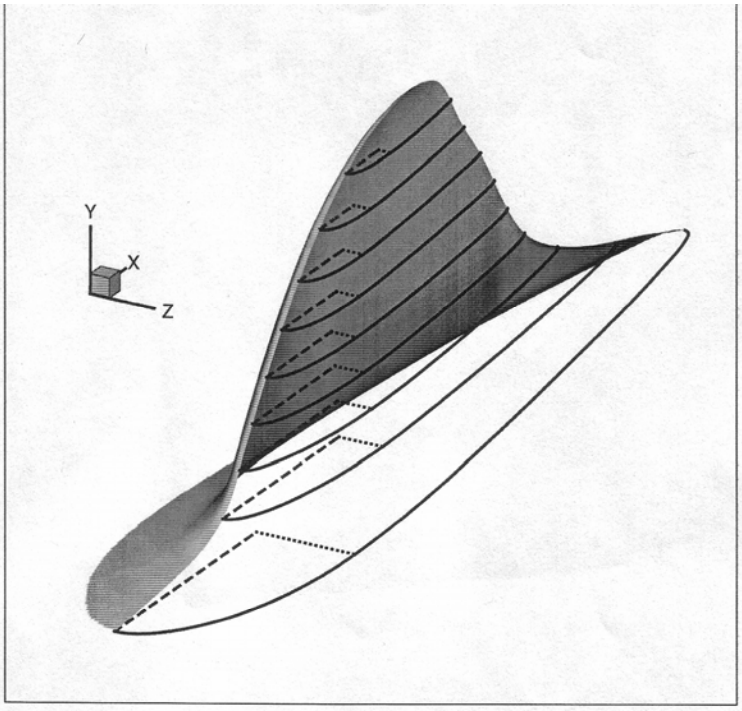

Fig. 2. Basic hydrodynamic parameters of the cross sections of the harbour porpoise dorsal fin. Solid lines indicate chord length, dotted lines indicate maximum thickness, and dashed lines indicate position of the maximum thickness.

POLLUTION

LINKAGES AND INTERACTIVE THREATS OF OZONE DEPLETION AND GLOBAL CLIMATE CHANGE TO THE CETACEAN ENVIRONMENT

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This paper considers ozone depletion and global climate change which are arguably the two most serious anthropogenically-induced perturbations to threaten global ecosystems. Evidence is presented from review of a range of laboratory, field and modelling-based studies to describe the potential effects on the cetacean environment of the interactions and linkages of these two environmental factors. A systematic review of the numerous interactions between the processes involved in ozone depletion and global climate change is presented. These processes are considered at the level of individual organisms and ecosystems as well as broader atmospheric dynamic, radiative and chemical interactions. The current status of the ozone layer and of global climate change is considered in light of projected future scenarios. Many studies exist which identify deleterious effects in the marine environment caused by ozone depletion and by global climate change, and there is a small but growing literature which identifies synergistic and additive interactions of these. It is considered that unless the effects of simultaneous and interactive multiple stresses are taken into account, appraisals of environmental pressures on cetaceans may be significantly underestimated.

THE DYNAMICS OF VITAMIN A, VITAMIN E AND PCBS IN SEALS DURING LACTATION

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This study focused on the dynamics of vitamin A, vitamin E and PCBs in grey seals (*Halichoerus grypus*) during lactation. Mother-pup pairs have been serially captured between birth and weaning in order to take milk and blood samples at different lactation stages. Milk vitamin E concentrations decreased sharply between colostrum (90 mg/kg) and milk from early-mid lactation (20 mg/kg). This drop corresponded to a decrease of vitamin E levels in maternal serum (15 mg/l at day 0 and 10 mg/l at late lactation - 11 days -). Newborns appeared to have low serum vitamin E concentrations (lowest concentration : 3 mg/l). The levels rapidly increased to reach a peak at day 1-3 (30 mg/l) and then dropped and stabilised until the end of lactation (20 mg/l), reflecting the dynamics in milk. Vitamin A levels in milk remained stable during the first part of lactation (6 mg/kg in colostrum) and then increased at late lactation (10 mg/kg). At birth, the concentration of circulating vitamin A in pups was low (110 µg/l). It then increased to reach 500 µg/l at late lactation. Milk PCB concentration stayed constant during the first part of lactation (310 µg/kg) and increased at late lactation (670 µg/kg). This phenomenon was the reflect of an increase in the serum of mothers at late lactation (7 µg/l at day 0 and 12 µg/l at late lactation). Pups were born with circulating PCB levels higher than their mothers (12 µg/l at day 0), revealing an important placental transfer. At late lactation, the PCB concentration in pup serum was even greater (28 µg/l), due to the ingestion of milk. The dynamics of vitamin E and PCBs during lactation totally differed. Conversely, a curious parallelism was observed between vitamin A and PCBs, especially in milk, in which an increase of both types of compounds was noticed at late lactation. This phenomenon suggests a common mechanism of transfer of these compounds from mother body stores to the milk.

INVOLVEMENT OF METALLOTHIONEINS IN THE DYNAMIC OF ZN, CD, CU AND HG IN HARBOUR PORPOISES, *PHOCOENA PHOCOENA* STRANDED ALONG THE SOUTHERN NORTH SEA COAST

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Metallothioneins (MTs) have been studied in livers and kidneys of 14 harbour porpoises, *Phocoena phocoena*, stranded along the Belgian coast. The participation of this protein in metal detoxication has been investigated since high levels of Zn, Hg and Cu were previously measured in those animals and Zn concentrations were high in emaciated porpoises. Heavy metals have been measured by I.C.P. spectrometry and flameless atomic absorption in the livers and kidney after gel chromatography. MTs bind 50 % of total hepatic Zn, 42% and 56% of the total hepatic and renal Cd respectively, and 34 % of the total hepatic Cu. Moreover, when Zn increases in the liver, its percentage bound to MTs increases also (from 20 to nearly 70%), suggesting that these proteins might take in charge the Zn overload resulting from the emaciation process. On the contrary, the percentage of hepatic Hg bound to MTs is very low and this metal is mainly present (more than 90%) in the insoluble fraction reflecting its association with selenium (HgSe) under a detoxified form. To conclude, MTs appear to have a key role in the homeostasis of hepatic Zn and Cu and in the detoxication of renal Cd by harbour porpoises. Moreover, these metalloproteins appear to be involved in the physiological response of Zn homeostasis disruption related to the emaciation process of these animals.

HEAVY METALS IN TISSUES OF GRAY WHALES (*ESCHRICHTIUS ROBUSTUS*), IN THE SEAWATER AND IN THE SEDIMENTS OF OJO DE LIBRE LAGOON IN MEXICO

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The concentration of 12 elements (copper, zinc, iron, manganese, lead, vanadium, nickel, chromium, cadmium, mercury, arsenic and selenium) were measured in skin, bone, muscle and kidney of 8 gray whales (*Eschrichtius robustus*) stranded during the 1999 breeding season on the coast of Ojo de Liebre Lagoon in Mexico. The concentration of lead from all tissues was significantly higher compared with previous studies. Due to the fact that gray whales have a unique feeding strategy among Mistyceti by filtering sediments to obtain food, and also because in recent years, this feeding behaviour has been recorded inside the lagoon; it was also measured copper, zinc, iron, manganese, lead, vanadium, nickel and chromium from the sediments; and copper, lead and mercury from the seawater of the lagoon. From the sediments and seawater, it was determined that the levels of copper were significantly higher compared with those reported elsewhere; thus, the lead and copper concentrations in tissues were correlated with that of water and sediments, in order to establish if there was a relationship between the concentration of these metals from tissues of the whales and those from the sediments and the water. Results showed that there was not a correlation statistically significant between the concentrations. So, it could be established that the higher levels of lead in tissues showed little relationship to the levels of lead from the lagoon; and for copper it could be established that despite the higher concentrations of copper from the lagoon, the whales do not bioaccumulate the metal into their tissues to reach toxicological levels.

ANALYSIS OF HEAVY METALS IN BLUBBER AND SKIN OF MEDITERRANEAN MONK SEAL

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The presence of heavy metals in blubber and skin samples collected from stranded Mediterranean monk seals, *Monachus monachus*, from different localities all over the Aegean Sea was, for the first time investigated. The 25 samples used in this study were derived from necropsies performed in 10 females and 7 male animals, during the period 1994-1999. The metals originally examined were Al, As, Cd, Co, Cr, Cu, Fe, Mg, Mn, Pb, Pt, Se, Si and Zn using a semi-quantitative method of Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES). Pt and Se were omitted from the final analysis due to a great number of non-detectable concentrations. Cu and Zn were determined using a quantitative method as well. No significant difference was observed in the resulted concentrations of the methods for Zn, while for Cu concentrations obtained from the quantitative method were greater by almost a factor of 2, compared to the semi-quantitative one. Evaluation of the total metal concentrations, in comparison to other seal species and marine mammals in general, was extremely fatigued due to the variation in the tissue types studied and the limited available background literature. A thorough research was conducted and all feasible comparisons were evaluated. Strong inter-element association was detected between Cu and Zn. Extremely limited data regarding metal concentrations in monk seals are available, rendering the results of this study difficult to evaluate, as well as, important in terms of essential baseline information in relation to the pollutant levels in the species and its habitat.

NEW FINDINGS ON SELENIUM RELATED MERCURY DETOXIFICATION PROCESSES

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New results confirm earlier findings on the importance of age related Hg accumulation, impact of tiemannite accumulation on speciation and inter-tissue relationships. It is hardly surprising that, as opposed to what was concluded earlier, major inter-regional differences in Hg accumulation can be demonstrated when comparing several populations of harbour porpoise on an age corrected basis. Important inter-species differences, probably depending on prey choice, are found, even after correction for 'relative age'. Regional differences are more important than the inter-species variability, at least within both classically described sub-orders of cetaceans. Based on actual estimates of MeHg exposure and tissue concentrations of ?Hg and MeHg in harbour porpoise from the southern North Sea, Hg detoxification through precipitation of tiemannite is evaluated to neutralise on average 12% of the overall MeHg intake at age 7. Based on the idea of a 3 fold excess in toxicity of mercury over selenium and a 5 to 15 molar concentration excess of selenium over Hg in fish, Hg seems to play the major part in the mutual detoxification. The formation of tiemannite was previously described as resulting from a two-step accumulation mechanism appearing at a threshold level of ?Hg 100 µg/g fw in liver. The reaching of an equimolar Hg to Se ratio can, however, be fully explained by the gradual increase of tiemannite levels in liver only. The new view is that molar Hg to Se hepatic ratios go towards equimolarity along with the slow nature of the tiemannite detoxification process, with tiemannite gradually taking the upper hand over MeHg, IHg2+ and a surplus of 'free' selenium with the increase of the total Hg load.

FIRST STUDY OF NATURAL AND ARTIFICIAL RADIONUCLIDES' DISTRIBUTION IN MARINE MAMMALS OF THE CHANNEL

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INTRODUCTION Nuclear industry is present in several areas on the coasts of the Channel, in France and Great Brittain. The radioactivity is monitored in live organisms, like seaweeds, marine invertebrates and fishes. The objective of this theme is having an information about the natural and artificial radionuclides' distribution and concentration in a few marine mammals.

MATERIALS AND METHODS The measures have been realised on ten marine mammals, two seals and eight cetaceans, found dead on Normandy coasts (Fig. 1). Five species are concerned : the grey seal *(Halichoerus grypus)*, the bottlenose dolphin (*Tursiops truncatus)*, the common dolphin (*Delphinus delphis)*, the blue-white dolphin (*Stenella coeruleoalba)* and the harbour porpoise (*Phocoena phocoena).* Two kilogramms of muscle were taken from the animals and frozen before being reduced to powder in laboratory. The methodology used to detect the activity of radionuclides is the gamma spectrometry. The unit of measure is the Becquerel (Bq) per kilogram of fresh material.

RESULTS Only two gamma emitters radionuclides could have been measured : potassium 40, a natural radionuclide, and caesium 137, an artificial one. The measures of the thirteen other radionuclides are inferiors to the instruments' limits of detection (Table 1).

Potassium 40 (K-40) is present in all the live organisms (between 50 and 200 Bq per kg of fresh material, in fishes for example), and particularly in the vertebrates' muscles. It's a very important element of their functioning.

Caesium 137 (Cs-137) is associated to potassium's metabolism in the live organisms. This artificial radionuclide is detected in very little concentration in these marine mammals, as in other vertebrates like fishes (inferior to 1 Bq per kg of fresh material). We can found it all over the planet because its origin results from the testings of nuclear weapons in the athmosphere during the 1960s and the 1970s. A little part of it comes from the Tchernobyl nuclear disaster and from the effluents of nuclear industry.

CONCLUSION This analysis shows that only one artificial radionuclide (Cs-137) is detected in slight traces. It would be interesting to follow in the time the distribution of radionuclides in different species of marine mammals living in the Channel. We could compare it with other individuals of Atlantic's populations to evaluate the impact of nuclear industry's effluents.

ACKNOWLEDGEMENTS We gratefully acknowledge the terrestrial and marine autorities, the vets and all the informants in Normandy for their collaboration in the interventions of GECC on dead marine mammals. We also thank Mr Masson and the members of the LERFA for the realisation of the radionuclides' measures.

Table 1. Results of analysis in ten marine mammals of the Channel

					Activity [Bq/kg of fresh material]	
	Species	**Sex**	**Length (cm)**	**Tissues**	**Cs-137**	**K-40**
C1	*Phocoena phocoena*	F	129	muscle	0.7	112
C2	*Phocoena phocoena*	M	121	muscle	0.6	86
C3	*Phocoena phocoena*	M	142	muscle	0.35	86
C4	*Phocoena phocoena*	F	110	liver	0.5	84
C5	*Stenella coeruleoalba*	F	190	muscle	0.25	96
C6	*Stenella coeruleoalba*	/	/	muscle	0.30	80
C7	*Delphinus delphis*	F	170	muscle	0.75	104
C8	*Tursiops truncatus*	M	156	muscle and liver	0.40	97
P1	*Halichoerus grypus*	M	172	muscle	0.25	75
P2	*Halichoerus grypus*	M	137	muscle	0.11	60

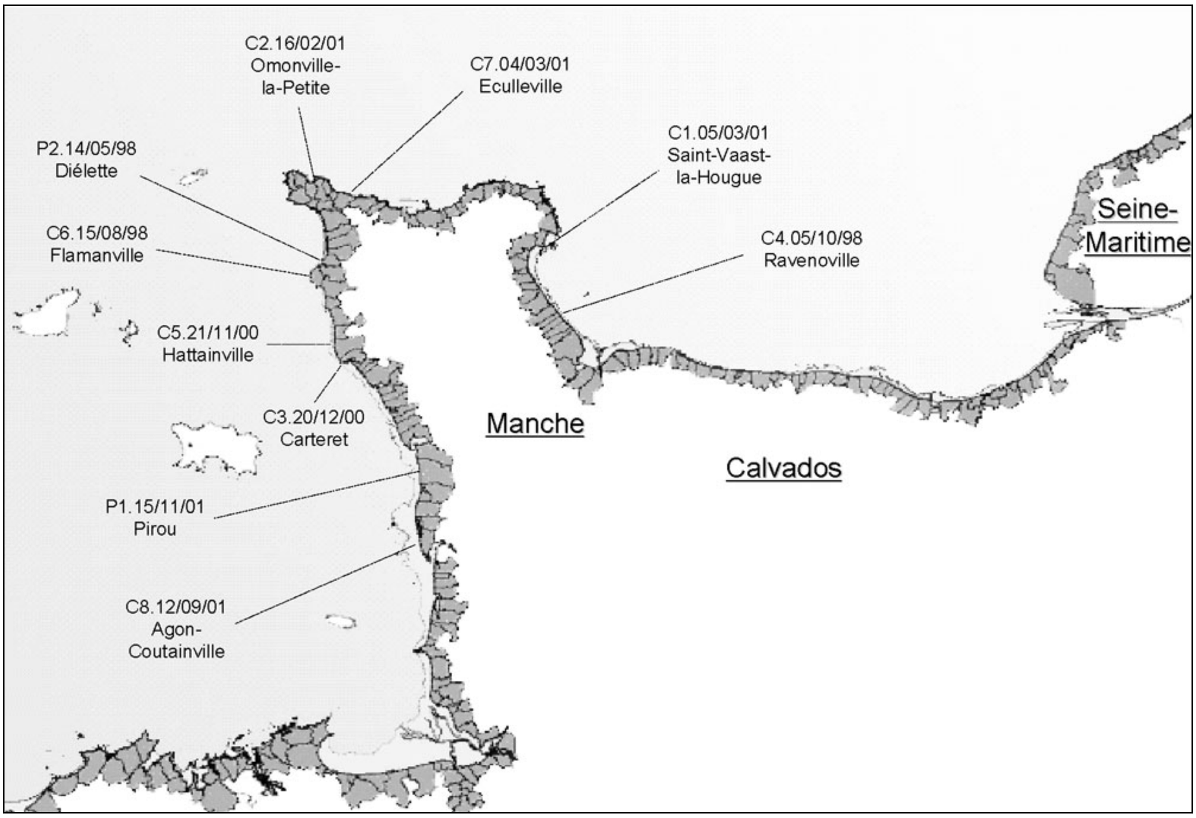

Fig. 1. Location of ten marine mammals stranded on the Normandy coast

BROMINATED DIPHENYLETHERS IN PORPOISES AND OTHER MARINE MAMMALS STRANDED OR BYCAUGHT AROUND THE UK

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Selected marine mammals stranded or bycaught around UK coasts are taken for post-mortem study. Tissues from these animals (principally blubber and liver) are analysed for a range of contaminants, and the contaminant burdens in harbour porpoises assessed for potential immunosuppressive effects. The range of contaminants which are determined has recently been extended to include a suite of brominated diphenylether congeners in blubber. In this paper we report initial data for these flame retardant compounds in the blubbers of 62 porpoises and 10 pelagic cetaceans of other species. These included two white-beaked dolphins, a white-sided dolphin, a common dolphin, a striped dolphin, a Risso's dolphin, a long-finned pilot whale, a fin whale, a minke whale, and a Sowerby's beaked whale. Porpoises feed primarily in shallow coastal waters, whilst the mysticetes are essentially open ocean animals, and the other odontocete species feed primarily either in deep waters over continental shelves and slopes, or in oceanic waters. The congeners found at the highest concentrations was BDE47 (2, 2', 4, 4'-tetrabromo diphenyl ether). BDE99 and BDE100 were generally the next most abundant congeners. In only one sample, a 15 year old male porpoise (SW1998/115) stranded in Lincolnshire, were these compounds not present at detectable concentrations. Of the pelagic cetacean, the lowest concentrations were found in baleen whales (fin and minke whales), and the highest in two white-beaked dolphins. Maximum concentrations of summed BDE congeners in both porpoises and the other cetaceans were approximately one-tenth of those observed for the sum of 25 chlorobiphenyl congeners determined in the same samples, although there was essentially no correlation between the concentrations of the two types of organohalogen contaminants in individual animals. Interspecies differences are examined, and the possible toxicological effects of these contaminants discussed.

THE POTENTIAL IMPACT OF POLLUTANTS ON MARINE MAMMAL HEALTH

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As top predators, marine mammals are exposed to contaminants predominantly through their diet. Some contaminants, such as trace elements, are of natural origin and marine mammals have historically been exposed to them. This has allowed the development of mechanisms either to control the internal concentrations of certain elements or to mitigate their toxic effects. Additional inputs of trace metals from anthropogenic sources could, however, increase body burdens to such an extent that these mechanisms could be overloaded or otherwise disrupted, and toxic effects could then result. For many modern synthetic chemicals, such as brominated flame retardants, their exposure is much more recent, and the interaction of these groups of compounds with the animals' biological functioning may be difficult or impossible to predict. This is particularly so in view of the scarcity of experimental studies producing empirical evidence of cause and effect relationships between indices of marine mammal health (particularly for cetaceans) and the range of contaminants that they are exposed to. Furthermore, the number of modern synthetic chemicals currently in use and finding their way to the oceans is both large and increasing, and for the more lipophilic and environmentally persistent of these compounds the bioaccumulation potential in marine mammals is also high. The known or predicted effects of different contaminants on marine mammals include reproductive impairment, immunosuppression, disruption of endocrine systems, increased incidence of infectious disease and carcinogenesis. These may have potential effects at both the individual and the population level, the latter particularly in areas where populations are already under stress from other sources, due, for instance, to the impact of fisheries bycatch.

CONTAMINATION OF RADIONUCLIDES (137CS, 239,240PU, 90SR) IN CASPIAN SEAL (*PHOCA CASPICA*)

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The Caspian seal (*Phoca caspica*) is endemic species to the Caspian Sea. Population of the species has declined from about one million animals early in the 20th century to about 35-40% of the size at the end of the 1980s. The decline might be due to various factors such as over-harvesting, destruction of their habitat by sea level rising up to 3m, and pollution of hazardous chemicals such as organochlorine compounds and radionuclides. Mass die-off of Caspian seals occurred in Caspian Sea in both 1997 and 2000. Causes of these events were discussed from various aspects. In the present study, 31 individuals of Caspian seals collected from Pearl Islands (45 01'N, 48 19'E) in 1997, 1998 and 2000 were examined in order to understand contamination of radionuclides (137Cs, 239,240Pu, 90Sr) in Caspian seals. Concentration of 137Cs of a pregnant Caspian seal (BL: 125 cm, BW: 52.5 kg, Age: 24.5 years) was highest in muscles (2.5 Bq/kg) followed by liver (1.3 Bq/kg), bone (1.2 Bq/kg) and blubber (0.16 Bq/kg). Level of 239,240Pu was detected in liver (0.34 mBq/kg) and muscle (0.16 mBq/kg) but neither in blubber nor bone. Total level of 137Cs in a male fetus (BL: 30.3 cm, BW: 638 g) was 0.17 Bq/kg. Contamination of 137Cs, 239,240Pu, and 90Sr in the liver ranged from 0.34 to 2.3Bq/kg, from 0.34 to 7.7 mBq/kg, and from 0.0049 to 0.036 Bq/kg, respectively. No significant difference in radionuclide level was observed between both sexes and between growth stages. To find out possible causes of mass die-off of Caspian seals, concentrations of radionuclides were compared with those of organochlorine compounds. We propose to establish the international cooperative study on systematic biological research of Caspian seals and monitoring research of their environmental condition.

FACTORS INFLUENCING BIOACCUMULATION OF TRACE ELEMENTS (CD, CU, HG, SE, ZN) IN THE GREY SEALS (*HALICHOERUS GRYPUS*) OF THE FAROE ISLANDS

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Top predators from the northern sub-polar and polar areas exhibit higher cadmium concentrations in their tissues than the same species from temperate waters, which raises the question of the toxicological impacts. In this work cadmium, copper, mercury, selenium and zinc were determined by atomic absorption spectrometry in liver, kidney and muscle of 46 females and 21 males of grey seals (*Halichoerus grypus*) from the Faroe Islands. A wide range of ages, including immature and adult individuals were sampled. Copper concentrations were much higher in the liver (39 ± 18.1 µg.g-1 wet weight) than in muscle (3 ± 0.46 µg.g-1 w.w.) and in kidney (1.54 ± 0.33 µg.g-1 w.w.) whereas zinc concentrations were relatively homogenous between tissues. Both cadmium concentrations in the kidney and mercury concentrations in the liver were relatively high with 16 ± 25 µg.g-1 w.w. and 60 ± 70.4 µg.g-1 w.w. respectively. Both these toxic metals accumulated with age. Nevertheless cadmium in kidney accumulated at a higher rate in females compared to males, whereas no differences between sexes were found for mercury accumulation rate in the liver. The significant linear relationship between cadmium and zinc concentrations in the kidney ($r = 0.91$; $p < 0.01$) suggest the synthesis of metallothioneins. The high significant correlation between mercury and selenium has been shown in the liver ($r = 0.99$; $p < 0.001$), suggesting the demethylation of mercury through the formation of tiemannite with a Hg:Se ratio of 1.05 ± 0.44 in the mature individuals. Both sexes would develop similar detoxification processes. Nevertheless because of the highest cadmium concentrations in the females, a toxicological impact in these individuals cannot be excluded.

METALLOTHIONEINS IN PERIPHERAL BLOOD LEUKOCYTES FROM A MARINE MAMMAL, IMPLICATIONS IN HEAVY METAL IMMUNOTOXICITY

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Metallothionein (MT) strongly modulate the toxicity of heavy metals. More recently, these proteins have been demonstrated to modulate important immune functions in human and rodent. We demonstrated the presence and characterized the induction of MT in peripheral blood leukocytes (PBL) from grey seals (*Halichoerus grypus*) in vitro exposed to heavy metals. Messenger RNA of MT-1 and MT-2 isoforms rapidly increased in grey seal PBL in vitro exposed to Zn, reaching the maximum level of relative induction after less than 3 hours of exposure. Zn induced a concomitant increase in MT proteins determined by flow cytofluorimetry. This increase was dose-dependant and positively correlated with the duration of exposure. Moreover, our results showed a strong heterogeneity among the 3 major PBL subpopulations; granulocytes, lymphocytes, monocytes. While heavy metals exposure failed to induce any detectable increase of MT in granulocytes, monocytes appeared to be the most responsive PBL subpopulation in term of MT induction following heavy metal exposure. The relative intracellular MT levels depended not only on the PBL subpopulation but also on the metal. On a molar basis, Cd was more potent than Zn as an inducer of MT in lymphocytes but not in monocytes. We also demonstrated that grey seal peripheral blood lymphocytes were less sensitive to Cd than human lymphocytes, indicating a possible adaptation to Cd exposure. Aside from provide us an essential tool to improve the use of MT as a biomarker of heavy metal exposures, this non-invasive approach help us to better assess the risk of heavy metal exposure.

INVESTIGATIONS OF THE INFLUENCE OF POLLUTANTS ON THE ENDOCRINE AND IMMUNE SYSTEMS OF HARBOUR PORPOISES FROM THE GERMAN NORTH AND BALTIC SEAS

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The harbour porpoise is the only true native cetacean species in the German North Sea and Baltic Sea. Because of a decline of the population in recent decades a project was launched aiming to investigate the influence of pollutants on the endocrinium and immune system of harbour porpoises. Investigations are performed to find endocrine and immune disrupting effects on animals originating from the North and Baltic Seas and to compare these findings with observations from animals of Icelandic, Norwegian and Greenlandic waters. Studies on the immune system revealed that several monoclonal and polyclonal antibodies from other species showed a specific reaction with cells of lymphoid tissues from harbour porpoises. Concanavalin A, pokeweed mitogen, phytohemagglutinin used in the lymphocyte transformation test showed a mitogen-induced induction of proliferation of peripheral blood lymphocytes. Using RT-PCR, cDNA of IL-2, IL-4, IL-6, IL-10,TGFß und TNF-alpha was amplified in mitogen-stimulated lymphocytes and expression of iNOS mRNA was detected in lymphoid tissue. Adrenal glands, hypophyses and thyroid glands represent major target organs of endocrine disruptors and were therefore investigated for possible pathological changes. The thyroid glands in animals from Germany, Iceland and Norway showed a significant difference in the degree of severity of fibrosis between the three groups. Minimal interfollicular fibrosis was observed in the thyroid glands of Icelandic animals. In contrast thyroid glands from German and Norwegian harbour porpoises showed a moderate to severe interfollicular fibrosis. In addition polychlorinated biphenyls, DDT, toxaphene and polybrominated diphenylethers were analysed in blubber samples of the harbour porpoises. The PCB concentrations (sum of 15 congeners) ranged from 0.05 to 13 µg/g lipid and that the animals from Iceland had lower levels. Summarizing the preliminary results suggest that thyroid glands of harbour porpoises are adversely affected by chemical endocrine disruptors, which might result in a thyroid disfunction.

DISTRIBUTION OF RETINOIDS IN THE MAIN BODY TISSUES OF COMMON DOLPHINS (*DELPHINUS DELPHIS*)

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INTRODUCTION Retinoids, also know as vitamin A, are non-endogenous molecules that are essential in many physiological functions in mammals). Organochlorine compounds, particularly PCBs and dioxins (TCDDs), induce retinoid deficiency, an effect which is associated with impairment of immunocompetence, reproduction and growth. This makes retinoids a potentially useful biomarker for organochlorine impact. However, baseline studies to allow appropriate assessment of retinoid levels are lacking in marine mammals. Information available in terrestrial mammals shown that retinoids are extensively stored in the liver (Borrell *et al*., in press), but this tissue is not accessible in free-ranging populations and decomposes rapidly post-mortem, so it is not suitable for monitoring purposes. Other tissues, such as kidney, adipose tissue, lung or testis, can also constitute significant retinoid storage sites.

The present work has two aims: *i)* determine the compartmentation and body topographical variation of retinoid concentrations in the tissues of dolphins and, *ii)* evaluate the representativity of the various tissues for the assessment of body retinoid availability. The study was carried out using the common dolphin (*Delphinus delphis*) as a model.

MATERIALS AND METHODS We examined 12 fresh carcasses of common dolphins that had been incidentally caught by fishing vessels in north-western Spanish waters during 2001. Samples of liver, kidney, lung, heart, muscle and blood, and blubber from 11 body positions (figure 1) were collected before 12h post-mortem. These samples were analysed for retinoids by high-performance liquid chromatography (HPLC).

In marine mammals, retinoid concentrations are dependent on age, sex, and, potentially, other biological variables (Borrell *et al*., 1999). In order to compensate for this undesired variability, we standardized the analytical results of each individual by calculating the proportion that the concentration from the various body locations represented relative to the mean of all values obtained from the blubber (11 positions) of that particular dolphin. The proportions so obtained were the values used in the statistical comparisons.

Data were tested for normality with a Kolmogorov-Smirnov test of goodness of fit. As the data distributed normally, differences in retinoid levels were determined between groups using Student's t-test (2 groups) and analysis of variance (ANOVA) (3 or more groups) followed by the Tukey t-test to identify different sample pairs at $p<0.05$. All calculations were carried out using the SPSS-x statistical package.

RESULTS AND DISCUSSION We compared relative retinoid levels in different tissues, considering blubber concentration as the mean of all blubber position concentrations, and found statistically significant differences among them. As expected (Borrell *et al.,* in press), liver had the highest concentrations of retinoids. However, concentrations in blubber were also high. Concentration in other tissues was very low (figure 2).

We also compared the distribution of blubber retinoid in different body positions (figure 1). Position 5 had the highest concentration and position 11 the lowest. Table 1 lists the relative retinoid concentration found in the blubber locations from lowest to highest, with an indication of which showed significant differences.

In order to examine variation between main body regions, we also grouped the blubber positions as follows:

-Dorso-ventral variation: positions 1,3,6,9 were pooled to produce a dorsal mean, positions 4,7,10 were pooled to produce a lateral mean, and positions 2,5,8,11 were pooled to produce a ventral mean.
-Head-tail variation: positions 1,2,3,4,5 were pooled to produce an mean for the anterior body region, and positions 6,7,8,9,10,11 were pooled to produce a mean for the posterior body region.

We found significantly higher levels in the ventral region of the blubber than in the dorsal, but neither was significantly different from the lateral section, which was indeed at an intermediate level of concentrations (figure 3). On the other hand, anterior blubber positions presented significantly higher levels than the posterior region (figure 4).

CONCLUSIONS
1) Given the high retinoid levels of blubber and the large contribution of this tissue to body mass, blubber can be considered a significant body site for retinoid deposition.
2) As a consequence, blubber biopsies, which can be obtained by non-destructive methods (Aguilar and Borrell, 1994), can be used as a reliable indicator of retinoid status in dolphins.

3) Body location is a significant source of variability when assessing retinoid concentration in the blubber. therefore, sampling protocols should consistently use the same body location.

ACKNOWLEDGEMENTS The survey was funded by the Ministry of the Environment of Spain, CICYT project AMB99-0640, and the CIRIT of the Generalitat de Catalunya. Samples were supplied by the BMA with the support of the Pew Fellows Program in Marine Conservation, and Earthtrust.

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Table 1. Significant differences found between the relative retinoid concentrations of the 11 blubber body locations.

11	**6**	**10**	**9**	**3**	**7**	**1**	**2**	**8**	**4**	**5**		blubber location
0,76	0,82	0,85	0,88	0,88	0,92	1,00	1,04	1,14	1,25	1,47	mean	
											0,76	**11**
											0,82	**6**
											0,85	**10**
											0,88	**9**
											0,88	**3**
											0,92	**7**
											1,00	**1**
											1,04	**2**
											1,14	**8**
											1,25	**4**
											1,47	**5**

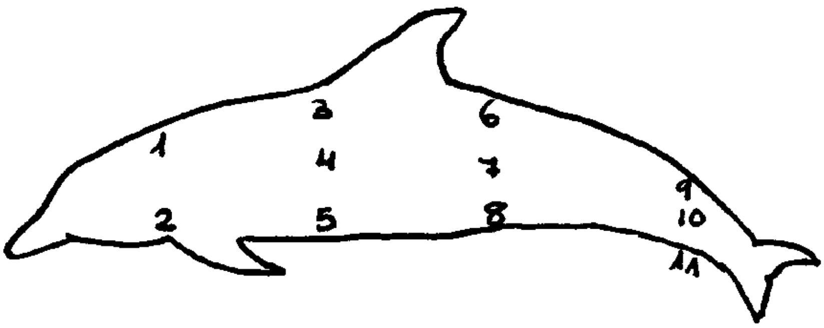

Fig. 1. Blubber sampling locations examined

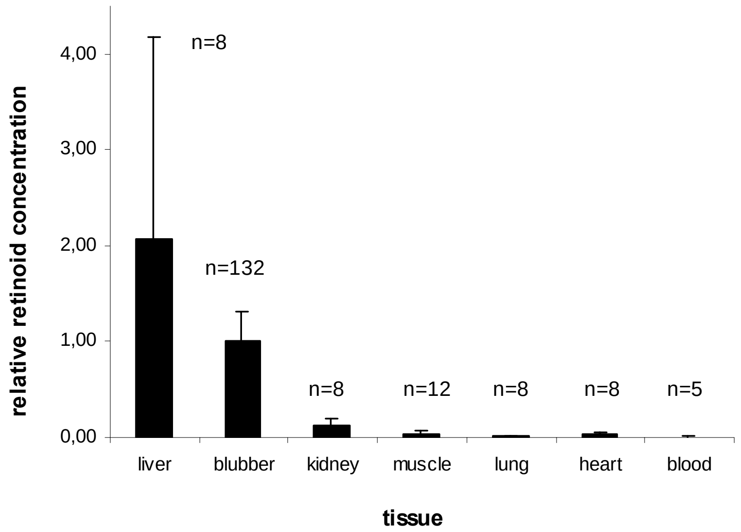

Fig. 2. Comparison of relative retinoid concentrations in tissues of common dolphins

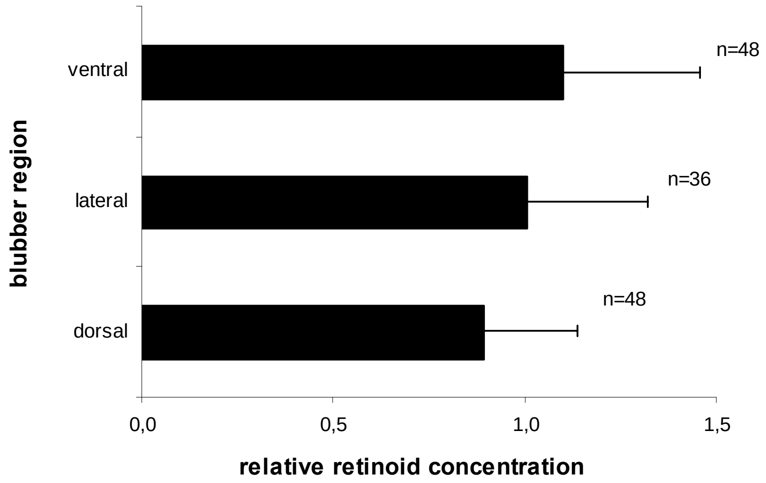

Fig. 3. Dorso-ventral variation of blubber relative retinoid concentrations in the common dolphins examined

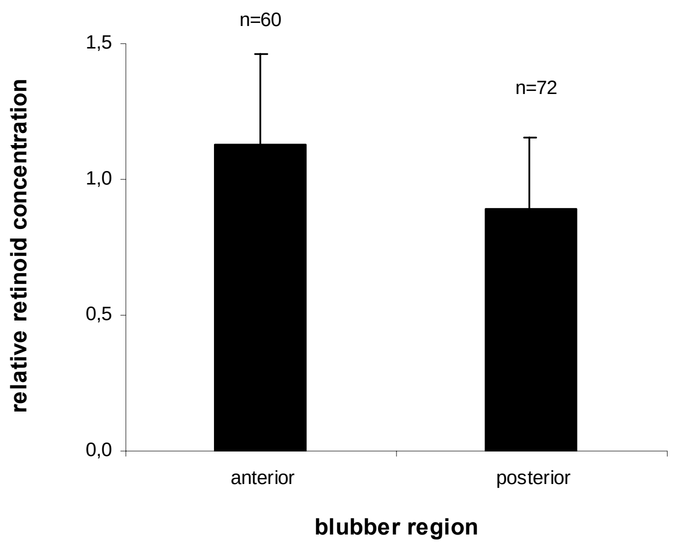

Fig. 4. Head-tail differences in blubber relative retinoid concentration in the body regions of the common dolphins examined

STOCK IDENTITY AND DISTRIBUTION

BOTTLENOSE DOLPHIN SUBPOPULATIONS AROUND THE IBERIAN PENINSULA IDENTIFIED BY ORGANOCHLORINE COMPOUNDS AND STABLE ISOTOPES

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INTRODUCTION The organochlorine (OC) pollutant load in an organism reflects the characteristics of the waters in which it lives and feeds, so populations inhabiting different geographical areas tend to have qualitatively and quantitatively different pollutant loads. Moreover, different sources of carbon in the diet have distinct isotopic relationships ($^{13}C/^{12}C$), which are conserved in the consumer.

To study the population structure of bottlenose dolphins and potential isolation of subpopulation units, we measured the concentrations of organochlorine compounds (PCBs, DDTs, and HCB) and isotopic patterns ($\delta^{13}C$ and $\delta^{15}N$) in body tissues of bottlenose dolphins (*Tursiops truncatus*) from the Mediterranean and the Atlantic waters of the Iberian Peninsula and examined geographical differences.

MATERIAL AND METHODS Stranded bottlenose dolphins from the Mediterranean (Catalonia (n=6), Valencia (n=11), Balearic Islands (n=6)) and the Atlantic (Portugal (n=7) waters of the Iberian Peninsula (Figure 1) were sampled from 1990 to 2000. Organochlorine compounds were measured in blubber by gas chromatography and electron capture detection. The technique used for analysis of stable isotopes in skin was EA-IRMS (elemental analyser isotope ratio mass spectrometry)

Results of isotopic signatures are expressed in standard δ notation relative to carbonate PeeDeeBelemnite and atmospheric nitrogen, where:

$\delta^{13}C$ or $\delta^{15}N(‰) = (R_{sample}/R_{standard}) - 1) X1000)$ and $R = (^{13}C/^{12}C)$ or $(^{15}N/^{14}N)$, respectively.

Data were tested for normality with a Kolmogorov-Smirnov test of goodness of fit. As the data distributed normally, differences in lipid content and organochlorine compounds were examined between groups using Student's *t*-test (2 groups) and analysis of variance (ANOVA) (3 groups). Discriminant analysis was used to test the significance of multivariate differences in PCB patterns (relative abundance of the various congeners in relation to the tPCB) between groups. All calculations were carried out using the SPSS-X statistical package.

RESULTS AND DISCUSSION Table 1 shows the mean and the standard deviation of the percentage of lipid extraction, organochlorine concentration (calculated as mg/kg on a lipid basis), and $\delta^{13}C$ and $\delta^{15}N$ found in the blubber and skin of bottlenose dolphins, split by locality of sampling.

Differences between Atlantic and Mediterranean dolphins. Figure 2 compares the mean concentration in blubber of the PCB congeners and the various forms DDT, tDDT, PCB and HCB of individuals from the two regions. Concentrations of all the compounds in the Mediterranean individuals were about double those in the Atlantic dolphins. All differences were significant ($p<0.05$) except for HCB and opDDE. Discriminant analysis also revealed significant differences in the PCB pattern of dolphins from the Atlantic and Mediterranean waters, and all individuals were correctly classified in their respective area on the basis of their PCB pattern.

The high OC levels shown by the Mediterranean population are consistent with the semi-enclosed nature of this sea and its high level of contamination. Corsolini *et al.*, (1995) and Marsili and Focardi (1997) found similar, or even higher, concentrations that those found in this study, in bottlenose dolphins from Italy.

The $\delta^{13}C$ and $\delta^{15}N$ values found in the skin of the bottlenose dolphins are shown in figure 3. The mean $\delta^{13}C$ in the Atlantic individuals is significantly higher than in dolphins from the Mediterranean ($p < 0.001$). Conversely, we did not find differences in $\delta^{15}N$ between Atlantic and Mediterranean populations. This is not surprising because dissimilarity in the abundance of ^{15}N usually reflects variation in trophic level, which is unlikely between populations of the same species.

Differences within the Mediterranean set. Figure 4 shows the mean concentration of OCs in the blubber of individuals from the 3 Mediterranean subareas. The $\delta^{13}C$ and $\delta^{15}N$ values from Mediterranean samples are shown in figure 3.

No significant differences were found between areas either in the concentration of any of the OCs, $\delta^{13}C$, $\delta^{15}N$ or in the PCB profile . Dolphins from Catalonia and Valencia showed higher OC values than Balearic individuals, but the difference was not significant because the variability within groups was very high. This high within-group variability is attributable to the fact that sample sets were composed of individuals of different sex and age, which variables have a strong influence on the individual pollutant load (Aguilar *et al.*, 1999).

Lipid content was significantly lower ($p<0.01$) in Balearic individuals than in individuals from other regions, which suggests greater competition for food in this region than in Valencia or Catalonia.

CONCLUSIONS The qualitative (profile of relative concentrations of PCBs) and quantitative (DDTs, HCB and PCB concentrations and $\delta^{13}C$) differences observed between Atlantic and Mediterranean bottlenose dolphins suggest geographical segregation between the two regions.

Conversely, the analyses failed to show any clear segregation between the Mediterranean subareas, although comparisons were statistically weak because of the high individual variability and insufficient number of samples in some subareas. Further research is needed in this geographical region to improve knowledge on bottlenose dolphin population structure.

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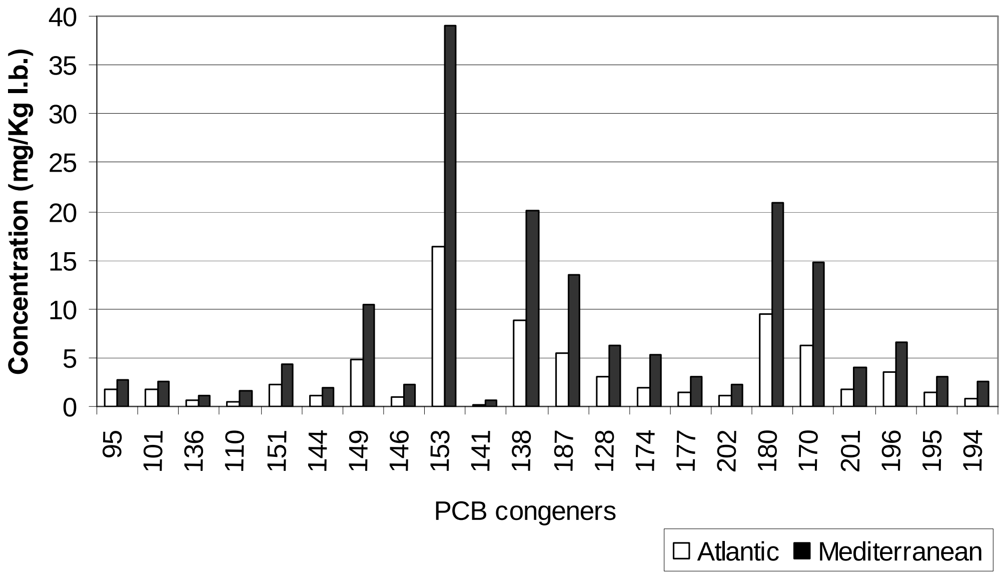
Table 1 Results of the analyses of the blubber and skin of bottlenose dolphins, split by locality of sampling.

	CATALONIA		VALENCIA		BALEARIC ISLANDS		PORTUGAL	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
% Lipid	73,12	5,57	67,59	13,27	39,23	21,33	51,65	11,14
HCB	0,62	0,34	1,59	1,71	0,53	0,46	0,38	0,20
opDDE	0,77	0,34	0,93	0,50	0,87	0,65	0,65	0,48
ppDDE	49,91	21,20	60,44	38,17	45,83	50,63	25,11	18,91
ppTDE	5,33	2,24	7,15	4,72	2,79	2,67	2,46	1,39
opDDT	2,34	0,66	2,58	1,82	2,09	1,94	0,70	0,39
ppDDT	6,07	2,69	7,13	4,70	3,00	2,50	2,13	0,89
tDDT	64,03	26,53	78,23	48,53	54,58	58,07	31,03	20,04
PCB	168,47	90,44	205,67	132,98	97,64	101,55	75,31	39,45
δ15N	12,28	0,64	12,94	0,94	11,95	1,34	13,31	1,11
δ13C	-18,90	0,76	-19,02	0,82	-19,32	1,02	-17,23	0,87

Fig. 1. Sampling areas.

a



b

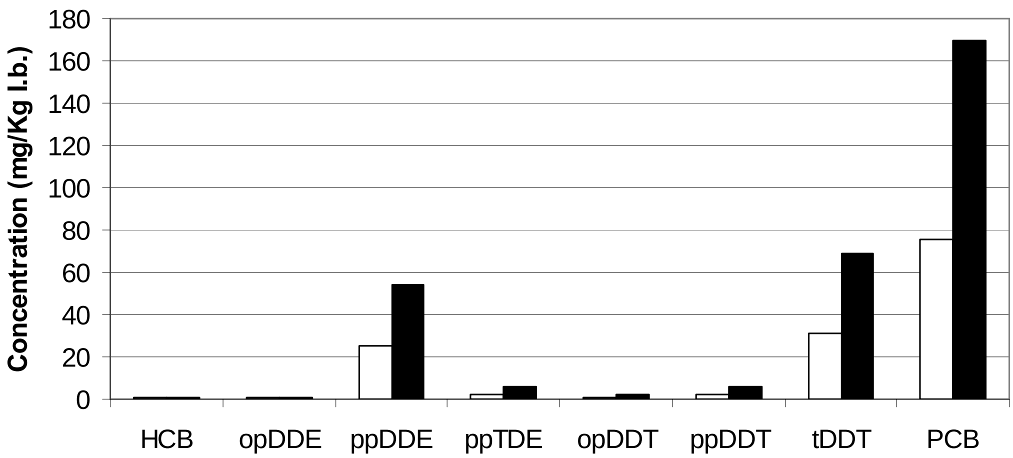


Fig. 2. Comparison between blubber concentration of PCB congeners (a) and the various forms of DDT, tDDT, PCB and HCB (b) in individuals from the Atlantic and the Mediterranean

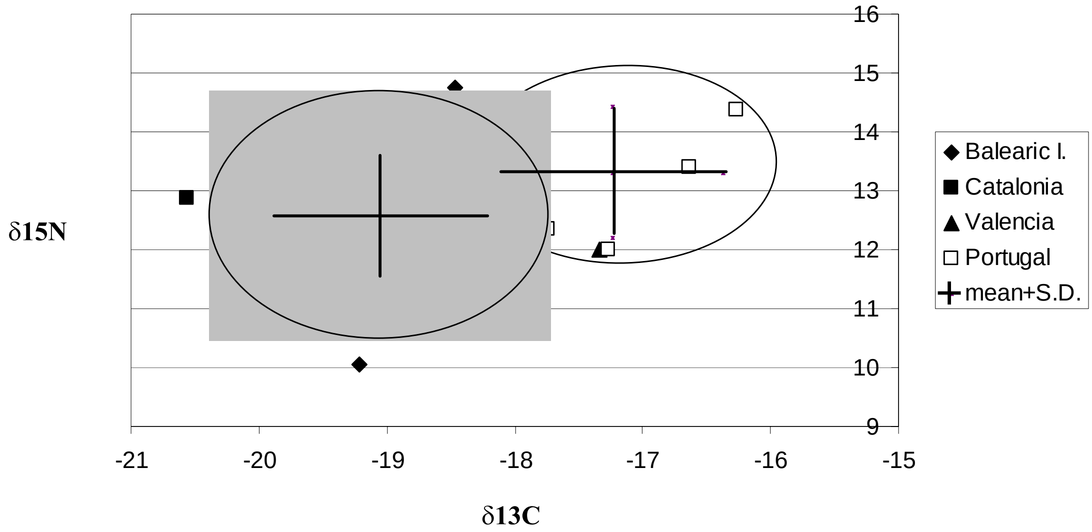


Fig. 3. Scatter plot of $\delta^{13}C$ and $\delta^{15}N$ signatures of bottlenose dolphin sampled at the four study subareas. The plot includes points of individual dolphins and mean (± SD) values for Mediterranean and Atlantic groups.

a

b

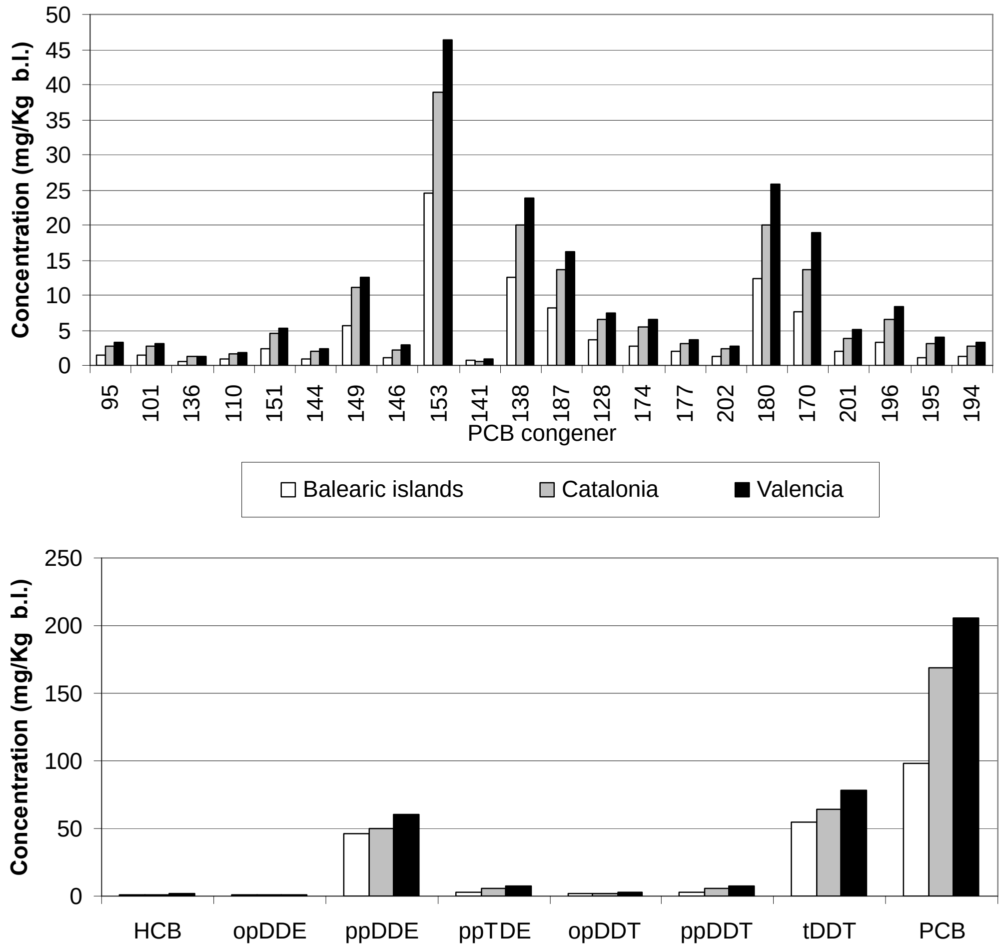


Fig. 4. Comparison between blubber concentration of PCB congeners (a) and the various forms of DDT, tDDT, PCB and HCB (b) in individuals from the different Mediterranean locations

ONE YEAR CETACEAN SURVEY IN THE STRAIT OF GIBRALTAR AND THE COAST OF CEUTA

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Several studies have been done in the Strait of Gibraltar in the last years from whalewatching platforms. These studies show the importance of the area for sperm whale (*Physeter macrocephalus*), common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*), killer whale (*Orcinus orca*) and fin whale (*Balaenoptera physalus*). However, these studies do not give any information about the distribution of the animals. A year long survey has been carried out in the Strait of Gibraltar and along the coast of the Autonomous Town of Ceuta, in the African Continent, between December 2000 and December 2001. A total of 2456.6 nautical miles have permitted an exhaustive knowledge about the temporal and spatial distribution and preferred depth ranges of these species to be gained. Data were analysed using GIS software. To estimate the spatial distribution of the species along the strait, the survey area was divided by 3x3 km grids. The nautical miles were calculated in each grid to normalise the distribution of the species in the area. This survey shows that four species (common, striped, bottlenose dolphins and pilot whales) were seen all year around, sperm whales were seen all year except in autumn, and killer whales were found during the summer in the study area. Pilot whales and sperm whales were distributed at an average depth of 500-700 metres while common dolphins were widely distributed. Striped dolphins and bottlenose dolphins were found mainly at a depth of 400-900 metres. Pilot whales show different spatial distribution throughout the year while sperm whales were found in the same area all year. The study also permitted to investigate problems that affect cetaceans in this area such as the high maritime traffic, and the increase of whale watching companies. The results will help to set up conservation measures in this area.

NEW RESULTS ON THE DISTRIBUTION AND RELATIVE ABUNDANCE OF THE SPERM WHALE IN THE NORTHWESTERN MEDITERRANEAN

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INTRODUCTION Since 1997, four summer surveys have been dedicated to the distribution of sperm whale in the Mediterranean Sea. We present here the results concerning the western Mediterranean basin, north of 38° latitude, including the International Marine Mammals Sanctuary. This protected zone is one of the main productive areas of the Mediterranean Sea, in term of primary production, and is known to host high abundance of cetaceans in summer. Sperm whale is one of the eight common species in this area but its local abundance, relative to other areas of the Mediterranean Sea, is unknown. Our study aimed to define areas of major importance for sperm whale in the western basin as a whole, in order to know whether the Sanctuary is relevant to the species conservation.

MATERIAL AND METHODS The survey area was divided into 6 regions: the northern Tyrrhenian, the Corso-Ligurian, the Provence, the Gulf of Lion, the Baleares and the Central basin. Visual and acoustic surveys were combined along linear transects conducted at an average speed of 5 knots on a 12m motor sailing boat.
Visual survey implied continuous scanning of the sea surface with 3 observers sharing the 180° sector in front of the boat. An index, from 0 (null) to 6 (excellent), was used to report the observation conditions (Gannier, 1998). When sperm whales sighting occurred, the position was logged, the animals were tentatively approached, and pod size was recorded together with other relevant information (animal size, activity, etc...). From these data, the sighting frequency (number of sightings/km of transect) and relative abundance (number of animals/km) were calculated.

Acoustic survey consisted of one minute listening/recording station every 2nm with a towed hydrophone. A dual channel hydrophone (provided by IFAW) was used in 1997, 1999 and 2000 surveys and a mono hydrophone (MAGREC), with similar specifications, during 1998 survey. A high-pass filter was added to remove excessive noise and a Sony TCD 7 DAT was used for recording. At each station the presence/absence of sperm whale was recorded and underwater noise was scored using a 5 level scale (Gordon *et al.* 2000). The successive positive acoustic station were grouped into 'acoustic sequences', as the same sperm whale (or group) could be detected over several stations (Gordon *et al.* 1998). The number of whales detected was estimated by playing back the entire recording sessions of each acoustic sequence. When more than 3 animals were clicking simultaneously, school size estimate was not possible by ear and we considered the minimum pod size of 3 animals. From these data, acoustic frequency (AF: number of acoustic sequence /km of transect) and relative abundance (minimum number of animals/ km) were calculated.

The survey effort represented 6424 km of transect distributed over the 6 regions and a total of 1894 acoustic stations (Table1). The transect lines were divided into 40nm segments (sample unit) for which visual and acoustic variables were computed in every region. Regional comparisons could then be carried out.

RESULTS Sperm whales did not appear to be homogeneously distributed within the regions investigated. Overall, sperm whale groups were detected more frequently in Gulf of Lion and Baleares than in other regions of the basin.

In the regions north of the 41° parallel (northern Tyrrhenian, Corso-Ligurian, Provence, Gulf of Lion), visual and acoustic detection rates tended to increase from eastern to western regions: from low in the Tyrrhenian and Corso-Ligurian sectors (AF of $2.4.10^{-3}$ to $4.79.10^{-3}$/km), sightings and acoustic detections became significantly more frequent through Provence zone (AF of $9.79.10^{-3}$/km) and the Gulf of Lion (Kruskal-Wallis Test: H=8,28, p=0.004, df=1). In these 4 regions, the use of acoustic technique enabled the detection of more sperm whale groups than the visual survey: sightings occurred at a rate of $1.70.10^{-3}$/km to $7.58.10^{-3}$/km (no sighting in the northern Tyrrhenian sector) when $2.4.10^{-3}$ to $1.6.10^{-2}$ acoustic sequences were detected every km on average (Table 2 and 3). In term of number of animals, these regions were characterized by a relatively low abundance of whales seen at the surface, with between 0 and $7.58.10^{-3}$ whales seen/km (Table 2). The group size never exceeded 2 animals, and whales were generally alone at the surface. In the Gulf of Lion, the estimate number of whales detected acoustically markedly exceeded the number of whales observed at the surface ($7.58.10^{-3}$ whales seen/km against $3.80.10^{-2}$ whale heard/km). Thus, although surface observation tended to show isolated animals at the surface, acoustic survey suggested that several whales were present in the same area, at a scale corresponding to our hydrophone range.

In the regions south of the 41° parallel (Baleares and Centre sectors) visual and acoustic results showed reversed trend: with higher values obtained from the visual survey than from the acoustic one, both for detection rates and relative abundances: in the Baleares for example, an average of $9.69.10^{-2}$ whales/km were observed visually while acoustically, 3.34. 10^{-2} whales/km were detected. This difference was particularly obvious in the Baleares, where numerous large groups, up to 7 animals, were observed visually while acoustic estimates were limited to 3 animals. In this region, 80% of the acoustic sequences indicated more than 3 animals clicking simultaneuosly and group size were likely to be under-estimated by acoustics.

DISCUSSION The Corso-Ligurian sector, where the Sanctuary lies, displayed significantly lower detection rates and relative abundance than regions further west. From visual observations and analysis of the acoustic recordings, it appeared that animals in the northern regions were mainly involved in feeding activity, performing cycles of 50min dives and 10min surfacing. The Gulf of Lion was a favoured region: whales observed in this area were mostly adult or sub-adult animals (>12m), involved in prolonged dives (Drouot and Gannier, 2001). No grouping has been observed at the surface, however, the acoustic data indicated clusters of feeding individuals (Drouot *et al.,* 2000). In the continuity of the Gulf of Lion, the Baleares sector showed similarly relative high abundance (visually). In fact, nursery groups, including calves, were observed around the Balearic Islands (Drouot and Gannier, 2001). Thus, the Gulf of Lion would sustain a suitable food chain to support a large relative abundance of sperm whale during summer, when the Baleares appeared to provide the species with both suitable feeding and breeding conditions. The superficial current flows westerly from the Ligurian Sea through the Gulf of Lion and down to the Balearic Islands (Millot, 1987) and might play a major role in the distribution of sperm whale preys. These regional differences in sperm whale abundance might also be related to the topography: the northern Tyrrhenian Sea includes almost exclusively continental shelf and upper slope waters while the Gulf of Lion features several deep sub-marine canyons and the Baleares Islands offer steep continental slopes. The Ligurian Sea encompasses various facies of topography.

This combined survey highlighted respective advantages of the acoustic and visual techniques. In regions such as the Gulf of Lion, acoustic survey substantially increased the number of whales detected on the line transect and allowed the detection of submerged (feeding) whales that would have been otherwise missed by visual observers. However, our method and equipement did not seem to be appropriate in areas where large groups of whales were present and spent longer periods at the surface (without emitting regular clicks): acoustic technique could not replace visual method for estimating large group sizes.

Although, this summer study showed the Sanctuary was not favoured by sperm whales, results from cold seasons may bring important elements to evaluate the role of this protected area in the conservation status of this species.

CONCLUSION This study showed that Mediterranean sperm whales may be better protected by extending effective protection to areas such as the Gulf of Lion and the Baleares Islands, where the species is abundant during summer. The regular presence of new-born calves in the latter region further urges the need for such protective measures.

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Table 1. Distribution of survey effort, as transect length with good observation conditions (index>3) and number of acoustic station in low background noise (underwater noise index<3)

	Transect length (km)	Transect length (km) in I >3	Number of acoustic stations	Number of acoustic station in noise<3	Number of 40nm segments
Tyrrhenian	895	589	234	192	15
Corso-Ligure	2058	1548	584	473	39
Provence	963	583	301	254	36
Gulf of Lion	731	553	244	200	12
Baleares	971	494	274	224	20
Centre	906	450	257	230	16
Total	6524	4219	1894	1573	138

Table 2. Visual survey results: Sighting Rate (number of sightings /km) and relative abundance (number of animals seen /km) of sperm whale in the 6 regions. N refers to the number of 40nm segments

	N	Sighting Frequency	Sd	Relative Abundance	Sd
Tyrrhenian	13	0	0	0	0
Corso-Ligure	33	$1.70.\ 10^{-3}$	$5.71.10^{-3}$	$1.70.\ 10^{-3}$	$5.71.\ 10^{-3}$
Provence	15	$4.59.\ 10^{-3}$	$1.43.10^{-2}$	$5.56.\ 10^{-3}$	$1.54.\ 10^{-2}$
Gulf of Lion	12	$7.58.\ 10^{-3}$	$2.02.10^{-2}$	$7.58.\ 10^{-3}$	$2.02.\ 10^{-2}$
Baleares	14	$2.96.\ 10^{-2}$	$7.29.\ 10^{-2}$	$9.69.\ 10^{-2}$	$2.85.\ 10^{-1}$
Central basin	11	$1.32.\ 10^{-2}$	$3.91.\ 10^{-2}$	$8.43.\ 10^{-2}$	$2.75.\ 10^{-1}$

Table 3. Acoustic survey results: Acoustic Frequency (number of acoustic sequences/km) and relative abundance (number of animals heard /km) of sperm whale in the 6 regions. N refers to the number of 40nm segments

	N	Acoustic Frequency	Sd	Relative Abundance	Sd
Tyrrhenian	13	$2.41.10^{-3}$	$5.89.10^{-3}$	$4.83.\ 10^{-3}$	$1.34.\ 10^{-2}$
Corso-Ligure	33	$4.79.\ 10^{-3}$	$1.24.\ 10^{-2}$	$5.32.\ 10^{-3}$	$1.32.\ 10^{-2}$
Provence	18	$9.79.\ 10^{-3}$	$1.25.\ 10^{-2}$	$1.60.\ 10^{-2}$	$2.45.\ 10^{-2}$
Gulf of Lion	12	$1.69.\ 10^{-2}$	$1.85.\ 10^{-2}$	$3.80.\ 10^{-2}$	$5.39.\ 10^{-2}$
Baleares	19	$1.23.\ 10^{-2}$	$2.98.\ 10^{-2}$	$3.34.\ 10^{-2}$	$8.95.\ 10^{-2}$
Central basin	15	$7.23.\ 10^{-3}$	$2.38.\ 10^{-2}$	$2.17.\ 10^{-2}$	$7.15.\ 10^{-2}$

SOME ASPECTS OF DISTRIBUTION, POPULATION DYNAMIC AND CONSERVATION OF THE HARBOUR SEAL (*PHOCA VITULINA*) IN FRANCE (1989-1999)

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INTRODUCTION First publications about the status of the harbour seal (*Phoca vitulina*) in France describe a group of some individuals in the Somme estuary (eastern French Channel coast) in the 1980's. At the end of the 1980's, the support of the French Department of the Environment to naturalists associations strengthen prospecting seal sites (and also potential sites). This permitted to observe new groups and the development of known colonies (Lastavel, 1996 ; Aubrais, 1990 ; Aubrais *et al.*, 1991 ; Gavory, 1990). This study is the result of an inter-regional co-operation of French organisations working on harbour seals follow-up.

METHOD For this study, data were collected from 1989 to 1999 in several sites all situated along the English Channel and southern North Sea coasts of France (the species is absent on the Atlantic side) and surveys consisted to quantify seals number, pups production and disturbance factors. From north to south, seals groups are located near Calais and Dunkerque and most important ones are found in the Somme estuary, in the Veys estuary and in the Mont-Saint-Michel Bay. Observation effort varied according to the sites. Calais and Dunkerque areas were respectively surveyed occasionally and monthly, seasonally (during the summer) for the Mont-Saint-Michel Bay and weekly for the Veys and Somme bays.

RESULTS AND DISCUSSION Distribution of harbour seals colonies in France The French coasts constitute the southerly distribution area for the harbour seal in Europe (De Jong *et al.*, 1997). Four groups are known to occur along the French Channel coasts. They are from north to south (Fig. 1) :

- Dunkerque and Calais sandbanks
- The Somme estuary
- The Veys estuary
- The Mont Saint Michel Bay

Aspects of population dynamic : evolution of colonies and reproduction Between 1989 and 1999, the average inter-annual evolution of seals number was 24% for the Somme estuary (maximum number of 66 individuals in 1999), 19% for the Veys estuary (max. of 26 ind. in 1999) and 21% in the Mont-Saint-Michel Bay (max. of 23 ind. in 1999) (Table 1; Fig. 2). We can observe the expansion and development of French colonies is simultaneous, but only for the Somme, Veys and Mont-Saint-Michel bays/estuaries (most important groups) (Fig. 2). The other sites (Dunkerque and Calais) are not all year round frequented and maximal numbers do not exceed 7 to 12 individuals. For the inter-annual evolution of seal's number per site, we used maxima occurring in August. This period seems, after Thompson et al. (1997) the most significant for harbour seals populations estimation.

The development ratio estimated for the total population (all sites included) is on increase by 6 (Fig. 3). The Somme estuary sub-population shows the greatest increase, by 7. Since 1994, this area accommodates much as half of the French seals population. In 1989, reproduction was recorded for the first time in the Veys estuary (one birth). Then, this last one, the Somme and Mont-Saint-Michel bays groups are known to produce pups yearly (Fig. 4). Pups production tends to be stabilized since the late 1990's (Table 1). Nevertheless, absolute pups number tends to increase significantly since the early 1990's (R^2=0,82) (Fig. 4).

Some aspects of conservation. The implementation of legal measures in most important sites induces probably colonies development and stabilization (Fig. 2). The Somme and Veys estuaries are, in seal's haul-out sites areas, Nature Reserve but also Z.N.I.E.F.F., Z.S.P. and affiliated to the RAMSAR Convention. The Mont-Saint-Michel Bay is also included in these three last conservation statuses. For Dunkerque site, after 1999, the group of about 4 to 7 individuals have disappeared, probably because of too strong human pressure (Kiszka and Pezeril, in prep.). None conservation measures are effective to contribute to seals protection. In all the French sites, the Habitat Directive could permit the stabilization (at long term) of seals groups.

CONCLUSION In conclusion, we remarked a significant difference between each sites potentiality, depending of sandbanks/estuaries surface and human activity concentration. These variables influencing certainly harbour seals groups densities and population dynamic. The growing of the French harbour seal "population" during these last 10 years reflects simultaneously the European population expansion and habitat protection measures as well as the adoption in France of conservation means - legal and policy -, notably Nature Reserves implementation (in the Somme and Veys bays) and naturalists associations actions. However, European co-operation with adjacent countries could increase the understanding of the French harbour seal meta-population.

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Table 1. Average pup production and inter-annual evolution of French Harbour seals colonies between 1989 and 1999

Sites	AVERAGE INTER-ANNUAL EVOLUTION	Average pups production
Dunkerque-Calais	20%	No reproduction
Somme estuary	12%	24%
Veys estuary	13%	19%
Mont-Saint-Michel Bay	24%	21%
French coasts	14%	21%

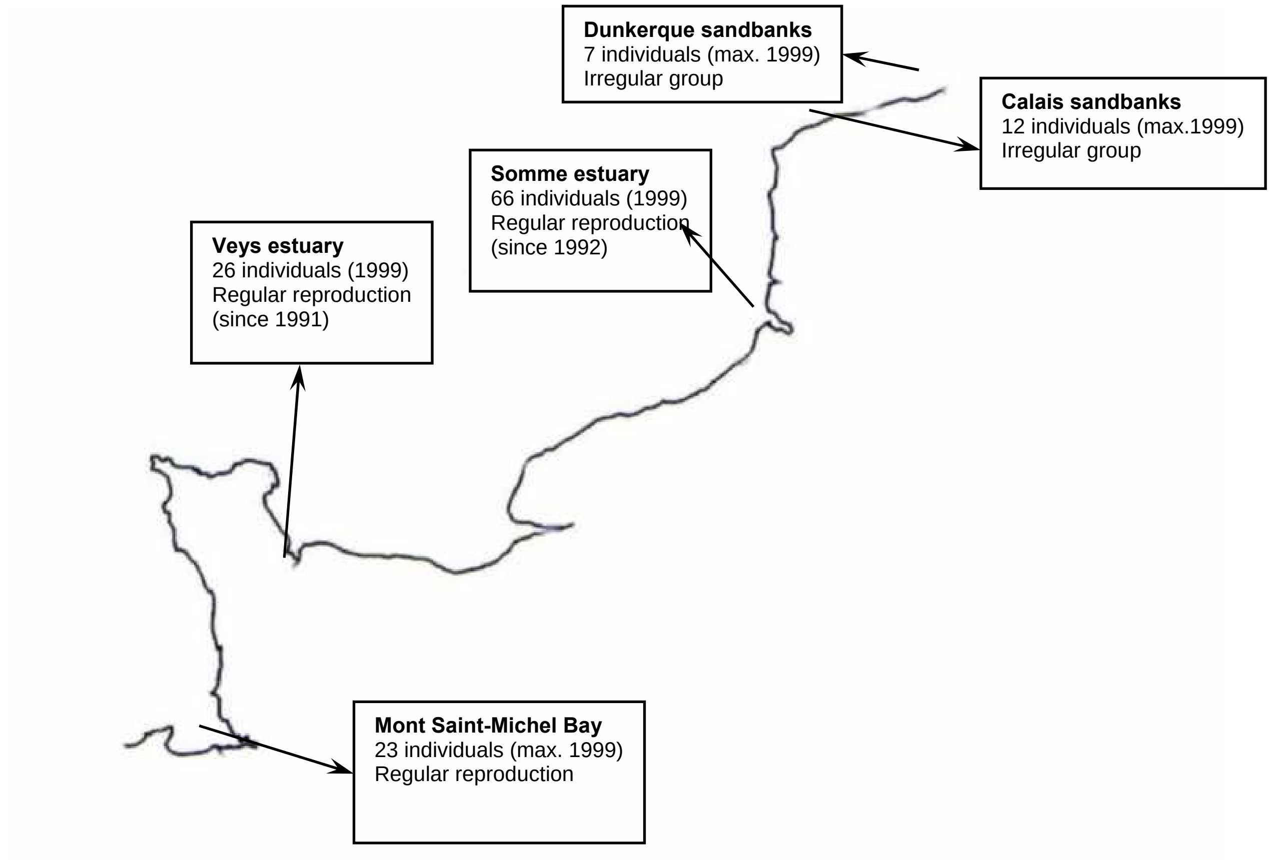

Fig. 1. Map of study area showing harbour seal colonies

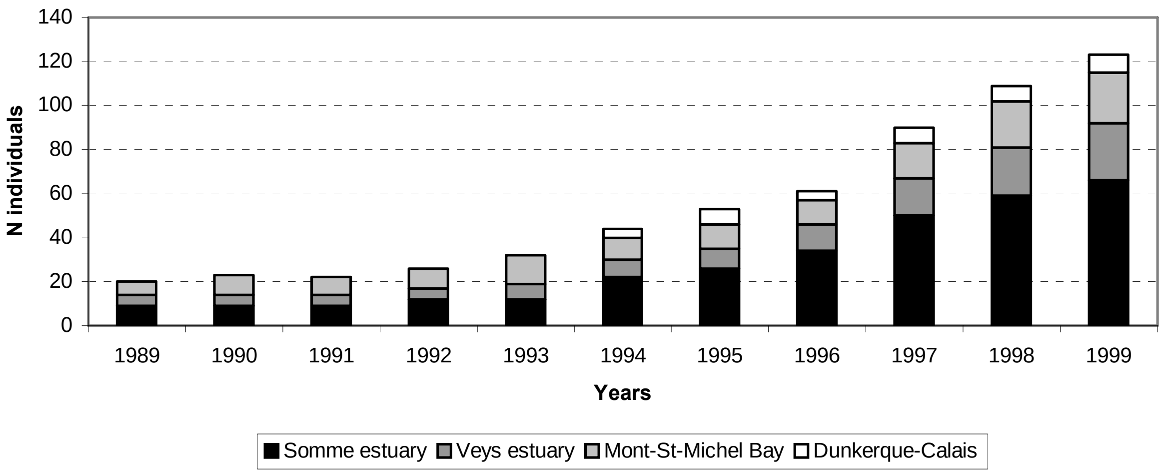

Fig. 2. Inter-annual evolution of maximal numbers of harbour seals in each French sites

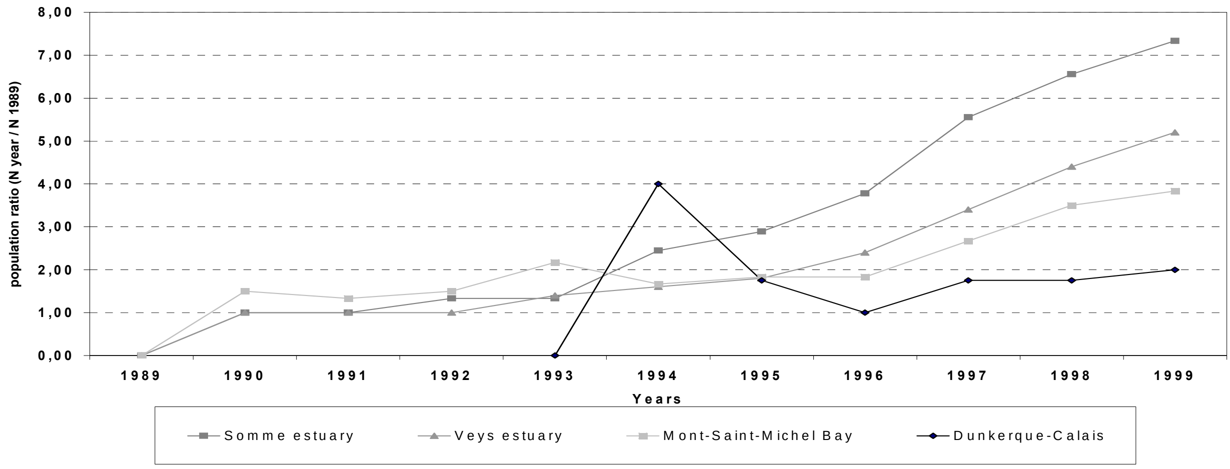

Fig. 3. Population development ratio within the four harbour seal colonies

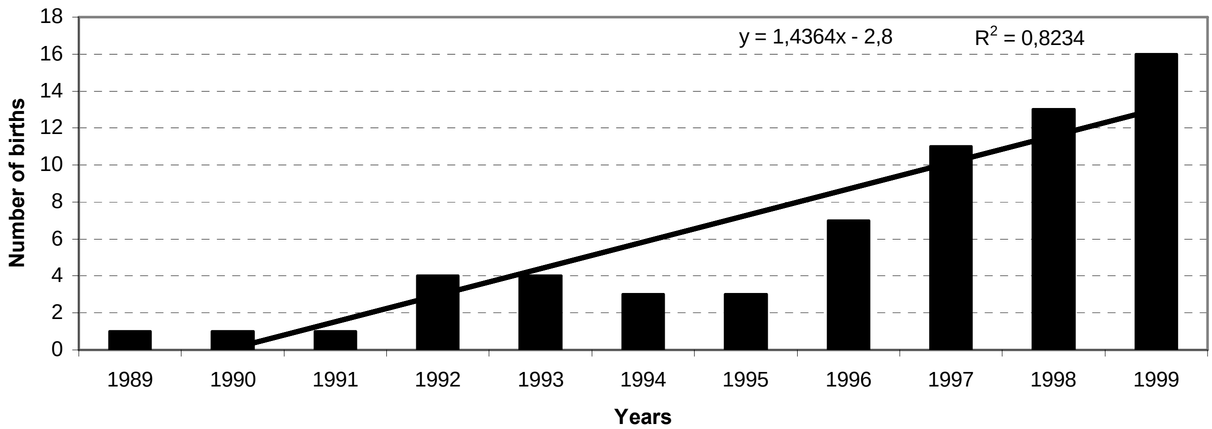

Fig. 4 . Inter-annual distribution of cumulated harbour seal births in all French sites (except Calais-Dunkerque sites) between 1989 and 1999

TEMPORAL VARIABILITY OF SPINNER DOLPHIN RESIDENCY IN A BAY OF TAHITI ISLAND (1995-2001)

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INTRODUCTION Long-beaked spinner dolphins (*Stenella longirostris*) are common delphinids in French Polynesia, ranking first in sighting frequency in the Society Islands (Gannier, 2000). In this archipelago, they use sheltered sites for resting and socializing purposes as was studied by Poole (*unpublished PhD dissertation*) in Moorea Island. They are believed to feed mainly on mesopelagic fishes and squid, during darkness in water 100 to 1500 meter deep. The « Baie des Pêcheurs » is located in the western (leeward) side of Tahiti Island (Figure 1). It is probably the most exposed spinner resting site in French Polynesia, due to anthropic activities on the nearby shore and along the Punaruu River, whose mouth is in the bay. The spinner dolphin presence has been studied here from October 1995 to December 2001.

Study site. The « Baie des Pêcheurs » is located 13km south of Papeete (capital of French Polynesia), along the populated western coast of Tahiti. It is a 1200 x 500 meter gap in the coral reef-lagoon system, with an area of 0.55 km^2. Depth gently increases to 25 meter within the bay and steeply reaches 100 meter in the center part of the bay. Industrial activities are important along the Punaruu River, including an energy plant, a brewery factory and gravel extraction in the river bed. Three international hotels are within 20 minutes of boat ride. The water quality is influenced by swell, river inputs and the current flowing into the bay from the southern lagoon, depending on the southwesterly swell.

MATERIAL AND METHODS 869 shore-based sighting sessions were carried out during the period of study, one observer using 8x25 binoculars from the same sighting site. They commonly lasted 5 or 10 minutes and took place from 6:30 to 16:00 local time. Several environmental parameters were recorded, mostly using semi-quantitative variables:

- cloudiness (index 1 to 5)
- water turbidity (index 1 to 5 relating to the proportion of the bay area occupied by turbid waters)
- current intensity (index 1 to 3 relating to the current outflowing from southern lagoon, Figure 1)
- swell (index 1 to 5, 1 being unconspicuous swell and 5 being swell height over 2 meter)
- sighting conditions index (3 to 6, 6 being perfect and 4 being the low limit for effective sighting)

The presence/absence of the dolphin was noted together with the following variables on dolphin position, spatial structure and activity pattern:

- radial position in the bay (related to six conspicuous locations on the shore)
- distance to shore (eye estimate, refered to one mooring buoy 500 meter from shore)
- minimal and maximal estimates of school size
- school structure (grouped, spreaded, sub-groups)
- surface activity (active, resting, coherent swimming, interactive behavior)
- number of breaching events (standardized for a 5 minutes period)
- number of boats visiting the dolphins at close distance

Residency rates were computed from presence/absence recordings (as frequency of presence). Different time strata were considered:

- time of the day (to establish the duration of daily residency)
- month (to obtain monthly average residency rates)
- year (over 12 months except for 1995)

Other sighting parameters were analysed:
- minimal and maximal school sizes (by year and month, only for sighting condition index >4))
- mean distance to shore (by hour and year)

To compare residency rates, T-test were made assuming a normal distribution for parameters
$(p\ ;\ [(p)(1-p)/(n-1)]^{0.5})$, with p the residency rate for the whole period .

RESULTS A total 804 sighting sessions were performed with good sighting conditions and showed an average morning residency rate of 72.8% with school sizes (Smin-Smax) ranging from (10-20) to (120-200). Dolphins generally stayed slightly beyond the limit of turbid waters caused by the river flow, which is often kept within 300 meter from shore by the outflowing lagoon current. Average distance from dolphins to shore generally varied from 350m to 550m (Fig.1), with a global increase from early in the morning (before 9h00) to noon (11h00-13h00).

Dolphins were found farther offshore in 1999 compared to 1998 (ANOVA, $F=14.9$, $p>0.995$), with a mean distance of 527m in 1999 against 403m in 1998 ($T=3.95$, $p>0.995$) and 327m in 2000 ($T=5.96$, $p>0.999$) (Table 2 and Fig. 1). In average, their residency rate decreased from 78.4% (8h01-9h00 period) to 28.6% (15h01-16h00), showing a plateau around 75% up until 11h00 (Fig. 2). The hourly residency rate thus indicated that spinner dolphins started to leave the site from 11h00. This is in agreement with the increase of distance to shore shown above.

Monthly residency rates taken before 11h00 were higher from June to October, with frequencies over 80% (Table 1) and lower from December to April (less than 70%), with signifant difference (T-test; $p>0.95$) between March ($f=65.3\%$) and October ($f=83.3\%$). Yearly residency rates showed a near-significant dissimilarity with a value of 63.3% in 1999 (Table 2), compared to other annual rates of 72-76% and in particular 1998 and 2000 (T-test; $p>0.90$).

School size estimates varied daily from 10-20 and 120-200. Monthly averages of school size showed heterogeneity (ANOVA; $F=2.96$; $p>0.99$) with lower estimate in April and August.Yearly average estimates of mini and maxi school sizes showed respective ranges of 30.0-42.0 and 48.6-70.6, respectively (Table 3). In both cases, the 1999 average was the lowest estimate, significantly different from either 1998 or 2000 estimates (T-test; $p>0.99$).

DISCUSSION Much variable school size ranges showed that the « Baie des Pêcheurs » resting site is not frequented by a dedicated group of spinner dolphins, but by an agregation of individuals. This is to be related to the recognized social structure fluidity of this species demonstrated in Hawaii (Perrin and Gillpatrick, 1994). Lower school sizes in April and October do not relate apparently to the reproduction cycle.

The decrease of the residency rate from the morning (8h00-11h00) to the afternoon and the parallel increase of distance to shore showed that dolphins leave the resting site between 11h00 and 16h00. Limited data also show they can enter the bay as soon as the sunrise (5h45 to 6h30) and they were sometimes observed -by boat- feeding 1-3km offshore 2 hours before sunset (*unp. data*). However factors influencing the duration of resting in the bay are not presently known. Lower monthly residency rate in December-April coincide with the apparent calving period and the warm (SST = 28°C-30°C) and rainy season.Convergent signs showed that spinner dolphins has been less present in the site during 1999: average residency rate fell to 64.5%, mean distance to shore augmented to 527m and lower mean school sizes were observed. El Nino event affected French Polynesia from mid-1998 to mid-1999, with effects on sea surface temperature and unknown influence on pelagic higher trophic levels. The Punaruu River and « Baie des Pêcheurs » were exposed to an unusually strong rain episode in December 1998, which significantly altered water turbidity for several months. It is not known if spinner dolphins directly reacted to water turbidity in the resting site or were influenced by changes in prey availability in their nearby feeding areas.

CONCLUSION Our study showed that dolphin sensitivity to the resting site « quality » may be high. This quality is influenced by antropogenic activities: turbidity suffer from industrial activity along the Punaruu valley, and concern rises regarding higher exposure to dolphin-watch boats (affecting 13% of sightings in 1998, 21% in 1999 and 44% in 2000). Both types of potential disturbance are now under scrutinity.

ACKNOWLEDGEMENT Thanks to Stéphane Bourreau (Centre de Recherche sur les Cétacés) for dealing with the difficult task of poster editing.

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Table 1. Monthly residency rate 1995-2001 (calculated before 11h00)

Month	sample size	dolphin presence	residency rate
Jan.	75	53	0.707
Feb.	78	54	0.692
Mar.	72	47	0.653
Apr.	75	54	0.720
May	66	51	0.773
June	49	42	0.857
July	24	24	1.000
Aug.	23	21	0.913
Sep.	61	48	0.787
Oct.	42	35	0.833
Nov.	52	41	0.788
Dec.	69	49	0.710

Table 2. Yearly residency rate and mean distance to shore (*data for 1995 is for Oct.-Dec. period)

Year	sample size	residency rate %	average Dshore (m)	SE Dshore
2001	127	86.6	384.6	138.7
2000	71	75.0	325.3	84.6
1999	79	63.3	525.4	93.1
1998	132	72.9	400	187.7
1997	87	73.6	355.7	237.8
1996	58	75.9	307.4	149.2
1995 *	44	88.6	365	153.9

Table 3. Yearly estimates of mean school sizes Smin and Smax

Year	sample size	Smin	Smin range	SE Smin	Smax	Smax range	SE Smax
2001	124	39.70	10-120	21.20	70.60	20-200	33.60
2000	68	41.10	8-100	19.90	65.20	15-130	27.80
1999	69	30.00	5-60	11.90	48.60	15-100	18.50
1998	93	38.90	5-100	16.70	62.30	20-150	24.70
1997	55	42.00	20-100	16.60	69.20	30-130	20.90
1996	35	32.80	8-60	13.20	59.50	15-100	19.60

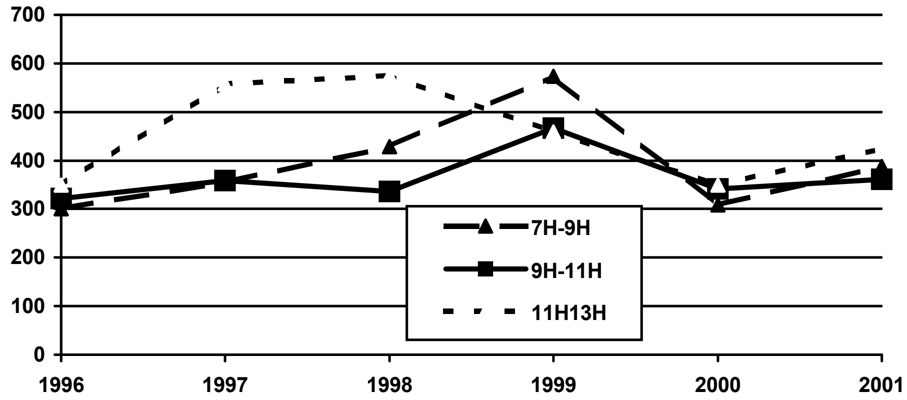

Fig. 1. Distances from shore (m) with year and time

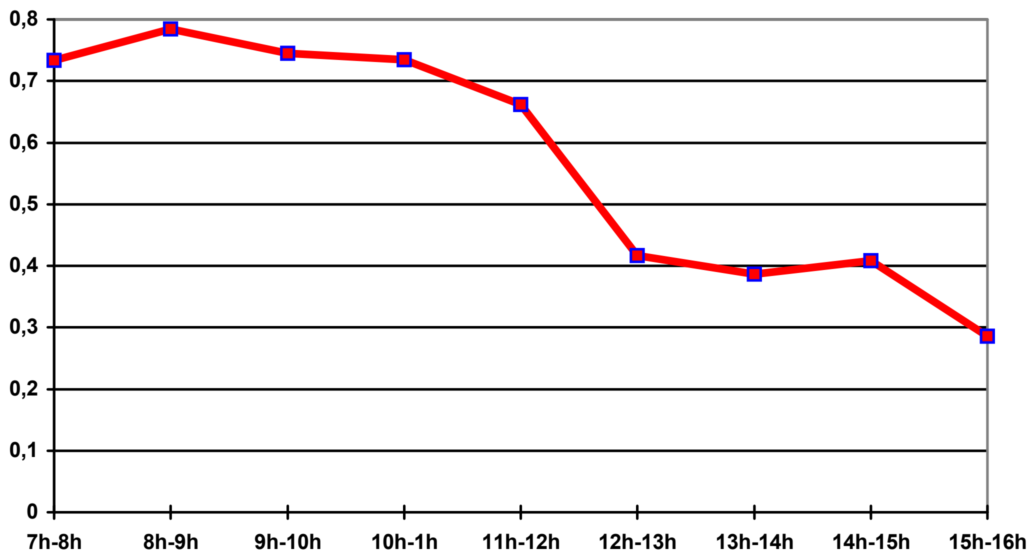

Fig. 2. Residency rate with time of day

REVIEW OF 20 YEARS OF OCCASIONAL CETACEANS SIGHTINGS OFF THE FRENCH CHANNEL COAST (1980-2000)

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INTRODUCTION The English Channel is a relatively shallow stretch of sea in the North Atlantic extending from the south coast of England to the north coast of France. This junction area between the North Sea and the Atlantic Ocean is highly exposed to human activities such as fishing and commercial shipping traffic. This study compiles and analyses 21 years of occasional cetacean sightings data (1980 – 2000) collected between the Franco-Belgian coast and the northern Brittany (area located between 51°00'N-48°00'N in latitude and 06°00'W-02°00'E in longitude) (Fig. 1). This study is a preliminary investigation of cetaceans off the French coast in the English Channel.

MATERIAL AND METHOD Data were collected between 1980 and 2000 by various French institutes working on marine mammals in this area, stretching from northern France to Brittany : the "Coordination Mammalogique du Nord de la France" (Nord-Pas-de-Calais-Picardy region), the "Groupe Mammalogique Normand" (Normandy region) and the Laboratory of Marine Mammals Studies, OCEANOPOLIS (Brittany region). Observations were carried out near "sea users" (fishermen, yachtmen) or from naturalists such as ornithologists and marine mammalogists. The analyse presents sightings distribution and occurrence.

RESULTS Between 1980 and 2000, 1,356 sightings data involving ten cetacean species were recorded off the French Channel coast, they are in order of occurrence : Bottlenose dolphin (*Tursiops truncatus*), Long-Finned pilot whale (*Globicephala melas*), Common dolphin (*Delphinus delphis*), Harbour porpoise (*Phocoena phocoena*), Risso's dolphin (*Grampus griseus*), Killer whale (*Orcinus orca*), Striped dolphin (*Stenella coeruleoalba*), White-beaked dolphin (*Lagenorhynchus albirostris*), Sperm whale (*Physeter macrocephalus*) and Minke whale (*Balaenoptera acutorostrata*) (Table 1).

There is a heterogeneous inter-annual sightings distribution between 1980 and 2000 (Fig. 2). In addition, despite an all year round sightings distribution, there is a significant increase in data number during the summer months, especially in August (Fig. 3). Spatial distribution of the data shows a substantial opposition between the two areas (east and west) (Fig. 4), especially for Bottlenose dolphins, Common dolphin and Risso's dolphins.

The encountered species *Tursiops truncatus* (n=1,031 data; 76%) is the most encountered species, this number does not include either the data collected during the study of the group of about 60 individuals present in the archipelago of Molene (Brittany) (Guinet et al., 1993 ; Ridoux et al., 2000) or the data from the group of 100 individuals present in the Normandy region (western part of the Cotentin peninsula) (Pineau et al., 2000). There is an occasional presence in the eastern part of the Channel, especially during the summer. This summer occurrence tends to increase since the early 1990's (Collet et al., 1994).

Globicephala melas (n=123; 9.1%). Most sightings are concentrated in the Normandy region (Channel Islands, Eastern Seine estuary and Northern Cotentin peninsula) and in Western Brittany. The monthly distribution of data shows a seasonal presence (83%) (summer and early autumn).

Delphinus delphis (n=83; 6.1%). 91.6% of the data are located off the western area of the French Channel coast, mainly during the summer. The common dolphin is rarely encountered in the eastern area.

Phocoena phocoena (n=47; 3.5%) is still uncommon in coastal waters except in northern France (72.3% of all data). Scarce sightings off Normandy (n=11) and Brittany (n=4).

Grampus griseus (n=44; 3.2%) is considered as absent in the eastern part of the Channel (Collet *et al.*, 1994) but frequently observed in the western area during the summer months, off the northern Brittany coast and in the Normano-Breton Gulf. There is a presumed summer site in the western Mont-Saint-Michel Bay (Beaulieu, 1996; Hussenot, 1985).

Orcinus orca (n=10), *Stenella coeruleoalba* (n=7) and *Lagenorhynchus albirostris* (n=5) are occasional species and observations are probably the result of erratic group dispersion. White-beaked dolphins appear to be regular in northern France during winter (Kiszka, 2001 ; Tavernier, pers. com.).

Physeter macrocephalus (n=3) and *Balaenoptera acutorostrata* (n=3) are considered as incidental species except for Minke whale which appears common in the western English Channel, especially during the summer (Brereton & Williams, 2001) and despite our three records.

DISCUSSION AND CONCLUSION This study reveals the limits of the use of occasional observations. Indeed there is a decrease in the number of sightings after 1992. This could indicate a lower number of cetaceans but it could also point to a decrease in observational effort (not quantified) if the observers are not regularly approached. The winter data may also be underestimated as observations are easier to undertake in the summer and recreational sailing activities increase during this period. Despite these limits, the English Channel and especially the French coastal waters seem to constitute an important area for a great number of cetacean species at different levels according to the exceptionally high occurrence of some of them. In fact, there are resident groups of Bottlenose dolphins and for other species, it is a seasonal foraging area. As the western part of the Channel is open to the Atlantic Ocean, the oceanic species such as Common dolphins, Long-finned pilot whales and Risso's dolphins can easily make incursions in their hunt for preys. Even though it is difficult to implement these occasional observations in order to monitor the precise abundance, occurrence and distribution of cetaceans off the French coast in the English Channel (wrong species identified and no quantified/regular observational effort). These data, however, help to define particular locations for cetaceans and more accurate studies should be carried out within a scientific protocol.

In conclusion, it is important that French marine mammalogists implement and manage more cetacean surveys and take part in greater regional/international co-operation.

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Table 1. Number and percentage of data for each species collected from 1980 to 2000.

Species	N data	%
Tursiops truncatus	1031	76
Globicephala melas	123	9,1
Delphinus delphis	83	6,1
Phocoena phocoena	47	3,5
Grampus griseus	44	3,2
Orcinus orca	10	0,7
Stenella coeruleoalba	7	0,5
Lagenorhynchus albirostris	5	0,4
Physeter macrocephalus	3	0,2
Balaenoptera acutorostrata	3	0,2

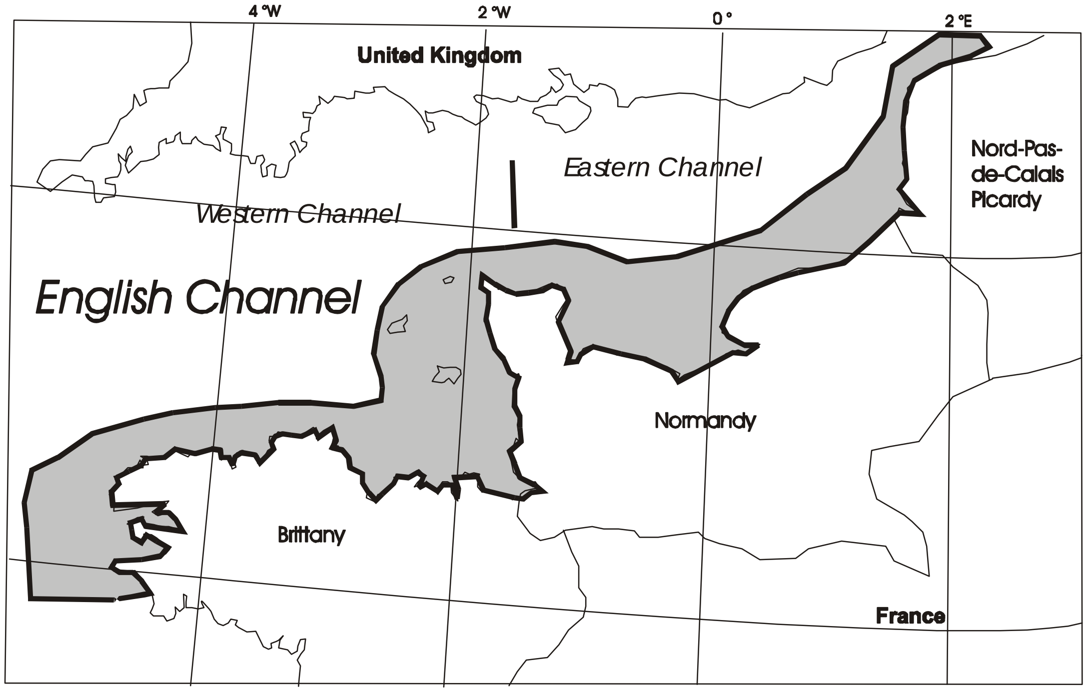

Fig. 1. The study area (grey area)

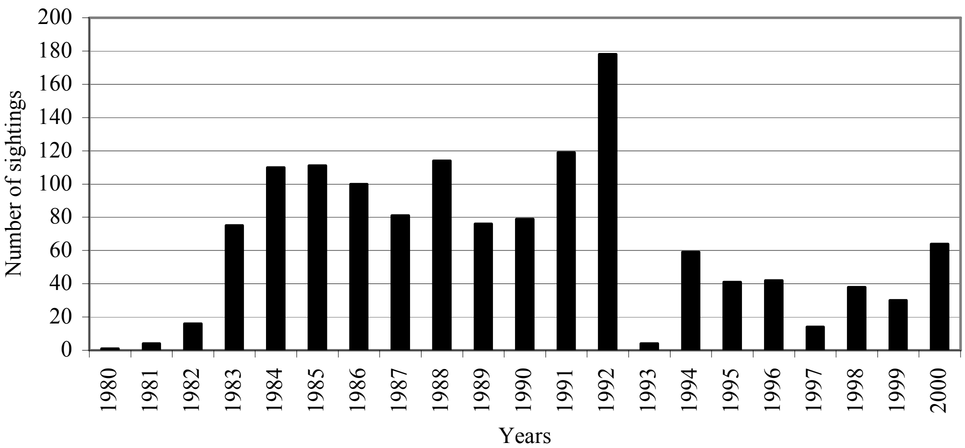

Fig. 2. Inter-annual distribution of occasional cetaceans sightings data (n=1,356) collected between 1980 and 2000 off the French coast in the English Channel

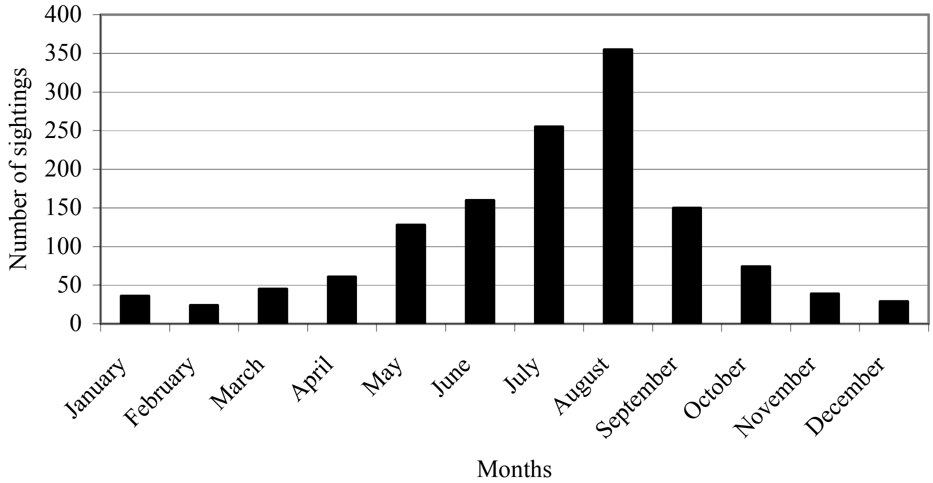

Fig. 3. Monthly distribution of occasional cetacean sightings data (n=1,356) collected between 1980 and 2000 off the French coast in the English Channel

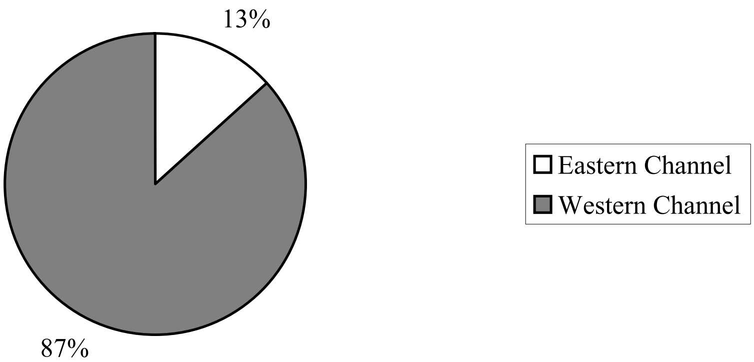

Fig. 4. Occurrence of cetacean sightings (n=1,356) off the Eastern and Western parts of the French Channel coast between 1980 and 2000

AN ANALYSIS OF DOLPHIN OCCURRENCES (GENERA *LAGENORHYNCHUS*, *TURSIOPS*, *DELPHINUS*, AND *STENELLA*) IN THE BALTIC SEA FOR THE PERIOD 1840-2001

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Available records on stranded, directly caught and incidentally by-caught as well as sightings of dolphins (Genera Lagenorhynchus, Tursiops, Delphinus, and Stenella) were reviewed to elucidate the temporal, seasonal, and spatial occurrence of these cetaceans in the entire Baltic Sea including the Kattegat for the period 1840 to 2001. Five species were identified with the white-beaked dolphin (*Lagenorhynchus albirostris*) as the most common species. The white-sided dolphin (*Lagenorhynchus acutus*) was the second most frequent species by number of individuals, but records cluster strongly around 1942 and the inner Danish waters with only a single genuine Baltic occurrence. The bottlenose dolphin (*Tursiops truncatus*) in third position exhibited a more even distribution over the entire period. Common dolphins (*Delphinus delphis*) and striped dolphins (*Stenella coeruleoalba*) in fourth and fifth position, respectively, may be considered "oceanic" indicators and their occurrence likely relates to salt water intrusions into the Baltic Sea. The striped dophin was documented from the area for the third year in a row (1999-2001). The geographical distribution of the records exhibited a decline from the Kattegat over the central Baltic Sea to the Bay of Bothnia and Finland in accordance with hydrographical barriers within the Baltic Sea.

SEASONAL DISTRIBUTION AND MOVEMENTS OF LONG-FINNED PILOT WHALES (*GLOBICEPHALA MELAS*) IN THE BAY OF BISCAY (FRANCE)

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INTRODUCTION Long-finned pilot whales (*Globicephala melas*) are considered as ubiquitous and common in cold and temperate waters of the North Atlantic and in the Southern Hemisphere (Mitchell, 1975). Yet, because of their generally offshore habits (Desportes, 1983), their use of marine habitat is still little known. We investigated pilot whales seasonal use of the Bay of Biscay by comparing aerial surveys carried out all year round by the French Customs and by the systematic winter aerial survey ROMER (*Recensement Oiseaux de MER*). At a smaller scale, photo-identification surveys carried out in the *Pertuis Charentais* area provided an insight into the routine nature of seasonal movements of pilot whales.

MATERIALS AND METHODS All the observations collected in the Bay of Biscay are the result of aerial surveys. First, custom aerial surveys were conducted all year round from 1980 to 2001 with a more consistent effort in areas figured with cells (Fig. 1 and 3). Secondly, sightings from the aerial survey ROMER have been made from October 2001 to March 2002, using a line transect method from the coast to the shelf-edge (-200 meters) operating 150 meters above sea surface at a constant speed of about 150 km/h (Fig. 2, shown as white tracks). Density indices (DI) resulting from the number of observations divided by the effort are displayed using Geographic Information System.

Taking advantage of the presence of long-finned pilot whales in the coastal *Pertuis Charentais* area (46°00'N, 01°10'W), dedicated boat surveys were carried out from 1997 to 2001 and photo-identification was undertaken during this period.

RESULTS AND DISCUSSION Although long-finned pilot whales are present all year round from the continental shelf to slope waters, the sightings from aerial surveys show that they concentrate along the shelf-edge (Fig. 1 to 3). This area is known to be a preferential habitat for cetaceans (Kenney and Winn, 1986), possibly linked to the availability of prey (*fide* David, 2000). Moreover present data suggest that pilot whales would move along the shelf-edge. Indeed, animals are particularly observed at the Capbreton trough in the winter (Fig. 1 to 2) and in the south of Brittany in the summer (Fig. 3). Nevertheless knowledge is still insufficient to assert such seasonal movements.

From sightings of yachtsmen and fishermen, pilot whales are also known to move in some coastal areas, like the *Pertuis Charentais*. From 32h40 of dedicated surveys in this area, we found that the species make short visits to these shallow waters from May to September. Photo-identification allowed the identification of 34 individuals. It also revealed a high inter-annual fidelity with 80% of individuals re-sighted at least once and an average of 1.65 (sd = 1.54) re-sighting per individual (Tab. 1). This site fidelity could be explained by trophic factors (Van Canneyt *et al.*, 1999) and perhaps by use of this coastal place as a calving site, as suggested by observations of very young calves.

CONCLUSIONS On the one hand, this study has revealed a high presence of pilot whales along the shelf-edge and on the other hand, it has suggested seasonal movements. These movements may result from trophic factors, with individuals moving according to seasonal resource variations. They should be part of group culture. This latter aspect is substanciated by the high inter-annual site fidelity observed in the *Pertuis Charentais* area, suggesting that seasonal movements are part of routine habitat use rather than of opportunistic movements. A photo-identification catalogue for the Bay of Biscay would allow us to examine large-scale movements in more detail.

ACKNOWLEDGEMENTS Many thanks are due to Custom Aerial Survey, Observation network (yachtmen, fishermen…) and Vincent Bretagnolles (ROMER).

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Table 1: A survey-by-survey summary of the presence of identified individuals

Individus	20/08/97	20/07/98	26/07/99	12/05/00	25/07/00	26/07/01
Gm 001						
Gm 002						
Gm 003						
Gm 004						
Gm 006						
Gm 007						
Gm 008						
Gm 011						
Gm 012						
Gm 014						
Gm 015						
Gm 018						
Gm 020						
Gm 022						
Gm 025						
Gm 026						
Gm 027						
Gm 029						
Gm 032						
Gm 033						
Gm 034						
Gm 035						
Gm 036						
Gm 037						
Gm 038						
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Gm 041						
Gm 042						
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Gm044						
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Gm046						
Gm047						

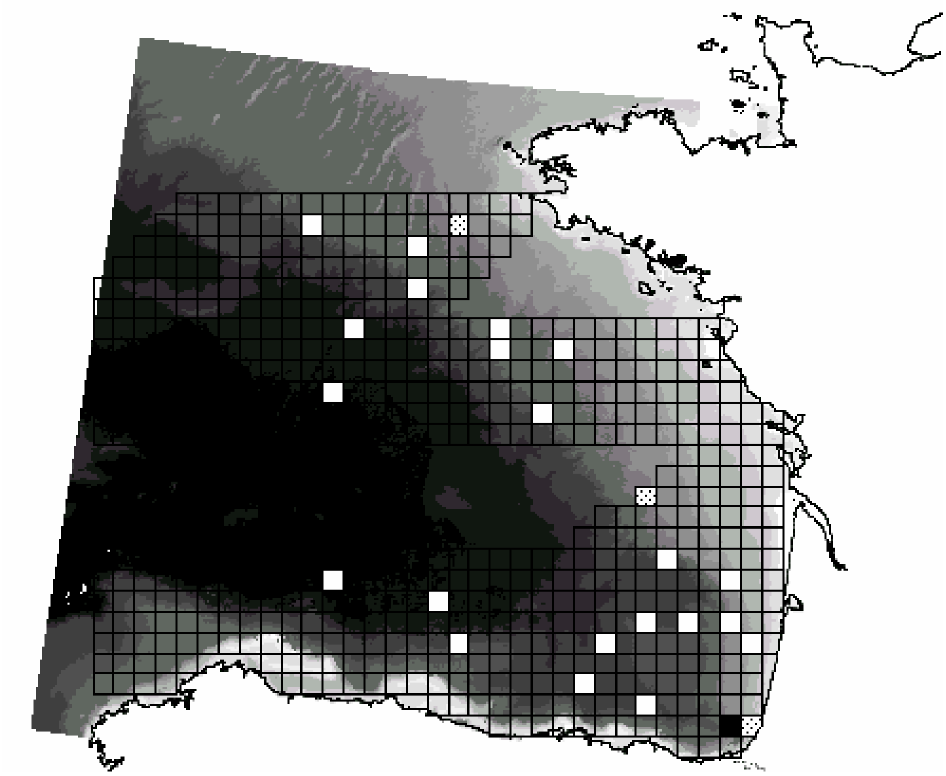

Fig.1. Custom Aerial surveys in the winter (n=50)

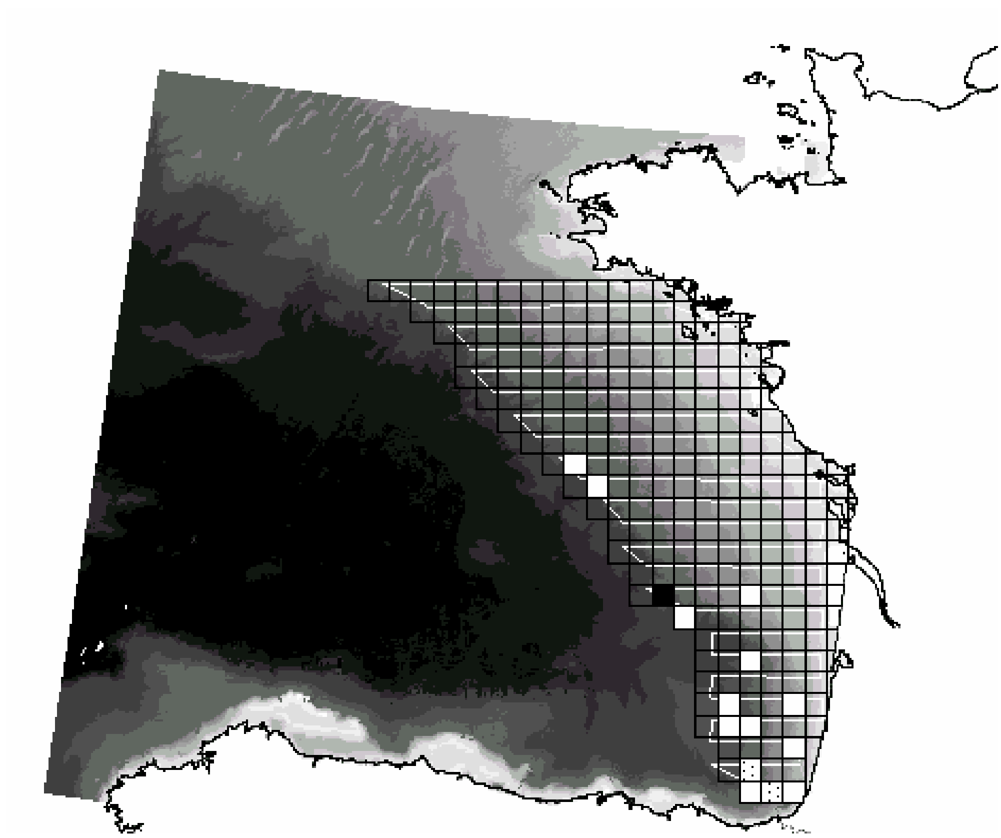

Fig. 2. ROMER surveys in the winter (n = 21)

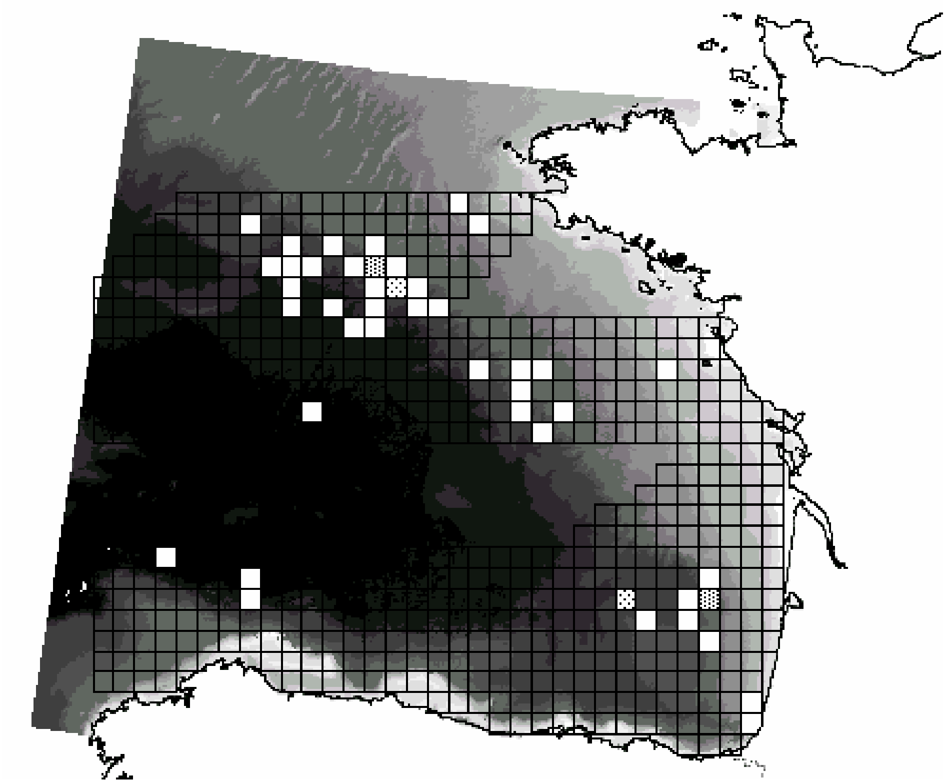

Fig. 3. Custom Aerial surveys in the summer (n=64)

Figures 1 to 3 : Distribution of *Globicephala melas* in the Bay of Biscay according to Density Indice (DI) in cells of 20 km x 20 km : DI = (observations / effort) x 100.

Legend :		
	DI = 0	2.01 < DI < 3
	0.01 < DI < 1	3.01 < DI < 4
	1.01 < DI < 2	4.01 < DI < 5

THE OCCURRENCE AND DISTRIBUTION OF CETACEANS EAST OF GREAT ABACO ISLAND, THE BAHAMAS, IN SUMMER MONTHS BETWEEN 1998 AND 2001

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The Bahamas is an oceanic archipelago characterised by a number of shallow banks (less than five meters depth) surrounded by very deep oceanic waters (up to 4000 meters depth) with little or no associated shelf area between these two extremes. As a result oceanic cetaceans are found close to shore making it relatively easy to study their occurrence and distribution using small research vessels (under 10 meters). This project studied the occurrence and distribution of oceanic cetaceans east of Great Abaco Island the northern Bahamas in the summer months (May to August) between 1998 and 2001. The overall occurrence of cetaceans within the study area was low in comparison to other parts of the world. However, 11 species of cetacean were encountered during the study. Four of these species occurred with sufficient frequency to allow a comparison to be made between the distribution of these species. The distribution of Blainville's beaked whale (*Mesoplodon densirostris*), dwarf sperm whales (*Kogia simus*) and Cuvier's beaked whale (*Ziphius cavirostris*) were all found to be associated with waters of particular depth, with K. simus being found in the shallowest water and *Z. cavirostris* in the deepest. *M. densirostris* occurred in water depths between these two extremes. In contrast, the distribution of the Atlantic spotted dolphin (*Stenella frontalis*) was not found to be associated with any particular water depth. From this we conclude that *S. frontalis* occupies a epipelagic niche in the study area, while the remaining three species occupy separate but overlapping benthopelagic niches. As with many tropical areas, the waters of the Bahamas are characterised by low overall productivity and niche separation between these species may allow these species to co-exist without undue competition.

DISTRIBUTION AND OCCURRENCE PATTERNS OF CETACEAN POPULATIONS IN TWO ISLANDS OF THE AZOREAN ARCHIPELAGO - PICO AND FAIAL

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INTRODUCTION Although usually characterised as low productive, waters around the Azores archipelago present a high abundance and diversity of cetaceans. Until now 21 cetacean species are confirmed, although the occurrence of a total of 26 different cetacean species is possible (Reiner *et al*., 1993; Steiner, 1995; Gonçalves *et al*., 1996; Simas *et al*., 199). The distribution and occurrence patterns of cetacean populations in the archipelago are poorly known. The only systematic studies were conducted by IFAW between 1987 and 1998, but this information is only available as unpublished reports.

MATERIALS AND METHODS Land-based observations and nautical surveys were carried out during March-October 1999 and January-October 2000 in the coastal areas of Faial Island, Azores.

Systematic land-based observations were carried out in two high vantage points located in Faial Island (*ca*. 85m and 120m high), with use of a high power binocular telescope to search an area up to 7nm.

Boat-based observations were conducted onboard an inflatable in two different ways: (1) systematic nautical surveys along predetermined transects at a constant speed of *ca*. 15kn and (2) non-systematic observations dependant on directions given by a land-based observer located on the south of Pico Island, without observation effort.

A sighting index was calculated (derived from systematic land and boat-based observations only) to investigate seasonality and habitat use with the study area, and corresponds to the number of sightings per hour of observation. For this purpose, the study area was arbitrarily dived into 4 sub-areas: Faial-Pico channel, north of Faial, south of Faial and south of Pico.

RESULTS A total of 334h of observations were carried out in 123 days from March-October 1999 and January-October 2000. Systematic land and boat based observations correspond to 56% of the overall observation effort (186h of effective effort).

Small delphinids preferred the Fail-Pico channel and were mainly sighted in areas of 200 to 800m deep (Fig.1.) Sperm whale sightings were concentrated in the area south of Pico between 500 and 1500m in depth.

The sighting index varied significantly amongst seasons with the highest peaks in winter (0.97) and spring (0.88). Besides the number of sightings, species diversity also varied throughout the year. *D. delphis*, *T. truncates* and *P. macrocephalus* were sighted in all seasons. Baleen Whales were sighted only between January and June (Fig. 2.)

The sightings index showed that the most used areas were the Pico-Faial channel (0.97), followed by the north of Faial (0.67) and the south of Pico (0.56) (Fig.3.). For *D. delphis* the most important areas were, in decreasing order, Faial-Pico channel, north off Faial, south of Faial and south of Pico. *T. truncatus*seemed to prefer the areas near the Faial-Pico channel, followed by the south of both islands. Contrarily to these two species, all the other species seemed to occur more frequently in the south of Pico and north of Faial.

DISCUSSIONS AND CONCLUSIONS The common-dolphin, bottlenose-dolphin and sperm whales were the 3 species most frequently observed and constituted 75% of the overall sightings. This is in accordance with previous studies (Mendes *et al*., 1999; Simas, 1999).

Within the study area some zones were frequently more visited by cetaceans or had a higher relative abundance. The Faial-Pico channel and the south of Faial were, respectively, the most and the least frequented areas. Different species used diverse zones with different intensities.

The common dolphin presented a wider distribution that the bottlenose dolphin, but both preferred the Faial-Pico channel. Although some studies show that odontocete species seem to exhibit little spatial overlap (Silber *et al*., 1994; Smith & Whitehead, 1999), the channel appears to combine two important aspects: it seems to be a good candidate for upwelling events and its strong currents may facilitate food intake by small delphinids, being energetically advantageous.

The Sperm whale occurred preferably in south of Pico Island in areas where the depth varies between 500 and 1500m. The occurrence of this species in these depths is largely documented and is generally associated with its feeding habitats (Evans, 1987).

Our results point towards a seasonal variation in cetacean abundance. The common dolphin, bottlenose dolphin and sperm whale occurred all year around suggesting that some individuals or groups might be resident in the study area. Baleen whales were only sighted between January and June suggesting that they were passing by on their migration routes. This is in accordance with the seasonality described for the periodical large-scale movements of baleen whales (Evans, 1987). The seasons of winter and spring presented the highest number of taxonomic groups, being the passage of the latter contribution to this result.

ACKNOWLEDGEMENTS We would like to thank Mr. Antero Soares for his help on the south Pico lookout. This work was partly funded by the EU Project LIFE98NAT/P/5275 and by the Azorean Regional Tourism Directorate. We thank Carlos Guerra, President of the Institute for Nature Conservation (Portugal) for allowing Mónica A. Silva to participate in this study.

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Table 1: Number and total percentage of cetacean sightings occurred during overall boat and land-based observations.

Species	N total sightings	% total sightings	N total individuals
Delphinus delphis	119	40.5	2109
Tursiops truncatus	62	21.1	619
Physeter macrocephalus	37	12.6	124
Balaenoptera musculus	8	2.7	12
Grampus griseus	8	2.7	86
Stenella frontalis	6	2.0	164
Globicephala sp.	6	2.0	67
Balaenoptera physalus	5	1.7	10
Balaenoptera borealis	4	1.4	26
Mesoplodon sp.	3	1.0	7
Pseudorca crassidens	2	0.7	55
Stenella coeruleoalba	1	0.3	1
Megaptera novaeangliae	1	0.3	1
Balaenoptera sp.	4	1.4	4
Delphinidae	21	7.1	122
Unidentified	7	2.4	7
Total	**294**		**3414**

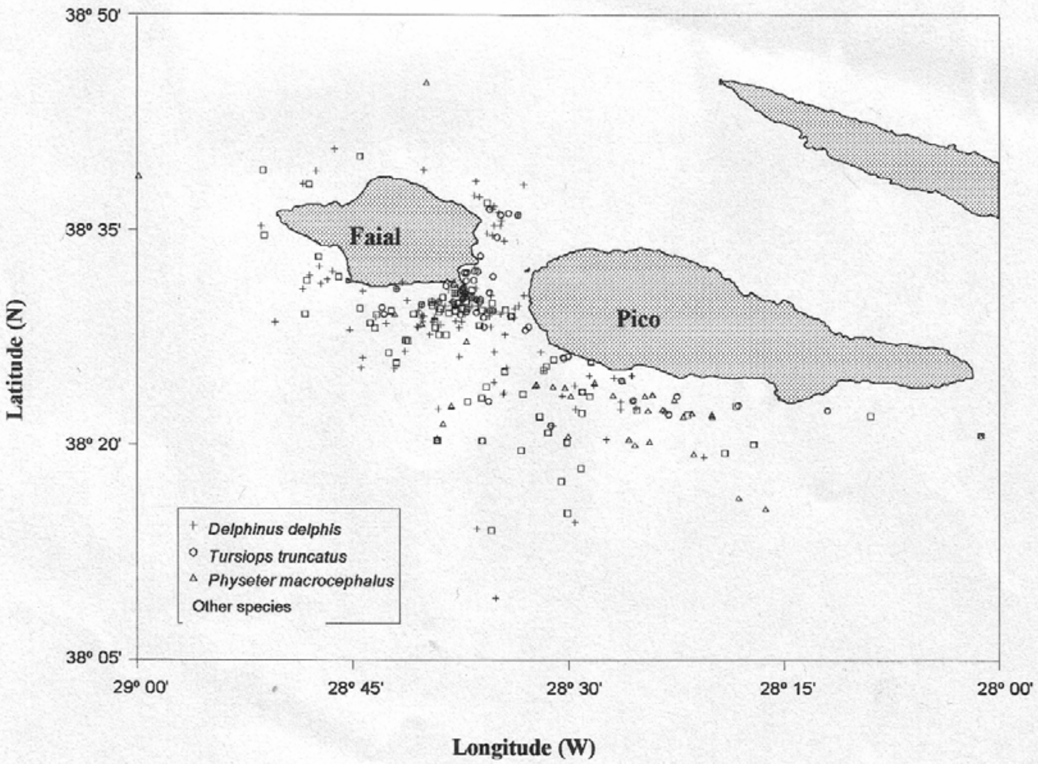

Fig. 1: Cetacean sightings distribution in the costal areas of Faial and Pico Islands during land and boat-based observations. Species not discriminated herein were included in the "Other species" category.

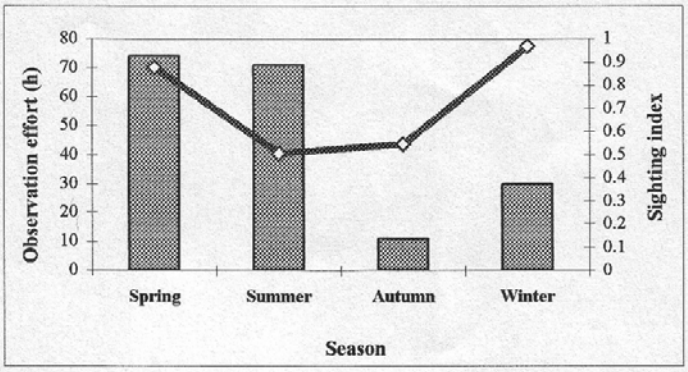

Fig. 2 : Seasonal variation of the observation effort (line) and cetacean sighting index (collumns).

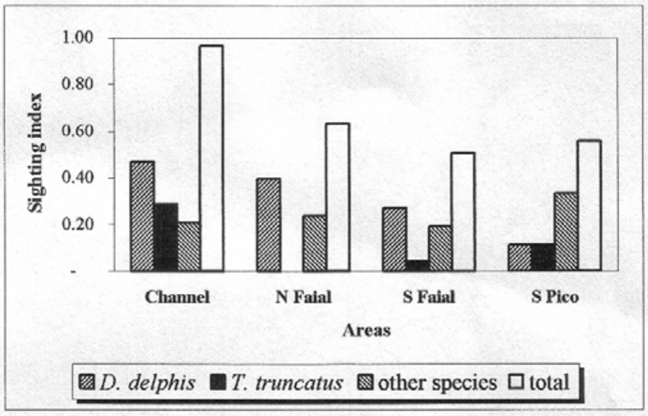

Fig. 3 : Sighting index of *D. delphis*, *T. truncatus* other species and total in the 4 sub-areas of study.

IMPROVING THE COMPARATIVE DISTRIBUTION PICTURE FOR RISSO'S DOLPHIN AND LONG-FINNED PILOT WHALE IN THE MEDITERRANEAN SEA

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INTRODUCTION Risso's dolphins (*Grampus griseus)* and long-finned pilot whales (*Globicephala melas)* are two mainly teutophageous delphinids in the Mediterranean Sea. Nowhere abundant, *Grampus griseus* is present all year round, off French continental coasts (Gannier, 1999; Bompar, 1997), whereas *Globicephala melas* is a migratory species. Pilot whales movement between regions is probably very seasonal : south to north in spring and north to south in autumn. Therefore, from July to November, they are mainly seen in the Ligurian-Provencal basin, from where they are absent during winter (Gannier, 1998).

The distribution of delphinids is usually described using the "distance to the coastline" (Dcoast) and "bottom depth" variables. So, we tried to improve their comparative distribution picture by using the "distance to the 200m isobath" (D200).

MATERIALS AND METHODS Data have been collected in GREC database, from small boat dedicated surveys, during summer, from 1989 to 2000. Surveys were conducted in the whole Mediterranean sea with a more important effort in the western basin. Boat moved on random linear tracks, either on pre-determined or weather-dependent routes. Three to four observers shared a 180° sector in front of the boat. Once cetaceans were detected, the position of the vessel and relative position of animals were recorded. Binoculars were used to confirm species identification and, from 1994 onwards, the distance and the bearing of the animals from the vessel. Sixty sightings of Risso's dolphins and 38 of long-finned pilot whales were used for the study.

The distance to the coastline "Dcoast" and distance to the 200m isobath "D200" variables were calculated using Oedipe GIS (Massé and Cadiou, 1994). Dcoast corresponded to the shortest distance to the coastline and D200 to the shortest distance to the 200m isobath. Histograms of sighting frequencies were done for both species in order to compare the distribution picture given by each variable. Then, both variables were also compared using Levene's statistical test of homogeneity of variance after Kolmogorov-Smirnov's test showed that both distributions were not normal.

RESULTS For Risso's dolphins, average Dcoast was 28.9km (SE=4.19) with a range of 0.7 to 147km (CV=14.5%). Risso's dolphins distribution was bimodal and dissymmetrical: 86 % of sightings were done within 40km from the coastline (Fig. 1). Also, the maximum frequency (21.7%) was obtained in the 5-10km interval, then decreasing gradually. Then, a secondary mode was found with 4 isolated sightings, located at a distance of more than 110km from the shore. Risso's dolphins had a very wide distribution: they were seen in western and eastern Mediterranean, in northern as well as southern areas (Fig 3).

The average of D200 was 20.4km (SE=3.93; CV=19.2%). This was also a bimodal distribution (Fig. 2). In the first mode, most of the sightings were grouped close to the 200m isobath: over 82% of sightings were within 30km from this isobath. Moreover, a maximum frequency of 31.7% was located in the 0-5km interval. Unlike the previous distribution picture obtained with the Dcoast variable, this maximum frequency formed a peak of abundance in the Risso's dolphins distribution, showing that this species had an affinity for the continental slope. But four isolated sightings secondary mode were still present far from the 200m isobath. This secondary mode was in itself causing an increase of variance. Removing those 4 isolated sightings, Levene's test showed that variances for the Dcoast and D200 variables were significantly different (p = 0.012).

Dcoast : variance = 323.64; mean =21.70km
D200 : variance = 158.26; mean = 13.08km

Variance for D200 was significantly lower than for Dcoast, when the secondary mode of isolated sightings was discarded. Risso's dolphins distribution was better described by "distance to the 200m isobath" variable.

For long-finned pilot whales, average Dcoast was 40.8km (SE=4.16) with a range of 3.3 to 149 km (CV = 10.2%). Unlike Risso's dolphins, long-finned pilot whales distribution picture was unimodal (Fig 4). Sightings were located further from the coastline than Risso's dolphins ones: 68.5 % were in the 20-50km interval. Also a peak of 34.2 % of sightings appeared for the 30-40 km interval. Most sightings were also obtained in two areas of the western basin (Liguro-Provençal and Alboran region) (Fig. 6). The distribution of long-finned pilot whales was well described using the Dcoast variable.

The average of D200 was 32.5km (SE=4.19; CV=12.9%). Using the D200 variable, the distribution picture of long-finned pilot whale was similar to using Dcoast (Fig. 4 and 5). 73.7 % of sightings were done in the 10-40 km interval and a peak of frequency (36.8 %) was present in the 20-30 km interval. The distribution did not appear visually to be better described by the new variable. Levene's Test on homogeneity of variance is not significant (p=0.914).

Dcoast : variance = 647.40; mean = 40.8km
D200 : variance = 683.85; mean = 32.5km

Hence, the "distance to the 200m isobath" was not a better descriptor than the Dcoast variable for the long-finned pilot whales distribution.

DISCUSSION D200 variable gave a better image of Risso's dolphins summer distribution, showing it is highly linked to the shelf break; several authors showed *Grampus griseus* had a clear affinity for the continental slope (Fabbri *and al*., 1992; Gannier A. and Gannier O., 1994; Di Méglio *and al*., 1999). This affinity may be explained by their diet, known to be composed of various species of cephalopods including benthic ones (Würtz *et al*, 1992), which are abundant on the continental slope. Also, we saw that Risso's dolphins may be travelling during all seasons, a nomad strategy of feeding (Casacci and Gannier, 2000). Although they stay most of the time along the continental slope for feeding, they may travel long distance over the Mediterranean Sea (Fig. 3). This strategy of moving is well adapted to a feeding resource present everywhere but nowhere abundant in permanence. The fact that a secondary distribution mode had to be discarded from our analysis showed however that Risso's dolphin ecology is more complex than usually thought, as also illustrated by new seasonal distribution results (Laran *et al*. 2002, this volume).

Although the D200 variable appears not to give a better image of the long-finned pilot whales distribution, it has permitted us to underline their affinity for both deep slope and open water (Gannier, 1998). Pilot whales move seasonally from a large area to another one. They don't have a widespread distribution like Risso's dolphins. In summer, long-finned pilot whales are mainly located off the Liguro-Provencal coasts (Fig 6), where the continental shelf is narrow, and Alboran Sea (Cañadas and Sagarminaga, 2000). Their distribution in precise regions might be explained by their diet, probably less diversified than Risso's dolphins one (Orsi Relini and Garibaldi, 1992) and linked to areas of higher primary production.

CONCLUSION With this study we improved the distribution picture of Risso's dolphins by using the distance to the 200m isobath variable. The major advantage of this variable is that it takes depth into account, allowing to compare dolphin distribution between regions with different continental shelf extents. We showed that the nomad *Grampus griseus* are mainly linked to the continental slope, whereas the migratory *Globicephala melas* show a better affinity for the deep water. This example shows that the choice of a suitable descriptor strongly influences cetacean distribution results.

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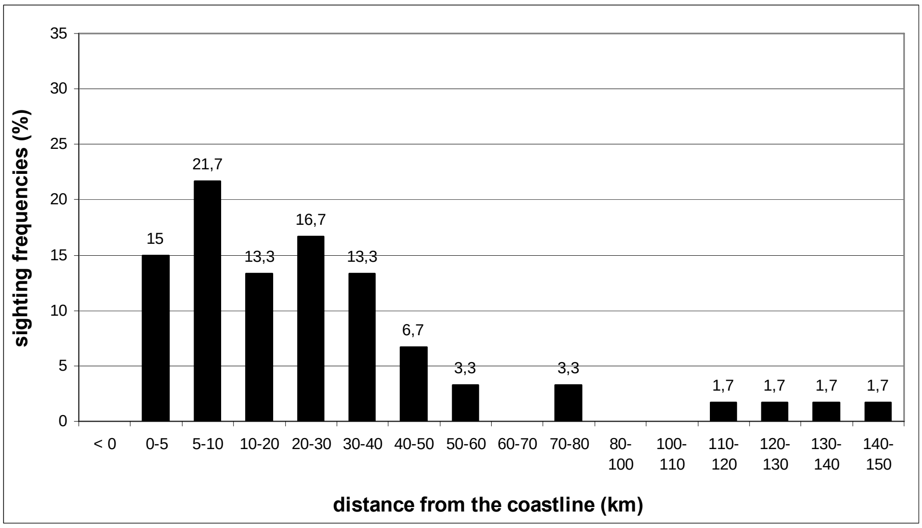

Fig. 1. Sighting frequencies of Risso's dolphins according to the distance from the coastline

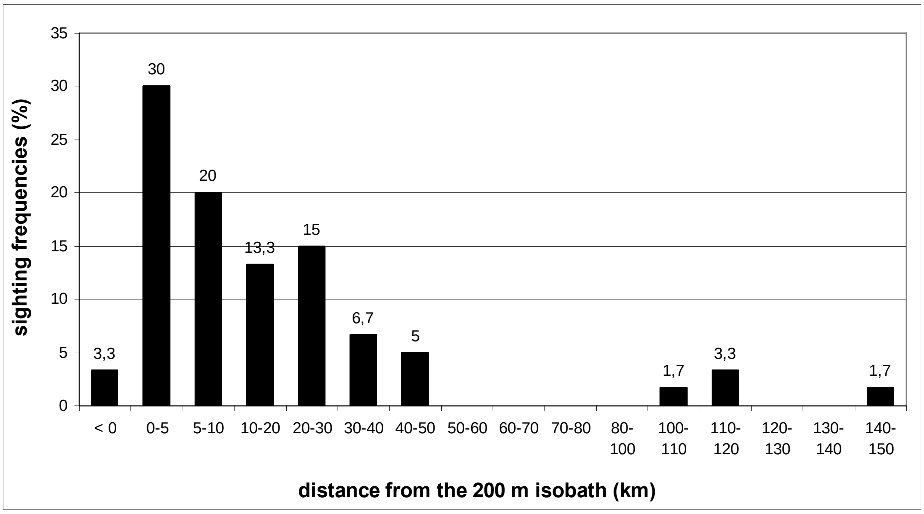

Fig. 2. Sighting frequencies of Risso's dolphins according to the distance from the 200m isobath

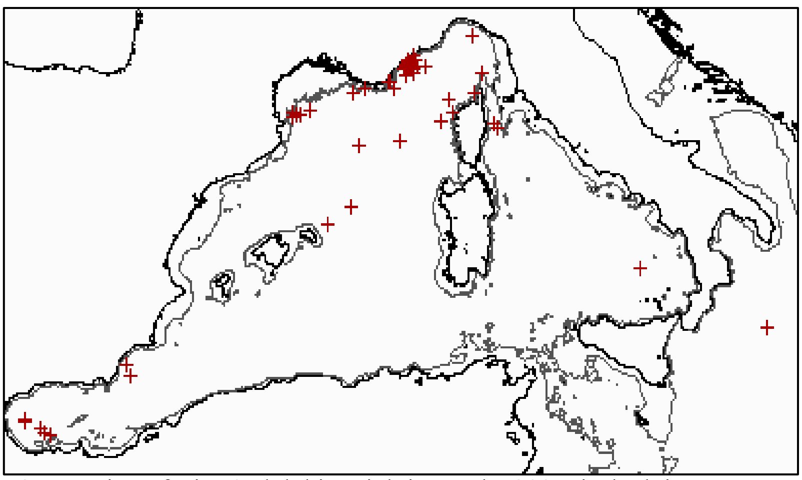

Fig. 3. Location of Risso's dolphins sightings. The 200m isobath is represented

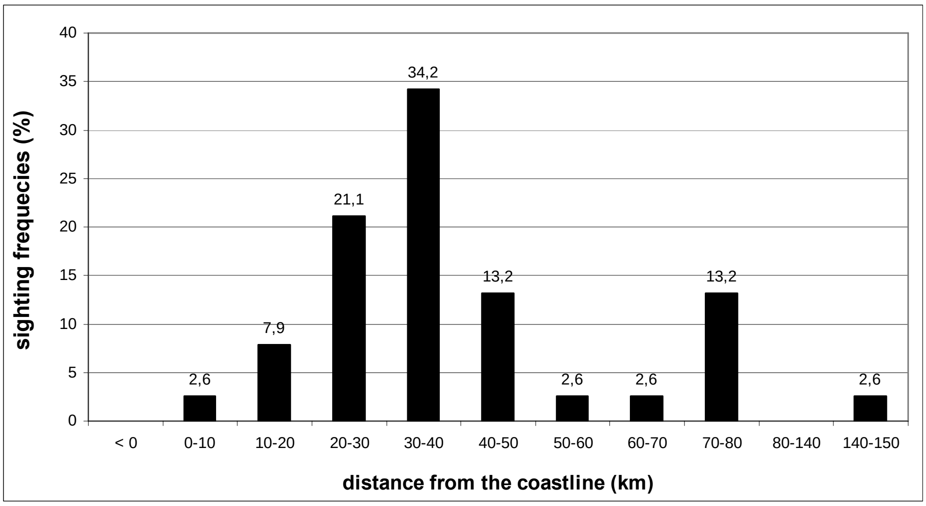

Fig. 4. Sighting frequencies of long-finned pilot whales according to the distance from the coastline

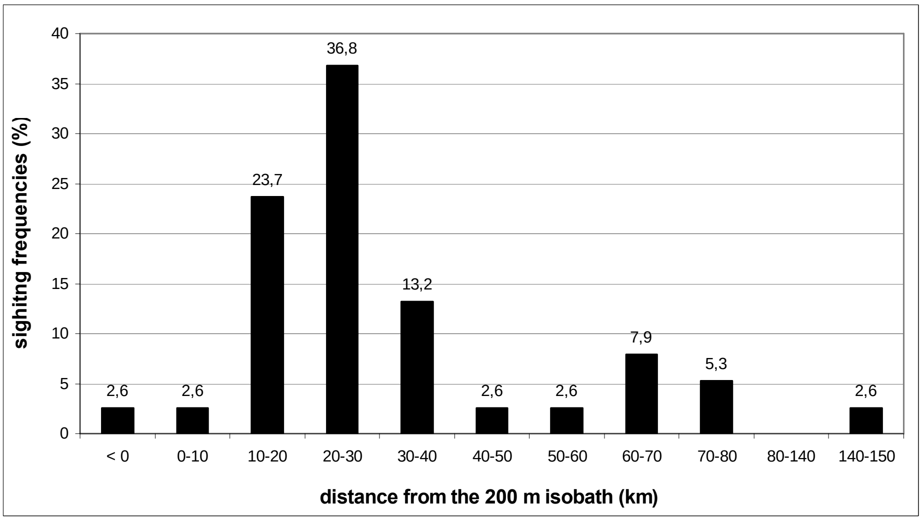

Fig. 5. Sighting frequencies of long-finned pilot whales according to the distance from the 200m isobath

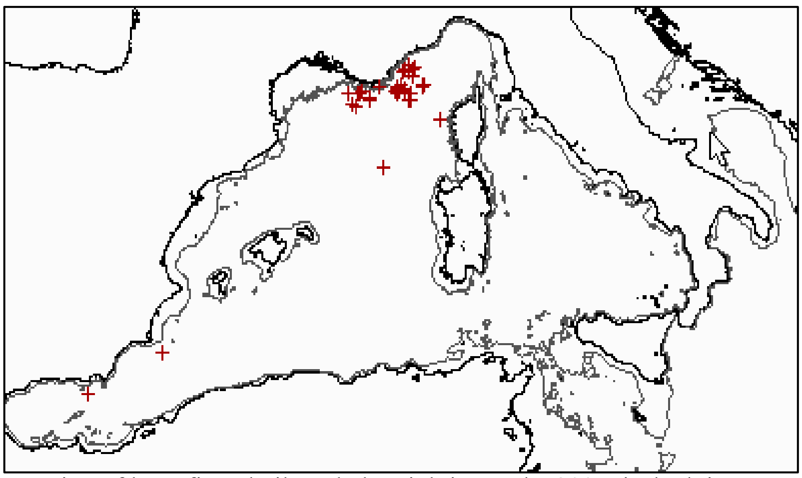

Fig. 6. Location of long-finned pilot whales sightings. The 200m isobath is represented

OBERVATIONS OF THE BRYDE'S WHALE (*BALAENOPTERA EDENI*) IN THE CANARIAN ARCHIPELAGO

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The Bryde's whale is distributed worldwide across temperate and tropical waters, usually below 30º latitude in both hemispheres. Little is known about the species in the northeastern Atlantic. At the Canary Islands there is a strong seasonally presence of *B. edeni* which is mainly found between june and october, beeing the most abundant member of the family Balaenopteridae. While carrying out a study on bottlenose dolphins at the island of Gran Canaria during 1999 and 2000, *B. edeni* was observed 58 times in a depth range from 94 and 1450m (n=52, mean=498.5m and SD=287.5m). Most of the sightings were lonely adult animals with a maximun group size of three individuals. The animals were photographed, filmed and 8 biopsy samples were taken for genetic analysis. Most of the times the species displayed an active behaviour probably asociated to feeding with the presence of Cory's shearwater (*Calonectris diomedea borealis*) but occasionally it also showed an interest for the research vessel. Canarian tuna fishermen use this species as an biological indicator due its association with some tuna species specially the Skipjack tuna (*Katsuwonus pelamis*). The Canarian Archipelago may constitute a feeding ground for *B. edeni* – the analysis of the stomach contents of a stranded individual reforces this hypothesis – and probably also a mating ground. Concerning the genetic analysis of the 8 biopsy samples, 363 bp of the mtDNA control region were sequenced and the gender of the animals was determined by amplifying the SRY gene. These sequences are the first ones for the Bryde's whale in the Eastern North Atlantic. Only one haplotype was found which differd from one found in the Eastern Indian Ocean by only one base pair. This difference is a characteristic for the samples taken from the Canarian population. From the 8 individuals, 50% were males.

ARE NORMANDY'S COASTAL WATERS A MAJOR AREA FOR LONG-FINNED PILOT WHALES (GLOBICEPHALA MELAS) DURING THE SUMMER?

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INTRODUCTION The long-finned pilot whale (*Globicephala melas*) is considered to be a common cetacean species in the North Atlantic, with a pelagic distribution. Nevertheless, seasonal movements from offshore to coastal waters have been noticed during the summer and autumn (Bloch *et al.*, 1989). This study compiles 21 years of sightings data of Long-finned pilot whales in Normandy's coastal waters. We have analysed intra-annual sightings occurrence, distribution, behaviour, group size, but also calf occurrence in order to establish the relative importance of Normandy coastal waters for this species.

MATERIALS AND METHODS The Normandy region is located along the French coast of the English Channel, between northern France and Brittany (Fig. 1). It is demarcated by the Somme estuary (North-East) and the Mont-Saint-Michel Bay (South-West). The region is bordered by shallow waters, with a maximum of 70-100 meters depth around the Casquet area (central English Channel), off the northern Cotentin peninsula (Fig. 2).

From 1980 to 2000, data were collected by the "*Groupe Mammalogique Normand*" on Long-Finned pilot whales during specific surveys. However, most of the recordings were witnessed by ornithologists and marine mammalogists and some were also noted by near sea users, like yachtsmen and fishermen.

RESULTS From 1980 to 2000, 88 sightings were reported all year round off the Normandy coast. However, 76% of the data focussed on the July to September period (August showed the highest number of summer sightings with 40% of the data) (Fig. 3). Three areas can be distinguished as "yearly frequented" :

the Seine estuary and adjacent waters (42%)
the Normano-Breton gulf and Channel Islands (29,5%)
the North Cotentin peninsula (28,5%)

All sightings occurred in shallow waters, from 5 to 70 meters in depth. Pod size was highly variable, ranging from a single individual to over 150 animals, with an average group size of 17 whales. However, 33% of the groups were made up of 1 to 4 animals (Fig. 5). Pods were also generally spread out in sub-groups, swimming in the same direction. During the summer occurrence, the last 10 days of July and the month of August showed a greater sightings frequency. Moreover, the presence of young animals reached 33% in the first 10 days period of September (Fig. 4). Daily site fidelity observations were made twice in the Normano-Breton gulf and in the North-east Seine estuary, over 6 and 7 days respectively. Concerning the behaviour of the animals, three categories were recorded : 1) moving (92.3%), 2) moving with other delphinid species (5.7%) (Bottlenose dolphins *Tursiops truncatus*, Risso's dolphins *Grampus griseus* and Common dolphins *Delphinus delphis*) and 3) foraging/feeding (2%).

DISCUSSION Published analysis suggests that Long-Finned pilot whales move into waters off southwest England during autumn and early winter (Evans, 1980). Conversely, the Pertuis Charentais (Bay of Biscay) seems to constitute a summer site (Van Canneyt *et al.*, 1999). In Normandy coastal waters, we observe a substantial summer occurrence, especially between late July and early September. However, this summer presence may be partially influenced by the increase in observational effort during this period. In addition, it is still difficult to explain the reasons for the presence of the whales. Although foraging and feeding behaviours were not frequently mentioned (2%), trophic requirements may well explain the appearance of the animals in the area. Daily observations probably reflect the low "foraging/feeding" behaviour sightings because of the main nocturnal feeding/foraging activities of the whales (MacDonald & Barrett, 1995).

In addition, it is widely accepted that Long-Finned pilot whales are observed mainly in offshore waters, beyond the bathymetric line of 200 meters (Desportes, 1983). However, movements into inshore waters are more probably linked to prey availability, especially cephalopods (most consumed prey), such as Sepia officinalis and fishes like the Mackerel (Scomber scombrus), which are very abundant in the Normano-Breton Gulf and in the Seine estuary in this period (Tetard, pers. com.). Nevertheless, their presence in coastal waters may be related to other eco-ethological factors.

CONCLUSION Although the presence of Long-Finned pilot whales seems to be annual in Normandy waters, it is currently impossible to know whether the three considered areas are visited by the same groups (seasonal site fidelity). Nevertheless, Normandy coastal waters appear to be a major area for Pilot whales during the summer. Therefore, a photo-identification programme should interesting to set-up in the future.

ACKNOWLEDGEMENTS We would like to thank all observers for contributing their sighting data to this study as well as naturalists from the Groupe Mammalogique Normand. Special thanks to Philippe SPIROUX (Groupe Mammalogique Normand) for giving us his pictures to illustrate this poster. Many thanks to Sami HASSANI, from the Laboratoire d'Etude des Mammifères Marins (Océanopolis) and Olivier VAN CANNEYT (Marine Mammal Research Centre, La Rochelle) for improving the English and the content of the manuscript.

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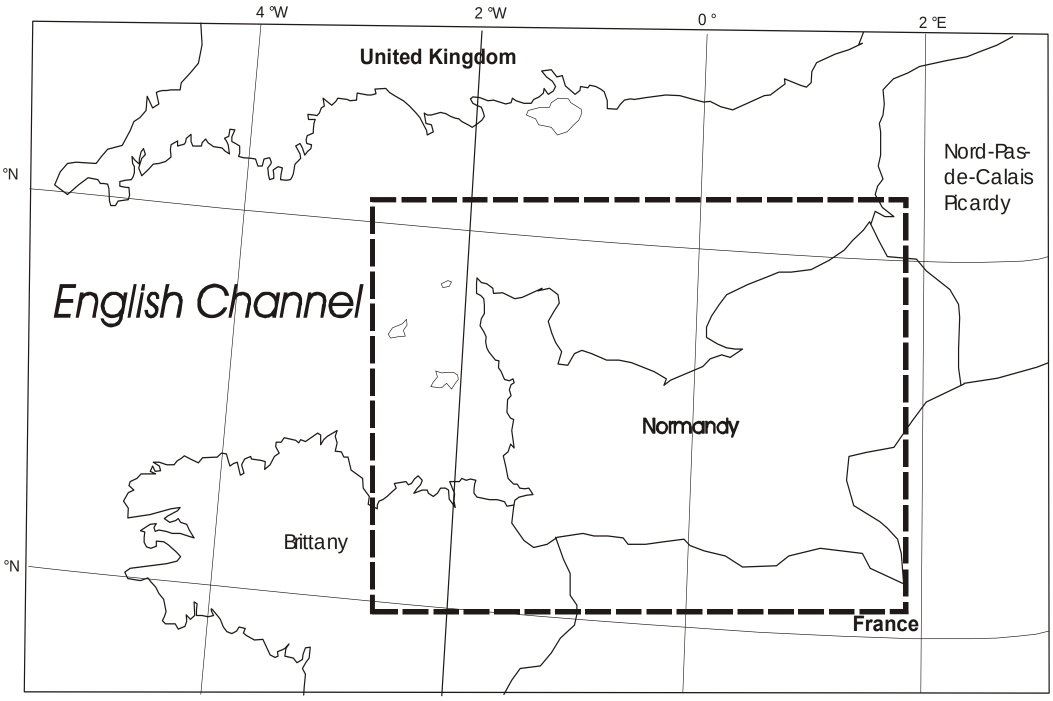

Fig. 1. The Study area

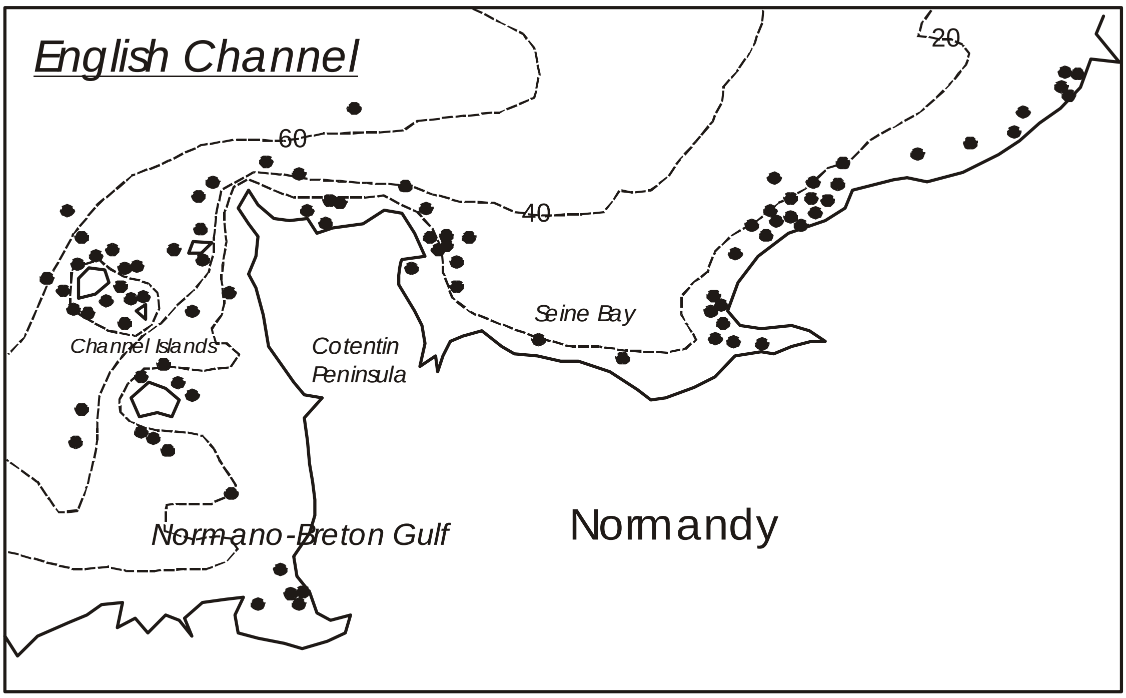

Fig. 2. Map on the distribution of long-finned pilot whale sightings in the coastal waters of Normandy between 1980 and 2000

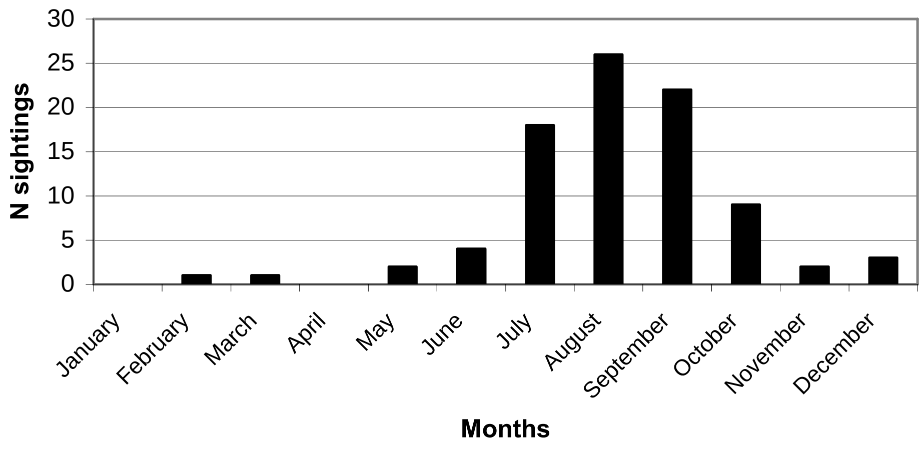

Fig. 3. Compiled monthly occurrences of sightings of long-finned pilot whales between 1980 and 2000

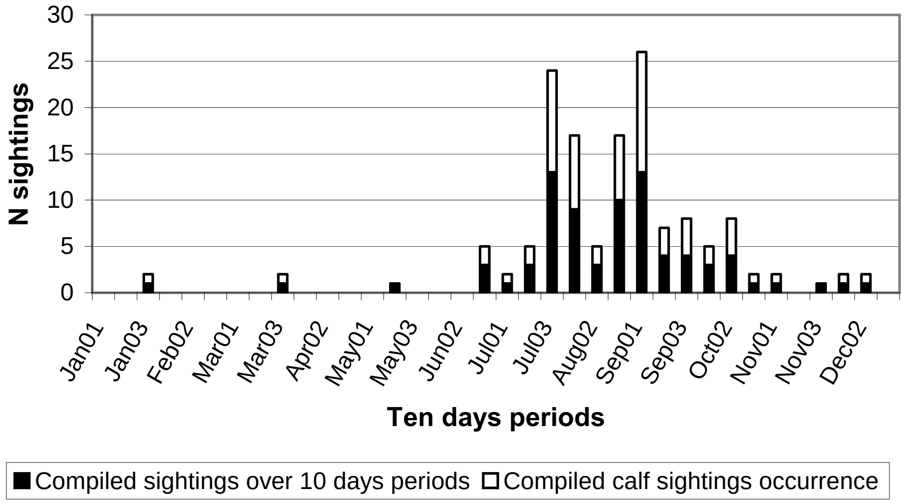

Fig. 4. Compiled proportion of calf sightings occurrence per 10 day periods versus compiled sightings data between 1980 and 2000

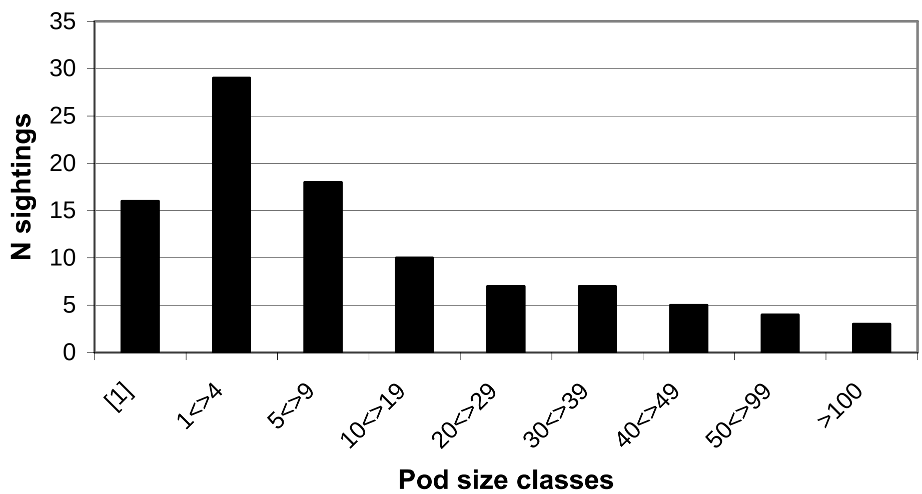

Fig. 5. Compiled pod size occurrence of long-finned pilot whales between 1980 and 2000

PAST AND RECENT EVOLUTION OF THE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) POPULATION IN THE GULF OF LIONS (NORTH-WESTERN MEDITERRANEAN)

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Several documents attest that Bottlenose dolphin was so abundant in the Gulf of Lions at the beginning of past century that fishermen regarded it as a wound. In 1913 the skippers of Grau d'Agde, one of the most internal sites in the gulf, requested a subsidy to manufacture a gear allowing "to wrap and surprise the fearsome "porpoises" and to bring them back to land". The intervention of the national Navy was even claimed in the middle of the century to bombard the dolphins and, thereafter, several operations of startling were led by using explosives. Three long data sets, from the Franco-Spanish border to Marseilles, were examined: the French file of stranded animals of the CRMM (1948-2000), the file of random cetacean sightings at sea of the CIESM (1969-2000) and the systematic campaigns of the EPHE (1990-2000). Four great phenomena appear. Sporadic mentions of stranded animals exist until 1961, translating the presence of the species in the gulf. Between 1962 and 1981, that is to say 20 years, only are available 2 indications of strandings and 4 of alive animals: the species became extremely rare. Since 1982, strandings are regular and increasingly frequent (up to 5 in 1997). Solitary and familiar animals are the first to be appeared in 1987 (FANNY), 1988 (MARINE) and 1989 (DOLPHY). Since 1992, the mentions of alive animals are regular each year, increasingly numerous like the maximum size of groups is (to 58 individuals in 2000). Human interventions to eliminate or startle the dolphins, too rambling, and the appearance of new technologies for the fishing gears cannot explain, only, the desertion from the gulf by the Bottlenose dolphin during nearly a quarter century. The causes are to be sought in deep modifications which have occurred in the whole ecosystem of the Gulf of Lions.

USE OF ORGANOCHLORINE POLLUTANT PROFILES TO STUDY HARBOUR PORPOISE *PHOCOENA PHOCOENA* STOCK DIVISIONS

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INTRODUCTION Studies on the population structure of harbour porpoises (*Phocoena phocoena*) in the NE Atlantic have found that the level of genetic differentiation of animals from different sea-areas tends to be low. If the current population structure is due to changes which have only arisen in the recent past then genetic markers would probably only have limited powers to resolve small population differences. Further information on more contemporary differences may be obtained from studying ecological factors such as fatty acids and organochlorine (OC) pollutants (Aguilar, 1987). These factors, do not define separate breeding populations but they can provide information on where an animal has spent time, local migrations, distribution and social structure (Avise, 1994). Total levels of OCs in animals are influenced by many factors such as age, sex, condition and location of animals and can be extremely variable even within populations. This complicates any between population comparisons but much of this variability can be reduced if one investigates pollutant 'patterns' rather than total levels.

In 1990-1993 SMRU, Institute of Zoology, London and MAFF, Burnham-on-Crouch laboratory performed a joint study to measure pollutant burdens in porpoises (Kuiken *et al*., 1994; Law, 1994). Data from that study has now been further analysed using a variety of multivariate statistical procedures to investigate if OC pollutant profiles are of value in determining porpoise population structure. In some cases males and females were tested separately since it appears that there is a greater mobility of males compared to females (Walton, 1997).

METHODS Blubber samples were collected (see Figure 1) from stranded animals from Irish and Celtic Seas (28), southern North Sea (31), and northern North Sea (18). Lipid extraction and OC analysis was as described by Allchin *et al*. (1989). 25 PCB congeners were assayed as well as the OC pollutants DDE and HCB. (see Law, 1994). The data was normalised by relating the levels of each OC to that of CB153 (Figure 2) according to Wells *et al*., (1996). For Principal Component Analysis the data was transformed according to Storr-Hansen & Spliid (1993).

As the statistical procedures used need a full data-set with no missing values only the most abundant 13 congeners (CB 52, 101, 118, 128, 138, 149, 158, 170, 180, 183, 187, 194) were utilized. The results were subjected to the following statistical procedures: Principal Components Analysis, Discriminant / Canonical Score Analysis, AMOVA, and Classification TREE Analysis as contained in SYSTAT and SIPINA.

RESULTS AND DISCUSSION **a) Principal Component Analysis PCA** Using PCA no readily apparent clear-cut clusterings of the animals according to geographical location could be seen. This was also found to be true if male and female porpoises were considered separately

PCA has been used previously to successfully identify differences among three harbour seal populations from around the coast of Denmark (Storr-Hansen and Spliid, 1993). However like us, they did not observe any distinct geographical grouping of porpoises using this method. They proposed that porpoises migrated more than seals or maybe that porpoises have a broader selection of food compared to seals. .

b) Discriminant / Canonical Score Analysis
Discriminant Analysis provides a series of discriminating factors which maximise the separation between populations. Table 1 shows the (jack-knifed) classifications following the Discriminant analysis procedure for all animals, males only and females only. The majority of animals were allocated to the correct geographic location, but nevertheless about 30-40% were "mis-classified". The correct percentage classifications varied from 54 to 75% with an overall accuracy in each case of 58 - 70 %. There was a tendency for the accuracy to be greater when only females compared to only males were considered.

c) Classification TREE Analysis
Classification TREES procedures were performed for all animals, males only and females only. The TREE for females only is shown in Figure 3. The procedure attempts to find one or more variables which can be used to optimally classify the data into the proposed geographical groupings. As can be seen from the figures the procedure was only partially successful and most of the resultant groupings contained "misclassifications". TREE plots can be difficult to follow when there are many branches, but the results can be summarised in classification tables. These are produced by the free computer program SIPINA (which allows merging of nodes). Table 2 shows that from 69 to 94% of samples were allocated to their correct geographical origin.

d) Modified AMOVA
This uses a matrix of OC distances and partitions the total variance into that due to between and that due to within population differences. A measure of interpopulation distance is produced and the statistical significance determined by Monte-Carlo resampling methods (Walton, unpublished). The results shown in Table 3 show significant differences between all the geographic locations considered, although the differences are greater if DDE, HCB and the PCBs are considered compared to the PCBs alone.

CONCLUSION
Analysis of normalised OC profiles does help in studies of population structure of the harbour porpoise. Using a variety of multivariate statistical techniques animals can be classified to their geographic location with a 60-80% accuracy rate. Differences between different areas are greater if a range of Ocs are considered rather than PCBs alone.

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Table 1. Discriminant Analysis : Classification (Jack-knifed) tables

a) all porpoises

	North Sea –north	North Sea –south	Irish Sea	Total	Accuracy %
North Sea –north	11	5	2	18	61
North Sea –south	6	18	7	31	58
Irish Sea	4	6	18	28	64
Total	21	29	87	87	61

Wilks lambda = 0.293 p=0.000

b) male porpoises

	North Sea –north	North Sea –south	Irish Sea	Total	Accuracy %
North Sea –north	6	4	0	10	60
North Sea –south	3	11	4	18	61
Irish Sea	2	4	7	13	54
Total	11	19	11	41	58

Wilks lambda = 0.152 p=0.001

c) female porpoises

	North Sea –north	North Sea –south	Irish Sea	Total	Accuracy %
North Sea –north	6	1	1	8	75
North Sea –south	1	9	3	13	69
Irish Sea	0	5	10	15	67
Total	7	15	14	36	70

Wilks lambda = 0.063 p=0.000

Table 2. Classification Tree (Sipina) Classifications (at leas 75% specificity in terminal nodes)

a) all porpoises

	North Sea –north	North Sea –south	Irish Sea	Unspecified	Accuracy %
North Sea –north	15	0	0	3	83
North Sea –south	1	24	3	3	77
Irish Sea	1	1	26	1	90
Total	17	25	29	7	83

Specific accuracy =91% Non-specific accuracy =83%
Nodes=22 terminal nodes =4 Depth=8

b) male porpoises

	North Sea –north	North Sea –south	Irish Sea	Unspecified	Accuracy %
North Sea –north	9	1	0	0	90
North Sea –south	1	15	2	0	83
Irish Sea	0	2	11	0	85
Total	10	18	13	0	86

Specific accuracy =85% Non-specific accuracy =86%
Nodes=8 terminal nodes =3 Depth=5

c) female porpoises

	North Sea –north	North Sea –south	Irish Sea	Unspecified	Accuracy %
North Sea –north	6	0	0	2	75
North Sea –south	0	9	2	2	69
Irish Sea	0	0	15	1	94
Total	6	9	17	5	79

Specific accuracy =93% Non-specific accuracy =79%
Nodes=13 terminal nodes =4 Depth=6

Table 3 AMOVA Analysis. "Fst" Measures. Values in the lower left of the diagonal are the "Fst" values. Values in the upper right of the diagonal the p values

a) PCBs only

	North Sea –north	North Sea –south	Irish Sea
North Sea –north		0.042	0.000
North Sea –south	0.034		0.000
Irish Sea	0.077	0.087	

a) PCBs + DDE + HCB

	North Sea –north	North Sea –south	Irish Sea
North Sea –north		0.000	0.000
North Sea –south	0.096		0.000
Irish Sea	0.133	0.309	

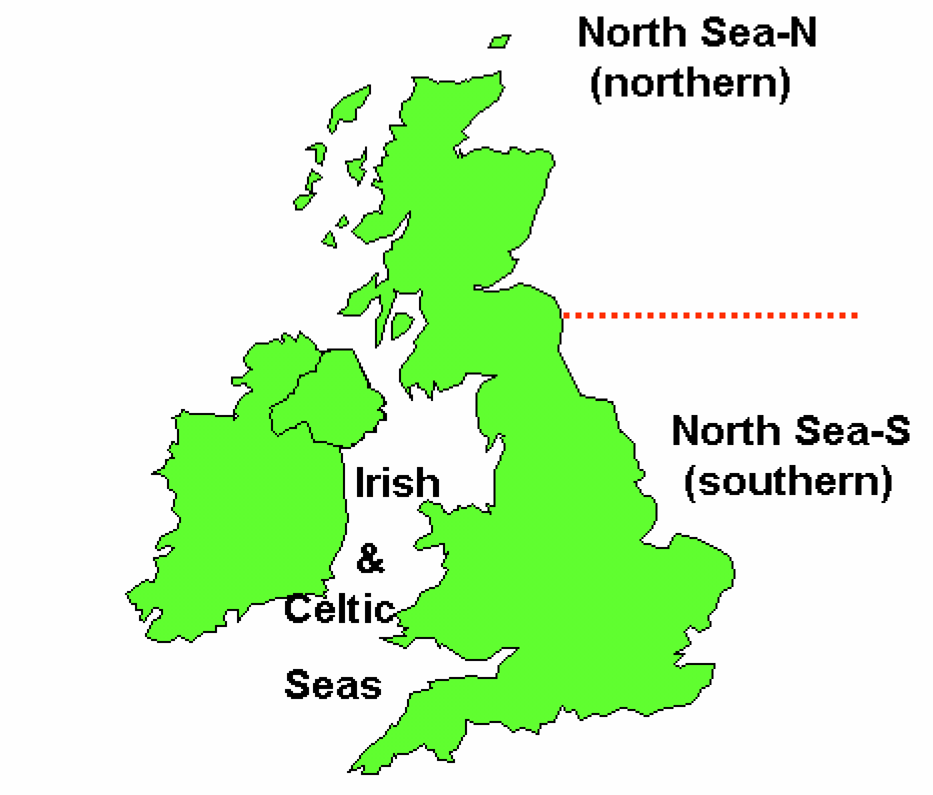

Fig. 1. Map showing divisions of porpoise "stocks"

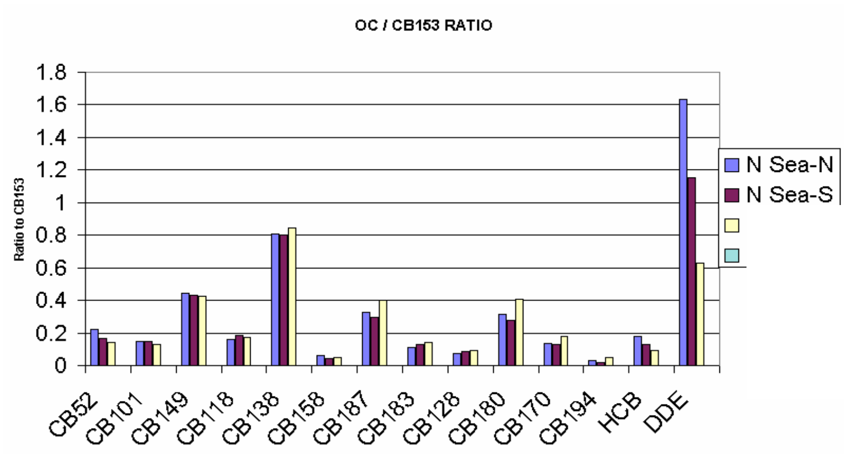

Fig. 2. Ratios of various OCs to CB153.

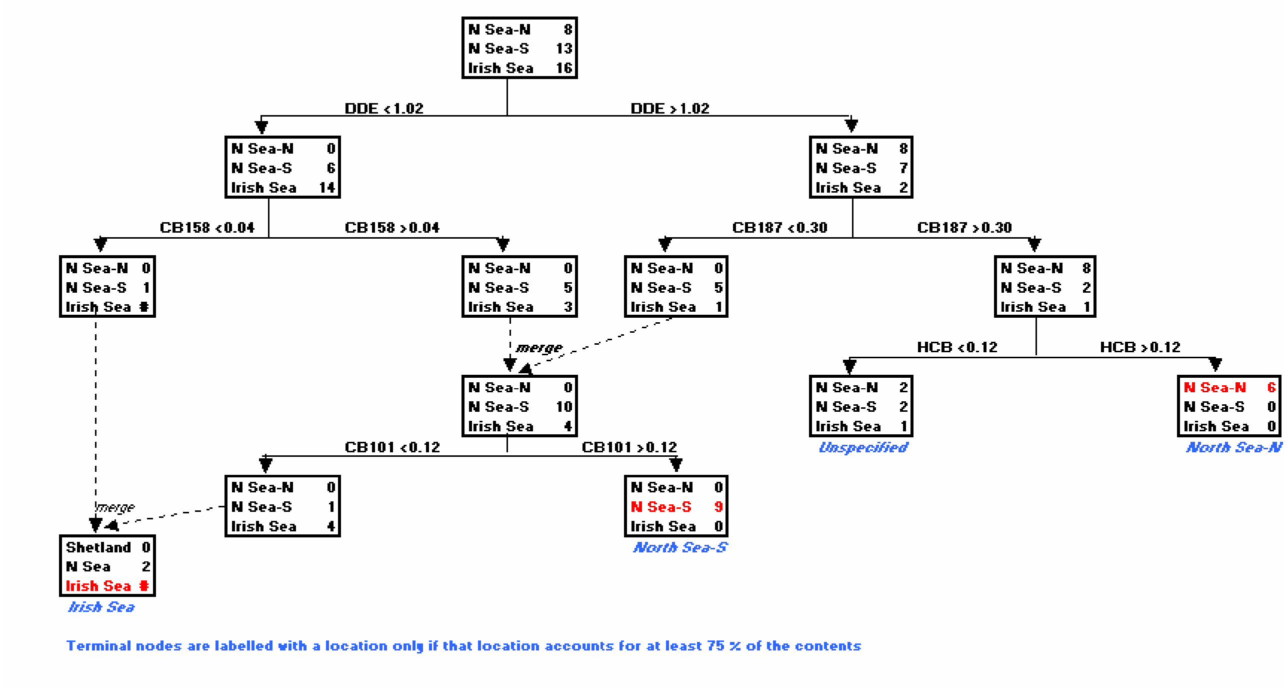

Fig. 3. Classification Tree Plot (Sipina) using OC ratios to CB153

SCAR PATTERN ANALYSIS: IDENTIFYING INDIVIDUAL BEAKED WHALES USING A FORENSIC APPROACH

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Photo-identification has been used to provide information on cetacean life history parameters and social and sexual development within a group, to develop population models, to examine site fidelity, habitat utilisation and seasonal variation in habitat occupation and to identify risk factors within individuals and groups. With the increasing use of platforms of opportunity and other vessels where sub-optimal photographs are generated of little known species, a need was identified to develop a quantitative technique to identify individuals using permanent scars and other natural markings and allowing the use of sub-optimal photographs, digital video and other data acquisition methods available on platforms of opportunity. This technique utilises the likelihood paradigm developed for fingerprint recognition. Natural occurring scars and marks are identified, described, positioned and it is ascribed as a dependant or an independent identifier. In order to describe the uniqueness of the individual the identifier is mapped relative to other dependant identifiers and placed by proximity to known stable reference features. As many dependant identifiers as possible are mapped and any independent identifiers are then mapped. Using the likelihood paradigm for 15 dependant markers produces a 1/134,000,000 chance of misidentification where 8 dependant identifiers are used or 1/134,000 where independent identifiers are used. This approach can make use of many photographs that would be unusable by usual standards of photo-ID. Many of the photographs from non dedicated ID effort have poor records and in many cases orientation cannot be determined, this leads to double counting error. Using this technique Cuvier's beaked whales have been recaptured for the first time using photographs taken of the dorsal surface from a height of 32 metres on a ship travelling at 18 knots. This opens up the opportunity to use photo-ID of beaked whales in particular to answer some distribution, site fidelity and migration questions.

SURVEYS AND ABUNDANCE

BOTTLENOSE DOLPHIN SITE USE AND INTERACTIONS WITH BOAT TRAFFIC IN COASTAL WALES

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INTRODUCTION Volunteer observers from local communities monitor site use by bottlenose dolphins (*Tursiops truncatus*) and interactions with boats in an area designated as Marine Heritage Coast in Cardigan Bay, Wales (Pierpoint and Allan, 2000; 2001; 2002). The project was initiated amid concern that high levels of boat activity were causing disturbance to bottlenose dolphins. More than 100 people have taken part in the project since 1994 - observer effort now exceeds 5000 hours.

METHODS Observations are carried out at four sites (Fig.1), with three 2h watch periods currently scheduled at each site daily, from June to early September. Observers systematically record the number of dolphins (adults and calves) present in successive 15min periods, and the prevailing sighting conditions. Data are also collected to summarise encounters between bottlenose dolphins and boats, including: the type of boat involved; the closest estimated distance to which boats and dolphins approach; whether the boats are stationary or underway. These data are used to monitor trends in dolphin occurrence and to assess whether both commercial and recreational boat owners adhere to codes of conduct. The overall level of boat traffic is monitored with 2h counts of different boat types.

RESULTS Bottlenose dolphins regularly use these coastal study sites – at Mwnt and New Quay, dolphins have been present in over 50% of 874 two-hour observation periods carried out in sea state 3 or less since 1994. Comparative sighting rates are given in Table 1. At New Quay, both the proportion of watches in which dolphins are recorded and the average number of animals present has declined since the mid-1990s (Cuzick's Trend Test: z (adj.) = -3.135, one-sided $P < 0.001$) (Fig. 2). No corresponding trend has been observed at any other site or using data for all sites combined.

The level of boating activity and the types of boat involved in encounters with dolphins varies between sites. For example, New Quay is the home port of several Visitor Passenger Boats, and these boats are encountered more frequently here than elsewhere. Mwnt however, is relatively distant from New Quay and from suitable launching points for small, recreational craft. Consequently levels of boat traffic are low and commercial fishing boats constitute a high proportion of all boats recorded. The observed decline in dolphin sighting rates does not appear to associated with trends in the level of boat traffic. Two-hour boat counts show that in recent field seasons the there has been less boating activity at this site than in previous years when dolphins were recorded more frequently.

At New Quay in 1997, tourist trip-boat operators introduced their own code of conduct for encounters with cetaceans. Following the adoption of these voluntary guidelines, the average 'separation distance' between dolphins and tourist boats during encounters increased significantly (Mann-Whitney U-test: $U = 9131$, $P < 0.001$) (Fig. 3). No corresponding trend was observed for recreation powerboat and motorboat operators.

DISCUSSION Systematic recording from coastal vantage points has provided an eight-year time-series of site use indices for bottlenose dolphins. A significant trend for declining sighting rates has been observed at one site. Changes in dolphin site use at New Quay however, is not thought to be directly related to prevailing levels of boat traffic, and corresponding trends are not evident at the other monitored sites. The trend may possibly reflect a reduction in the availability of prey resources locally. Analysis of comparable data from adjacent locations has aided interpretation of observations at this important site. It is clear that observations at single, high use sites do not necessarily reflect changes in relative abundance of dolphins in the region as a whole.

Significant changes in the nature of encounters between dolphins and boats were detected after the introduction of a voluntary code of conduct for commercial tourist 'trip-boat' operators. These vessels are now less likely to attempt close approaches to dolphin schools. On sighting dolphins, operators reduce speed to either drift or pass slowly by the school's position. The boat operators thereby allow dolphins to choose whether or not to approach more closely. Ceredigion County Council now encourages recreational power and motorboat users to behave similarly. Information on local habitat use by bottlenose dolphins and a code of conduct are provided at launch points, with the aim of reducing the risk of disturbance or injury to dolphins during encounters with these boats. Data collected by volunteer observers monitor dolphin-boat interaction and assist conservation managers to target measures appropriately.

This project has given members of local communities a stake in monitoring bottlenose dolphins, in which there is substantial interest, and with whom we share the use of near-shore habitats.

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Pierpoint, C. and Allan, L., 2002. *Cetacean site use & boat traffic on the Ceredigion Marine Heritage Coast 2001*. Cyngor Sir Ceredigion, Aberaeron, U.K., 32pp.

Table 1. Comparison of sighting rates of bottlenose dolphins at four sites within the Ceredigion Marine Heritage Coast, Cardigan Bay. For data collected in sea state 3 or less, the number of observation periods (W), percentage of watches with dolphins recorded (%W), the average number of dolphins present in each 15min interval and standard deviation are shown.

Site	*W*	*% W*	*Mean*	*sd*
Mwnt	181	63%	0.94	1.10
New Quay	693	50%	0.72	0.94
Ynys Lochtyn	247	45%	0.63	1.09
Aberporth	500	32%	0.32	0.60

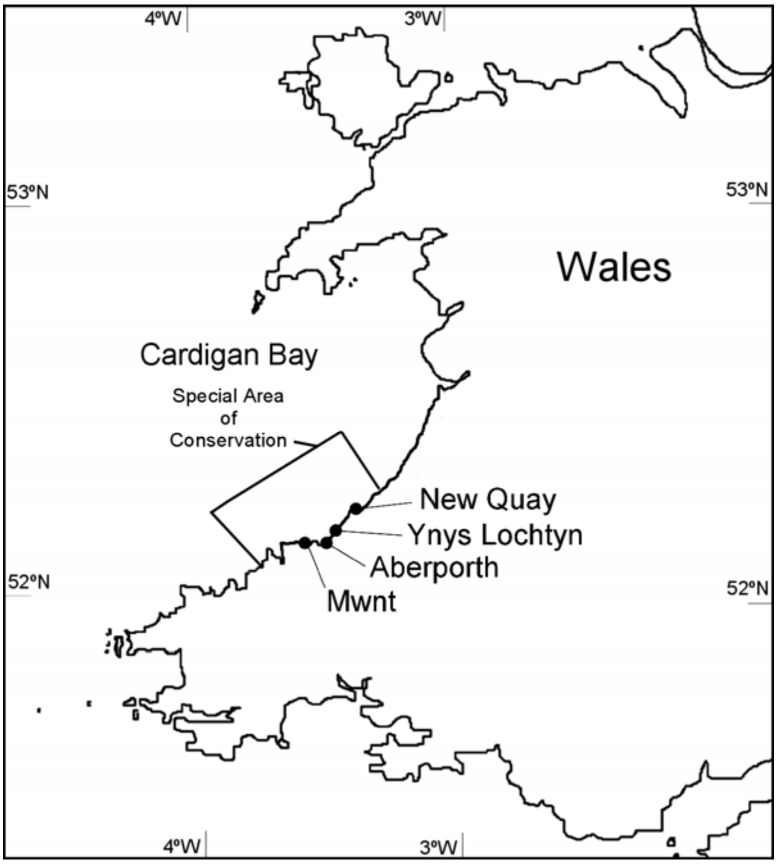

Fig. 1. The location of four sites at which observations of bottlenose dolphins are carried out in Cardigan Bay, Wales

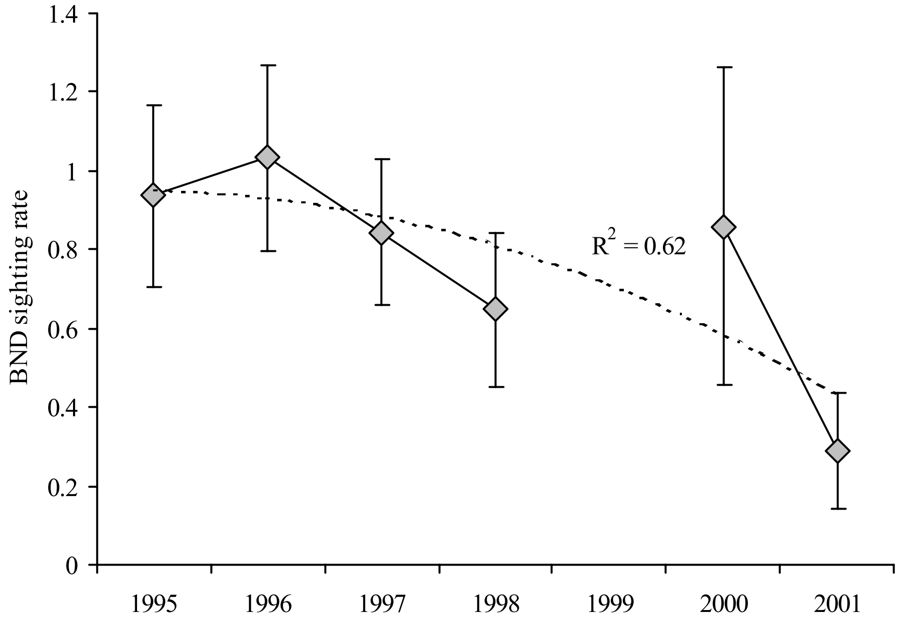

Fig. 2. The mean number of bottlenose dolphins recorded each 15min per 2h observation period at New Quay: 1995-2000. Error bars show a 95% confidence interval. All data were collected in sea state 3 or less. The fitted trend line is that of a 2nd order polynomial function with an R^2 value of 0.62

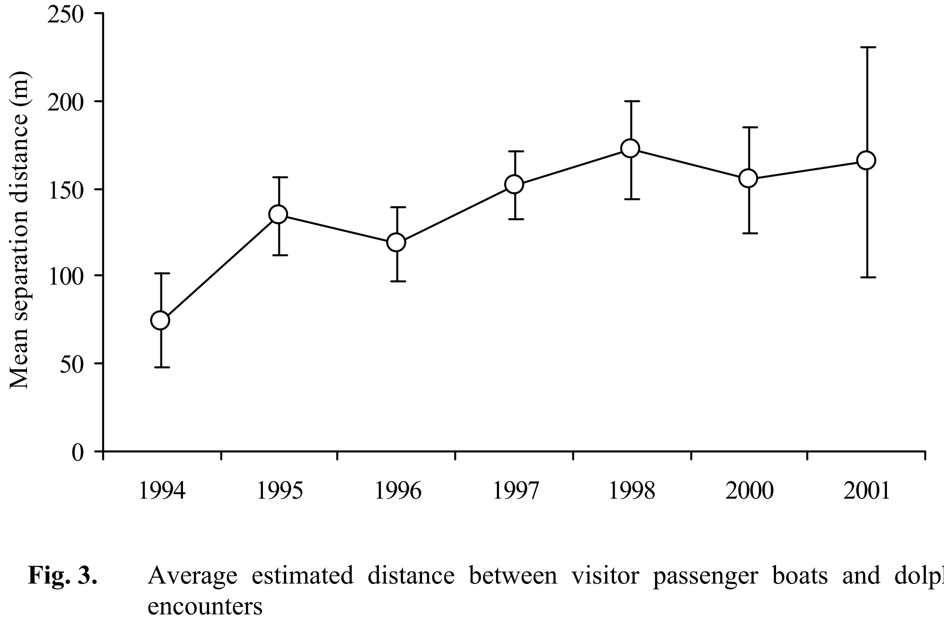

Fig. 3. Average estimated distance between visitor passenger boats and dolphins during encounters

PRELIMINARY DEVELOPMENT OF LOGISTIC MODELS TO PREDICT HABITAT USE OF CETACEAN SPECIES AS FUNCTION OF THE ENVIRONMENTAL CONTEXT IN THE LIGURIAN SEA SANCTUARY (SOLMAR - SIRENA'99 AND '00 CAMPAIGNS)

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The SOLMAR-Sirena cruises, respectively undertaken during the summer season in 1999 and 2000, allow comparison of environmental measurements with cetacean distribution on the same spatial-temporal scale in different years. In each Sirena cruise, more than 30 oceanographic and lower trophic level stations, each spaced 12 nautical miles from the others, were made by the Italian Navy Hydrographic vessel, the ITS Magnaghi. Data from lower trophic levels were collected by means of a profiling package consisting of a CTD probe, a fluorometer, and a Tracor Acoustic Profiling System (TAPS) that collected acoustic volume backscattering data at 6 different frequencies, approximately corresponding to 5 biovolume size-classes. A 120 kHz EY500 Echo Sounder (detection range ~ 250 m; towed-body) was also used in 2000 for estimating zooplankton abundance. Nutrient profiles were also assessed at each measurement station. Concurrently visual observations of cetaceans were collected from the three Sirena vessels. G.I.S. utilities were used to integrate cetacean sightings with the environmental data set and to grid, by means of an Inverse Distance Weighted interpolator, the measurements of each sampling station into 816 cells of 0.1 degree of latitude/longitude. Principal Component Analysis was used to reduce the redundancy and to define a subset of the environmental predictors to be used in the habitat modelling. Finally a Stepwise Logistic Regression analysis was carried out to build habitat models. Both logistic models for fin whale, *Balaenoptera physalus*, and sperm whale, *Physeter macrocephalus*, showed a good fit (Nagelkerke R-squared ranging from 0.70 up to 0.80) and good performances in their habitat predictions (70% up to 93-98% of correct presence/absence classifications). Particularly, they showed different preferences with respect to nutrient and density profiles. Also, fin whales were found associated with biovolume fractions and temperature fronts. The modelling for striped dolphin, *Stenella coeruleoalba*, was not as effective as the others.

PASSIVE ACOUSTIC AND VISUAL SURVEY OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN POLISH COASTAL WATERS CONFIRMS ENDANGERED STATUS OF BALTIC POPULATION

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The status of the Baltic harbour porpoise is endangered and there is high probability that this population may go extinct in the coming decades. Studies of skull morphology, mitochondrial DNA and contaminants show that this population is distinct. A survey in 1995 resulted in an abundance estimate of 599 (CV=0.57) in the currently known distribution range. However, that survey excluded Polish coastal waters where bycatch is known to occur year round. It has been suggested that Polish waters may support an unknown, yet significant, part of the Baltic porpoise population. In order to test this hypothesis a combined passive acoustic and visual line transect survey of Polish waters was carried out between 19 August and 15 September 2001. The survey was conducted using two visual observers during daylight hours and sea states Beaufort 0-2 and round the clock acoustic monitoring using an automatic high frequency porpoise click detector. A total of 2210 km of trackline were surveyed acoustically and 434 km visually, resulting in one acoustic and one visual porpoise detection. The two detections were not related but both were made in the western end of the survey area. Neither the acoustic nor visual detection allow for calculating estimates of abundance. However, the acoustic detection rate corresponds to 0.05 porpoises per 100 km of trackline in Polish waters. This can be compared to 2.1 per 100 km in the English Channel, 6.4 in the North Sea and 10 in the Kiel and Mecklemburger Bights using the same equipment. This leads us to reject the hypothesis that the Polish coastal waters sustain an additional and significant part of the Baltic harbour porpoise population. The results confirm that this population is endangered and may go extinct in the near future unless actions are taken to prevent future anthropogenic mortalities.

DISTRIBUTION AND ABUNDANCE OF CETACEANS IN THE SEA OF AZOV AND KERCH STRAIT: RESULTS OF AERIAL SURVEY (JULY 2001)

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INTRODUCTION The Sea of Azov – one of the most isolated seas in the world - represents the very north periphery of the Black Sea region (Fig. 1). It is linked to the Black Sea by the Kerch Strait and to the Baltic and Caspian Seas by the web of canals and big rivers extending from the Don Delta. Both the Azov Sea (up to 40,280 km^2) and Kerch Strait (890 km^2) are bordered by Russia and Ukraine which did not establish yet a treaty for joint management, use and conservation of that unique maritime area and its natural resources. Indeed, the Azov Sea evinces a number of specific traits. Its waters are very shallow (maximum 14 m deep) and lower in transparency and salinity (11.7‰ on average), being almost fresh in the northeastern corner, the Gulf of Taganrog. During frosty winters the sea gets covered by ice, while in summer the water temperature rises to 30°C. Exceedingly high level of biological productivity is peculiar to this basin inhabited by marine, euryhaline and typically freshwater organisms, including valuable fish species (sturgeons, turbot, mullets, anchovy, shad, *etc*.). Besides fisheries and shipping, the Azov Sea and Kerch Strait are used for mineral (gas) exploitation, recreation, tourism, military games and liquid waste disposal. The coasts and catchment area undergo the pressure from heavy industry, intense agriculture, urban development and land-improvement. Above activities still seem to be not adequately managed representing permanent threats to the Azov Sea ecosystem in whole and to its top hierarchs, the cetaceans, in particular.

According to previous studies, relating mostly to the 1930s-1940s and 1990s, all three Black Sea cetacean species – the harbour porpoise (*Phocoena phocoena*), the common bottlenose dolphin (*Tursiops truncatus*) and the short-beaked common dolphin (*Delphinus delphis*) – occur in the Kerch Strait, but only two former species can be observed in the Sea of Azov (Zalkin, 1940; Kleinenberg, 1956). It was stated also that within warm season harbour porpoises are distributed mainly in the south and west parts of the sea, and every year they leave it before winter and come back in spring. Sometimes rapid ice formation puts obstacles in the way of their fall migration towards the Black Sea causing mass mortality events due to the ice entrapment (Kleinenberg, 1956; Birkun and Krivokhizhin, 1997). Bottlenose dolphins form more or less compact accumulation in the Kerch Strait from spring to autumn (Birkun and Krivokhizhin, 1998) and visit the Azov Sea on occasion (Zalkin, 1940; Birkun *et al*., 1997). Common dolphins were not recorded in the strait since 1994 (Birkun *et al*., 1999). Any systematic research of cetacean distribution and abundance in the Azov Sea and Kerch Strait was never carried out before 2001.

MATERIALS AND METHODS The aerial surveys of dolphins and porpoises in this area have been conducted in the late July 2001 in the framework of Russian-Ukrainian project AZOVKA'O1 countenanced by the Ministries of Environment of both countries. One year before flights, the prospecting interviewing of local people has confirmed irregular distribution of harbour porpoises including their gravitating to the southern and western waters and their almost complete absence in the brackish northeastern sector.

Line transect surveys were executed under favourable weather conditions (Beaufort 0-2) at an altitude of 100-200 m and an average speed of 148 km/hr by means of high-winged twin-engine amphibian CHE-25M carried a crew of two pilots and two observers equipped with portable GPS and declinometers. During four days the cetacean sightings were recorded along 23 predetermined parallel trackliries (2,786 km in total) crossed the sea and strait at regular 15-km intervals in the direction SE127°–NW307° (Fig. 1). On the fifth day additional amplified survey (18 tracklines separated by 2.5 km; 353 km in total) was accomplished in the Kerch Strait. A total of 30 hours flying-time was allocated for the entire project.

Statistical analysis followed the methodology recommended by Buckland *et al*. (1993). All sightings of harbour porpoises and bottlenose dolphins were pooled separately to derive specific ESW for each species and each water body (the sea and strait). All sightings were truncated at a perpendicular distance of 400 m, partioned in 50 m intervals (Fig. 2) and fitted to the models by means of the program package “Distance 3.5” (Laake *et al*., 1993).

RESULTS AND DISCUSSION A total of 78 primary sightings of harbour porpoises (110 individuals) were recorded in the sea and seven (12 individuals) - in the strait, while all 13 primary sightings of bottlenose dolphins (33 individuals) were registered in the Kerch Strait only. Dolphins were distributed in the north and mid thirds of the strait including shallow Taman Bay (Fig. 1). Porpoises occurred in the north half of the strait and formed two nearly equal accumulations in the western, Ukrainian, and eastern, Russian, parts of the sea. Those spots were separated by free-of-sightings space over 65 km wide, coincident with busy shipping lane linking the strait with the north Azov's harbors

(Fig. 3). No cetaceans were recorded in the little brackish Gulf of Taganrog nor in Arabat and Kazantip bays (Fig. 4) which were affected at that time by the pronounced algal bloom accompanied by fish mass mortality caused admittedly by hypoxia.

The mean sizes of cetacean pods were 2.54 (*T. truncatus*) and 1.44 (*P. phocoena*); the biggest groups consisted of, correspondingly, 6-7 and 4-8 animals, although one school of 25 bottlenose dolphins has been met beyond the survey tracklines. The minimum (uncorrected for diving animals) absolute abundance estimates were evaluated as follows: number of harbour porpoises in the Sea of Azov - 2,922±1,200 individuals, number of bottlenose dolphins in the Kerch Strait 76±36. However, last value seems to be statistically incorrect because of small number of observations.

In conclusion, it seems pertinent to make a mention of intense water pollution and widespread illegal fishing in the Sea of Azov. The reddish black non-transparent water was observed from the aircraft in the Gulf of Taganrog with maximum its dirtiness in the vicinity of Mariupol city. Numerous installed nets, identified as the gill nets for sturgeon (this type of fisheries is prohibited in the Azov Sea), were detected along tracklines, and sometimes mobile fishing boats were seen checking those nets and operating with large fishes. Several cases of floating porpoise carcasses were recorded suggesting the idea of possible by-catch in gill nets.

ACKNOWLEDGEMENTS This study was carried out with the financial support of the Utrishsky Dolphinarium Ltd., Moscow. The aircraft was provided by the Federation of Amateur Aviation of Russia. The authors would like to acknowledge all staff and volunteers involved in the preparation and conducting of the surveys with special thanks to P. Kudryavtsev, N. Mazurkevich (pilots), S. Popov and A. Yelchaninov.

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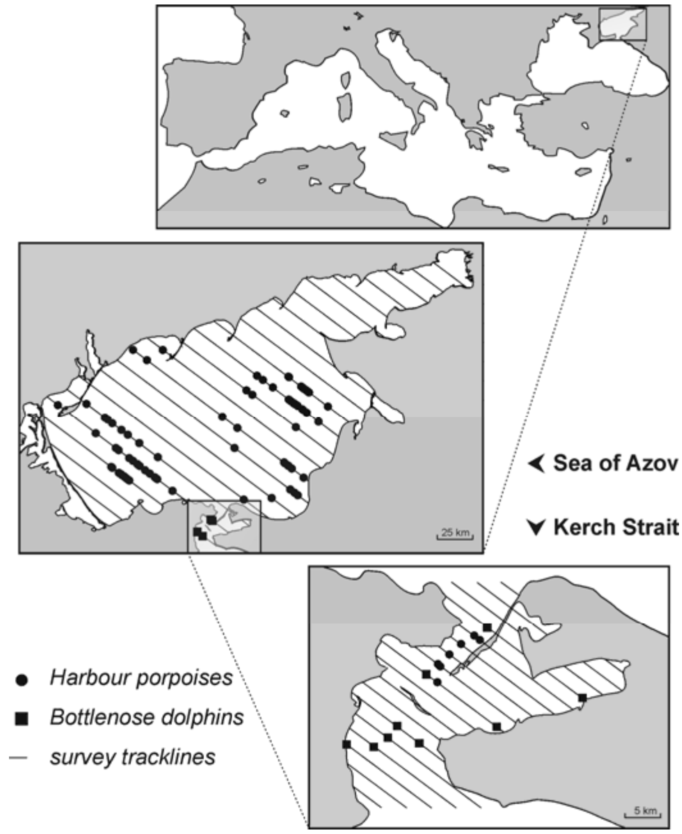

Fig. 1. Map of the study areas with cetacean sightings and survey tracklines

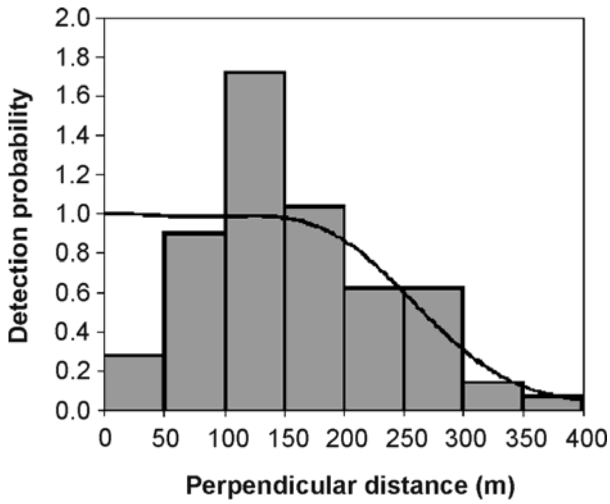

Fig. 2. Distribution of sightings of harbour porpoises from the trackline (the Azov Sea survey). The fitted curve shows the expected number of sightings

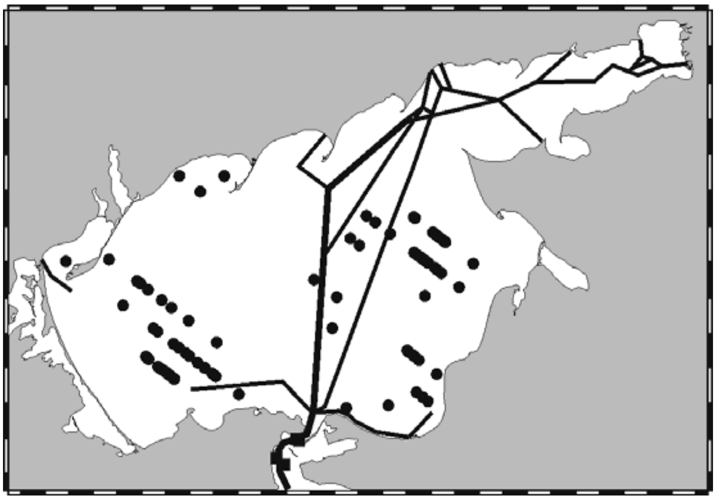

Fig. 3. Distribution of cetacean sightings and a scheme of main shipping lines in the Azov Sea

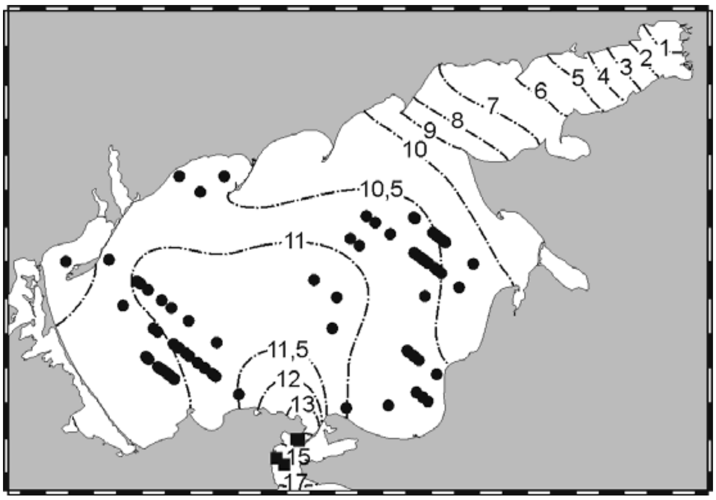

Fig. 4. Distribution of cetacean sightings and zones of different water salinity (‰) in the Azov Sea

NEW RESULTS ON A BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) COMMUNITY AT RANGIROA ISLAND (FRENCH POLYNESIA)

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INTRODUCTION By studying and comparing dolphin populations living in different habitats, we will be able to isolate the environmental factors shaping the range of behaviors this polymorphic species has developed. At Rangiroa Island (Tuamutu – French Polynesia), a population of bottlenose dolphins is described by the locals to be visiting the Tiputa pass almost every day, all year-round. A first study was conducted during four weeks from mid October to mid November 2001 in order to better understand the residency pattern, population size, habitat use, and social structure of this community.

MATERIALS AND METHODS **Study area** The atoll of Rangiroa has two passes. Out-flowing and in-flowing currents strongly influence the sea state in passes by making the waves respectively appear and disappear for periods of nearly 6 hours.. One of the passes, the Tiputa pass, covers an area of roughly $0.2km^2$. Its depth ranges from 15 to 60 m. For the purpose of this study, the pass was divided into two zones (zone I and zone II) based on their characteristics. Zone I is from 25 to 60 m deep, coral covers the bottom, and the waves, if present, are stronger than in zone II. This second zone is less deep, and its bottom is sandy. A third zone, called "zone III", is the edge of the pass at the ocean side. Deeper than the two other zones, no current is observed. The waves, if present, are wind-induced and not a result of in and out-going currents.

Shore-based surveys: Day long surveys Five complete days of 11 hours and 40 minutes each were spent on the pass shore to record every 15 minutes dolphin absence/presence, their relative activity, the direction of the current, the force of the waves, the meteorological parameters and the absence/presence of boats. **4pm to 5pm surveys**. During 11 days, a one hour period from 4pm to 5pm was spent on the pass shore to record every 5 minutes dolphin absence/presence, their behavioral sequences, the direction of the current, the force of the waves, the meteorological parameters, and the absence/presence of boats.

Boat-based surveys Thanks to the Rangiroa dolphin watch tour, 14 boat trips were conducted. Whenever a group of dolphins was detected, the boat would tend to approach the group. The dolphins appeared to be used to the dolphin watch boat and were easily approached. The data collection included date, hour, position, environmental data, a visual estimate of the group size, the name of the individuals we could recognize, and the behavior of the group related to the boat (avoidance, indifference, interest, interaction). In each sighting cruise, lasting about 1 hour, photo identification was conducted.

Underwater videos Three scuba-diving schools of Rangiroa provided us with about 7 hours of high quality underwater video footage. All of the video sequences were filmed in the zone III of the pass. Each footage was viewed in order to identify the individuals, determinate their sex, and study their social behavior. The number of dolphins per sub-group was defined and any kind of interaction was counted, describing the number of individuals implicated in the physical contact.

RESULTS **Population size and residency pattern: Boat-based surveys.** During the 14 boat trips, a total of 133 dolphins were observed. School sizes ranged from 4 to 15 individuals with a most frequent group size of 12 dolphins, and a mean size of 9.5 individuals per sighting. Thirteen individuals have been catalogued from a population locally estimated at 20-30 individuals. Four individuals of the 13 identified are juveniles (30.8%). 56.4% of the dolphins sighted belonged to the "identified" category and were frequently re-sighted.

Groups of spinner dolphins (*Stenella longirostris*) were sighted twice. On the first occasion, two catalogued bottlenose dolphins shared the bow wave with the spinner without any apparent aggressiveness.

Underwater video A total of 598 dolphins were sighted during the 7 hours of underwater videos recorded from 1996 to 2001. From the total, 31.6% belonged to the "identified" category. The high level of re-sightings for Titti (29.6%) and the "adopted" spinner dolphin (18.0%) can be due to the fact that conspicuous natural markings made them easily identifiable.

Habitat use: The influence of tidal rhythm From a total of 233 samples of "day long" surveys, dolphins were present in the pass 48.1% of the time. In the absence of waves (in-flowing current), the dolphins were present at a low frequency (16.2%). In this case, there were quiet for 82.4% of the time. In the presence of waves (out-flowing current), the dolphins were present at a higher frequency (74.2%) and they spent 65.3% of their time jumping and surfing. Hence, the dolphin presence (χ^2=19.2, p<0.01) (Fig.1) and the dolphin behavior (χ^2=13.4, p<0.01) seemed to be linked to the tidal rhythm.

From a total of 131 samples of "4 to 5pm" surveys, dolphins were observed in the pass 63.4% of the time. In absence of waves (in-flowing current) the dolphins were present at a low frequency (13.0%). In this case, the number of calm behaviors represent 70.7% of the 133 behaviors observed. In the presence of waves (out-flowing current), the dolphins were present at a higher frequency (90.6%) and the jumps and surfs represent 80.0% of the 2941 behaviors observed. Here again, dolphin presence (χ^2=65.9, p<0.01) (Fig.1) and dolphin behaviour (χ^2=377.7, p<0.01) were linked to the tidal rhythm.

The influence of the zone Of the eight different behaviors observed in the pass during "4-5pm" sighting surveys (131 samples), surfing and simple leaps represent the majority of the behaviors. Zone I was most_frequently used (83.6%) than zone II (Table1). The leaps were parallel to the shore for 91,7% and in the same direction as the current for 54,7%. When dolphins swim from the lagoon to the ocean, it is not linked to the flow direction (χ^2=0,3, p<0.01). When dolphins swim from the ocean to the lagoon, it is current-dependant (χ^2=76,9, p<0.01): in 80,3% of the case they move against the out-flowing current.

The influence of powerboats The presence of powerboats has been observed in 55.8% of "day long" shore based sighting sessions (233 samples). The absence/presence of small powerboats passing or crossing the pass doesn't affect the absence/presence and the behaviors of the dolphins (χ^2= 0.4, p<0.01). Once or twice a week, a cargo boat comes to Rangiroa to supply the island. No matter the direction of the current, dolphins escort frequently the cargo boats ahead and through the pass.

Social structure Dolphins were categorized into adult, juvenile or calf classes on the basis of body size. The three classes were observed in the three zones.

The total number of tactile behaviors (contact with pectoral fins, flukes, dorsal fins, or rostrum, and assisted swimming) between individuals were counted using the underwater video footage. Among the 73 interactions between *Tursiops*, 21 were between juvenile(s) or a calf and an adult, including 4 between a male and a juv/calf (from 7 cases with a sexed adult), and 52 were between adults (71.2%).

From the 73 intra-specific interactions, 61.6% concerned 2 adults, 17.8% an adult and a juvenile, 9.6% a calf and an adult, 9.6% three adults, and 1.4% two juveniles and an adult. Of the 73 interactions, 89% were between two individuals and 11% between three individuals. No interaction involving more than 3 bottlenose dolphins was observed (Fig.2).

Large groups of spinner dolphins and melon headed whales (*Peponocephala electra*) are frequently seen off Tiputa pass. Inter-specific relations have been recorded with both species: video footage shows a neonatal spinner dolphin swimming in echelon position with the catalogued male bottlenose dolphin Blanche Neige (estimated year 1996-1997). Still more footage shows a neonatal melon headed whale swimming in echelon position with an adult bottlenose dolphin of undetermined sex (estimated year 1997-1998). Both calves showed the fetal folds along their sides. No aggressive behavior from the adults *Tursiops* towards the calves was observed. The only behaviour observed was the typical assisted swim behavior. Both neonates actively swam to maintain the echelon position, and none of the two adults seemed to force the neonate to stay with them.

An adult female spinner dolphin was known to be part of the social community of the bottlenose dolphins group from 1996 to September 1998. This "adopted" spinner dolphin is present in 11.4% of the underwater footage. The majority of the time, she was accompanied by 2 (17.6%) to 3 (52.9%) bottlenose dolphins. She was hardly ever seen with four (8.8%) or five individuals (2.9%) and she was never observed alone or with more than five bottlenose dolphins. She had interactions with one or several *Tursiops* in 32.4% of the cases. If we look at the 12 interactions between this adult "adopted" spinner dolphin and the bottlenose dolphins, 42% were between the spinner and one bottlenose dolphin (two individuals), 33% were between the spinner and two bottlenose dolphins (three individuals) and 25% with the spinner and 3 bottlenose dolphins (four individuals) (Fig.2).

DISCUSSION Group size and residency pattern Group size of dolphins communities seems to depend on two factors: the predation on dolphins (small group size revealing low predation pressure - Norris and Dohl, 1980), and the distance to the coast (small group size from 2 to 14 individuals is founded near the coast – Weigle, 1990). Despite the presence of different species of sharks (Tiger shark *Galeocerdo cuvier*, gray shark *Carcharinus amblyrhinchos*, hammerhead shark *Sphyrna zygaena*, white tip shark *Carcharinus albimarginatus*) in high density at Rangiroa island, the dolphin school size stays small. Except cookie sharks (*Isitius brasiliensis*) bites, no injuries caused by sharks were reported. This low predation pressure may be explained by the fact that these waters are extremely rich in fishes, probably an easier prey for the sharks than the dolphins.

Habitat use The tidal rhythm influences the absence/presence and the behavior of the dolphins in the pass. When the current is in-flowing, there is a good chance of finding the dolphins swimming calmly in small sub-groups from 2 to 4 individuals et the "angle" of the pass. On an out-flowing current, the dolphins jump and surf in the waves of the pass. No feeding activities were observed, unless we consider breaching as indicative of foraging behaviour as sometimes may occur (Lewis and Evans, 1993) since we saw much of this in the pass. Moreover, Ingram and Rogan (1998) assert that areas of strong current in the entrance to rivers are important foraging habitats for bottlenose dolphins. Hence, contrary to local belief, the Tiputa pass might be also a feeding zone instead of being an area for social contact and play time.

Social structure. Male/juvenile or calf interactions In this study, the exceptional opportunity to easily determine sex with underwater videos helped us to discover these few reported male/juvenile or calf interactions in a community where the sex ratio is oriented to male prevalence. Tizzi *et al*. (1998) explain the function of the male-juvenile interaction as beneficial for the mother by releasing her for more efficient foraging. Bojanowski (1998) refers to male-juvenile interaction as a social tool. This type of interaction would help the males to have access to females by playing the role of agonistic buffer or protector.

Inter-specific interactions Inter-specific interaction with a lone cetacean neonate is rarely described in literature (Baird, 1998; Herzing and Johnson, 1997). Referring to Baird (1998), we would classify the interaction of this community with the two neonates (*Peponocephala electra* and *Stenella longirostris)* as displaced epimeletic behavior. However, the short length of footage and reduced time of observation *in situ* by the divers don't allow us from drawing conclusions.

In the case of the "adopted" spinner dolphin, the number of interactions with bottlenose dolphins shows that she was well integrated to the group. Her contacts with bottlenose dolphins implicate more dolphins than is observed for sub-groups formed by bottlenose dolphins only. It is the first time that a long term inter-specific interaction like this is reported. Usually, intergeneric associations implicate numerous animals of two or more different species. Usually, inter-specific associations implicate numerous individuals of different species (Gannier, 2000; Laran and Gannier, 2004).

CONCLUSIONS In spite of being observed by many scuba-divers and professionally filmed on several occasions, this population of bottlenose dolphins had never been studied before. Its fearless behavior in presence of humans and boats shows the respectful behavior that the locals developed in regard to this resident population. Some results like the small group size or the influence of the tidal rhythm on habitat use confirm results from other surveys world wide. Other results like baby-sitting males, inter-specific epimeletic behavior, and long term inter-specific associations are rarely mentioned in literature and make from this group of dolphins a unique community. This one month study just provided an insight on the ecological and behavioral parameters for *T.truncatus* inhabiting a so particular ecosystem. Further investigations need to be undertaken.

ACKNOWLEDGEMENTS This research was partially funded by the "Groupe de Recherche sur les Cétacés". We wish to thank the "dolphin watch activity", "The 6 passengers", "Raie Manta Club" and "Dream dive" for providing us the essential tools to achieve this study. We are grateful to Christiane and Gérald Lefèvre for the logistical support.

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Table 1. Percentage of the 8 behaviors observed in function of the zone of the pass

	Surfing	Simple leap	Stationary	Side breach	Swim from lagon to ocean	Swim from ocean to lagon	Belly breach	Upside down leap	Total
Zone I	35,5	25,2	9,7	5,4	3,8	3,0	0,7	0,4	**83,6**
Zone II	1,7	8,3	2,3	0,6	1,2	2,3	0,1	0,0	**16,4**
Total	**37,2**	**33,5**	**11,9**	**5,9**	**4,9**	**5,3**	**0,8**	**0,4**	**100,0**

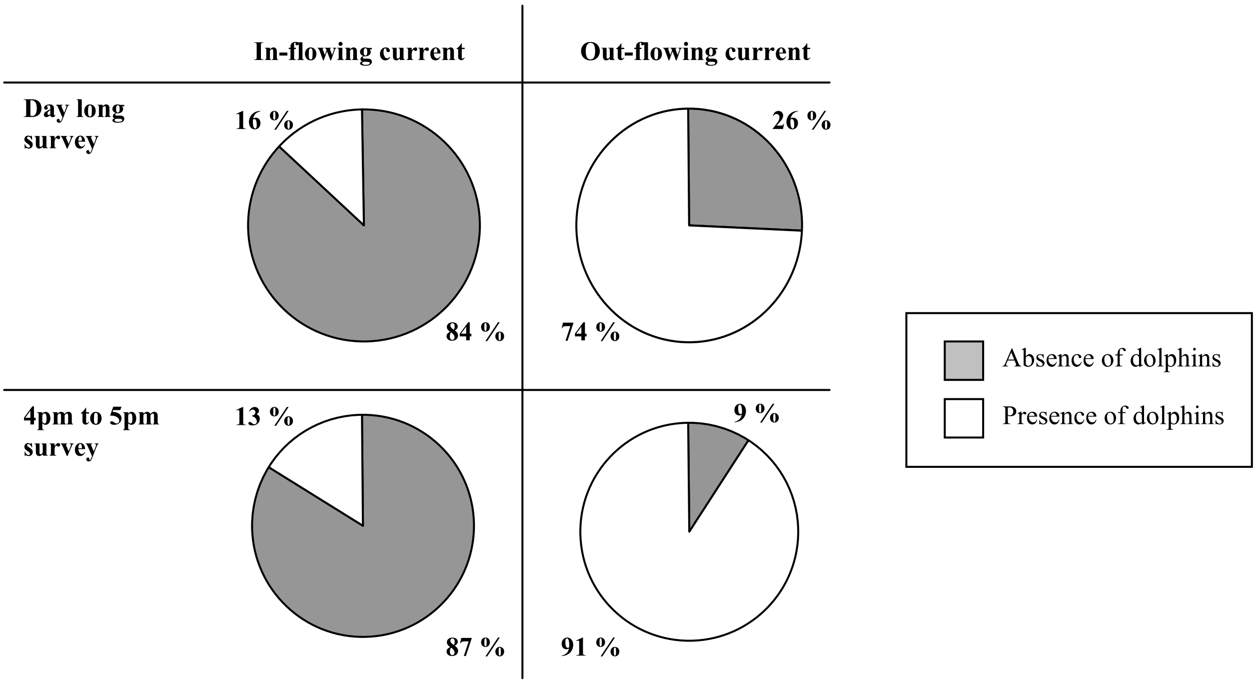

Fig. 1. Absence/presence of dolphins in function of in and out-going currents

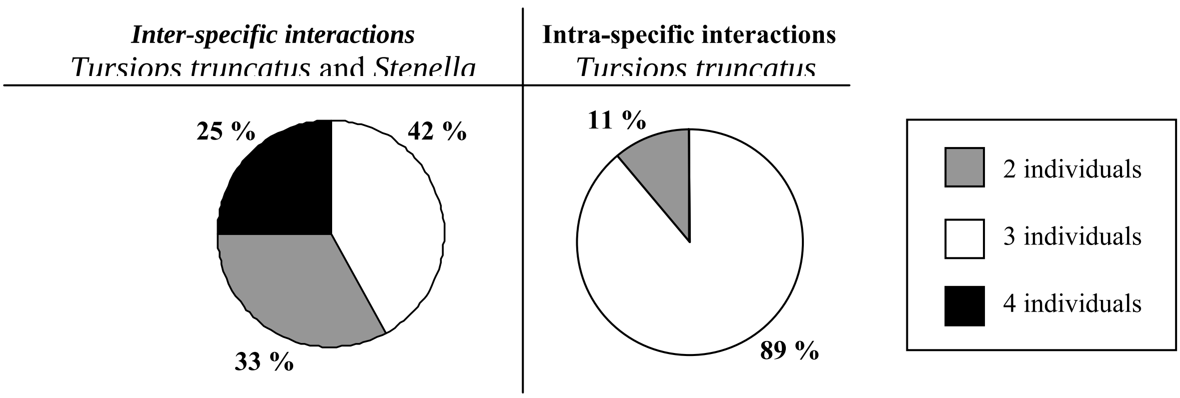

Fig. 2. Number of individuals implicated in intra and inter-specific interactions

SPATIO-TEMPORAL DISTRIBUTION OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE COASTAL WATERS OF BASSE-NORMANDIE, FRANCE

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Our understanding of habitat use by coastal bottlenose dolphins (*Tursiops truncatus*) depends essentially on studies conducted in tropical habitats or at the northern extreme of the species range. Habitat preferences of populations living in temperate coastal areas remain little documented. We present here the results from a 5-year study of habitat use by bottlenose dolphins in such an area, the coastal waters of Basse-Normandie in France. Our approach is based on three methods: an individual recognition of dolphins through photo-identification, behavioural observations of dolphins schools and information provided by a sightings network. We combine the data to identify the spatio-temporal distribution of dolphins along the Normandy coast and to determine the key areas exploited. Our results show that dolphins are seen in all months of the year and throughout the area of study. Analysis of the spatial distribution of the observations from both the sightings network and our boat surveys exhibits a heterogeneous repartition, with four peaks of presence located in the Mont Saint-Michel bay, the north-western Cotentin coast, the surrounding of Cherbourg and the eastern Cotentin coast. We show that these four areas do not correspond to isolated territories of closed subpopulations. Rather, analyses of movements and repartition of individually recognisable dolphins indicate that the observed patterns result from a differential exploitation of the environment at different temporal scales. Individuals adopt various spatial occupation strategies, some being highly sedentary on local areas, others moving through the whole area. We discuss the various bias that may affect the results and show a high degree of confidence of our conclusions. Finally we suggest which factors may originate the spatio-temporal distribution of bottlenose dolphins observed in this temperate coastal habitat.

THE IMPORTANCE OF LONG-TERM MONITORING OF BOTTLENOSE DOLPHIN POPULATIONS IN MEDITERRANEAN PROTECTED AREAS: THE CASE OF THE MADDALENA ARCHIPELAGO NATIONAL PARK, SARDINIA (ITALY)

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Because of their position at the top of the food chain, Bottlenose Dolphins (*Tursiops truncatus*) can be considered as excellent bio-indicators of a healthy marine environment. In 1999, the Nature Conservation Department of the CTS started a long term monitoring programme of the Bottlenose dolphin population in the Maddalena Archipelago National Park resulting in the creation of a Dolphin Research Centre in spring 2000. Research has been carried out through boat surveys and with the use of photo-identification techniques. From June 1999 to November 2001, 115 days have been spent surveying with a total of 524 hours spent at sea and 56 sightings. Research results have increased the knowledge on the population size and its habitat use. Population size is estimated of 20-40 individuals and habitat use has shown to vary according to the amount of boat traffic, to the presence of food resources and to that of females and calves. Major threats to the species in the park's waters have been identified as (1) nautical traffic, with more than 4000 daily tourist boats travelling in the area during the summer (2) potential pollution incidents deriving from the transit of cargo ships carrying hazardous substances in the Strait of Bonifacio (3) the presence of military installations (4) the degradation of the Posidonia seagrass beds (5) the over-exploitation of fish stocks. Based on the data collected a local action plan has been outlined entailing the following actions: a reduction of the impact of boat tourism, a regular monitoring of fishing activities to assess interactions with the dolphins, and the running of awareness programmes. As of 2002 an integrated monitoring programme involving the collection of physical and chemical water parameters and the set-up of fixed bio-acoustics recording stations will allow to collect further information to achieve effective conservation of the species.

USING VISUAL CRITERIA TO ASSESS GROUP COMPOSITION OF CUVIER'S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*) IN THE NORTH ATLANTIC

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INTRODUCTION Group composition of Cuvier's beaked whale (*Ziphius cavirostris*), like other members of the Ziphiidae family, is poorly known, with the majority of descriptions based upon stranded animals (Heyning, 1989; Houston, 1990; Castells & Mayo, 1992). In this study, a set of visual criteria based on colouration and scarring are tested to see whether they can be used to determine the age and sex of Cuvier's beaked whales at sea. It is hypothesised that these criteria can be used in order to assess group composition within this species by defining the age and sex of individuals in each group. If this hypothesis is correct, the following predictions will hold:

1. Scarring in mature animals is sexually dimorphic with males showing extensive scarring (linear marks), whilst females and calves show limited or no scarring.
2. Pale pigmentation in mature animals is sexually dimorphic with males showing a pale head and upper back. In females, the pale pigmentation is restricted to the head.
3. The extent of pale pigmentation increases with age in both males and females.

Criteria were first applied to animals of a confirmed maturity and sex, and then to groups where the sex and maturity of certain individuals was not confirmed.

METHOD Data were analysed from sightings and photographs collated from ORCA's Bay of Biscay database. Additional photographs and video footage were obtained from North Carolina and the Bahamas.

The hypothesis was tested using 22 photographs taken at sea in the North Atlantic in which the age and / or sex was known. These tests relied upon the following assumptions:

- That the sex of mature animals can be determined by the presence or absence of protruding teeth.
- That a mature animal closely accompanied by an animal of between half and three quarter size, represents a mother and calf pair.

Visual criteria were defined before the photographs were analysed (see table 1.). Diagnostic visual criteria relating to animals from the 22 photographs in which the maturity and /or sex was known, were then applied to 27 groups which included some animals of unknown sex or age. Photographic and video analysis combined with detailed notes enabled all of the animals within these groups to be categorised and the group composition ascertained.

RESULTS AND DISCUSSION **Group size variation.** Between 1995 and 2002, ORCA collated records from 59 groups of Cuvier's beaked whales involving 143 animals. The majority of sightings involved groups of between one and four animals and these accounted for 31%, 32%, 15% and 15% of the total respectively (fig. 1.).

Using visual criteria to age and sex individuals. The level of scarring and extent of pale pigmentation was examined in 22 individual Cuvier's beaked whales for which the age and / or sex was known (table 1.). Mature males differed significantly in the levels of scarring from mature females and calves (Chi sq. = 11, d.f. = 1, $p<0.01$), supporting the first prediction. Calves showed no scarring, whilst the largest number of scars recorded on a mature female was only five. By comparison, scarring in mature males was often so extensive that it was difficult to count the number of scars accurately.

Previous authors have suggested that the extent of pale pigmentation differs between the sexes in mature animals (Heyning, 1989; Martin, 1999). This assumption was tested with the second prediction but no significant difference was found (Chi sq. = 2.33, d.f. = 1, NS). Pigmentation patterns were therefore not found to be diagnostic, in terms of sexual dimorphism.

There is some evidence to support the third prediction. All six immature animals exhibited a dark head and back, and all 16 mature animals showed pale pigmentation on the head, suggesting that animals may become paler as they reach maturity. However, further information is required in order to assess whether mature animals become increasingly pale with age and whether the extent of pale pigmentation is sexually dimorphic in adults.

Sex ratio and group composition. The use of scarring as visual criteria for determining the sex of mature animals was then applied to a larger number of groups, which included some animals of unknown sex. Twenty-seven groups involving 61 animals were sexed, or identified as immature animals of unknown sex. Forty-one of the 61 animals were photographed.

Of the 56 animals identified to sex, 38 were female and 18 were male. Five immatures were also identified. The female to male ratio was found to be 2.1:1. Groups of different sizes also differed in composition (fig. 2.). Group sizes of one were made up almost entirely of mature males (83%). In contrast, group sizes of two were comprised of 67% mature females. This group size also included the highest proportion of immature animals (25%). Group sizes of three to six also involved a high proportion of females (76%) with male and immature animals constituting 19% and 5 % respectively. Finally, groups containing immature animals were comprised solely of mother and calf pairs.

Do males compete for access to female groups as part of a mating strategy? Many species of mammal live in polygynous societies, and many of these are sexually dimorphic (Macdonald, 1995). During a study of a closely related sexually dimorphic species, the Blainville's beaked whale (*Mesoplodon densirostris*), Macleod (2001) found that social groups, although frequently containing a number of adult females and juveniles, were not observed to contain more than one adult male. Macleod concluded that Blainville's beaked whales might have a primarily polygamous breeding system with adult males competing aggressively for access to receptive females.

This preliminary study suggests that Cuvier's beaked whale may be another species of Ziphiidae participating in this mating strategy. Extensively scarred mature males were primarily sighted as solitary individuals, or as the only male within groups of mature females, suggesting that males may compete for access to these female groups.

Mature males were also found to be absent from all female groups in which immature animals were present. These groups consisted solely of mother and calf pairs with no independent mature females or males present. As 32% of mature females exhibited some scarring, presumably from the teeth of mature males, it is possible that females with young avoid these groups either because they are not ready to mate, wish to protect their young from aggressive interactions, or both.

About ORCA. Organisation Cetacea (ORCA) provides a forum for raising interest and participation in conservation research on cetaceans by developing a network of volunteer observers capable of collecting information, photographs and video footage during offshore surveys. This information can be of great benefit to current research, particularly when the species being studied is poorly understood.

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Table 1. The sex, maturity, extent of scarring and extent of pale pigmentation in 22 Cuvier's beaked whales for which the age and / or sex was known

MATURE	IMM 3/4 SIZE	IMM HALF SIZE	SEX	EXTENSIVE SCARRING (>10)	LITTLE SCAR-RING (0-9)	NO SCARS	DARK HEAD & BACK	PALE HEAD, DARK BACK	PALE HEAD AND BACK
Yes			Female		Yes			Yes	
Yes			Female		Yes				Yes
Yes			Female		Yes			Yes	
Yes			Female			Yes		Yes	
Yes			Female			Yes			Yes
Yes			Female			Yes		Yes	
Yes			Female			Yes		Yes	
Yes			Female			Yes		Yes	
Yes			Female			Yes		Yes	
Yes			Female			Yes		Yes	
Yes			Female			Yes		Yes	
Yes			Male	Yes				Yes	
Yes			Male	Yes				Yes	
Yes			Male	Yes					Yes
Yes			Male	Yes					Yes
Yes			Male	Yes					Yes
	Yes					Yes	Yes		
	Yes					Yes	Yes		
	Yes					Yes	Yes		
		Yes				Yes	Yes		
		Yes				Yes	Yes		
		Yes				Yes	Yes		

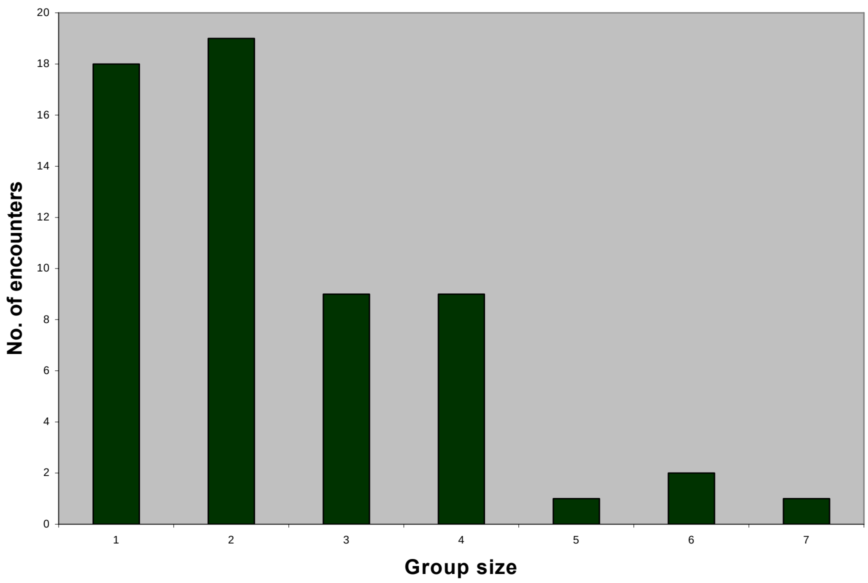

Fig. 1. Group size distribution of Cuvier's beaked whales during 59 encounters between 1995 and 2002

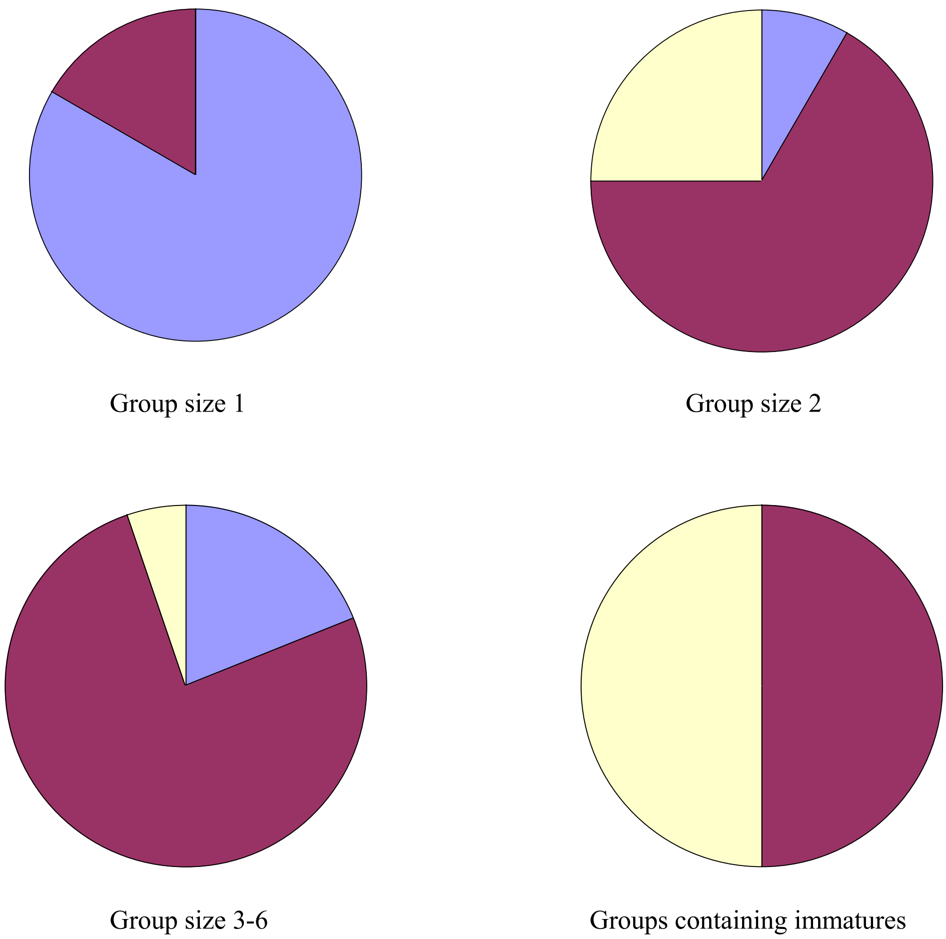

Fig. 2. Percentage of males (pale grey), females (dark grey) and immatures (white) in different group sizes based on the analysis of 27 groups of Cuvier's beaked whales

COMPARING TWO MONITORING TECHNIQUES FOR THE SUMMER POPULATIONS OF CETACEANS IN THE MEDITERRANEAN SANCTUARY

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INTRODUCTION Populations of cetaceans in the International Marine Mammals Sanctuary Mediterranean need to be monitored on a long term basis. This is particularly the case for striped dolphins and fin whales whose population have been estimated in various areas of the Western Mediterranean in the past (Forcada *et al.,* 1996; Gannier, 1998). As new limits have been agreed for the Sanctuary by Italy, France and Monaco on 29 November 2001 (Fig.1), a first important step was to determine the summer distribution of these populations and to quantify their abundance within the new area. During summer 2001, two simultaneous surveys took place in the Sanctuary: one carried out by the C.R.C./G.RE.C. and the other by the WWF-France. They were run independently and used two different sampling strategies, but were both to deliver relative or absolute abundance estimates on striped dolphins and fin whales populations. The distribution results obtained by each survey, and relative abundances for three regions of the Sanctuary could be compared. The discussion rose methodological points on both monitoring techniques, as well as practical consequences for future similar surveys.

MATERIAL AND METHODS: C.R.C./G.RE.C. survey. A standard line transect method was implemented from 25th July to the 3rd August, with a motor boat cruising at 10 knots average speed, in four regions of the Sanctuary. Four observers were seating on a 4.5 meter deck: three of them shared the 180° frontal sector, searching with naked eyes, one supplementary observer was also a sighting secretary. Observers rotated on a one-hour basis, two resting positions being available during the survey. Every 20 minutes, the boat was stopped during 3 minutes to carry out a passive acoustics monitoring session, and various environmental parameters recorded. Two reticuled binoculars were used for measuring the sighting relative position. Sampling consisted in pre-determined zig-zag lines in four stratified areas of the Sanctuary: the Central (CE), Northeast (NE), Southwest (SW) and Tyrrhenian regions. A passage mode was used (Hiby and Hammond, 1989) whenever cetaceans were sighted, the cruising speed being decreased to 7 knots for 30 sec-2 min to enable a more efficient school size estimate. The survey was designed to deliver absolute abundance estimate (Gannier *et al.*, 2001), however distribution variables and relative abundance estimates obtained with Distance 2.2 will be presented here.

Cap Ligures survey. The Cap Ligures survey (WWF-France) took place from the 20^{th} July to the 3d August : two motorised sailboats applied the LTM at 5.5 knots average speed. Three permanent observers cover the 180° frontal sector, with their eyes situated at 2,75 m above the sea surface. A fourth one recorded the sightings parameters. Two resting positions enable a rotation of the observers. We applied mainly (81%) a passage mode, and otherwise the boat moves briefly closer to the animals to precise the group size estimation. The sighting relative positions were measured with reticuled binoculars. Estimation of school size were rounded to the nearest 5 multiple (when the group encompassed 30 individuals). The positions of the boat given by a GPS, connected with the pilot automatic, were automatically recorded into a computer each half an hour. We noted at the same time the meteorological conditions. Based on a previous work named POSEIDON (Roussel *et al.*, 2001), the Sanctuary was split into 20' latitude/longitude squares. To ensure a sufficient and homogeneous prospection effort, 37 km to 74 km were to be cruised on-effort in each square in predefined straight segments. The aim of the survey was to obtain an extensive distribution of striped dolphins and fin whales and their relative abundance. Sampling was designed to avoid double counting between both boats, in principle.

Calculation of the indices of relative abundances per sector Relative abundance Indices R were computed with *Distance* 2.2 software (Laake *et al.* 1994). for both species and each survey in the three regions. Our relative abundance was obtained from the density estimator of Buckland *et al.* (1993) :

$$\underline{D} = (n / L) . \underline{E(s)} / 2 \text{ esw}$$

where n= the number of primary sightings, L= the transect length, E(s) the mean school size and esw effective detection half-width, which was considered constant for each survey team across all regions. Then R = (n/L)*E(s) as in Gannier (1999). This assumption holds if meteorological conditions were good or very good during all sampling period and E(s) was similar in all three regions. Only effort covered with sea state and wind conditions ≤ 3 Beaufort were retained for this study.

RESULTS Wind rarely exceeded Beaufort 3 during the period of study. E(S) were estimated for every region and tested to be not significantly different, hence they were latter calculated for the whole Sanctuary. Possible correlation between E(S) and perpendicular detection distance was also looked for (Buckland *et al.,* 1993) but found to be not significant. Hence, the assumptions for using relative abundance R were met for both surveys.

Sampling effort Effective effort amounted to 1182km (CRC/GREC) and 2095km (WWF), see Fig.2. It was verified that all three regions were homogeneously covered with a specific effort of about 20 m/km² for the CRC/GREC and 36 m/km² for the WWF (although in the latter case, effort in the NE region was slightly less intense).

The sampling homogeneities were compared for both surveys at three scales: mean sampling effort and associated variances were calculated on grids of 60x60, 30x30 and 15x15milles. Effort was more homogeneous at large scale for CRC/GREC (CV=0.40 against 0.52) and more homogeneous at small scale for WWF (CV=0.46 against 0.50), thus illustrating sampling strategies adapted to each survey specific goals.

Sightings and Mean group sizes For fin whales, 21 on-effort sightings were obtained by CRC/GREC during the period of study and 35 by WWF (Fig.3). A mean school size of 1.18 (CV=10.4%) was estimated by CRC/GREC against 1.66 (CV=14.1%) for WWF. Estimates of E(S) were significantly different between both surveys (test T p>99%).

For striped dolphins, 42 on-effort sightings were obtained by CRC/GREC during the period of study and 53 by WWF (Fig.4). A mean school size of 18.8 (CV=12.6%) was estimated by CRC/GREC against 25.7 (CV=18.9%) for WWF. Estimates of E(S) were significantly different between both surveys (test T p<0.01).

Abundance indices For fin whales, CRC/GREC obtained abundance indices of 0.46, 3.40 and 1.26 ind./km^2 in SW, Central and NE regions respectively (Table 1, left part) when WWF estimated 2.68, 3.33 and 1.45 respectively. Hence, if both surveys agreed on relative abundances in NE and Central regions, their estimates were different for the SW region, found to be much higher by WWF than by CRC/GREC. Within each survey, statistically significant differences (95%CL) were found between all regions (CRC/GREC) and NE/Centre regions (WWF).

For striped dolphins, CRC/GREC obtained abundance indices of 44.3, 88.3 and 50.3 ind./km^2 in SW, Central and NE regions respectively (Table 1, right part) when WWF estimated 52.1, 83.2 and 33.7 respectively. Both surveys agreed on relative abundances in NE, Central and SW regions, their estimates being in the same order of magnitude, with the possible exception of NE area. The differences were found significant between all sectors for the WWF survey (p<0.05), and not significant at the 95%CL for CRC/GREC survey.

DISCUSSION Since significant differences arose between both survey results, discussion focused first on the influence of methodological points on relative abundance results and then on cetacean distribution aspects, in the perspective of efficient monitoring of the protected area.

Concerning WWF Cap Ligures ‘s data, the risk of double counting for one boat was verified by considering archive data on cetacean movements and existed in 5 cases only. Double counting between boats was similarly estimated to be possible in 8% of the cases. We assumed that double counting could not seriously affect our results and both the data sets.

Group sizes, E(s), was similar between boats data sets for fin whales, and significantly different for striped dolphin with : boat 1 E(S)=24,5 ; boat 2 E(S)=19,2 (T=2,52 et p=0.017).

The R values for each boats were found to be significantly different for both species between the three sectors (test T, p<0.01 for fin whales, and p= 0.01 for striped dolphins). This is due to sampling covering distinct areas for each boat (within one region), the strategy being to obtain global and representative result by grouping both data sets together.

The differences of the E(s) values obtained by the C.R.C./G.RE.C. and the Cap Ligures surveys, could arise from bias or rounding effect in estimates. Possible correlation between number of individuals and date, time or sighting distance were tested unsuccessfully. The possible influence of remote (over 2500m in radial distance) and short duration (less than 30sec) sightings was observed in the GREC data set : after removing those cases, the school size estimate rose to 1.29 instead of 1.18. Also, due to insufficient sample size, differences might be the consequence of spatial heterogeneity in distribution. The fact that variable school sizes were also estimated for striped dolphins indicates that increased attention should be given on this delicate methodological point.

The differences of R values between surveys was not important for striped dolphins and significant for fin whales, mainly affecting the SW region (NE being less covered by WWF). Although, inter-survey difference may be caused by respective sampling design within study areas, they could also highlight movements of animals during the summer period. In the SW, Cap Ligures survey, which took place on 23, 24 and 25th of July, numerous sightings of both species were made near the western and northern borders of this region (Figs 1-2). Moreover, Cap Ligures survey sampled the Central sector mainly on 21, 22 and 26th of July, and the C.R.C./G.RE.C. 8 to 10 days later. Westwards distribution shifts could be possible for fin whale during this time lapse, as northwards movement of striped dolphins are plausible. These results would confirm and precise phenomena of movements in the Mediterranean sea (David *et al. 2001 ;* Roussel *et al.* 2001).

Teaching about both type of surveys An "absolute abundance" survey like the C.R.C./G.RE.C. one, allow an homogeneous sampling effort over vast sectors. It is realised in a short period of time, so that the hypothesis of non transfer of animals between sectors is accepted, and with a design avoiding double counting inside sectors. But the sampling is not exhaustive on a smaller scale. The "hazard" of sampling can lead to differences between estimated and real abundance, although this is normally covered by variances estimate.

A « small squares » survey like the Cap Ligures one, benefits of exhaustive sampling over the sectors covered. The duration of field sampling cannot *a priori* avoid transfer of animals. According to the cruise speed and distance between transects, double counting between different boats may be excluded within sectors, enabling to get relative abundance results on large scale in these sectors.

The comparison of both surveys allowed to compare indices of abundances R between regions, and to highlight distribution results given by the « small squares » survey.

CONCLUSION For the first time an exhaustive distribution survey was coupled with a survey designed to deliver absolute abundance estimate on large scale, complementary approaches leading to additional results. The "time" factor which arises from our findings highlights probable summer movements of cetaceans within the Sanctuary and from/to adjacent waters, potentially important points for the monitoring of cetaceans population in the Sanctuary.

ACKNOWLEDGEMENTS We thank La Fondation Natures et Découvertes, and the benevolent observers.

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Table 1: Effort, sightings, mean size group and indices of abundances for fin whale and striped dolphin obtained by the C.R.C./G.RE.C. survey and by the Cap Ligures survey

CRC/GREC						CAP LIGURES				
	Effort	**Sighting**	**E(S)**	**Indice R**	**R**	***Effort***	***Sighting***	***E(s)***	***Indice R***	***R***
Fin whale	**(km)**	**nb**	**CV%**	**(ind./100km)**	**CV %**	***(km)***	***nb***	***CV%***	***(ind./100km)***	***CV %***
NE	374	4		**1.26**	50.2	*458*	*4*		***1.45***	*55.0*
Central	553	16	**1.18**	**3.40**	26.3	*1144*	*23*	***1.65***	***3.33***	*29.5*
SW	254	1	10.4%	**0.46**	97.9	*493*	*8*	*14.1%*	***2.68***	*77.2*
THREE REGIONS	1181	21		**2.18**	23.4	*2095*	*35*		***2.56***	*29.7*
Striped dolphin										
NE	374	10		**50.3**	16.1	*458*	*6*		***33.7***	*39.9*
Central	553	26	**18.8**	**88.3**	27,0	*1144*	*37*	***25.7***	***83.2***	*34.7*
SW	254	6	12.6%	**44.3**	50.8	*493*	*10*	*18.9%*	***52.1***	*21.5*
THREE REGIONS	1181	42		**67.8**	20.8	*2095*	*53*		***59.6***	*26.7*

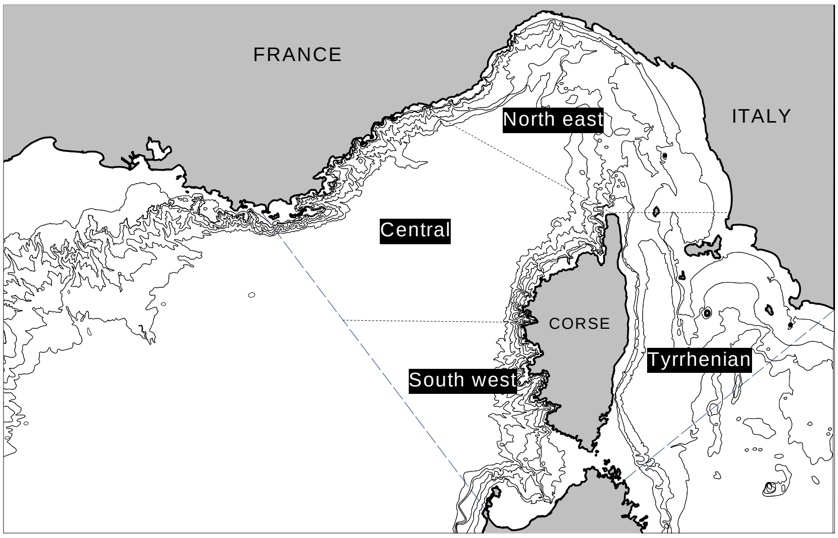

Fig. 1. Limits of the International Marine Mammals Sanctuary Mediterranean, and of the fourth regions of study, Central, South-west, North-East and Tyrrhenian Sea

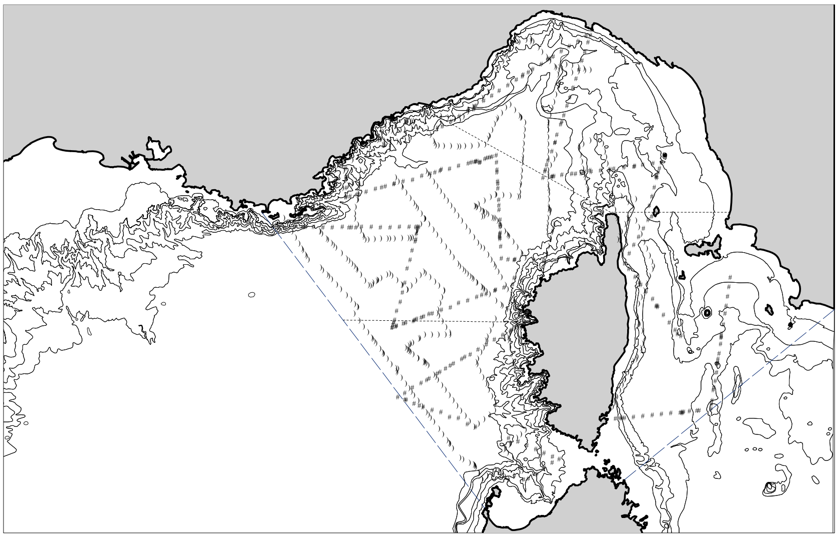

Fig. 2. Sampling effort in wind conditions ≤ 3 Beaufort for the C.R.C./G.RE.C. survey (black) and Cap Ligures survey (grey)

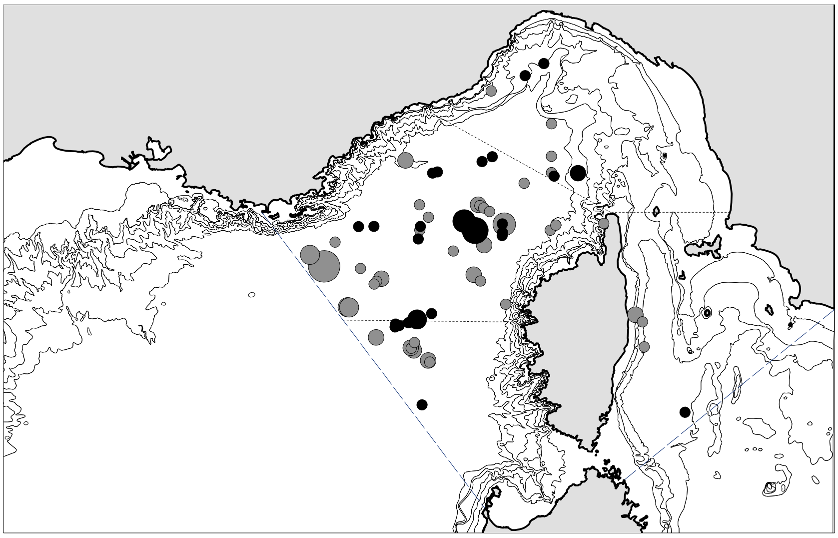

Fig. 3. Sightings of fin whale during the C.R.C./G.RE.C. survey (black) and Cap Ligures survey (grey). The smallest circle = 1 individual, the biggest = 7 indiv.

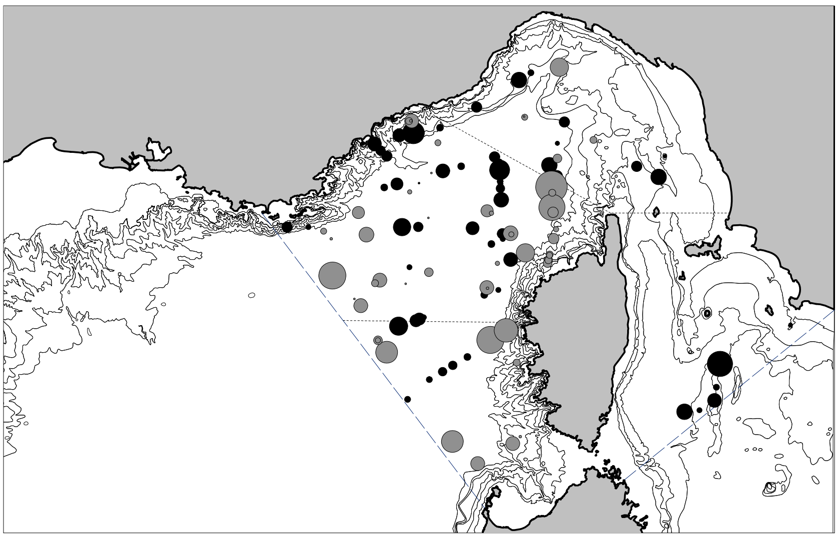

Fig. 4. Sightings of striped dolphin during the C.R.C./G.RE.C. survey (black) and Cap Ligures survey (grey). The smallest circle = 1 individual, the biggest = 130 indiv.

USE OF A SIGHTINGS NETWORK INCLUDING PROFESSIONAL MARINE USERS IN THE STUDY OF A POPULATION OF BOTTLENOSE DOLPHINS IN NORMANDY, FRANCE

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INTRODUCTION A population of bottlenose dolphins (*Tursiops truncatus*) lives along the Normandy coast, in France. Dolphins are seen on a wide territory (around 3500 km2) including the coastal waters of the Cotentin Peninsular (from Mont Saint-Michel Bay to Veys Bay) and Channel Islands (Jersey, Alderney, Minquiers reefs).

We study the population since 1995. We use boat-based surveys and photo-identification techniques to investigate the distribution, habitat use and social organisation of dolphins. However, our first prospecting clearly suggested that focusing on few local areas would lead to important misinterpretations. The relevant analysis scale of the population includes all the coastal waters around the Cotentin Peninsular. The methodological problems induced by this large area led us to develop an important sightings network, whose originality and efficiency is due to the implication of numerous marine professional users.

METHODS The sightings network includes both professional and non-professional marine people. Since 1997, a convention associates officially the six French Navy Semaphores (installations of Marine) and the professional fishermen authorities (700 boats concerned) covering the area. Others marine professionals (coastguards, marine customs, shuttles boats,...) are also involved in the network, though not on an official basis.

Militaries within Semaphores make themselves sightings. Other professional marine users transmit directly their observation by VHF to the nearest Semaphore. Information is collected on data grids that are ordered to us each month. Data include information on the observer and eventually its boat, on location, date and time of the sighting, on behavioural observations and meteorological conditions. Data grids are also available in harbours and are used by non-professional observers. Reliability of the information provided by the network requires an important work of public information. Meetings with professionals and conferences are regularly organised. Quality index are allocated to sightings depending on location precision and other cues.

RESULTS **Network efficiency** *Observational pressure* 1006 sightings of bottlenose dolphins were collected between 1995 and 2001. Numerous parameters (number of observations per year, number of observers per year, mean number of observations per observer per year, etc.) indicate that the observational pressure is stabilised since 1998. (Fig.1.)

Complementarity between professional and non-professional marine users Professional and non-professional marine users provide approximatively the same amount of sightings (Fig.2.). The contribution of professional marine users to sightings is more especially essential outside summertime. Survey areas of professional and non-professional marine users are complementary.(Fig.3.)

Increased efficiency of photo-identification The network increases greatly the efficiency of our boat-based surveys and consequently photo-identification. Locating of dolphins is highly facilitated. For instance, in 1995, dolphins were encountered 7 times on 20 boat prospecting days; in 1999 and 2000, 31 of 36 boat prospecting days were successful. (Fig.4.)

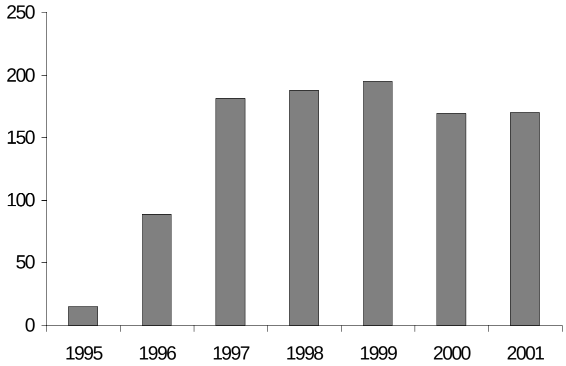
Spatio-temporal distribution of sightings (Fig.5.) Dolphins are seen throughout the area and, since 1998, each month of the year. Since this year, the shape of the monthly distribution of sightings stays constant, with a high peak in summer and especially in August, and a decrease in winter. Meteorological observational conditions and variations in the intensity of boat traffic are undoubtedly involved in these time fluctuations.

Spatial sightings are not evenly distributed. Some areas show high concentrations. Dolphins are however regularly observed in the intermediate areas. Seasonal changes affect the distribution of sightings. For instance, sightings in the North (Cherbourg) occur mostly in winter, whereas sightings in the East (St-Vaast) occur mostly in summer.

Determining the link between spatio-temporal distribution of sightings and the actual spatio-temporal distribution of dolphins requires to take account of the underlying bias, especially nautical activity and weather conditions. The diversity and the complementarity of observers allows a cross-checking of information, thus a partial control of bias. Data from our boat surveys and especially from photo-identification provides additional information for the validation of the analyses.

CONCLUSION The relevant scale for the study of the population of bottlenose dolphins living in the coastal waters of Normandy is large. To obviate this methodological constraint, the sightings network presented here is an essential tool, that reinforces and complements boat-based surveys and photo-identification. Furthermore, the partnership forged with marine users, professional or not, positively affects their concern in the protection of bottlenose dolphin, and more generally of marine mammals, in an area with important boat traffic.

ACKNOWLEDGEMENTS We gratefully thank all the members of the network, and especially the marine authorities and fishermen for their collaboration.



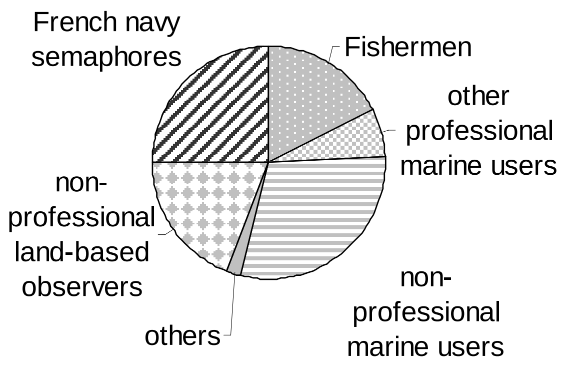


Fig. 1. Number of sightings per year	**Fig. 2.** Repartition of sightings

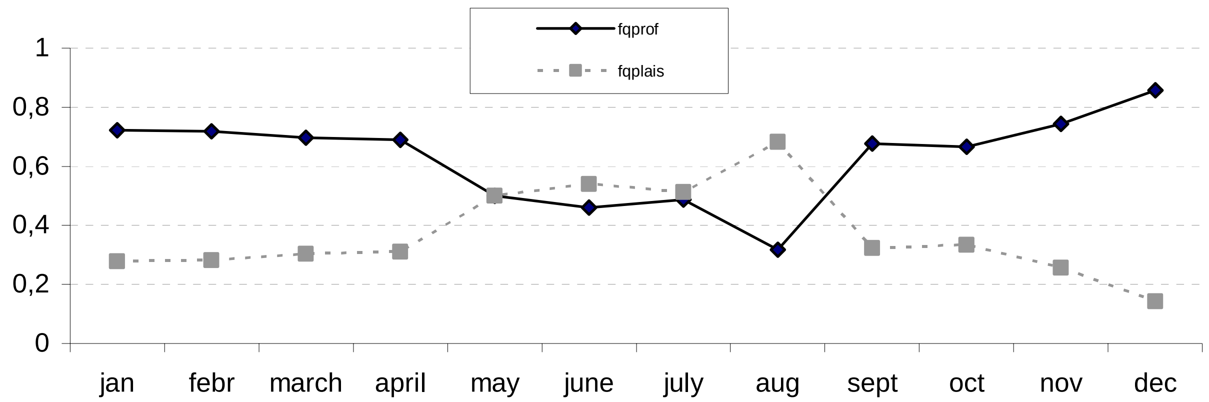
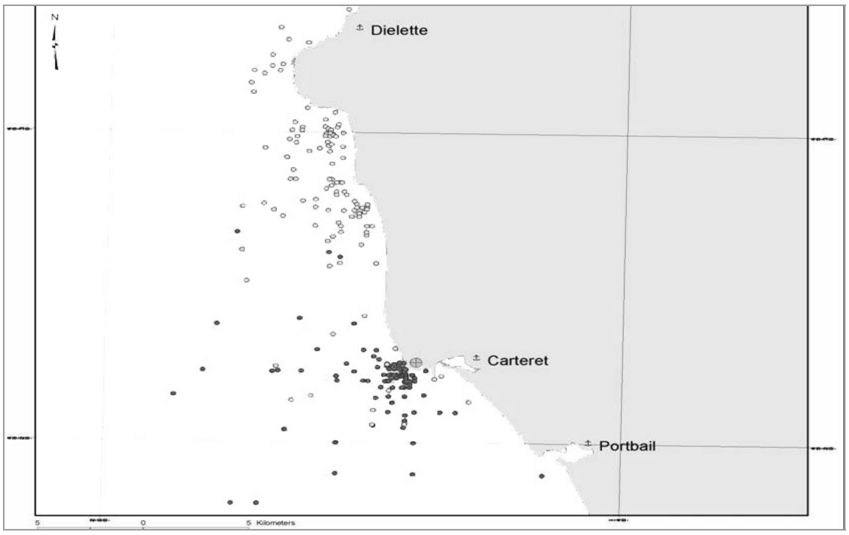


Fig. 3. Seasonarity of sightings



Land-based sightings ● French Navy Semaphores
● non-professional observers

Fig. 4. Complementarity of professional and non-professional land-based observers : example of Carteret area

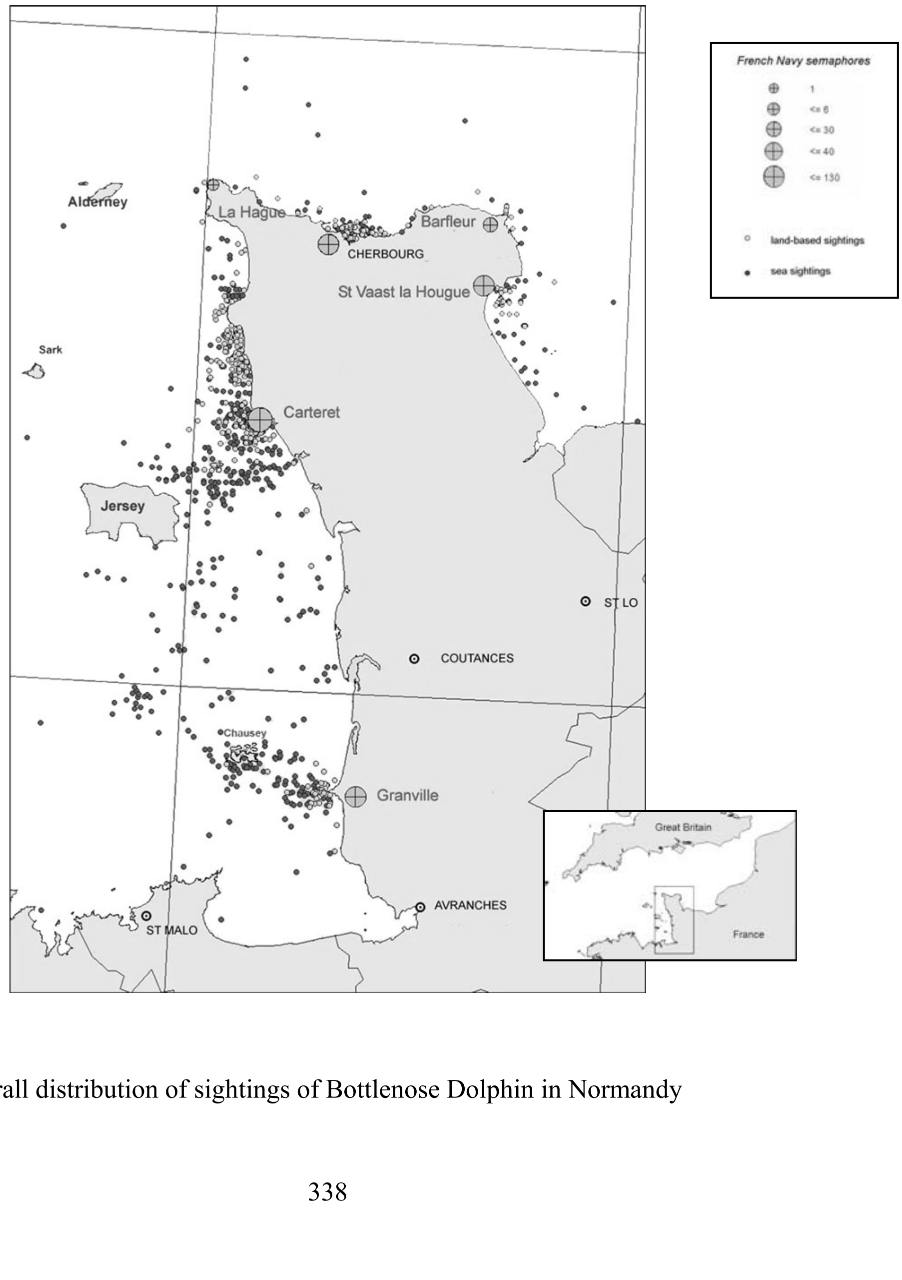


Fig. 5. Overall distribution of sightings of Bottlenose Dolphin in Normandy

PHOTO-IDENTIFICATION OF BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS* (MONTAGU, 1821), IN WATERS OF NORTH-EASTERN SARDINIA

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Up to now really few long term studies on bottlenose dolphin have been carried out in the Mediterranean sea, and much fewer on photo-identification of a resident population. Since 1991 the "Accademia del Leviatano" is involved in the behaviour ecology study of a resident bottlenose population in waters of north-eastern Sardinia. This photo-identification study presents the results obtained during seven years of research between 1991-1994 and 1999-2001. All photographs have been realised in the Olbia Gulf (SS) from a motor boat and the observation effort has been uniform all over the months. A Nikon F401x AF reflex camera with zoom lens of 35-80mm e 100-300 mm has been used with Kodak ELITEchrome ASA 100 films. All of the photographs have been selected, labelled and included in a chronological catalogue. 1500 photographs have been considered useful for the study and 18 dolphins have been identified by natural marks. Also, in 2001 there are some individuals already recognised in the years 1991-1994. The photo-identified dolphins belonged to schools with a size mean of 5,14, SD=2,82, and, with a confidential interval of 95%, the school size was between 4,03 and 6,26 individuals. Schools change constantly in the population, that means they are not clearly defined and a constant fission-fusion model characterises them. By this photo-identification study a higher presence of the animals in this area compare to the 1991-1994 study period has been showed up.

MONITORING HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN CAPE MONDEGO, CENTRAL PORTUGAL

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The occurrence of harbour porpoises was monitored in the Cape Mondego region between March 2000 and February 2001. The fieldwork was based on land-based observations using binoculars and telescopes. During the study period, a total of 172 observation' hours allowed harbour porpoises to be detected in 46 different occasions. The animals were present all year round and the most common behaviour detected involved foraging or feeding. Although most sightings involved one single animal, group size ranged between 1 and 3 individuals, with a mean group size of 1,7 ± 0,7 animals. Calves were first seen in late July, in accordance with records for the breeding season for this species in European waters. The sighting index (number of sightings/hour of observation) in relation with tide has shown that harbour porpoises frequently occur in the area between water peak levels and during the low tide. This pattern could be related to the foraging activity, considering that porpoises might use the current flow to capture their prey. Despite the relative low number of harbour porpoises detected, it was possible to conclude that this area is important in terms of feeding resources. Further studies will be developed in order to evaluate the real importance of this region and also to allow a deeper knowledge of harbour porpoise densities and distribution along the Portuguese coast.

INDICATIONS OF A RESIDENT POPULATION OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) IN MADEIRA

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The volcanic Islands of Madeira are located in the North-eastern Atlantic and represent an area of increased productivity in relation to the surrounding oligotrophic ocean. Until recently it was however unknown whether the productivity and the local conditions of these waters were enough to sustain resident cetacean species. The photo-identification of bottlenose dolphins (*Tursiops truncatus*) carried out in 1997 and 1998, during opportunistic encounters, and in 2001, during cetacean census surveys, revealed inter-annual sightings of some individuals, revealing their residency in these waters, at least in a seasonal basis. The presence of some individuals in the Autumn and in the successive Spring and of other animals in the spring and in the following summer, suggests that some animals can be present all year round in Madeira. Further photo-identification effort, mainly during the winter season, is however needed to clarify their residency patterns. No preferred areas were detected. Further investigation will enable to verify whether all regions are evenly used by this population.

OCCURRENCE AND HABITAT USE OF DUSKY DOLPHIN, *LAGENORHYNCHUS OBSCURUS*, IN SUMMER AND FALL, IN GOLFO NUEVO, ARGENTINA

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Off Patagonian coasts, in the Southwestern South Atlantic, dusky dolphins are common small cetaceans. This species is the aim of newly developed watching activities during summer in Golfo Nuevo, Argentina. However the real occurrence and movement pattern are unknown. The objectives were to determine the occurrence of dusky dolphins in the western portion of Golfo Nuevo, to determine the relationships between environmental features (bottom depth, bottom depth gradient, substrate) and sighting data and to determine whether group behaviour is related to environmental features. Shipboard surveys were conducted from January to May 2001, through random transects. When a group of dolphins was sighted, estimates of group size, composition (mothers with calves, adults and juveniles only, and mixed groups) and the predominant activity (feeding, travelling, socialising, resting, social-travelling and milling) were recorded and thereafter for each 2min intervals. The location of each group was tracked and recorded by a GPS. A grid of 1.5x1.5km squares was constructed and each square was characterised by depth, depth gradient and substrate. The tracks were overlapped to the study area. Two indices were used, Area Use Index and Activity Index. Eighty-eight trips were performed, watching 151 groups, from which 93 were tracked. Mothers with calves were more frequent in January while mixed groups were more frequent at the end of the study period ($G=12.7$, $p=0.048$). Areas with steepest gradient showed highest values of Area Use Index ($G=14.36$, $p=0.006$). Mothers with calves occurred in shallowest waters ($KW=14.02$, $p=0.0009$). Smallest groups occurred in shallowest waters ($KW=23.77$, $p=0.0002$). “Resting” occurred in shallowest areas and “travelling” occurred in deepest areas ($KW=13$, $p=0.019$). Bottom depth and bottom depth gradient were the more important environmental features determining dolphins distribution. These variables could be related to preys distribution, although “feeding” is not the only activity developed in the study area.

DISTRIBUTION, ABUNDANCE, HABIT USE AND SOCIAL BEHAVIOR OF *GRAMPUS GRISEUS* IN THE EAST OF CANARY ISLANDS

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INTRODUCTION Little is known about the Risso´s dolphin communities in the North and South coast of Gran Canaria island. Risso´s dolphin *(Grampus griseus)* lives in coastal waters characterized by very depth slope, surely due to the high biological productivity associated to these areas. The habitat of Risso´s dolphin in Gran Canaria supports a high maritime traffic density, which originates acoustic contamination and elevates the probabilities of collisions with boats. The population in the North of the island has been observed close to the Puerto de La Luz. This is a very busy harbour which supports a high commercial traffic whereas in the South, the maritime traffic is mainly tourist and recreational. Also whale-whatching activities are becoming more important in this area and these boats don't always respect the whale-watching regulations.

Study area The study areas include Places of Communitary Interest (LIC). The LIC of "La Isleta" is in the North of the island. La Isleta was a small barren island separated from Gran Canaria, which is now linked to the main island due to the formation of a sandy structure. The topography of the area is influenced by the oceanic location and the volcanic origin of the islands. Its main feature is a small continental shelf and an abrupt bathymetry with a profile that emerges rapidly from the sea bottom only a few kilometres away from coast. These conditions seem to favour the establishment of the species in this zone. The LIC of the marine strip of Mogán, located in the South-Southwest coast of the island, however presents an extensive shelf and the 50 m. isobaths extends several miles away from the coastline.

METHODS

1. Area prospection and effort.

The area was prospected by means of transects which were designed in zigzag and perpendicular to the coastline arriving until the 1500 m. isobaths. GPS data, sea disturbance and wind force, were taken every 15 minutes.

2. Information taken during each encounter.

Number of animals, age classes, activity, group structure, etc.

3. Photographic sampling and social behaviour**.**

Photographs were taken for later identification and each encounter was video recorded for a later analysis of behaviour.

RESULTS Total boat effort was 137 days, 917.9 hours and 6.529,5 nautical miles. Risso´s dolphins were observed 19 times around the islands of Fuerteventura, Lanzarote and Gran Canaria. The species was most frequently found in the north of Gran Canaria despite the small searching effort. The depth of the encounters was betweeen 54,5 m. and 1.100 m. (mean: 647,6 m SD=229.8). Group sizes ranged from 3 to 30 with all age classes present. The photo-identification study was initiated in January 2000. A total of 1.200 photograhs of dorsal fins and bodies have been taken for photoidentification. At the moment, 59 animals have been identified from the left side, 23 from the right side and 8 from both sides. Two animals belonging to the same sighting in June 2000 in the North of Gran Canaria were re-sighted in December 2001 in the South. At least four animals belonging to the same sighting in February 2000 were re-sighted in November 2000 and December 2001.Calves were present in both encounters. Also two animals seen in the South of Gran Canaria were seen again off the East coast of Tenerife.(fig.1)

Risso´s dolphins have been classified in different categories attending to the percentage of scars on their bodies:
1- 0-25%
2- 25-50%
3-50-75%
4- 75-100%

CONCLUSIONS The present study pretends to obtain more information about a species which very frequently observed in its distribution area worldwide but which is poorly known. Risso´s dolphin is one of the species that has been mostly seen in the eastern islands of the Canary Archipelago by the ships in the area all over the year (pers.com). At the moment, we have more information about this species in Gran Canaria that in the other islands, which will be sampled soon. Risso´s dolphin is present in Gran Canaria during the whole year. From the obtained data, we can say that it can be found everywhere around the island except a small coastal area in the Southeast where no sightings have been made until now. All age groups were present in all encounters, except twice where calves were not observed. Groups with calves were always seen in the South of the island in shallow waters (55m) and in the months of winter. We suppose, that the South of the island offers more protection to the calves. A change in behaviour has been observed during encounters with whale-watching vessels. Animals that at the beginning were very quite, became evasive and increased their swimming speed as soon as the boats arrived.

Fluke exposition was present in all sightings. The meaning of this behaviour is still unknown A long-term study will help us to know much better the biology and social behaviour of *Grampus griseus* in Canary waters. It is also important to know how the presence of numerous boats influences on the species, both in the North as in the South of the island. The results and recommendations derived from this study will be worth full to design a conservation plan of this species in the area.

ACKNOWLEDGEMENTS We would like to thank the entire crew of Monachus: Silvia Hildebrandt, Antonella Servidio and Chago Quintana for all their help and friendship, both ashore and at sea.

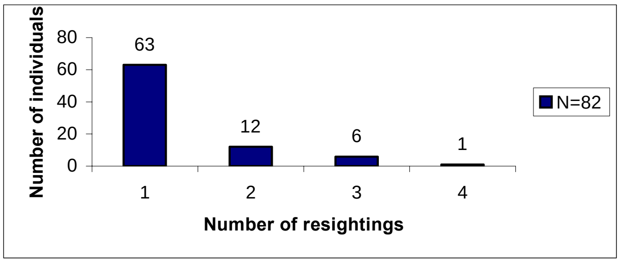


Fig.1 Percentage of resightings

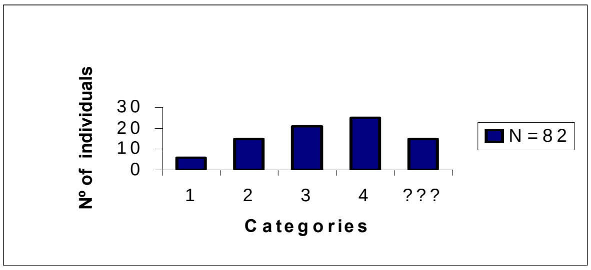
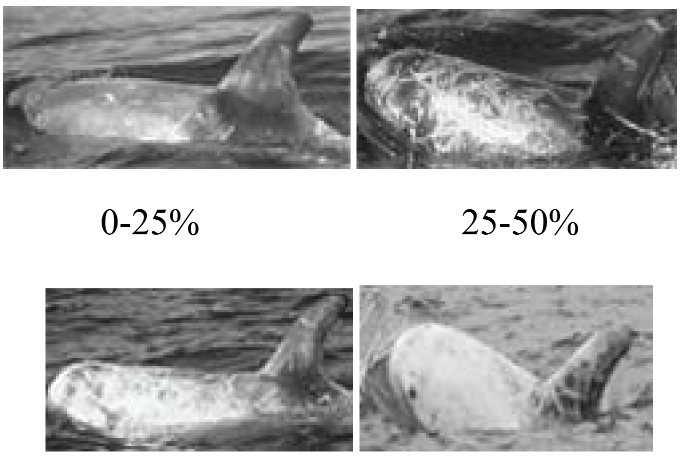


Fig.2 Percentage of individuals by categories



0-25% 25-50%

50-75% 75-100%

Fig. 3

KERCH STRAIT AS THE GATE OF CETACEAN MIGRATIONS: ECOLOGICAL AND GEOGRAPHICAL ASPECTS

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INTRODUCTION The detailed investigation of cetacean migrations and direct and indirect factors affecting them is the essential part in research concerning population dynamics and status, and principles of wildlife management and conservation. The migrations of Black Sea dolphins are non-accidental; nevertheless, after the long period of research (Mal'm, 1938), our knowledge of their patterns remains insufficient because of lack of data. Some attempts to get any notions in this sphere by the way of animal marking in the past (E. Mal'm, V. Zalkin) were unsuccessful (Zalkin, 1935).

The role of straits is very important in migration process; in particular, the Kerch Strait attracts an attention as the unique sea area with the shoals creating the favorable feeding conditions for bottlenose dolphins and harbour porpoises (Kleinenberg, 1956). The Kerch Strait was formed in Pliocene, its outlines changed during recurring transgressions; it is regarded as a submerged ancient delta of "Palaeo-Don" River (Muratov, 1960; Shnyukov *et al.*, 1979). The Kerch Strait connects the Black Sea and intracontinental basin of the Sea of Azov (Fig. 1). It occupies the sea area limited by the lines between Khroni and Achilleon Capes in the north and Takyl (Takyl Kavolari) and Panagia Capes in the south (in 8 INM each one) and Kerch and Taman coastlines in the west and in the east. The length of the Kerch Strait is 42.7 km; the width is 3.2-16.0 km. Fairway is very narrow because of numerous rocks and banks. The deepest part of the Strait is about 17.7-18.3 m, further north it becomes shallower (4.3-4.9 m). The special navigating channel (10.7 km in length, 106.7 m in width and 6.4 m in depth) was dug across the Strait near Yenikale in 1886 (Semenov Tyan Shansky, 1910), later it was deepen up to 11.0-12.0 m, but during the last time the channel was out of maintenance. In winter a surface of the Strait is covered by floating ice, the longest time of total freezing took 42 days (Semenov Tyan Shansky, 1910). The Sea of Azov is an isolated shallow gulf of the Black Sea on one hand, and spacious – about 38 000 km^2 – and low saline estuary (liman) of Don River, on the other hand. The Sea of Azov is characterized by very high plankton and benthos productivity and by sites of fattening not only Azov fishes but also Black Sea ones, such as shad, haarder, anchovy, blunt-snouted mullet etc. (Zenkevich, 1956). The Kerch Strait and adjoining region excel the rest Black Sea coastal zones taken together in diversity and richness of fishery. A foundation of high productivity of this sea area is the abundant intrusion of freshwater drainage (Knipovich, 1932). Combination of the natural conditions of different marine basins inevitably had to cause the original phenomenon such as interaction of their faunistic complexes and exerted influence over all ecosystem components.

During 1997 a series of cetacean observations was conducted by BREMA Laboratory team in the Kerch Strait in the frames of project supported by the Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée (CIESM). Some of their primary results were published (Birkun and Krivikhizhin, 2000). Meanwhile we have to establish an absence of complex investigations in the Black Sea coastal region concerning characteristics of the different links of ecosystem and their interrelations. Close connection and interdependence existing between hydrological and biological phenomena are obvious, because the whole complex of hydrological conditions determines the main principles of aquatic biology (Knipovich, 1932). In particular, it means the necessity of monitoring of a number of structural units, each taken separately and together, - geological composition and dynamics, relief, climate and hydrology, living organisms of the different evolutionary level and factor of anthropogenous intrusion. In this work we tried to consider some cetacean migrations realizing the complex and analytical approach to contemporary ecological situation and geographical characteristics of the Kerch Strait.

MATERIALS AND METHODS 24 observation cycles (twice a month in the first and in the last days) were carried out using ferries (3) between Ukrainian (Crimean) and Russian (Caucasian) coasts of Kerch Strait along the line Port Krym - Port Kavkaz (about 4 km) by Evgeny Gol'din (16), Alexei Birkun & Sergey Krivokhizhin (9), Andrey Artov (2) and Vadim Pavlov (2). Order ferry crewmembers kept on the observations during the periods between these dates. For evaluation of some aspects of cetacean migration in the Kerch Strait and adjoining area of the Black Sea and Sea of Azov we used field observations data, and also the information block received from local people (sailors, fishermen, authorities, inhabitants of fishing villages, specialists in fishery), material of their systematic observation and life experience, comparative analysis of contemporary and past landscape, data on climatological and hydrological characteristics etc.

RESULTS AND DISCUSSION Bottlenose dolphins *Tursiops truncatus ponticus* (TT) and harbour porpoises *Phocoena phocoena relicta* (PP) were registered in the Kerch Strait all year round except of periods of very hard ice conditions in the Sea of Azov and the Strait. The ratio between these species is labile and varies seasonally (Fig. 2) and annually. So the most cases of sightings (40 in total) took up PP (25 ones or 70 individuals) and then TT (13 ones or 34 individuals) and unidentified cetaceans – 2 ones. By the numerous evidences of the different local people, abundance of cetaceans was significantly higher in the past years. Besides, the common dolphin *Delphinus delphis* was not recorded any time in spite of facts of its distribution in the Strait in the past (Semenov Tyan Shansky, 1910). In all of situations TT and PP kept separately. Large groups of animals were not recorded any time (no more than 4-7 individuals). The main part of dolphins was seen very close to the coastline, harbours of Port Krym and Port Kavkaz (or inside) and in the area of Channel. The prevalent types of behaviour were hunting, games or replacement (Table 1). Hunting was previously observed early in the morning.

Migrations of PP from the Black Sea to the Sea of Azov and back, as well as TT movements within the Strait and Black Sea, depend on a number of abiotic and biotic factors, and only complex ecological approach can give explanation of these processes. The global factors of influence on the dynamics of biological processes in marine environment (atmospheric circulation, solar activity and vibration of the earth's crust) may undergo some changes under the influence of anthropogenic activity. These human affairs in the region of the Strait include immoderate fishery, pollution of coastal environment, excessive exception of continental waters and intensive hydraulic arrangements bringing alterations into the hydrological regime of sea area.

The main factors known to affect cetacean migrations are prey fish migrations (haarders, Azov anchovy, shad, silverside etc.), climatological and hydrological characteristics (ice regime, air and water temperature dynamics, wind direction and speed) varying from year to year. In particular, anchovy is very important for PP nutrition since Miocene (by N. Danilevsky, I. Puzanov, E. Mal'm, V. Zalkin, S. Kleinenberg), periods of anchovy accumulations are also preferable for TT. Thus, large and dense anchovy concentrations in the Strait during spring and autumn may be the guides for cetacean migration within the sea area. In the spring time the main part of PP flocks to the Kerch Strait and the Sea of Azov. In April-May 1997 some PP were observed in the freshwater – the animals came in several km up Molochnaya (Milk) River in the northern Azov coast. In this part of the sea PP can stay till the late autumn. So in October-November 1997 a sufficient part of population was concentrated near Kazantip Cape, the main site of anchovy shoals location that time. Meanwhile dolphins were regularly found in October in the Kerch Strait during the shad run. The autumn migration back to the Black Sea closely depends on replacement of anchovy, haarders and shad (Table 2). The most of PP leave the Strait before the end of December, the terms of this outcome correlate with fish migration. TT can be found in the Strait and in adjoining Black Sea area, possibility of its getting into the Sea of Azov is rather low (Fig. 2).

Anthropogenic activity has an indirect impact on those processes (e.g., creation of some reservoirs caused changes in wind regime that affected the migration patterns). Variation of biological characteristics of ichthyofauna in the Sea of Azov and in the Strait (number of populations, migration, reproduction etc.) correlates with fluctuations in hydrological regime of the basin (drainage, sea level, water temperature and salinity etc.). In particular, regulation and dissipation of Don drainage (1952) and especially creation of Krasnodar reservoir in Kuban River (1975) caused alterations of coastline contours and coastal depths as the after-effects of salinization, decrease of some mollusks and degradation of coquina sediments, wind direction (before strong north and north-eastern winds were dominated, now southern and south-western ones changed them) and sea currents (Fig. 3). These changes have brought their influence to the processes of fish and dolphin migrations.

The existing situation needs in the future implementation of purposeful complex research works. The most acceptable and expedient decision for their realization would be the organization of stationary monitoring of cetacean migration and marine environment in Kerch.

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Table 1. Cetaceans in the Kerch Strait in April and October 1997

Time of observation	Species	Number of individuals	Location	Type of behaviour
April	Unknown	2	Middle of Strait	Not registered
	PP	1	Buoy 42, 43	Motion to the N
		2		Motion to the S
		7	Channel	Motion towards Sea of Azov
	Unknown	2	Port Crimea	Not registered
	PP	2-3	Channel	Motion towards Sea of Azov
October	PP	2	Port Crimea	Hunting
		3	Port Caucasus	
		2	Port Caucasus	
		1	Port Caucasus	
	TT	1	Port Caucasus	
		2	Port Caucasus	

Table 2. Fish migration and hydrometeorology in April and October 1997

Month	Days	Temperature, ºC		Wind, direction & speed, m/sec.	Fish migration
		air	water		
April	1-10	15-17	4-5	W; 5-8 - 12-17;	Very intensive but prolonged and slow run of anchovy to Sea of Azov because of low water temperature despite favourable hibernation in the Black Sea, non-active spring run of silverside and blunt-snouted mullet in the Strait
	11-20	15-17	6-7	W; 5-8 - 12-17;	
	21-30	15-17	8-10	W; 5-8 - 12-17;	
October	1-10	10-18;	14-16	S, SE, SW; 6-11;	Active anchovy migration from Sea of Azov (21.10) to the Black Sea, shoaling in the N of Strait and frontier part of Sea of Azov
	11-20	9-15;	14-16	N; 6-14;	
	21-30	4-9	8-16	N; 6-14; 3 stormy days	

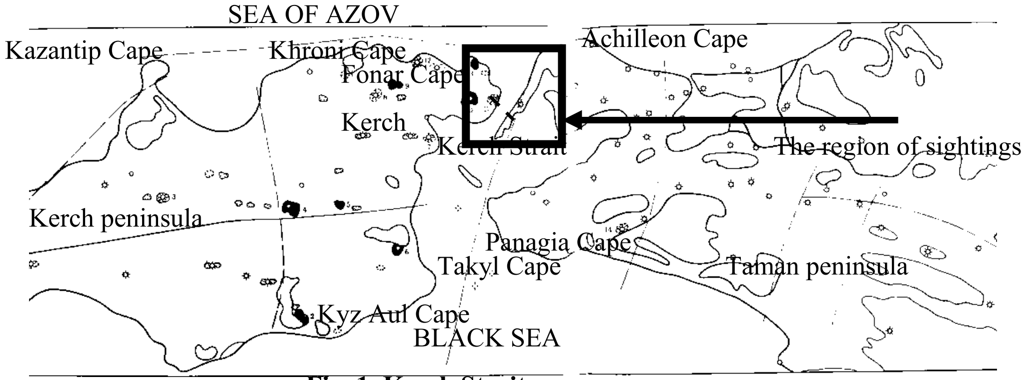

Fig. 1. Kerch Strait.

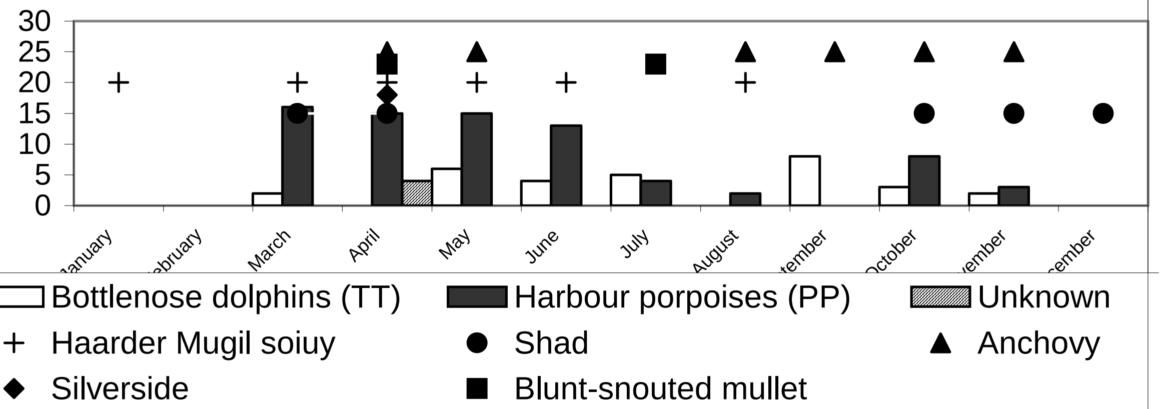

Fig. 2. **Distribution of dolphins in the Kerch Strait in 1997 in dependence on season and fish migration (number of individuals by the results of sightings)**

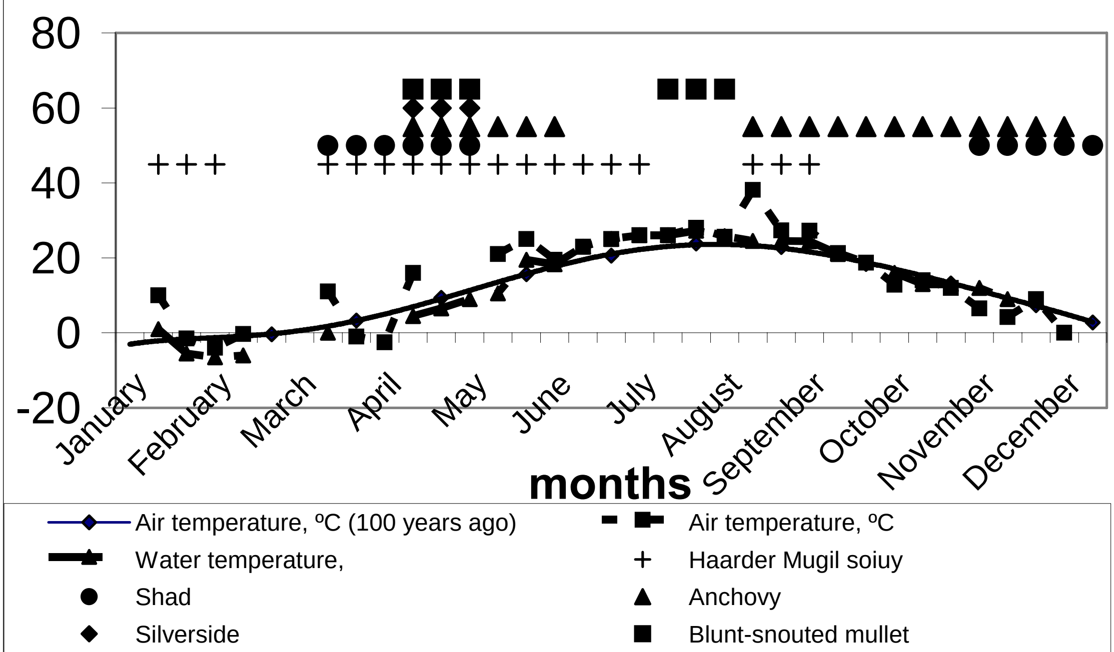

Fig. 3. Temperature conditions and fish migration in the Kerch Strait in 1997

ACTIVITY AND HABITAT USE OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA)* IN SOUTHWEST BRITAIN

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INTRODUCTION Over the past 50 years there has been a marked reduction in harbour porpoise (*Phocoena phocoena*) numbers in Britain, largely due to incidental entrapment in fishing gear, depletion of prey populations, pollution and other anthropogenic disturbances (Tregenza, 1992; Reeves & Leatherwood, 1994). There is however, little detailed information on the ecology and behaviour of porpoises, which limits the effectiveness of conservation measures.

This research focused on a coastal population of harbour porpoises, which are seen regularly off North Devon. Coastal habitats are composed of a variety of areas, which differ both biologically and physically from one another (Ballance, 1992). Whilst some areas support large numbers of individuals others support comparatively few or none at all (Hui, 1979). Although research on harbour porpoise populations exists (Sonntag *et al*, 1999; Heide-JØrgensen, 1993; Benke *et al*, 1998), we still know relatively little about factors influencing porpoise habitat selection.

The main aim of this research was to investigate harbour porpoise activity and habitat use off the coast of North Devon.

METHODS The study was carried out throughout August and September 2001 from a land-based station, on Morte Point (SS 455 443). A series of watches were conducted throughout the two-month period, during which focal group follows were conducted. A complete record of the porpoises group movements and behaviours were recorded during the watch period. Porpoise positions were recorded using a combination of compass bearings and landmarks.

Observations were analysed in relation to both tidal and diurnal variation. Positional data were divided into morning (10:00 – 14:00) and afternoon (14:00 – 18:00) readings. Tidal data were split between high and low tide (± 1 hour).

RESULTS Although positional data were recorded continuously, analysis revealed that a time interval of fifteen minutes was required to ensure that the data were temporally independent.

Porpoise sightings were found to be tightly clustered in one area of the bay (χ^2 = 73.97, df = 43, p<0.05). This corresponds to an area of tidal rapids, where prey were assumed to be in higher abundance. On several occasions multi-species feeding associations were observed with gannets (*Morus bassana*) and porpoises within the area.

Porpoise presence within this area did not differ statistically between high or low tides (t = -1.34, df = 7, p = 0.22), and did not vary with time of day (t = -1.54, df = 7, p = 0.17).

The porpoises behaviours were also recorded (See Figure 1). The porpoises were observed feeding 52% and foraging 7% of the time. Feeding was defined as behaviour, which was occurring in a specified area, whereas foraging, encompassed a degree of travel and searching, broken by feeding bouts. Although focal group follows were conducted a number of separate groups were also noted as present.

CONCLUSION It is clear from the distribution of sightings, behavioural data, and physical properties of the area that an important feeding ground exists for harbour porpoises off the coast of Morte Point.

As this area corresponds to tidal rapids it is assumed that the area is also important to prey species such as herring (*Clupea harengus*) and mackerel (*Scomber scombrus*). The increase in feeding efficiency by utilising this area probably outweighs the energy required to maintain their position in the tidal currents (Shane, 1990). Indeed their overall presence within the area is assumed to be related to the distribution of their prey species. Both Kenney (1990) and Saayman *et al* (1973) concluded that a major factor influencing distribution in the bottlenose dolphin was prey availability. The utilisation of this area however does not depend on either time of day or tidal state.

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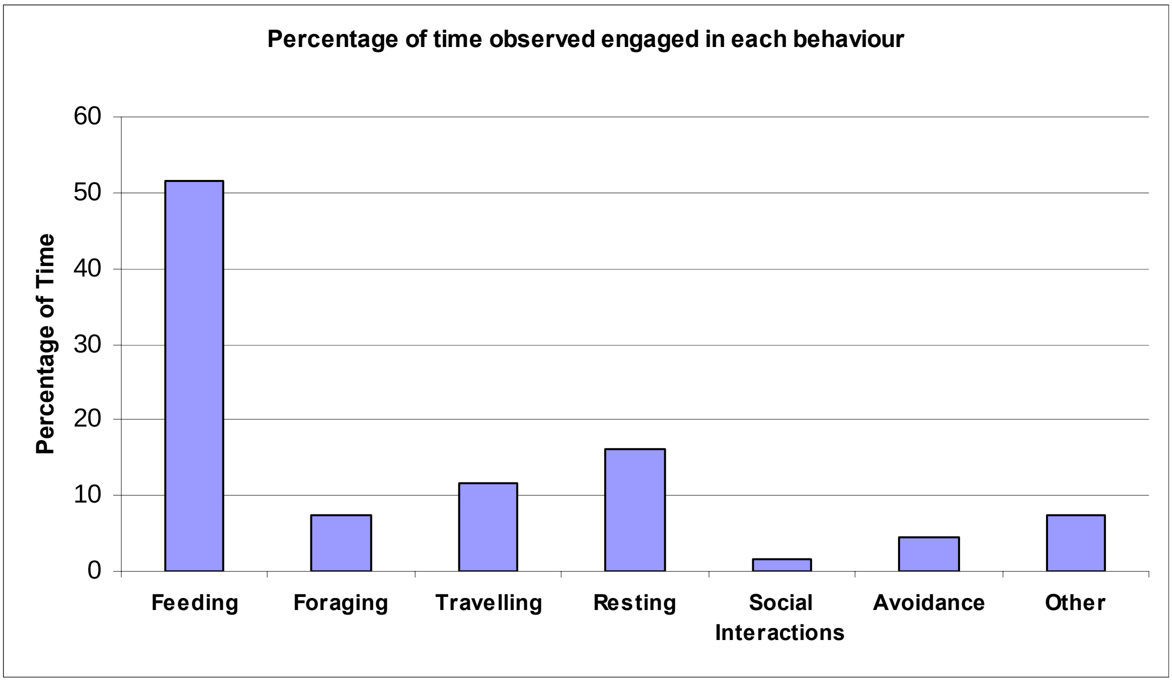

Fig. 1. A summary of behavioural observations in the harbour porpoise (*Phocoena phocoena*)

INTEGRATING VIDEO PHOTOGRAMMETRY, STAND-MOUNTED BINOCULARS AND GPS TO TRACK THE MOVEMENTS OF SPERM WHALE GROUPS DURING DISTURBANCE STUDIES

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Tracking the location of cetaceans at sea provides measures of fine scale movements and grouping behaviour, and can be particularly valuable during studies to measure disturbance. Close to land, accurate locations of animals at the surface are often made using theodolites but these techniques are impossible to apply in the open sea. A method of measuring range accurately by computer analysis of video was described by Gordon (2001), and a technique for combining this with angular bearing to measure animal locations was outlined by Leaper and Gordon (in press). Here we have developed the method further to track sperm whale groups encountered in the open ocean of the Gulf of Mexico. Video cameras were mounted on three big eye binoculars on the flying bridge of the NOAA Ship Gordon Gunter allowing the location and behaviour of several groups to be tracked concurrently. Data collection was integrated using specially designed forms in the LOGGER 2000 data-logging program (D. Gillespie). Calculated locations of a moving object (a small research vessel) whose position was logged from GPS are presented and provide a measure of the accuracy that can be achieved in field conditions. Data on the distribution of animals within undisturbed sperm whale groups and their patterns of movements will also be presented. This technique was developed to provide data to complement that provided by archival telemetry tags and acoustic tracking as part of a coordinated study of disturbance by airguns supported by MMS and NMFS.

MOVEMENTS AND SITE FIDELITY OF SPERM WHALES IN THE GULF OF CALIFORNIA, MEXICO

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It has been shown that groups of female and immature sperm whales have home ranges of about 1,000 km and that they tend to concentrate over "grounds". However, there is currently very little knowledge about movements between grounds. Furthermore, whether sperm whales have preferred habitat within their home range and whether site fidelity is related to food resources remain a mystery. The Gulf of California is one of the very few areas where sperm whales feed on a commercially-fished species of squid (jumbo squid), presenting a unique opportunity to investigate sperm whale large scale movements and site fidelity in relation to food resources. Data were collected during two field seasons in spring-summer 1998 and 1999 using standard non-invasive techniques (photo-identification and behaviour observations). Photo-identifications of sperm whales taken opportunistically in the Gulf of California between 1992 and 1999 and Hal Whitehead's (Dalhousie University) extensive catalogue were also used. Seven female sperm whales moved into the Gulf of California from the Galápagos Islands, travelling up to 3,803 km. To date, these are amongst the longest documented movements for female sperm whales. In areas where jumbo squid were abundant, the mean distance between resightings was 6 km over a temporal scale of a few days, 21 km over a scale of a few months and 27 km over a scale of a few years. On the other hand, in areas where jumbo squid were less abundant, the mean distances between resightings was 100 to 160 km over a temporal scale of a few days to a few years. Our results on resighting rates and relative abundance suggest that there were substantial movements in and out of the Gulf of California. As the same individuals kept returning to the same spot within the Gulf, it appears that sperm whales have preferred "territory".

PRELIMINARY RESULTS ON SEASONAL VARIATION OF CETACEAN POPULATIONS IN THE MEDITERRANEAN SANCTUARY

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INTRODUCTION The region between Corsica Island and mainland France includes the International Marine Mammal Sanctuary of Mediterranean Sea. In this region the cyclonic Ligurian current generates a frontal system, conspicuous on satellite imagery. A high primary productivity period occurs once a year, in March-April and slighter production peak occurs in October. This area is known as an important summer feeding ground for fin whales (Relini *et al*., 1992) and several odontocete species. Few attempts have been made to describe the situation during the winter, however, four species are known to be present between September and June: striped, Risso's, bottlenose dolphins and fin whale (Gannier, 1998). Monitoring surveys have been conducted during one year on a monthly basis to assess the seasonal variation of cetacean population (distribution and relative abundance) in this area.

MATERIALS AND METHODS Since February 2001, monthly transect have been carried out between Cap d'Antibes and Calvi, which are 90 nautical milles (167km) apart. The surveys were always conducted along the same track, on two parallel transect lines, covered during a two-day round trip in good meteorological conditions (*i.e.* wind less or equal to 3 Beaufort). We used a 12 meter Grand Banks motorboat with a 4 m high observing deck. Three experienced observers in duty were searching a 60 degree sector each with naked eyes, with observers rotating every hour (one off-duty position being available). Two reticuled binoculars were used for measuring sighting bearing and radial distance. During the first day, the 160km long transect A is conducted between Cap d'Antibes and Calvi (Corsica) at an average speed of 10 knots. The boat is stopped on ten stations (every 18.5km) to perform a 2 minutes hydrophone listening and sampling of superficial water for salinity analyses. The second day, the anti-parallel transect B (11km apart from A) is cruised at 7 knots, with only the 74km central part carried on with the standard sighting protocol. To access monthly variation we determined a relative abundance index, *R* (individuals by km) obtained from the line transect estimator of Buckland *et al*. (1993):

$$R = \left(\frac{n}{L}\right) \cdot E(s)$$

with n: the number of primary sightings, L: the line transect length and E(s): the mean school size. This index was estimated for the two main species (striped dolphin and fin whale) from visual data obtained from transect A (first day) with good sighting condition (Beaufort $\leq$ 3). Results were computed with *Distance 3.6*, with samples of 10 nautical milles for striped dolphin and 20 n. milles for fin whale. T-test was used to assess seasonal variation.

Acoustic data were analysed as binary outcome: presence or absence of dolphins were reported for each listening station, by listening to the recordings performed during the survey. The rate of positive listening stations was defined as the ratio between the number of stations where dolphin presence could be detected and the total number of listening stations (ten). Chi-square test was used to analyse temporal variation of positive/negative listening number.

RESULTS Eleven surveys were conducted (February 2001 to Feb. 2002), representing 2595km of on-effort sampling. A total of 130 sightings and 1500 individuals were recorded, and four species observed (table 1): the striped dolphin (*Stenella coeruleolaba*), fin whale (*Balaenoptera physalus*), Risso's dolphin (*Grampus griseus*) and sperm whale (*Physeter macrocephalus*). All four species were observed throughout the year, summer excepted. The striped dolphin was the most abundant species encountered, followed by the fin whale.

Striped dolphin - This species represented 43% and 100% of the individuals sighted on-effort in August and January respectively. Larger pods occurred in February and June with a mean size of 27.3 and 22.6 animals respectively while smaller groups were observed in October and January (13.5 and 7.6 individual on average).

The annual mean relative abundance index on the transect A is 0.37 individual/km (max: 0.73 - min: 0.02 ind./km). The index (figure 1) for June and July was 0.73 ind./km (SE=0.05, n=2), while the rest of the year 0.29 ind./km were observed on average (SE=5.6, n=9). A t-test showed a significant difference between both periods (T= 7.88, p<0.001). The mean distance from the shore was 43km (SE=1.16) with 63% of striped dolphin sightings observed between 15 and 35 n. milles off-shore (28 to 65km, figure 2).

Overall, acoustic survey for dolphins (table 2) provided a mean positive listening rate of 50%. However three surveys presented a maximum of positive results of 70%: February and April (beginning and end) and October. In summer, positive listening were not obtained in large number, contrary to what we would expect from the relative abundance results.

Fin whale - This species was observed from February to October, with a mean group size of 1.8 (SE=0.2). The annual mean index of relative abundance on the transect A is 0.03 individual/km and maximum index was recorded in August (0.19 ind. / km). Then, fin whales were relatively rare during the cold months (figure 1): December, January, February and April, with a mean relative abundance of 0.34 .10^{-2} ind. / km (SE=0.23, n=6 surveys).
The mean distance from the coast was 62km (SE=1.31) and 91 % of fin whales were observed further than 25 n. milles off-shore (46km, figure 2).

Sperm whale - Sightings occurred twice: in May and in October (2 animals), both of them being observed at less than 13km off-shore, in 1000 to 1500 m deep waters. This species was also detected acoustically on three other occasions (table 2) in June (one animal), in April and February (two animals).

Risso's dolphin - This species was observed four times: in April, in December (two pods) and in February. The mean distance from the shore was 47km (SE=11.1).

DISCUSSION Our results suggest an increasing number of striped dolphins in the area during summer (June, July and August) and fin whales maximal occurrence one month later, in July until October. A decrease in whale abundance in autumn has already been reported in the Ligurian Sea (Gannier, 1998; Panigada *et al*., 2001). This absence could correspond to the breeding season, assuming that it occurs in autumnm (September to November), based on the North Atlantic observation (Gambell, 1985). In the Tyrrhenian Sea however, Marini *et al*. (1992) have reported an almost constant occurrence of striped dolphins and considered *Balaenoptera sp.* as a year round resident with a peak from April to May. Sperm whale presence in the Ligurian Sea is known for summer months (Gannier, 1998; Gannier & Drouot, 1999; Gordon *et al*., 2000) but its occurrence throughout the year in this area is a new result.

In some cases we have observed heterogeneous distribution with strong variation between transect A and B. More dolphin sightings (and larger pods) were made on transect B. For instance, in April the relative abundance index (R) of striped dolphin on the return transet (B) was more than three times higher than on transect A. For fin whale, the highest difference occurred at the beginning of April. However, a paired t-test did not reveal any significant difference between transect A (sampling speed of 12 knots) and transect B (7 knots) in the monthly relative abundance indices computed for striped dolphin (T=-1.86, p=0.11, df=6) and fin whale (T=-0.03, p=0.98, df=5). These differences are probably due to our straight line sampling strategy: spatial heterogeneity ("one whale is missed because a few kilometers off the sampling line") converts into temporal heterogeneity (one month with few sightings or not at all). This term of sampling variance should be dampered as number of samples increase. The same reason explain inconsistencies between transect A and B. One of the assumptions made for the sampling scheme was that no significant density gradient existed between transect A and B.

CONCLUSION As this study will be carried on during the year 2002, additional data will allow us to estimate cetacean density and seasonal trends. In addition, comparison of cetaceans distribution with primary biomass data obtained from satellite imagery could allow us to further investigate the seasonal variation observed.

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Table 1. Number and size of cetacean schools detected during the 11 surveys

	Schools detected		School size (total)		
Species composition	Total	On-effort	Range	Mean	S.E.
Striped dolphin	90	84	1-90	16.9	1.63
Fin whale	39	39	1-5	1.8	0.2
Risso's dolphin	4	4	2-20	7	4.36
Sperm whale	2	2	2	2	0

Table 2. Acoustic results on 10 stations between Antibes and Calvi

Antibes -- Calvi

Stations

Date	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Feb-01		1	1	1	1	1	1	1	1	1
Apr-01			1		1				X	X
Apr-01			1	1	1	1	1	1	1	1
May-01	X	X	1					1		
Jun-01	1			X						
Jul-01	0									1
Oct-01		X	1	1	1		1	1	1	1
Dec-01			1	1	1			1		1
Jan-02					1	1	1	1		1
Feb-02			X		1	1		1	1	1

Legend :

1 Delphinid whistles
X Sperm whale
No signal
0 No listening

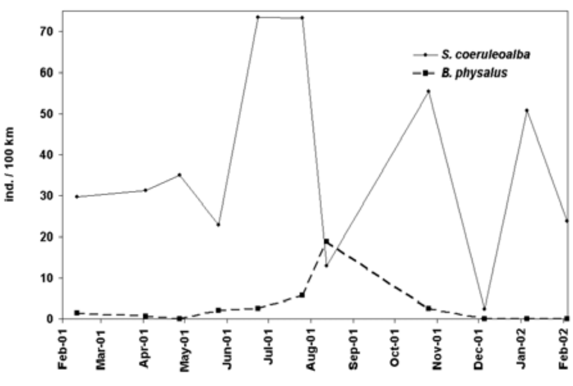

Fig. 1. Relative abundance index (individuals per km) of striped dolphin (—●—) and fin whale (_ _■_ _) obtained on transect A (continuous line) and with monthly total effort (dotted line)

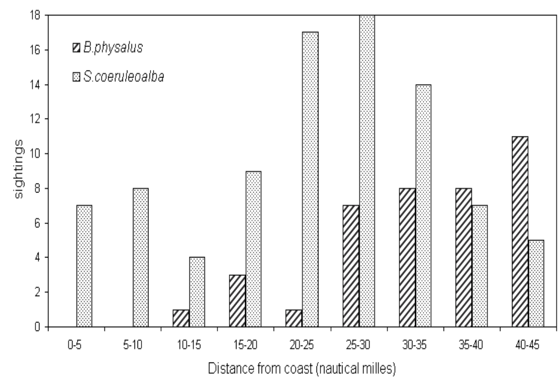

Fig. 2. Distribution of striped dolphin and fin whale on-effort sightings, function of distance from the coast

WALRUSES (*ODOBENUS ROSMARUS*) FORAGING ECOLOGY AND AREA USE IN AN EAST GREENLAND FJORD

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INTRODUCTION Quantitative data on walrus (*Odobenus rosmarus*) predation is needed in order to determine their role in the High Arctic marine ecosystem. Since 1997, the project CAMP (Change in Marine Production http://www.dmu.dk/LakeandEstuarineEcology/CAMP/) has studied various aspects of marine productivity in Young Sound, East Greenland in relation to changes in sea ice. In this area walruses are important predators of the benthic invertebrate fauna. To understand the net flow of organic matter and energy in the marine ecosystem it is therefore necessary to quantify the food consumption of walruses.

In August 2001, we attempted to quantify the walrus predation on the mollusc banks of Young Sound. Here we present preliminary results of observations of diving walruses, with estimated calculations of their predation within the observation area.

METHODS Systematic visual observations of walrus diving activity were made in the period from July 26 – August 20 in Young Sound, East Greenland (74°18 N; 20°15 W). Fig. 1 shows the location of the field site. Sandøen is a permanent sandbank island in Young Sound used for terrestrial haul-out by walruses during the open water period. An observation point on the coast (45 m above sea level) was used for tracking the walruses by theodolite and spotting scopes.

Simultaneous with these observations, scuba divers were diving with foraging walruses when possible in order to determine the number of prey consumed per foraging dive. When a walrus initiated a foraging dive a scuba diver would closely follow the walrus to the sea bottom, mark the feeding patch, wait for the animal to finish and then collect the shells of bivalves eaten by the walruses (Born *et al.* submitted).

RESULTS Between 26 July and 20 August 2001 a total of 102 hours were spent looking for walruses in a feeding area regularly used by walruses in previous years. Fig. 2 shows the diurnal coverage of observation periods of walrus diving activity in Young Sound. Walruses were sighted for 47% of the 102 hours of observation time.

All walruses that were observed within the effective radius of 4 km were tracked, their positions were determined by theodolite and their diving and surfacing behaviour was described in detail. Feeding walruses were only observed up to a distance of 1500 m where water depth is less than 30 m. The area used by walruses for feeding in the present study was 3.5 km^2. Fig. 3 shows the location of the observation point, observation area and a sub-sample of walrus foraging dives.

During the observation time, a total of 47 h and 33 min. defined as ”walrus hours” (i.e. number of animals multiplied by time spent in the area) were used within the search area, producing 293 hours of walrus foraging during the observation period.

The walruses dived and surfaced in a stereotypic manner characteristic of foraging walruses. A walrus dive had an average duration of 6.7 min (sd=1.56; min-max: 1.9-12.1 min; n=115) with at surface intervals of 1.0 min (sd=0.47; min-max: 0.13-4.03 min; n=104). If it is assumed that all dives between 5 and 7 min were foraging dives (Wiig *et al.*, 1992; Jay *et al.*, 2001; Gjertz *et al.*, 2001), 40.5 % of the observation time consists of foraging dives with a total of 1211 foraging dives in the observation period in the observation area.

Scuba divers were able to collect the empty shells of newly eaten mollucs representing single foraging dives. It was calculated that during a typical feeding dive a walrus consumes c. 600 g of mollusc biomass (SF wet wt.) (range: 240-

1000 g per dive). The 1211 walrus foraging dives in the observation period would have consumed 726 kg of mollusc biomass (SF wet wt.).

CONCLUSIONS With the assumptions of 47% of walrus sightings in total time spent observing and 40.5% of dives being foraging dives the walruses in the observation area consumed a total of 726 kg mollusc biomass (208 kg/ km^2) during the observation period, or 28 kg per day. Walruses feed inshore in Young Sound between break up of the ice in late July until formation of a new layer of solid ice in late October (i.e. for ca. 90 days). If our estimate of predation is extrapolated to the entire open water period, a total of 2513 kg of mollusc soft parts are eaten by walruses in the observation area (0.8 g SF wet wt./m^2). Thus walruses consume less than 1% of the standing stock of bivalves during the open water period in the observation area.

Further analysis will include relation of geographical positions to water depth and density of prey i.e. bivalves.

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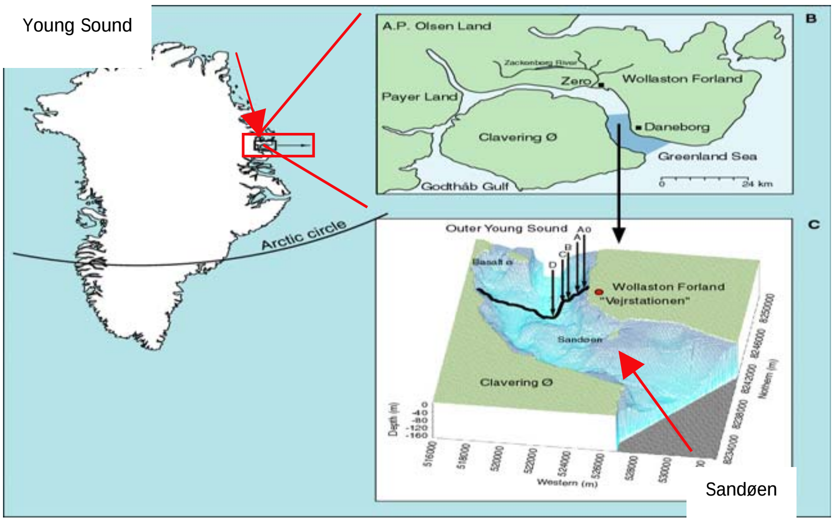

Fig. 1. Location of field site: Young Sound, East Greenland 2001

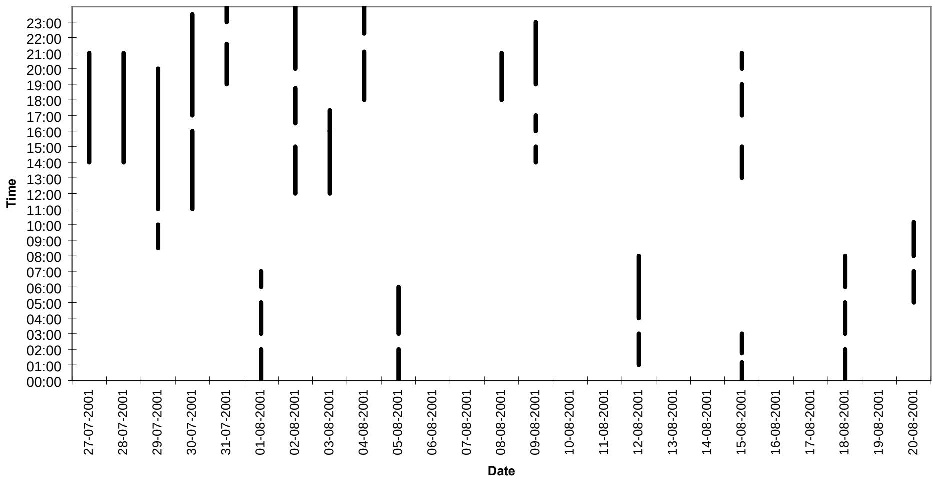

Fig. 2. Diurnal coverage of observation periods of walrus activity, Young Sound, East Greenland 2001

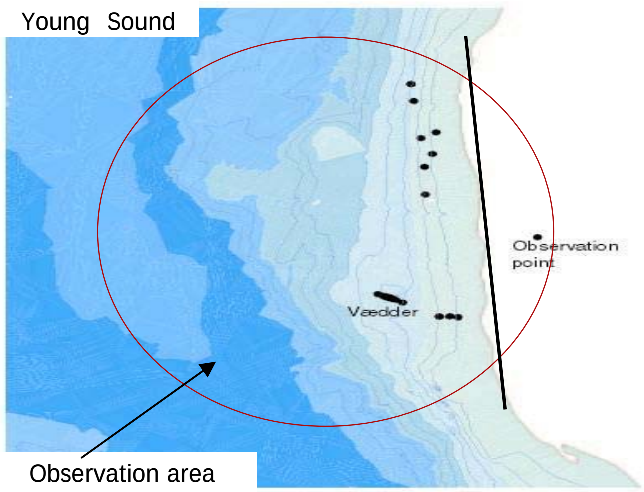

Fig. 3. Location of observation point and area with sub-sample of walrus foraging dives, Young Sound, East Greenland 2001. Measuring scale: Diameter of red circle: 4 km

ABUNDANCE ESTIMATION OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) FREQUENTING THE ASINARA NATIONAL PARK, SARDINIA

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This study is the first dedicated to directly investigating the bottlenose dolphin population abundance in the Asinara national park. It is part of a larger study investigating dolphin fishery interactions in this area. Photo-identification data taken from 1994 to October 2001 were used to compile an identification catalogue and create a discovery curve for the population. The catalogue consists of 39 individuals recognised from long-term markings on the dorsal fin. The plotted discovery curve for this population is approaching asymptotic suggesting that either the population, or the sample area is small. The frequency of individual re-sighting was also calculated for the 39 individuals sighted since 1994. Photo-identification data from the 2001 season were used to attempt a population estimate using CAPTURE software. Bottlenose dolphins were observed on 15 occasions on 13 days (mean group size = 4.9, mode = 4, range 1-10). The population was estimated at 22 individuals (22-27(95% CI) with a 0.58 SE). Variations in re-sighting frequencies suggest that some individuals have higher site fidelity whilst others frequent the area more sporadically. Records from Maddelena national park also indicate that there maybe some migration of individuals between the two national park areas, over one hundred kilometres apart. It is important to ascertain the size and home range of this population and hence quantify the importance of these protected areas. The population estimate is extremely small and although there is no documented minimum estimate for the use of CAPTURE software there is question over the validity of its application in this case. It is also highly likely that the study area is only a small proportion of the home range of this population. Only through more extensive research can the estimate be verified. Increased survey effort and the extension of the study area for dedicated photo-identification are suggested.

THE USE OF WELSH COASTAL HABITATS AS CALVING AND NURSERY GROUNDS FOR THE HARBOUR PORPOISE *(PHOCOENA PHOCOENA)*

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INTRODUCTION Since 1913 marine mammal strandings data have been collected in the UK by the Natural History Museum, London. In 1990 the Collaborative UK Marine Mammal Strandings Project was initiated, part-funded by the Department of Environment, Food & Rural Affairs (DEFRA). The project is supported in Wales by the Welsh Assembly, The Countryside Council for Wales and The Collaborative Celtic Marine Mammal Project. Data for harbour porpoise strandings on the Welsh coast between January 1989 and January 2002 are presented here.

RESULTS From January 1989 to January 2002, 633 harbour porpoise strandings were recorded on the coast of Wales, UK (Figure 1). Of 168 harbour porpoises found stranded alive (condition code 1)[1] or in a state of fresh/slight decomposition (condition code 2)[1] and for which measurement data were available, 25% were neonate animals of body length 90cm or less. Several female animals were also examined which had recently given birth or were carrying a near full-term foetus.

Most calving takes place in June and July in UK waters (Lockyer, 1995) and during these months, 63% of condition code 1&2 harbour porpoise strandings were neonates. Larger calves of 91-110cm stranded during the late summer and autumn (Figure 2). Neonates in condition code 1&2 were recorded only in Cardigan Bay, Carmarthen Bay and Swansea Bay (Figure 3), indicating the proximity of habitats of particular importance for calving or for females nursing neonate calves.

METHODS In the absence of precise age data for these animals, we used overall body length to separate stranded animals into approximate age classes. Lockyer (1995) examined 234 harbour porpoises from UK waters that were aged by counts of growth layer groups in teeth. The maximum length of Year 0-1 animals of both sexes (n=58) was 118cm. Fitted growth curve values at 12 months were approximately 110cm. For the present study, we have classified all animals of 110cm or less as 'calves'. Following Lockyer (1995) we also used a body length maximum of 90cm to identify 'neonates', i.e. neonates and calves assumed too young to survive alone.

DISCUSSION Investigating the origin of carcasses found stranded is problematic. Physical factors, including the direction and strength of prevailing winds and currents as well as the topography of the shoreline itself, also influence the location at which stranding occurs and the period that carcasses remain drifting at sea.

Clusters of neonate animals in fresh condition may however indicate the proximity of habitat used regularly for calving, breeding and nursing young animals. In the present study, sub-sets of data from live animals or carcasses found in condition code 1&2 only were identified; dead animals in condition code 1&2 are assumed to have died only a relatively short time prior to discovery and to have drifted a relatively short distance *post mortem*. Neonate animals within the U.K. birth length range and found in condition code 1&2, are assumed to have not travelled far from their natal site. Although natal sites could not be identified precisely, these clusters of fresh, neonate animals indicate the proximity of habitats of particular importance for female porpoises with dependant calves.

In comparison with the rest of the UK & Eire over the same period 1989 to 2002, 33% of all neonate harbour porpoise strandings (all condition codes), were reported from Wales. The overall number of neonate strandings, compared to animals of other sex-age classes over this 13 year period, was higher on the Welsh coast (20%) than in either England (12%) Scotland (12%) or Ireland (8%), although Wales represents only 6.5% by length, of the total UK & Irish coastline.

The frequency with which stranded neonate animals are recorded on the Welsh coast suggests that the region includes breeding and calving habitat of national importance for this species.

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[1] Body condition based on the UK Institute of Zoology condition code.

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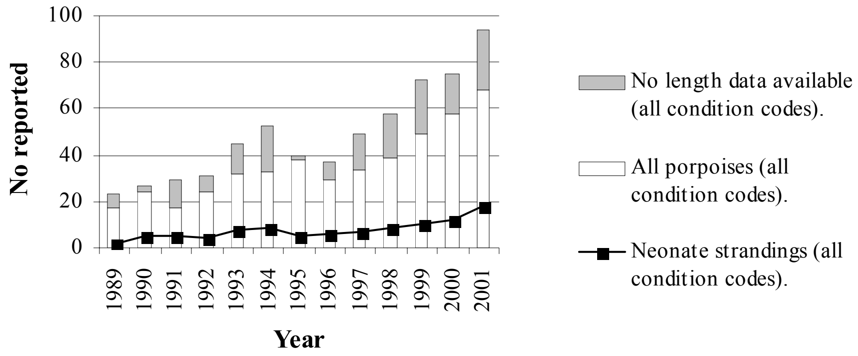

Fig. 1. All harbour porpoises by year

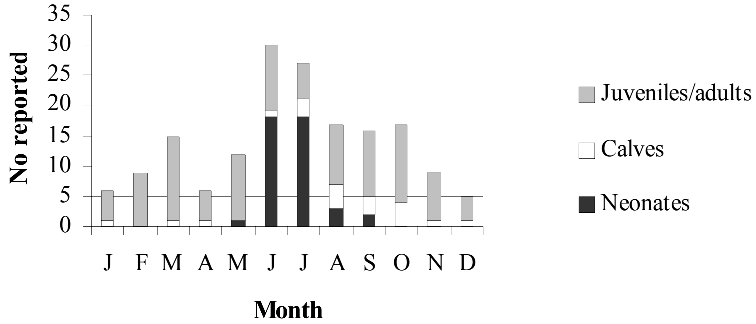

Fig. 2. All live and condition code 1&2 harbour porpoises with length data by month

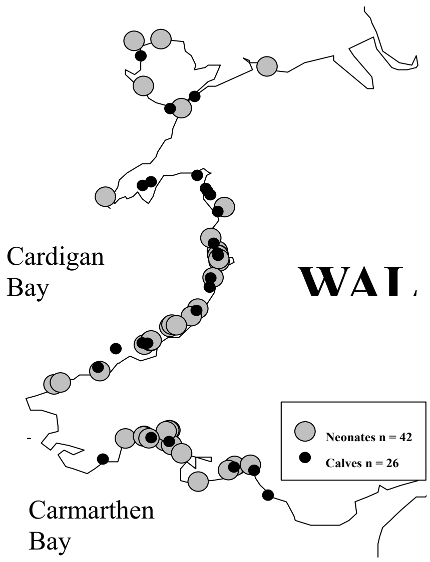

Fig. 3. All live and condition code 1&2 neonates and calves with length data plotted on the Welsh coast

A VISUAL AND ACOUSTIC SURVEY OF HARBOUR PORPOISE DISTRIBUTION IN WELSH COASTAL WATERS

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INTRODUCTION The harbour porpoise (*Phocoena phocoena*) is the most frequently reported cetacean in the coastal waters of SW Wales (Baines *et al.,* 1997). There have been no previous dedicated seabourne surveys, but reports of incidental sightings held in the Sea Watch regional cetacean database, suggest that the species is widely distributed. Systematic observations at headland sites indicate that porpoises regularly gather at some near-shore locations, often foraging in tidal races (Pierpoint, 1993; Pierpoint *et al.,* 1994). Acoustic monitoring has been used to confirm regular occurrence at one site, where porpoise activity closely followed both tidal and day-night cycles (Pierpoint *et al.,* 1999). The area has been suggested as a possible Special Area of Conservation (SAC) for the species. The lack of baseline data on the distribution and relative abundance of porpoises however, hampers the ability of conservation managers to select and designate appropriate areas for this purpose. The present survey aimed to improve our understanding of harbour porpoise distribution in the region.

MATERIALS AND METHODS The survey area (approximately 2411km^2) was divided into four regions (A-D) (Fig. 1). In July 2001, three one-day surveys were carried out in each of regions A-C. A single survey was carried out in region D, a candidate SAC for bottlenose dolphins (*Tursiops truncatus*). Each region was further stratified into inshore blocks (0-2nm) and offshore blocks (2-10nm from the mainland coast). The survey vessel followed predetermined transects – each one-day survey consisted a follow-the-coast inshore track and a randomised zigzag sampler offshore. The survey was carried out in dual mode: sighting data were collected by a team of observers from a single platform, following distance sampling methods (Burnham *et al.,* 1980); acoustic data were collected using a towed, stereo hydrophone array and automated detection system developed by IFAW (Chappell *et al.,* 1996; Gillespie & Chappell, in press).

RESULTS Visual effort on transects, in good sighting conditions (sea state 2 or less), totalled 574km. Acoustic coverage on transects was 802km, and 1074km overall. Schools of harbour porpoises were sighted on 254 occasions (Fig. 2). The overall sighting rates in sea states 2 or less were 0.22 schools / km and 0.39 animals / km. There was a significant trend for school size estimates to decrease as sea state increased from 0-3 (Cuzick's Trend: z (corr.) = -3.403, n = 251 schools, one-sided P < 0.001). The mean school size in sea state 0 was 1.97 (sd = 1.20, range = 1-8, n = 108).

Forty-nine schools (19%) included calves. With increasing sea state, it became progressively more difficult to determine whether calves were present. However, in sea state 0, calves were present in at least 26 of 108 schools observed (24%). Porpoise calves were widely distributed. However, aggregations of schools with calves were encountered most frequently between Strumble Head and the Teifi Estuary: in this region 34% of porpoise schools included calves.

The number of harbour porpoise events (click trains) recorded was 2108. Continuous sequences of events were grouped into 197 'encounters' each of which was separated by a distance of at least 500m without porpoises being detected. Although some encounters included single events only, some lasted as long as 24 minutes and included over 270 click trains. During the most prolonged encounter the survey vessel covered 5.5km of trackline. Porpoise detections were most frequent west of the Pembrokeshire Islands, off Strumble Head, west of Cemaes Head and in the vicinity of the Teifi Estuary. Sighting data support this distribution. Acoustic detection rates were plotted for 10 x 10km cells, accounting for variation in the distribution of survey effort (Fig. 3).

The visual data were more affected by prevailing sea conditions than the acoustic data. There was a strong negative correlation between sighting rate and sea state (Kendall's Rank Correlation: tau b = -0.56, z (corr.) = -3.42, P <0.001). Although acoustic detection rates fluctuated with sea state, there was no tendency for detection rates to fall as sea state increased (tau b = 0.17, z (corr.) = 1.10, P = 0.137, ns). The nominal range of the acoustic data was estimated at 250m, based upon the frequency distribution of acoustic ranges to individual click train events. A simple model was used to match sightings and acoustic detections. Porpoise schools were more frequently detected acoustically than they were seen. Sightings were made in 46% of acoustic encounters in sea state 0-1. The proportion of encounters with corresponding sightings then decreased with sea state (Fig. 4). It was estimated that 75 of 113 of sightings (66%) made within the nominal range of the acoustic system were detected acoustically.

DISCUSSION Harbour porpoises were widespread off the coast of SW Wales throughout July. They were recorded in each survey strata on each day. Schools were however, over-dispersed or clumped rather than evenly distributed. Aggregations of animals were recorded in certain areas repeatedly on different survey days. The overall sighting rate in sea state 2 or less was approximately 22 schools / 100km, higher than that reported for Celtic Shelf waters as a whole (<2 schools / 100km: Hammond *et al.,* 1995). In comparison, Palka (1995) reports sighting rates of 11 schools / 100km for the coastal strip of the Gulf of Maine, USA and 35 schools / 100km for the lower Bay of Fundy, Canada.

Approximately 24% of schools recorded on the Welsh coast included calves. Calves were probably 1-2 months old (Lockyer, 1995). The proportion of schools with calves was comparable with data from a nursery and breeding area for harbour porpoises on the German North Sea coast (27% of 30 sightings: Benke *et al.,* 1998; Sonntag *et al.,* 1999). During SCANS the proportion of calves of all porpoises recorded in Celtic Shelf waters was highest close to the southern coast of Eire (Hammond *et al.,* 1995), for which the proportion of schools with calves in July 1989 was reported as 15% (Leopold *et al.,* 1992).

Complimentary visual-acoustic methods and the use of small survey vessels provided an economical system for assessing harbour porpoise distribution in coastal waters. The acoustic detection system was less affected by prevailing sea conditions than the sighting survey and therefore more suited to describe harbour porpoise distribution. Visual data provided sighting rates, school size estimates and an assessment of calf distribution.

ACKNOWLEDGEMENTS Observers: Chris Pierpoint, Cliff Benson, Powell Strong, Rod Penrose, Rob Colley, Michael Betts, Mick Baines, Maren Reichelt, Miriam Romagosa Vergés, Doug Gillespie and Ruth Jones. Thanks also to Tim Lewis and Justin Mathews. This survey was funded by the International Fund for Animal Welfare. A full report of the survey is available as a .pdf file from www.eurydice.co.uk.

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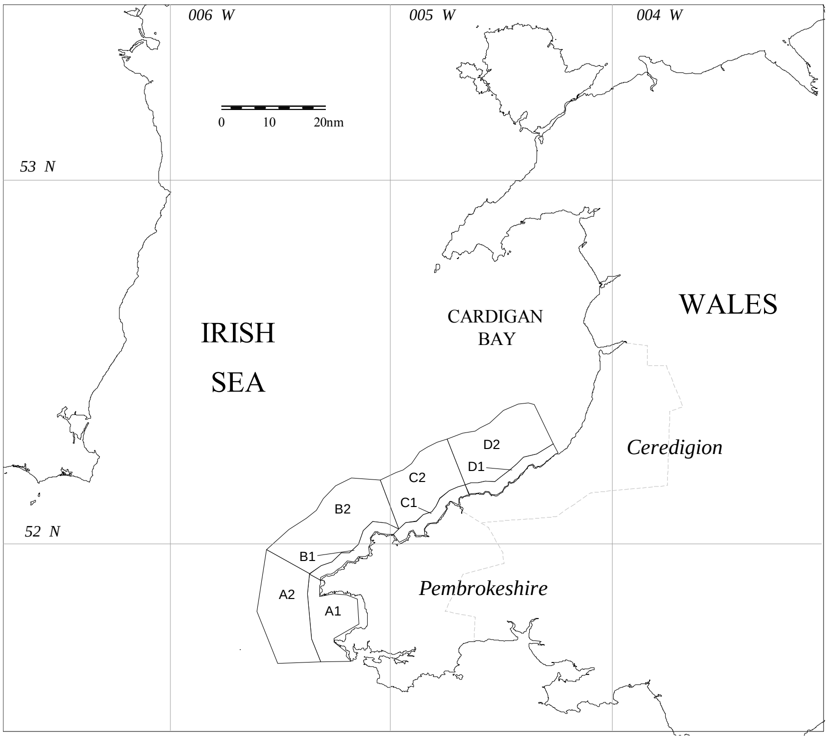

Fig. 1 The survey area, showing blocks and inshore / offshore strata

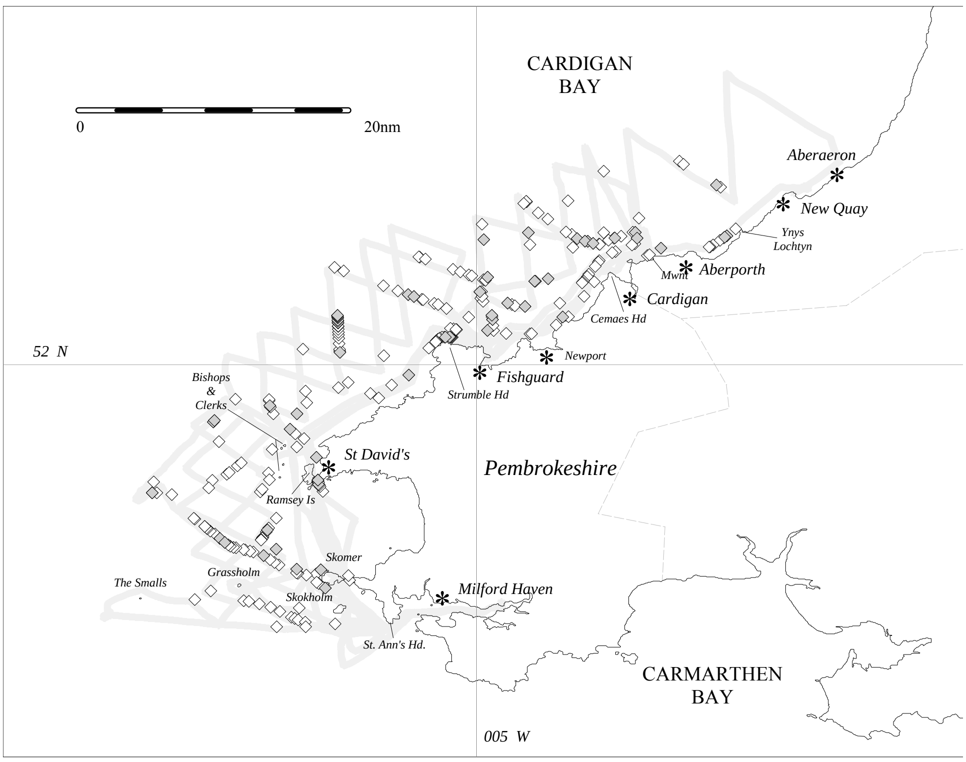

Fig. 2 Harbour porpoise sightings. Each symbol represents the vessel's location when porpoise schools were sighted. Schools with calves are shown with shaded symbols. Observer effort is shown as a grey line

Fig. 3 Acoustic detection rates in 10 x 10km cells. The circles shown are proportional to harbour porpoise clicks detected / survey km, values for which are given beneath. Only cells with more than 10km survey effort are shown. The origin of the grid is 51° N 003° W

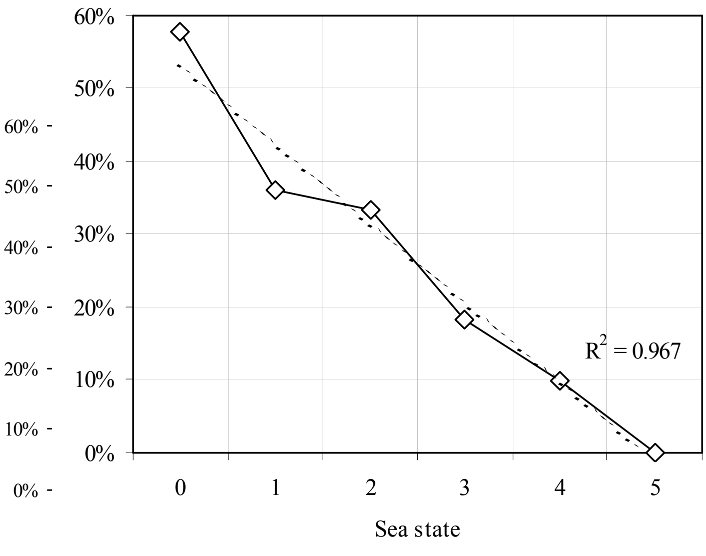

Fig. 4 The proportion of acoustic encounters for which a sighting was also made. The fitted linear trend line has the formula:
y = -0.109x + 0.642

DISTRIBUTION AND PHOTOIDENTIFICATION OF SHORT-FINNED PILOT WHALE (*GLOBICEPHALA MACRORYNCHUS*) IN GRAN CANARIA, CANARY ISLANDS

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INTRODUCTION The short-finned pilot whale (*Globicephala macrorhynchus*)is a species widely distributed in the tropical and subtropical waters of all the oceans. Nevertheless, little is known about its behaviour and social structure, which are still not clear. In the Canary Archipelago, the only systematic studies carried out on this species exclusively considered the population in the south of Tenerife (Heimlich-Boran, 1993), while the scarce information on the short-finned pilot whale in Gran Canaria came from occasional observations of fishermen, from some strandings and also the few whale-watching boats active in this island. The present research project, developed parallel to a LIFE project on the conservation of the bottlenose dolphin around the island of Gran Canaria, was focused on the study of the short-finned pilot whale, through the creation of the first photoidentification catalogue realised in this island.

The main purpose of this study was to realise a preliminary study on this species in the island of Gran Canaria in order to obtain basic information on its presence and distribution. Many factors, such as the whale-watching activity, the environmental degradation, and the increasing maritime traffic might compromise its conservation in the Archipelago. Facing this critical situation, and considering that the short-finned pilot whale is included in the National Catalogue of Endangered Species, as “Special Interest Species”, it seems essential to obtain a clearer picture of the species in these waters: identifying the different populations, knowing the movements and the grades of residency in every island of the Archipelago.

METHOLOGY From January 1999 to June 2000, 16 sea surveys were conducted, with a total effort of 137 days, 6.529,5 nautical miles covered and 917.9 hours employed in the searching, cetacean observation and photoidentification, with 16.02 hours spent with the short-finned pilot whales. Random linear transects were realised, oceanographic parameters were noted, and for every encounter with the animals the “sighting” and “behavioural” sheets were compiled, video recordings were realised and photographs (Nikon F-801s and Canon Eos 50, objectives Sigma 300mmm and 50 mm) were taken for the photoidentification analysis.

RESULTS AND DISCUSSION During the study, 17 sightings of short-finned pilot whales were recorded, 24% in the north-east and 76% in the south-west of the island, even though this difference probably depends on the minor effort employed in monitoring the northern waters (only 36 days), because of the bad conditions of the sea. A total of 915 slides were analysed, 232 individuals were identified (47% from the left side of the dorsal fin, 27% from the right side, and 26% from both sides), and at least 35 animals were recaptured (Fig.1).

A pilot whale was identified in the north as well as in the south of the island. The Ratio Association Index, calculated for these animals, highlighted the great mobility in the composition of sighted groups (64.4 % of the values were lower than 0.33), and at the same time demonstrated a high fidelity of some pairs of animals (RAI values = 1 for a 20% of the total pairs). The range dimension of the group mainly represented a comprise between 16 and 20 individuals; the mean depth to which they were met was of 834 m, with an increase during the late-afternoon hour interval, and significantly inferior to the 1386 m found in the south of Tenerife (Heimlich-Boran, 1993).

The comparison between the photoidentification catalogue of Gran Canaria created in the present study and the one realised in 1990-1991 in the south of Tenerife by James Heimlich-Boran (1993) allowed the recapture of 6 short-finned pilot whales. The differences in the criteria of cataloguing and the different quality of the photographs (in colour the first, in black and white the second) rendered the comparison more difficult, limiting probably the number of possible recaptures, already conditioned from the long time interval passed between the realisation of the two catalogues.

Four of the six animals were recaptured in the south of Gran Canaria during the same sightings (Fig.2), two of which had been considered in Heimlich-Boran’s study as residents in Tenerife (the number 179 and 197) and two others as visitors (number 69 and 139). Moreover, the short-finned pilot whales number 179 and 197 were sighted together both in Tenerife (10/30/’90) and in Gran Canaria. The animal number 139 was re-sighted for the second time in March 2000.

Based upon the findings, we can state the following:

1. The existence of effective movements of the *Globicephala macrorhynchus* between the islands of Gran Canaria and Tenerife.
2. The existence of mobility between waters of the north and the south of Gran Canaria.
3. The existence of a strict association between animals of the same pod, confirming long-term links in the social structure of this species, as mentioned by other authors (Heimlich-Boran, 1993).
4. The permanence of scars and nicks in the dorsal fin for long periods of at least 10 years.

For the few recorded sightings in the islands of Gran Canaria and for the necessity of a long-term study, it is still too early to define the existence of resident and transient pods, considering the eventual presence of grades of residency. In the light of these observations, it was also proposed the hypothesis of a wide home range, that comprises also the other islands of the archipelago, maintaining, therefore, preferential areas, such as the south of Tenerife.

From June 2002, a wider and in-depth research project will be conducted, inside of the CETOC project (SECAC). This will widen the area of analysis to all the Canary Archipelago, in an attempt to determine the abundance of this species, the eventual seasonal tendencies in its distribution, identifying its routes and trying to understand the regulating factors. Moreover, its social structure will be considered, with particular attention to the role of the males inside the groups.

ACKNOWLEDGEMENTS We wish to thank Sonia García and Silvia Hildebrant for the constant and essential collaboration during all the phases of the investigation, with their great professionalism and availability, and Chago Quintana for his great job as skipper and as a companion during the surveys.

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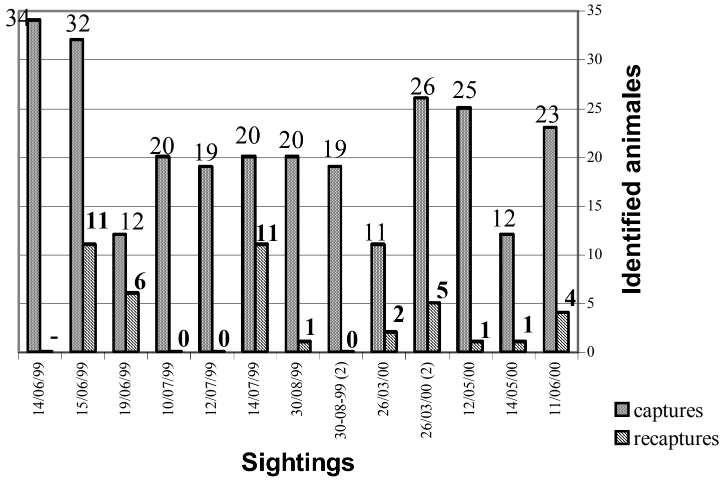
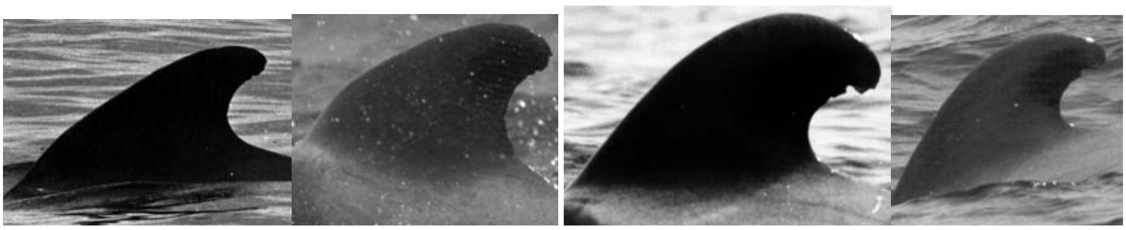
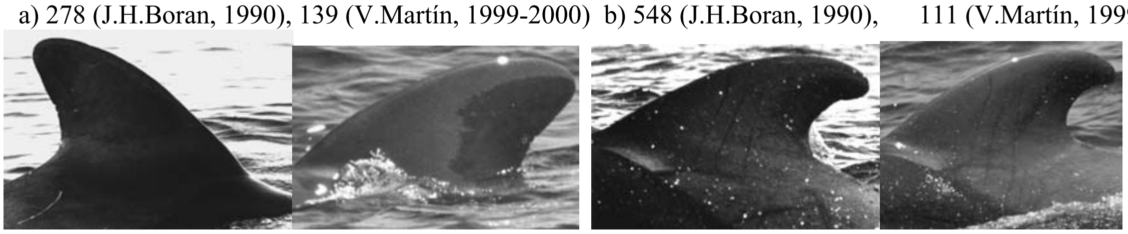


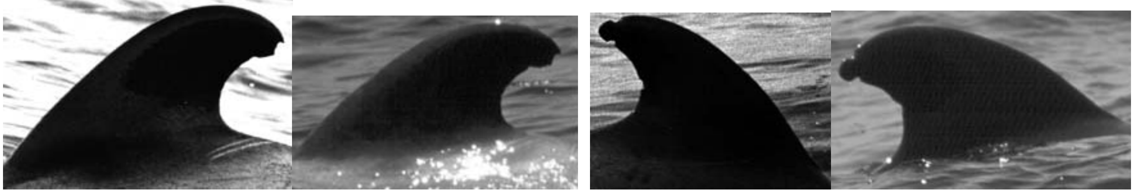
Fig.1: Capture and recapture of *Globicephala macrorynchus* for each sighting



a) 278 (J.H.Boran, 1990), 139 (V.Martín, 1999-2000) b) 548 (J.H.Boran, 1990), 111 (V.Martín, 1999)



c) 556 (J.H.Boran, 1990), 220 (V.Martín, 2000) d) 450 (J.H.Boran, 1990), 179 (V.Martín, 1999)



e) 444 (J.H.Boran, 1990), 197 (V.Martín, 1999) f) 366 (J.H.Boran, 1990), 69 (V.Martín, 1999)

Fig.2. The six (a-f) short-finned pilot whales recaptured comparing the Tenerife catalogue (photographs by Heimlich-Boran) and the Gran Canaria one (photographs by V.Martín)

DOLPHINS IN THE RED SEA AND ADJACENT WATERS

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During five voyages through the Red Sea and adjacent waters of the Indian Ocean we used Dutch research vessels as platforms of opportunity for recording cetaceans. Continuous watches were kept during daylight hours. In the Red Sea, the vessels followed the main shipping route through the central basin, which generally is in deep water except near the Hanish Archipelago in the south. The four most frequently observed species in the Red Sea were *Stenella attenuata, S. longirostris*, *Tursiops* spp. and *Delphinus* cf. *tropicalis*. The first three taxa were distributed throughout the Red Sea, *Delphinus* cf. *tropicalis* was found only in shallow waters near the Hanish Archipelago. *S. attenuata* in the Red Sea has no spots. In the northern part of the Red Sea several *S. longirostris* showed a clear, dark demarcation line between the light-coloured flank and white abdomen; elsewhere this feature was not seen. The Tursiops encountered in the Red Sea were clearly *T. truncatus*, whereas *T. aduncus* was seen in the Straits Bab-al-Mandab, the Gulf of Aden and off Somalia in the Indian Ocean. Other species recorded were Sousa plumbea (Suez Canal: one record), *Stenella coeruleoalba*(Bab-al-Mandab and Gulf of Aden), *Grampus griseus*, Feresa/Peponocephala, *Globicephala macrorhynchus*, *Pseudorca crassidens*, *Orcinus orca* (Gulf of Aden) and *Physeter macrocephalus* (Indian Ocean and Gulf of Aden). In the Indian Ocean, *S. longirostris* was observed foraging in large groups numbering hundreds of animals, whereas in the Red Sea groups consisted of 50 animals at most.

SHORT-BEAKED COMMON DOLPHIN AND COMMON BOTTLENOSE DOLPHIN SIGHTINGS ALONG THE TUNISIAN COASTS AND IN THE SICILY CHANNEL

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This paper presents data on the presence of short-beaked common dolphins (*Delphinus delphis*) and common bottlenose dolphins (*Tursiops truncatus*) along the coasts of Tunisia and in the Sicily Channel, where limited information exists about cetacean sighting frequencies and distribution. Emphasis is given to information on the short-beaked common dolphin, a species that reportedly faced a dramatic decline in the central Mediterranean Sea over the last decades. Data were collected between 24 May - 1 June 1998 during a dedicated research cruise, from a 19 m motorsailer travelling at a speed of 10.2 km/h. A total of 565 km were surveyed, of which 321 under favourable conditions (sea state <3). Seven cetacean sightings were made: 4 of short-beaked common dolphins and 3 of common bottlenose dolphins. No other cetacean species were sighted. All common bottlenose dolphin sightings occurred within 7 km from the nearest coast, over a maximum depth of 126 m. Short-beaked common dolphins were seen both in the coastal and in the pelagic environment, at distances from the coast ranging between 3.7-35 km, and over depths between 50-540 m. Short-beaked common dolphin group size ranged between 2-30 individuals (mean 14.5, sd = 12.9), with significantly larger groups in deeper waters ($T=1$, $n=4$, $p<0.05$). The relatively high short-beaked common dolphin sighting frequency in the area, as compared to most other portions of the central Mediterranean Sea, further indicates that critical habitat may exist in the Sicily Channel and along the Tunisian coasts, and that the area deserves systematic investigation.

FIFTEENTH ANNUAL REPORT OF
EUROPEAN CETACEAN SOCIETY: 2001

Paid-up members of the European Cetacean Society for the year 2001 numbered 473 with 37 countries represented. The highest representation came from Italy (137), United Kingdom (55), Germany (45), Spain (43), France (34)), Portugal (22), USA (21), Denmark (19), Switzerland (18), and Greece (11).

Countries with ten members or less include Algeria, Argentina, Australia, Belgium, Canada, China, Croatia, Finland, Hong Kong, Hungary, Iceland, Ireland, Israel, Japan, Luxemburg, Malta, Mexico, Monaco, The Netherlands, New Zealand, Norway, Peru, Poland, Slovenia, Sweden, Turkey, and Ukraine.

The Membership list of the Society continues to be run from the German Oceanographic Museum in Stralsund, which also takes care of the mailing of material including Proceedings. The Society is very grateful to its director Harald Benke, and to Ines Westphal who is responsible for these tasks.

The European Cetacean Society Annual Conference in May 2001 was hosted by the Central Institute for Applied Marine Research (ICRAM), and held at the Frentani Conference Centre in Rome, Italy, The conference was attended by 420 people from 33 countries. The theme was 'Marine Protected Areas and Other Approaches for the Management of Threats to Marine Mammals'

The conference was organised by Giancarlo Lauriano and Fabrizio Borsani. Abstracts were reviewed by a team of reviewers, organised by Fabrizio Borsani and Greg Donovan. Awards were judged by a team led by Jaume Forcada.

A total of 36 talks and 200 posters were presented at the conference; there was a student meeting, a Seal Working Group meeting and four workshops:

- Collisions between vessels and cetaceans – can we find solutions?
- Acoustic harassment devices
- Use of Controlled Exposure Experiments for investigating effects of anthropogenic noise on marine mammals
- European studies of *Tursiops*

A Special Newsletter Issue from the Workshop on Protected Areas for Cetaceans was published, edited by Peter Evans. The Society web page continued to be managed by Jan-Willem Broekema.

Following the expression of concern for the serious conservation status of the vaquita sent to the government of Mexico, an update of the situation was presented by Jaume Forcada at the AGM.

The Society has continued to provide information or advice to government departments and non-governmental organisations in European countries, with representation at ASCOBANS and ACCOBAMS.

The Society is grateful to members and others who have assisted with conferences and in other ways. Particular thanks are due to Roland Lick for all his work on the finances of the society.

Nick Tregenza
Secretary

FINANCIAL REPORT FOR THE YEAR UP TO 1 MAY 2002

	Irish account EUR	German account EUR	British account GBP
Balance as of 1 May 2001	19,585.42	34,507.05	96.12
INCOME			
ECS account savings from 2001	22,029.79	34,507.05	796.62
Membership fee during the year 2001/2002		10,454.65	12.50
Profit, Conference Rome		6,834.81	6,184.45
Transfer from German Account			800.00
Other payments (Sale of Proceedings, T-Shirts, etc)		1,985.62	
Interest on Savings account, 2001		794.62	2.39
Total Income	**22,029.79**	**54,576.75**	**7,795..96**

EXPENSES	**Irish account EUR**	**German account EUR**	**British account GBP**
Travel expenses board meeting 2001		1,048.00	93.58
ECS Newsletters (printing)		6,093.16	
ECS Proceedings Cork (printing, typing, etc)		5,624.21	300.00
Proceedings Index Editing			800.00
Editorial Expenses			313.42
Postage (Newsletters, Proceedings, E-mail subscription, etc)		2,575.74	150.00
Bank account and credit card expenses		1,310.48	34.87
Total Expenses	**0.00**	**16,651.59**	**1,691.87**
Balance as of 1 April 2002	**22,029.79**	**37,925.16**	**6,104.09**
	Overall balance	**EURO**	**69,721.50**

Roland Lick
Treasurer

EUROPEAN CETACEAN SOCIETY – 2002

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 ASCOBANS, a regional agreement for the protection of small cetaceans in Europe (in co-operation with the United Nations Environment Program/Convention on the Conservation of Migratory Species of Wild Animals, Secretariat in Bonn, Germany). Some of these have been disbanded now, having served their purpose, and other groups (such as one specifically addressing seals) have been established. The names and addresses of contact persons for all working groups are given at the end.

Contact persons have been set up in each European member country, where appropriate, to facilitate the dissemination of ECS material to members, sometimes carrying out translations into the language of that country. Their names & addresses are given below.

Special issues of a newsletter are produced at intervals for members. Otherwise, news regarding conservation issues, notable cetacean information from Europe, information on legislation & regional agreements, and reports and notices from Council are posted on ECS e-mailing lists and, where appropriate, the ECS website as topics arise.

There is an annual conference with talks and posters, and at which the annual general meeting is held. The results are published as annual proceedings, under the title *European Research on Cetaceans*. Besides the present volume, others have been published for conferences held in Hirtshals (Denmark) in 1987, Tróia (Portugal) in 1988, La Rochelle (France) in 1989, Palma de Mallorca (Spain) in 1990, Sandefjord (Norway) in 1991, San Remo (Italy) in 1992, Inverness (Scotland) in 1993, Montpellier (France) in 1994, Lugano (Switzerland) in 1995, Lisbon (Portugal) in 1996, Stralsund (Germany) in 1997, Monaco in 1998 (in conjunction with the Society of Marine Mammalogy, as the 1st World Marine Mammal Science Conference), Valencia (Spain) in 1999, Cork (Ireland) in 2000, and Rome (Italy) in 2001.

At intervals, workshops are held on particular topics, and the results published as special newsletter issues: no. 6 - a workshop on the harbour porpoise, held in Cambridge (England), 1988; no. 10 - a sightings workshop, held in Palma de Mallorca (Spain), 1990; no. 17 - a workshop to standardise techniques used in pathology of cetaceans, held in Leiden (Netherlands), 1991; no. 23 - a workshop to review methods for the field study of bottlenose dolphins, held in Montpellier (France), 1994; no. 26 - a workshop for the diagnosis of by-catches in cetaceans, held in Lugano (Switzerland), 1995; no. 37 – a workshop on Lung Pathology, held in Lisbon (Portugal), 1996; no. 38 - a workshop on Protected Areas, held in Valencia (Spain), 1999; and no. 40 – a workshop on collisions between cetaceans and vessels, held in Rome (Italy), 2001.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **DM 75** (=39 Euros) for full members; **DM 150** (= 77 Euro) for institutional members and **DM 45** (= 23 Euro) for student members. For members outside of Europe, an additional **DM 30** (= 15 Euro) will be charged for higher postage costs. Payment may be made at the Annual Conference in Euro or the currency of the host country. During the year, membership fees can be paid by **credit card** or **transferred directly** to the following ECS-account: Dr Roland Lick, ECS, Postbank Hamburg, Germany, *national bank transfer*: Account No. 789584-205, Bank Code 200 100 20, *international bank transfer*: Account-No.: IBAN DE21 2001 0020 0789 5842 05, BIC (SWIFT-Code): PBNKDEFF (giving your name and calendar year for membership fee.) Payment in excess of the membership fee will be gratefully received as a donation to the Society.

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Members of the European Cetacean Society are invited to submit summaries of their talk or poster for publication in the Society's Conference Proceedings. They can be half-page abstracts as submitted before the conference, or fuller papers up to five pages in length. These are reviewed by two independent persons. Please use the format given below.

(1) Keep the text, references, and figures/tables to a total of no more than five pages (single-spaced). For those to whom English is not their native language, please ask an English speaker to check the entire text. Unless stated otherwise below, please use Times New Roman font, size 10 throughout.

(2) Prepare all tables and figures in their final form (in black and white NOT colour), and provide the originals for camera-ready printing. Number every table and figure for cross-reference to the text. Place tables, then figures, in chronological order, separate from the text. DO NOT INCLUDE THEM WITHIN THE MAIN BODY OF THE TEXT. Re-size so they occupy as little space as possible whilst still being legible. Place Figure captions underneath each figure, and Table captions above each Table, with Fig. 1, Table 1, etc. in bold type, lower case, and the caption itself in ordinary type, lower case and centred.

(3) Centre the title of your contribution, in capitals and bold type (latin names in the title should be in capitals and italics); one line below place a list of authors in lower case ordinary type (with their initials/first names BEFORE the surname, and a space between initials); one line under this, use ascending numbers (Times New Roman font size 10, at 5-point position superscript) for the addresses of the respective authors.

(4) Place the main text two lines below the authors' addresses. Do not indent the first line but include one line space between paragraphs. Please use double-spacing for two of the three hard copies of the text.

(5) Use common (vernacular) names of species in preference to Latin names, but on the first occasion only, please use both. All Latin names should be in italics and in parentheses. References in the text should be written as follows: (Capelli *et al*., 1979; Di Sciara, 1982). Note the commas between name and year.

(6) Sub-headings such as **INTRODUCTION**, **MATERIALS AND METHODS**, **RESULTS**, **CONCLUSIONS**, and **ACKNOWLEDGEMENTS** should be in the body of the text, at the left edge, but **REFERENCES** should be centred above. There is no need for an abstract of any five-page contribution.

(7) Check references carefully to ensure they are complete, including full title and page numbers. Place in ordinary type (except for book titles which go in italics), in Times New Roman font, size 9 pt, as follows:

Aguilar, A. and Jover, L. 1982. DDT and PCB residues in the fin whale, *Balaenoptera physalus*, of the North Atlantic. *Rep. int. Whal. Commn*, 32: 299-301.

Sequeira, M.L. 1990. On the occurrence of Ziphiidae in Portuguese waters. Pp. 91-93. In: *European Research on Cetaceans - 4*. Proc. 4th Ann. Conf. ECS, Mallorca, 2-4 March, 1990 (Eds. P.G.H. Evans, A. Aguilar & C. Smeenk). European Cetacean Society, Cambridge, England. 140pp.

Stewart, B.S. and Leatherwood, S. 1985. Minke whale *Balaenoptera acutorostrata* Lacépède, 1804. Pp. 91-136. In *Handbook of marine mammals,* vol. 3. (Eds. S.H. Ridgway and R.J. Harrison). Academic Press, London. 430pp.

(8) Please provide either half-page abstracts or longer five-page contributions both as hard copies and on CD, using Microsoft Word, and Times New Roman font, size 10 throughout (except references which are size 9 pt). **Do not send by e-mail**. Include three copies of the longer contributions (two of which will go to independent referees).

PLEASE ENSURE THAT YOU FOLLOW THE ABOVE INSTRUCTIONS.

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