EUROPEAN RESEARCH ON CETACEANS - 17

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONFERENCE

OF THE EUROPEAN CETACEAN SOCIETY,

LAS PALMAS DE GRAN CANARIA, CANARY ISLANDS, SPAIN

9-13 MARCH 2003

EDITORS: P. G. H. EVANS, P. ANDERWALD & M. ANDRE

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European Cetacean Society, Kiel, Germany

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INTRODUCTION

The Seventeenth Annual Conference of the European Cetacean Society was held at the Auditorio Alfredo Kraus in Las Palmas de Gran Canaria, hosted by the University of Gran Canaria between 9th and 13th March 2003. It was attended by 510 people.

The theme this year was "Marine Mammals and Sound", and speakers invited to give keynote addresses to this theme included: Ted Cranford on "Building an Acoustic Model of a Cuvier's Beaked Whale (*Ziphius cavirostris*), Bertel Mohl on "The Monopulse Nature of Sperm Whale Sonar Clicks", and John Potter on "Detection Classification and tracking of Marine Mammals Using Passive, Active and Ambient Noise Techniques". In addition to these, there were 53 other talks and 416 posters.

Associated with the Conference, there were workshops on the following themes: Cetaceans and Active Sonar, POD Technologies and Use, The Phocine Distemper Epidemic in 2002, Maximising Ships of Opportunity for Cetacean Research, Whale Watching Issues, and Research in the Bay of Biscay.

The Society is very grateful to the Conference Organiser Michel André, other members of the Organising Committee: Josep Maria Alonso, Manuel Arbelo, Eduard Degollada, Eric Delory, Antonio Fernandez, Thierry Jauniaux, Marta Nín y Camps, and Mike van der Schaar, and their team of volunteers and student helpers. Thanks also go to 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: Gobierno de Canarias, Consejería de Politica Territorial y Medio Ambiente, Vice Consejería de Medio Ambiente, and Direccion General de Politica Ambiental.

A Conference Scientific Committee was chaired by Michel André, and also comprised Krishna Das, Eduard Degollada, Eric Delory, Greg Donovan, Peter Evans, and Thierry Jauniaux. The following persons have reviewed abstracts: Alex Aguilar, Josep Alonso, Mats Amundin, Michel André, John Bannister, Lance Barrett-Lennard, Giovanni Bearzi, Pierre Beaubrun, Simon Berrow, Peter Best, Fabrizio Borsani, Doug Butterworth, Manuel Carrillo, Florence Caurant, Phil Clapham, Chris Clark, Anne Collet, Enrique Crespo, Krishna Das, Cathy Debier, Eduard Degollada, Eric Delory, Genevieve Desportes, Mariano Domingo, Greg Donovan, Peter Evans, Antonio Fernandez, John Ford, Alexandre Gannier, Manuel Garcia Hartmann, David Goodson, John Goold, Jonathan Gordon, Christophe Guinet, Phil Hammond, Stephan Harzen, Sara Heimlich, Denise Herzing, Silvia Hildebrandt, Lex Hiby, Rus Hoelzel, Nathalie Jacquet, Vincent Janik, Thierry Jauniaux, Paul Jepson, Colleen Kastak, Seamus Kennedy, Thijs Kuiken, Christina Lockyer, Klaus Lucke, Lori Marino, Tony Martin, Vidal Martin Martel, Brenda McCowan, Antonio Mignucci, Michel Milinkovitch, Bertel Mohl, Maria-Jesus Muñoz, Simon Northridge, Dan Odell, Todd O'Hara, Simone Panigada, Gianni Pavan, Bill Perrin, John Potter, Toni Raga, Andy Read, Diana Reiss, Vincent Ridoux, Emer Rogan, Véronique Servais, Nick Tregenza, Peter Tyack, Mike van der Schaar, Linda Weilgart, Hal Whitehead, and Bernd Würsig.

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

Very much effort has gone into the editing and production of these Proceedings. In this connection, I should like to thank my co-editors Pia Anderwald and Michel André for their invaluable help, with support from Lucy Buckingham. And finally, I should like to thank Roland Lick for his help with the final production of the Proceedings.

Peter G.H. Evans

ACOUSTICS

APPLICATION OF WAVELET TRANSFORM FOR ANALYSIS SIGNALS EMITTED BY SPERM WHALES. PRESENTATION OF THE RESULTS OBTAINED USING DAUBECHIES 15 WAVELET

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Through this article our aim is to demonstrate the advantages of using the wavelet transform to provide a representation of the intrinsic characteristics of sound emissions from marine mammals and specifically those of the sperm whale. This approach serves as an alternative to more commonly used estimators which are based on the Frontier Transform, an approach which tends to leave too large a margin for discrepancy as the hypotheses necessary for its application are in certain cases, not sufficiently confirmed. A wide range of alternative mathematic estimators can be used to satisfy cetologists priorities. For instance, they would gain from a simple yet through representation of the signals they are recording in order to carry out an analysis of identification and recognition of the marine mammals. A variety of signal processing techniques are widely known in time series analysis. In the following article, we will adapt these algorithms so that they can fulfil the same needs as the time series analysis. Secondly, cetelogists are currently employing new means in locating and tracking marine mammals. At iSNS (our laboratory), we are working on an approach based on the recordings of marine mammal signals; the results from this data com from the wavelet transform. This article provides the reasons behind this approach. In addition, thanks to the use of new processors, this algorithm once heavy in calculation time can be integrated in a real-time system

EFFECTS OF SHIPPING NOISE ON SPERM WHALE POPULATIONS

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Along with the rather recent interest and findings on the cetacean use of sound as an ad-hoc source of energy in the underwater environment, concerns about the effects of environmental degradation and, particularly, the effects of man-made noise on marine mammal conservation, including acoustic pollution, have been mentioned increasingly often. Some direct effects are already notable, such as the increasing mortality rates from shipping collisions with dolphins and whales. From preliminary data in the region of the Canary Islands where resident cetacean populations, particularly sperm whales, are exposed to heavy maritime traffic it is suspected that the local acoustic budget may be influencing the increasing collision rates. Controlled Exposure Experiments (CEE) were conducted to test the feasibility of using an underwater speaker system to prevent collisions and repel sperm whales from ferry routes. None of the low frequency sounds tested were found to have an effect on the whales behaviour. The analysis of the inner ear structures of two sperm whales killed after a collision with a ferry in the Gran Canaria waters showed that there were no fractures or other overt evidence of impact, or ship strike related injuries; however, ears from both animals had reduced auditory nerve volumes. One animal also had patches of dense tissue in the inner ear. These findings confirmed by the histological analysis are consistent with auditory nerve degeneration and fibrous growth in response to low frequency inner ear damage. Although there is no available data on a direct relationship between long-term low frequency sounds exposure from shipping and the increasing collision rate possibly inducing the decline of the local population of sperm whales, the combined results from the CEE and the inner ear structures analysis suggest that low frequency sounds could be considered a marine hearing hazard.

ANALYSIS OF ACOUSTIC SIGNALS EMITTED FROM A HERD OF SPERM WHALES (*PHYSETER MACROCEPHALUS)* ENCOUNTERED OFF VENTOTENE ISLAND (SOUTHERN TYRRHENIAN SEA, ITALY)

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INTRODUCTION The first recordings of underwater sperm whale sounds have been made on 1952 (Watkins, 1980). Half part of a century has spent and a lot of studies have been done on this type of sounds. Four main categories have been classified (Whitehead and Weilgart, 1990; Goold and Jones, 1995; Jaquet *et al.*, 2001): (1) regular clicks have an interclick interval (ICI) of about 0,5 to 1 s and are produced for echolocation purposes; (2) slow clicks have an ICI of about 5 to 7 s and may have several different functions; (3) creaks are series of very rapid clicks with up to 220 clicks per second and represent short-range echolocation when sperm whales are closing in on their prey; (4) codas are short, patterned series of clicks with irregular repetition rates and are mainly produced during social interactions, playing a role in communication.

Among these sounds emitted by sperm whales, the sequences of clicks, named creaks, stand out as conspicuous signals, indicative of peculiar behaviours. Sequences of clicks were recorded continuously for 17 minutes from a herd estimated acoustically in 12 sperm whales, included a juvenile, found in the archipelago Pontino – Campano off the Ventotene island in the October 2002. This area have been intensely studied since 1991, and Sperm Whales, among other seven species of cetaceans, have been frequently encountered (Airoldi *et al*., 2003; Impetuoso *et al.,* 2004). The rhythmic fashion of the sequences emitted from all the members of the group are presented together with the strips of high noise level, probably produced by the vessel. Some sequences emitted by eight different individuals are examined in detail. The spectra of the selected sequences are shown and discussed.

MATERIALS AND METHODS Data were collected on board of StudioMare research vessel "Jean Gab", a 17.70 m wooden cutter equipped for underwater listening with towed hydrophones synchronized with an underwater camera (Panasonic CCD Camera WV-KS152). However the present study focuses only the acoustic signals emitted by the whales, while the biological and social context of the click emission is not investigated. Signals were recorded from an hydrophone (3 – 32000 Hz) with pre – amplifier into a DAT (Sony TCD – D100). The sperm whale herd, subject of the study, was encountered off the cost of Ventotene the 8th October 2002 at 12:45. However the recording presented in this study started only at 17:20, when the sperm whales approached the vessel, and lasted 17 min. At least four whales were clearly sighted including at least one juvenile. It was definitely a juvenile that got more and more close to the vessel until it broke the hydrophone (17:37). However the number of whales, counted visually, was scarcely reliable and surely underestimated. From the analysis of the features of the recorded signals, carried out in laboratory, 12 different individuals were identified. The acoustic recognition of the whales and the processing of the signals emitted by them was based on Rainbow Click (Vers. 3.00.0002 copyright IFAW -1998-2002) programme and on a SW packet developed originally by C.N.R. of Ancona on MATLAB platform. . The 17 min of recording were divided into 51 equal intervals of 20 s (Table 1). The resulting bins of identical length were then inspected and the sequence of clicks falling into each bin classified on the basis of its features. In total 41 sequences were analysed, classified and attributed to 12 different whales. Each row in Table 1 contains the series of click sequences emitted by the whale, identified by the number in the first column. Within the bins of a row are reported the beginning and the end of each sequence (i.e. the sequence length) emitted by the animal related to that row. The noisy and the empty bins of each row are also shown in Table 1.

RESULTS The Table 1 shows the click sequences emitted by each component of the herd identified acoustically. The click sequences have different lengths from about 1 to about 14 seconds (average length = 4.34 s; SD = 3.35 s) and contain from dozens to hundreds of clicks in the frequency range from few up to eight thousand Hertz. An interesting aspect of the click sequences is their apparent rhythmicity. It seems that there is a sort of synchronization between the sequences emitted by the different whales of the herd (Table 1). All the animals are involved, almost cyclically, in producing click sequences as in accordance with a certain formalized repertoire. Only whales 2, 7 and 9 emitted two consecutive sequences, before receiving apparent answers from other components of the group. Moreover some animals seem to be more active (whale 2 emitted 7 sequences in 17 min.) than others (whales 3, 4, 5 and 6 emitted only 2 sequences in 17 min.). In the bins with noise no sequence was detected, but only few separated short clicks. It seems that the whales were almost silent during the noise intervals.

The mean spectra of a selected number of sequences, emitted by eight whales (Nr. 1, 2, 3, 5, 6, 9, 11 and 12) and indicated in Table 1 by bold type, are shown in Fig. 1. The fundamental frequencies differ in each animal. The spectra of whales 5, 6 and 11 have only one clear fundamental frequency, at 2.9, 1.9 and 1 kHz respectively; the other frequencies in the spectra are small in comparison with the dominant ones. The spectra of the whales 1, 2, 3, and 9 have from two to four peaks, close in amplitude, in the range 2- 4 kHz. The spectrum of the whale 12, identified visually as juvenile, is characterized by about ten harmonics falling in the range 2- 4 kHz. These harmonics superimposed on the spectrum of whale 12, as well as the ones visible on the spectra of whales 1, 2, 5, 6, 9 and 11, are probably the effect of pulse repetition frequency (RPF) of the click signals that are contained in the analyzed sequences. However the actual PRF of whale 12 is very peculiar for the high number and the intensity of the harmonics that appear in the spectrum. It may be related to the high interest shown by the juvenile towards the hydrophone, as described above.

CONCLUSIONS The investigation on the click signals produced by a herd of sperm whales, included at least one juvenile, in 17 minutes of continuous recording indicate that:

The fundamental frequencies in the spectra differ in each animal. This has allowed identification of the number (12) of animals in the herd that is greater than the one deduced visually (at least 4 individuals).

The spectra of 11 whales are characterised by few clear peaks falling at frequencies different in each animal.

The spectra of the juvenile are characterised by many harmonics, superimposed on a spectrum that seems to have no fundamental frequency. These harmonics, probably due to the high pulse repetition frequency of the click signals contained in the sequences, are interpreted as a high interest of the juvenile towards the hydrophone.

The sequences of clicks were emitted almost cyclically by the whales during the intervals free of noise: apparently a sender waited for the answer of one or more listeners before emitting a new sequence of clicks.

During the intervals with noise the whales were almost silent.

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Table 1. Click sequences emitted by a herd of 12 sperm whales in 17 minutes of continuous recording. Each row contains the series of click sequences emitted by the whale, identified by the number in the first column. Within the bins of a row are reported the beginning and the end of each sequence emitted by the animal related to that row. The noisy ▩ and the empty ☐ bins of each row are also shown .

Whales	Rhythm of click sequences
12	00:07-00:10; 06:56-07:00; 12:03-12:05; 15:50-15:52
11	00:30-00:32; 12:12-12:16; 14:50-14:55
10	06:41-06:43; 13:43-13:46; 16:41-16:45
9	06:04-06:06; 09:55-09:58; 10:05-10:11; 11:52-11:53
8	05:38-05:49; 11:45-11:46; 13:18-13:19; 15
7	09:45-09:48; 11:20-11:26; 11:34-11:36; 13:07-13:11
6	05:13-05:15; 14:14-14:26
5	09:02-09:10; 12:47-12:51
4	04:22-04:36; 08:55-08:57
3	04:22-04:36; 08:55-08:57
2	03:26-03:34; 04:12-04:19; 08:45-08:50; 10:37-10:40; 12:32-12:34; 12:42-12:45; 15:06-15:08
1	04:02-04:08; 07:13-07:15; 10:44-10:46; 12:26-12:30; 14:58-14:59

20s 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 min

TIME (min)

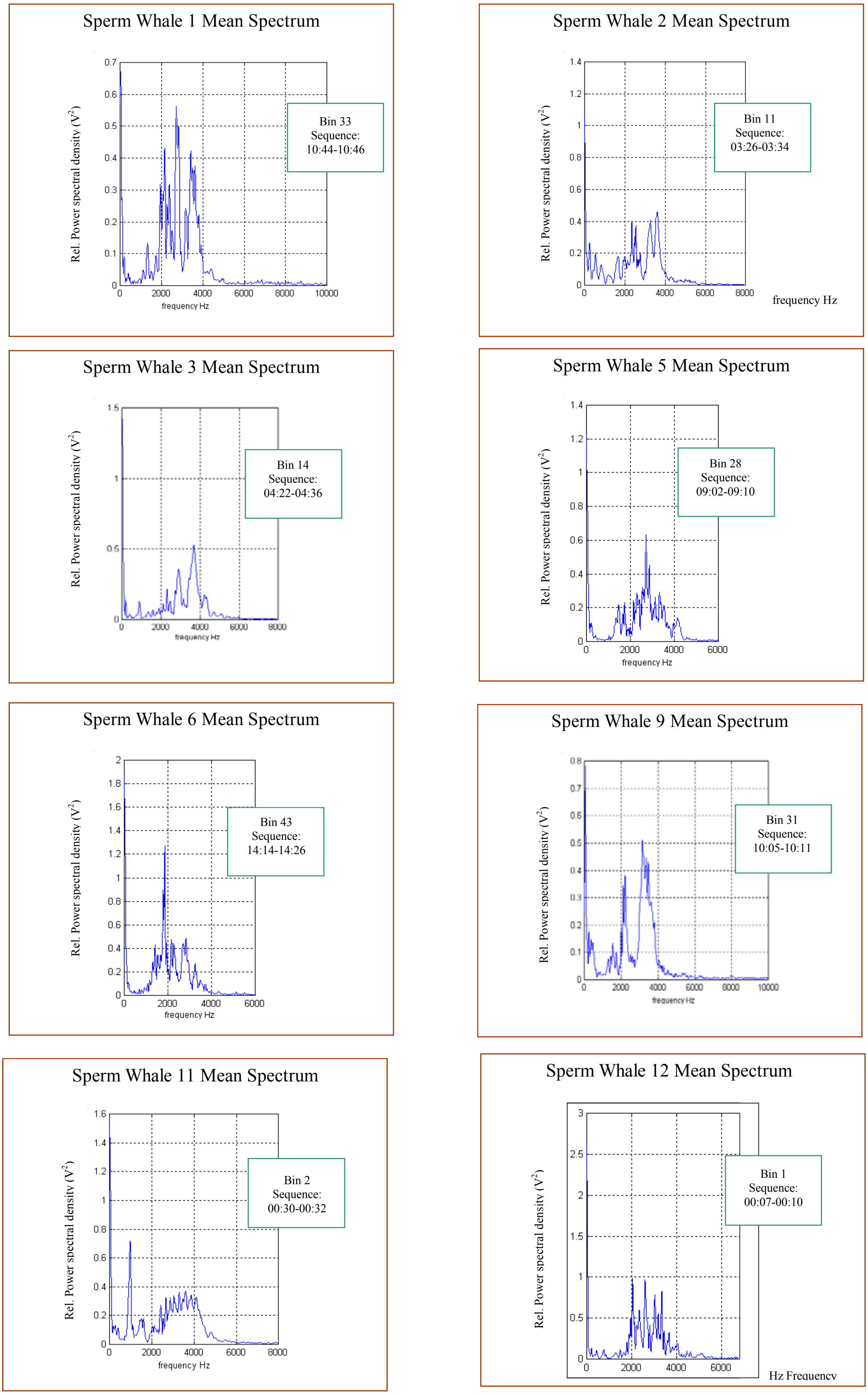

Fig. 1. The mean spectra of a selected number of sequences, emitted by eight whales, included a juvenile. The spectra of whales 1, 2, 3, 5, 6, 9 and11 are characterized by few clear peaks falling at frequencies different in each animal. The mean spectrum of the juvenile (whale 12) is characterized by about ten harmonics, falling in the range 2- 4 kHz

THE ACOUSTICAL REPERTOIRE OF BELUGA WHALES (*DELPHINAPTERUS LEUCAS*) SUMMERING AT SOLOVETSKII ISLAND, THE WHITE SEA

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Beluga whales are among the most vocal cetaceans, possessing a great acoustic repertoire. Besides, some evidences suggest that white whales have geographic dialects. However, few studies of beluga vocal behaviour have been conducted. Therefore our aim was to quantitatively describe the acoustic repertoire of the White Sea beluga whales. Recordings of free–ranging belugas were made in the whale reproductive concentration at Beluga Cape of Solovetskii Island during summer 1999 - 2001. A total of 1200 signals were analyzed in the frequency range 0–20 kHz. Beluga signals were divided into four large categories: 1) echolocation emissions (4 types), 2) whistles (12 types), 3) pulsed tones (12 types) and 4) burst-pulsed calls (12 types). The White Sea belugas also produce combined signals that consist of both a pulsed and whistle component. The following signal parameters were measured: start frequency, end frequency, minimum frequency, maximum frequency of fundamental frequency (repetition rate for pulsed calls), duration, number of inflections and number of predominant harmonic. Range and mean frequency of the calls were measured for some pulsed signals and ones with noise component.

INVESTIGATING THE RELATIONSHIPS BETWEEN WILDLIFE TOURISM AND SEA OTTERS (*ENHYDRA LUTRIS NEREIS*) IN THE MONTEREY BAY, CALIFORNIA

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Monterey Bay is a popular destination for visitors wishing to observe marine wildlife such as dolphins, whales, seals and sea otters. Activities such as kayaking, diving and wildlife watching tours allow people to get closer to these marine mammals and also provide excellent opportunities for environmental education. In recent years there has been some concern that these recreational activities may have the potential to disrupt the natural behaviors of the threatened southern sea otter, a species whose numbers are currently declining. Previous research on marine and terrestrial wildlife has shown that human disturbance can have a variety of negative behavioral and physiological impacts. At present there is very little information on the effects of human disturbance on sea otters. This project is working with local scientists, non-profits, enforcement agents, tour operators and visitors to investigate current interactions between marine recreation and sea otters. Data is being collected via focal observations of interactions between people and sea otters, comparison of sea otter time activity budgets at various sites in Monterey Bay and through interviews and surveys with all stakeholder groups. The project aims to provide information on the current situation, ascertain if marine recreation is having any detrimental impacts on the sea otter population and work co-operatively with all interested parties to develop and improve current management strategies such as environmental education programs. Results of the first field season (2002) are currently being analysed and will be presented at the conference. Preliminary analysis indicates a relationship between increasing numbers of kayaks and decreasing numbers of otters. It also appears that there is some degree of habituation of otters remaining in areas with heavy boat traffic. Interviews and questionnaires have shown awareness of the harassment issue across all stakeholders and a desire to improve management through development of educational programmes.

PULSED SOUNDS RECORDED WITH AN ACOUSTIC TAG ON FREE RANGING BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN NEW JERSEY COASTAL WATERS

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We developed a mobile sound recording unit, MOSART (MObile Submarine Acoustic Recorder of Transients), aiming at recording the directional part of social pulses emitted by pod mates. The unit has a broadband hydrophone and a custom-made envelope click detector, with an 8th order band pass filter centered at 120 kHz (3 dB bandwidth 10 kHz). The signal is stored on a Sony digital mono dictaphone and retains pulse duration and repetition rate patterns of the original pulses within the filter band frequency. The VOR function (Voice Operated Recording) of the dictaphone was used in an attempt to eliminate silent periods. We attached the unit non-invasively to the right pectoral fin of two free ranging dolphins in New Jersey, USA, during a NMFS capture/release program in September 2002. The units had a corrosive zinc-link release mechanism. The animals were tracked from a small boat by using VHF transmitters attached to their dorsal fin. Recordings were obtained from one of these animals during the 22 hours of attachment. This animal swam over a 65 km distance during the first 15 hours of attachment, moving 27 km along the coast. The furthest offshore distance of 3,5 km took place during night. A total of 313 VOR sequences (mean = 6,2 seconds/sequence) contained 2932 rather weak pulses (mean = 9,4 pulses/VOR sequence). These sounds occurred regularly throughout the whole attachment period, suggesting the origin being a weak side-lobe of the tagged animal's own sound production. Mean pulse repetition rate was 4,0 pps, ranging from occasional pulses to slow, stereotyped pulse trains, A few, low amplitude buzzes with short duration and higher repetition rates were also recorded. The results suggest a routine navigation/orientation function of these pulse trains. They also show that the pectoral fin may be a useful attachment point for acoustic tags.

NOISY NEIGHBOURS? VOCALISTIONS OF RESIDENT BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) POPULATIONS VARY BETWEEN FJORDS IN FIORDLAND, SOUTHWEST NEW ZEALAND

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Three separate groups of bottlenose dolphins (Tursiops truncatus) are resident in the waters of Fiordland, southwest New Zealand, over a combined range of 200km. Two of these groups have potential overlaps in home range, and acoustic studies suggest vocalisation use varies with fjord membership. In this study, vocalisations are classified as either click trains, burst pulses or whistles. Burst pulses are further differentiated as either single pulse, multiple pulse or sequenced pulse. Whilst the production rate of clicks and whistles seems similar in Milford Sound and Doubtful Sound, there are differences in production rate for all 3 burst pulse categories (measured as calls per dolphin per minute per behavioural state). Whilst the function of theses calls is still unclear, it would appear many have social importance. Further examination of whistle parameters suggest some differences in structure between fjords. Whistles from Doubtful Sound were significantly longer, with higher maximum frequencies (and thus higher frequency range) and more frequency inflections than from Milford Sound. Whistles seem to serve a largely social function in free-ranging dolphins, serving as contact calls for group cohesion and during individual separation. The more frequency and/or amplitude modulations a whistle possesses, the more distinct it becomes and increased whistle complexity may be a function of both social structure and home range. The dolphins of Doubtful Sound appear to have stronger social bonds than those of Milford Sound, with long-lasting male-male, female-female and male-female pair bonds. The home range of the Doubtful Sound dolphins seems limited to approximately 50km, whilst the range for the Milford Sound dolphins is in excess of 100km. High degrees of social interaction such as those seen in Doubtful Sound, combined with small home range, may result in more individualistic whistles and other observed differences in vocalisation rate.

DOES SHIPPING NOISE IN THE LIGURIAN SEA COMPETE WITH FIN WHALE SONG?

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Between 31 August 1999 and 7 September 2002 a total of 18 Pop-ups were deployed within the area of the Sanctuary for Cetaceans of the Ligurian Sea. Goals of the study were: a) to determine presence/absence of fin whales (Balaenoptera physalus) acoustically, b) to describe fin whale vocalizations, and, c) to describe the concurrent acoustic environment. The first 12 units were deployed close to the coast of Imperia and North of Corsica. These units sampled sounds at 2 KHz, in order to cover a wider range of frequencies; in 2002, 6 units were deployed in two sets of 3 Pop-ups each. These units sampled at 1 KHz sampling rate. The two sets were deployed with a geometry allowing later triangulation of sound sources and a good approximation of their depth. Deployment depths were known and ranged from –370 m to –1421 m. A total of 15720 h of recordings were collected, covering one spring, two summers, one autumn and one winter. Finwhale vocalizations were composed from two types of 20-Hz pulses, respectively referred to as "classic" (with peak energy at 21.3 Hz, 3 dB bandwidth 19.2-24.6 Hz) and "backbeat" (with peak energy at 19.8 Hz, 3 dB bandwidth 18.7-21.5 Hz). Pulse interval for classic pulses was around 14 s. Finwhales were found to be present and singing year-round, with hourly vocalization counts varying according to whale numbers and whale movements across the basin. Cathegories of man-made sound sources were described, with commercial shipping outnumbering by far all other, such as fisheries-related, ferries, pleasure craft, seismic, military, and other. The most frequent cathegory of noise may mask finwhale song, however the repetitivity of the vocalizations enhances their detectability.

LEFT BRAIN HEMISPHERE DOMINANCE FOR CON-SPECIFIC CALLS IN SEA LIONS (*ZALOPHUS CALIFORNIANUS*)

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Language is mainly under the responsibility of the left brain hemisphere in humans. A left hemisphere dominance has been also demonstrated for communicative calls in apes and monkeys. The origin of asymmetry for language of the human brain should be then interpreted in evolutionary terms rather than being confined to the human specie.Using a head orienting task toward sounds played back we describe a right ear - left hemisphere - presentation dominance to con specific calls adult California sea lions (*Zalophus californianus*) but not in infants. These findings draw maturational steps regarding communication in pinnipeds brain similar to what has been described in human and non human primates. Such a result in a specie far away from us on the phylogenetic tree speak for an old emergence of the left brain specialization for communicative sounds perception.

PULSED SOUNDS OF THE BOTTLENOSE DOLPHINS IN THE SADO ESTUARY

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Studies of the sounds emitted by the resident bottlenose dolphins (*Tursiops truncatus*) in the Sado estuary (Portugal) have shown complex acoustic patterns, comparable to other populations of the same and other delphinid species. In the pulsed sounds category (which includes echolocation and social signals), bray series appear as the most conspicuous signal type, but we can also find creaks, moans, squawks, squeaks, screeches and bangs. Here, we investigate the emission patterns of some of the pulsed sounds (click trains, moans, creaks and bray series) and analyze them in relation to social variables. We found no effect of group size in the production of any of these pulsed-sounds. A higher production of bray series was noted when other dolphin groups were near our focal group. No significant differences were found in the emission of slow click trains in the various activities, but we noted that creaks (faster click trains) were more abundant in Feeding and Travel/Feeding. Other fast click trains, the moans, and also the bray series, were particularly abundant both in Feeding and Socializing. These sounds have a probable social function, since their abundance increases with group excitement regardless of the behavioural context.

DISTRESS CALLS IN BOTTLENOSE DOLPHINS AND OTHER ODONTOCETES: IMPLICATIONS FOR ANIMAL CARE AND OUR UNDERSTANDING OF DOLPHIN WHISTLE REPERTOIRES

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INTRODUCTION Although distress calls have been reported in many animal species, little attention has been focused over recent years to distress calls in cetaceans, despite earlier references (Lilly, 1961; Lilly and Miller, 1961a,b, 1962; Lilly, 1963; Busnel and Dziedzic, 1966a,b, 1968). Lilly (1961) was the first to report distress calls in bottlenose dolphins (*Tursiops truncatus).* He reported a stereotypic rise-fall contour whistle type, in the context of physiological pain (Fig. A).

Rising contours have been reported as predominant call types in bottlenose dolphin repertoires and have been suggested as possible contact or attention calls (Dreher and Evans, 1964; Dreher, 1966; Lang and Smith 1965; Evans, 1967; Burdin *et al.,* 1975; Kaznadzei *et al.,* 1976; McCowan and Reiss, 1995a,b; Moore *et al.,* 1995; Herzing, 1996; McCowan and Reiss, 2001). Some authors have included these whistle types in their analyses of "signature whistles" (Tyack, 1986; Caldwell *et al.,* 1990; Sayigh *et al.,* 1990; Janik *et al.,* 1994). Falling contours are another common whistle type that have been reported in the whistle repertoires in the bottlenose dolphin (Lilly and Miller, 1961a,b, 1962; Lilly, 1963; Dreher and Evans, 1964; Lang and Smith, 1965; Dreher, 1966; Busnel and Dziedzic, 1966a,b, 1968; Caldwell and Caldwell, 1979; Tyack, 1986; Janik *et al.,* 1994; Herzing, 1996; Bonsignori *et al*., 1998) and in other odontocete repertoires (Busnel and Dziedzic, 1966a,b; Dreher and Evans, 1964; Evans, 1967; Moore and Ridgway, 1995).

In his discussion of the rise-fall distress whistle, Lilly (1963) suggested that this distress call may in fact be a combination of two separate whistles types: a rise portion - an attention call, and the fall portion - a stress call that is enhanced in combination with the rise to become a distress call reserved for real or potential physical distress.

Similar whistle types have been reported in other studies. Dreher and Evans (1964) studied whistle contours of four different species of both captive and wild dolphins (*Globicephala scammoni / macrorhynchus, Delphinus bairdi, Tursiops gilli, Tursiops truncatus).* They concluded that both fall and rise-fall contours were definitely associated with fright or violent disturbance. Busnel and Dziedzic (1966b, 1968) reported distress calls in the acoustic behavior of several harpooned odontocetes (Fig. B). They suggested that in fact, there may be two different distress-type calls generating two different behavioral responses: a fall-rise contour associated with immediate negative phonotaxy and alarm behavior and a rise-fall contour associated with positive phonotaxy and cooperative or epimeletic behavior as described by Lilly (1961, 1963). Ford (1989) provided further evidence in the description of rise-fall whistle types emitted under painful/stressful situations recorded from many killer whale pods, including members of different resident communities and even in captive animals. Recently, whistles with a similar rise-fall distress contour were reported in a Pacific Humpback dolphin (*Sousa chinenis*) that stranded alive, was rehabilitated and subsequently died of a chronic illness (Van Parijs and Corkeron, 2001) (Fig. C). However, the authors interpreted this signal as a "signature whistle."

Here we report additional evidence for the existence and function of a distress call in dolphins.

METHODS AND RESULTS We recorded the vocalizations of a young female bottlenose dolphin, (*Tursiops truncatus*) that stranded, was rehabilitated, and subsequently succumbed to a chronic illness. The estimated age for the calf was 1.5 years. The orphaned calf was immediately transported to the National Aquarium in Baltimore for rehabilitation, were it was maintained in quarantine for 112 days and then integrated into a social group for 73 days until she suddenly died. A necropsy revealed an ulcerous intestine infection and abnormalities in various organs. The calf's vocalizations were recorded for one hour in the context of isolation on the 31st, 32nd, 35th, 36th, 37th, 43rd, 44th and 45th days of quarantine. Recordings were made using a Sony DCR-TRV120 video camera and C-21 Cetacean Research Technology hydrophone (Freq. Range: 0.012-60kHz [+3/-6 dB], Nominal Sensitivity: -165dB [re 1V/µPa]). Audio recordings were analyzed using CoolEdit Pro (version 1.2) sound analysis software (Syntrillium Software Corporation, Phoenix, Arizona, U.S.A) and wSpecGram Real time Spectrograph (version 1.0) sound analysis software (developed by G. Pavan, CIBRA, Pavia, Italy).

A total of 1,438 whistles were recorded, analyzed and categorized into 57 different whistle types, 46 of which only occurred once. Analysis of the vocal repertoire of this dolphin indicated a predominant, stereotypic, and repetitious rise-fall whistle type whistle (n=1301) (90.47%) (Fig. D) that resembled what has been previously described as a "distress whistle" by some authors and as a "signature whistle" by others.

DISCUSSION AND CONCLUSIONS We hypothesize that the rise-fall whistles emitted by the 1.5 year-old rehabilitated female dolphin we recorded and the whistles reported by Van Parijs and Corkeron (2001) from a dolphin which also stranded, was rehabilitated and subsequently died of chronic illness may be distress calls. The finding of a remarkably similar whistle type produced by two different cetacean species, under similar physiological and environmental circumstances suggests this whistle type is context-specific and not a signature whistle. Furthermore, this whistle type is consistent with vocalizations reported as distress whistles emitted under distress or chronic physiological pain in earlier studies. In our study and theirs, based on the dolphin's vocal behavior and the physiological state of the animals, we propose that the distress whistle hypothesis is the most consistent interpretation of the acoustic behavior recorded.

The apparent lack of recent references to distress calls in dolphins and more generally in cetaceans may be due in part to the focus on the signature whistle hypothesis. This proposes that each dolphin tends to produce a predominant, stereotypic, and individually distinctive whistle contour that functions to broadcast individual identity of the sender to other members of its social group and may serve as a contact call between individuals (Caldwell and Caldwell 1965a, 1968; Caldwell *et al*., 1990). It is striking that categories of whistles like the rise-fall, the fall and the rise are consistently reported by many in an a priori manner as signature whistles, based only on the fact that they are predominant whistles and produced in repetitive sequences. However, other studies have questioned the existence of signature whistles suggesting instead that dolphins share common contact calls, a rise type whistle, that have "individual distinctiveness" as is the case for many mammals (McCowan and Reiss, 2001).

It is highly probable that distress calls exists in bottlenose dolphins and other cetacean species, thus, it could be a potentially important diagnostic tool for assessing health and well-being in captive animals and for the care and management of stranded animals.

More recordings are needed and should be obtained opportunistically when animals are in potentially stressful contexts (e.g., illness, injury, stranded, or entangled in nets) to further test this hypothesis and gain a clearer understanding of the occurrence and function of this call. We have made other observations of the use of this whistle type although acoustic recordings were not conducted in all cases.

One of the authors (DR) recorded a sequence of rise-fall type whistles (Fig. F.) from a post-partum female when her newborn departed her side and swam into a wall. The use of the whistle type was immediately discontinued upon her retrieving the calf and was not the contact call normally used in the repertoire of this female or her social group (McCowan and Reiss, 1995a; Reiss and Castellote, in preparation). A similar rise-fall whistle type was also recorded during the birth process of a captive bottlenose dolphin at the Genova Aquarium in Italy (Fig. E.) The birth process is potentially a stressful and painful situation.

Additionally, one of the authors (MC), while at another facility, heard similar rise-fall type whistles emitted by a captive bottlenose dolphin that incurred an abrasion to its dorsal fin during transport. The dolphin emitted a rise-fall type whistle of 1.5 -2 seconds of length, highly comparable to those previously described as a distress call in the bottlenose dolphin. After the dolphin's introduction into the oceanaria pools, the use of this whistle type ceased. On another occasion the same author heard three other dolphins producing this same whistle type during transport via sling while the animals were being lowered through the air into the oceania pools. Again, production of the whistle types ceased upon introduction to the pools.

More research is needed to determine the distribution and use of distress calls across cetacean species and ascertain whether it could serve as an important "acoustic diagnostic" or indicator of stress or illness in captive, stranded animals or free-ranging animals.

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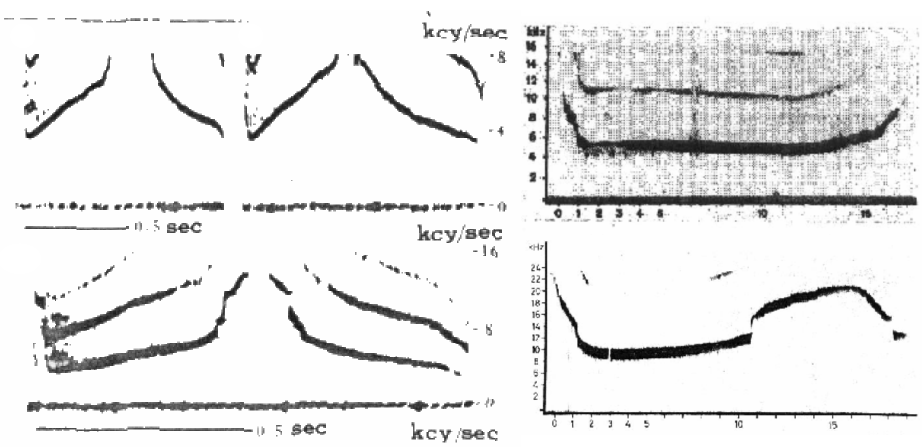
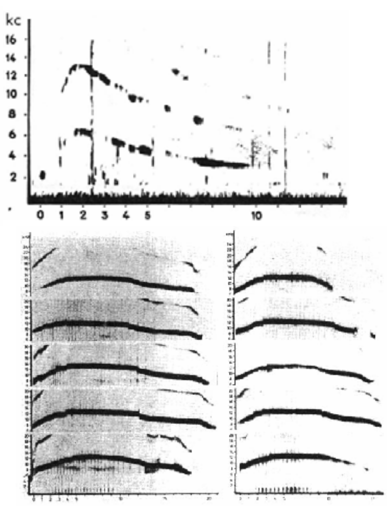
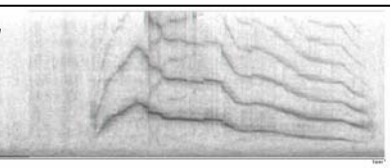




FIGURES: **A** Lilly (1961) *T. truncatus* distress call. **B** Busnel and Dziedzic (1968) distress calls from: **B1** *T. truncatus*; **B2** *D. delphis*; **B3** *G. Malaena*; **B4** *S. Coeruleoalba*.

E



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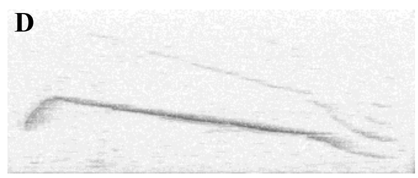
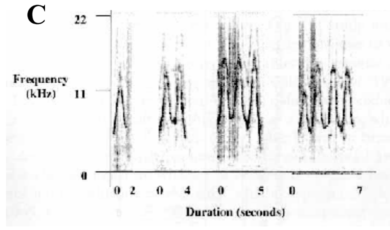


FIGURES: **C** Van Parijs and Corkeron (2001) signature from *S. chinensis*. **D** Castellote and Reiss in prep. distress call from *T. truncatus*. (0-22 kHz, 1,5 sec) **E** Bonsignori *et al*. (1998) Whistle type from *T. truncatus*. **F** Reiss unpub. data whistle type from *T. truncatus*. (0-22 kHz, 1,5sec).

C



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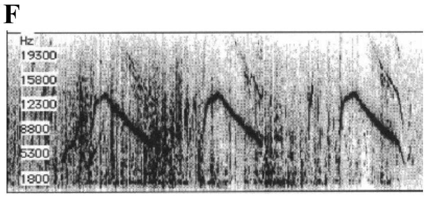

INDIVIDUAL VARIATION OF COW-PUP "ATTRACTION" CALLS IN WEDDELL SEALS, *LEPTONYCHOTES WEDDELLII*

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Individual vocal recognition may function as a key factor in maintaining the cow-pup bond during the lactation period. For individual recognition to function, the caller must produce individually distinct vocalisations that require stereotypy within individuals and variability among them. Cow-pup vocal recognition has been studied extensively in the colonial otariids and appears to be characteristic of this family. Empirical studies of phocid species are fewer, however, and have revealed a range of cow-pup recognition abilities. The presence or absence of individual recognition may reflect the diversity of phocid social organisations, ranging from colonial to solitary breeding species. This study investigated whether Weddell seal cows and pups produce individually distinct in-air vocalisations. 15 vocalisations from each of ten cows and 15 pups recorded in the Vestfold Hills, Antarctica were analysed using Signal RTS 3.1. Temporal and frequency characteristics were measured, with all frequency characteristics measured from the fundamental. Coefficients of variation (CV) were calculated and Canonical discriminate analysis performed to determine whether the calls were individually distinct. Cows produced individually distinct vocalisations, with 77.0% of the data assigned to the correct individuals. Although pups do not appear to produce individually distinct vocalisations, with only 50.7% of the data assigned to the correct individuals, examination at an individual level appears to reveal a pattern to the classification values. The observed trend suggests that individual variation of pup vocalisations may be influenced by an additional factor, pup age, not corrected for in the canonical analysis.

BUILDING AN ACOUSTIC MODEL OF A CUVIER'S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*)

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Recent beaked whale stranding events associated with sonar operations catalyzed an effort to build a finite element (FE) model to simulate acoustic propagation within the body of a Cuvier's beaked whale. Thus far, we have completed: (1) construction of a registration "sarcophagus" containing the specimen and specific density rods so that the scans could be calibrated and accurately reconstructed in three space, (2) cutting the entire sarcophagus into four manageable pieces, (3) CT scanning each piece, (4) detailed sectioning of the specimen and extraction of more than 600 samples for analysis of biomechanical properties such as acoustic velocity, attenuation, and tissue elasticity. Preliminary analysis suggests the data are robust and consistent with the trends in structure and acoustic velocity as shown for the biosonar apparatus in other species. We are currently constructing an FE model from the empirical data that should allow us to: (1) Create tools to simulate the effects of man-made sound on organ systems, tissue interfaces and the peripheral auditory system, (2) Investigate acoustic pathway(s) through the peripheral auditory system to the ears, including the juxtaposed and hypertrophied trabeculae of the pterygoid sinuses, (3) Predict sound levels within the body as a function of source intensity, frequency, range, and bearing, (4) Examine mechanisms for how sound may be focused, refracted, reflected, or altered in various parts of the body. These simulations may provide insights into the factors that contribute to the stranding events of recent years.

THE STRIPED DOLPHIN (*STENELLA COERULEOALBA*) IN CANYONS AND THEIR EXTENSIONS, NORTHWESTERN MEDITERRANEAN: RESULTS FROM ACOUSTIC AND VISUAL DETECTIONS USING GEOGRAPHIC INFORMATION SYSTEM

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INTRODUCTION Bathymetric preferences of the striped dolphin have been demonstrated (Gannier and David, 1997; David, 2000; Cañadas *et al*., 2002). These results were obtained from the analysis of depth strata (0-200 metres, 200-500 metres,…), from the coast to the deep sea. The use of Geographic Information System (GIS) not only allows for cartography and analysis of data according to depth strata, but also to underline topographic particularities, such as canyons and their extensions. This study provides a different approach to the study of distribution and abundance of marine mammals. The striped dolphin represents the most abundant species in the Mediterranean. Therefore, it is an appropriate species to evaluate distribution and the abundance from visual and acoustic data.

MATERIALS AND METHODS Data were collected from July to mid-September 2001 in the Provencal Basin, located in the northwestern part of the Mediterranean (Fig. 1). The area (6860 km²) was divided into 20 polygons of the same size (10 by 10 minutes, latitude and longitude). Each area was assigned to a bathymetric category (Fig. 2): continental shelf, canyons and their extensions, slope and slope-open sea, open sea. The area included two canyons (Fig. 2): Toulon (polygons 9-10-17) and Magaud (polygons 5 to 8). Line transects (n=1595 nautical miles) and listenings (n=774) were carried out using a motorized sailing vessel (14 meters), at an average speed of 5 knots. Only surveys conducted with a sea state up to 3 Beaufort were retained for analysis. One-minute listening sessions were held every 20 minutes, using a towed omnidirectional hydrophone (C53, Cetacean Research Technology; frequency range: 12Hz-60kHz and 100kHz-250kHz). Presence or absence of marine mammals was noted. Sounds of species that could not be identified at the listening stations were recorded using a DAT Sony TCD-8 (20Hz –22kHz; response of frequency of 48kHz) and later analysed using Cool Edit pro 1.2a. The hydrophone utilized of a high-pass filter of 300Hz in order to suppress the background noise. During sightings, behaviour was observed. It was attributed to four categories: feeding (F), resting (R), socializing (S) and travelling (T). Day was divided into four periods: 1) dawn (D), from sunrise to two and a half hours after sunrise, 2) morning (M), until the passing of the meridian, 3) afternoon (A), until two and a half hours before sunset, 4) evening (E), until sunset. Acoustic and visual efforts are mentioned in Table 1.

Visual and acoustic data were analysed using Geographic Information System (GIS; ArcInfo 8.1 and ArcView 3.2; ESRI, 1996, 1997). All species visually or acoustically encountered during the period of study were analysed, but only results which concern the distribution and abundance of the striped dolphin are presented here. Maps including acoustic and visual abundance indices were built from a georeferenced data base, using ArcInfo 8.1, to represent the spatial distributions of this species.

RESULTS AND DISCUSSION

1. Distribution and abundance during the summer Visual sightings of the striped dolphin represent 82.7 % of encounters (n=81) with five visually and acoustically detected species (Table 2). 20.28% of the listenings were positive (n=141/774) and 51.8% of the acoustic contacts came from the striped dolphin. Visual and acoustic abundance indices, calculated for each polygon, are represented on maps (Fig. 3a and 3b), including abundance and effort. Both methods of detection showed no significant difference of the abundance of the striped dolphin in the summer (Khi², Yates correction, p=0.2054). Testing by lunar month showed no significant difference (Khi², p-1st lunar month=1, p-2nd lunar month=0.9098, p-3rd lunar month=0.0548). Both indicated that striped dolphin is present in almost the entire area (no visual observations were made on the continental shelf). On the shelf, acoustic contacts were made in polygons 1 and 4, which are both located in the heads of the canyons.

We calculated the mean value of acoustic and visual abundance for each bathymetric category (Fig. 4) and observed: 1) acoustic abundance predominates in the canyons and their extensions, then in the open sea, 2) difference between visual and acoustic abundances is larger in the canyons and their extensions, compared to the others bathymetric categories. This can be explained when comparing the abundance of this species with behaviour during the day.

2. Distribution and abundance during the day Visual and acoustic surveys showed no significant difference for the periods of the day (Khi², p-morning=0.8183, p-afternoon=0.8828, p-evening=0.6235). Both indicated that striped dolphin is present in the canyons/extensions during the entire day (Fig. 5a-b). At dawn, it was exclusively observed in canyons/extensions. In the evening, it was mostly distributed on the slope (A.I.=4.38 sightings for 100 nautical miles). Acoustic contacts were more abundant in the canyons/extensions during the evening (A.I. =30.76% positive listenings) and at dawn (A.I.=18.32). These results underline a scheme of displacement of the striped dolphin during the day: at dawn , it is present in the canyons and their extensions; in the morning , it is distributed over the entire area; in the afternoon , it is more abundant in the deep sea; in the evening, it comes closer to the coast. A similar scheme was proposed by Gannier and David (1997).

3. Behaviours The four behaviours (F, R, S and T) are observed during the four periods of the day (Fig. 6). They vary significantly during the day (Khi², p=0.0437). Most of the groups feed at dawn and during the evening (Fig. 6). In the afternoon, rest was the most abundant activity. Socialisation was the most observed activity in the evening. Dawn and evening represent the periods where acoustic contacts are the most abundant in the canyons / extensions. During these periods, feeding and socialisation were principally observed, which results in a high emission of sounds.

CONCLUSION Both acoustic and visual survey allow for the understanding of the distribution and abundance of the striped dolphin. The three mean reasons for this are: 1) individuals are numerous in the studied area; 2) they are very loquacious and 3) their vocalizations would propagate a few kilometres only. This may not be the case, however, for a species like the sperm whale. In fact, the distance of propagation of sperm whale sounds would be about 10 kilometres (Luke Rendell, *pers. comm*.), with distance varying according to the authors. Leaper *et al*., (2000) indicated that we can hear sperm whale from a maximum distance of 30 kilometres. Sonor emissions of the striped dolphin would propagate only a few kilometres. This means that the size of the polygons of the studied area should be accurately adjusted according to the species and to the topographic characteristics. Both types of survey, acoustic and visual, indicated that canyons and theirs extensions represent an important area for feeding since they are known to concentrate preys, acting as a trap (Macquart-Moulin and Patriti, 1993; Degiovanni *et al*., 1993). The attractive part of canyons and theirs extensions for feeding could favorise the socialisation.

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Table 1. Acoustic (n listenings) and visual (nautical miles) monitoring effort for the periods of the day

	Dawn	Morning	Afternoon	Evening	Total
Minimal acoustic effort	60	120	120	60	360
Listenings	89	341	248	96	774
Minimal visual effort	100	200	200	100	600
Nautical miles	278	579	565	173	1595

Table 2. Percent of visual and acoustic contacts

	Sightings (n= 81)	Acoustic contacts (n=141)
Sperm whale	8.6	43.3
L-finned pilot whale	3.7	1.4
Risso's dolphin	2.5	0.7
Bottlenose dolphin	2.5	2.8
Striped dolphin	82.7	51.8

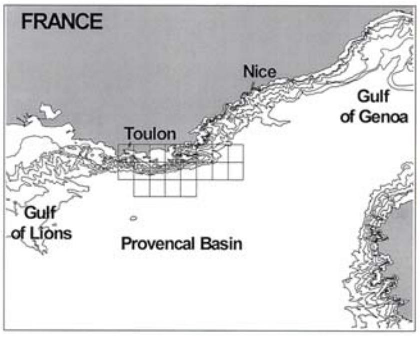

Fig. 1. Study area.

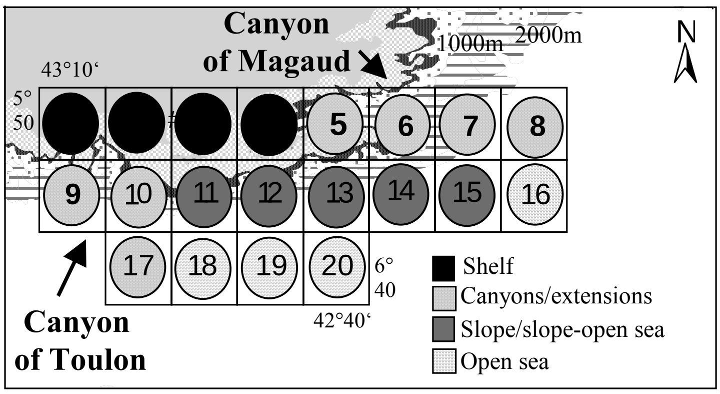

Fig. 2. Bathymetric categories

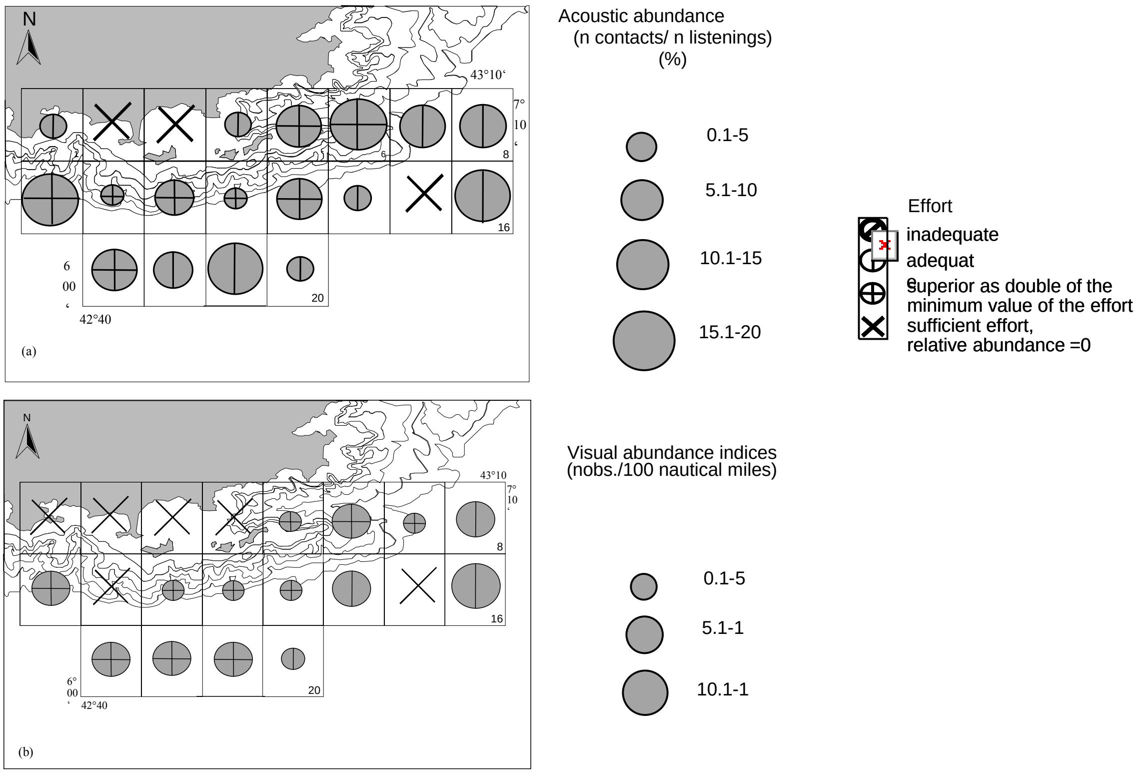

Fig. 3a-b. Acoustic (a) and visual (b) relative abundance of the striped dolphin during summer 2001

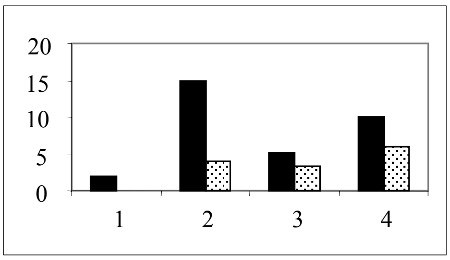

Fig. 4. Mean value of relative abundance for each bathymetric category. Acoustic abundance= in dark (n contacts/n listenings); visual abundance= in hell (no obs./100 nautical miles). (1) Shelf; (2) Canyons and extensions; (3) Slope and slope-open sea; (4) open sea

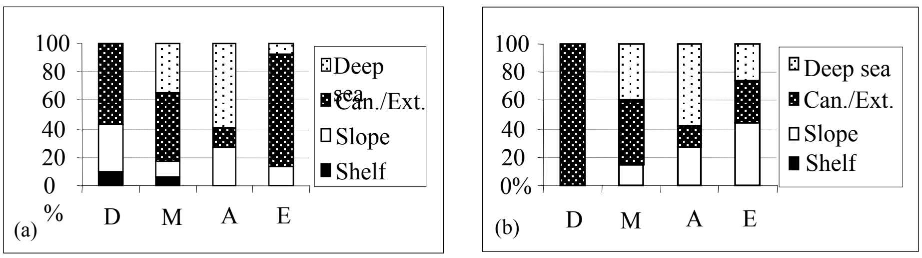

Fig. 5a-b. Spatial distribution of the striped dolphin during the day, obtained from acoustic (a) and visual (b) data. D= Dawn; M= Morning; A= Afternoon; E= Evening

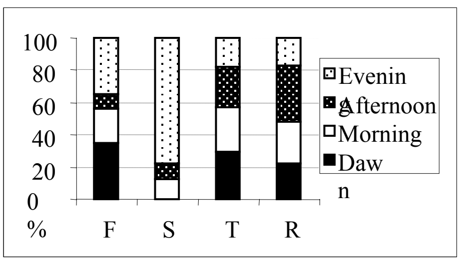

Fig. 6. Behaviour of the striped dolphin during the day. (F) Feeding; (S) Socializing; (T) Travelling; (R) Resting

DYNAMICS OF ACOUSTIC AND RESPIRATORY BEHAVIOUR IN A CAPTIVE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) DURING PREGNANCY

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INTRODUCTION The aim of this study, carried out at Palablù Delphinarium (Peschiera del Garda, Verona, Italy), was to determine how pregnancy alters the acoustic and respiratory behaviour of a captive bottlenose dolphin (*Tursiops truncatus)* and if members of its community are aware of this alteration. Even though acoustic and breathing behaviour of bottlenose dolphins has been studied for years, not many references are at present available about the changes that occur during pregnancy. The Palablù community counts four members, two adult females, Betty and Squeak, one adult male, Robin and one juvenile Teide. Each dolphin has been long studied (Azzali *et al*., 1998; Cialamitaro *et al*., 2000), so that we had clear information about each single acoustic habit and had consequently a background to base any changes upon. Betty got pregnant in November 2000 and gave birth to a calf the 27th October 2001. We had the chance to examine systematically the acoustic behaviour of Betty and of the other members of the community before and during its pregnancy till one month after the birth of the calf.

Betty's respiratory behaviour was examined as the parturition time approached, in aim to record any alteration on the breathing habits of the dolphin. The method for monitoring breathing behaviour was suggested by a similar study carried out in Rimini Delphinarium (Tizzi *et al*., 2001).

MATERIALS AND METHODS The main subject of this study was Betty, a 20 years old bottlenose dolphin. The other dolphins involved in the research were Squeak, a 31 years old female, and Robin, a 21 years old male. All the three dolphins were free-born. Teide, the five years old male born in captivity, was not considered, because still subadult.

Acoustic data presented in this paper regarded three periods: pre-conception period (June-November 2000); pregnancy period (March-October 2001); post-parturition period (November 2001). From June to November 2001 the females and the males were located in two different pools. However this separation did not prevent Robin and Teide from communicating acoustically with Betty and Squeak and vice versa through a large window (2.5x3m), that connected the two pools. Generally the signals emitted by each dolphin were collected in sessions of three consecutive days per month. A session consisted in about two hours of recording randomly distributed during the three days. Signals were recorded from the hydrophone (Brüel and Kjær Type 8105) into the wide band (30Hz-300kHz) channel of an analogical recorder and were monitored on a oscilloscope (HP 54520-A). The comments of the researcher who was observing the animals and in particular which dolphin was pointing towards the hydrophone, were recorded into the low band (<20 kHz) channel of the same recorder. The hydrophone was positioned around two meters in depth, and either three meters from the pool wall (until June 2001) or close to the window between the two pools (July-November 2001). The signals were collected during the day, while the dolphins were free-swimming or sometimes involved in training. It is assumed that during the experiments the dolphins had a natural behaviour. In laboratory the recorded signals were attributed to a dolphin on the basis of the comments of the observer. Uncertain signals were discarded. The signals were processed using MATLAB m-file language (Azzali *et al*., 1998; Ciaramitaro *et al*., 2000). In the present study the following parameters for each session are presented: the mean number of signals emitted by each dolphin per session referred to ten minutes; the GABOR bandwidth and the first frequency moment (i.e. the barycentre of spectrum; Blahut, 1991) of the signals emitted by Betty and Squeak.

The respiratory observations were held throughout twelve weeks, from August 2001 to October 2001. Apnea durations were recorded two days a week, on the basis of four 15 minutes observations, randomized among four 3-hr periods (observational phases: from 8.00 am to 8.00 pm). A 1/1000 sec chronograph was used to value apnea durations. Statistical significances between mean apnea values were calculated via 1-way-anova test. Attention was paid to the dynamic of the breathing actions, dividing 'Dive times' (immersion time lapse from a breath and the next one) from 'Roll interval' (surface time lapse from a breath and the next) as stated by Watson and Gaskin (1983). Peculiar dive habits were also pointed out, as pool bottom grazing apneas.

RESULTS **Acoustic behaviour** The mean number of signals produced by Betty (ref. 10 min) decreased of 70% (fig.1, fig. 2) from the pre-conception period (Jun. –Nov. 2000: mean value=10.4 ± 8.1 clicks per 10') to the pregnancy period (March -September 2001: mean value=3.1 ± 2.5 clicks per 10'). The other female showed a quite opposite behaviour. Squeak increased its acoustic activity in average of 180% from the first to the second period, passing from a mean value of 6.2 ± 3.2 up to 18 ± 13.3 clicks per 10 min (fig. 3, fig. 4). However in the session carried out in the month of the birth (October 2001), surprisingly, no signal was recorded by any female. The mean number of clicks produced by the adult male, Robin, decreased of 30% (fig. 5, fig. 6). from the first to the second period (i.e. from 9.1 ± 6.7 to 5.5 ± 4.6 clicks per 10'). In October 2001 no signal was recorded by Robin. In November 2001, a month after birth, the three dolphins seemed to enhance the acoustic behaviour showed in the pre-conception period: Betty decreased further its acoustic activity (2.1 clicks per 10'), as well as Robin (3.3 clicks per 10'), while Squeak increased it remarkably (26.4 clicks per 10').

A typical spectrum of Betty in the pre-conception period was characterised by frequency of maximum power 45-60 kHz, frequency barycentre 50-70 kHz, Gabor bandwidth 35-50 kHz. These parameters kept pretty stable until May 2001, then the frequency of maximum power and the frequency barycentre showed a progressive increase and remained above 100 kHz in the last months of pregnancy. In particular the frequency barycentre of Betty average spectrum was in August 119.8 ± 3.5 kHz, in September 101.7± 8.6 kHz (fig. 7) and in the month after parturition 108.1± 28 kHz. It is interesting to note that the spectra parameters of Squeak had a trend similar to the ones of Betty. In particular the frequency barycentre of Squeak spectra from May 2001 changed almost in synchronism with that of Betty and remained close to 100 kHz in the last two pre-partum months (fig.8). The spectra parameters of Robin showed no significant changes during the three periods of the research.

Respiratory behaviour The mean weekly apnea durations of Betty are represented in Fig. 9. The diagram points out as Betty's mean apnea values undergo an almost regular increase from August (12 weeks before birth) to October 2001. The mean values passes from 27-28 seconds (August 2001) up to about 29-30 seconds (October 2001). The mean increase was 0.17 seconds per week, as shown by the tendency line in Fig. 9. The study, carried out in 1997 upon a pregnant dolphin in Rimini Delphinarium showed a similar tendency, but with a mean increase almost four times higher (0.66 seconds per week; Tizzi *et al*., 2001). Fig. 10 shows the percentage of apneas that Betty dived really grazing the pool bottom. The number of deep dives passes from 3% to 20% in the research period, with a mean increase of 0.9% per week. No particular results were get by the analysis of the percentage of "dive times" and "roll interval", except in the very parturition day, when Betty stayed at surface slowly rolling most of the time.

DISCUSSION AND CONCLUSIONS The above mentioned results seem to suggest that pregnancy considerably affects the acoustic and respiratory habits of a dolphin. Betty during the pregnancy slowed down of 70% the number of emitted clicks probably to save energy, but increased the frequency barycentre of the emitted signals from 50-60 to 100-110 kHz to get more accurate information and a better control on the surrounding environment. The other female of the group, Squeak, seems to have had some sort of consciousness of the Betty condition. During Betty pregnancy, Squeak tripled her acoustic activity and produced signals similar in shape to those of Betty. It is probable that while Squeak were actively producing those sonar signals at high frequency Betty were listening Squeak's echoes and could know the focus of her companion's attention. This sharing knowledge may be the mechanism that allowed the two dolphins to cooperate in this critical situation. Similar behaviours were observed when stressful or exciting events occurred in the Palablù community (Azzali *et al*., 2002). It is uncertain if Robin were aware of Betty and Squeak acoustic changes: Robin decreased of 30% its acoustic activity during the pregnancy period, but did not change the characteristics of its signals during the research. However Robin remained physically separated from both Betty and Squeak during most of pregnancy period and this could have influenced its acoustic behaviour. Finally it is interesting to observe that in the month of birth no signal was recorded neither from the two females nor from Robin.

Betty's respiratory habits also changed during the twelve weeks from parturition. The increment of the mean dive time, though more moderate than the one reported in the available literature, was quite evident. This leads to the likely conclusion that a pregnant dolphin feels the need to slow down her breath rates (so as her acoustic activity), probably because of the progressive tiredness caused by the metabolic changes consistent with her condition. In addition, the diving performance shows that, even though the dolphin did not change the percentage of "dive times" and "roll interval", yet she chose to spend her dive times grazing the pool-bottom. This is probably an alert behaviour (like increasing click frequency) performed to avoid any kind of disturb or danger that can come from the surface.

ACKNOWLEDGEMENTS This research was supported by GARDALAND. This study could not be done without the kind cooperation of the staff of Gardaland Palablù. Particularly, we thank Luigi Cingolani for technical help, Dr. Raffaella Simoni for her assistance in data collection Valeria Redivo, Daniel Barres and Monica Acciai for the facilities in which the four dolphins were held during the research.

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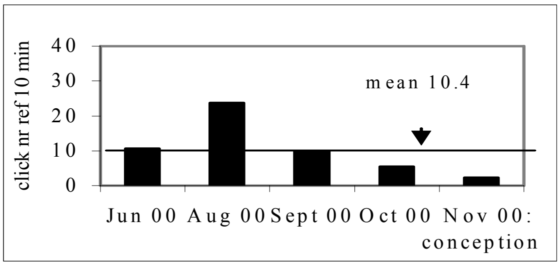

Fig 1: Betty's click number during pre conception period (ref. 10')

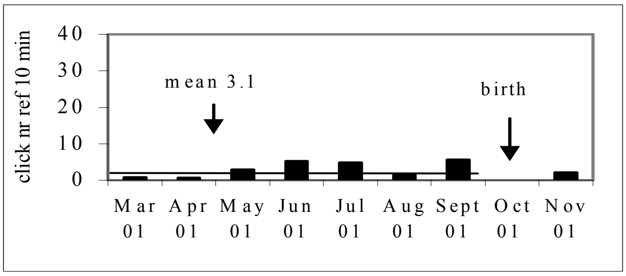

Fig. 2: Betty's click number during pregnancy (ref 10')

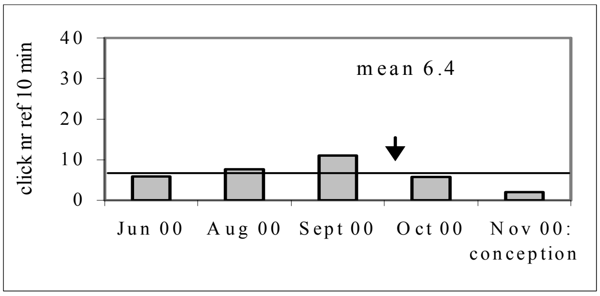

Fig 3: Squeak's click number during Betty's pre-conception period (ref. 10')

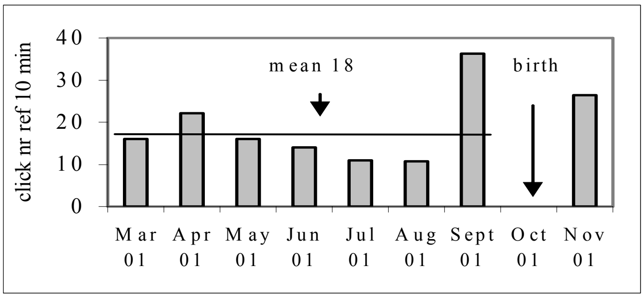

Fig. 4: Squeak's click number during Betty's pregnancy (ref 10')

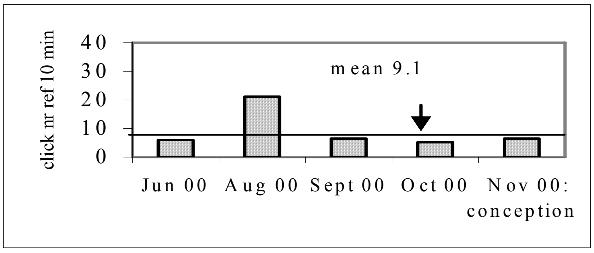

Fig 5 Robin's click number during Betty's pre-conception period (ref. 10')

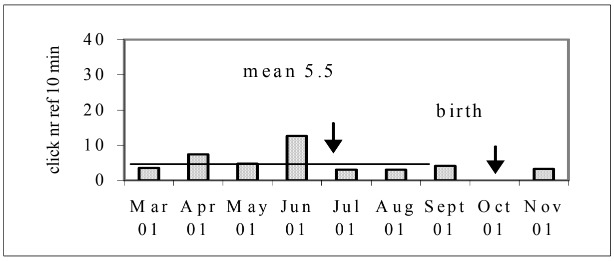

Fig. 6: Robin's click number during Betty's pregnancy (ref 10')

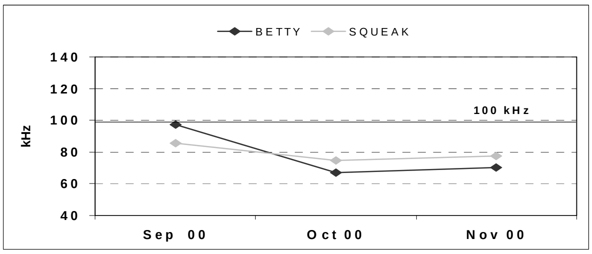

Fig. 7 Betty and Squeak mean barycentre values during pre-concepion period (kHz)

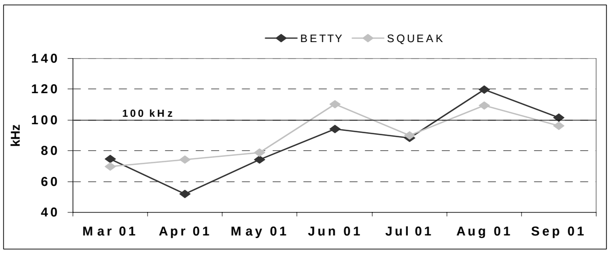

Fig. 8 Betty and Squeak mean barycentre values during pregnancy (kHz)

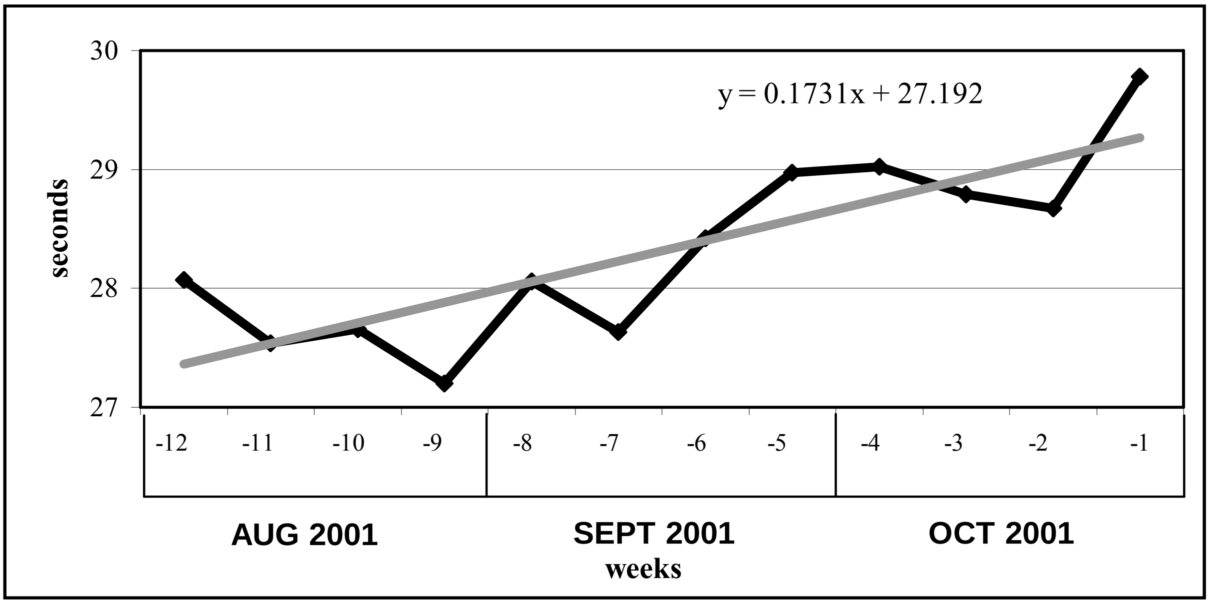

Fig. 9. Betty's mean weekly apnea durations during the last 12 weeks before parturition

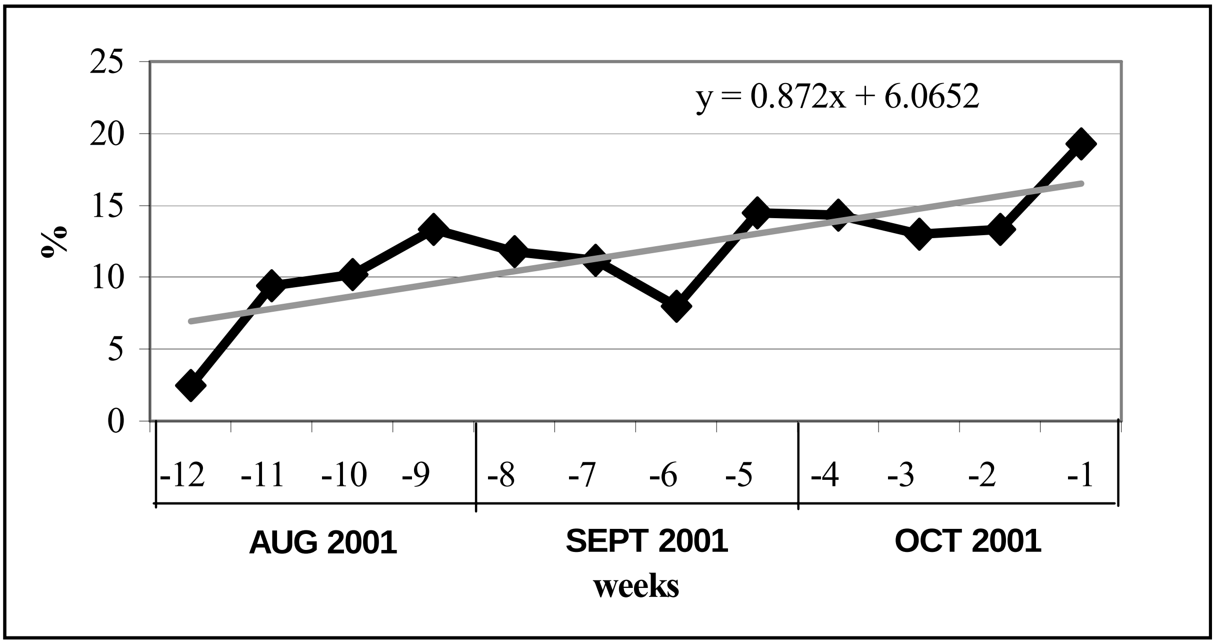

Fig. 10. Betty's deep diving apneas (apneas dived grazing the pool-bottom) during the last 12 weeks before parturition

SEABED INFLUENCE ON CLICK RATES DURING SPERM WHALE DIVES

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INTRODUCTION There have been few direct measurements of the sperm whales dives. Although it is generally believed that sperm whales use echolocation to locate major target as the sea bottom and prey, direct evidence is not available. The acoustic recordings performed during 1997 to 2002 surveys in the Mediterranean Sea were used to investigate the click rate variations during the initial phase of sperm whale dive in order to find insights as to whether clicks are used to locate the sea bottom during the descent.

MATERIALS AND METHODS Eighteen regular click sequences of whales recorded at the beginning of the dive, after the whale fluked-up, were selected and sampled at a sampling frequency of 62.5 kHz, using a Cambridge Electronic Design (CED) 1401 laboratory interface. The waveform of the click sequences were displayed using CED Spike 2 software V.4.70. Inter-click intervals (ICI) of successive clicks were marked manually and the click rate (CR) was taken as the reciprocal of each of the ICIs (1/ICI). ICIs longer than 3 seconds in duration were considered as interruption in the click sequence and these periods were not included in the click rate computation. The first 3 minutes of clicking after the whale fluked-up was used to analyse and interpret the initial descent phase of the dive. The click sequences were differentiated into deep waters (≥1800m) and shallow water (≤1400m) categories. No acoustic sequence was available for dives between 1400m and 1800m.

The "extrapolate whale depth", $Z_{we,}$ was computed, assuming the whale emit a click after the reception of the bottom echo, as follows:

$$Z_w = Z - (ICI \cdot c) / 2$$

Where Z is the bottom depth, c is the sound velocity in water (1520m.s^{-1}) and ICI the Inter-Click Interval (s).

The extrapolated descending rate (DR_e) was also calculated as follows:

$$DR_e = (Z_{weF} - Z_{weI}) / (T_F - T_I)$$

Where Z_{weF} and Z_{weI} are the final and initial extrapolated whale depth and T_F and T_I the final and initial time. In cases where both the click and the echo of the click reflected from the bottom were conspicuous on the waveform trace, the onsets of the clicks and the corresponding echos were marked and plotted against time.

RESULTS In dives performed in deep waters (≥1800m), no obvious correlation was observed between click rate and time in the initial phase of the dive: the click rate remained constant, at an average of 0.9 click.s^{-1} as the whale dives toward the bottom (Table1). In these sequences clicks appeared to be emitted before the reception of the bottom echo from the previous click. In shallower water (≤1400m), click rate generally increase progressively with time as the whale dives. The extrapolated whale depth corresponding to these sequences suggested a relatively constant whale descent, with an average descending rate ranging from 76.1m/min to 298m/min (Table 2). The analysis of the bottom echo demonstrated that a click was emitted immediately after reception of the echo from the previous click.

DISCUSSION The constant click rate during the initial phase of dives performed in oceanic waters indicates that the whale does not adjust the rate at which it emits clicks as it get closer to the sea-floor, but rather maintain a fixed time interval between clicks. The 1800m distance between the whale and the seabed would be regarded as a threshold over which the whales do not wait for the return of the echo but produce clicks without changing the emission rate. In contrast, in shallower waters, the increase in click rate during the initial phase of the dives shows a consistent correlation with whale depth, suggesting that the whales adjust their click rate as the seabed is approached. These results are consistent with the commonly accepted theory that regular clicks are used to locate the sea floor. Other sperm whales studies have reported an adjustment of the click rate during the dive and suggested that ICI is reduced as the whale approach the bottom (Madsen *et al*., 2002; Gordon, 1987). However, our results propose that this adjustment occurred when a threshold distance to the bottom is reached; above that threshold sperm whale clicks at a constant pace. Whether the whale uses height above sea floor to adjust their foraging depth is still unknown. The extrapolated whale depth in shallow waters gave credible estimates of the whale descent speeds (113m/min on average), consistent with previous estimates ranging between 75 and 150m/min (Lockyer, 1997; Gordon, 1987; Mullins *et al.*, 1988; Papastravou *et al.,*1989; Goold, 1998; Madsen *et al.,* 2002; Watkins *et al*., 2002).

CONCLUSION The results suggest that in oceanic waters sperm whales maintain a regular click emission rate without taking into account the echo received from the seabed. In contrast, in continental slope waters, sperm whales appear to use the echo and adjust the click rate according to the approaching distance to the sea bed. Thus, it appears that echolocation is a very active process where whale clicks to locate the seabed and responds with varying click rate pattern according to the target distance.

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Table 1. Basic statistic for click rate (click.s-1) of the 3 first minutes of the click sequence, after the whale fluked-up in deep waters ((≥1800m). Bottom depth and whale size estimates are also reported

Sequence ID	N	Mean CR (click.s-1)	SD	Depth (m)	Estimated whale size (m)
A9718	154	0.89	0.065	2500	13.5
A9911a	158	0.92	0.068	2400	12.9
A9911b	147	0.89	0.115	2400	12.9
D0116Aa	129	0.75	0.049	1800	13
D0116Bao	152	0.88	0.059	2000	13
D0116Ca	162	0.94	0.056	2000	13
D01016Da	128	0.83	0.259	1800	13

Table 2. Basic statistic for click rate (click.s-1) of the 3 first minutes of the click sequence, after the whale fluked-up in shallow waters (<1400m) and extrapolated descending rate (DR)

Sequence ID	N	Mean CR (click.s-1)	SD	Depth (m)	DR (m/min)
A9702	205	1.23	0.172	900	110.6
D9806b	236	1.89	0.503	800	125.8
D9911	250	1.46	0.201	700	96.2
D9922	227	1.41	0.488	875	205.6
D0007be	109	0.65	0.0542	1400	141.5
D0106eg	275	2.16	0.672	850	119.1
D0107de	277	1.67	0.373	800	151.4
D0109ac	142	0.84	0.088	1200	122.8
D0110af	127	0.77	0.148	1200	298
D0113Aal	149	0.9	0.085	1000	76.1
D0113Bal	153	0.96	0.18	900	175.8

ACOUSTIC PLAY-FIGHT SIGNAL IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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Play-fighting is a common feature of juvenile/subadult behaviour in many species of mammals (e.g. chimpanzees, dogs and hyenas), where young individuals practice behaviours important to adulthood, e.g. catching and handling preys, and aggressive behaviours required to establish and maintain a position in a dominance hierarchy or to get access to estrous females. Most of the aggressive social interactions in dolphins are settled with displays (e.g. distinct postures, jaw claps and/or head jerks) but if needed severe injuries can be inflicted by biting, tooth raking and strikes with the rostrum and/or the fluke. Therefore a specific signal, signaling play-fight, is needed to distinguish this from true agonistic encounters and to ensure that the play does not escalate into a real fight. We studied aggressive and affiliative behaviours in a resident breeding group of 16 bottlenose dolphins (*Tursiops truncatus*) at the Kolmården Wild Animal Park, Sweden. The study was done by on-line observation and also using previously recorded data on visual and acoustic behaviours in different social situations. The results show that juvenile/subadult dolphins, engaged in what was interpreted as play-fight, emit pulse bursts similar to those observed in true agonistic interactions in adults, but with a trailing whistle. This pulse burst-whistle combination has never been observed in adult aggressive interactions. The whistle has an average maximum and minimum frequency of 13 677 and 6 976 Hz respectively, and a mean duration of 409 msec. The duration of the pulse bursts in these play-fights is significantly different from that of pulse bursts emitted in adult aggressive interactions (Kolmogorov-Smirnoff test D=0,2915; p<0,001). We suggest that this combined burst-whistle signal can be considered equivalent to e.g. the ape and human giggle, resulting in a non-aggressive agreement between the combatants during play-fights.

CAN PODS SAVE THE DAY? LESSONS FROM BROADHAVEN

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The occurrence and distribution of cetaceans in Broadhaven Bay, northwest Ireland were monitored visually and acoustically in order to determine the risks and minimise the impacts from construction of a gas pipeline. The bay is a designated marine Special Area of Conservation (SAC) in one of the more exposed parts of Ireland. Passive echolocation click detectors (PODs) were used to monitor the occurrence of odontocetes close to the proposed landfall site at which drilling and blasting activities were to take place. An acoustic "gateway" consisting of three fixed listening stations placed 500 m apart across the inner bay, was set up from May 3 to October 10, 2002. The detection rate and duration of acoustic encounters were used to investigate the degree to which harbour porpoises (Phocoena phocoena) and dolphin species used the "critical zone", in which death, injury and other significant impacts might occur. Acoustic encounters were defined as periods of click activity separated by silent periods of at least 10 minutes. The data were further analysed to reduce the risk of including false positives. Acoustic monitoring totalled 7,912 hours of listening time, using five separate POD units. Simultaneous visual monitoring detected harbour porpoises in proximity to the critical construction area on one occasion. However, 46 distinct porpoise encounters were logged acoustically in the area on 25 separate days. A further 13 acoustic encounters of dolphins were made on four days. However, due to unsuitable environmental conditions none of these encounters were supported by visual monitoring. The results were essential to the development of optimum measures to protect animals from construction activities. Results therefore confirmed that the use of PODs can be an invaluable component in cetacean monitoring and conservation programmes, providing the opportunity to assess the ecology of small cetaceans in conditions when visual monitoring may be difficult.

CULTURAL CHANGE IN THE SONGS OF HUMPBACK WHALES IN TONGA THROUGH A DECADE

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Some humpback whales migrate annually from Antarctic feeding grounds to the seas around the Tongan Islands to give birth and mate. The Tongan humpbacks are considered part of Group V that splits during migration, some swimming to Eastern Australia and others to Polynesia. During this time long complex songs are produced. The song is thought to be a male breeding display and may serve either as an intra-sexual or an inter-sexual signal or both. It is in a constant state of change that occurs every season. Since these changes are directional they cannot be described by drift. Singers incorporate changes as they occur, and song must thus be shared through cultural transmission. This investigation describes the cultural changes that occurred in 159 songs recorded from Tongan humpbacks through the 1990s. The rate of change differed within years, some themes were retained for as much as five years and others were lost after only two years. The farther apart the years the less similar are the songs, as in the humpback songs of the Northern Hemisphere. The largest number of changes seems to have occurred in the early 1990s where all themes were lost and new ones originated. What initiates these changes remains speculative, but we assess some hypotheses in relation to humpback whale behaviour and cultural transmission in avian song.

RESEARCH TO DETERMINE THE CAUSAL MECHANISMS OF SONAR-RELATED BEAKED WHALE STRANDINGS

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We are learning more about the relationship between military sonar use and strandings of beaked whales, but we do not yet have a good understanding of how sonars cause the physiological and behavioral effects observed in recent strandings. Knowledge of the mechanism(s) by which sonars contribute to beaked whale strandings is a key part of designing effective conservation measures. The Office of Naval Research is supporting investigations of beaked whale distribution and habitat, anatomical studies, and development of tools for improved monitoring of beaked whales (e.g. passive acoustics): these research efforts will be briefly reviewed. The research community also has demonstrated the ability to apply more challenging research approaches, including Controlled Exposure Experiments (the subject of a discussion session at the Rome 2001 ECS conference), and bringing beaked whales into a lab environment for testing of a variety of physiological, hearing, and behavioral parameters. These and other proposed research approaches present risks as well as potential benefits. A list of possible research efforts, along with their respective risks and benefits, will be presented for the purpose of stimulating discussion among the interested research and conservation community. Our goal is to build a clearer sense of what the marine mammal research community sees as its most important and readily achievable contributions this issue, so that limited research resources can be put to the most effective use.

SPERM WHALE DISTRIBUTION AND SEASONAL DENSITY IN THE FAROE-SHETLAND CHANNEL

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Results from previous surveys suggest that an area of the north-east Atlantic, the Faroe-Shetland Channel is important for cetaceans. This study utilised passive acoustic survey techniques to evaluate the density of sperm whales in the Faroe-Shetland Channel. Two-week surveys were carried out during oceanographic cruises in May and October 2001 and May 2002. A two hydrophone array was towed behind the vessel throughout the majority of the survey routes and was monitored by a two person team and by software designed to automatically detect and measure bearings to whales. Distances of individual sperm whales from the trackline were determined using target motion analysis. To calculate the density of whales during surveys we applied standard line transect techniques. The effects of sea conditions and survey vessel on our ability to detect whales were tested; the encounter rate and effective strip-width (esw) were estimated independently for each sea state and for each of the vessels. A total of 79 individual whales were detected, and their distances from the trackline were calculated. As a probable result of insufficient sample size and a small effects size, neither the esw nor the encounter rates varied significantly with sea state or between the two survey vessels. The density of sperm whales during each of the surveys was estimated to be 2.05, 0.52 and 1.75 whales per 1000km2 for the May 2001, October 2001 and May 2002 surveys respectively. Sperm whales were distributed across the majority of the Faroe-Shetland Channel. This study has provided the basis for meaningful hypothesis generation in future studies and to gain a better understanding of the factors underlying the spatial and temporal distribution patterns of sperm whales in this area, data on oceanographic, biological and anthropogenic determinants should now be examined.

USE OF PASSIVE PORPOISE DETECTORS (T-PODS) IN LARGE SCALE TO DETECT ENVIRONMENTAL IMPACTS ON HARBOUR PORPOISES FROM OFFSHORE WINDTURBINES

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Large-scale offshore wind-farms are being constructed in North European waters in order to reduce CO2-emissions. The impact on harbour porpoises from the construction and operation of 3 large Danish and German offshore wind-farms is being investigated by means of permanent acoustic monitoring. It is hypothesised that these constructions will cause porpoises to disappear during the construction. It is further expected that porpoises will return once the wind-farms are in normal operation. In each wind-farm area a baseline study has been carried out according to a BACI-design (Before-After-Control-Impact). T-PODs that logs acoustic porpoise activity has been deployed in both wind-farm areas and reference areas. Changes in relative porpoise density for each wind-farm area is monitored and tested against changes in the reference area(s) before/during and before/after the construction. Data analysis from the baseline studies in the wind-farm areas have shown that the data requirements varies substantially from the high-density areas in the North Sea to the low-density areas of the Baltic Sea. In all cases one year's baseline data has been gathered from two T-PODs in the impact areas and two in the reference areas. In the high-density area one year's data is required during/after the construction to detect a relative change of 10% between control and impact areas, to obtain statistical power of at least 80%. More than 10 year's of data is required to detect a 50% change in the low-density areas. We conclude that the use of T-PODs is a very efficient method to monitor the impact on porpoises from offshore construction work, but it is crucial to determine statistical power before designing effect-studies. The baseline studies also revealed seasonal trends in echolocation activity in the Baltic Sea and that moving coastal frontiers of freshwater efflux from the continent influences the North Sea population off the Danish coast.

ARMA MODEL OF THE SPERM WHALE SOUND PRODUCTION SYSTEM

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Processing sperm whale signals for individual localisation or classification is an attractive scientific challenge for which modelling the sound production system can help achieve an optimal solution. We start from the most accepted hypothesis that a broadband pulse is produced at the 'monkey lips'. From there, a realistic approach is to consider that this pulse propagates by different physical processes depending on the ratio (wavelength [lambda] / organs size [d]). We focus on low lambda/d ratios for which the pulse energy propagates back to the frontal sac and part of it is ducted through the junk to the water (main click). Meanwhile, part of the higher frequency (low lambda/d) vibrations would also propagate back through the spermaceti organ to the distal sac producing a series of reverberant clicks. With this hypothesis we formulate an autoregressive moving average (ARMA) model for individual clicks. Our experiments show that the clicks' spectrum reflects the existence of resonances and antiresonances in accordance with the tube-like structure of the spermaceti organ and the cone-shaped junk. This is reflected in the model where the AR and MA parameters model resonances and antiresonances, respectively. We adopt an input-output approach for the estimation of the ARMA parameters where the input is a broadband pulse and the output is a given click signal. This approach also allows an elegant reformulation to include clicks from several series in the estimation of their common parameters. Our experiments are carried out with click series from several sperm whales. The results lead to three main conclusions. Firstly, the sperm whale click propagation hypothesis is plausible. Secondly, an ARMA model is appropriate for the sperm whale sound production system. And, thirdly, an input-output approach seems to be a proper choice when we try to estimate the common parameters of several clicks.

INVESTIGATING THE HABITAT USE OF HARBOUR PORPOISES IN GERMAN WATERS USING PORPOISE DETECTORS (PODS)

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INTRODUCTION For many years, concern has been raised about the status of the harbour porpoise (*Phocoena phocoena*) in the North and Baltic Sea (Hammond *et al.*, 2002). Yet only few systematic studies on habitat utilisation are available which are necessary for management purposes. In the present study, we investigated the habitat use of harbour porpoises employing Pods, hydrophones connected to self-contained submersible computers that recognise and log echolocation clicks from porpoises. These acoustic devices are very apt for this purpose as they collect data over long periods regardless of weather conditions. The ongoing project is aimed to assess important areas for harbour porpoises, also in regard to planned offshore windfarms, and to implement a new method of long-term monitoring.

METHODS Since summer 2002, about 25 Pods were employed in selected areas of the German Bights and the Baltic Sea, as well as in the porpoise sanctuary west of the Island of Sylt in the North Sea. Here, 5 Pods were arranged in an array and moored in shallow waters of 8 m depth within the whale sanctuary. In the German Bights and the Baltic Sea, Pods were moored along the 10 m depth line as well as further offshore.

The data was first analysed for porpoise encounters, which are characterised by the occurrence of echolocation clicks. A new encounter is defined by starting after a silent period (no porpoise clicks) of at least 10 min. These porpoise encounters were used as a basic unit for further analyses. For all locations of data collection, the percentage of porpoise positive days (days with encounters) and the average number of encounters per day (Enc/d) were calculated. Variations in encounter length (time from first to last echolocation click of an encounter) and the daily rhythm (distribution of encounters over the 24-h period) were analysed for those areas with a regular occurrence of harbour porpoises. To investigate seasonal differences, the percentage of porpoise positive days was depicted monthly for those locations with longer periods of data collection.

RESULTS AND DISCUSSION For the German Bights and the Baltic Sea, the percentage of porpoise positive days as well as the average number of encounters per day show a decline from West to East (figure 2). There is a regular occurrence of porpoise encounters around the Island of Fehmarn, whereas only few encounters were registered around the Island of Ruegen. Remarkable is the low number of encounters east of the Darss underwater ridge, which delineates a borderline for two harbour porpoise populations (Huggenberger *et al.*, 2002). The recordings of the Pod array moored off the coast of the Island of Sylt in the North Sea revealed a high percentage of porpoise positive days (figure 1). The average number of encounters per day in this study area within the whale sanctuary is similar to the numbers recorded around the Island of Fehmarn. This suggests a similar intensity of habitat use for these two areas.

The lengths of the porpoise encounters varied between 1 min up to more than an hour. Short encounters (up to 5 min) were most common for all areas investigated. Yet in some places, the percentage of long encounters was higher than in others (figure 3). This could point at geographical differences in habitat use. As regards the distribution of encounters over the 24-h period (daily rhythm), there was a high variability among the different locations. In some areas, encounters were evenly distributed over night and day periods, whereas in others, encounters prevailed at night (figure 4). The latter suggests diurnal differences in habitat use.

Figure 5 shows the data over two monthly periods for two locations. Whereas the data for the location off the Island of Fehmarn demonstrates a high intensity of habitat use over the whole period of data collection, the percentages of porpoise positive days for the area off the Prepomeranian coast reveal differences between the two depicted periods. Though future data will yield a more detailed picture, these first results suggest that seasonal differences depend on habitat location.

CONCLUSIONS AND FUTURE RESEARCH Pods were found to be a very valuable device for investigating the habitat use of harbour porpoises, also in the Baltic Sea where porpoise abundance is expected to be low. The collected data provides information on diurnal, geographical and - with long-term employment – seasonal differences in habitat use.

Future research will focus on more detailed data analyses and on investigating habitat characteristics such as food availability, weather conditions, and traffic, to assess the reasons for the variations in habitat use.

ACKNOWLEDGEMENTS The project has been financed by the German Federal Ministry for the Environment.

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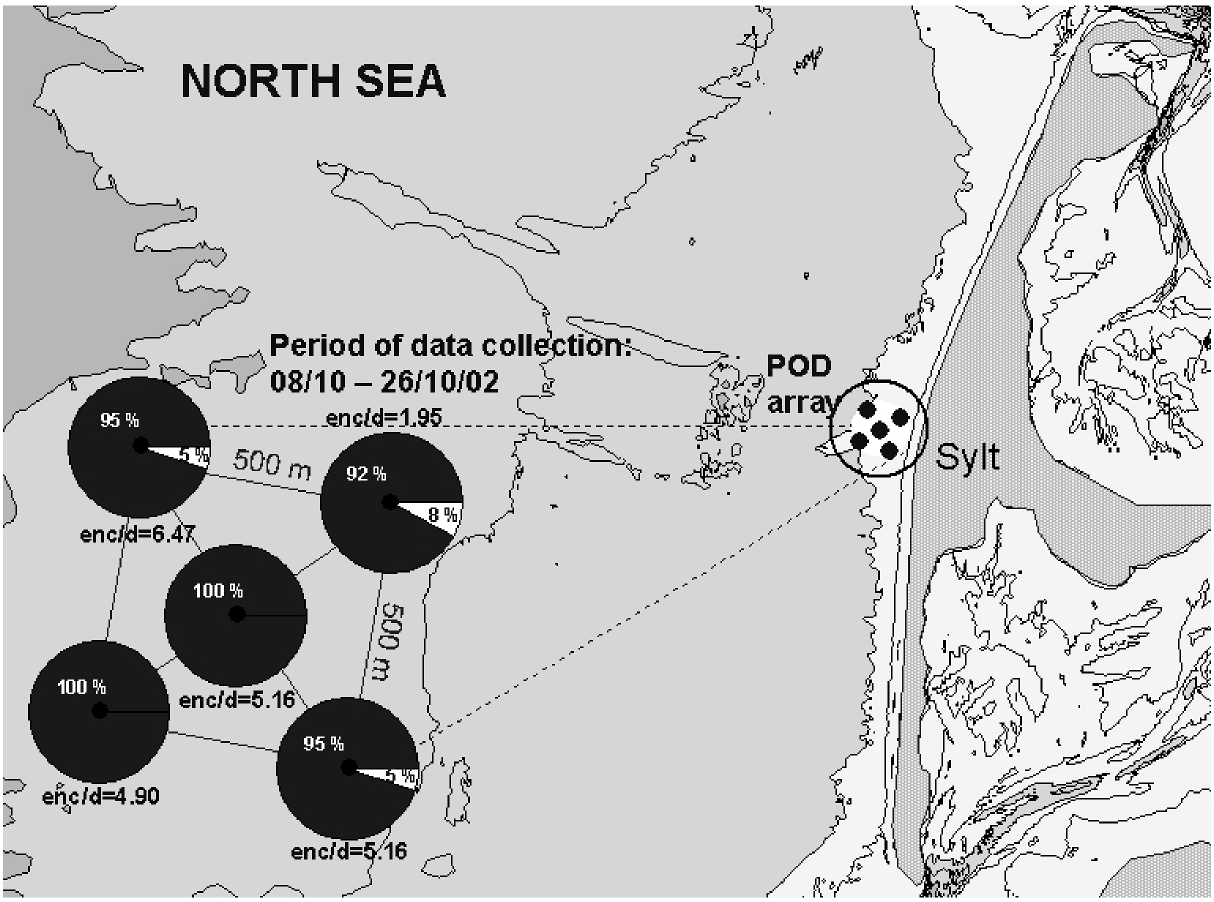

Fig. 1. Location of the Pod array in the North Sea off the west coast of the Island of Sylt. Pods were moored in shallow waters of 8 m depth within the whale sanctuary. The diagrams show the percentage of porpoise positive days for each location (legend see Figure 2)

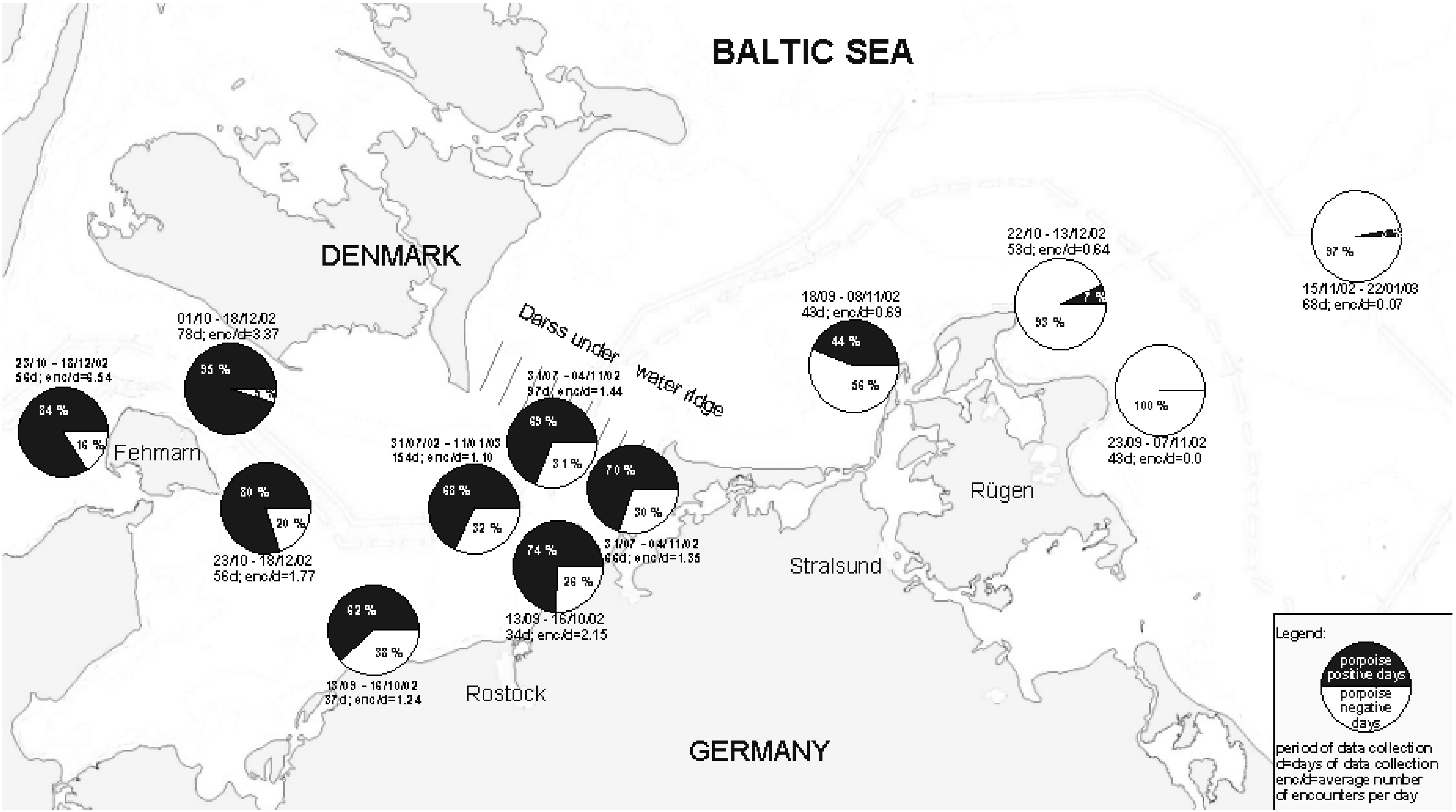

Fig. 2. Pod locations and data for selected areas of the German Bights and the Baltic Sea. There is a decline in the percentages of porpoise positive days as well as in the average numbers of encounters from Western to Eastern locations.

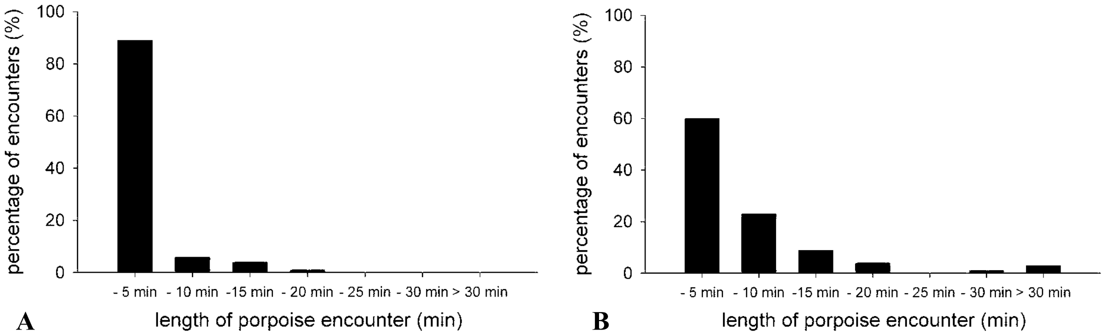

Fig. 3. Variations in encounter length (time from first to last echolocation click of a porpoise encounter) for two Pod locations. The percentage of long encounters is higher for B than for A

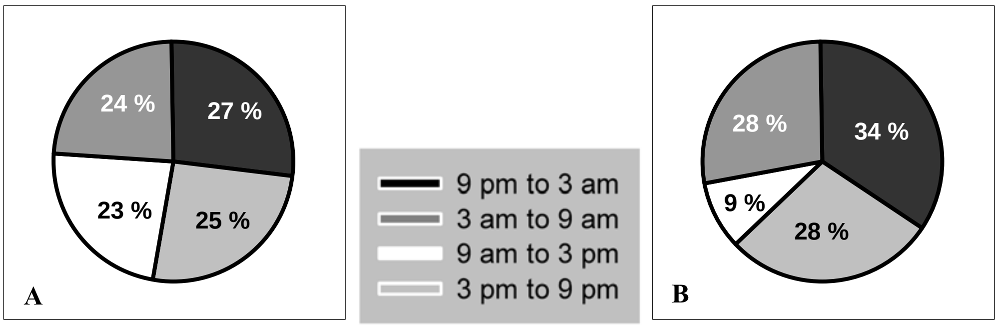

Fig. 4. Distribution of porpoise encounters over the 24-h period (daily rhythm) for two Pod locations. Encounters may be evenly distributed over night and day periods (A), or else prevail at night (B)

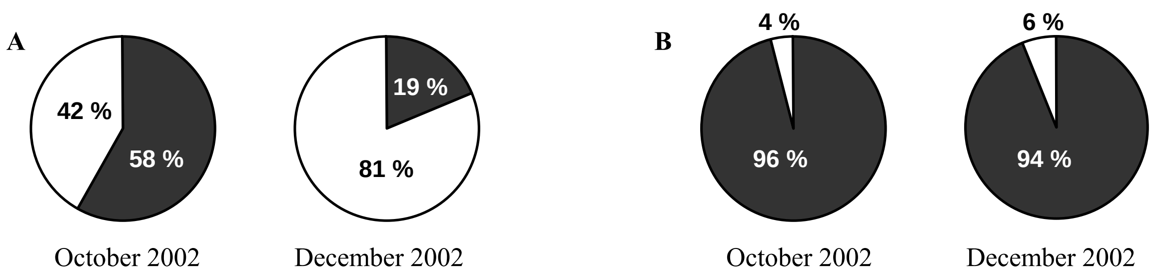

Fig. 5. Percentage of porpoise positive days for two monthly periods of two Pod locations (A: off the Island of Fehmarn; B: off the Prepomeranian coast). Only A shows obvious differences between the two time periods

ANTHROPOGENIC NOISE AND SPERM WHALE SOUND PRODUCTION

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INTRODUCTION Many parts of the ocean are becoming quite noisy, due in large part to the activities of mankind. The extent to which increased levels of anthropogenic noise affect the behavior and well-being of marine mammals is a matter of considerable debate (Watkins and Schevill, 1975; Frantzis, 1998; Madsen and Mohl, 2000; Parsons *et al*., 2000; Madsen *et al*., 2002). We investigated the relationship of anthropogenic noise and sperm whale (*Physeter macrocephalus*) sound production at various depths in the Gulf of Mexico by collecting data at three locations using bottom moored single hydrophones. The goals of this research were to assess baseline levels of ambient noise, variations in levels and types of anthropogenic noise, and variations in frequency of sperm whale clicks and click train type.

MATERIALS AND METHODS Three hydrophones and recording systems were moored in the Gulf of Mexico at sites where sperm whales were known to congregate. Each hydrophone was anchored 50 feet from the ocean floor at depths of 600 m, 800 m, and 1000 m in a line spanning 25 km. The 600 m and 800 m buoys were located 7.5 km apart, and the 800 m and 1000 m buoys were located 17.4 km apart. Each system continuously recorded sounds at a sampling rate of 11,718 Hz for 36 consecutive days in Summer 2001. Data consisted of 5.5-minute files, which were converted to .wav files and analyzed using a number of acoustic analyses programs. Boat noise, air gun, and sperm whale vocalizations were identified during this process. Any other interesting sounds were noted for later analysis.

RESULTS The recordings yielded 216 Gb of acoustic data as well as detailed oceanographic and bottom data. The recordings revealed considerable amounts of anthropogenic noise at all depths in addition to frequent sperm whale clicks. The anthropogenic noise consisted primarily of sounds produced by either boat engines or air guns employed in the topographical mapping of the ocean floor. Frequency and intensity of boat noise and frequency of sperm whale clicks varied throughout the course of the study.

As shown in Fig. 1, some differences in click production were related to the date of recording. This figure shows the number of files that contained sperm whale clicks for each of three dates. Other differences were related to the depth of the recording system. Fig. 2 shows the number of files that contain sperm whale clicks for these same three dates at each of the recording depths.

We have begun our analyses of the relationship between anthropogenic noise and sperm whale click production. Our initial analyses have focused on the frequency of anthropogenic noise. Fig. 3 summarizes the results for the three days described in the earlier figures. These preliminary results suggest that noise that exceeds 3500 Hz may decrease the frequency of sperm whale click production. However, it must be noted that whales produced clicks in the context of higher frequency noise, and that our results are based on analyses of a subset of our data (three days out of 36 total days).

CONCLUSIONS Both anthropogenic noise and sperm whale clicks were recorded with considerable frequency at all three depths. Both noise and clicks varied across days and depths. Our goal is to better determine the relationship of variation in anthropogenic noise and variation in sperm whale click production. This will be accomplished by investigating diurnal patterns of both types of sound, and more fine-tuned analyses of the relationship of the frequency and intensity of anthropogenic noise and sperm whale click production.

It seems likely that periods of intense boat noise affect sperm whale click production, particularly if the whales cannot hear clicks or perceive returning echoes during these times. However, we have not yet been able to reliably determine the presence or absence of sperm whale clicks when intense boat noise occurred. Less intense noise did not seem to affect click production, suggesting that the whales had adapted to such levels of noise, at least insofar as click production at these depths is concerned. Additional analyses will focus on specifying the number of animals present and the effect of other types of sounds (e.g. those produced by killer whales) on sperm whale sound production. Future plans include incorporating data collected in the same area in Summer 2002 and the use of a hydrophone array with the ability to record at higher frequencies.

ACKNOWLEDGEMENTS This research was supported by the Office of Naval Research (N00014-01-1-0915)

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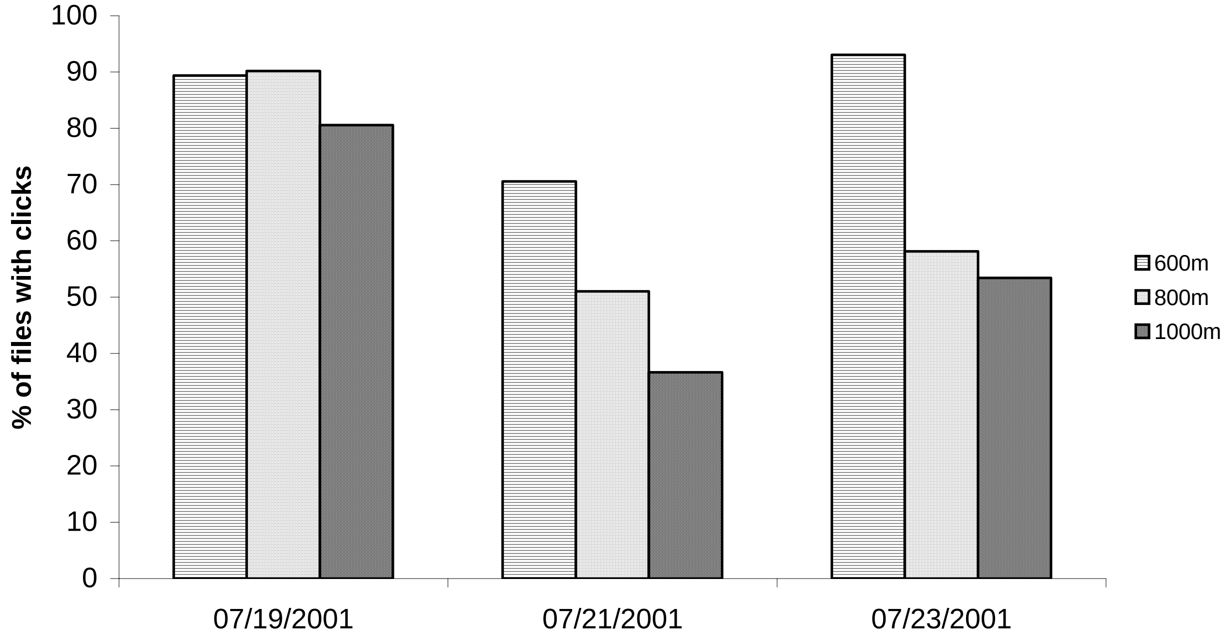

Fig. 1. Percentage of files with sperm whale clicks for three different days

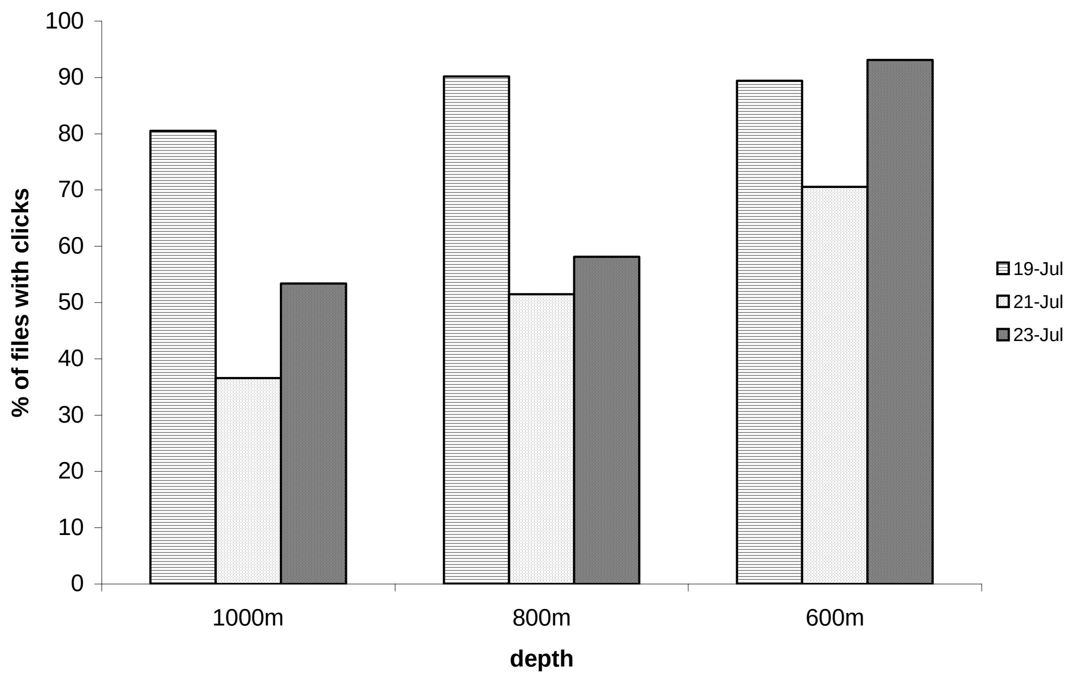

Fig. 2. Percentage of files with sperm whale clicks at three different depths

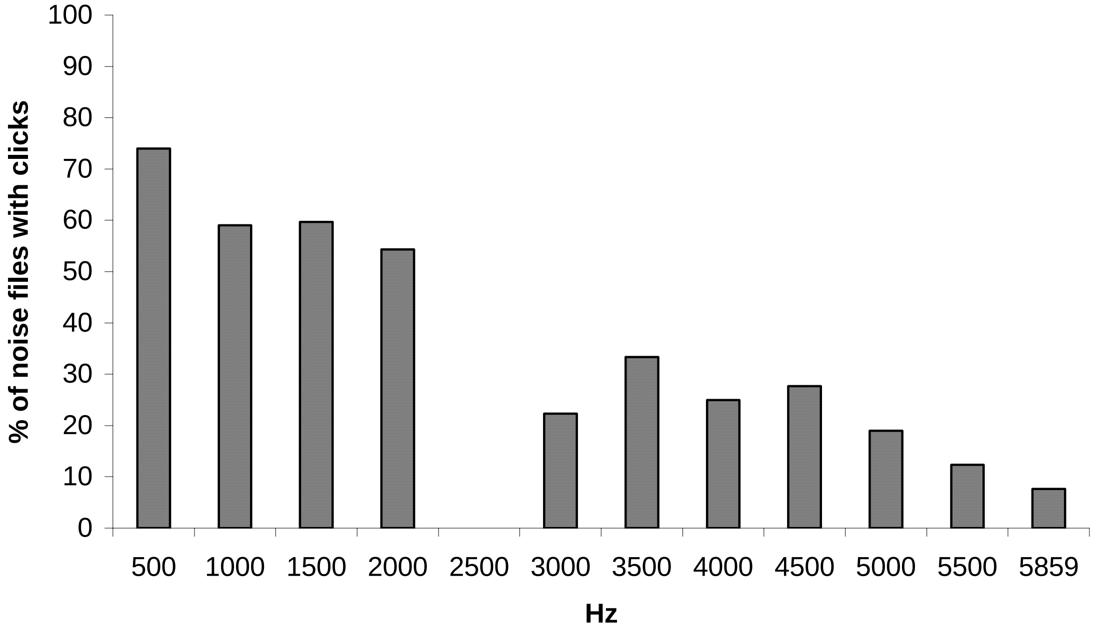

Fig. 3. Percentage of files with boat noise and sperm whale clicks averaged across three days at 1000 m

CAN ACOUSTIC ANALYSIS BE USED TO STUDY POPULATION COMPOSITION IN SPERM WHALES?

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The vocalisations of the sperm whale, *Physteter macrocephalus* L. consist of broadband clicks with a frequency range of 100 Hz – 30 kHz. In addition to making clicks in long regular sequences during foraging dives, sperm whales make clicks in stereotyped patterns called codas. These are heard most often in social contexts and are thought to have a role in communication.Recordings of vocalisations from two geographically distinct regions were analysed using software capable of detecting sperm whale clicks and assigning them to individual whales. The interval between clicks was measured to determine click patterns within codas and where possible the inter-pulse intervals of clicks were analysed to estimate the length of whales making the codas. Other parameters including whether codas overlapped and where they occurred within sequences were also examined. The lengths calculated were consistent with the mixed groups of mature females, and juveniles. Significant positive correlations were found between whale length and both coda duration and the number of codas within a burst (a sequence of 2 or more codas made by the same whale, not separated by more than 10 seconds). The order of different types of codas within either a burst or a sequence was found to be random. Whilst no specific coda type was found to initiate a period of vocalisations, the initial codas recorded were produced by whales of adult size. This is consistent with the use of codas within a social context– the mature females, possibly vocalising in order to maintain group cohesion on return to the surface. As deep diving animals, sperm whales are practically very difficult to study. If the population composition can be estimated using acoustic analysis, it could prove to be an invaluable tool for non invasive tracking and monitoring of these populations.

FACTORS AFFECTING THE FATTY ACID PROFILES OF SCOTTISH HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

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INTRODUCTION Analysis of fatty acids (FA) in marine mammal tissues is considered a useful method for investigating diet. It is based on the principle that the fatty acids in the diet will be reflected in the predator's tissues (Iverson *et al*., 1995; Kirsch *et al*., 1998; Kirsch *et al*., 2000). However, many factors other than diet have the potential to influence the FA profile of cetacean tissues. The FA profiles of blubber samples from harbour porpoises (*Phocoena phocoena*), stranded around Scotland during 2001 and 2002, were examined with the objective of assessing sources of variation in FA profiles, between individuals, and determining whether FA analysis can provide useful information on the diet of the harbour porpoise.

MATERIALS AND METHODS Blubber samples from cetaceans stranded around Scotland were collected during necropsy, from the left side in front of the dorsal fin. Animals sampled ranged in decomposition state from extremely fresh (2a) to moderately decomposed (3) (Kuiken, 1991). Preliminary analysis showed only four fatty acids to be significantly different between animals of different decomposition states, 18:1 (n-7) [3>2b], 18:2 (n-6) [2b>2a], 18:3 (n-3) [3>2a] and 22:1 (n-11) [2b>2a] ($p<0.05$, Mann-Whitney U test).

The inner blubber layer was used, as preliminary analysis indicated the presence of higher levels of primarily diet-derived fatty acids in this layer (e.g., 18:1 (n-9), 20:0, 20:1 (n-11), 20:5 (n-3), 22:1 (n-11), 22:5 (n-3) and 22:6 (n-3)). This is consistent with the idea that the inner blubber layer may be more metabolically active than the outer layer (Koopman *et al*., 1996).

Lipids were extracted using the method of Bligh and Dyer (1959) as modified by Hanson and Olley (1963). FA methyl esters were prepared by acid catalysis and analysed by gas chromatography with flame ionisation detection (GC-FID). Individual FAs were identified using mass spectrometry and commercial standards. The normalised area percentage (NA%) was calculated for 26 FAs: 14:0, 15:0, 16:0, 16:1 (n-7), 16:2 (n-6), 16:3 (n-6), 16:4 (n-3), 18:0, 18:1 (n-9), 18:1 (n-7), 18:2 (n-6), 18:3 (n-6), 18:3 (n-3), 18:4 (n-3), 20:0, 20:1 (n-11), 20:1 (n-9), 20:4 (n-6), 20:4 (n-3), 20:5 (n-3), 22:1 (n-11), 22:1 (n-9), 21:5 (n-3), 22:5 (n-3), 22:6 (n-3) and 24:1 (n-9). Animals were classed according to (a) the time of year they stranded (spring, March-May, n=21; summer, June-August, n=8; autumn, September-November, n=0; winter, December-February, n=4), (b) sex (female, n=16; male, n=17), and (c) body length (<90 cm, n=5; 91-110 cm, n=10; 111-130 cm, n=8; 131-150 cm, n=5; >150 cm, n=5).

RESULTS **Season:** Relative amounts of eight FAs were found to vary significantly ($p<0.05$, Mann-Whitney U tests) between porpoise stranded during different seasons (designated by stars on Figure 1). FAs 14:0, 15:0 and 16:1 (n-7) were higher in spring than winter while 18:0, 20:4 (n-3), 20:5 (n-3), 22:5 (n-3) and 22:6 (n-3) were higher in winter than spring. 16:1 (n-7) was also higher in summer than winter and 20:4 (n-3) and 22:6 (n-3) were also higher in winter than summer. No significant differences were found between the median amounts of FAs acids from animals stranded in the spring and summer.

Santos (1998) and Santos *et al*. (unpubl.) found that sandeels were the most important component of harbour porpoise stomach contents in spring/summer while other species, such as whiting and herring, were more important in winter. The differences in FA profiles found in the present study are consistent with such seasonal variation in diet. For example, FAs 18:0, 20:5 (n-3), 22:5 (n-3) and 22:6 (n-3) have been found to be higher in herring and lower in sandeels and 16:1 (n-7) higher in sandeels compared to herring.

Sex: Seven of the 26 FAs were found to be significantly different between males (n=17) and females (n=16). The medians of 16:3 (n-6), 16:4 (n-3), 18:2 (n-6), 18:4 (n-3), 20:4 (n-3), 20:5 (n-3) and 22:6 (n-3) were significantly greater (designated by stars on Figure 2) in male harbour porpoise ($p\leq0.01$, Mann-Whitney U tests). Higher levels of 14:0, 16:0, 16:1 (n-7), 18:1 (n-9) and 18:1 (n-7) were observed in females, but these differences were not found to be statistically significant (Figure 2).

Stomach content analysis of Scottish harbour porpoise indicated that males had a slightly higher overall prey diversity and slight differences in prey size compared to females (Santos, 1998; Santos *et al*., unpubl.). It is thus possible that the between-sex differences in FA profiles reflect diet, e.g. differences in FAs 18:2 (n-6), 20:5 (n-3) and 22:6 (n-3), which are primarily derived from the diet.

Body Length: Ten FAs (designated by stars on Figure 3) were found to differ significantly between harbour porpoises in different body length classes. These were 16:2 (n-6), 18:1 (n-9), 20:1 (n-11), 24:1 (n-9) ($p<0.01$, Kruskal-Wallis tests) and 15:0, 16:1 (n-7), 18:2 (n-6), 18:3 (n-6), 18:3 (n-3) and 22:1 (n-11) ($p<0.05$, Kruskal-Wallis tests). Harbour porpoises <90 cm showed major differences in concentrations of these FAs - except 18:3 (n-6) for which animals 131-150 cm had higher levels (Figure 3). The smallest size class of porpoises (<90 cm) are calves, probably still suckling, and their FA profiles would be expected to reflect this.

Various studies, using stomach content analysis, have shown significant differences in the diet of harbour porpoise of different body lengths, for example in Scottish harbour porpoise gobies are more numerous in the smallest size class and clupeids more important in medium size classes (Santos *et al*., unpubl.).

Principal component analysis (PCA): PCA results broadly support the results of the univariate analyses. The majority of males formed a group corresponding to higher proportions of 20:4 (n-3), 18:4 (n-3), 22:6 (n-3), 22:5 (n-3), 16:4 (n-3), 18:2 (n-6), 20:1 (n-11) and 22:1 (n-11) (Figure 4). The majority of animals <90 cm formed a group corresponding to higher proportions of 16:1 (n-7) and 16:0 (Figure 4).

CONCLUSION The variation observed in the FA profile of Scottish harbour porpoises, of different sex, body size class and season, could be related to diet although this has not yet been formally tested. Firstly, results were consistent with trends in diet previously determined from stomach content analysis. Secondly, the FAs that showed the most variability are thought to be dietary in origin. FAs with a carbon chain length of 14 or greater are often deposited in animal tissue from the diet with minimal modification (Iverson, *et al*., 1997). Major FAs, such as 20:1(n-11), 20:1(n-9), 20:5(n-3), 22:1(n-11) and 22:6(n-3), are likely to be primarily dietary in origin and therefore most indicative of prey consumption. Several FAs, e.g. 16:0, 18:0, 16:1(n-7) and 18:1(n-9), can be biosynthesised, but a significant dietary component is also likely in these cases (Iverson *et al*., 1997; Kirsch *et al*., 2000; Hooker *et al*., 2001). Therefore, preliminary results suggest fatty acid analysis is a useful method of assessing the diet of harbour porpoise. FA profiles of putative prey species are now being assembled for comparison with porpoise FA profiles.

ACKNOWLEDGEMENTS Sample collection by RJR and IAPP was funded under a contract from the UK Government's Department of the Department of Environment, Food and Rural Affairs. FA analysis was funded by the European Commission as part of the BIOCET project (EVK3-CT-2000-00027). Many thanks to various staff members at the University of Aberdeen and FRS Marine Laboratory for all their help and support.

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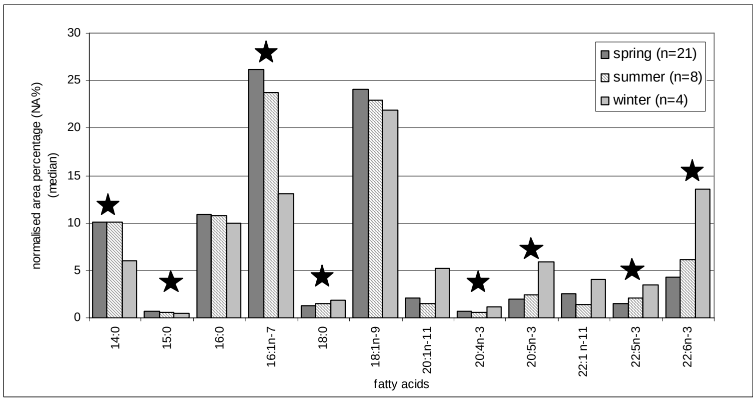

Fig. 1. Fatty acid profiles of the inner blubber layer of Scottish harbour porpoise stranded at different times of the year (spring: March-May; summer: June-August; autumn: September-November; and winter: December-February)

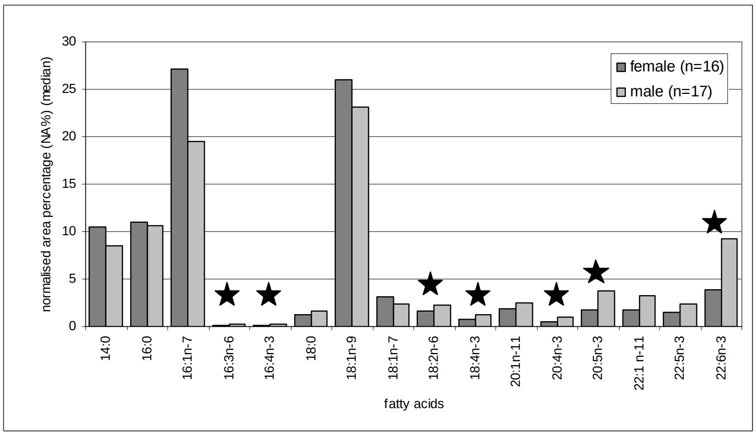

Fig. 2. Fatty acid profiles of the inner blubber layer of male and female Scottish harbour porpoise

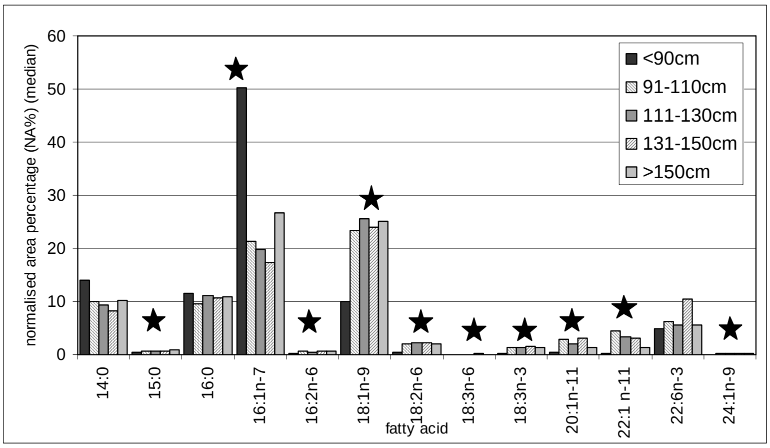

Fig. 3. Fatty acid profiles of the inner blubber of Scottish harbour porpoise of different body lengths, <90 cm (n=5), 91-110 cm (n=10), 111-130 cm (n=8), 131-150 cm (n=5) and >150 cm (n=5)

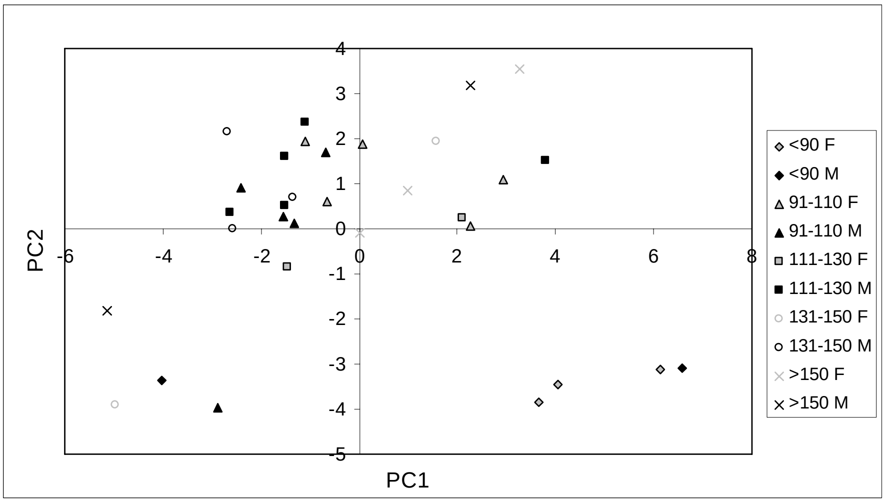

Fig. 4. Principal component analysis of male and female Scottish harbour porpoise of different body length

NO GENDER DIFFERENCES IN SIGNATURE WHISTLES IN CAPTIVE BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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The bottlenose dolphin (*Tursiops truncatus*) has a highly variable acoustic repertoire used for social communication and sonar. Each individual produces a so-called signature whistle, characterized by a unique, stereotyped, frequency modulated contour. Neonates produce simple whistles already during the first day postpartum. The signature whistle develops from these simple whistles, at least partly through a learning process and is believed to be fixed 6 to 12 months postpartum. It then stays stable throughout life, with only slight variations in response to different social situations. Earlier studies have suggested that the signature whistles of male calves resemble more their mothers' signature whistle, whereas those of female calves are more different. This study, carried out at the Kolmården Wild Animal Park, Sweden, attempted to reveal the "role model" used by the calf during the shaping of its signature whistle. The development of the signature whistle in three calves (two males and one female) was followed from birth until they were two years old. Independent human observers were asked to categorize the spectrograms and playbacks of the signatures whistles of these animals. The observers found no gender differences in these signature whistles ($p<0,05$), since they paired the female calf's signature whistles with its mother, but not those of the male calves. They also paired the calves' signature whistles with other than their own mothers ($p<0,05$), and they also paired the signature whistles of different calves ($p<0,05$). These results indicate that the formation of the signature whistle is under the influence of the entire acoustic environment experienced by the calves and not only of their mothers' signature whistles.

DIEL OCCURRENCE OF CHARACTERISTIC ACOUSTIC EMISSION IN FEEDING STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

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INTRODUCTION This paper reports on the occurrence of a class of underwater acoustic signals detected during research cruises carried out in eight years, from 1994 to 2002, in the Mediterranean Sea.

Two ship classes were available to our research group in the period: small motor sailing boats (around 16 metres long) and a large research ship made available by NATO Saclant Undersea Research Centre, for the "SIRENA" cruises, part of the international SOLMaR project.

The Mediterranean Sea is an oligotrophic basin. The largest part of the research effort was concentrated in the Northern area of the central sector, named Ligurian Sea and Northern Thyrrenian Sea, while one cruise ranged south to the Ionian Sea. The first areas, because of a rich up-welling and other not yet well described reasons, show high biodiversity, with relatively large Cetacean stocks. Today the Ligurian Sea is also known because its area forms the largest part of an International Cetacean sanctuary.

MATERIALS AND METHODS As the authors' main interest is in acoustics, their tasks during the cruises were devoted to collect short samples and long recordings of acoustic behaviours and repertoires, linking them with surface behaviours and environmental parameters whenever possible.

Acoustic data collection was achieved using both stationary and towed wideband hydrophones, usually cruising along a programmed course, sampling a variety of environments, ranging from coastal waters to deep sea (-2500 metres). Audio range (10Hz to 20kHz) and, later, ultrasonic range up to 350kHz, were received and recorded, with an instrumental set-up improving over the years. During eight years of surveys in different seasons, and total of about 180 days at sea, the authors were able to continuously detect and record night and day changing underwater repertoires, from morning to morning, about 130 times.

Protocols currently followed by the group, for data classification require a skilled operator to score detected sounds into fixed categories, minute by minute, with the help of a real-time spectrographic display. This is immediately carried out by a devoted team when working on large ships. From small platforms, where a reduced crew limits the available effort, the scientists are usually asked to report about what is received during a five minute period every twenty, going then back to other needed tasks. All received signals, on both platforms, are today recorded on hard-disks or digital tapes for post-analysis and classification. While working from small ships offers a flexible re-planning of the research, according to emerging needs, it allows a few days autonomy only before going to a port. Working from large ships offers long autonomy, in the order of "weeks-at-sea", allowing collection of data in far-from-the-coast zones, with almost no interruptions. This produces valuable data, usually hard to get, for off-shore areas.

Starting from the first cruises in 1994, an important part of the acoustic activity detected around the clock, together with already described signals, related to well determined species, was represented by click series with high energy at low frequencies, which gave the signal a peculiar tone, different from standard dolphin echolocation clicks. The sources of these sounds (described in another paper presented in this Conference, and named "nacchere" pron.:nakkere trans.: castanets) were undetermined, and so was their function. Also they were always associated with high frequency whistles, standard echolocation click trains and "buzzes" typically produced by dolphins.

The authors' interest was to determine the origin of this signal and to test if a relation between a circadian cycle and the detection of this class of signals is confirmed after extended sampling.

To do this two groups of simplified data tables, resulting from cruises' acoustic data loggers, were compared along a slotted 24hrs time-line: EFFORT(time spent listening) was noted on the first tables, while NACCHERE DETECTED (positive when present) was on the second.

In order to match different sampling schemes collected data were grouped into 30 minutes slots. The PRESENCE/ABSENCE of the class of interest within the examined slot is reported with a YES / NO index.

RESULTS AND CONCLUSIONS *Nacchere* sequences occur mostly at night with a clear circadian cycle. A sampling scheme considering daylight only, would give this category a marginal weight in the total acoustic activity, while *nacchere* are the most frequent signal present at night in the whole study area. This suggests that any future underwater acoustic sampling should be programmed along a 24hrs period.

Striped dolphins were observed diving, at night, in concomitance with this sound, and they, with maybe other dolphin species, should be considered as the source of this class of signals. The authors suggest *nacchere* are produced by dolphins feeding in prey rich layers during the daily zooplankton concentration and vertical migration. Is zooplankton acting as food chain primer determining, with its position, the depth at which preys concentrate and dolphins dive?

The typical acoustic features of these sounds are determined, according to the authors' opinion, by the source depth (i.e. the dolphin) and by peculiar resonance of its preys.

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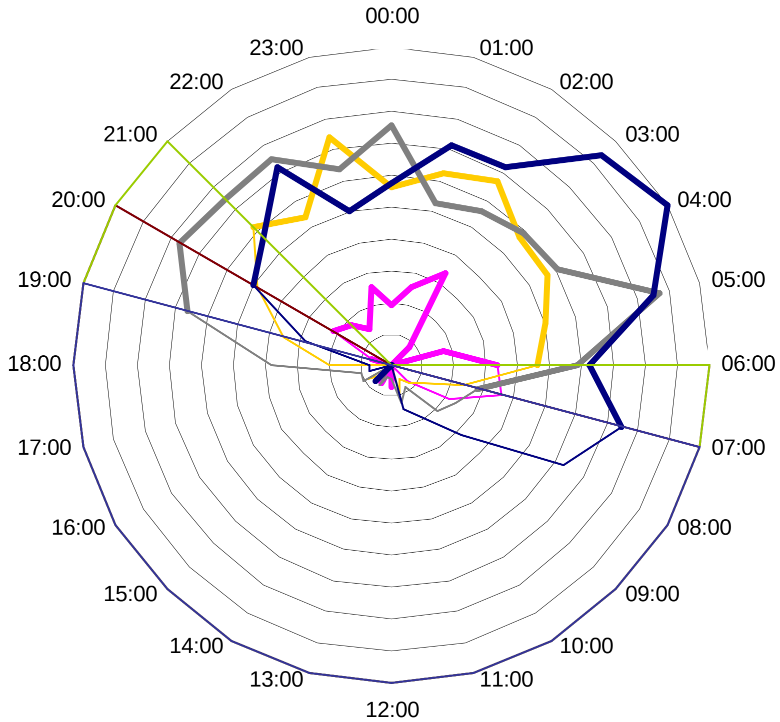

Fig. 1. This 24hrs watch show, year by year, the ratio between positive nacchere detection and effort during survey phases in NATO Sirena cruises carried out from 1999 to 2002, for a total of about 30 days. Data from 1999 are the lowest in ratio, and this is probably due to the still under development equipment, protocols and skills of the under training rotating operators. Lines are thick from sundown to sunrise showing a clear relation between underwater night and these sounds.

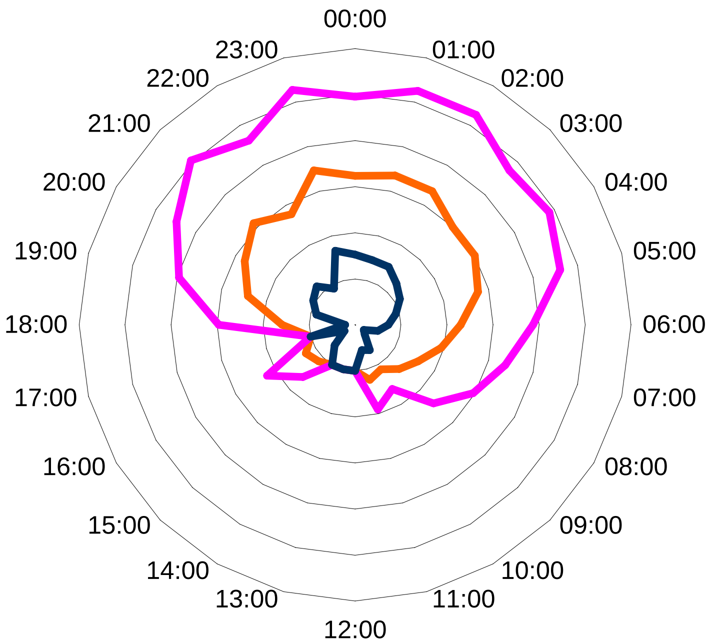

Fig. 2. This graph is plotted with average (number of detections per time-slot), + and - standard deviation, with the year 2002 data resulting from the Sirena cruise. It shows the quite high variability in detecting Nacchere given a time at night.

DETECTION AND ESTIMATION OF CETACEAN TONAL CALLS USING A TRACKING ALGORITHM

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Many cetacean calls are tonal and frequency-modulated. An algorithm has been implemented which efficiently tracks this type of sound even under relatively high noise conditions. The algorithm has been developed to assist the detection of North Atlantic right whales (Eubalaena glacialis). At the present time, parts of the range of these rare animals are being monitored using bottom-mounted units that make long recordings (~weeks). Such large datasets benefit from computer-assisted detection and classification. The algorithm is equally applicable to the tonal calls of other species, including whistles from odontocetes. The acoustic time-series is adaptively filtered so that the spectrum it is approximately flat, and the underlying signal is then modelled as a sequence of linear chirps. The resulting data is very compact, and can therefore be more easily stored, displayed or further processed. Examples of recordings, in which tonal calls are tracked, are given for (a) calls from right whales and (b) whistles from pilot whales (*Globicephala* sp.). Results of simulations in white noise are presented comparing the algorithm with the traditional approach based on peaks of the short-time Discrete Fourier Transform (DFT). These indicate that the algorithm attains better resolution and operates at a lower signal-to-noise ratio than one based on the DFT.

UNDERWATER NOISE POLLUTION AND MARINE MAMMALS: REGUALTION AND CONSERVATION MEASURES

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The effects of underwater noise are increasingly recognized by scientists, non-governmental organizations, and individual states as a problem in relation to a variety of ocean uses. The impacts of noise on marine mammals include direct effects such as mortalities and strandings, and indirect effects such as long-term behavioural modifications and changes in other marine life that are vital components of the food chain. Because no international treaties or laws specifically address the transmission of sound in territorial waters or on the high seas, there is no coherent policy framework for addressing the environmental impacts of underwater noise pollution. This paper examines the issue of transboundary underwater noise pollution in a global context and discusses the extent to which the international legal and environmental communities have addressed it. It investigates the role of the 1982 United Nations Convention on the Law of the Sea and the potential for several regional agreements and treaties to regulate noise. Recommendations are made for the development of appropriate policy on the use of sound in the ocean including the designation of an international organization to oversee and monitor noise and its sources. It encourages the adoption of a more holistic approach to ocean noise pollution that incorporates all sources of underwater sound and discusses the applicability of marine protected areas and ocean zoning ordinances to regulating noise.

WHISTLE PRODUCTION PRE PARTUM IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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The bottlenose dolphin (Tursiops truncatus) has a highly variable acoustic repertoire (whistles, clicks and burst pulses) used for social communication and echolocation. Whistles can be used to express individuality (signature-whistle), emotional states and to maintain or initiate contact between individuals in a pod. This study was done to investigate the whistle production pre partum of three female bottlenose dolphins at the Kolmården Wild Animal Park, Sweden. Observations of the behaviour and sound production were done up to 9 months prior to birth. The results show that whistle production increases significantly for all 3 females not only during the 9 months prior to birth ($F=3{,}4997$; $P=0{,}0234$) but also during the days prior to birth ($F=8{,}6982$; $p=0{,}0043$). The whistles, therefore, might be used as an indicator that delivery is imminent.

OCEAN NOISE AND MARINE MAMMALS

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In 2000, the U.S. National Ocean Partnership Program, an interagency ocean program, with leadership of the Office of Naval Research, requested the U.S. National Academies examine the potential effects of ambient noise, and noise from anthropogenic sources, on marine mammals. A committee of 11 international experts was convened to study this controversial issue. The committee included marine mammals specialists, acousticians, bioacousticians, a geophysical exploration expert, and an expert in vessel engineering. Specifically, the committee was asked to evaluate the human and natural contributions to marine ambient noise and describe the long-term trends in ambient noise levels, especially from human activities. In the report the committee outlines the research needed to evaluate the impacts of ambient noise from various sources (natural, commercial, naval, and acoustic-based ocean research) on marine mammal species, especially in biologically sensitive areas. The study reviews and identifies gaps in existing marine noise databases and recommends research needed to develop a model of ocean noise that incorporates temporal, spatial, and frequency-dependent variables. The committee's report was awaiting final approval at the time of abstract submission. The findings and research recommendations will be presented.

THE MONOPULSE-NATURE OF SPERM WHALE SONAR CLICKS

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New, large aperture array recordings of regular clicks from foraging, male sperm whales off Andenes, Norway, show high directionality (DI ~27 dB) and record-high source levels (~235 dB rms re. 1 μPa) for clicks presumably recorded on-axis. Such levels require a peak power capability of 4 kW from a sound generator at the stated directionality. The latter may conceivably vary from click to click but the methods used preclude observations on this aspect. Less than 0.1 % of the clicks analyzed are of the on-axis type. This low yield is understood as a consequence of high directionality of the source and the unfavorable geometry of the recording situation (whales at about 1 km of depth, hydrophones near surface). The spectra of on-axis clicks are broadband (Q ~3), peaking in the 12 kHz region, and the classical, multi-pulsed pattern of the clicks is suppressed: 99.6 % of the energy is concentrated in one pulse having a duration of ~100 μs between -10 dB limits of the envelope. In off-axis recordings of the same clicks, the multi-pulse structure is fully developed but the levels are ~40 dB below that of the on-axis click. The spectral properties place the on-axis click at the optimum frequency range for a long-range sonar looking for targets with cross-sections down to 5 cm. The combination of the pulse properties with the acoustic behavior of male sperm whales supports the conjecture that the clicks are used for sonar. Accordingly, only the on-axis, mono-pulsed version of a click is likely to benefit the animal, while the off-axis, multi-pulsed version (the 'classical' sperm whale click) may, from a sonar analysis point of view, be regarded as detrimental, clutter-generating noise.

SIGNATURE WHISTLES IN A LONG FINNED PILOT WHALE (*GLOBICEPHALA MELAS*) POD OFF VENTOTENE ISLAND (SOUTHERN TYRRHENIAN SEA, ITALY)

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Long finned pilot whale (*Globicephala melas*) has a various acoustic repertoire, associations between social behavioural context and vocalisation type have been documented, however little is known about the degree of stereotypy of whistles and data for the "signature" function are still limited. A single stable pod seasonally resident off Ventotene Island has been monitored since 1995 (Mussi et al. 2000). Through the years, whales' number in the pod decreased from 6 to 2. Acoustic recordings were synchronically collected with behaviour, photo and video data. The observations were carried out on board sailing boats, equipped with towed hydrophones (10 Hz- 20kHz frequency response). From 1995 to 2002, a total of 30 hours of extended recording were collected on a Hitachi 88EX and Sony TCD-D100 DAT recorders. Recordings were later digitised at 24 kHz and spectrograms made, using a real-time analyser. All whistles (n=899) were classified in different categories based on their shape, following the scheme of Taruski (1979) and Weilgart and Whitehead (1990). Calls were assigned to whales by observing air bubbles released simultaneously to the sound production (McCowan and Reiss, 1995) during bow ride behaviour. 723 whistles were consequently attributed to four different individuals: Cagliostro adult male, the "pilot", Santiago, adult male, Pan, juvenile male and Señora, adult female. Results showed that whales produced mostly (80%) their own signature call that remains stable over long periods of time and its frequency versus time "contour" shows a high degree of stereotypy. Male's individual calls were found to be predominant (90%).

LOW-FREQUENCY SOUNDS RECORDED ON HYDROPHONES MOORED ALONG THE MID-ATLANTIC RIDGE

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Six autonomous hydrophones were moored on either side of the mid-Atlantic ridge in February 1999 in a very remote, oligotrophic part of the Atlantic Ocean (between 35N - 15N and 50W - 33W). They recorded sound continuously (sample rate 110 Hz, low-pass filter 50 Hz) during two one-year deployments. Sound spectrograms from data spanning these two years (1999-2001) were visually inspected for whale vocalizations and geophysical activity. The most common marine mammal sound detected was a series of short, down-swept 22 Hz pulses from fin whales (Balaenoptera physalus). Also quite common was the 25 s, two-part, low frequency (18-25 Hz) moan that has been attributed to the blue whale (B. musculus). Sounds that resembled those identified as minke (B. acutorostrata) and humpback (Megaptera novaeangliae) whale vocalizations in other parts of the Atlantic were also recorded. All calls were detected most often in the winter. Blue and fin whale calls were detected most often on the northern hydrophones, the humpback-like sounds were recorded on the northern and central phones, and the minke whale sounds were detected primarily on the central and southern phones. Biological sounds were often obscured by man-made sounds from ships, especially the impulsive signals of seismic airguns. Although deployed for seismic monitoring, this hydrophone array recorded numerous whale vocalizations in an area typically inaccessible to traditional monitoring programs. Hydrophone-derived data sets from remote deployments may be useful for understanding long-range movements of cetaceans on multi-year time scales.

TEMPORAL RATES OF OCCURRENCE IN CAPTIVE ORCINUS ORCA VOCALIZATIONS: INFRADIAN, CIRCADIAN, AND ULTRADIAN PATTERNS

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Wherever they have been encountered, killer whales have been observed to produce vocalizations characterized by whistles and pulsed calls. Although the maintenance of social cohesion is presumed to be a primary function of such calls, it is highly likely that other needs are also served and alternative hypotheses about their functions have been advanced. It was the goal of this project to ascertain if temporal patterns exist in the rates of occurrence of killer whale vocalizations in the hope that they would provide insight into their functional significance. Continuous hydrophone recordings (24 hrs/day, 7 days/wk) were obtained at Marineland of Canada where three adult orcas (of Icelandic origin) and their four captive-born juveniles were present. Recordings from 52 different 24-hr temporal epochs were analyzed via a process in which the time and date of each orca call was recorded. Within days, vocalizations were characteristically produced in calling bouts that were separated by highly variable periods of silence. These calling bouts tended to last between 5 and 45 minutes with a mean duration of 22 minutes. An inverse relationship was observed between calling bout length and the duration of the subsequent inter-bout silent period. There was also a characteristic 24 hour rhythm in call production in which vocalizations were least common (averaging 255 calls/hr) between 1300 – 1900. They peaked in occurrence (490 calls/hr) between 0100 – 0700. Finally, over the course of the year, there was a dramatic seasonal trend in vocal production. During Winter and Spring months, the whales were largely silent and only produced one tenth as many calls as were typical for Summer and Fall months. We interpret these infradian, circadian and ultradian (seasonal) rhythms as suggesting a strong influence of motivational state on the rates of occurrence of killer whale vocalizations.

THE RESPONSE OF NORTH ATLANTIC RIGHT WHALES (*EUBALAENA GLACIALIS*) TO PLAYBACKS OF CALLS RECORDED FROM SURFACE ACTIVE GROUPS IN BOTH THE NORTH AND SOUTH ATLANTIC

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The surface active group (SAG) is the most obvious social interaction of the endangered North Atlantic right whale (Eubalaena glacialis). These groups are typically composed of an adult female with two or more males engaged in social behavior near the surface. Distinct calls, believed to be produced by the female, are commonly recorded from these groups. Calls recorded from three North Atlantic right whale SAGs and three South Atlantic right whale (Eubalaena australis) SAGs were played back to North Atlantic right whales to determine if these sounds are sufficient to attract males to the groups. Playbacks of gunshot sounds produced by North Atlantic right whales which have been recorded both from SAGs and from lone animals were used as a control stimulus as these sounds are a less reliable cue that a SAG is present. Thirty-six trials were carried out from 1999-2001 in the Bay of Fundy, Canada. Whales approached 27 of 31 SAG playbacks and 0 of 5 gunshot playbacks. Where sex has been determined (n = 28), all approaches to North Atlantic SAG recordings were by males. Individuals (n = 22) of all age and sex classes approached South Atlantic SAG playbacks. These trials indicate that SAG calls from both populations are sufficient to attract right whales to SAGs and that males and females respond differently to stimuli recorded from the North Atlantic. The difference in response to North and South Atlantic SAG stimuli was unexpected. Novelty, species differences in calls, and different seasonal or behavioral context for the recorded stimuli may be responsible for the observed differences in response to these playbacks.

NACCHERE: AN ACOUSTIC BEHAVIOR OF STRIPED DOLPHINS

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During years of cruises around Italy, CIBRA team collected hundreds of hours of striped dolphins' (Stenella coeruleoalba) vocalizations, all classified and stored in their Digital Sound Library. In the most recent years, improvements in instrumentation and procedures allowed to record 24hrs/day for several consecutive days. The statistic analysis of these recordings clearly proved a well characterized cyclic pattern of striped dolphins' vocalizing behaviour. Their acoustic activity is definitively higher from dusk to dawn, and even the composition of recorded signals follows a similarly distributed pattern. While echolocation clicks, bursts and whistles are present on the 24 hours, with simple abundance variations, another sound, similar to an echolocation click train, but with one or more resonant frequency, sometimes slightly shifting in frequency, generally below 10 kHz, appears almost exclusively during the underwater night. It sounds like the Spanish castanets, and was named "nacchere" (Italian term for castanets, pron. nakkere). It was associated with feeding striped dolphins thanks to sightings occurred at night. The research has been carried out within the NATO Saclantcent's SOLMAR Project with ONR Grants N00014-99-1-0709 and N00014-02-1-0333.

SURFING THE POD: THE USE OF A TOWED PORPOISE DETECTOR IN VISUAL AND ACOUSTIC SURVEYS ON HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE GERMAN BIGHT

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Since several years, there are plans to install wind farms off the German coast. This has raised concerns on their possible impacts on marine mammals, especially harbour porpoises (Phocoena phocoena). It has also lead to requests by government agencies toward scientists, to design long-term monitoring programs for the designated areas. One method to collect data on the abundance and distribution of harbour porpoises are visual surveys by ship. However, the probability that animals are detected by the observers is massively affected by several factors, such as sea state, glare and response movements towards the vessel. Therefore shipboard surveys are limited to a certain extent. The aim of our study was to combine visual with acoustic surveys by means of towed hydrophones in order to collect data from submerged but acoustically active individuals. We undertook visual and acoustic surveys in the German Bight in June, July and November 2002. The surveys were carried out in sea states between 0 and 4 and lasted between 8 and 14 hours. As listening device, we used a Porpoise Detector (POD, Nick Tregenza, Chelonia Marine Research). The POD was towed behind a surfboard, app. 3 m below the surface and > 100 m behind the search vessel. Porpoise clicks were successfully recorded on most surveys. Between 0 and 18 click trains with a total amount of clicks of more than 800 were recorded. The time interval between successive click-trains indicates that they were emitted by different individuals. The combination of acoustic and visual data shows that in most cases more porpoises were heard than seen, especially in high sea states. We conclude from our results that towed porpoise detectors are a promising tool and can therefore be an important addition of shipboard based studies on harbour porpoises.

THE INDO-PACIFIC HUMPBACK DOLPHIN (*SOUSA CHINENSIS*): ACOUSTIC ADAPTATIONS TO LIFE IN HONG KONG SHIPPING LANES

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Since 1993, the population of Indo-Pacific dolphins that reside in Hong Kong and adjacent waters has been intensively studied. Surprisingly, however, little work on the species acoustic repertoire has been conducted, either in Hong Kong or on other populations. Any acoustic study of the Hong Kong underwater habitat is confounded, however, by the intense shipping and development activity that occurs in and around the dolphins preferred habitat. In addition, only a small number of this species reside in captive facilities and no studies on them have been reported. Recently, acoustic studies on both a captive and a free-ranging population have been undertaken. In April 2001, a three month study of the Singapore captive population of Sousa chinensis was completed and, in June 2002, an acoustic study was initiated in Hong Kong waters. Preliminary results indicate that the Hong Kong population displays several adaptations to living in an acoustically disturbed habitat; periods of vocalising were longer in duration and exhibited a larger variety of sounds than that recorded in Singapore and also than those reported for another, free-ranging population of the same species. In addition, recorded whistles were highly variable and more complex than that reported from this and other coastal species of delphinids. Further, the consistent occurrence of unique whistles between mother and calf pairs both in the Singapore captive facility and in Hong Kong waters suggest the presence of signature whistles in these populations. In Hong Kong, a better understanding of the dolphin populations acoustic requirements and limitations, in addition to a better understanding of the acoustic underwater environment, is essential for the establishment of effective mitigation measures during coastal developments.

SOUND ANALYSIS WORKSTATION FOR THE IMPLEMENTATION OF ACOUSTIC RISK MITIGATION POLICIES

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INTRODUCTION Concerns that acoustic emissions can affect marine mammals have grown over the past few years, mainly with the increased use of low-frequency active sonars and seismic surveys. Particular evidence of harmful interactions among Cuvier's beaked whales and military sonars is derived from a series of mass strandings occurred in recent years. Whether it is in support of mitigation measures, or in the larger field of marine mammal studies, passive acoustic techniques in marine mammal detection and localization have gained high importance in recent years.

Passive acoustics is an efficient tool that can be used for (a) expanding knowledge about marine mammals' distribution in space and time (i.e. with surveys), (b) evaluating the effects of sound exposure on animals' behaviour, (c) in situ monitoring to detect acoustically active animal within, or approaching, the dangerous sound exposure area. Though, no definitive methods today exist for predicting or determining, with very high confidence, whether marine mammals are present in a given area or not. To get a complete picture of an area it is thus important to integrate different methods including visual sightings, aerial surveys (Fossati *et al*., this volume) and any new technology aimed at detecting surfacing and diving animals (work in progress).

Since 1999 CIBRA co-operates with the SACLANT Undersea Research Center in the SOLMAR project (Sound, Oceanography and Living Marine Resources). The project is aimed at developing Acoustic Risk Mitigation Policies (ARMP) for NATO Navies and at characterizing and testing the required tools and protocols. Although some "Dual Use" experiments provided excellent results, mainly in the study of low frequency sounds, limited bandwidth, high self noise, operator interfaces not suitable for rapidly time-varying signals and expensive hardware, severely limits the effectiveness of standard ASW (antisubmarine warfare) equipment as ARMP tool.

MATERIALS AND METHODS To support the implementation of Acoustic Risk Mitigation Policies a PC based Sound Analysis Workstation has been designed, assembled and extensively tested to provide an affordable and flexible tool for wide-band acoustic detection and monitoring (Pavan *et al*., 2001). Complimentary sensors have also been tested to set up a self contained, lightweight, easy to install and use, affordable equipment to be used for both wide area surveys and local monitoring needs (Fig. 1 and 2). The package can be quickly installed on different platforms to offer detection and processing capabilities when and where needed. An observation protocol has been also developed to maximize the results over the 24 hours. By continuous monitoring with expert operators it is possible to reveal the presence of animals vocalizing sporadically or only in specific hours, for example at night, in relation to very peculiar feeding activities or behaviours (Manghi *et al*., Pavan *et al*., this volume).

Wideband sensors, wideband arrays deployed at different depths, integration of signals gathered by a sparse array of sensors, and wideband beamforming are the possible hardware solutions for further improving detection capabilities. A large bandwidth is required to capture ultrasonic signals, including echolocation clicks, that are not usually detected with equipment deployed for underwater military operations. This maximizes detection capabilities at short and mid range, i.e. within the most sensitive range for ARMP. Our current sensors configuration consists in a two channel towed array, designed in 1993, characterized by very low noise and 45 kHz bandwidth (Pavan *et al*., 1997) (Fig. 2), and other experimental arrays with bandwidth up to 300 kHz. A compact multisensor array is now being assembled to allow beamforming up to 20 kHz.

The PC based workstation is assembled with off the shelf components; in the basic configuration it offers 8 channels with high resolution spectrographic display and real-time beamforming capabilities. The basic bandwidth is 48 kHz per channel, expandable up to 100 kHz in the multi-channel configuration and up to 400 kHz on a single channel configuration. The software package provides hard-disk recording capabilities together with real-time high-resolution spectrographic display, beamformer display, GPS and navigation data logging, operator based acoustic classification logger, GIS plotting as well as file analysis and post-processing capabilities (Fig. 3). An important feature of the workstation is the ability to provide high resolution monitoring and recording 24h/day. Signals can be continuously recorded on a disk array to provide continuous recording for days or weeks, as required during wide area surveys. Storage is organized in user defined time cuts which are georeferenced by automatic GPS logging.

Navigation data and georeferenced acoustic events, categorized by trained operators, can be sent to a GIS for a near-real-time mapping (Manghi *et al*., 2004). With these features, the workstation returns a picture of the underwater acoustic environment not available with traditional equipment.

CONCLUSIONS The multichannel approach allows to monitor different sensors at once, for example shallow and deep hydrophones or a sonobuoy network, while large bandwidth allows to detect ultrasonic signals that can't be detected with traditional audio equipment and which can be the only signals revealing the presence of animals at short range. This system has been tested in four SIRENA cruises organized within the SOLMAR Project. A downsized version, based on a laptop pc, is normally operated on small boats for research purposes. The sound analysis software can be downloaded from CIBRA website for evaluation.

ACKNOWLEDGEMENTS Project carried out within the SACLANT Undersea Research Center's SOLMAR Project with ONR Grants N00014-99-1-0709 and N00014-02-1-0333. The development of the first CIBRA array was granted by the Italian Ministry of the Environment in 1993.

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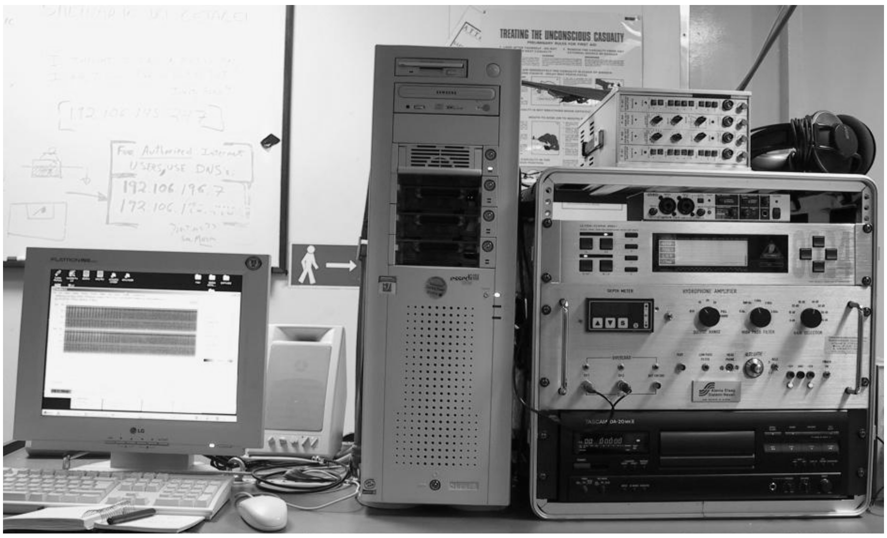

Fig. 1. The CIBRA workstation with the complementary equipment for the hydrophone arrays and a supplemental DAT recorder. The present PC configuration is based on a dual screen system with 640 GB disk storage

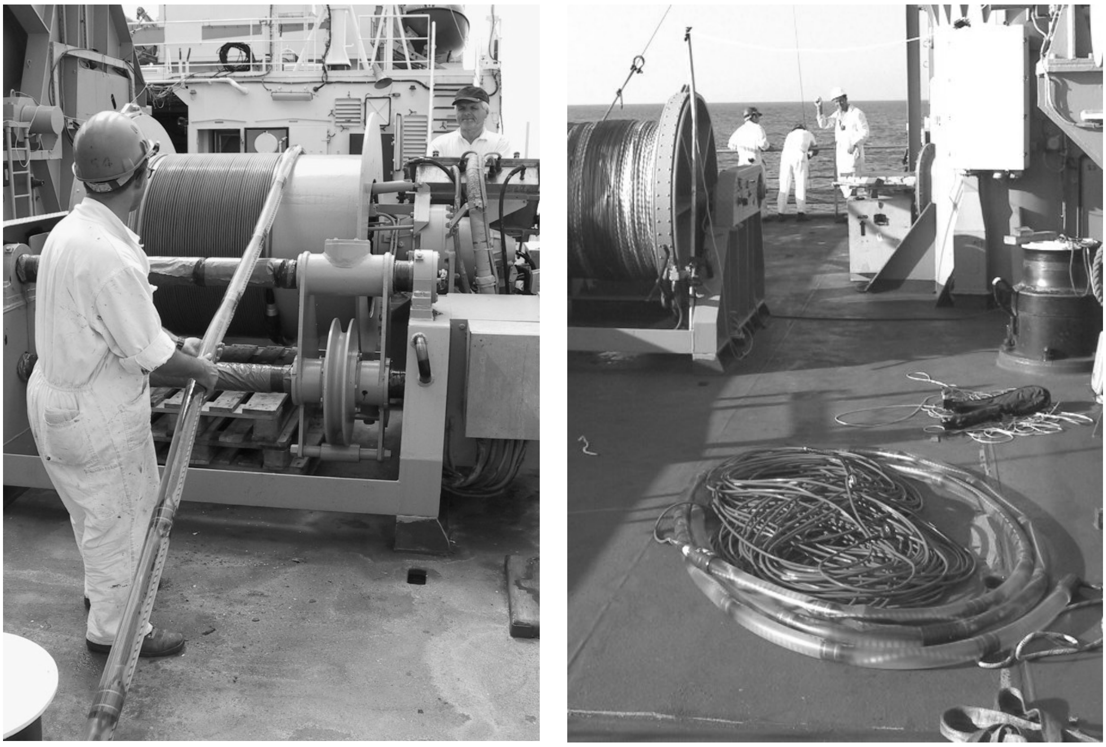

Fig. 2. The CIBRA arrays were designed to fit the needs of bioacoustic research in the field. They can be used with a small winch, though they can be easily moved, deployed and recovered by hand as well

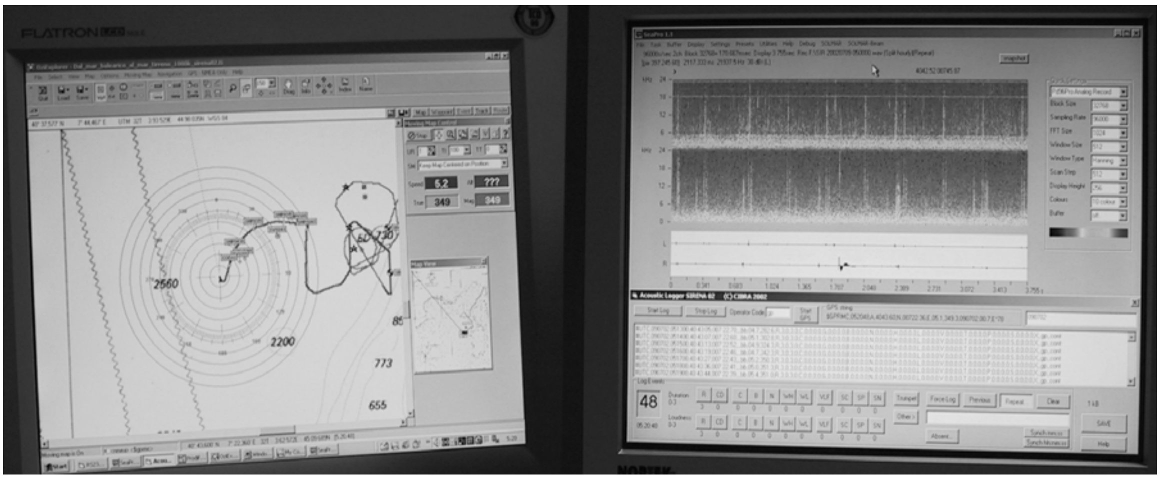

Fig. 3. While listening and observing real-time spectrograms, researchers classify received signals 24h/day and fill an acoustic log with 1 minute time slots. Each slot is georeferenced, thus allowing a direct link to a GIS for acoustic mapping. On a dual screen system, recording, analysis, display and GIS plotting can be performed at the same time

DEVELOPMENT OF THE ACOUSTIC AND LOCOMOTOR BEHAVIOUR OF AN INFANT BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

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INTRODUCTION With the birth of a female bottlenose dolphin (*Tursiops truncatus*) in the Palablu Delphinarium (Peschiera del Garda, Italy) we began a two years program of observations and recordings of its behavioural and acoustic development. From the birth until six month the dolphin and its mother resided separately from the other dolphins of Palablu. The present work refers to this period and attempts to provide information on the development of echolocation in the young dolphin and on the dynamic relationships between the acoustic and non-acoustic behaviour of the mother and its offspring.

Acoustic and behavioural development in infant dolphins has been described in the literature (Lindhardt, 1988; Reiss, 1988; Manoukian *et al.*, 2002). However, in the published works the calf shared the pool with all the other dolphins of the community at all times since its birth, thus precluding a close examination of the relations between the dolphin and its mother and how they change with the age. This study attempts to evaluate in particular these relations.

MATERALS AND METHODS The dolphin Nau was born the 28th Oct. 2001 in a 30x15x6 m kidney shaped pool, which it shared only with its mother, called Betty, until May 2002. This pool is the biggest of the four pools in Palablu Delphinarium, it has large underwater viewing windows and walls covered with sound absorbent material. These circumstances and facilities made sound source identification and behavioural observations easier.

Dolphin signals were observed on a oscilloscope (HP 54520A) and recorded with input from a COLMAR hydrophone (3 dB flat response between 1-200 kHz) onto the wide band channel of an analogic recorder (flat response from 1-300 kHz). Comments from the researcher who was observing the animals were recorded on the audio channel of the same recorder so that echolocation and dolphin behaviour could be studied simultaneously. The hydrophone was positioned about 2 m deep and about 3.5 m from the pool wall. A 30 mm diameter copper sphere was used to attract the animals attention. It was suspended from hydrophone with a fine monofilament thread (10 cm length, 0.2 mm diameter). Recordings were done while both animals were swimming freely. The acoustic data were collected in sessions of three consecutive days held every 4-6 weeks, starting from the second postnatal week. A session consisted of four 30 min recordings, distributed randomly in the three days. Sonar signals were analysed in the laboratory. The signals were attributed to Nau or Betty, using the comments registered on the audio channel of the recorder, digitised at 5.12 samples per microsecond and processed using MATLAB m-file language. The number of clicks emitted in each session by both dolphins was calculated and their average spectra were analysed. Four parameters were extracted by each pulse and averaged per session. These parameters are (Blahut, 1991): the barycentre and the Gabor time width of the signals (calculated from the first and the second moment in time); the barycentre and the Gabor bandwidth of the spectrum (calculated from the first and the second moment in the frequency). They were used, together with two statistical parameters asymmetry and kurtosis related with the shape of the spectra, to estimate the acoustic similarity/dissimilarity (i.e acoustic distance) between the mother and its offspring (Azzali *et al.*, 1998) and how they changed session by session.

Ethological data were collected one day per week, starting from the second postnatal week, on the basis of two 60 min observations randomized on eight hr period. The "Focal Animal Sampling" method was used (Altmann, 1974). The behavioural data presented in this paper are:

- mother-infant association. The number and duration of the departures of the infant from the mother were measured (Tavolga, 1966).
- mother-infant swimming position. Three swimming attitudes are considered in this paper (Fig. 5): 1) the infant swims below and in contact with its mother in resting position (Tavolga and Essapian, 1957); 2) the infant swims close to or in contact with its mother in echelon formation (Essapian, 1953); 3) mother and infant pair separates, the infant swims alone with rapid changes in direction (random swimming), the mother follows/chases the infant until the pair reunites (Chirigin, 1987).

RESULTS **Acoustic development of Nau in relation with its mother** The clicks detected when Nau was 2 (session of November '01) and 6 (session of December '01) weeks old were attributed to its mother. These sessions were characterised by almost constant mother-infant contact in close resting position and sometimes in echelon formation swimming. The mother and its offspring swam in circle. When the pair approached the hydrophone / target, Betty sometimes looked at it and a click train was detected. The number of click trains recorded were: 37 in November and 35 in December. The average spectra of these clicks (Fig.1) are multimodal with 4-5 peaks (maximum peak around 120 kHz). They contain most of energy between 90 and 130 kHz: mean frequency barycentre = 102.52 kHz (SD 22.04), mean Gabor Bandwidth = 45.55 kHz (SD 2.86 kHz), mean Gabor time width = 9 μs (SD 2 μs).

At 11 weeks (session of January '02) 14 single clicks most likely from Nau were detected. Generally these clicks were observed on the oscilloscope during short departures of Nau from its mother: the young dolphin left its mother, approached the hydrophone/target, and came to about 1m from it, the mother and infant then reunited. The clicks from Nau had a duration of few cycles and a main frequency component around 50 kHz. A typical spectrum of these clicks is shown in Figure 2 A: it has only one peak around 53 kHz and contains very little energy below 30 and above 100 kHz. In the same session of January '02 were detected around 20 click trains emitted only from Betty (Fig. 2 B). The spectra produced by Betty in this period were characterised by only one peak, as to the ones of Nau, but shifted at much higher frequency (around 140 kHz). The spectra contained most of energy between 110 and 160 kHz: mean frequency barycentre = 147.4 kHz (SD 3.34), mean Gabor Bandwidth = 44.26 kHz (SD 7.62 kHz), mean Gabor time width = 6.6 μs (SD 0.6 μs).

At 16 weeks (session of February '02) Nau produced 9 clicks, during short departures from its mother as in January '02. The spectra of these clicks (Fig. 3 A) are poorly structured as the ones detected in the previous session. They show a single power peak at 50 kHz and contain very little energy below 30 and above 80 kHz. However, surprisingly, Betty produced in this session a number of clicks (13) with spectra very similar to the ones of its offspring (Fig. 2 B). These spectra show a dominant peak at 50 kHz and contain most of energy between 30 and 80 kHz, although a secondary peak at 120 kHz is visible.

At 21 weeks (March '02) Nau emitted for the first time about 14 waveforms with several cycles containing two frequency components spaced roughly 15-20 kHz. These two components are visible in the spectrum (Fig. 3 A) that is bimodal: the peak at high frequency (60 kHz) is dominant and concentrates more energy than the other peak at lower frequency (40 kHz). The click trains attributed to Betty were 27. Figure 3 B shows a typical power spectrum of a click train produced by Betty in March '02. It is a peculiar spectrum for its shape and for its extremely broad frequency range (20-200 kHz) . Two parts could be distinguished. The first part exhibits components in frequency range 20-110 kHz, with a dominant peak at 80 kHz and two secondary peaks at 60 and 40 kHz. It includes all the frequency components present in the spectrum of Nau and has peaks similarly spaced (around 20 kHz). The second part shows only one peak at 148 kHz and high frequency components distributed between 110-200 kHz. Similar signals, with spectra divided in low frequency components distributed around a dominant peak at 60-80 kHz and in high frequency components concentrated around a dominant peak at 135-145 kHz, were produced by Betty in the sessions of April when its offspring was 26 weeks old. The young dolphin in the sessions of April continued to produce waveforms characterised by two frequency components. The typical spectra of these signals show a dominant peak around 50 kHz and a secondary peak around 60-80 kHz. Both peaks are slightly shifted towards frequencies higher than those recorded in March '02. However, apparently Nau was not able to produce signals with spectra containing considerable energy above 100 kHz, also when it was 26 weeks old.

Since the session of January '02 we observed circumstances in which the mother and the infant swimming in echelon formation simultaneously oriented the hydrophone/target and two slightly overlapping clicks were recorded, one adult type click and one lower both in intensity and frequency, emitted by Nau apparently for mimicry. In average we recorded 20-30 double clicks per session. The spectrum of these double clicks shows 3-4 peaks ranging between 48 and 140kHz: mean frequency barycentre = 104 -106 kHz, mean Gabor Bandwidth = 54-64 kHz, mean Gabor time width = 15-25 μs. No significant change was observed in the spectra of these double clicks from January to April '02. Apparently, they were stereotyped mother-infant signals.

The acoustic distance (i.e. the acoustic dissimilarity) between the mother and its offspring decreased from week 11 (d=3.49) to week 16 (d= 1.23), when the acoustic dissimilarity mother-infant reached the minimum. From week 16 to week 21 the acoustic distance increased up to d=5.53, then remained almost constant until week 26 (d=5.11).

Non-Acoustic behaviour of Nau The non-acoustic behavioural development of Nau during the first 26 postnatal weeks can be divided in three periods. The first period, from birth through the 9th postnatal week (Dec. '02), was marked by Nau swimming prevalently (>80%) in resting position (Fig. 5) and in close contact with its mother (Fig. 6). The second period extended from postnatal weeks 10 (Jan. '02) through 17 (Feb. '02) and was characterised by Nau swimming almost in equal proportion (Fig. 5) both in resting position (50%) and in echelon formation (>40%), though mother and infant remained in close contact, as in the first period (Fig. 9). The third period, from postnatal weeks 18 through 26, is typified by more and more frequent departures of Nau from its mother (Fig. 6). From the birth Nau swam in echelon formation more often than in resting position only during the weeks 18-22 (March '02; Fig. 5).

CONCLUSIONS The infant from birth to 6^{th} postnatal week did not emitted signals and in this period swam prevalently in resting position. At 11 weeks Nau was able to produce clicks with few cycles and with only one peak energy at 50 kHz. Similar clicks were recorded from the dolphin when it was 16 weeks old. It is unclear if these first simple signals with poorly structured spectra were emitted by the dolphin intentionally to obtain environmental information and if they were related with the changes of mother-infant swimming position (Fig. 5), occurred during the weeks 10 and 17.

At 21 weeks Nau produced more structured waveforms with several cycles and with two frequency spaced 15-20 kHz. The spectra of these signals were bimodal with peaks energy at 40 and 60 kHz. They seem to reflect an improvement of acoustic control from the young dolphin. Few changes were observed in the clicks emitted by Nau when it was 26 weeks old: the average spectra of these clicks show a dominant peak around 50 kHz and a second peak at higher frequency between 60-80 kHz, but they are yet lacking of frequency components above 100 kHz. Since postnatal week 19 the departures of the young dolphin from its mother became longer and more frequent (Fig. 6). This suggests that the bimodal clicks, emitted by the young dolphin since March '02, were intentional echolocation signals used to move in the pool without maternal aid. The isolation of Nau from the community could have delayed its acoustic and motor development , that in other pools, where calves stayed since birth within the social group, seemed to be evolved quicker (Manoukian *et al.*, 2002).

It is difficult to analyse the role the mother played in providing echolocation model and instructions to its offspring. Since when Nau emitted its first clicks, Betty seemed to simplify her own typical clicks (Figs.1) and to adapt them to the acoustic characteristics of Nau (Figs. 2 B, 3B, 4 B). It is interesting to speculate if this may reflect the intention of Betty to share environmental information with its offspring. Finally it is unclear the function of the two almost simultaneous pulsed emissions from mother – infant, recorded without any significant changes in many sessions. These signals may have been used by the two dolphins to maintain acoustic contact or the mother may have produced standard echolocation signals as models, expecting that its offspring imitated them.

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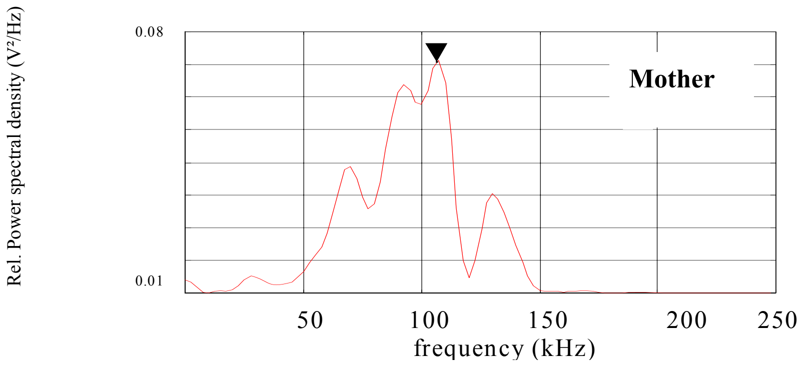


Fig.1. Average spectrum of a click train produced by Betty when its offspring was 2 and 6 weeks old (Nov. and Dec. '01), showing energy peaks at 90 and 120 kHz. No clicks from Nau was recorded in this period

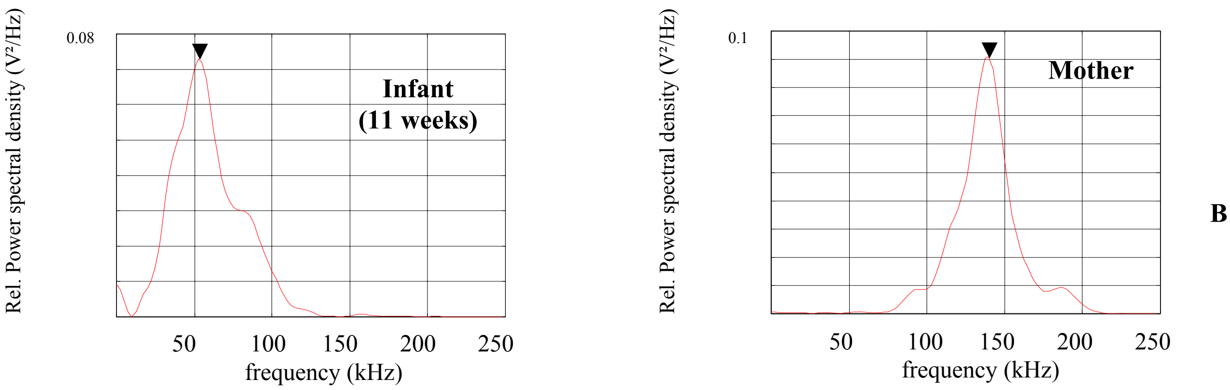


Fig. 2. Typical spectra of the first clicks recorded from Nau (A), when it was 11 weeks old. The average spectra of the clicks trains emitted by Betty are shown in (B)

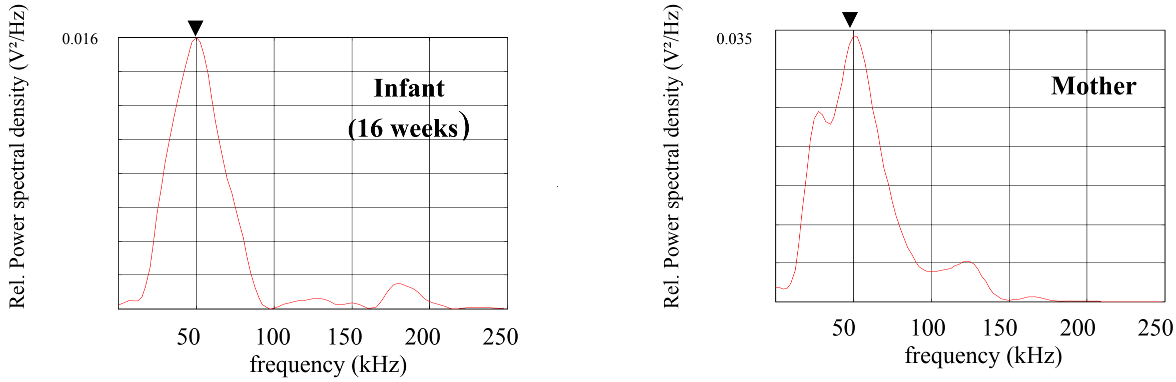


Fig. 3. Typical spectra of clicks emitted by Nau (A), when it was 16 weehs old. In this period Betty produced clicks with spectra very similar to the ones of its offspring (B)

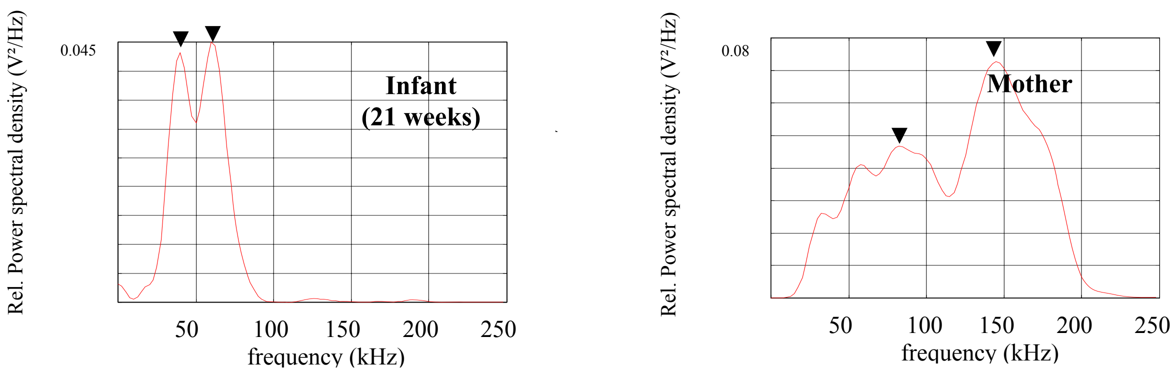
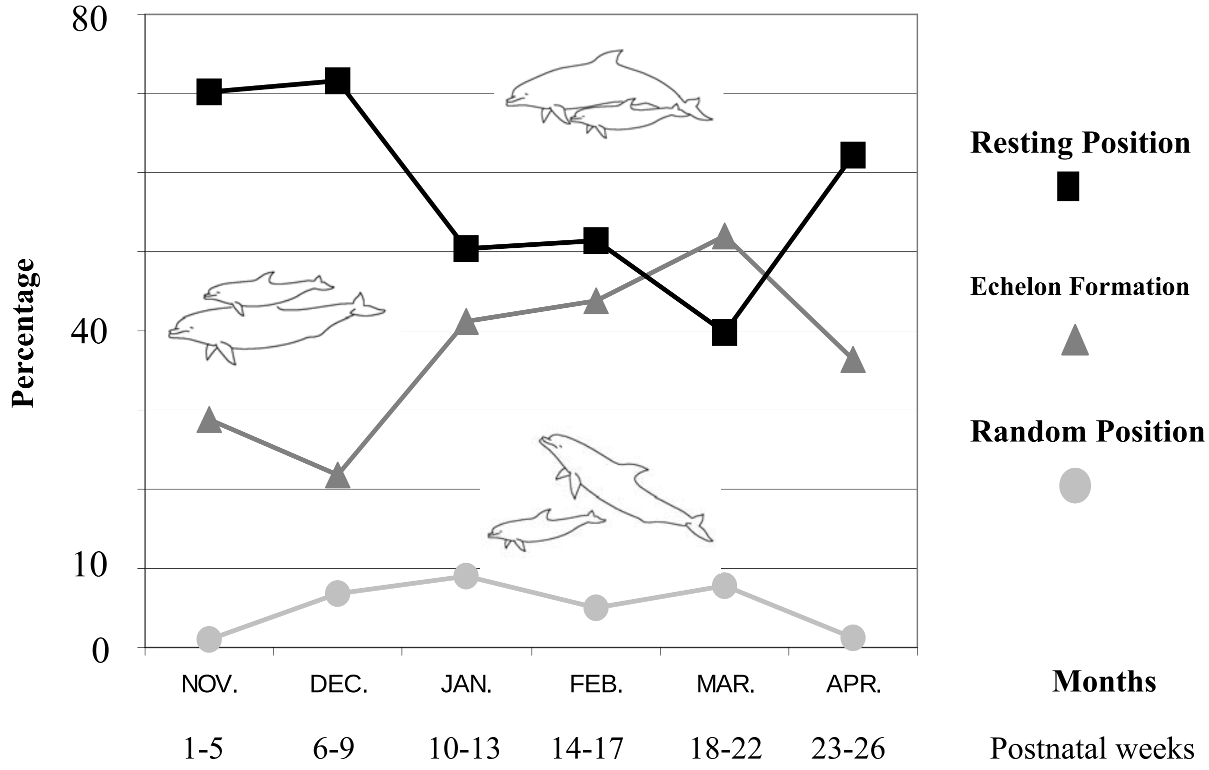


Fig. 4. From 21 to 26 postnatal weeks Nau emitted clicks with bimodal spectra (A). During this period the stectra of Betty clicks show two peaks roughly at 80 and at 150 kHz



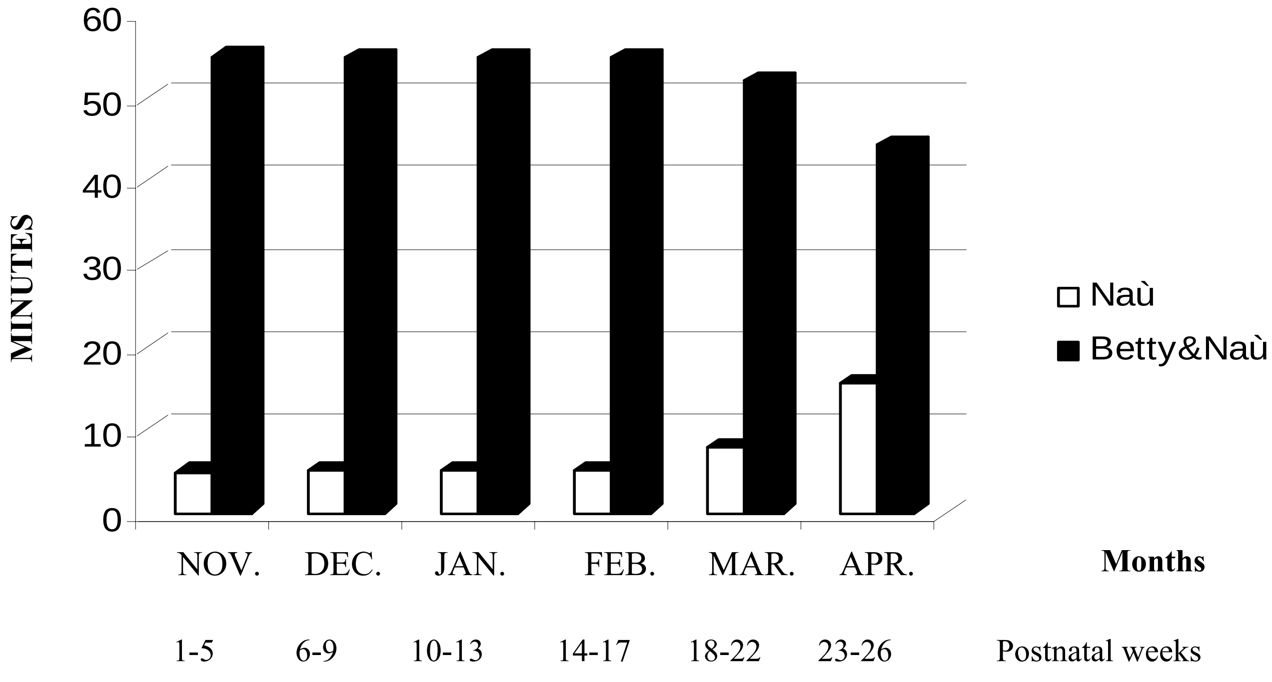


Fig. 6. Departures of the infant dolphin (Nau) from its mother (Betty) during the first 26 postnatal weeks

FACTORS INFLUENCING ACOUSTIC BEHAVIOUR IN PHOCID SEALS

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A series of factors were examined to identify which are likely to be influencing the development of acoustic behaviour in male phocid seals. Contrary to traditional thought degree of polygyny and density did not appear to influence vocal development. Other factors such as pupping substrate stability, duration of lactation and guard-ability and predictability of oestrus females appear important. Species pupping in stable habitats tend to have low minimum frequency vocalisations with few elements, while pack-ice breeders produce multi-element vocalisations with high minimum frequencies. Most pack ice breeders are widely dispersed, so increasing the number of elements per call might increase detectability and maximum detection distance of the vocalisation. In species where oestrus females are predictably distributed and guardable (southern and northern elephant, grey, hooded, and crabeater seals) male acoustic displays are associated with male-male agonistic interactions and are likely to be intra-sexual in function. Male vocal repertoires tend to be composed of a reduced number of primarily simple, broad-band pulsed sounds. In species where females do not remain hauled out with their pups until weaning, guarding them until oestrus is more difficult. Due to this female inaccessibility males may use vocal displays to attract a mate. As oestrus females are widely and unpredictably dispersed long-range underwater advertisement displays are necessary. Since male vocalisations of these species; (leopard, Ross, bearded, and ribbon, seals) must travel large distances, the calls are constrained by propagation difficulties and background noise. These species tend to have fewer, narrower band, highly stereotyped sounds and repetitive displays which help ensure maximum detection distance of the signal. In species where oestrus females are predictably distributed but unguarded (Weddell, harp, harbour, and ringed seals), males perform shorter-range underwater advertisement displays. As these signals are not constrained by propagation difficulties these species may adopt a large array of sound types, with subtle variations, greatly increasing their overall repertoire size.

QUANTITATIVE ANALYSIS OF THE WHISTLES PRODUCED BY THE BOTTLENOSE DOLPHINS IN THE SADO ESTUARY

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Among the various types of sounds emitted by bottlenose dolphins (*Tursiops truncatus*), whistles have received particular attention, given their obvious social functions (not understood in detail), their occurrence through vocal learning, and their perceived potential as communication signals. Ever since studies began on the underwater sound emissions of the bottlenose dolphins in the Sado estuary, in Portugal, these unpulsed and variable signals were found to be an important part of their repertoire, as in other populations, and classification efforts were started. Here the results of 90 field trips conducted between 1987 and 2001 are presented, during which digital recordings were complemented with photo-ID, behavioural observations and group follows through the study area. Sonogram analysis of 1131 whistles allowed us to recognize 26 frequency-modulation categories ("contours"), some of which show remarkable stability throughout the years. In terms of whistle production rate, no relationship was found with group size. Group size did not appear to influence the number of different contours emitted, against our initial predictions. Activities during which observers at the surface were able to detect many excited behaviours, such as Feeding or Social Interactions, show greater absolute whistle production, as well as greater contour diversity. Our results so far are compatible with different hypotheses regarding the exact functions of these sounds, namely the ideas that they may be produced in matching sequences for social cohesion, or may be related to the complexity of the dolphins' activities or even be produced as shared calls.

VOCALIZATIONS OF FREE-RANGING SHORT-FINNED PILOT WHALES (*GLOBICEPHALA MACRORHYNCHUS*) OFF TENERIFE: SIGNAL REPERTOIRE AND CHARACTERISTICS

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INTRODUCTION The vocal repertoire of free-ranging short-finned pilot whales (*Globicephala macrorhynchus*) has been reported in part by several authors from other populations (Schevill, 1964; Evans, 1967; Caldwell and Caldwell, 1969; Fish and Turl, 1976; Taruski, 1976; Rendell *et al*., 1999). Scheer *et al*. (1998) describes stereotyped calls among social groups off Tenerife. Each observed group showed a group-specific call repertoire with no call sharing between groups. All these studies are focused on whistle, call or whistle-like vocalization descriptions. Only Fish and Turl (1976) and Evans (1973) report frequency and energy measures for broadband clicks of free-ranging short-finned pilot whales. With regard to frequency and duration measures for all vocalization types as well as in detail repetition rates per time unit for click and grunt vocalizations, further sound categories used by this species remain un-notified. In this work we will describe physical characteristics for all sound categories being recorded for the Tenerife population and give spectrographic examples.

MATERIALS AND METHODS Observations and recordings were made during September and Oktober 1996 off the southwest coast of Tenerife (between 27°58‘36‘‘ to 28°01‘56‘‘ N and 16°42’21‘‘ to 16°50‘50‘‘ W), a region where at least a part of the population of short-finned pilot whales is resident and can be found year-round. Research platform was the *Caldéron* being normally used to patrol the southwest coast to enforce legislative rules during whale watching activities. This research was especially authorized by the Canary government. During 55 h 7 min within observation contact a total of 12 h 58 min of audio recordings were obtained. Altogether 1 h 12 min of the recordings were used for analysis. 1315 vocalizations were counted. The flat frequency response of the recording system was 200 Hz to 24 kHz using a pre-amplified (+/- 30 dB) Sea Mike SM – 1000 hydrophone (Deepsea Power and Light, San Diego, California) and a Sony TCD3 digital audio tape recorder. For spectrographic analysis we used Avisoft Sonagraph™ software (by Raimund Specht, Berlin, Germany; Pro Version 2.5). Sound sequences were digitised at 48 kHz (16 bit), spectrograms (512 pt FFT, 75% overlap, Hamming window) had a time resolution of 2.67 ms and a frequency resolution of 121 Hz. For visual inspection of the spectrograms we used the same time and frequency resolution for all sounds to ensure fixed parameters for comparisons. For calls physical parameters in this study were derived from the band with the most energy. For call comparisons and classification we used the overall spectrographic contour (time vs. frequency). Stereotyped calls were matched subjectively by comparing spectrograms. To compare calls in this study more in detail and to adjust parameters for comparisons with previous studies from other authors we measured duration (D), initial frequency (IF), end frequency (EF), minimum frequency (MiF) and maximum frequency (MaF) (the limit was the upper range of the recording system) for each call.

RESULTS 87% or 1144 of the total 1315 recorded vocalizations were calls. Of these, 199 calls were spectrographically analysed. Calls subjectively appeared tonal to the human ear, however these sounds have different spectrographic appearances and are supposed to be generated using different sound production mechanisms. A huge proportion had sideband structures and are presumed to be pulsed sounds (Watkins, 1967) (Fig. 1 a, b). Others had harmonics thus being tonal (Fig. 1 c, d). Some calls showed a tonal and a pulsed part. Calls can rise and fall as well as being leveled or multiply modulated in their contour. Generally calls (n = 199) had a mean MaF of 10.97 (± 4.02) kHz and a mean MiF of 2.53 (± 1.54) kHz. Mean IF was 3.6 (± 2.26) kHz and mean EF 8.12 (± 4.7) kHz. The general frequency range for sidebands with most energy was 280 Hz - 23.44 kHz. For some calls harmonics or energetically less pronounced sidebands had frequencies >24 kHz. Mean D of calls was 0.9 (± 0.32) s (range 0.09 – 4.55 s). Out of 199 spectrographically analysed calls, 177 (89%) were heard more than once and up to 15 times during recording sessions and are termed stereotyped calls (Fig. 1 a, d). 22 calls (11%) were only heard once and are termed variable calls (Fig. 1 b, c). A spectrographic overview of stereotyped and variable calls can be found in Scheer (1999).

Grunts represent 3% of all recorded vocalizations. Though grunts subjectively sound tonal, they seem to be sounds exclusively generated by pulses at high repetition rates having broadband frequency distributions as well as several relatively narrowband frequencies with more energy (Fig. 2 a, b). Compared with calls, sidebands for grunts are less narrow, thus they sound less clear tonal than calls. For grunts we spectrographically measured 290 – 690 pulses/s. Energetically pronounced frequency bands are less broadband for grunts (Fig. 2) than for clicks.

Clicks represent short pulses mostly having a broadband frequency composition. We observed many sequences in which short-finned pilot whales emitted click sequences with click intervals of 0.5 s with total sequence durations ranging 5 - 60 s or even longer. We observed clicks with a continous energy distribution from 200 Hz to >24 kHz and clicks with frequency bands being energetically emphasized. Generally a single pulse duration ranged 5 - 13 ms. For many sequences we observed an increase in pulse repetition rate ranging 20 - 80 pulses/s. These sequences were termed click trains. For certain click sequences pulse repetition rate increased to 280 pulses/s. Sequences with repetition rates ranging 90 to 280 pulses/s were termed fast click trains. The latter sequences generally lasted 1 - 2 s. Click trains and fast click trains were each handled as an own vocalization category, representing both 10% (7% for click trains and 3% for fast click trains) of all recorded vocalizations. Clicks with a repetition rate of less than 20 pulses/s were not handled as an own subcategory because they did not form discrete units but occurred permanently during general vocal activity, thus being excluded from total vocalization number. All click vocalization categories are variations of click sequences depending on pulse repetition rate.

DISCUSSION Based on comparisons of spectrograms, physical characteristics and occurrence rates reported from other authors, our call vocalization category is likely to match ‚squeals' as described in Schevill (1964), ‚calls' reported by Evans (1967) and ‚whistles' from Caldwell and Caldwell (1969) and Taruski (1976). Taruski (1976) describes and compares frequencies and durations of short-finned pilot whale whistles of populations off California (frequency range 0.6 – 11.5 kHz; duration range 0.2 – 2.6 s), Peru (1.4 – 6 kHz; 0.15 – 1.5 s) and the Caribbean (1 – 17.5 kHz; 0.15 – 1.9 s), indicating geographic variations in whistle vocalizations. Compared with call parameters in our study (frequency range 0.28 – 23.44 kHz; duration range 0.09 – 4.55 s) call vocalizations among short-finned pilot whales off Tenerife represent a geographic variation, having a broader frequency and duration range. Fish and Turl (1976) report a peak in frequencies for broadband clicks of short-finned pilot whales around 25 kHz, but also having higher frequencies (at least up to 40 kHz). Evans (1973) describes frequencies of 30 - 60 kHz for click vocalizations for this species. The click frequency range from both studies remains unknown, thus not enabling a comparison with data from our study (range 0.20 - > 24 kHz).

CONCLUSIONS Short-finned pilot whales off Tenerife produce calls, grunts and click vocalizations. They generate pulsed as well as non-pulsed signals and thus show a typical odontocete sound repertoire. In comparison with call vocalizations being recorded in other locations (and from other populations), short-finned pilot whale calls off Tenerife show a geographic variation. The majority of calls were heard more than once and are termed stereotyped calls. The minority of calls were only heard once and are labeled variable calls.

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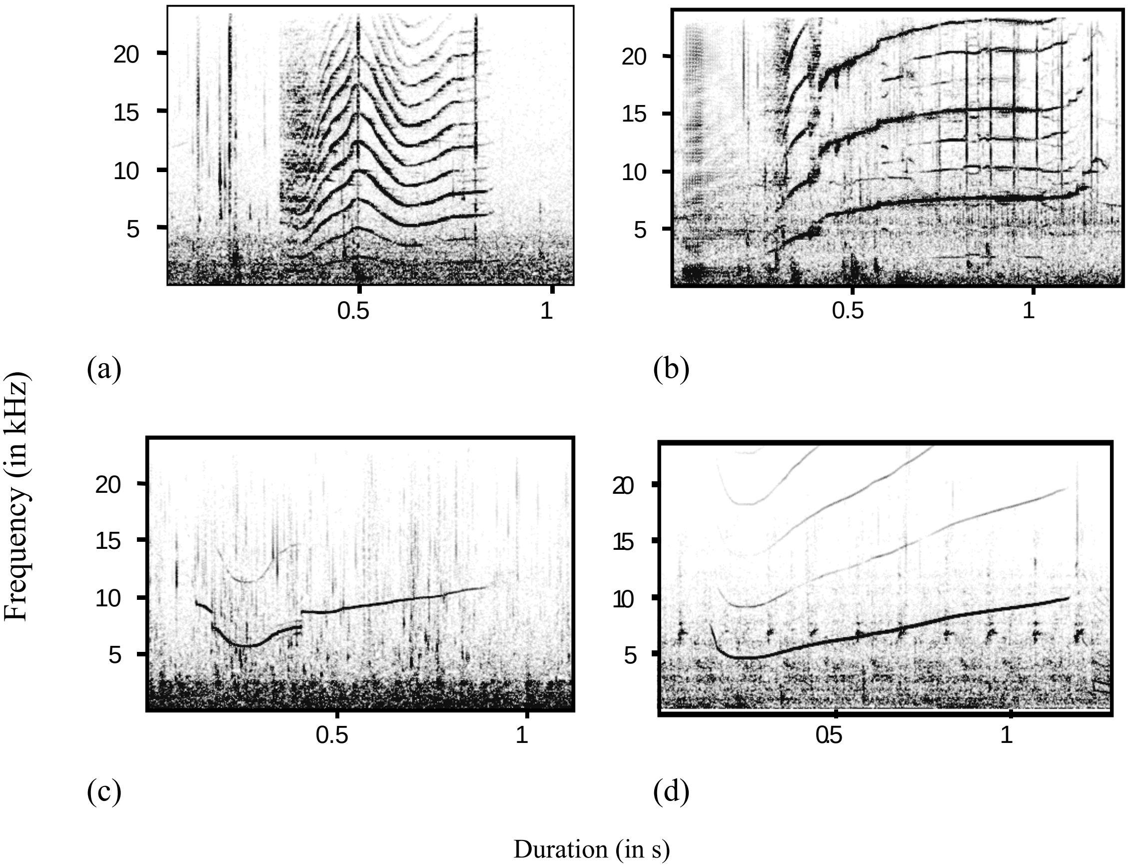

Fig. 1. Spectrograms of call vocalizations of short-finned pilot whales. (a) Stereotyped pulsed call #A-2 (n=15). (b) Variable pulsed call #B-6 (n=1). (c) Variable tonal call #A-14 (n=1). (d) Stereotyped tonal call #A-7 (n=7)

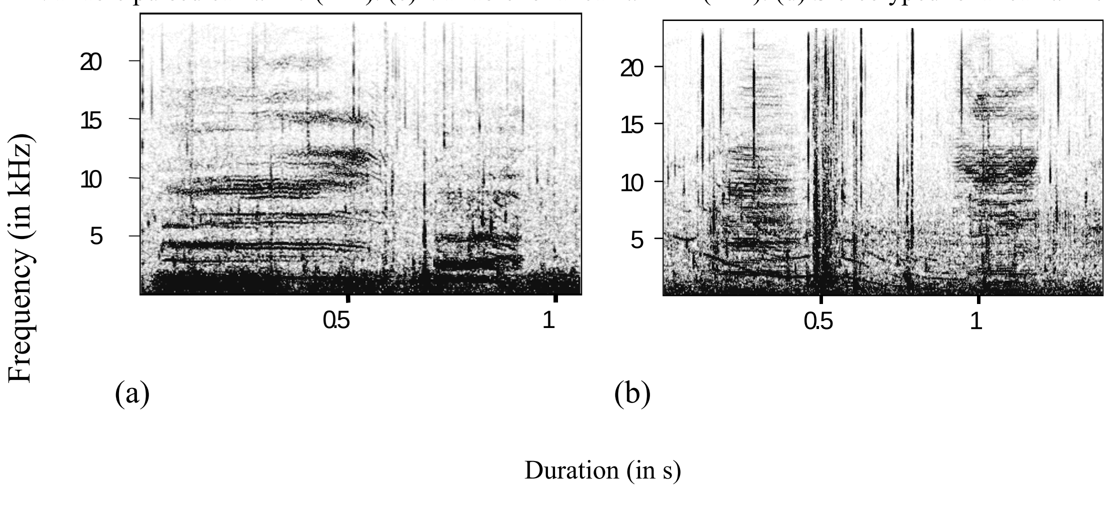

Fig. 2. Spectrograms of grunt vocalizations of short-finned pilot whales. (a) Two successive pulsed grunts (0.1-0.6 s and 0.7-0.9 s). (b) Two successive pulsed grunts (0.2-0.5 s and 0.9-1.2 s)

PRELIMINARY MEASUREMENTS OF THE SOURCE LEVELS OF SOUNDS PRODUCED BY NORWEGIAN KILLER WHALES, *ORCINUS ORCA*

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It is necessary to know the physical characteristics of killer whale sounds to study several ecologically relevant questions: To measure the distance at which killer whales can detect herring through echolocation, the distance at which killer whales can detect each other, or how herring react to killer whale sounds, all demands that the source parameters have been determined. The aims of this study were to measure source levels and spectral characteristics of sounds produced by Norwegian killer whales while feeding on herring. Recordings of wild killer whales were obtained during October and November 2001 in Vestfjord, Norway. We used a four-hydrophone array (recording bandwidth: 1Hz to either 150 kHz or 300 kHz). Underwater video was simultaneously recorded on VHS tape. In order to estimate the apparent source levels (ASL), the distance to the whales was estimated from the differences in the time of arrival of the sound to the hydrophones. Analyses were done using Matlab software. Preliminary results suggest that the presumed echolocation clicks of these killer whales are broadband, with centre frequencies of 26-57 kHz, which falls within the high sensitivity areas of published killer whale audiograms. The 10 dB bandwidth was 14 - 44 kHz and 81 – 112 kHz. The average click duration was 38 µs. ASL's ranged from 187 to 213 dB re. 1µPa (p-p) @ 1m (n = 52 clicks, including clicks on- and off-axis). The underwater tail slaps, used by the whales to stun herring, produced multi-pulsed broadband sounds with ASL of 187 dB re 1µPa (pp) @ 1m (n = 1).

THE UNDERWATER ACOUSTIC ENVIRONMENT OF FIN WHALES IN THE VICINITY OF AN OIL AND GAS DEVELOPMENT AREA

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We used a speculative mysticete audiogram proposed by Clark and Ellison to determine the impact on fin whales (*Balaenoptera physalus*) of activities related to an oil and gas development area west of the Shetland Islands, UK. Arrays of pop-ups (autonomous bottom mounted recording systems) were used to track the fine scale movements of fin whales and to determine received noise levels in 1/3rd octave bands across a 1kHz bandwidth. Additional information about industrial activities and shipping movements within this area were used to identify potential sources of low frequency noise. Recordings were characterised by high levels of low frequency noise associated with the dynamic positioning systems used on the FPSO's (Floating Production Storage and Offloading facilities), supply vessels and tankers using the development area. In addition, summer recordings were dominated by seismic activity from geophysical surveys. Noise levels ranged between 134 dB re 1 mPa2 / Hz (1-3Hz) and 51 dB re 1 mPa2 / Hz (355-447Hz). Noise levels in two fin whale bands (18-22Hz and 22-28Hz) ranged between 120 dB re 1 mPa2 / Hz and 49 dB re 1 mPa2 / Hz at distances of 8.5 and 40Km respectively. Predicted source spectrum levels ranged between a maximum of 209 dB re 1 mPa2 / Hz and a minimum of 147 dB re 1 mPa2 / Hz; and were similar to those previously recorded from drillships and supertankers. In 50% of the data, noise levels in 1/3rd octave bands exceeded our predicted lower limit for the threshold of mysticete hearing (Urick, 1983 Ambient + 16dB), and in 25% of cases noise levels exceeded our predicted upper limit for the threshold of hearing (Urick, 1983 Ambient + 24dB). The management implications of these results are discussed.

INTER CLICK INTERVAL VARIATION OF DEEP-DIVING SPERM WHALES IN THE MEDITERRANEAN SEA

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INTRODUCTION Research has established that sperm whales produce series of loud, impulsive broadband sounds called clicks with a variety of repetition rates (Backus and Schevill, 1966), described by the following categories: regular or usual clicks, creaks, codas, slow clicks, trumpets and fast or rapid clicks (Weilgart and Whitehead, 1988; Gordon, 1987). This generally accepted classification was applied to a set of 25 hours of deep diving sperm whale vocalizations, acquired during three years in the Ligurian and Corsican Seas. In order to characterize in detail the different phases of foraging dives, the temporal variation of the Inter Click Interval (ICI) was used.

MATERIALS AND METHODS Sperm whale recordings were acquired with a towed array of 128 hydrophones and self-recording devices attached to the animals (D-tags). Spectrogram analysis was performed using SeaPro © software developed by Gianni Pavan 1998-2002 and Nauta. Basic statistical parameters of 28 dives from 5 individuals were obtained (Table 1) using the following criteria: *dive time* the time between the first and the last click of each dive, *inter-dive time* the time between the last click of a dive and the first click of the following one and *dive cycle* the time between the first click of a dive and the first click of the following one. An automatic click detector was used to obtain the ICI and its variation during the dive. Histograms of ICI were performed with a bin width of 1ms.

RESULTS Nearly all sperm whale sound categories occurred (Table 2). Although the incidence of slow clicks is low trumpets are well represented. Pauses (ICI > 2 seconds) occur as expected, just after a creak or during regular clicking. The role of this disruption is still unknown. No fast clicks as described by Gordon (1987) were found, whereas codas were observed and occurred, when observed, during the final phase of the dive.

Based on the ICI variation, four well-defined phases (Fig. 1) have been identified within a dive: An *Initial Phase*, usually less than 1 minute, where the first clicks may have an ICI > 1.5 s. This is consistent with the sonar probing the maximum dive depth (2 s correspond to 1500 m maximum sonar range). A *Descending Phase* where the ICI varies with the animal pitch (ICI ~ 1/sin(pitch), Zimmer *et al.*, 2003). A *Searching Phase* characterized by larger oscillations of the click sequences with ICI between 0.5 and 1.5 s. (Teloni *et al.*, 2000) and a remarkable presence of creaks. An *Ascending Phase*, when usually no vocalization is produced. A description of each observed sound category against this classification is following.

Regular clicks commence on average 48.65 s (SD 31.71) after the fluke up and stop on average 7.42 min (SD 1.03) from surfacing. These clicks start during the descent phase and continue for the entire searching phase but stop during the ascent phase when the animals are usually silent. Histograms of ICI for the five sperm whales show two maxima: one for regular clicks and one for creaks. A well-defined peak characterizes creaks, whereas regular clicks present secondary peaks before (SW01-275b) and after (SW02_191b) the maximum (Fig. 2 and Fig. 3, upper left).

Creaks are series of very rapid clicks, usually more than 10 clicks per second. The production of this sound starts on average 5.33 min (SD 1.92) from the first regular click and occurs only in the search phase. Within the recordings, two main types of creaks were identified: one with a progressive variation of the repetition rate till a constant ICI (Fig. 3, lower left); the other (*neat creaks*) with a fairly immediate transition of the ICI from a regular click rate to a creak rate (Fig. 3, lower right). The progressive decay of ICI values is apparent in the main plot of SW00_250. The overall percentage of *neat creaks* is 65.11% of the total number of creaks.

Codas, usually defined as short series of clicks with characteristic time patterns, have been observed at the end of dives just before the ascent phase (Fig. 3, middle left). The set of analyzed codas presents the typical pattern 3+1 (III I) of the Mediterranean Sea (Pavan *et al.*, 2000).

Trumpets are a relatively rare vocalization usually occurring just after fluke up and before the whale emits regular clicks. No obvious function has been attributed to this sound. It seems to be emitted as the vocal system is prepared for use. Trumpets were found in both data sets, the towed array data and tag recordings (Fig. 3, middle right). Trumpets are usually followed by a short sequence of slow clicks (ICI between 5 and 7 seconds).

Stereotype clicks are a particular kind of click, which have been observed between sequences of regular clicking or within pauses. These clicks (in series of 3 to 7) usually show significantly different ICI from the previous clicks and a lower intensity (Fig. 3, upper right). As of 98 series of stereotype clicks, 95 were shortly followed by a creak. One explanation could be that the animal attempts a creak and then fails or decides to not continue. Or, their repetition pattern, which is similar to the coda pattern, could have a role for communication.

CONCLUSIONS A set of sperm whale recordings, from towed array data and D-tag recordings, was analyzed. The first was a macroscopic overview of the standard sound categories for this species, of which almost all were found within the recordings. However, a never reported vocalization occurring significantly often and named stereotype clicks was described. Basic statistical parameters of dive cycles were unremarkable for the Mediterranean Sea.

A more detailed analysis was carried out also on the temporal variation of ICI. The dive status of a sperm whale can be characterized by the time interval between clicks. In particular, four different phases were identified and described in more detail. Each observed sound category seems to be related in a deterministic way to a particular phase. Foraging dives, recorded from different sperm whales, show the same general structure. The dive status of a clicking animal is therefore recognizable, as well as from the presence or absence of a particular vocalization, on the basis of the ICI variation.

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Table 1. Dive cycle statistics calculated in minutes over 21 dives from D-Tag and 7 dives from BF array.

	Mean	Min	Max	SD
Dive Time	37.38	21.40	51.97	6.96
Inter-Dive Time	18.50	15.33	22.73	2.27
Dive Cycle	56.71	40.23	73.37	6.78

Table 2. Sound classification results (D-tag data only).

	# of Dives	Depth Max (m.)	# of Creaks	# of StC	# of Trumpets	# of Pauses	# of Pauses after Creak	# of Slow Clicks	# of Codas
SW 250_00	3	955	54	12	1	76	44	5	--
SW 265_01	4	910	53	28	1	112	37	2	9
SW 275_01	8	895	94	40	2	212	86	--	18
SW 189_02	1	840	6	3	--	23	6	--	--
SW 191_02	5	1160	71	15	--	69	69	--	--

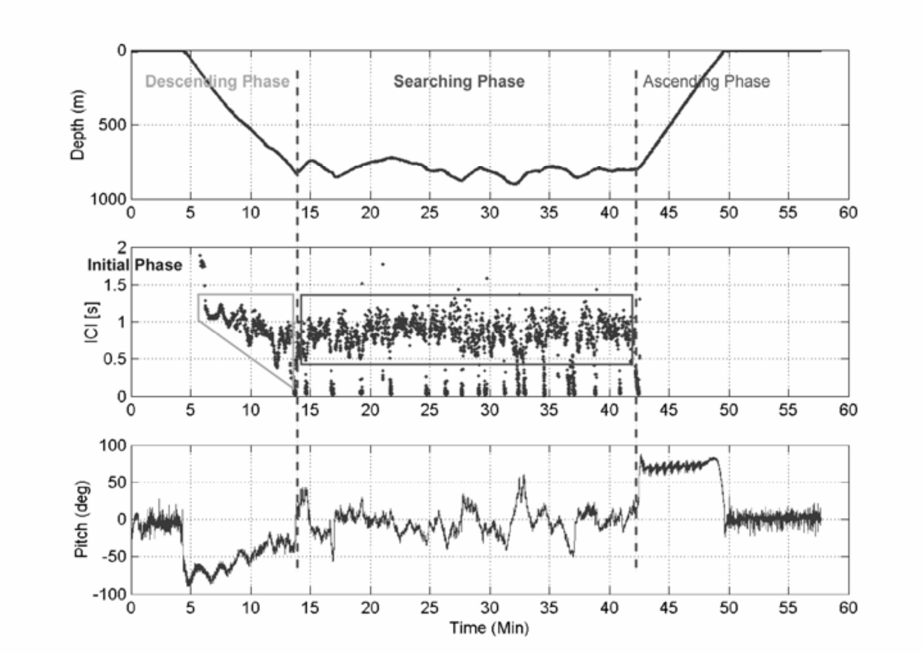

Fig. 1. Comparison of depth, ICI and pitch of SW00_250 during the first dive after tagging

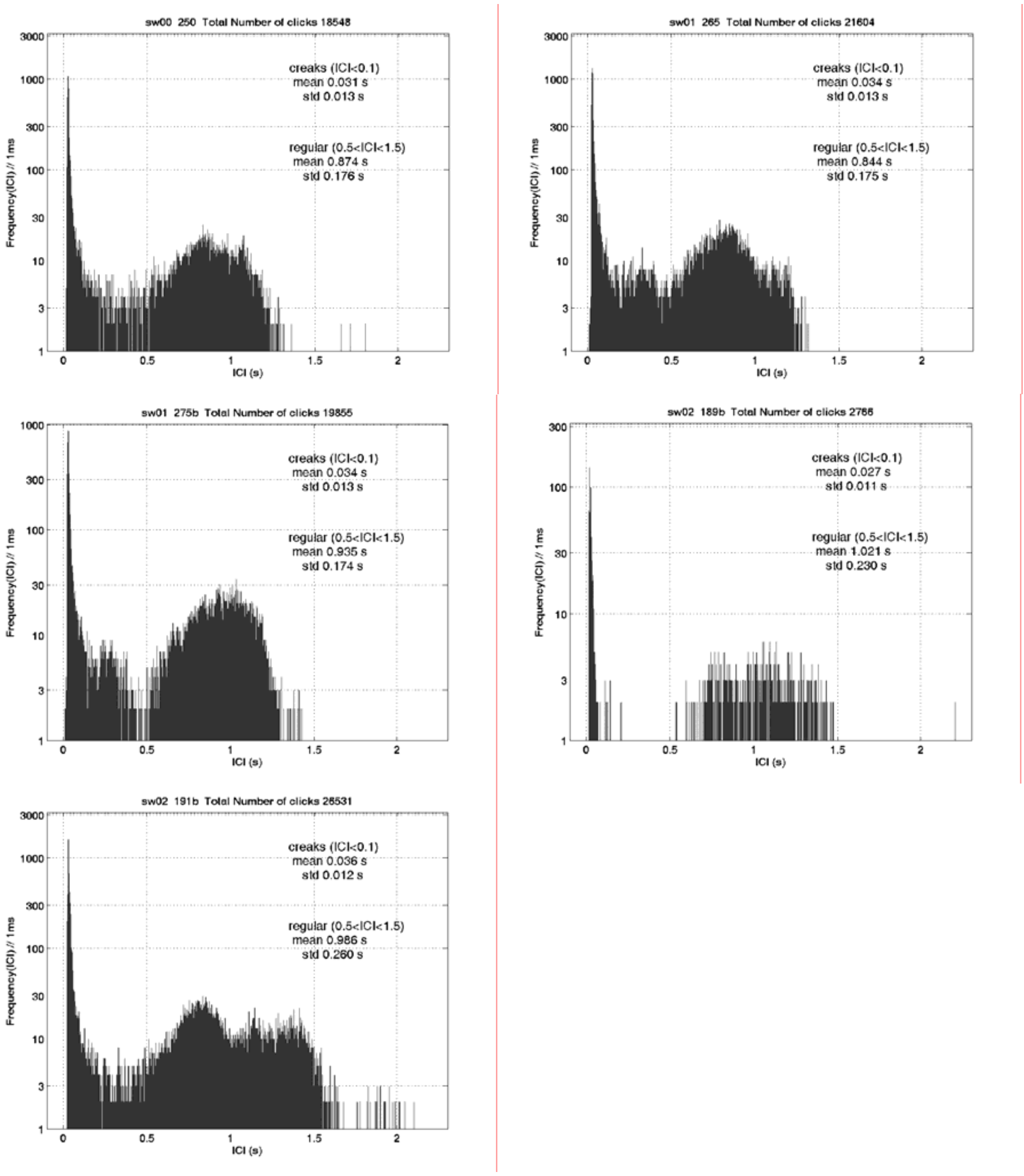

Fig. 2. Histograms of ICI for each tracked sperm whale

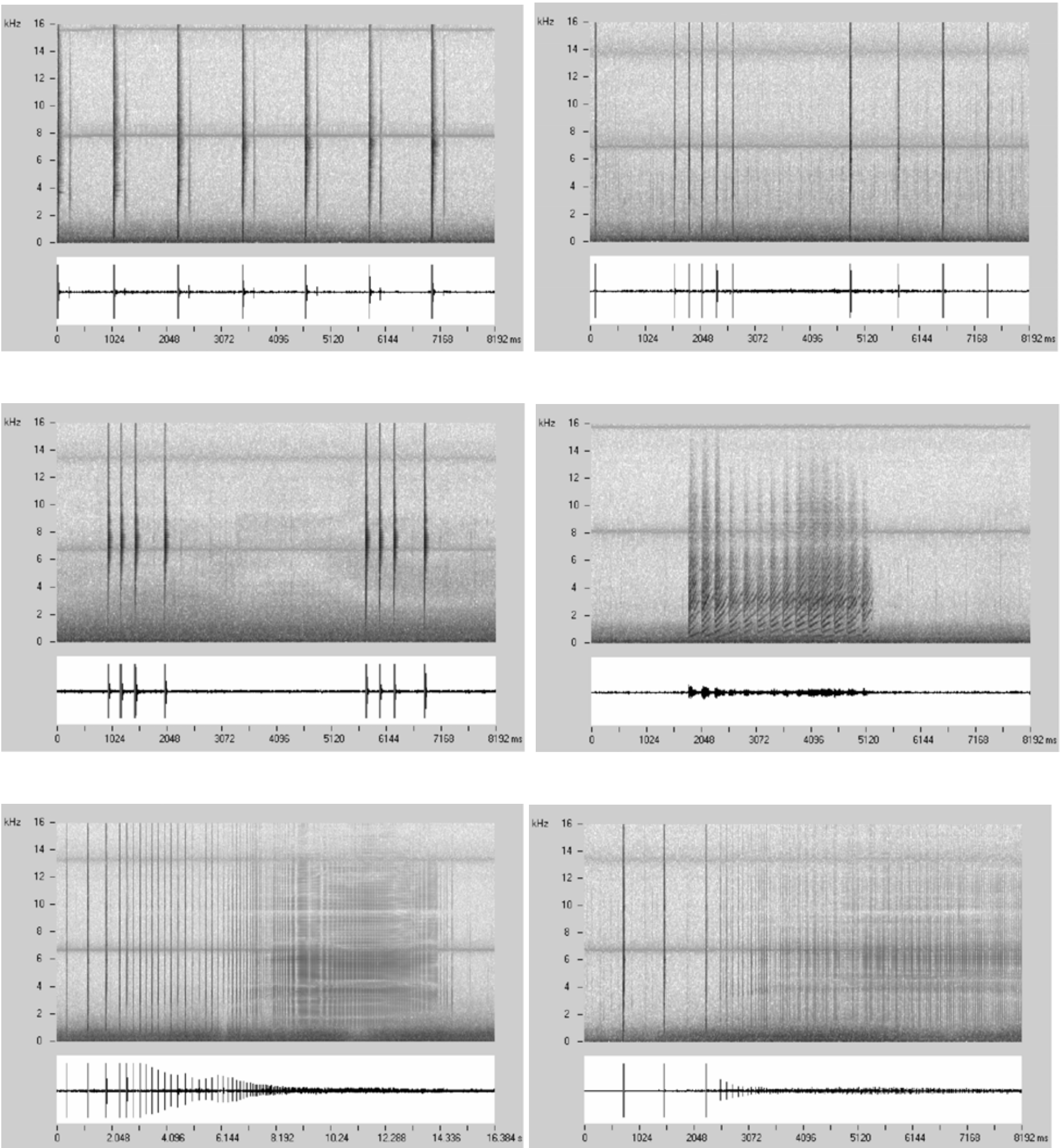

Fig. 3. Spectrogram examples: regular clicks (upper left, stereotype clicks (upper right), codas (middle left), trumpet (middle right), progressive creak (lower left) and neat creak (lower right)

AN ANALYSIS OF STEREOTYPED WHISTLES IN WILD KILLER WHALES (*ORCINUS ORCA*) OFF THE COAST OF VANCOUVER ISLAND, BRITISH COLUMBIA

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In several delphinds, for example the bottlenose dolphin (Tursiops truncatus), stereotyped whistles serve as individual signatures which function as cohesion signals. They are most commonly produced during long-range communication when individuals are separated, or during reunions of mother and calf pairs. Killer whales (Orcinus orca) off the coast of Vancouver Island, British Columbia produce whistles at high rates when interacting at close-ranges. During long-range, for example foraging and travelling, whistles are only sporadically emitted. Earlier studies indicate that some whistles are highly stereotyped and can be classified into six stereotyped whistle types. The aim of this study was a detailed structural and behavioural analysis of types of stereotyped whistles in wild killer whales. Simultaneous underwater recordings and surface behavioural observations were made on resident killer whales in Johnstone Strait, British Columbia, between 1978-2000. Whistles were analysed with the RTS and SIGNAL computer programs for sound analysis. A total of 3000 whistles were visually inspected. Whistles were classified according to their spectrographic contour. A subset of 100 randomly chosen whistles was used to confirm our initial classification. Five additional observers were asked to classify these whistles independently by their shape. About 22 % of all whistles appeared to be stereotyped. The whistle contours of most types were consistent in shape for at least 18 years. The additional observers agreed on the classification of the six stereotyped whistle types. Further, the same whistle-types were recorded from individuals of different matrilines. Finally, whistles of each of the six types type were almost entirely associated with close-range behaviours such as socializing or social-travelling. It appears unlikely that stereotyped whistles in northern residents are signatures of individuals like those reported for a variety of other delphinds. We conclude from our results, that in northern resident killer whales stereotyped whistles are used to coordinate close-range interactions.

VOCAL RECOGNITION SYSTEMS IN ADULT MALE AUSTRALIAN FUR SEALS

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Australian fur seals, Arctocephalus pusillus doriferus, are colonial breeding animals that form highly dense groups during the breeding season. During this time males establish territories and defend these areas through physical clashes, stereotyped posturing and vocalisations. Vocalisations are also suggested to play an important role in the recognition system amongst males. However, most studies in otariids have focused mainly on mother-pup vocal recognition and little attention has been given to vocal recognition in males. Territory holding fur seal males have been suggested to habituate to neighbouring males, vocalising less towards these seals as the breeding season progresses. The lack of intense aggressive interactions between neighbours compared with higher levels of aggression toward unknown stranger males suggests a recognition system amongst males. The increased aggression shown towards stranger males decreases the chance of loss of territory to these unknown stranger male adversaries. The neighbour/stranger recognition system, therefore would function as a reproductive strategy, enabling males to recognise potential threats. The objective of this study is to determine whether there is a vocal recognition system amongst adult male Australian fur seals. Recordings of adult male Australian fur seals were made during the breeding seasons of 2000 and 2001 on Kanowna Island, Australia. Males of this species produce two types of in-air vocalisations, the bark and the adult male guttural threat. This study examined the bark vocalisation to determine whether males produce individually distinct calls which could be used as a basis for vocal recognition. A total of 180 barks from 10 individual males were analysed using SIGNAL 3.1 (Engineering Design, Massachusetts). Fifteen call characteristics were measured including frequency, temporal and amplitude variables. Results indicate that there is sufficient stereotypy within individual calls and sufficient variation amongst them to enable vocal recognition amongst male Australian fur seals.

DOMINANT FREQUENCIES IN SPERM WHALE CLICKS

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regular clicks from single diving male sperm whales off Kaikura, New Zealand were currently investigated on the presence of dominantfrequencies in the Fourier spectrum. Notwithstanding the results of Goold and Jones (\cite{goold95}) for the clicks in our dataset the higher dominantfrequency did not clearly show up in a plot of the Fourier spectrum.Therefore a parametric estimation of the two dominant peaks is proposedbased on a Gabor model. Although this method seems to yield a goodmodelling of the dominant frequency, the variability in a click train does not make it a reliable parameter for individual identification of asubject.

FROM A COMPOSER'S PERSPECTIVE

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Our attempts to understand the acoustic realm of cetaceans have traditionally adhered to the research tools of science. As a Humpback Whale field researcher and a classical musician by training, I propose a more interdisciplinary approach whereby the investigation of acoustic behavior is conducted through the creative process of composition. Composer Edgar Varese, who once gave a definition of music as "organized sound", understood that the process of composition involves integrating multiple levels of organization, where any given level can be designated (parameterized) by a time of duration; from the duration of a pitch or rest up to the time duration of the entire composition. Within this duration, elements are structured and layered with purpose and order such that the listener can grasp the music's various and diverse intents. To explain how this musical organization can be of benefit to the rigorous demands of cetacean acoustic research, we can create a composition whose principles of organization are derived solely from the inherent rhythms, patterns and sounds of cetacean vocal behavior. From this point of acoustic re-organization, we can hear how various attributes of vocalizations compare and contrast to one and another. For instance in the case of Humpback Whales, how frequencies in Feeding Calls match or mingle with each other or how select phrases of the Winter Song, when layered and stretch, begin to evolve and mutate. By following this particular method of organization, the composition becomes not just a creation of its composer, but a sum total of the attributes present in the source material. This re-alignment and re-organization of material reveals qualities of vocal behavior that may not become evident through more traditional means of analysis and serves as a point of comparison between human and cetacean acoustic ecologies.

SIGNATURE WHISTLE PRODUCTION BY FREE-RANGING MALE BOTTLENOSE DOLPHINS

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Bottlenose dolphins in Sarasota Bay, Florida, USA, produce individually-distinctive signature whistles when recorded under controlled circumstances in the absence of other nearby dolphins. Free-ranging dolphins were recorded with a hydrophone array that allowed identification of whistling individuals. In total, 168 whistles were assigned to 10 individuals during focal follows. These whistles were compared to whistles recorded under carefully controlled circumstances during brief restraint for health assessment. Most animals produced the same whistle types while isolated and free ranging. The number of whistles assigned to individuals was low compared to the total number of whistles recorded during a focal follow. We could not always identify the whistler during follows, but when we could it was clear that individuals were producing the same types of whistles during restraint and when free-ranging. Therefore, we compared all whistles recorded during focal follows with signature whistles produced during brief restraint. We looked at whistles produced by three social groups: paired adult males together, a paired adult male in the absence of a partner, and paired adult males together with a female. Whistle rates were lower in groups of single males and paired males together than in groups containing paired males with a female. However, significantly more of the whistles produced by a single member of a pair alone were signature whistles. Additionally, paired males together were significantly more likely to remain silent. These data support findings with captive animals that signature whistles are used as contact calls. Male pair bonds represent one of the most stable associations in bottlenose dolphin communities. Paired males in Sarasota are sighted together more than 75% of the time. The strength of the association suggests that it is important for pair members to maintain contact, and signature whistles appear to serve this function.

LFA SONAR AND MARINE MAMMALS: SCIENTIFIC LIMITATIONS, CREDIBILITY, AND MANAGEMENT

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We scientists need to be frequently reminded of the following quote: Scientists have an "unquestionable duty towards nature: we must protect it with all our means and forces." (Miroslaw Romanowski, eminent metrologist). There have been three recent court cases over a 3-mo. period (October 2002 through January 2003) in the U.S., all pitting environmental groups against ocean noise producers or against the regulators which issued the noise producers their permits. In all three cases, the judges sided with the environmental groups.

As two of these cases concern the U.S. Navy's Low Frequency Active (LFA) Sonar program, we will be using it to illustrate some of our points. First, we will briefly describe LFA sonar, then discuss the involvement of marine mammal science in the LFA program, then illustrate how the science can become compromised, and finally we'll suggest ways to make the process work better.

LFA sonar is a new type of sonar developed by the U.S. Navy to detect newer, quieter enemy submarines. Its effective source level is around 235 dB re 1 microPa, re 1 m and because it uses low frequencies which propagate large distances, its potential range of impact is huge. The level drops to 120 dB at a distance of 1,111 km from the source (Johnson, 2003). Past studies have indicated that several marine species, not just whales, try to avoid sound at an average received level of 120 dB, so, as this is a moving source, this could mean that marine life over an area of 3.9 million sq. km is impacted during every broadcast of LFA sonar. This area is roughly equivalent in size to twice the area of France, Spain, Germany, and Britain combined.

To gain a better idea of what the impact of LFA sonar might be, a Scientific Research Program (SRP) was undertaken and funded directly by the U.S. Navy. The principal investigators were Chris Clark and Peter Tyack. They decided to focus their efforts on four whale species that they thought to be most sensitive to LFA sonar. Results were that for Phase I, which studied feeding blue (*Balaenoptera musculus*) and fin whales (*Balaenoptera physalus*), the whales called less often during LFA broadcasts than when the system was off. In Phase II, which studied migrating gray whales (*Eschrichtius robustus*), "whales avoided levels low enough to raise serious concern about disruption of migration" (Tyack, 2002) when the source was located inshore. With an offshore source, there was no obvious avoidance. In Phase III, which studied breeding humpback whales (*Megaptera novaeangliae*), exposed singing whales showed avoidance responses and half stopped singing, resuming singing within the hour (Clark *et al.*, 1999). Those that did not stop singing, sang 29% longer songs during LFA transmissions (Miller *et al*., 2000). For all three phases "...analyses revealed modest changes in behavior related to the LFA broadcasts, none of which persisted more than 2 hours after the broadcasts ended." (Fristrup, 2002).

The limitations of these studies, which unfortunately were never spelled out by the principal investigators are:

1) Studies took place over weeks (19 days in the case of Phase I)
2) Only a handful of individuals were studied (17 singers in Phase III), except in the case of Phase II
3) Only 4 species of whales, out of about 80 species of cetaceans and roughly 30 additional species of marine mammals, were studied (no deep-diving whales, considered by many to be most vulnerable)
4) Only short-term, visible changes in behavior, rather than long-term population effects about which we are most concerned, were studied, and
5) The source was not used at full, operational power (exposures limited to 155 dB received level).

This last limitation was stated by the principal investigators in their technical report: "...[it is] difficult to extrapolate from these results to predict responses to higher exposure levels." (Clark *et al.*, 1999). Unfortunately, not even this one caveat made it into the Environmental Impact Statement (EIS) the Navy had to prepare for this project (Department of the Navy, 2001).

Based on the SRP and other assumptions, the Navy concluded that LFA, at operational levels, was safe to deploy in 70 - 75% of the world's oceans (Department of the Navy, 2001). Not unexpectedly, many marine mammal scientists, including ones who had participated in the SRP, felt the results were at best, inconclusive, and at worst, cause for alarm. Patrick Miller, the first author of a published study on Phase III (Miller *et al*., 2000), writes that LFA use could "reasonably be predicted to reduce the gene pool by as much as a quarter of the [humpback] males." (Letter to the National Marine Fisheries Service). The Principal Investigators of the SRP, however, came out in support of their funders. Their conviction about the lack of biologically significant effects was so strong that they felt compelled to testify for the Navy in this court case. Here, Peter Tyack writes "I disagree with Miller that the responses [of the humpbacks] indicate significant disruption of breeding behavior".(Tyack, 2002).

David Bain concludes that "deployment of LFA..is likely...to adversely affect marine mammals in subtler but significant ways on a population scale" (Bain, 2002). However, Chris Clark in his sworn declaration states: "Statements such as [the above] are not supported by direct scientific evidence relative to LFA." (Clark, 2002).

Kurt Fristrup writes: "The brevity and subtlety of [the] behavioral responses are strong indications that LFA exposures at received levels up to 155 dB could not affect survivorship or reproduction." (Fristrup, 2002). However, John Twiss from the Marine Mammal Commission, which is charged with providing advice to the executive branch of the U.S. government, states: "Although it is true that only minor, short-term behavioral responses were detected, it does not necessarily follow that there were no long-term effects". (Twiss, 1999). He also writes: "[it is unclear from the EIS] why sounds...would not be expected to have biologically significant effects on breeding, feeding, or other behavior."

Kurt Fristrup states: "There is no chance that masking will be a problem for [blue and fin whales due to LFA exposure]" (Fristrup 2002). (Masking is when an animal's sounds are lost in noise of a similar frequency). Ron Schusterman and colleagues counter with "The assumption that the potential masking effects of ...LFA are expected to be 'negligible'...is incorrect" (Schusterman *et al*., 2002). These are all quotes from experienced marine mammal scientists. So, there is controversy, which is not surprising, given the ambiguity of the results.

Some observations are quite clear-cut, however. A type of LFA sonar was in use off Greece in 1996 as 14 beaked (Family: Ziphidae) whales stranded and died. The correlation in time and space between the ship's movements and the strandings was very strong, so LFA is suspected of causing this stranding (Frantzis, 1998). In March of 2000, this tragedy was repeated off the Bahamas. 17 whales of 3 species, but mostly beaked whales, stranded and at least 7 died. In its Interim Report (Evans and England, 2001), the U.S. Navy admitted that its tactical mid-range frequency sonar was "the most plausible sound source of the stranding". Necropsies showed hemorrhages around the ears and brain, and these injuries were "most consistent with acoustic trauma". Most devastatingly, Ken Balcomb, who has studied the population for the past decade, believes all Cuvier's beaked whales (*Ziphius cavirostris*) in the study area either died or were permanently displaced, as there has only been one resighting of a known whale since the stranding (Balcomb and Claridge, 2001). Here, we have a very clear population-level effect, one that no one predicted. And then, of course, there is the beaked whale stranding that occurred here in the Canaries in September of last year, also correlated with military exercises and with whales presenting acoustic injuries similar to those of the Bahamas (8 died, 6 were returned alive, 3 different species—see this volume).

Given that a) such a reaction was entirely unpredicted, that b) a mechanism for the beaked whales' injuries has yet to be determined, and c) that it is still unknown which characteristics of the sonar caused it to be so deadly, one might suppose these events would have some relevance to LFA sonar (despite LFA's lower frequency) and would argue for precaution. Not so, according to Chris Clark: "...the correlational references [of the Bahamas stranding] do not specifically address LFA, and they do not contradict the results of the scientific research on LFA...or the conclusions of the EIS." (Clark, 2002). Darlene Ketten writes: "It is inappropriate and premature...to extrapolate one event involving two species to all marine mammals and from one sonar to another sonar of a very different signal type."(Ketten, 2002). Edward Cudahy concurs, writing: "..to make such an extrapolation [from mid-frequency data to low-frequency data], clear physiological data on a large sample (tens or hundreds) of animals exposed to mid-frequency underwater sound is needed". (Cudahy, 2002).

Yet, these same scientists seem to have no problem using the SRP results of mostly a few individuals of four species of whale exposed to reduced power levels and whose short-term reactions *only* were studied over periods of weeks and extrapolating these results to marine mammal populations in general. So there seems to be a double standard here, and one that turns precaution on its head**.** Similarly, Edward Cudahy has no problem extrapolating results from terrestrial animals to marine mammals, even calling such extrapolations "conservative" because "...terrestrial mammals would be more susceptible to underwater sound damage than animals that were exposed to underwater sound as a regular part of their life".(Cudahy, 2002).

The trouble is, the judges of the past three court cases don't seem to be buying the argument In the case of LFA deployment, the judge ordered that the sonar be restricted to avoid areas particularly rich in marine life. This is something many of us had argued for from the start and would have been a vastly more useful, precautionary, and cheaper approach than the one taken by the Navy. Especially considering that a seismic research ship appears to have recently caused the stranding and death of two beaked whales (*Center for Biological Diversity v. National Science Foundation*), it seems scientifically indefensible to argue that the previous strandings have no relevance to LFA. The dominant frequencies of these seismic signals are in fact more similar to LFA than the mid-range tactical sonars used in the Bahamas, and still they were likely deadly. We believe the public views this controversy much like the case of a doctor who wishes to give your child a drug, even though a related, but not identical, drug has inexplicably killed other children. The doctor will not convince you as a parent that this drug is sufficiently different to be of low risk, especially if the mechanism causing the deaths is still unknown.

The scientists trying to dispel the public's fears about the effects of LFA on the marine environment will only lose credibility and trust. The public's confidence in them wanes with each new stranding. Scientific credibility suffers when: 1) scientists overstate their data and don't clearly spell out the limitations of their results or alternative interpretations of the data; 2) when results don't jibe with experience, common sense, and precaution; 3) when no attempt is made by the scientists to rectify others' misuse of their data; 4) when double standards are used in arguments; 5) when there is a rush to conclusions before the data are fully analyzed (as was the case for the LFA EIS) and most importantly, 6) when there is a perceived conflict-of-interest, as when there are close ties between scientist and funder. There are certainly courageous scientists who have spoken out against their powerful funders, the Navy, but they are the exception.

To avoid placing scientists in such difficult positions, to make results more credible, and such studies more useful, it is preferable that noise producers provide funds to an independent agency to sponsor non-aligned research on the effects of noise on marine life. An independent committee which has power and meaningfully represents all major stakeholders including the environmental community, could establish priorities for the research, commission it, and recommend regulations. The above suggestions should help reduce gridlock in the courts, facilitate the study of marine mammals and noise, assist noise producers and regulators in determining sensible regulations, and ultimately, help the most important beneficiaries, the whales.

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FACTORS INFLUENCING VOCAL ACTIVITY IN RESIDENT ORCAS IN BRITISH COLUMBIA

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INTRODUCTION The resident killer whales or orcas (*Orcinus orca)* of British Columbia are a behavioural phenotype feeding predominantly on fish (Ford *et al.*, 1998). They live in extremely stable family groups, so called matrilines, where offspring of both sexes travel with their mothers throughout their lives (Ford *et al*., 2000). The most common vocalizations are highly stereotyped pulsed calls that can be divided into discrete call types (Ford, 1989; Strager, 1995). None of the call types have been attributed exclusively to specific behaviours (Ford, 1991), but acoustic similarities within groups have been shown to reflect common ancestry (Barrett-Lennard, 2000; Yurk *et al*., 2002). Closely related matrilines share most, or all of their call repertoire, but may differ in relative production rate and certain structural variables of shared calls (Miller and Bain 2000). These dialects are believed to serve as signals of group affiliation and for maintaining contact and coordinating activities within groups. Vocal signals function in maintaining group cohesion in a variety of species (birds: Hausberger 1997; primates: Elowson and Snowdon 1994; cetaceans: Sayigh *et al*., 1990; Weilgart and Whitehead 1993; Janik and Slater 1998), and a consensus is emerging that avian and mammalian species living in complex social environments have at least some vocalizations, that are responsive to changes in social environment, such as group composition. In orcas, however, these hypotheses have been mostly untested. In the course of our study we investigated the influence of group size and composition as well as location and travelling direction on the vocal activity of resident orcas.

METHODS Western Johnstone Strait and adjacent waters off northeast Vancouver Island, British Columbia, form the summer core area for the northern resident community of orcas. More than 200 known individuals, belonging to three different acoustic clans, can be found there reliably from July to October and occasionally through the rest of the year. OrcaLab is a permanent research facility on Hanson Island operating a network of remote, radio-transmitting hydrophone stations (Fig. 1), which enable the underwater acoustic environment of the surrounding area to be monitored continuously, 24 hours a day and year-round. Whenever whales are vocal, the mixed output of several radio receivers tuned to the specific frequencies of the remote transmitters is recorded on a two-channel audio cassette recorder (Sony Professional Walkman TCD-M5 or Sony TCD-D3). Supplementing the acoustic information are regular visual sightings of the whales. Whenever whales pass OrcaLab (operated year-round) or one of the other shore-based observation camps (operated from July up to November), they are observed with spotting scopes and identified from natural markings by experienced observers. In addition to the identity of individuals, information about group size and cohesion, movements and behavioural state (travelling, foraging, resting or socializing) is recorded in one-minute intervals.

When travelling to or from Johnstone Strait via Blackney Pass (hereafter called a "passage" später verwendest du passes), whales are visually observed from the main lab as well as acoustically recorded as they pass three hydrophone stations. One listens to the central Blackney Pass area (Fig.1, “C”), the other two to the northern (Fig.1, “N”) and southern portions (Fig.1, “S”) of Blackney Pass and adjacent waters. Due to the relatively small distance between the surrounding islands and usually little boat noise in Blackney Pass, whales can reliably be visually and acoustically detected. We therefore analyzed vocal activity of orcas travelling through Blackney Pass in respect to the number of whales, group composition and cohesion, direction of travel, and time of day for all passages in the year 2000. Cohesion was classified as the whales being spread out (more than one body length between all individuals), whales spread out into subgroups (less than one body length between some, but not all individuals) or whales tightly grouped (less than one body length between all individuals). Vocal activity was scored qualitatively, i.e. whether or not whales called at the three mentioned hydrophone stations. No attention was given to the actual number and type of calls.

Data were analysed using one-way ANOVAs and chi-square tests. All statistical tests were two-tailed.

RESULTS In the year 2000, 148 passages through Blackney Pass were detected. Vocal activity ranged from being totally silent (n=11), over being vocal at one or two of the stations (n=66), to being vocal all the way through (n=71). For the 98 passages in which the whales could be visually identified, the influence of the number of individuals, matrilines, pods (closely related matrilines) and acoustic clans on vocal activity was investigated. Whales were vocal at more stations, the more individuals, matrilines, pods or clans were passing through at the same time (ANOVA, individuals: $F_{(2, 94)} = 7.307$, $p = 0.001$, matrilines: $F_{(2, 95)} = 9.025$, $p < 0.001$, pods: $F_{(2, 95)} = 10.528$, $p < 0.001$, clans: $F_{(2, 95)} = 7.517$, $p = 0.001$). This remained true for all passages with only one clan present, but not when all individuals belonged to the same matriline or pod (Fig.2). Consequently, the number of social units, pods in particular, rather than the mere number of individuals, influenced vocal activity. We could not detect significant correlations between vocal activity and cohesion among whales ($\varphi^2 = 5.2$, df = 4, p = 0.257).

The travelling direction could be determined for 147 out of all 148 passages. Whales swam south through Blackney Pass 66 times, north 72 times, and turned around while in Blackney Pass 9 times (2 turns to the north, 7 turns to the south). Direction of travel significantly influenced where whales called ($\varphi^2 = 25.1$, df = 12, $p < 0.031$). In particular, orcas that were initially silent and began to vocalize, were more likely travelling south (Tab.1). In all 9 cases where whales turned around while in Blackney Pass, they were consistently vocal. No significant correlations between vocal activity and time of day were found ($\varphi^2 = 4.051$, df = 10, p = 0.945).

DISCUSSION Our results show that resident matrilines travelling in the company of other residents were vocal on more locations than when travelling alone. Increased vocal activity may be of particular importance in a location like Blackney Pass, where the surrounding islands constrain the distribution of calls more than in the connecting Johnstone Strait. Even a few calls, emitted in more or less regular intervals, would allow detection and possibly location and identification of the sender. We found that the spacing of calls (where the whales vocalized) was influenced by the social environment of whales travelling through Blackney Pass: the whales were more continuously vocal when a higher number of social units, pods in particular, was passing through together. Our present data do not provide information about whether or not the actual number of calls increased too, but Ford (1989) described an increase in the number of calls per minute when two groups of orcas, that had been travelling separately, encountered each other. In our study the groups had always met prior to travelling through Blackney Pass together. Whether or not this too led to an increase of calling and/or a change in the call types being used, is still being investigated and will be presented elsewhere.

Blackney Pass is one of the main waterways used by the Northern Residents to reach Johnstone Strait. Swimming south through Blackney Pass therefore often signified travelling into the summer core area and vice versa. In almost one quarter of all passages south, the whales were silent when entering and passing through Blackney Pass but became vocal upon entering Johnstone Strait, where calls can spread widely and allow the newly arrived groups to be heard by or hear other whales in the area. In addition, whales changing direction were vocal in all observed cases, which suggests that the calls of resident orcas indeed play a role in group co-ordination, as well as in advertisement of their presence in key locations.

CONCLUSIONS Vocal activity in resident orcas depends on the number of social units travelling together as well as on travel directions. Whales usually became vocal at a location where calls could spread widely and allowed other whales in the area to hear the newly arrived groups. The results indicate that calls not only function in intra-group communication, but also in social communication between groups.

ACKNOWLEDGEMENTS This study was made possible by the contribution of recordings by OrcaLab. Paul Spong, Anna Spong and Helena Symonds provided valuable support throughout the study. The study was funded by a DOC-stipendium of the Austrian Academy of Science.

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Table 1. Vocal activity and travelling direction in Blackney Pass. Vocal activity is given as whales silent (0) or vocal (1) in the order of hydrophone stations passed by the whales (0 0 0: whales silent on all three stations, 0 0 1: whales silent on the first two stations and vocal on the third, etc ...). N = 72 (north) and 66 (south)

	travelling direction	
Vocal activity	North (%)	South (%)
0 0 0	8.33	7.58
0 0 1	6.94	22.73
0 1 1	12.50	9.09
1 1 1	51.39	42.42
1 0 1	9.72	10.61
1 0 0	6.94	3.03
other	4.17	4.55

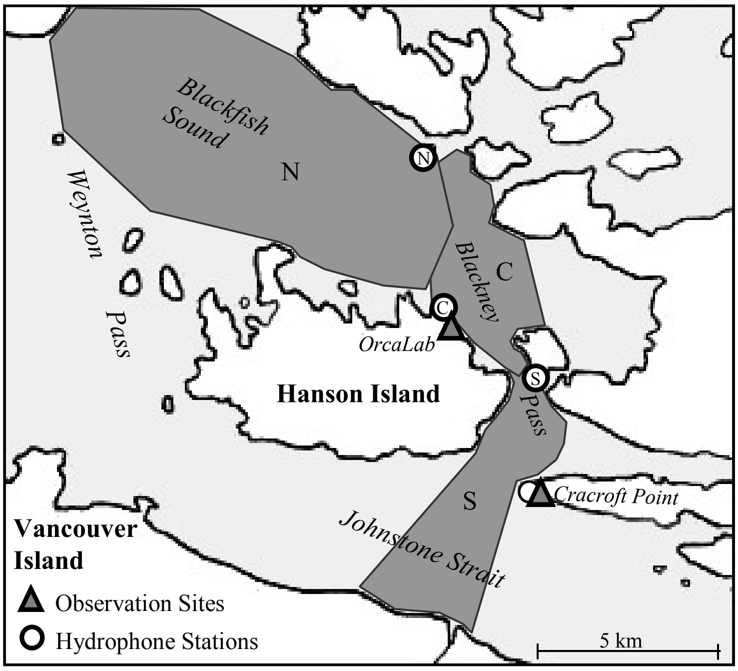

Fig. 1. Northern Residents summer core area showing hydrophone stations and their approximate ranges as well as observation sites in Blackney Pass and adjacent waters

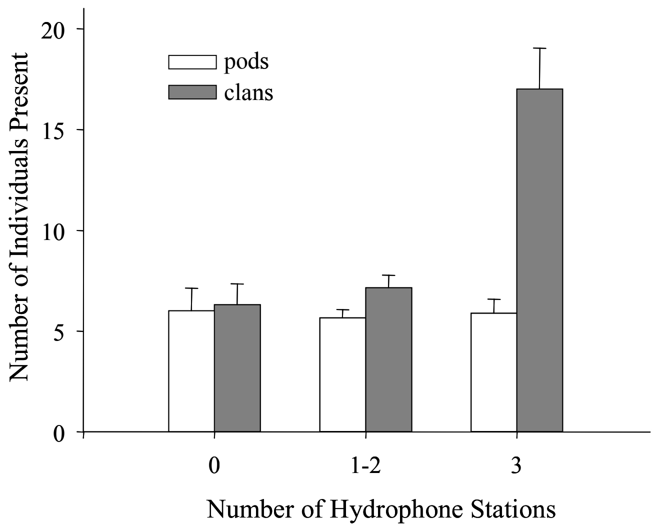

Fig. 2. Number of hydrophone stations where calls were recorded in relation to the number (mean ± SE) of individuals present, when all whales belonged to the same pod or clan

POTENTIAL IMPACT OF UNDERWATER NOISE ON SMALL CETACEANS WITHIN THE DURLSTON MARINE RESEARCH AREA

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INTRODUCTION In 1988, a systematic survey was initiated to record the presence of cetaceans, primarily bottlenose dolphins, off the coast of Dorset in southern England. A team of dedicated local volunteers formed a "Dolphin Watch" that recorded cetacean sightings and behavioural patterns. The project has since developed to include collection of data on shipping intensity and photo-identification of individual dolphins, together with the recording and identification of noise sources within the Durlston Marine Research Area (Owens *et al.*, 2001). The two main species under consideration are bottlenose dolphin (*Tursiops truncatus*) and harbour porpoise (*Phocoena phocoena*), both identified as priority species requiring protection in the UK Biodiversity Action Plans. Other occasional visitors to the area are common dolphin, striped dolphin, long-finned pilot whale and minke whale.

The pattern of shipping activity recorded shows a major influx of recreational boating over the summer months as compared with a low background of activity from commercial traffic, including the local commercial fishing and angling industry, all year through. The present study intends to test any correlation between cetacean activity and anthropogenic noise generated by shipping. As part of this work we have measured the underwater noise signature of a number of typical craft to be found in the area. This paper considers the potential impacts of this underwater noise on cetaceans in the Durlston Marine Research Area (MRA).

METHODS A hydrophone was deployed in 7m of water in Durlston Bay, Dorset, on the south coast of the UK. The hydrophone was marked by a buoy and the boats instructed to pass as close as possible to the buoy. Visual observation during the tests showed that all passes used for analysis were within 3m of the buoy. Each test craft was asked to make at least two passes at each speed and to pass at two or three speeds. In each case the speed over ground was measured using an onboard GPS receiver.

The hydrophone signal was amplified by a preamplifier and line driver which then fed the signals ashore via 300m of cable. The signals were recorded on a Sony DTC-690 DAT recorder and the data were analysed using the SpectraLab software package. The spectra were averaged through CPA and then averaged across multiple passes. The levels were corrected for hydrophone/preamplifier calibration, bandwidth and slant range to give the source levels shown in the figures below.

The spectra were formed using an FFT of 1024 samples with Hanning weighting and a sample rate of 44.1KHz. On each pass 100 spectra were averaged. The data collection system has a high-pass filter rolling off at 50Hz. The acoustic signals below this are attenuated at 12 dB/octave. The dominant components of ambient noise are distant shipping, biologics and distant wave noise. The peak at 3.5KHz is due to a snapping noise of biological origin.

RESULTS The spectrograms (Figures 5 - 7) give a visual impression of the extent of the noise field around the craft. The threshold has been set to be just above the level of ambient noise so the noise increase due to the craft can be seen. The FFT used 16384 samples with Hanning weighting at a sample rate of 22.05KHz and a decimation ratio of 8.

The dark lines running through the spectrograms are nulls caused by Lloyd's mirror effects. Multipath interference causes cancellation of energy at some frequencies.

The ambient noise levels are shown for reference in Figures 1 - 3. These correspond to sea state 2, wind Beaufort 3. Both the source levels and the ambient noise are levels in a 1Hz bandwidth.

DISCUSSION This current set of measurements has only been possible for three craft: two RIBs and one motorboat. However, it is believed that these are representative of a significant proportion of the craft using the MRA.

From the results in Figures 1-3, it can be seen that the two RIBs show evidence of machinery lines at low frequencies. The motorboat has much less evidence of machinery lines except at very low speeds when an extremely strong machinery line is evident. At higher frequencies the dominant noise sources are cavitation noise from the propellers and water disturbance noise.

The spectrograms show clear asymmetry in the noise field around the boats. This is caused by asymmetry in the shape of the boat and by sound masking by the bubbles in the wake. In addition, there is asymmetry in the propagation paths around the hydrophone. To the west of the hydrophone the seabed is a series of rocky ledges while to the east the seabed is sandy and the water depth increases. By comparing two passes E - W then W - E we found that the asymmetry due to the acoustic path was small compared with the other effects.

The audiograms for the bottlenose dolphin and the harbour porpoise are shown in figure 4. The maximum sensitivity is around 44dB re 1uPa at frequencies around 20KHz and then falling to around 110dB re 1uPa at 200Hz. The level of noise perceived by the animals will be determined by the bandwidth of the receptor mechanism, in this case the cochlea. The cochlea is a dispersive sensor with different parts of the basilar membrane responding to different parts of the spectra. In determining the effect of broadband noise we need to understand the bandwidth of each part of the sensor. Au and Moore (1990) suggest this corresponds to a Q of 2.2. At 15KHz this will correspond to a bandwidth of 6KHz. The RIBs, which have a source level of around 95dB re 1uPa @ 1m in a 1Hz BW at high speed will therefore have an effective source level of 133dB re 1uPa @ 1m. In the same bandwidth, ambient noise will have a level of 98dB re 1uPa. The RIBs will therefore be audible to the animals at a range of $20 \text{ LOG}(R) + \alpha R = 133 - 98$ dB. This corresponds to a range of approximately 80m.

For the launch with a source level of 110 + 38 = 148dB re 1uPa @ 1m this range increases to around 300m. However, these ranges assume free-space propagation. In the very shallow water of the MRA there is strong interaction with a very variable seabed and the sea surface. This will significantly reduce these ranges.

At low frequencies the hearing sensitivity of the animals rolls off more quickly than the anthropogenic sounds and below 1KHz the range of audibility will be determined by the hearing threshold rather than the ambient noise level.

At 1KHz, the critical bandwidth will be 400Hz so the noise from the launch in this bandwidth will be around 150dB re 1uPa @1m compared with the hearing threshold at 90B re 1uPa. This gives a free-space audibility range of 1Km compared with around 500m for the RIBs.

From the above it can be seen that an individual craft can be heard to an appreciable distance by the animals. During the summer there are sufficient numbers of craft in the MRA for the sound fields to overlap, causing the ambient noise levels to rise to levels that impair communication between animals and their echolocation performance. It is also interesting to note that a RIB travelling at 30knots will go from being audible to passing the animal in just 29 seconds. Can the animal form a solution to the trajectory of the boat and formulate an evasive manoeuvre in this time?

Future work The quality of this data is much higher than that previously reported (Owens *et al*, 2001) due to the tighter control on the craft being measured. It is now planned to extend the data set to include representative craft of all types using the MRA. It is also hoped to explore the effect of propagation through the very shallow water of the MRA and how this modifies the sound of the craft. It would also be beneficial to extend the frequency range to echolocation frequencies.

This information will then be used along with the statistics from the boat watch to estimate the total contribution by shipping to the noise levels in the MRA.

ACKNOWLEDGEMENTS We would like to thank all connected with the Durlston Marine Project, the Durlston Dolphin Watch team, English Nature for their support of the Dorset Marine Mammal Research Programme, Dorset Marine Police and the crew of the Swanage Inshore Lifeboat, and the Durlston Marine Project partners (Dorset Coast Forum, Dorset County Council, English Nature, Friends of Durlston, Wessex Water and WWF).

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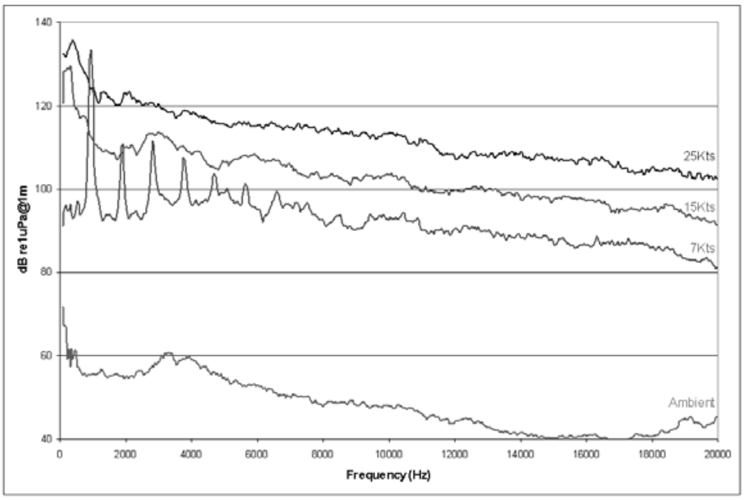

Fig. 1. Acoustic characteristics of Police launch

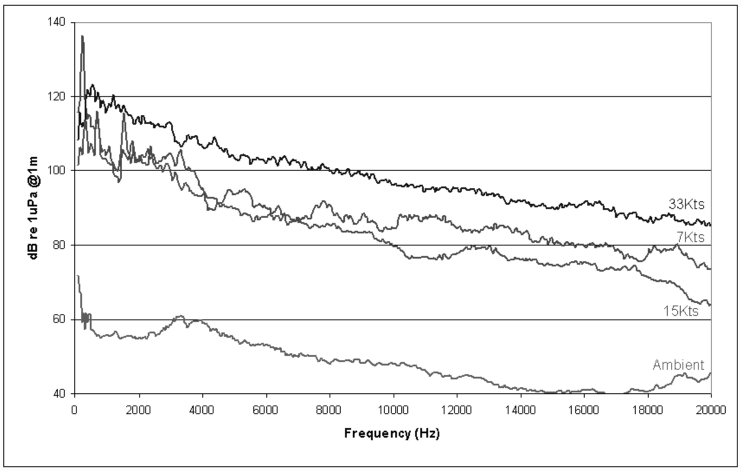

Fig. 2. Acoustic characteristics of Police RIB

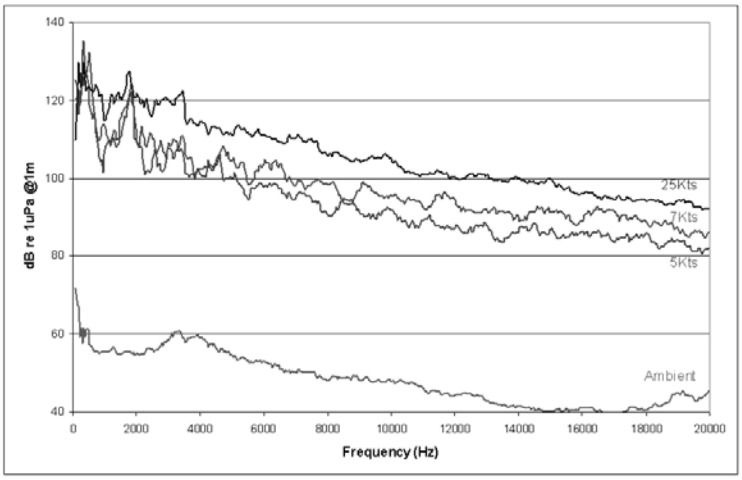

Fig. 3. Acoustic characteristics of Inshore lifeboat

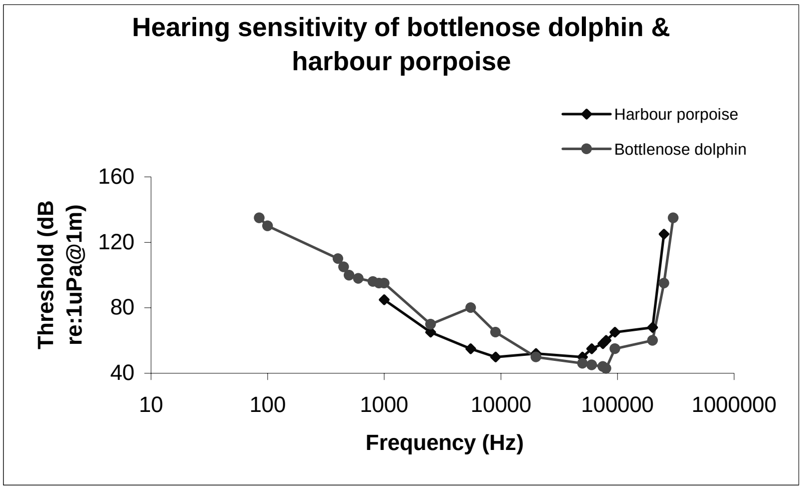

Fig. 4. Audiograms of bottlenose dolphin and harbour porpoise (Richardson *et al.*, 1995)

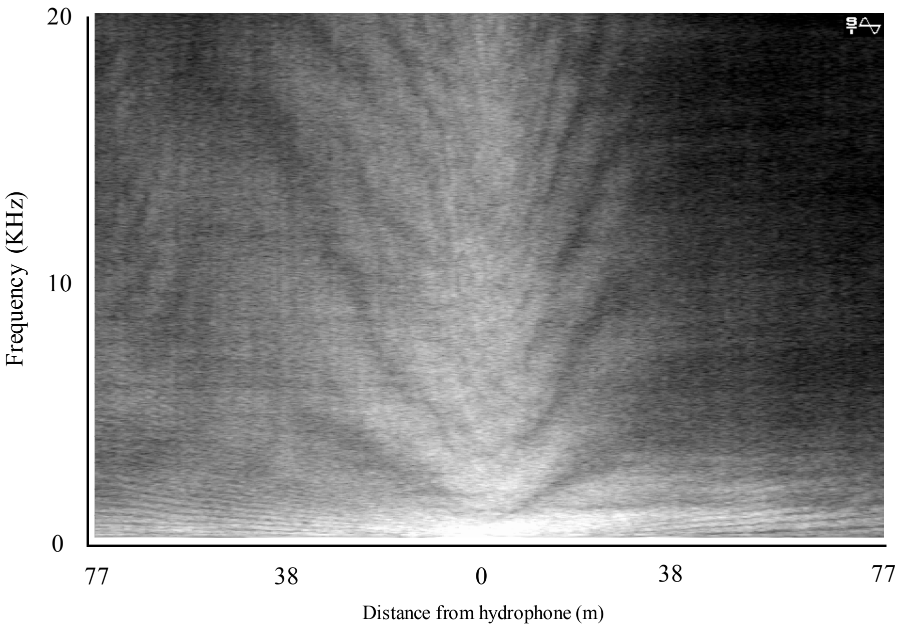

Fig. 5. Noise spectrogram for Police launch

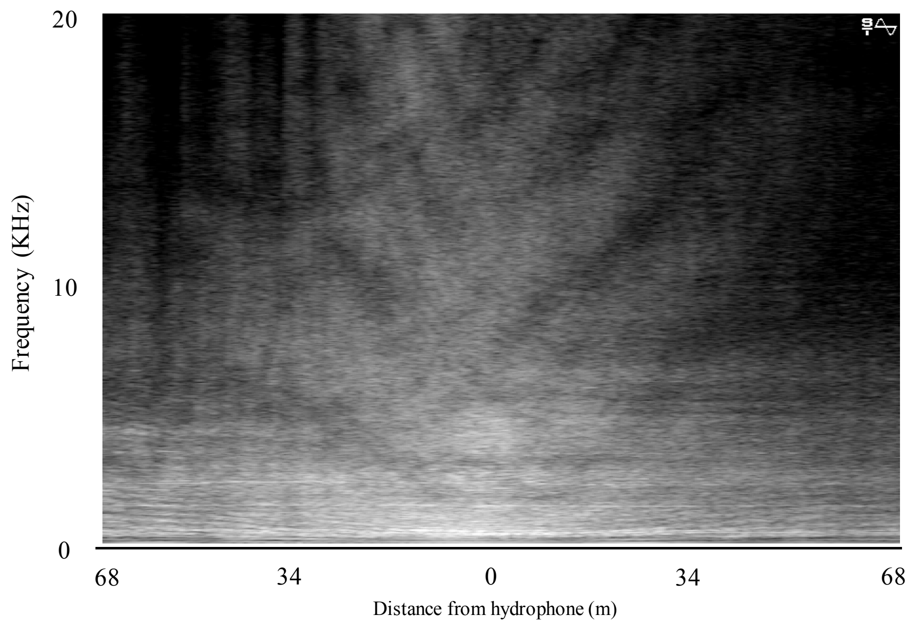

Fig. 6. Noise spectrogram for Police RIB

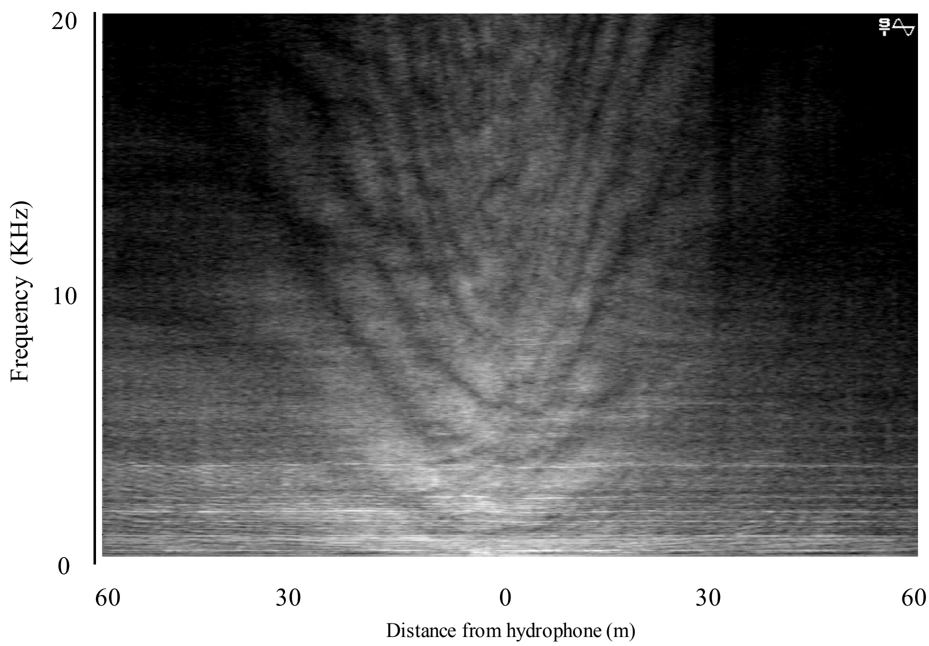

Fig. 7. Noise spectrogram for Inshore lifeboat

BUILDING BRIDGES: A COGNITIVE SCIENCE APPROACH TO A HUMAN-DOLPHIN DIALOGUE PROTOCOL

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Suppose for a while, that we were able to communicate with animals to a further extent than what is possible today. Wouldn't that be of great interest to a number of people, as well as to many scientific disciplines? Let's further suppose, that perhaps there had been technical barriers preventing us from extending the nature of such communication, apart from the more obvious cognitive barriers. If language technology could help bridging the human-animal communication gap, we could more readily explore the true limits of such issues as level of abstractions. We know the concept of 'Frisbee', despite being alien to animal's natural environment, is well within reach for many – while 'democracy' definitely is not. But how abstract can we get? We know dolphins have been able to grasp some aspects of syntax – how far can we take this?

This paper is based on the assertion that our efforts at human-animal communication is in fact hindered by technical challenges, and that these have prevented us from exploring the cognitive challenges in full. I will introduce a new piece of software called GAPR, developed for the purpose of bridging some of the technical gaps in our communication with animals. The tremendous advances in computer power and new algorithms for processing data are today making it possible to create software that was not possible even few years ago.

GAPR is a tool for reducing the distance between communicative agents of different domains (e.g. humans and dolphins), using language technology and neural networks as a bridge. In arguing for which elements to incorporate in such a tool, some fundamental linguistic and cognitive aspects of language and communication are discussed first.

Processors, protocols, and interfaces The first question that arises is: How different are the internal conceptual structures of humans and other animals? Sorting out sensory input and classifying it, is one of the basic jobs of all brains. For a rabbit to distinguish between a carrot and a fox, knowing when to forage and when to flee, classification and a conceptual structure must be made. Although previously believed to be uniquely human, a wide variety of recent studies indicate that nonhuman mammals and birds have rich conceptual representations (Hauser *et al*., 2002). In addition to this nonverbal classification, human beings utilize an innovation known as symbolic reference in order to communicate internal objects, events, and emotions to each other. This is the fundamental abstraction on which human linguistic communication is built. The general function of symbolic reference – as implied by the name – is to refer to a concept by the use of a symbol. The choice of symbol is arbitrary (i.e. there is no inherent relation between symbol and concept), as long as both communicative parties are able to produce and perceive the symbols of exchange. Information is not embedded in the symbol (signal) by itself, but in the symbol together with an agreement on how to interpret the symbol. This agreement is called *a protocol*. Can nonhuman animals handle this? For any creature to attempt this type of communication, we see at least three interdependent requirements.

1) *A processing unit*: A brain that is able to do the internal workings of, for example, exchanging symbols for concepts.

2) *An interface*: A compatible input output system that is capable of producing and perceiving the symbols of exchange.

3) *Access to a protocol*: The agreement, on what the symbol, or combination of symbols should represent, allowing the exchange of symbols to be correctly interpreted.

Bottlenose dolphins (*tursiops truncatus*) seem to be good candidates for an empirical test for several reasons.

Processing unit The bottlenose dolphin's brain shows many characteristics generally associated with intelligence: It has a large size, a high surface area/fold density/fissuration, high neural density, and a high ratio of cerebral cortex to motor cortex. Bottlenose dolphins have excellent short and long-term memory. They live in complex social groups, they vocalize a lot and mimic well. All indications of a brain well suited for communication.

Investigations such as those done in the Kewalo Basin Marin Laboratory (Herman *et al*., 1984) have given us indications as to the bottlenose dolphin's abilities to understand both symbolic reference and aspects of syntax.

Artificial languages introduced to dolphins included words representing agents, objects, object modifiers, actions, and conjugations that were re-combinable, using sentences from two to five words in length. The word order was shown to be understood by testing the dolphins with semantically reversible sentences. The dolphins also responded correctly the first time they were exposed to new sentences on the basis of previous understanding of the words, and their relationships in a command structure. One dolphin that was taught a sign language did also respond correctly to commands given to her on a TV monitor viewed through an underwater window already first time with no previous experience of TV.

Interface Dolphins have excellent hearing, and voluntary motor-control of their sound productive organs (Deacon, 1998). The sounds dolphins make are however incompatible with human input/output devices and vice versa. Two-way communication was made impossible in the experiments in Kewalo Basin by the choice of symbols used for giving linguistic cues. (It was not a target in that investigation either) The choice of symbols is not arbitrary in relation to our perceptive and productive capabilities. The anatomy of the dolphin makes it impossible to use sign language or human speech as an interface. This is a problem GAPR aims to solve, by exchanging symbols via a transfer to the respective perceptive domains.

Protocol Human linguistic communication protocols are built up around a set of atomic units (phonemes) here referred to as Symbolic Message Units (SMUs). With some variations between languages, humans use about 50 SMUs in linguistic exchange. Sequences of SMUs combine into larger units (normally referred to as words), here called symbols, which are the units that are linked to concepts. Finally, these symbols combine in a structured way, according to a protocol, into phrases and sentences.

We may use the same communications scheme with other animals and create an intermediate protocol and a device that bridges the interface barrier. In order to use this communications scheme, an agent needs at least to be able to grasp the concepts of symbolic reference and syntax, and needs to have voluntary motor control of their sound production. Bottlenose dolphins meet these requirements, as I have argued.

The general audio-pattern recognizer- GAPR The general Audio-Pattern Recognizer – GAPR (pronounced 'gapper') is a piece of software that addresses the interface barrier, and handles a protocol (Wik, 2002). In general, GAPR is a tool for classifying and translating arbitrary audio-patterns into symbolic representations, and for linking combinations of these symbols to words.

GAPR can be used both for setting up a language structure, and to translate between two agents of different domains, for audio communication or for interactive games. GAPR uses sounds from the agent's domain as SMUs and a Learning Vector Quantization (LVQ) neural network to recognize and classify these sounds. Symbolic message units are being used as a kind of 'Interlingua' i.e. a neutral intermediate representation of a word, that can be turned into dolphin friendly, human friendly, or animal-x friendly sounds. Unique sequences of these SMUs are then linked to words according to a protocol.

The steps involved in setting up a structure in order to use GAPR for two-way communication are:

1) Record the audio-patterns you wish the classifier to recognize as symbolic message units.

2) Assign a label to each recording. The label serves as a peg for the classifier, and is as arbitrary as the relationship between a sound and its reference (meaning) in a word. I.e., we could have given the audio pattern any label, (for example 'SMU1', 'SMU2'...)

3) Decide on which kind of feature extraction to use. Most pattern recognition tasks are preceded by a preprocessing transformation that extracts invariant features from the raw data. For acoustic signals, this might be some spectral components. Since the salient features in a signal are not given, GAPR offers the possibility to experiment with different settings and filters on the feature extraction.

4) Train the LVQ classifier on the recorded and labeled SMUs.

5) Add words you wish to have in the language, and give each word a unique combination of SMUs as a 'word' in the target language. GAPR offers the possibility to load an existing dictionary, and to add or to edit words. It is also possible to select a series of words into a sentence, and have it played back in the target language. Playback in the artificial language is done by a concatenation of the collected SMU samples. The SMUs are loaded into RAM and joined together in any combination. This technique is used extensively in applications of a restricted domain (e.g. an automatic telephone operator that tells you a phone number).

Pulses (bursts) produced by bottlenose dolphins have some characteristics that would make them suitable as SMUs in a dolphin version. They are clearly separated in the time domain, and experiments have shown that they are possible to classify with the LVQ neural network (Wik, 2002). The distinctness of the pulses makes it possible to classify them, even at a relatively low sample rate (44.1 kHz), something advantageous for computational reasons. Since we don't know the protocol, it is not an attempt to capture the information content that a dolphin is putting into the signal, but to find a set of distinguishable SMUs from their productive domain that we are able to classify. The task of classifying dolphin vocalizations differs from regular speech recognition. Standard classifiers popular in speech recognition, such as Back-propagation neural networks, and Hidden Markov Models need a large amount of samples of each category in order to work well. This makes standard speech recognition approaches useless, since we have no way of collecting many samples to train the network. An alternative classification technique has been found, using an LVQ classifier, which overcomes this problem.

Running/classification mode When GAPR is used in real-time two-way communication mode, it is using a Signal-detection module. Recording starts when the audio signal reaches a certain threshold, and continues until there has been silence for a certain time. The captured signal is passed in a pipeline to the feature extraction, and further to the classifier. What happens with the output of the classifier depends on the settings in the Socket-Tab.

Several instances of GAPR can be linked up with each other, in a server-client relationship, using the Tcp/Ip protocol. The Socket-Tab lets you decide which role each particular instance of GAPR should play internally. An instance switched to Human-mode will act a little different from other modes, giving the user access to a keyboard for input, (or automatic speech recognition (ASR) in a future version), and a dictionary with English translations of the protocol for ease of operations. Each instance of GAPR will receive and send out symbolic SMUs, without concern for who is in the other end. It would for example be possible to have one instance of GAPR loaded with a project suitable for pigs, and another for dolphins. The pig instance would work exactly in the same manner as described above, but would have recordings of pig sounds, and a codebook trained for those sounds instead. Whether other animals are capable of grasping the concepts necessary for this kind of communication, is not a concern with GAPR. It is simply removing some technical barriers.

GAPR can also be used in game mode. Interactive games can be created to teach different aspects of the language. Macromedia's Flash and Director are programs that have been used extensively to create interactive games and educational content. With Flash 5 it is possible to send and receive data as Xml. This enables GAPR to work in a server-client modus, as a 'plug-in' for Flash, so that events can be speech-controlled by the dolphins. GAPR provides structure, not content, and further work on creating appropriate content is required.

CONCLUSIONS Recent technological advances allow us to address certain communication issues in a new manner. The General Audio Pattern Recognizer (GAPR) is presented as a way to bridge the interface barrier between dolphin and human vocalization. By allowing dolphins to use sounds from their own domain, two-way communication by previously incompatible communicative agents may be possible.

We really don't know where the cognitive limits are. With some of the technical challenges possibly bridged by GAPR there should be a vast territory on the other side of the bridge to explore.

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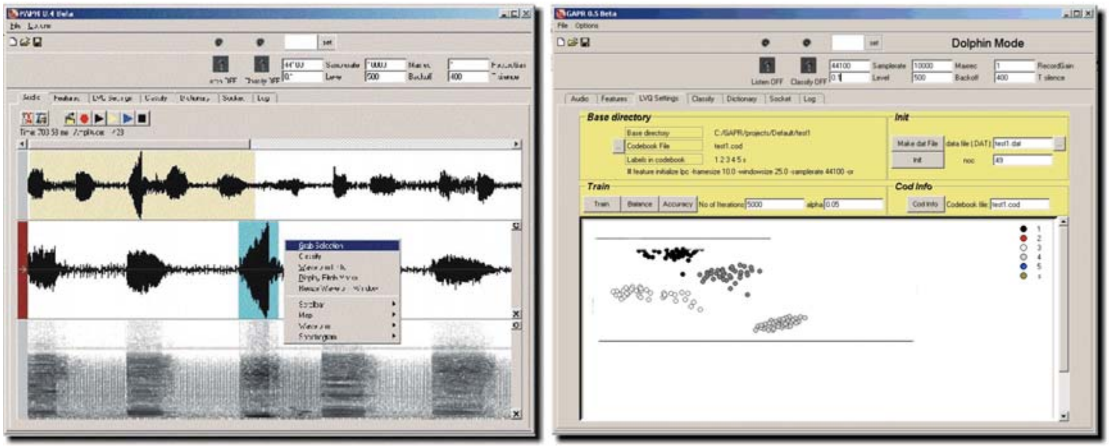

Fig. 1. Screenshots from GAPR: The Audio-Tab used for recording and labeling (left) and the LVQ-Tab used for training the LVQ neural network classifier (right)

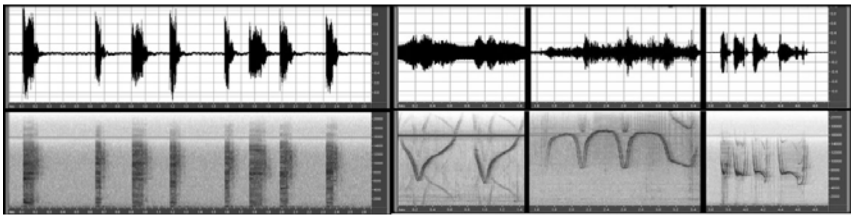

Fig. 2. Pulses (left) and whistles (right) are examples of dolphin vocalizations that could be used as SMUs

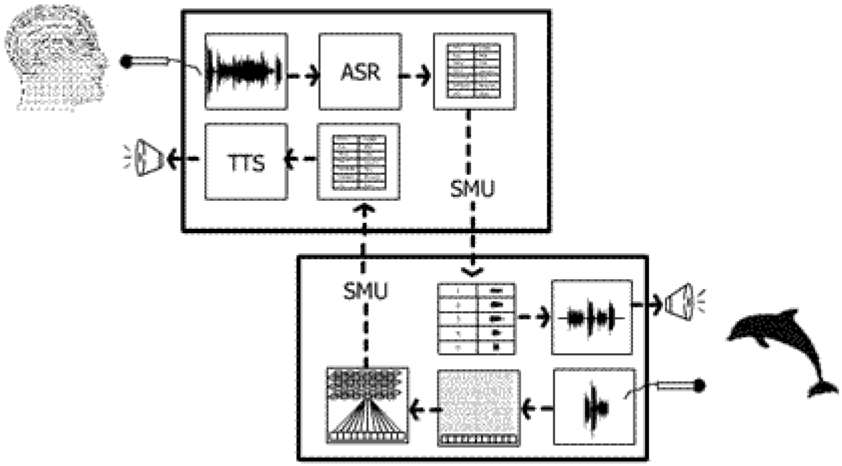

Fig. 3. sketch of how data flows in human-dolphin communication setup.
TTS= Text to Speech ARS=Automatic Speech Recognition

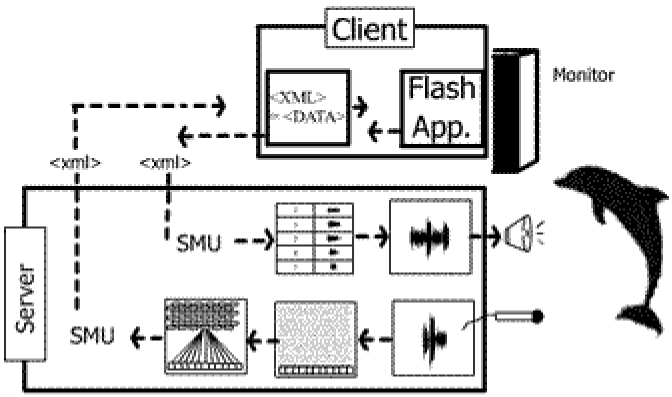

Fig. 4. Sketch of how data flows in computer-dolphin setup

ACOUSTIC SIGNALS OF GROUP-FEEDING RORQUAL WHALES IN THE NORTHWEST ATLANTIC

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The objectives of this study are 1) to establish the seasonal vocal repertoire of minke, finback and blue whales in the gulf of St. Lawrence, an important feeding area for baleen whales of the Northwest Atlantic and 2) to identify sound patterns that are exclusively associated with group-feeding. Sounds produced by rorqual whales as well as their behavioural patterns were recorded during the summer feeding season 1997-2002 in the estuary and the gulf of Saint-Lawrence (Canada). A calibrated omnidirectional hydrophone with a built-in preamplifier and a Sony DAT recorder with a linear system frequency response from 18Hz-22 kHz were deployed from a rigid-hulled inflatable boat, covering a total area of 8000 km2 in three distinct coastal habitats. Behavioural data sampling was conducted simultaneously with the sound recordings by doing focal animal or focal group sampling, using a microcorder and applying a standardized ethogram. In all three species, we identified at least one distinct low-frequency sound pattern that was typically associated with one particular behavioural context, i.e. cooperative feeding in groups. However, the sound patterns varied considerably between the three species as indicated by the respective spectrograms. Repetitive sequences of pulsed sounds with regular inter-pulse intervals, also referred to as thump or pulse trains, were recorded in the presence of group-feeding minke whales, while a particular type of downsweeps (80-30 Hz) was recorded in the proximity of group-feeding finback whales. On a very rare occasion in the vicinity of six feeding blue whales, a distinct downsweep (170-60 Hz) followed by a broad-band rumble (20-180 Hz, 4 sec.), both with extremely high source leves, were recorded. In conclusion, our data support the hypothesis that certain sound patterns are exclusively associated with cooperative group-feeding in all three species of rorqual whales.

BEHAVIOUR

DOLPHINS AND AUTISTIC CHILDREN ENCOUNTERS: THE ANIMAL POINT OF VIEW

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INTRODUCTION Among the animal assisted therapies, the encounter between patients who suffer from communicative disorders such as autism, and dolphins represents an innovative approach if compared with the more consolidated therapies with dogs or horses. While several studies have tried to point out the effects of these interactions on human beings (Smith, 1983; Nathanson *et al.*, 1993; Nathanson *et al.,* 1997) research on the animals' side is at the moment completely lacking. This study aims to investigate the behaviour of a *Tursiops truncatus* community during autistic children encounters at the Rimini Delphinarium.

MATERIALS AND METHODS Subject of the study was a community of bottlenose dolphins (*Tursiops truncatus*) – two adults and three juveniles - housed in the Rimini Delphinarium (Table 1). A specific ethogram, including 35 behavioural elements organized into 3 main classes ("Neutral", "Approach" and "Avoid"), was first set up and then used during the observations (Table 2). In June and September 2001 individual-follow (continuous sampling) observations (Mann, 1999) were daily carried out from 08.00 a.m. to 10.00 a.m. during six 20 minutes periods corresponding to as many consecutive children swim sessions. A total number of 120 hours (24 h/animal) of sampling was performed. Frequency and duration values were scored by means of a videocamera and analysed by Observer 3.0 (Noldus, 1997) software and $\chi 2$ Test.

RESULTS Swim participants (animal or children) determined the occurrence, kind and duration of the interactions, since no control of the dolphins' movements was performed by the trainers.

"NEUTRAL" behaviours (frequency 75%, duration 93%), especially "Locomotory and Postural" displays, were the predominant activities seen, revealing that solitary patterns with no relationship neither with humans nor with conspecifics were the dolphins' most usually exhibited activities in assisted therapy sessions (Fig. 1). This result is consistent with Samuels and Spradlin (1995) who studied bottlenose dolphins during swim programs for tourists.

"APPROACH" patterns (frequency 24%, duration 5%) showed gradually decreasing values from "Investigation" "Interest" and subsequently to "Light Contact" behaviours (Fig. 2). In fact, the animals were more frequently seen to be involved in activities as standing in front of or inspecting the human beings. However, as the interaction with children became more intense - e.g. including opening the rostrum, shaking flippers or physical contacts – the frequencies reduced their number.

As for "AVOID" class, fast swim and flipper/tail slap towards the water surface were the only potentially risky displays seen while no evidence of dangerous actions - as hit or strongly pull - for animals or humans was observed.

A significant relationship between interaction and age class was observed with the youngest and still immature individuals showing the highest values of approaches both in frequency (adult=84; young=440) (Fig. 3) and duration (adult=17.0 min.; young=90.5 min.). According to Constantine (2001), the playful bent of the juveniles' interactive displays - e.g. brief repeated contacts with the childrens foot and light ceaselessly seizing by the rostrum at the children wet suit's hood - was clearly evident.

Every day six autistic children, one by one and following a random order, swam in the pool with dolphins for a 20 minutes period each. An evident dolphins' decreasing interest in humans appeared after the first three periods, corresponding to an hour from the beginning of the swimming sessions (Fig. 4). According to Orams *et al.* (1996) and Constantine (2001) and as observed in other mammals (e.g. *Pongo pygmaeus, Pan paniscus*), bottlenose dolphin revealed a clear tendency to habituation to a stimulus' presence by a gradual diminishing of behavioural responses.

CONCLUSIONS Although the investigation here presented is far to be conclusive, some of these findings will help in better understanding the animals' point of view during dolphins/autistic children encounters.

ACKNOWLEDGMENTS We thank Rimini's Delphinarium owners and trainers for the logistic support, the SITACA's Operators for all their work and, above all, the young autistic children involved in the study.

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Table 1. Subjects and social contest in the Rimini Delphinarium

RIMINI DELPHINARIUM			
BEHAVIOUR	SEX	BIRTH DATE	PROVENIENCE
ALFA	F	1979	Gulf of Mexico
SPEEDY	M	1970	Adriatic Sea
SOLE	M	03 May 1993	Born in captivity (Alfa x Speedy)
LUNA	F	12 May 1995	Born in captivity (Alfa x Speedy)
BLUE	F	26 June 1997	Born in captivity (Beta x Speedy)

Table 2. Ethogram

		BEHAVIOUR	DESCRIPTION and REFERENCE
NEUTRAL	LOCOMOTORY and POSTURAL BEHAVIOURS	Circle swim	Swimming clockwise or counterclockwise (Sobel *et al.*, 1994)
		Random swim	Random swimming (Sobel *et al.*, 1994)
		Glide	Moving forward without swim strokes for at least 5 seconds [Anonymous at Monkey Mia (Australia), 1990]
		Stand	The dolphin lays inactive in the water (Denkinger and von Fersen, 1996)
		Exploratory behaviour	Scanning horizontal/perpendicular to the bottom (Herzing, 1996)
		Pool rub	Dolphin is rubbing side/ventral, back area on bottom (Herzing, 1996)
		Leap	Entire body clears the water, exit and enter head first (Shane, 1990). Dolphin lifts itself out the water on an angle so that only the caudal peduncle and the tail remain underwater and then falls back into the water (Pilleri, 1986)
	SOCIAL BEHAVIOUR	Contact	Any behaviour which involved physical contact between two animals (Nelson and Lien, 1994)
		Chase	One dolphin, or group of dolphins chasing each other in fast, medium, or slow chase (Herzing, 1996)
		Push	Pushing with the beack, the side or ventral part another animal (Pilleri, 1986)
		Hit	A dolphin strikes another violently with its rostrum/tail/body [Anonymous at Monkey Mia (Australia), 1990]
		Sexual behaviour	The animals used their penis to touch every part of each others body even to extend them into the blowhole or rarely into the anus; passive animal was swimming in normal posture on the surface underneath in belly-up (Renjun, 1994)
		Suckling	When the calf inserts its lower jaw into the mother's urogenital groove and the upper jaw is in contact with the lateral skin of the mammary gland, it suffers its neck as if bracing , with a cessation of tail flexing (Peddemors *et al.*, 1992)
	PLAY	Play with objects	Play with a number of different toys, plastic balls, rings, rubber tubes, brushes rugby balls, carried in the mouth of underneath a flipper, balanced on the rostrum or thrown above the surface of the water (Renjun, 1994)
	BUBBLES	Bubble	Producing bubbles from the blowhole (von Streit and von Fersen, 1996)
		Bubble interest	The animals show interest for the bubble movements and follow it up to the water surface (Pace, 2000)
APPROACH	INVESTIGATION	Swim around the stimulus	Circling slowly stationary objects (Lockyer and Morris, 1986)
		Stand by in front of the stimulus	Remain motionless [in front of the object] (Pilleri *et al.*, 1990)
		Inspection of the stimulus	The object was inspected from a distance of 50 cm, then from 30 cm and lastly from only 2-3 cm away (close inspection) (Pilleri *et al.*, 1990)
	INTEREST	Open jaws in front of the stimulus	The dolphins open jaws in front of the object (Lockyer and Morris, 1986)
		Bubble in front of the stimulus	Producing bubbles from the blowhole (von Streit and von Fersen, 1996)
		Shaking flipper/head in front of the stimulus	Shaking the flippers (von Streit and von Fersen, 1996). Dolphin moves head vertically/horizontally usually in rapid motion (Herzing, 1996)
		Slapping the water close to the stimulus	Swimming towards the stimulus, diving under and swerving and slapping the water with the flukes close to the model (Caldwell and Caldwell, 1964)
		Bring objects to the stimulus	The dolphin brings objects to the stimulus
		Squeeze in front of the stimulus	Swim in between two or more animals, pushing them apart [Anonymous at Monkey Mia (Australia), 1990]
	LIGHT CONTACT	Contacts with the stimulus	The dolphin contact the object (Pilleri *et al.*, 1990)
		Push the stimulus	Push the object using the beak (Pilleri *et al.*, 1990)
		Seize by the rostrum the stimulus	The dolphin takes the object cautiously between its slightly open jaws and bite it (Pilleri *et al.*, 1990)
AVOID	STRONG CONTACT	Hit the stimulus	Spear the object with the tip of the beak [or other parts of the body] (Pilleri *et al.*, 1990)
		Pull up the stimulus	The dolphin strongly pulls up the stimulus
	AVOIDANCE	Fast swim/extreme agitation	The dolphin would first freeze and then gradually begin swimming faster and faster in small circles (Pilleri *et al.*, 1990)
		Avoiding	The dolphin avoids the object and remains for a long time in the back part of the tank (Pilleri *et al.*, 1990)
		Passing in front of the stimulus	Mother passes calf very closely, thus carrying it in her wake to her side (von Streit and von Fersen, 1996)
		Jaw clap	An animal claps his jaws together forcefully to produce a sharp loud sound, as form of intimidation or displeasure (Tavolga and Essapian, 1957)
		Flipper or tail slap	Pectoral flipper slapping the surface. [...] Flukes raised above the surface and ventral/dorsal side slapped downward, usually making a loud, percussive sound (Shane, 1990)

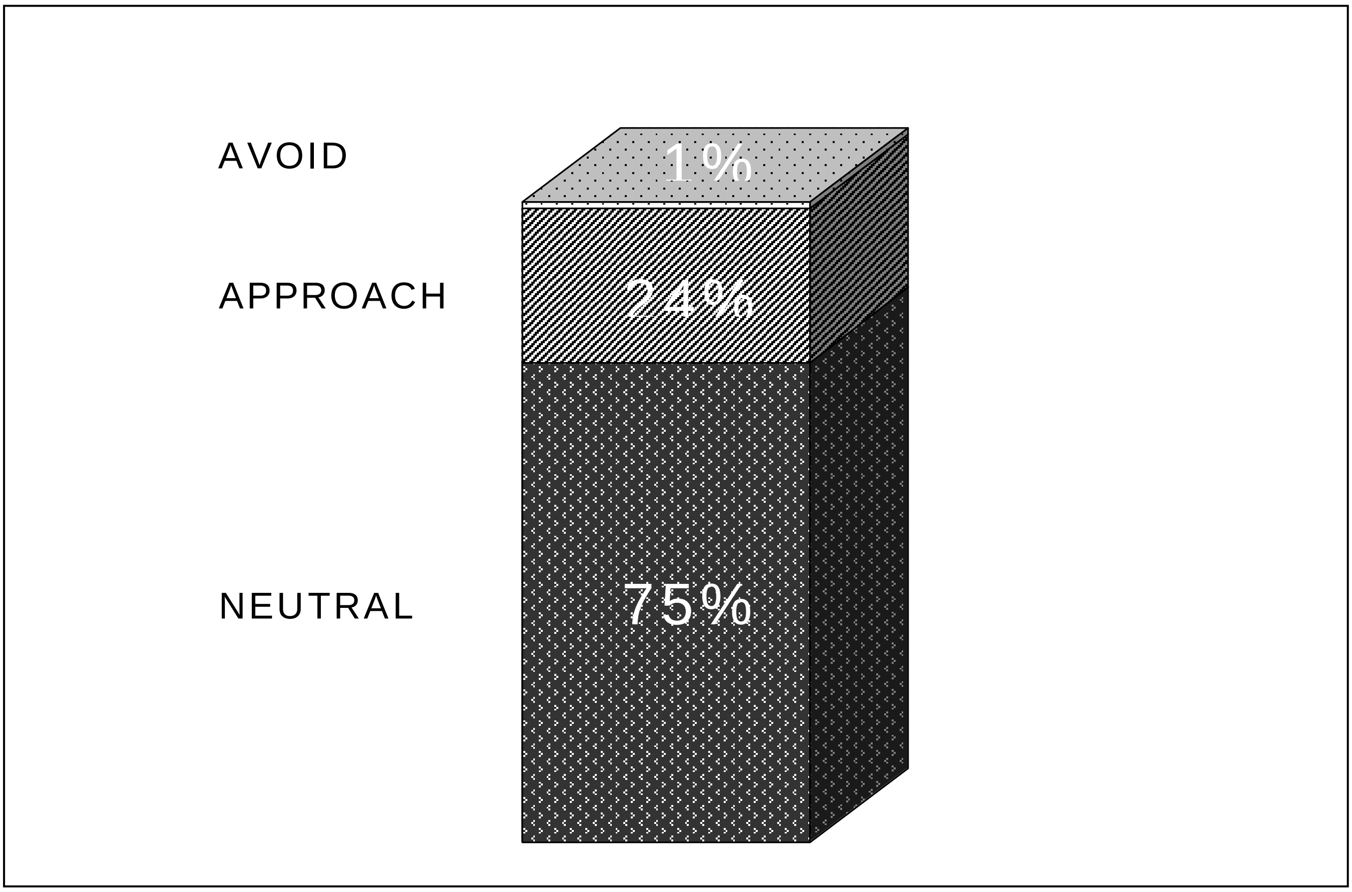

Fig. 1. Behavioural classes: Frequency distribution

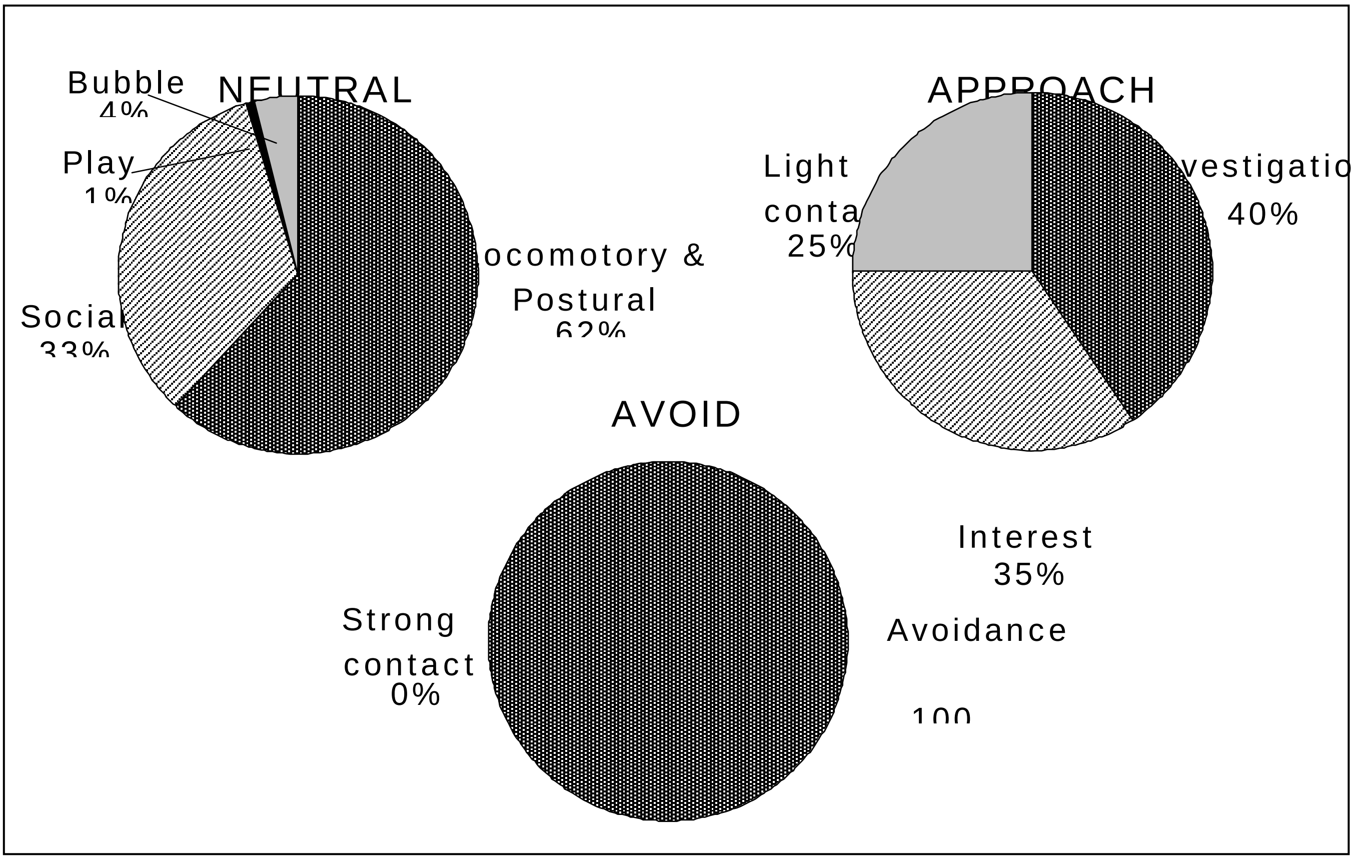

Fig. 2. Behavioural categories: Frequency distribution

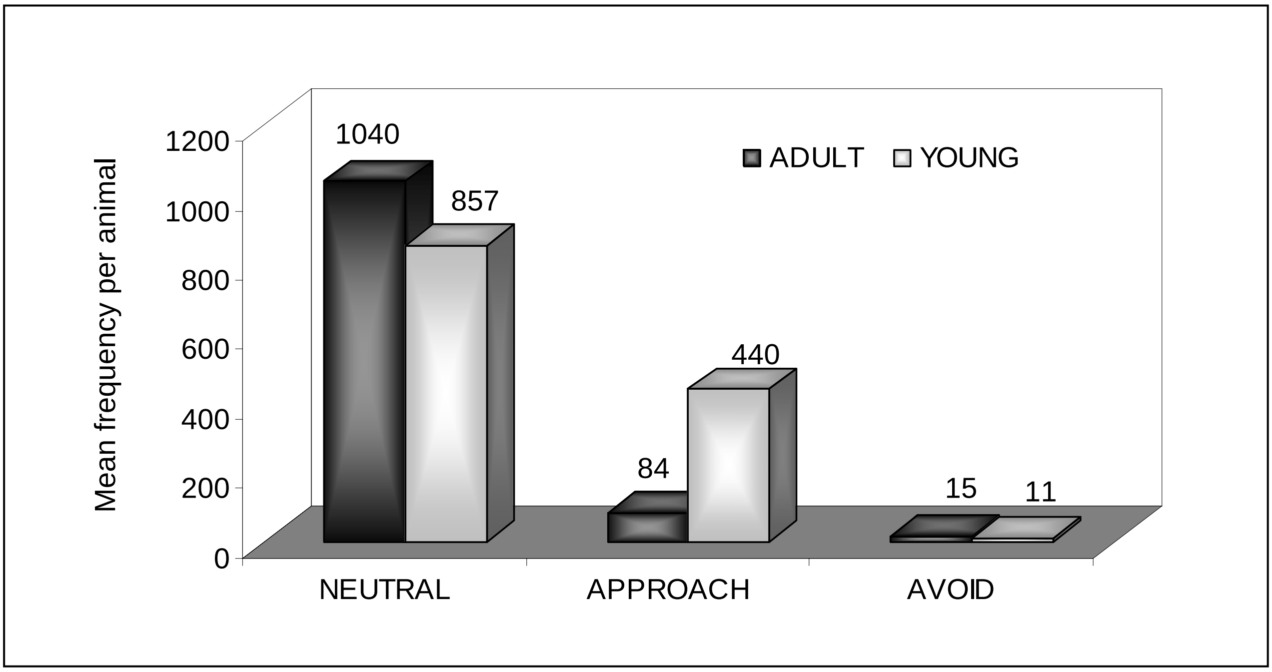

Fig. 3. Behavioural classes frequency distribution: adults vs. juveniles

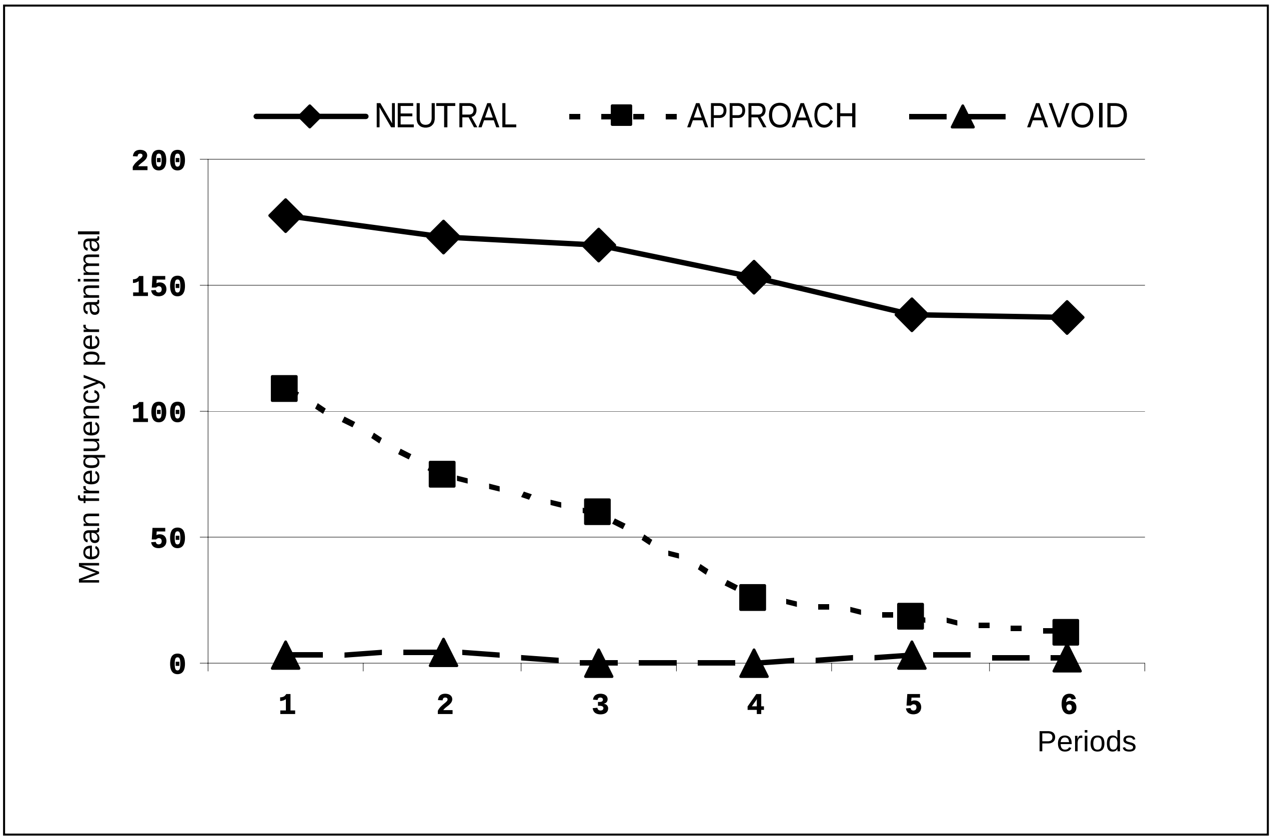

Fig. 4. Behavioural classes trend

SUB-SURFACE AND NIGHT-TIME BEHAVIOUR OF SHORT-FINNED PILOT WHALES IN HAWAII: INFORMATION FROM SUCTION-CUP ATTACHED TIME-DEPTH RECORDERS AND VIDEO CAMERA (CRITTERCAM) SYSTEMS

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Pilot whales have long been thought to be deep divers, yet until recently no information has been available on diving depths of either species. Limited information on long-finned pilot whales in the Ligurian Sea suggest they remain relatively inactive during the day, dive deeply at dusk following vertically migrating prey, and feed near the surface at night. In Hawaii, short-finned pilot whales are found year-round associated with island slopes, typically in waters ranging from 1000 to 2000 m. We tested the hypothesis that this species also feeds on vertically migrating prey, with deep dives at dusk and dawn following vertically migrating prey, and near-surface foraging at night, using suction-cup attached time-depth recorders (TDRs) and video camera systems (Crittercam). In 2002 we deployed 10 TDRs (9 recovered) and 6 Crittercams, collecting 101 hours of TDR data and approx. 10 hours of video footage. The deepest dives recorded (typically 600-800 m, max. 27 minutes) were during the day. Such deep dives were recorded for all 5 individuals where TDRs remained attached for extended periods. At night, all whales dove regularly to between 300 and 500 m, and the rate of deep (>100 m) dives at night was almost four times greater than during the day. Long bouts of shallow (<100 m) diving occurred only during the day. Video footage from the Crittercams during these shallow dive bouts indicated the whales were engaged in social, rest and travel behaviours, but no feeding was documented. Overall our hypothesis of a crepuscular diving pattern and near-surface feeding at night was not supported. However, dive depth differences between day and night presumably reflect vertically migrating prey, though the prey are concentrated at depths of 300-500 m during the night. Differences in diving patterns from long-finned pilot whales likely reflect differences in the vertical movements of prey.

BEHAVIORAL OBSERVATIONS AND NON-INVASIVE TAGGING OF CUVIER'S BEAKED WHALES, *ZIPHIUS CAVIROSTRIS*, IN THE LIGURIAN SEA

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In recent years there has been growing concern about the effect of noise on deep diving Odontocetes, particularly on the poorly known beaked whales. During 2001 and 2002 we conducted two cruises in the Ligurian Sea for 12 days each year to explore the feasibility of measuring responses of beaked whales to controlled sound exposures. Our specific objectives were to collect baseline behavioral data on Cuvier's beaked whales, *Ziphius cavirostris* G. Cuvier, 1823, and attempt to attach a suction-cup tag that records depth, movement and sound up to 16 kHz (D-Tag). Cuvier's beaked whales were positively sighted twice in 2001 and eight times in 2002, with two associated animals re-sighted on different days in 2002. We employed standard photo-id and focal animal sampling techniques to identify individuals and to record the behavior of animals. We conducted 9 focal follows for a total of 15 hours, in sea-states up to Beaufort 3. Three of these follows lasted over 2 hours. Short surfacing times of less than 5 minutes (between dives ranging from 15min to possibly over an hour in duration) made it difficult to approach animals for tagging. We did deploy one D-Tag using a 5m carbon fiber hand-held pole during logging behavior, which occurred rarely. The tag remained attached for a full 20-minute dive to 450m. No sounds attributable to the tagged whale or the other group members were heard on the tag. While this study shows the difficulty of following and tagging Cuvier's beaked whales, it does suggest that detailed behavioral observations are possible with this poorly understood species.

EFFECTS OF DISTURBANCE ON DOLPHIN DISTRIBUTION IN BAHIA DE ALGECIRAS

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Common dolphins (*Delphinus delphis*), striped dolphins (*Stenella coeruleoalba*) and pilot whales (*Globicephala melas*) occur in Bahia de Algeciras (Gibraltar Bay) off Southern Spain. Behavioural and habitat-utilisation observations on *D. delphis* carried out between April 1996 and September 1997 show maximum recorded numbers of up to 200 animals in a single 2.5 hour survey. The dolphins utilise the bay in a spatial/temporal dynamic manner. The dolphins have two principal feeding areas: 'north-west' within the bay, off the mouth of the Palmones river and 'south-east' within the bay, to the west of Europe Point, Gibraltar. They also occupy an 'eastern' nursery/resting area to the west of Gibraltar. Heavy commercial and pleasure water craft, especially the fast ferries and catamaran ferries which regularly transit between Algeciras and North Africa, disturbs the normal dolphin behaviour and occupation range. Such 'disturbed' dolphins congregate in deep water in the centre of Bahia de Algeciras. This disturbance-altered behaviour has potential implications for the welfare of the dolphins and we suggest that efforts are implemented to minimise the impact from commercial traffic on the local common dolphin population of Bahia de Algeciras.

SEASONAL OCCURRENCES OF BLUE, FIN, HUMPBACK AND MINKE WHALES IN THE EASTERN NORTH ATLANTIC BASED ON PASSIVE ACOUSTIC MONITORING

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Blue, fin, humpback and minke whales produce patterned sequences of sounds referred to as songs. Species specific songs contain energy in the 10–400Hz band and are well adapted to function for long-range communication. Singers can be detected throughout large portions of an ocean basin. Passive acoustic monitoring for these species in 12 sub-regions of the eastern North Atlantic has been ongoing since 1996 using US Navy SOSUS arrays. Fin whales are acoustically the most prolific, with an order of magnitude more singers than other species. All four species show seasonal fluctuations in singing activity: blue and fin whales throughout the year, but lowest in May and June, humpbacks from October through March, minkes from September through November. Tracks indicate some seasonally directed movement for blue and humpback whales, but not for fins or minkes. Blue and fin whales tend to occur in separate areas. Most fin and humpback singers remain north of the British Isles throughout the entire winter. Food availability is assumed to be a factor in these observed spatial and temporal distributions.

MULTIPLE, SIMULTANEOUS OBSERVATIONS OF SPINNER DOLPHINS (*STENELLA LONGIROSTRIS*) ON A HAWAIIAN ISLAND: A USEFUL TOOL FOR FUTURE RESEARCH

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INTRODUCTION Studies that accurately explore the life dynamic of nearshore spinner dolphin (*Stenella longirostris*) populations, and evaluate the impacts of human activities on these dolphins, are needed. Multiple, simultaneous observations of Hawaiian spinner dolphins were conducted in order to get an overall picture of (1) the distribution and abundance of the spinner dolphin population around Oahu, Hawaii and (2) the impact of human activities on the dolphins' behavior and distribution. These spinner dolphins typically come close to shore in early morning to rest in shallow, protected areas with sandy-bottoms (Norris *et al.*, 1994, Marten and Psarakos, 1999), consequently they are easily accessed by eco-tour boats, kayaks, and swimmers. We were interested in observing identified anthropogenic factors and their possible effects on dolphin frequency or behavior in given areas.

METHODS This study took place on the island of Oahu, during August 2002. We arbitrarily chose three spinner dolphin resting spots around the island: location ← on the northwest coast of Oahu, ↑ on the central west coast and → on the northeast coast (Fig. 1). We trained 19 observers: (1) to identify the dolphins and estimate their group size, (2) to complete a simple ethogram including swimming direction, activity level, and social behaviors and (3) to record the number and activities of boats, kayaks, and swimmers in the vicinity of the dolphins (distance < 5m). There were 18 days of observation from 0700 to 1200-1300h (108 hours) at locations ←, ↑ and → with six observers at each location: four on shore and two in water.

RESULTS When considering the following four parameters together: numbers of dolphins, boats, kayaks, and swimmers, the three locations showed a heterogeneity (ANOVA test significant, K.W.= 81.565, $p<0.0001$).

1. Dolphin frequency *per* location (Fig. 2)
The dolphins frequented all three locations equally (Kruskal-Wallis test not significant).

2. Sources of potential disturbance
We first pooled the number of boats and kayaks in order to get an overview of human recreational water activities with vehicles around the island: a disparity was apparent between locations ↑ and → (Kruskal-Wallis test, K.W.= 8.406, df= 2, $p<0.05$).

We then analyzed boat and kayak activities individually:

a. Boats (Fig. 3)
Eco-tour boats were preferentially found in location ↑ (Kruskal-Wallis test, K.W.= 27.986, df=2, $p<0.0001$).

b. Kayaks (Fig. 4)
Kayakers preferentially used location ← (Kruskal-Wallis test, K.W.= 20.304, df=2, $p<0.0001$), moreover the presence of the kayakers in that particular area was correlated to the absence of the dolphins (Spearman test, r=-0.5416, p=0.0203).

c. Swimmers (Fig. 5)
Swimmers frequented locations ← and ↑ equally. Only location ↑ had fewer swimmers than location → (Kruskal-Wallis test, K.W= 11.561, df=2, $P<0.01$).

DISCUSSION Our results revealed a heterogeneity in anthropogenic factors displayed in the three study areas: location ← is a small beach mainly frequented by local fishermen and by people running «swim-with-wild-dolphins» programs; location ↑ is difficult to access from shore (narrow, rocky, and turbulent entrance to the sea) but boats frequently occupy the area; and location →, along a popular tourist stretch, is a vast bay where people enjoy swimming. The study showed a disparity in human behaviors towards the dolphins according to site location: location ← was mainly frequented by kayaks and swimmers, location ↑ was mainly visited by eco-tour boats, and location → was preferentially chosen by swimmers. Recent studies have shown that boat traffic increases breathing synchrony in dolphins (Hastie *et al.*, 2003); in order to avoid boats, fin whales (*Balaenoptera physalus*) travel at increased velocity and reduce their time spent at the surface (Jahoda *et al.*, 2003). Driscoll-Lind and Ostman-Lind (1999) reported on the possible disturbance engendered by swimmers on Hawaiian spinner dolphins: animals were observed changing direction and traveling speed to avoid people and boats. If these types of human activity have such noticeable short-term impacts, we can wonder what the long-term effects would be within the dolphin and fin whale populations. For this reason, these parameters and the ones we studied are likely to evolve over time, and thus it is advisable to extend this kind of work over months and years in order to get a more accurate picture of the real impacts of anthropogenic factors on dolphin behavior and distribution. In our study area, location ← mainly attracts people interested in swimming with wild dolphins as opposed to location → where people are primarily drawn by the chance to swim in clear, shallow water. Even if the primary swimmer motivation is different in these two locations, we still must ask what the real impact of swimmer density is on dolphin behavior and distribution, and what the cumulative effect of this parameter is over time. If the dolphins come to these particular habitats to rest, what is the long-term effect of having people continuously approach them during most of this rest period? The results also revealed that the expected heterogeneity in dolphin frequency at the study areas was not supported by statistical tests. Since our work lasted a month and covered 18 days of observation, we think that a longer period of observation is necessary to validate that preliminary finding.

CONCLUSION The primary value of multiple, simultaneous observations of known spinner dolphin rest areas is to yield a more accurate picture of dolphin abundance and distribution. This type of approach may be critical in assessing the effect of human activities on their behavior. A study of this nature would benefit from a long-term approach, as the parameters are likely to evolve over time.

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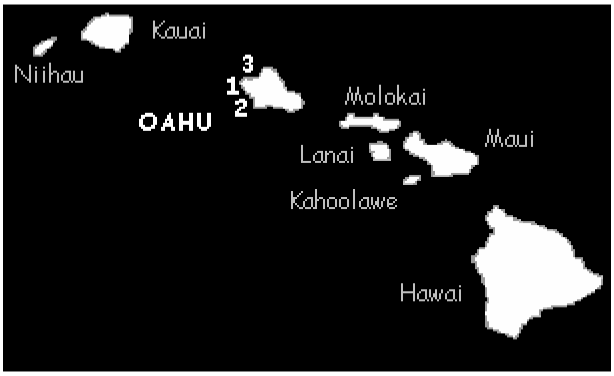

Fig. 1. Map of the Hawaiian Islands with the three locations where dolphin and human activities were observed

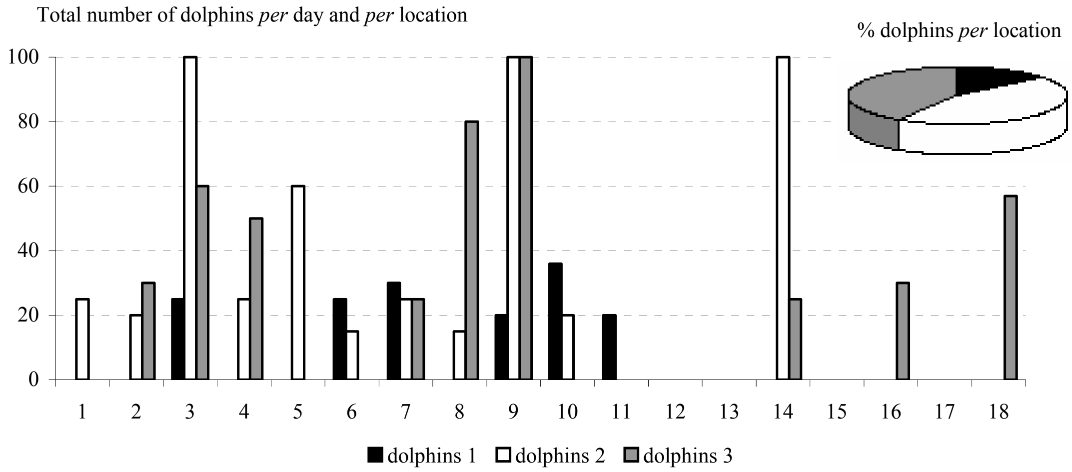

Fig. 2. Total number of dolphins *per* day and *per* location with an insert representing the percentage of dolphins *per* location. «Dolphins 1» means dolphins observed in location ←, same thing for locations ↑ and →.

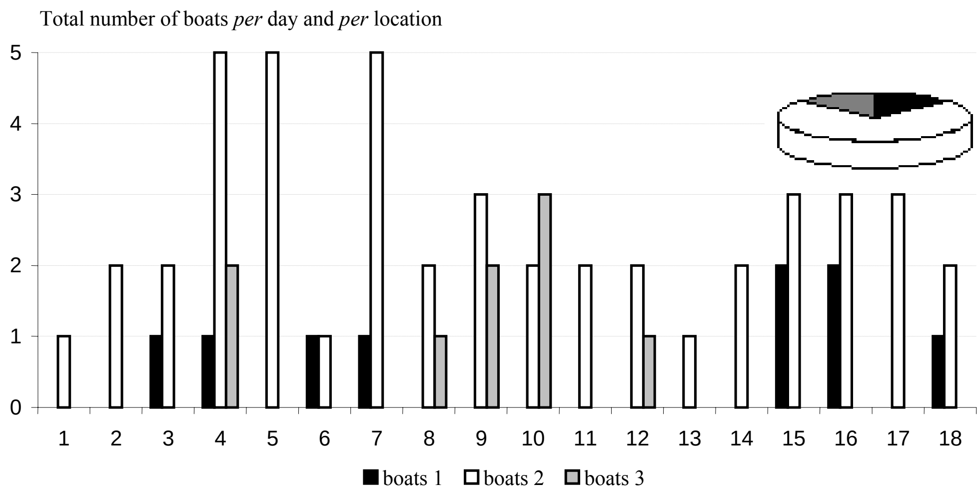

Fig. 3. Total number of boats *per* day and *per* location with an insert representing the percentage of boats *per* location

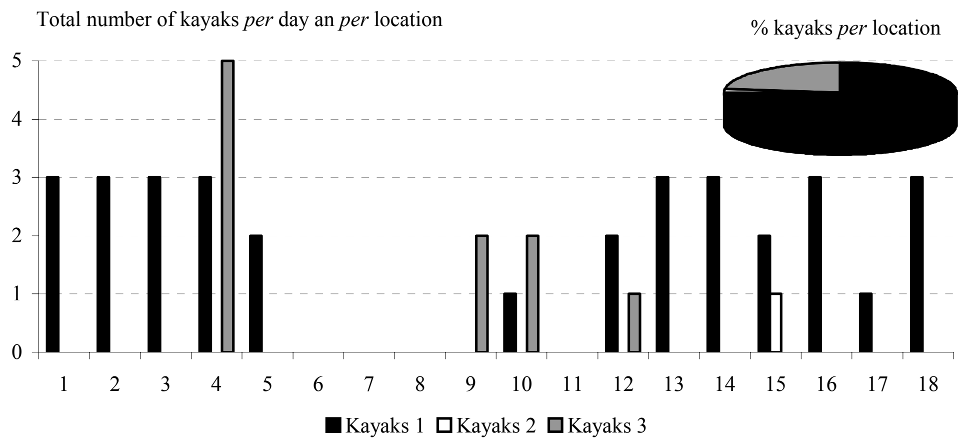

Fig. 4. Total number of kayaks *per* day and *per* location
with an insert representing the percentage of kayaks *per* location

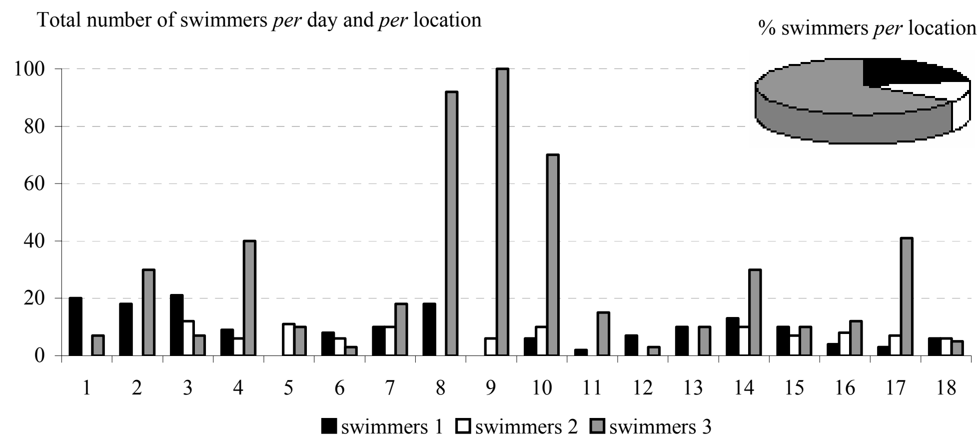

Fig. 5. Total number of swimmers *per* day and *per* location with an insert representing the percentage of swimmers *per* location

BEHAVIOURAL IMPACT OF WHALE WATCHING ON TROPICAL PILOT WHALES AND BOTTLENOSE DOLPHINS IN THE CANARY ISLANDS

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A study of the behavioural impact of commercial whale and dolphin watching operations on resident *Tursiops truncatus* and *Globicephala macrorhynchus* populations was made from 1998 to 1999 off the SW coast of Tenerife. This area is part of the EU Habitat Directive network of Special Areas of Conservation (SAC). In the study, whale watching boats and an inflatable boat were used as research platforms to collect 636 behavioural samples. Data on boat traffic were collected from four high points on land with the help of a theodolite.In 21.8% of sightings, more than three boats were positioned within 200m of the animals, in infringement of current regulations. A correlation study explored the relationship between different parameters of the encroaching vessels (number of boats within 200m of a group of animals, distance of each boat to the group, and the direction and speed of approach) and the behaviour of the cetacean group (parameterized by changes in speed, heading and group cohesion). Correlations were performed for the two species and for different group compositions (with/without calves/mature males).The results for bottlenose dolphins showed significant correlation between (i) decreasing boat distance and changes in heading and group cohesion of the animals, and (ii) between increasing number of boats and change in group heading. When calves were present in the groups, the responses were more marked. Results for tropical pilot whales showed less evident response, although change in group heading correlated with decreasing boat distance and approach direction. When both mature males and calves were present, the behavioural response became more significant. It was concluded that, while the behavioural responses of cetacean groups to nearby boat traffic are dependent on both species and group structure, certain boat approach strategies provoke more significant levels of response than do others.

MIGRATION PATTERNS OF MYSTICETES THROUGH THE CANARY ISLANDS

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This report examines the movements of Sei whales, *Balaenoptera borealis*, and Fin whales, *Balaenoptera physalus* off the coast of SW Tenerife. Extensive details of every cetacean sighting between October 1999 and May 2001 were recorded twice-daily on the whale-watching vessel 'Nashira', including GPS position, cetacean type, direction of movement and sea conditions. *B. borealis* were sighted during October, travelling as solitary animals, often in the presence of Bottlenose dolphins, *Tursiops truncatus*, and Striped dolphins, *Stenella coeruleoalba*. *B. physalus* were seen travelling slowly North during March. It is hypothesised that the waters of SW Tenerife form part of Mysticete migrations south towards warmer waters for the winter (as observed in *B. borealis*), and north towards cooler feeding grounds in the summer (as observed in *B. physalus*), as a consequence of two major factors. (1) the water depth between Tenerife and La Gomera reaches 2000m and attracts migrating whales due to its corresponding low geomagnetic intensity (Walker *et al.*, 1992). (2) of the eleven migratory species identified in this study, Orcas, *Orcinus orca*, were not observed, while they are regularly sighted in other regions of the Canary Islands. It seems likely that Mysticetes use the waters of SW Tenerife due to the lower risk of predation by *O. orca*, supporting the theories of Corkeron and Connor (1999). Research is now necessary to determine how the migrations of Mysticetes affect resident cetacean populations. Observations imply associations between *B. borealis* and dolphin species, but not with *B. physalus*, which may deter dolphins (during the 3 days that *B. physalus* were sighted in 2002, there was a notable absence of the resident *T. truncatus*). Secondly, it is necessary to determine whether *B. physalus* migrate southwards around October, and *B. borealis* northwards in March as expected. Further research will provide important insights into these little-studied migrations.

GEOGRAPHIC DIFFERENCES IN INTER-TYPE VARIABILITY OF BOTTLENOSE DOLPHIN WHISTLES

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Bottlenose dolphin (*Tursiops truncatus*) whistles are heavily influenced by vocal learning in which previous experience is used to make a new signal more recognizable by increasing the difference in acoustic parameters to other existing types. Signature whistles of bottlenose dolphins are used for individual recognition and the maintenance of group cohesion. They are developed at an early age and can remain stable for more than 12 years. Differences between signature whistle types facilitate individual recognition and are therefore an important feature of the communication system. A larger difference between whistles and therefore greater inter-type variability should be found in populations with higher animal density, higher background noise levels or larger home ranges. To investigate this claim, I compared whistle type variability between two sites, the East coast of Scotland and Shark Bay in Australia. Recordings were conducted during a variety of social contexts including resting, foraging, traveling and socializing. The contour of the fundamental frequency was extracted from 200 whistle types at each site. To look at overall variability, only one specimen of a whistle type was included in the analysis if several copies of the same whistle type were recorded within a site. Cross-correlation analysis demonstrated that whistle type variability was significantly different between sites with bottlenose dolphins in Australia producing structurally much simpler and less varied whistles than those in Scotland ($p < 0.05$). While communication signals are influenced by social learning, environmental factors can influence variability within a population through individual learning. Shark Bay dolphins have much smaller ranging patterns than dolphins off Scotland and are generally exposed to lower noise levels. Therefore, they do not need the same acoustic difference between whistle types to ensure effective communication.

MULTIPLE SIMULTANEOUS ACOUSTIC TAGGING OF SPERM WHALES (*PHYSETER MACROCEPHALUS*)

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A recently developed tag for cetaceans (called DTAG), records high bandwidth sound synchronously with the orientation and depth of the tagged whale. Sensor sampling rate is sufficient to resolve individual fluke beats. The DTAG has been applied to more than 40 sperm whales, providing unique information on their acoustic ecology (see Tyack paper, this conference). Normally, we apply a single tag each day and the tagged whale is followed both visually and acoustically until the tag releases. However, on two occasions in a September 2002 experiment in the Gulf of Mexico, DTAGs were applied to multiple whales in a group at the same time: three whales carried DTAGs simultaneously for over 11 hours on Julian day 254 while two whales carried tags for a single overlapping dive on day 239. Clicks made by each tagged whale are invariably heard in the tag recordings made on the other whales, providing a precise means to determine the distance between each pair of whales throughout a dive. In the three-whale case (day 254), the relative position of each tagged whale can be determined from the tag data by triangulation. The resulting 3-whale baseline can then be used to resolve the relative position of other untagged whales in the group. By integrating visual observations, the whale tracks can be fixed in a geographic frame. Such data provides a unique opportunity to examine social organization during deep foraging dives and to assess the effects of anthropogenic sound on social behavior. Preliminary results indicate that the tagged whales tend to separate during the descent phase of a foraging dive, and maintain a distance of a few hundred meters from each other at the base of the dive. The whales appear to re-group while ascending or at the surface.

DYNAMICS OF BELUGAS (*DELPHINAPTERUS LEUCAS*) BEHAVIOUR IN REPRODUCTIVE GATHERINGS

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We studied behaviour of belugas in reproductive gatherings near Cape Beluzhy (Solovetsky Island, White Sea). Five of belugas movement activity types (MAT) were described. Type R – resting near water surface or very slow swimming. Type S – quiet swimming with shallow dives. Type F – fast swimming. Type D – synchronous, fast swimming of the entire group. Type G – intense interaction of dense group of animals. F, D and G MATs are observed during copulative, hierarchical and playing behaviour. We used the "coefficient of activity" (k) as a formal criterion in order to objectively estimate the behavioural dynamics of a reproductive gathering. This coefficient allowed the quantitative estimate of input of various age groups of belugas in total swimming activity of the herd. It was calculated on a daily basis for each MAT for two age-groups of belugas (white – ad. and gray – subad.). $k=(A1+A2+\ldots+An)/n$, where An – the proportion of animals within the group, showing the particular MAT during one observation frame and n – number of observation frames per day. We described 6 periods in the life of reproductive gathering of belugas off Cape Beluzhy: beginning period, period of giving birth, copulation period, activity of non-mature individuals period and period of reproductive gathering disintegration. Changes in periods are accompanied by changes in swimming activities, size and age composition of beluga groups. Such periods are repeated annually, but time and order of some periods can be different from year to year. The exact time interface between these periods during observation season, could be determined based on the activity coefficient k. In the conditions of increasing of human activity (eco-tourism, intense navigation activities, fishery, etc.) our new data on biology of belugas in reproductive gathering allow to develop concrete measures of conservation of this unique nature object.

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 from 1999. Within these groups, several striped dolphins with attached suckerfish or with sucker disc spots on their bodies have been sighted. Exceptionally, an individual with two sucker-fish attached contemporaneously has been also photographed. The individuals with attached suckerfish have been always observed far from the group showing unusual behaviours. They travelled rapidly changing continuously their direction often performing fast surfacing and diving leaping. It seemed they tried to get ride of the suckerfish. More of one sucker disc spot has been photographed on the body of the same dolphin. This is probably due to the changes of the suckerfish position on the body of the hosted. Videotapes and photographs have been taken and accurately analysed to understand the observed behaviours and to try to identify the suckerfish species. This is probably the whale sucker (*Remilegia australis*) which is the reported host cetacean's species.

ACQUISITION OF TEMPORALLY FINELY-RESOLVED DATA ON THE BEHAVIOUR OF FREE-RANGING HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE BALTIC: A FIRST ATTEMPT

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The development of effective protection measures for harbour porpoises regarding bycatch and habitat depletion depends basically on knowledge of the behaviour and ecology of these animals. The use of satellite telemetry and data loggers currently provides the only direct approach to gather data. In 1999 a young male porpoise, caught in a pound net in the Inner Danish Waters, was fitted with a self-releasing buoyant unit attached to the dorsal fin. The unit contained a Platform Transmitter Terminal and a data logger recording water temperature, animal swim speed, dive depth, heading and inclination at intervals of 6s. The system was designed to be released after ca. 14 days corresponding to the time when the data logger memory was full. Numerous position fixes were obtained during the period of deployment. Dring the period of logging, speed was recorded for the first 17.5 hours only, after which the sensor failed. Other than that, animal activity was consistently recorded for the full logging period. The porpoise dived almost continuously during the logging period exploiting depths up to 43 m and remaining underwater for up to 100s. Various dive profiles were exhibited, including 'U', 'V' and 'W' shaped dives as well as other types. There was a clear relationship between the maximum depth reached during a dive and the following parameters: dive duration, descent duration, ascent duration, time spent during the bottom phase of the dive, descent and ascent rates. The animal tended to dive deeper around dawn and dusk although extensive diving was apparent at all times.

REACTION OF THREE BOTTLENOSE DOLPHIN DAMS WITH CALVES TO OTHER MEMBERS OF THE GROUP IN CONNECTION WITH NURSING

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The bottlenose dolphin calves are nursed for approximately 18 months, but from 6 months of age, they start to eat solid food, and the suckling is reduced. During this period, the calf learns the behaviours necessary for capturing prey. A study was done at the Kolmarden Wild Animal Park, Sweden where the suckling behaviour of three calves was followed from birth until they were two years old. The behaviour of the mother towards other dolphins present in the pool just before or during suckling was also studied. The results show that the mother preferred to be alone when suckling (F=40,1473; p<0,0001), rather than being accompanied by another member of the group. This preference changed, as the calf grew older (F=58,9857; p<0,0001). Further analyses revealed that just before or during suckling, it was the mother, which left the companying dolphin significantly more often than the company leaving the mother, the company joining the mother or the mother joining the company (c2=7,8308; p=0,0496). This indicates that another dolphin is not automatically an asset to a mother with a newborn, and that, in human care, ample space must be provided to allow the mother the necessary privacy in connection with nursing.

SURFACING RATES OF MINKE WHALES IN THE NORWEGIAN SEA

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The methods we use for estimating abundance of minke whales in the northeast Atlantic based on sightings survey data depend on availability of information on surfacing patterns of the whales. Although the main goal of the research presented here is collecting such dive behaviour information, this also gives us insight into other aspects like migrational patterns and possible associations with physical and biological factors. Results from two minke whale VHF tracking experiments conducted in the Norwegian Sea in July 2002 are presented. Both whales were followed for about two days and travelled approximately 124 and 178 kilometers during the observational periods. Based on the total data collected, the mean intersurfacing intervals for the two whales were 71.56s (SD 1.8) and 122.67s (SD 3.6), corresponding to blow rates of 50.3 and 29.3 blows/hour, respectively. These estimates are comparable to blow rates recorded earlier in the northeast Atlantic by VHF radio tracking and also visually collected surfacing data. As the experiments were conducted in Beauforts over the range 0-8, possible effects of wind is discussed, as well as diurnal and hourly patterns.

INTERACTIONS WITH FISHERIES: MODALITIES OF OPPORTUNISTIC FEEDING FOR BOTTLENOSE DOLPHINS AT LAMPEDUSA ISLAND (ITALY)

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INTRODUCTION Interactions between various cetacean species and fisheries in the Mediterranean Sea are reported in some geographic areas, although most data are sparse and difficult to evaluate. Since 1996, a population study on bottlenose dolphin (*Tursiops truncatus*) has been conducted in Lampedusa Island (Italy). One of the primary focus of the research trips in the 1997-1999 period was to monitor the interactions between a) dolphins and trawls, and b) dolphins and aquaculture facilities, in order to assess degree and nature of these relationships and eventual threats for the animals.

MATERIALS AND METHODS Boat and land-based surveys and photo-identification techniques were used to examine movements and behaviour of individuals over a three-months summer period (July-September each year, from 1996 to 2000). Land-based observations lasting three hours were made from the two island's higher places (Albero Sole, NW and Capo Grecale, NE) at fixed times, both in the morning (07:00-10:00) and in the afternoon (17:00-20:00).

Dolphins number, position, estimate behaviour and direction of movement were recorded onto data sheets. Using a 4,5 inflatable powered outboard, boat-based surveys were made trying to homogeneously cover the 4 zones we divided the area in and within 6 miles around the island. However, the northern part was rarely accessible due to the awful sea conditions. 35 mm cameras equipped with 35-80 mm, 70-210 mm and 60-300 mm lens were utilised for photo-identification purposes. Instantaneous, focal group and *ad libitum* sampling methods were used to assess dolphins' behavioural activity (Altmann, 1974; Mann, 1999), using both a videocamera and a tape voice recorder.

RESULTS A total number of 281 sightings (188 boat-based and 53 land-based) was recorded during the five-years study, 104 of them concerning the dolphins-trawls interaction and 44 in association with a submerged cage for aquaculture (Fig. 1). Bottlenose dolphins have been documented in association with trawling operations in all parts of the study area (significant prevalence in zone 2; ANOVA F=3,8; gdl=3; p=0,04), with a number of 86 recognizable individuals involved. The entire catalogue consists of 140 photo-identified animals. Four different behavioural phases were observed during the animals' interaction with trawls (see Fig. 2 and Tab. 1). Twenty mother-calf pairs were observed during the interactions with trawls, showing behavioural phase 1 only.

The opportunistic relationship with the coastal fish farm located at 35 m. in the NE part of the Island (near Cala Calandra) involved 40 photo-identified animals. Highly repeated behavioural sequences in relation with the fish farm were observed. Feeding fishes possibly attracted by the favourable environment in the proximity of the cage was the most frequent activity seen, followed by a milling-like behaviour, socializing, moving away, mixed behaviours and resting (see Fig. 3).

Twenty six photo-identified individuals appeared to be implicated in both kind of interactions, spending a considerable amount of time associated with trawls or cage, and decreasing natural feeding activities.

In 1999 an adult individual was found dead near the cage. The carcass' examination revealed that the animal presented evident lesions near rostrum, suggesting a possible collision with a boat. The constant bottlenose dolphins' presence near the fish farm, in fact, attracted an incredible number of tourist boats in the area, often producing dangerous conditions for the animals' safety.

CONCLUSIONS The association of bottlenose dolphins with trawls and cage indicates the behavioural plasticity of these animals to capitalize on human activities. These feeding patterns may be beneficial in that they reduce time required to forage and provides the animals with an easier way to obtain food. Engines on trawlers produce a characteristic sound when changes stages of operation, probably attracting the animals and allowing the development of peculiar behaviours for each phase. The hypotheses that this process raised high levels of efficiency in this population, as exemplify by the highly structured behavioural phases, is supported by the fact that any catch was seen or reported by fishermen during the five-years observational period.

As for the opportunistic interaction with the fish farm, mainly consisting of feeding preys in the proximity of the cage, it is important to note that the animals spend a considerable amount of time in a "milling-like" behaviour, probably being attracted to potential food that is clumped or patchy in distribution. In addition, the observation of some mother-calf pairs associated to trawling boats and fish farm suggested that bottlenose dolphins could have learned the advantages of following and feeding in conjunction with trawls as well as remaining near the cage. In this respect, it has been speculated that the calves may learn this foraging behaviours by observation and participation.

While this study has provided a baseline data set relating to the Lampedusa Island population, it is important to maintain a scientific monitoring of bottlenose dolphins interactions with human activities in order to accumulate significant information to be used for the conservation management of the species in the coastal zones.

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Table 1. *Tursiops truncatus* behavioural phases in association with trawls

DESCRIPTION		PHASE DURATION (minutes)	RESPIRATORY PATTERN	DIVE DURATION RANGE
PHASE 1	following the trawls at a distance of 100-200 m. while the net is in	about 100	highly standardized and generally characterized by 5-6 short surfacings followed by a dive lasting about 4 minutes	2-6 minutes
PHASE 2	feeding on the net while it is hauling in, close to the boat, at a distance of less than 30 m.	about 5	quite irregular, with rapid surfacings and short dives	8-30 seconds
PHASE 3	waiting for the net withdraw and trash fish while swimming close to the boat	about 15	more regular, with surfacings every 15-30 seconds	15-30 seconds
PHASE 4	feeding of trash fish discarded at the end of a trawl	about 5	irregular, with rapid surfacings to catch the floating fishes	5-10 seconds

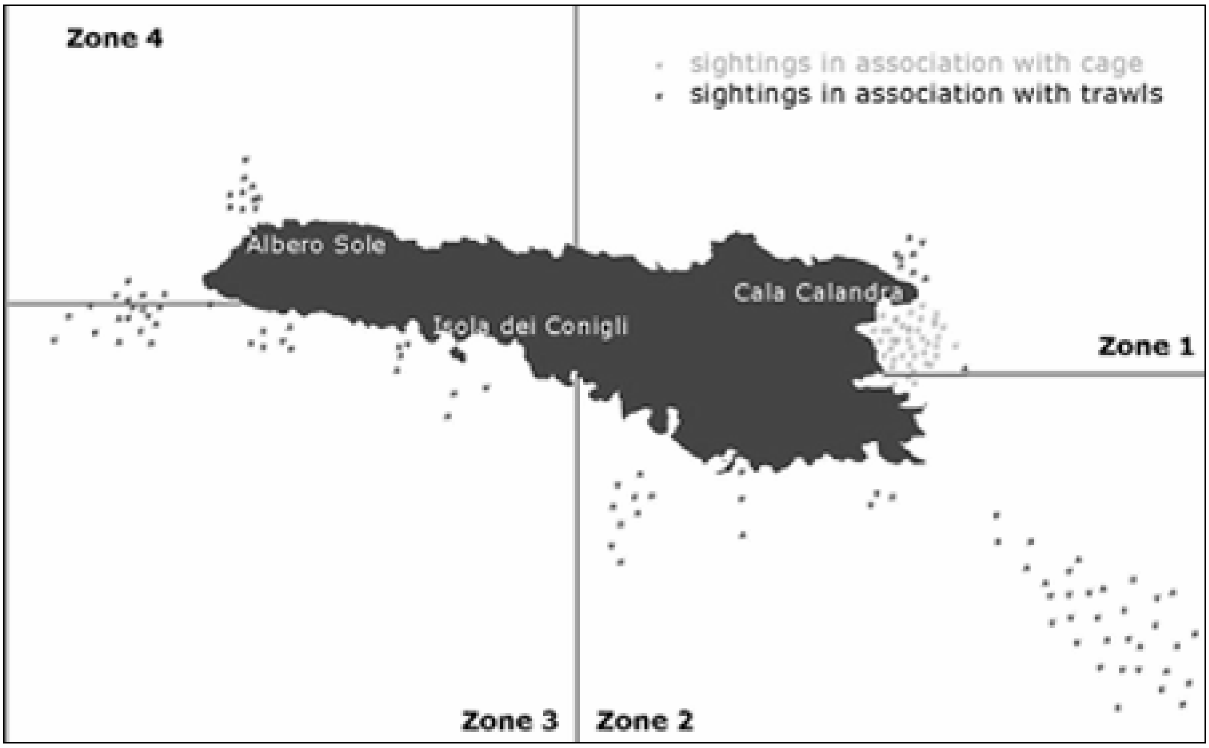

Fig. 1. Total sightings of bottlenose dolphins in association with trawls and fish farm

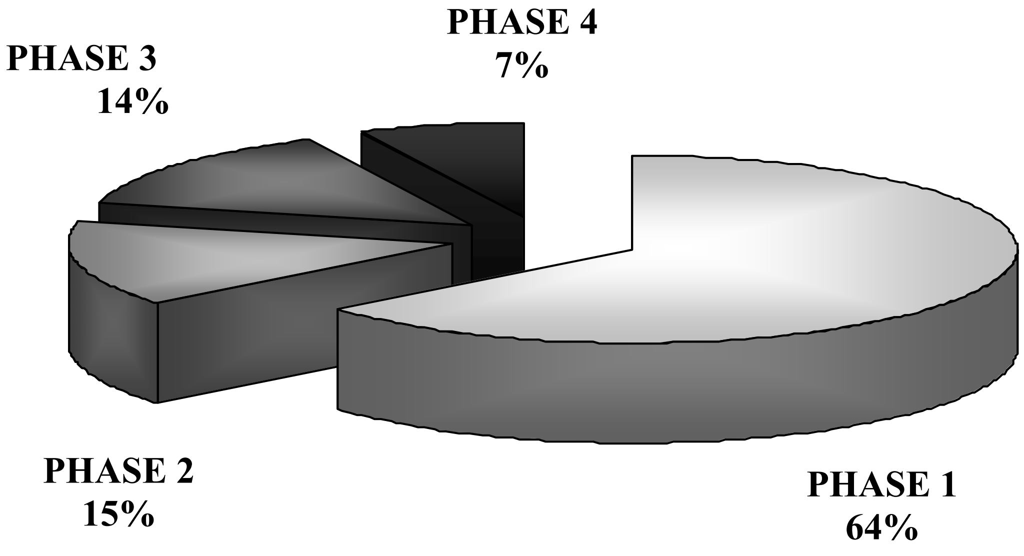

Fig. 2. Total frequency of *Tursiops truncatus* behavioural phases in association with trawls

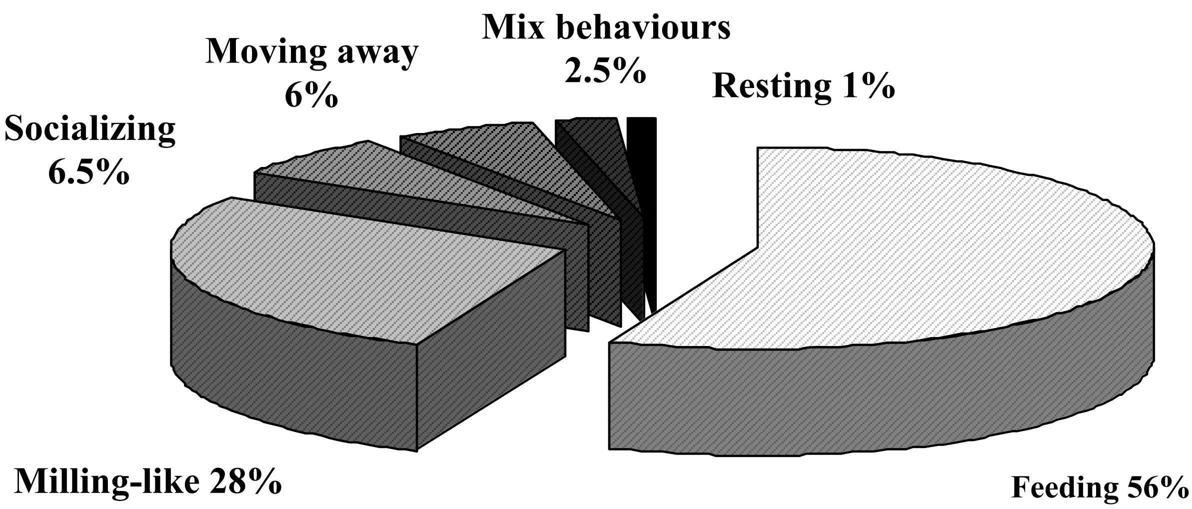

Fig. 3. Total frequency of *Tursiops truncatus* behavioural elements in association with cage

BOTTLENOSE DOLPHIN PRESENCE RELATED TO BOAT ACTIVITY INSHORE AROUND NEW QUAY HARBOUR, WEST WALES

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INTRODUCTION Many coastal bottlenose dolphin utilises areas of high boat traffic, especially during summer when the number of recreational boats is at its highest. Boat traffic, in West Wales, is mainly concentrated between 1 and 3 miles from the coast, the same area that is used by dolphins for feeding (Baines et al., 2000; Hall and Donovan, 2001). Moreover, fishing efforts for crabs and lobsters takes place in the spring, summer and early autumn months. During the summer months, drift and set nets are occasionally used to catch a variety of sea fish that dolphins include in their diet (Baines et al., 2000) implying direct competition between the two (Crespo and Hall, 2001).

Cardigan Bay in West Wales is home to a resident population of bottlenose dolphins, it was declared a candidate marine Special Area of Conservation in 2001 (Ceredigion County Council, 2001), the estimate of 215 individuals were calculated by mark-recapture methods for the entire cSAC by Baines et al. (2002). To manage such protected marine areas, it would be useful to know the effects of marine traffic on behaviour and distribution of coastal bottlenose dolphin populations.

There is only one deep-water harbour in Cardigan Bay and about nine smaller tidal harbours, one of which is New Quay (52º13'N, 4º21'W). The stretch of coast from New Quay to Tresaith, extending for one mile seaward, is also a designated Marine Heritage Coast (MHC). This awards it the status of voluntary marine protected area. Within the MHC there is an 8-knot speed limit for 300 metres off the coast, which is in place to protect the wildlife and is marked out with yellow buoys. New Quay harbour is in a semi-enclosed, shallow bay that does not exceed 12 metres in depth (Gregory et al., 2001). The harbour has mooring facilities for 133 boats (Ceredigion County Council, 2001), the majority of which are used for recreational vessels. However, fishing and tourist boats also use this facility. The coastal bottlenose dolphin population of New Quay mainly rests within an area that includes the harbour entrance. The population has been estimated at about 50 individuals and the dolphins have been observed to use the area mainly for feeding (Bristow et al., 2001).The principal aim of this study was to determine diurnal behaviour patterns both for sightings of bottlenose dolphins and boat activity in the vicinity of New Quay harbour. To test the hypothesis that boat activity may affect diurnal patterns of activity of bottlenose dolphins.

MATERIALS AND METHODS A shore-based study of the behaviour and occurrence of the bottlenose dolphin was conducted from a cliff vantage point inside the harbour. The observations were carried out from August to September 2002. Scans were conducted each quarter hour in time shifts, recording dolphin and boat activity and differentiating between categories of vessel. At the beginning of each watch environmental conditions (visibility, sea state, swell) were recorded, with the aim of collecting behaviour patterns under similar conditions. The data have been organised into 15 hour-long time intervals through the day, (from 06:00 to 21:00 hr), with each one having 180 minutes of observation. Group size was also noted. Survey effort at New Quay harbour totalled approximately 45 hrs.Data were statistically analysed using SPSS software and represented graphically with Microsoft Excel.

RESULTS During 45 hours of observation, dolphins were present for 31.85% of the time and boats were active 56.4% of the time. The period of time that boats moved around the harbour remained high and reasonably constant from 08:00 to 18:00. Sightings rates, expressed as the number of dolphins present in time periods, were highest between 10:00-11:00 (see Fig. 1). Similarly, the highest number of animals in the area was recorded between 10.00 and 11.00 (after 12:00, far fewer dolphins were observed), and this coincided approximately with a peak in the average number of boats. Boats showed a sharp and asymmetric peak between 10:00 and 12:00. The maximum mean length of time that dolphins remained around the harbour was in the morning and afternoon (fig. 2).

The mean group size was 4.2 individuals (sd=3), with a maximum group size of 12. A non parametric test of normality (Kolmogorov-Smirnov) revealed, as expected, that only the variables of frequency of dolphins and of tourist boats were normally distributed. Linear association between the variables was carried out using Spearman's coefficient (Table 1).

Dolphin behaviour varied during encounters with different boats, although no significant changes were observed in dolphin behaviour before and during encounters.

CONCLUSIONS The dolphins seem to display a daily pattern of movement, arriving in the area during the morning, and being more abundant during the hours before noon and in the evening, moving away at dusk. A similar pattern hasn't previously been observed by Gregory and Rowden (2001). There was a positive though not statistically significant correlation between the number of dolphins observed per unit time and the number of boats. When the boats were separated into categories, other positive relationships close to significance were found between boats of a particular type and the presence of dolphins. It has been observed by Pierpoint and Allan (2000) that bow riding occurred more with sailing and fishing boats. Dolphins displayed a low negative response towards canoes, kayaks and tourist boats, but higher negative response toward speed-boats, inflatables and tender vessels. This may be because dolphins are more likely to become tolerant of predictable or regular boating activities, such as the slow movement of a large displacement vessel along a steady course. Dolphins maybe deterred from certain vessels by the sound of their engines, or by subtle characteristics of hull shape, combined with vessel speed (Evans *et al*., 1992; Würsig *et al.*, 2001).

Areas such as New Quay may satisfy a dolphin's basic requirements such as feeding and nursery area, and it may be that potential disturbance from recreational boats has a lower influence on dolphin distribution than prey availability. Other observations have shown a general level of tolerance to increasing boat traffic over a period, with reactions varying by boat type (Bristow, 2001). This may indicate that dolphin tourism in its present form (the presence of a Code of Conduct) does not significantly affect the behaviour of bottlenose dolphin in New Quay, but most activity within the harbour is not actual dolphin tourism rather than boats simply entering or leaving their moorings and the quayside. The dolphin watching from these boats tends to occur away from New Quay harbour itself. It would be interesting to consider further both the vessel type and the behaviour of this, as other studies have suggested (Evans, 1997), there could be long-term adverse effects.

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Table 1. Results of correlation analysis.

Variable	VARIABLE	Spearman ρ	Sig.(P-value)
Frequency dolphins	Frequency boats	0.292	0.292
	Frequency sailing boats	0.346	0.207
	Frequency fishing boats	0.456	0.087
	Frequency tender /small row boats	-0.118	0.676
	Frequency tourist boats	-0.035	0.901
	Frequency inflatable boats	-0.112	0.692
	Frequency kayaks /canoes	-0.033	0.907
	Frequency speed boats	-0.185	0.510
	Frequency motor boats	0.404	0.135

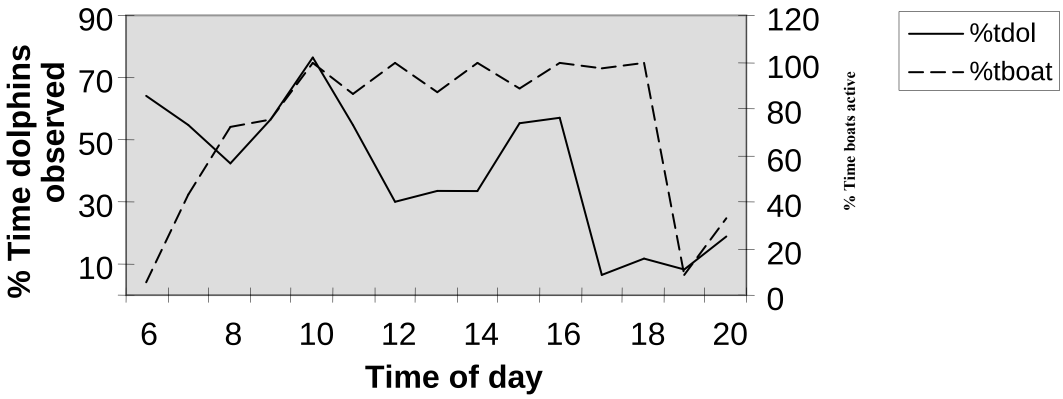

Fig. 1. Percentage of time dolphins were observed in the harbour in relation to the level of boat activity

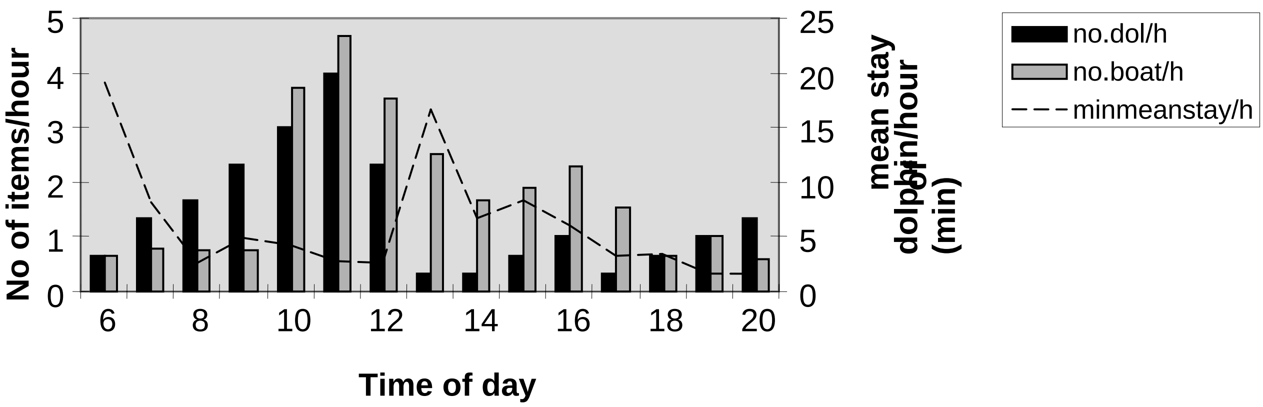

Fig. 2. Boat activity, presence and length of stay of the dolphins

ASSOCIATION PATTERNS AND SYNCHRONY LEVELS IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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INTRODUCTION Coordinating behaviors to achieve a shared goal is a specific form of cooperation that is recognized in many species (Dugatkin, 1997). It has been documented for different social contexts such as courtship (Maynard-Smith, 1978: 168-170; Serpell, 1981a,b), aggression (Schuster, 1976; Serpell, 1981a; Todt, 1981), foraging or hunting (Kruuk, 1972; Boesch and Boesch, 1989; Packer *et al*., 1990; Caro, 1994), reproduction in pair bonds (Todt, 1975; Serpell, 1981a,b; Hall, 2000), and defense against a common enemy (Packer *et al*., 1990; Boehm, 1992; Connor *et al*., 1992; Grinnell *et al*., 1995; Heinsohn and Packer, 1995; Hall, 2000). When explaining cooperation, most theories predict that behavior will follow evolutionary expectations emphasizing the contingency between individual behavior and outcomes (Skinner, 1953; Hake and Vukelich, 1972; Brown, 1983; Clements and Stephens, 1995; Dugatkin, 1997). However, explanations of proximate causes need to consider cooperation also from an intrinsic perspective, that is, from a perspective that relates to cooperation as a social behavior whereby aspects such as coordinated actions, roles, ranks, intrinsic rewards and prior relationships influence behavior and outcomes in ways that affect both the behavior and the preference between options of cooperating or acting alone (Schuster, 2001, 2002). In other words, the behavior itself is incorporated into the proximate causes of cooperation with respect to motivation and rewards. One aspect is how animals work together, e.g., Boesch and Boesch (1989), in their research on chimpanzees (*Pan troglodytes*), defined different levels of complexity when cooperating according to the way in which animals use each other. For example, synchrony occurs when animals perform similar actions toward the same goal related in time to the other participants' actions. Another prediction from the social-behavior perspective is that cooperation is influenced by social structure, i.e., existing relationships among chimpanzees were the best predictor of cooperative hunting (Mitani and Watts, 2001).

The overall aim of our research is to test this perspective on Bottlenose dolphins (*Tursiops truncatus*), a species known for coordinating behaviors that include breathing (Mann and Smuts, 1999; Hastie *et al*., 2003), foraging/ hunting (Reynolds *et al*., 2000) and consorting of females for mating (Connor, 2001). The first stage of our study was to document and analyze both association patterns (as one feature of social structure, see Cairns and Schwager, 1987) and spontaneous synchrony levels in dolphin pairs and the correlation between them. Evolutionary perspectives assume that the main determinant of synchrony derives from individual benefits without considering social structure (Trivers, 1985; Dugatkin, 1997). From that, one derived prediction is a high correlation between synchrony and association patterns, with low variance among participants. Evidence for significant deviations from this pattern would support the hypothesis that coordinated actions also influence, and are influenced by, social dimensions of relationships between specific individuals other than, or extending beyond, the contingency between individual behavior and immediate reward.

METHODS The study group consisted of 13 dolphins living in a semi-free marine enclosure at the "Dolphin Reef" site, Eilat, Israel. A gate was open to the sea all year round, 24 hrs a day, enabling the dolphins to have unlimited access to the open sea. Association patterns and synchrony levels between individuals were studied from April 2002 to January 2003 from an observation tower adjacent to the enclosure. The dolphins begin to congregate around the tourists' pier about 15 min before feeding time. We defined four areas inside and outside the enclosure and documented the dolphins' locations every minute during this period using the method of scan sampling (Altmann, 1974). A one minute interval was selected because this period is sufficient for the dolphins to move from any defined area to any other area, making the observations biologically independent. We assumed that association patterns are reflected by the different ways that dolphins cluster in the four defined areas while waiting for food. Half Weight Index (HWI) was used to estimate association patterns (Cairns and Schwager, 1987; Maze-Foley and Würsig, 2002), and Monte-Carlo iterations on the dolphins' locations were used to test for significance (i.e., a frequency distribution from 1,000 iterations was generated from permutations of the original data; in a two-tail test, any value exceeding 0.025 probability on the high or low tails of the distribution was considered significant, see Bejder *et al*., 1998). Surface breathing was selected to quantify synchrony differences between two dolphins swimming in close proximity (i.e., within one body length in the same direction and pace) because it is an objective, discrete and unambiguous event (Hastie *et al*., 2003). We defined four levels of synchrony based on variation in the timing of breathing: 1 – simultaneous; 2 – second dolphin breathes while first is still out; 3 – second dolphin breathes after first dolphin is already submerged up to a maximum of 10 sec; 4 – greater than 10 sec between breathing of two dolphins. The mean levels of synchrony were then converted to a scale of 0 to 1 in which 0 indicates the lowest level and 1 the highest level. Three age categories were defined: adults - sexually mature males and females (1M, 4F); adolescents - dolphins between 3-8 years of age (2M, 2F); and calves - dolphins under 2 years of age, still dependent on mothers (2M, 2F). Non-parametric statistical tests were used because there was no compliance with homoscedasticity or normal distribution (Sokal and Rohlf, 1995).

RESULTS Association levels differed significantly among age/sex categories (HWI, Kruskal-Wallis test: $p < 0.001$, Fig. 1). The highest levels, indicating strong attraction, were found between adolescent males and, as expected, between mothers and calves. The lowest levels, indicating repulsion (significantly lower than expected from random association), were found between adult and adolescent males, and random association levels were found between adult females and adolescent males.

Synchrony levels were significantly different between the five lowest categories ("poor" synchronizers: adult male/others; and all mixed adult/adolescent categories) and the five highest categories ("good" synchronizers: adolescent pairs, adult female pairs and mother/calf pairs) (Mann-Whitney U-test: $p < 0.005$, Fig. 2).

There was considerable variation in the relationship between levels of association and synchrony. Overall, HWI and synchrony levels were positively correlated (Pearson correlation $r = 0.35$, $p = 0.015$, Fig. 3). Mother/calf pairs and the adolescent male pair were both good synchronizers and had high association levels. In contrast, although the adult male had high association levels with the adult females, the synchrony levels were low. Both low association and low synchrony levels characterized the adult male with the two adolescent males, most adult female/adolescent male pairs, and the alpha/beta female pair. Relationships among other adult female pairs varied widely.

DISCUSSION AND CONCLUSIONS The individual perspective in both Evolutionary Biology and Psychology predicts that cooperation, like any other behavior, will be best explained by the contingency between the behavior and outcomes for each individual (Skinner, 1953: 301; Lindsley, 1966; Weingarten and Mechner, 1966; Hake and Vukelich, 1972; Brown, 1983; Clements and Stephens, 1995; Dugatkin, 1997). One prediction is that each individual's preference among cooperation partners should be based mainly on the total outcomes obtainable with each partner. For example, it is the most rewarding to cooperate with the partner that is the best hunter while foraging (Boesch and Boesch, 1989), or to choose the strongest ally in agonistic confrontations (de Waal, 2000).

In some cases, however, evolutionary models following explanations such as kin selection fail to predict the incentives for cooperation (Möller *et al*., 2001; Mitani and Watts, 2001; Krützen *et al*., 2003). In the case of synchronization in dolphins and other species, five explanations (not mutually exclusive) have been suggested for proximate advantages at the individual level: 1) decreased drag effects while swimming in order to increase swim efficiency (Mann and Smuts, 1999); 2) decreased predation risk (Whitehead, 1996; Hastie *et al*., 2003); 3) increased bonding relations between partners (similar to what has been found in birds, see Todt and Fiebelkorn, 1972; Todt, 1975; Todt *et al.,* 1981); 4) decreased stress between competitors (Schuster, 1976; Todt, 1981; Dugatkin, 1997: 71-73); and 5) enhanced vocal, visual and tactual communication, especially in areas exposed to high ambient noise pollution (Hastie *et al*., 2003). The first four explanations predict that synchrony levels will be the highest in specific associations, e.g., mother-calf pairs (1st and 2nd explanations), male-female pairs (3rd explanation), and among all-male or all-female pairs (4th explanation). The 5th explanation predicts that there should be no effect of specific patterns of association.

If cooperation is also analyzed as a social behavior, synchrony levels will be influenced not only by immediate consequences but also by a broader range of social variables such as kinship, temperament, age/sex groups, social hierarchy, and current and previous relationships. (Schuster, 2001, 2002). Without analyzing each of the above variables, it is possible to identify their combined effect, the social structure, and specifically the association levels between all group members as one representation of social structure (Cairns and Schwager, 1987). Our data show that the individual-evolutionary perspective by itself is insufficient for predicting our observed correlation between association patterns and synchrony. Whereas high mother-calf synchrony levels were as expected from individual-level explanations (1st and 2nd explanations, although there is no predation risk inside the enclosure), male-female relations were highly dependent on age category, a relationship inconsistent with the 3rd explanation. Although adult male/female pairs exhibited high association levels, there were all poor synchronizers. In the opposite direction, whereas adolescent male/female pairs were good synchronizers, association levels varied with the age of females. The 4th explanation, the influence of social conflicts, was also not a good predictor for synchrony levels. The pairs with the highest levels of conflict, adult male/adolescent male pairs and alpha/beta female pair were all poor synchronizers with low association levels. Social factors such as dominance hierarchy, sex and age groups revealed differences between categories in both association and synchrony levels, and the positive correlation between synchrony levels and association patterns, although significant, revealed a low r^2 value due to high variance among pairs. Thus, the 5th explanation predicting similar levels among all group members was also a poor predictor of synchrony. The insufficiency of individual-level explanations alone for predicting levels of synchrony in our research suggests that the synchrony between mother and calf may arise in part from social processes as well.

Overall, the prediction from the individual-evolutionary perspective of a strong link between synchrony levels and association patterns was not supported by our observations. The low correlation level and the great variance among different individuals support the social behavior perspective predicting that coordinated actions influence, and are influenced by, social dimensions of relationships between specific individuals that extend beyond the contingency between individual behavior and immediate reward. These findings support the prediction that cooperation is influenced by social structure and will be the baseline for future experimental studies of cooperative behaviors.

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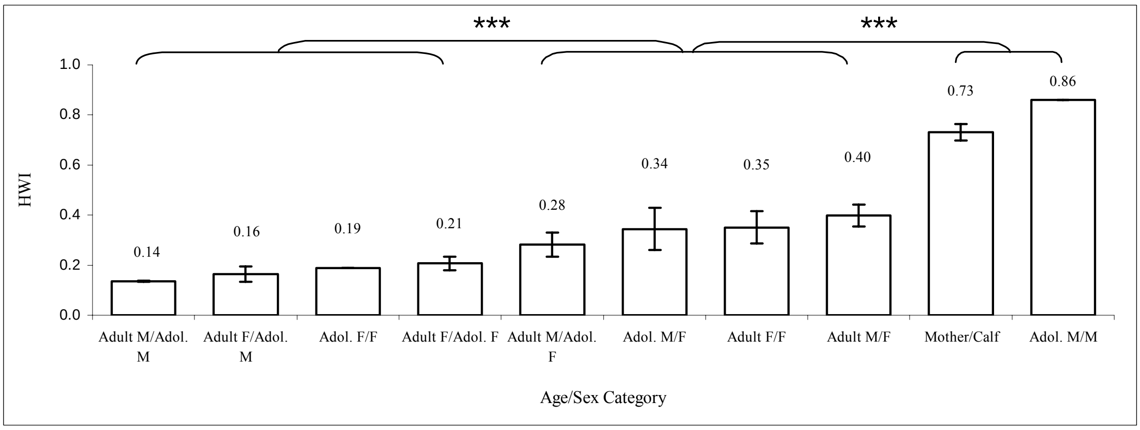

Fig. 1. Association patterns measured by HWI between age/sex categories (M = Male, F = Female, Adol. = Adolescent)

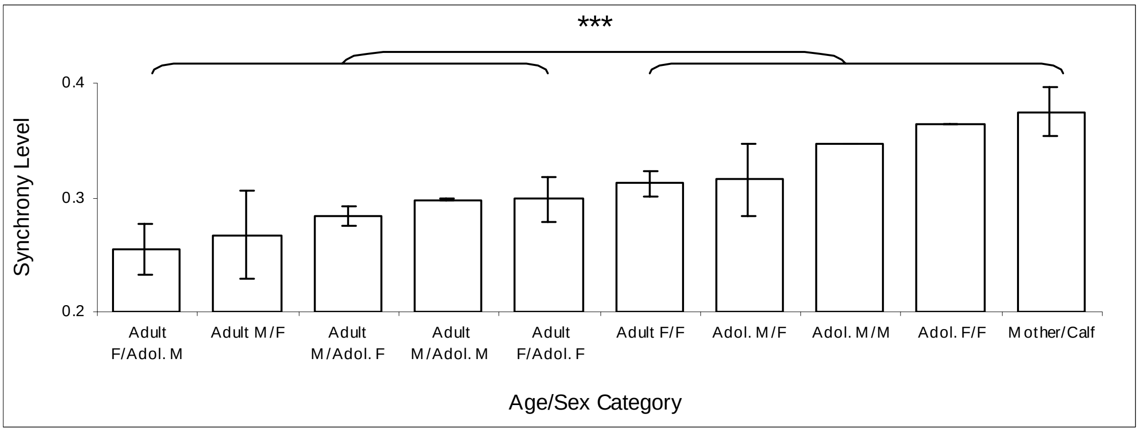

Fig. 2. Synchrony levels between age/sex categories (M = Male, F = Female, Adol. = Adolescent)

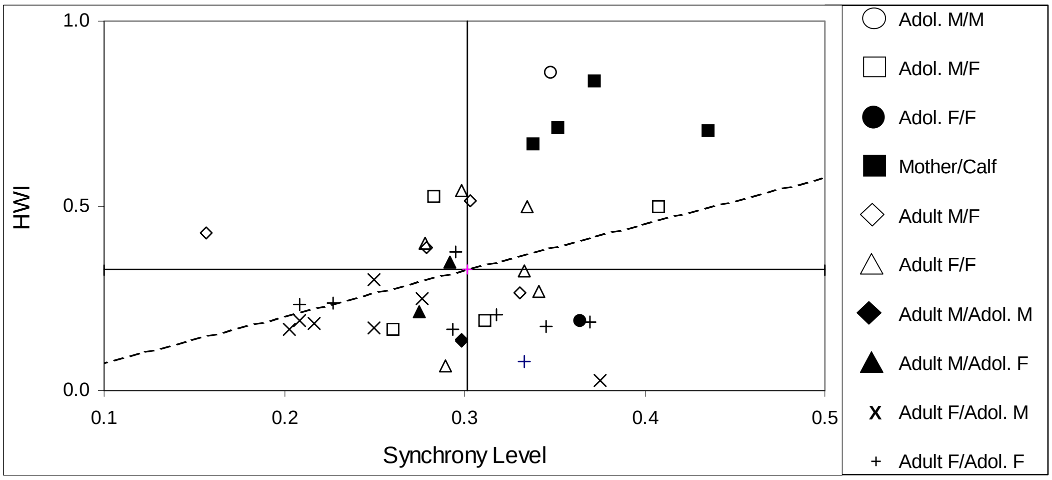

Fig. 3. Correlation between HWI and synchrony levels (M = Male, F = Female, Adol. = Adolescent)

BOAT-RELATED BEHAVIOURS OF CETACEANS AS A TOOL FOR THE DEVELOPMENT OF SPECIES-SPECIFIC WHALE WATCHING GUIDELINES

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INTRODUCTION Since the 1990s, the whale watching industry has world-wide growth rates of more than 10% per year and the numbers of whale watchers has increased exponentially to more than 10 million in 2000 (Hoyt, 2001). Despite the need for stricter control, whale watching regulations often lack scientific background or are too vague (Herzing, 1995). Rarely the spectrum of the whales' and dolphins' reactions to boats is known hardly ever it is documented scientifically.

Different species (re)act in different ways, and even within a species the behaviour can vary (Frohoff and Dudzinski, 1996; Constantine, 1997; Ritter, 2003). Off La Gomera (Canary Islands), numerous cetacean species can be sighted, some of them staying all year round (Ritter, 2001). Here it is feasible to study their behaviour in a comparative way in the context of still moderately developed whale watching activities. The study arose from a co-operation between a tour operator and the German NGO M.E.E.R.

MATERIALS AND METHODS From 01 September 1995 until 31 December 2001, behavioural interactions of cetaceans with whale watching boats were studied. Data were collected during regular whale watching trips. Eight behavioural units defined as boat-related were sampled: *approach* (APP), *scouting* (SCO), *bowriding* (BOR), *wake riding* (WKR), *spyhop* (SPY), *orientation towards the boat* (ORI), *accommodation of speed* (ACS) and *accommodation of direction* (ACD) (Ritter, 2002). Additionally, sightings were categorised into *avoidance*, *no response*, *proximity* and *interaction* (compare Würsig *et al*., 1998). Non-parametric statistical tests were used to answer the following questions:

- Is there a difference between species in the frequency of occurrence of boat-related behaviours?
- Do the species differ in the occurrence of sighting categories?
- Does the frequency of boat-related behaviours vary in different behavioural states?

RESULTS A total of 1680 samples (80.2 hours of observation) were analysed: 600 (30 h) for bottlenose dolphins (*Tursiops truncatus*), 363 (18.2 h) for rough-toothed dolphins (*Steno bredanensis*), 356 (17.8 h) for pilot whales (*Globicephala macrorhynchus*), 284 (14.2 h) for Atlantic spotted dolphins (*Stenella frontalis*), 39 (2 h) for striped dolphins (*Stenella coeruleoalba*) and 38 (1.9 h) for common dolphins. 268 sightings, additionally comprising encounters with dense beaked whales (*Mesoplodon densirostris*), were categorised.

The predominant type of boat-related behaviour was *bowriding* (41% of samples), followed by *approach* (26%) and *scouting* (13%, see Fig. 1). *No response* (35%) and *proximity* (31%) made up the major part of sighting categories, *interaction* 24% and *avoidance* 10% (see Fig. 2).

Bottlenose dolphins showed a wide range of responses to boat presence and their behaviour was not predictable. Atlantic spotted dolphins interacted with boats more than all other cetaceans off La Gomera. Pilot whales in general were not attracted by boats, although they could be easily approached. Rough-toothed dolphins showed a marked ambiguity, sometimes being inquisitive, on the other side behaving quite reserved. The common dolphin in general appeared to be "open" for attractions from outside. Of the delphinids, striped dolphins were the least easy to approach, they generally behaved warily. Sightings of dense beaked whales typically lasted only about 2-3 minutes with the whales disappearing afterwards.

Some species performed all types of boat-related behaviours, others didn't. The frequency of boat-related behaviours differed significantly between the species for all but two boat-related behaviours (Kruskal-Wallis, all df=5, all H>25.5, all $p \leq 0.001$ for APP, BOR, WKR, ORI, ACS and ACD). Only *scouting* and *spyhop* showed non-significant results (Kruskal-Wallis, both df=5, SCO: H=6.885, p=0.227; SPY: H=1.486, p=0.958). Also, the frequency of sighting categories differed significantly between six species (Pearson Chi-Square=200.186, df=18, $p<0.001$).

Relating the frequency of boat-related behaviours with behavioural states, the results were highly significant for the bottlenose dolphin (Chi-square=52.984, df=4, $p<0.001$) and the Atlantic spotted dolphin (Chi-square=18.804, df=3, $p<0.001$). Bottlenose dolphins interacted more than expected (by chance) during *travel*, and less than expected during *dive* and *dive travel*. In the spotted dolphin, during *travel* and *milling* the animals interacted more than been expected and less during *socialising* and *surface* *feeding* behaviours. In the pilot whales, though not significant, during *resting* behaviour the animals interacted more with the boats than expected.

DISCUSSION Different cetacean species (re)acted differently in relation to whale watching boats, strongly suggesting that each species has its own character, which is reflected by the way the animals are dealing with vessel presence. The results can be used to establish species-specific and behaviour-specific guidelines for boat-based whale watching: The likelihood of occurrence of boat-related behaviour in different cetacean species was ranked (see Table 1). A listing of this kind is a valuable tool for whale watching skippers (and boat drivers in general) to evaluate, which kind of interaction can be expected and to accommodate their conduct accordingly.

In Table 2, proposals for the best conduct so as to acknowledge different responsiveness according to behavioural states, is presented. Rules should be established recognising *feeding/foraging* and *social* behaviours to be critical activities with a higher degree of co-ordination and intra-group interactions and thus should be dealt with special care. *Resting* pilot whales should be left alone soon after the recognition of this behaviour.

The establishment of species- and behaviour-specific guidelines is but one way to protect cetaceans from (excessive) whale watching. To further apply the precautionary approach, it is recommended to establish a marine protected area the waters south of La Gomera (MPA). This should be an *MPA of IUCN Category VI: a protected area mainly managed for the sustainable use of cetaceans* (see Salm *et al*., 2000), to bring fisheries, recreational use and whale watching in line within the same area. Thus a basis can be created for the reconciliation of economic development and ecologic sustainability. A detailed presentation of a model for an MPA off La Gomera is given in Ritter (2003).

ACKNOWLEDGEMENTS M.E.E.R. e.V. is supported by: Gesellschaft zur Rettung der Delphine, Deutsche Umwelthilfe, Whale and Dolphin Conservation Society,Lighthouse Foundation, TUI & Pentax. This research is hosted by the University of La Laguna (Tenerife) and the Humboldt University (Berlin). Many thanks to the local whale watching operator on La Gomera (Club de Mar, VGR) for the constructive co-operation over years.

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Table 1. Likelihood of occurrence of boat-related behaviour in different cetacean species (organised according to decreasing likelihood of interactions)

Species	Interactions to be expected	Likelihood of occurrence
Atlantic spotted dolphin	**Interactions in general**	**Very likely**
(Stenella frontalis)	**Close distance**	**Likely**
	Approach	Very likely
	Bowriding	Very likely
	Scouting	Likely
	Accommodation of speed	Possible
	Accommodation of direction	Possible
Common dolphin	**Interactions in general**	**Likely**
(Delphinus delphis)	**Close distance**	**Likely**
	Scouting	Likely
	Approach	Likely
	Bowriding	Likely
Bottlenose dolphin	**Interactions in general**	**Depending on behaviour**
(Tursiops truncatus)	**Close distance**	**Depending on behaviour**
	Scouting	Possible
	Approach	Possible
	Bowriding	Possible
Pilot whale	**Interactions in general**	**Less likely**
(Gl. macrorhynchus)	**Close distance**	**Possible**
	Orientation towards boat	Possible
	Approach	Possible
	Scouting	Less likely
Rough-toothed dolphins	**Interactions in general**	**Less likely**
(Steno bredanensis)	**Close distance**	**Less likely**
	Approach	Likely
	Scouting	Possible
	Bowriding	Less likely
Striped dolphin	**Interactions in general**	**Unlikely**
(Stenella coeruleoalba)	**Close distance**	**Unlikely**
	Bowriding	Less likely

Table 2. Relation of interactions and behavioural states in four cetacean species off La Gomera with proposals for the "best conduct"

Species	Behaviour	Best conduct
Atl. spotted dolphin *(Stenella frontalis)*	**SOCIAL**	**Keep observation to a minimum of time** **Do not approach animals closer than 100 m**
	Close distance	Possible
	Interactions with boat	Less likely
	SURFACE FEEDING	**Keep observation to a minimum of time** **Do not approach animals closer than 100 m**
	Close distance	Possible
	Interactions with boat	Less likely
Bottlenose dolphin *(Tursiops truncatus)*	**DIVE/ DIVE TRAVEL**	**Keep observation to a minimum of time** **Do not approach animals closer than 100 m**
	Close distance	Not possible
	Interactions with boat	Unlikely
Pilot whale *(Gl. macrorhynchus)*	**REST**	**Leave animals after 15 minutes the latest** **Inform others not to approach the group**
	Close distance	Possible
	Interactions with boat	Possible
Rough-toothed dolphin *(Steno bredanensis)*		**In general: very careful conduct** **The type of approach will influence the responsiveness of the dolphins**

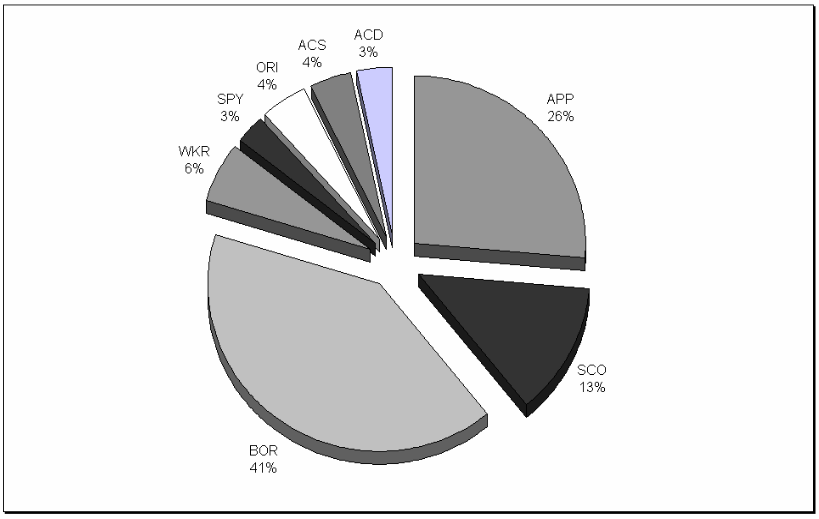

Fig. 1. Relative frequency of boat-related behaviours (all species).

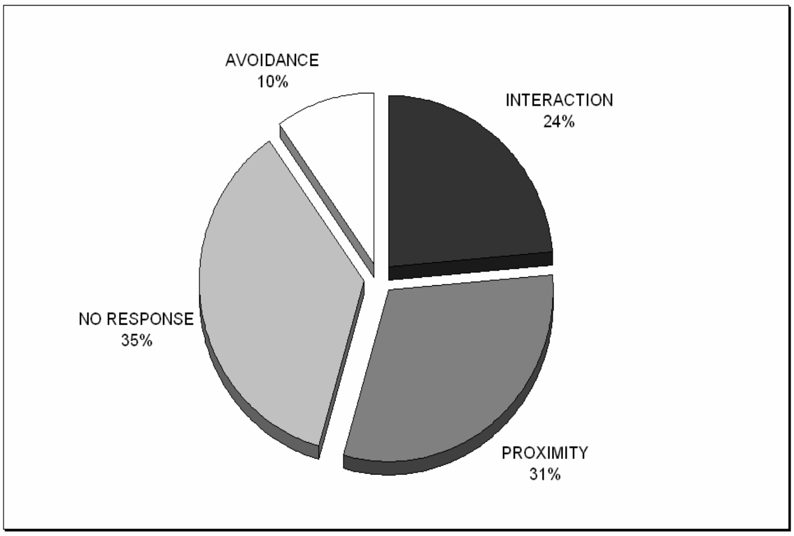

Fig. 2. Relative frequency of sighting categories (all species)

SIGNATURE WHISTLES OF BOTTLENOSE DOLPHINS: A REVIEW

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David and Melba Caldwell (1965) were the first to report that bottlenose dolphins produce whistles with stereotyped, individually distinctive contours, which they called "signature whistles". I will review current findings on signature whistle development, stability, and functions, as well as present several ongoing areas of research in my laboratory, all of which utilise a unique database of whistles recorded from known, temporarily captured free-ranging dolphins in Sarasota, Florida. The first data set addresses whether signature whistles are produced by undisturbed, free-ranging dolphins. Whistles recorded during 150 hours of observations of free-ranging dolphins were matched to those produced by the same dolphins during temporary capture. Approximately 52% of all whistles recorded from undisturbed dolphins were signature whistles. The second research area focuses on whistle stability, by measuring frequency parameters of whistles recorded from individuals over periods of 5-25 years. Results indicate that females with calves that develop whistles similar to their own are more likely to change their whistles over time than are other females; analysis of data from males is ongoing. Third, I will present data that test a recent claim by McCowan and Reiss (2001) that all or most whistle types are shared among dolphins, and that prior reports of signature whistles were biased by selection of certain exemplars from each individual. We are asking a large pool of judges to visually sort a random sample of 20 whistles from each of 20 dolphins (10 male, 10 female). Preliminary data indicate that whistles are grouped reliably according to the identity of the vocaliser, in contrast to the predictions of McCowan and Reiss. Finally, I will critique the paper by McCowan and Reiss that claims that signature whistles do not exist, and I will attempt to reconcile their data with the large body of data in support of signature whistles.

BEHAVIOURAL LANDMARKS IN THE DEVELOPMENT OF NEONATAL BELUGA WHALES (*DELPHINAPTERUS LEUCAS*)

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The careful documentation of the behavior of newborn captive animals can provide age-related landmarks against which the adequacy of behavioral development in subsequent captive newborns can be assessed. Such landmarks can also prove useful for researchers in estimating the age of young animals that are observed only briefly in the wild. We report here on the postnatal behavior of two beluga whales that were born one week apart at Marineland of Canada. A scan-sampling paradigm was employed that assessed behavioral state, inter-whale distance, and inter-individual touching every 60 seconds over 45 hours of observation (1 hr/day, 3 days/week). Observations were made in real time and subsequently validated for reliability via blind videotape review. Both newborn belugas were nearly stationary on 80% of observations during their first week of life (in contrast to the nearly constant swimming that is characteristic of neonatal dolphins and orcas), a proportion which gradually declined to 30% by the 7th week of age. Not surprisingly, in their first weeks of life, the calves were found in very close proximity to their mothers on the majority of observations. However, at the 4th week of age it was noteworthy that both calves showed a significant increase in the amount of time they spent at a distance of more than 5 m from their mothers. Nevertheless, although they shared the same enclosure, it was not until the 7th week of age that the two calves were observed to make direct contact with each other. Both calves and their mothers showed quite similar behavioral progressions in the postpartum weeks, suggesting that the documentation of age-specific behavioral norms can be achieved.

FEASIBILITY STUDY: LAND-BASED OBSERVATIONS OF CETACEANS ON LA GOMERA (CANARY ISLANDS)

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INTRODUCTION Off La Gomera (Canary Islands), 21 cetacean species have been reported (Ritter, 2001). This extraordinary species diversity represents an outstanding potential for both scientific research and whale watching activities. Some of the species are regularly encountered close to the shore. While a boat-based study on human-cetacean interactions is going on since several years (Ritter, 2003), no effort has been made to date to systematically observe cetaceans from land. The coast of La Gomera predominantly is rocky and steep, and heights of up to several hundred metres are reached within short distances from the shoreline, thus constituting favourable conditions for such a scheme.

La Gomera has a moderate whale watching commerce, based in Vueltas (Valle Gran Rey, where much of the island's tourism is concentrated), in the southwest of the island. Whale watching has grown comparably slow during the last few years. However, a strong expansion of tourism activities can be witnessed on the island. The harbour of Vueltas is being re-built suited for large ferries and incorporating a huge marina. Hence, an expansion of seagoing tourist activities is foreseeable. This study was conducted to obtain preliminary knowledge about the following questions:

a) Are behavioural observations of cetaceans from an elevated viewpoint possible?
b) Is it possible to observe interactions between boats and cetaceans? and
c) Is it feasible to direct whale watching boats to groups of cetaceans spotted from land?

MATERIALS AND METHODS In October 2002, a suitable vantage point was searched for. The south coast of La Gomera is largely uninhabited with few roads and pathways, many existing ones often are in a bad condition. Several locations were verified for their accessibility. A viewpoint was chosen, lying at the tip of the "Lomo de Arguyaoda", approximately 160 m above sea level. Observations were made from 04-10 October 2002. A *KOWA Prominar TSN-3* telescope with 20x, 30x wide angle and 20-60x oculars, mounted on a Manfrotto 144B tripod, and a standard pair of binoculars (8x) were used. Communication between the observer on land and skippers on board of whale watching vessels was established via mobile phones.

RESULTS A total of 13 h 25 min of sighting effort was made, resulting in five cetacean sightings and 2 h 53 min of observation (22% of sighting effort). During three sightings, the species could be determined: bottlenose dolphin (*Tursiops truncatus,* two sightings) and pilot whales (*Globicephala macrorhynchus*). During two sightings, either bottlenose or rough-toothed dolphins (*Steno bredanensis*) were seen. The distance of the groups varied from approximately 1-3.5 nm from shore.

During four sightings it was possible to conduct behavioural observations by determining group formation, movement patterns, travel direction and recording individual behaviours like breaches, leaps, etc. Interactions of cetaceans with whale watching boats were recorded in three instances: the swimming direction in relation to the boat was identified and bowriding behaviour was recorded. On 10 October, a whale watching boat was directed to a group of pilot whales via mobile phone.

DISCUSSION The idea of land-based observations of cetaceans and to guide boats to cetaceans sighted from land originates in the Azores, where so called "vigias" (Gordon and Matthews, 1999) are used for these purposes since many years (Hoyt, 2001). With this study it was demonstrated that this is principally feasible also on Gomera. We were able to show that observation of cetacean behaviours and their interactions with boats are feasible and it is realistic to direct whale watching boats to cetaceans spotted from land.

These results will add to the development of a detailed, land-based study. The aim is to establish a practical and methodological basis for monitoring cetacean abundance and behaviour, as well as vessel activities and interactions with cetaceans in the South of La Gomera. Moreover, the possibility to direct whale watching boats to cetaceans can be used to improve sighting success of whale watchers.

This study has great relevance to the development of whale watching on a sustainable ground on La Gomera: if more boats will set out to search cetaceans on a regular basis, with a land-based look-out it will be possible to disperse

boat presence over a greater area, thus minimising the total time cetacean groups are subjected to boat presence monitor whale watching boat activities and control their compliance to the Canarian whale watching regulations
It is also thinkable to observe and document reactions of cetaceans to fast ferries operating in the area. For these reasons, it is recommended to establish a permanent outlook on the coast of La Gomera.

ACKNOWLEDGEMENTS This study was conducted with the support of the Gesellschaft zur Rettung der Delphine and TUI Germany. The project *M.E.E.R. La Gomera* is also supported by: Deutsche Umwelthilfe, Lighthouse Foundation and Pentax.

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INDIVIDUAL DIFFERENCES IN MATERNAL BEHAVIOUR PROFILE IN BOTTLENOSE DOLPHIN: PRESENCE OF CRUCIAL FACTORS?

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INTRODUCTION Individual differences in behaviour, found in virtually all species, are potentially important in the adaptive sense. Because parental care is a costly component of reproduction, individual differences in it may have important evolutionary implications. Furthermore, it has been recently described that temperament disposition and experience affect mothering style in many mammal species.

This study analyzed whether individual differences in pattern of maternal care are related to distinctive features involving experience, environment and social context in bottlenose dolphin (*Tursiops truncatus*).

MATERIALS AND METHODS Since 1993, a behavioural research program on maternal care in bottlenose dolphin has been conducted for definite time periods in two different Italian Delphinaria placed in Rimini and Cattolica. During the observational phases, each facility housed two females (a nulliparous one and a multiparous one) with their calves and, at the Rimini's Delphinarium, two males (Table 1).

A specific ethogram with a 32 behavioural elements, organized into three main categories ("Locomotory and Postural Behaviours", "Female/Female Interaction" and "Mother/Calf Interaction") was used for the data collection (Table 2). Selected displays including swim activities, general interactions and physical contacts were analyzed for the purpose of this study.

Individual-follow (continuous sampling) method (Mann, 1999) was applied to systematically monitor the behaviour of each female over one year after parturition (Cattolica's Delphinarium: June 1993 – July 1994; Rimini's Delphinarium: May 1995 - June 1996 and June 1997 – July 1998). Observation times were randomized among 3-hr periods and balanced for equal representation within a month and at different times of day (observational phase: from 08:00am to 08:00 pm). A total number of 466 hours of observation was recorded. Frequency and duration values were first analysed by means of Observer 3.0 software (Noldus, 1997) and then statistically investigated with ANOVA and χ^2 Test.

RESULTS Both nulliparous females (Beta and Isa) had the opportunity to observe the parturition of the other female present in the pool before to gave birth to their own calves, probably gaining specific maternal skill.

No major differences in the three main behavioural categories were found between the four mothers (all χ^2 Tests no significant), even if individuals housed in the same environment showed a higher degree of similarity in their values (Fig.1).

However, the monthly trend of "swim in association" as well as "mother/calf interaction" revealed significant differences both between animals in the same pool and within structures (all ANOVAs $p<0,05$), underlining the possible influence of primiparity and the potential weight of an enriched social context at the Rimini's Delphinarium. In particular:

- Both multiparous females (Alfa and Candy) allowed the primiparous ones to spend a considerable amount of time with them, especially during the first three months of the calves' life; possibly, this phase corresponded to a crucial period for the "education" of the future mothers and represented a useful social tool for the mother-calf pairs. On the other hand, primiparous females (Beta and Isa) seemed to be less associated with the expert mothers, remaining principally with their own calves for the entire year of the study (ANOVA not significant, $p>0,05$; Fig. 2).

- The Rimini's environment, with the presence of individuals other than females, appeared to be more complex, often stimulating - in the mother/calf pairs - the emergence of individual behavioural responses to reliant conditions (Fig. 3).

CONCLUSIONS This study revealed a complex pattern of relationship between environment, maternal behaviour and individual behavioural profiles. A number of different papers reported that individual differences in bottlenose dolphins can occur in both spatial and social behaviour. The open questions are how individual differences in a situation are related to those in other situations and what their ecological consequences may be.

ACKNOWLEDGEMENTS We thank Rimini's and Cattolica's Delphinarium owners and trainers for the logistic support, and all the students who took part into the project.

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Table 1. Subjects and social contest in the Rimini and Cattolica Delphinaria

a) RIMINI DELPHINARIUM			
BEHAVIOUR	SEX	BIRTH DATE	PROVENIENCE
ALFA (multiparous)	F	1979	Gulf of Mexico
BETA (primiparous)	F	1981	Gulf of Mexico
SPEEDY	M	1970	Adriatic Sea
SOLE	M	03 May 1993	Born in captivity (Alfa x Speedy)
LUNA	F	12 May 1995	Born in captivity (Alfa x Speedy)
BLUE	F	26 June 1997	Born in captivity (Beta x Speedy)

b) CATTOLICA DELPHINARIUM			
BEHAVIOUR	SEX	BIRTH DATE	PROVENIENCE
CANDY (multiparous)	F	1978	Texas
ISA (primiparous)	F	1986	Cuba
TABO	M	15 June 1993	Born in captivity (Candy)
GOLIA	M	06 July 1993	Born in captivity (Isa)

Table 2. Ethogram

	BEHAVIOUR	DESCRIPTION and REFERENCE
LOCOMOTORY and POSTURAL BEHAVIOURS	Swim	The usual mode of swimming or normal swimming posture (Renjun *et al.*, 1994)
	Exploratory behaviour	Scanning horizontal/perpendicular to the bottom (Herzing, 1996)
	Loop	Looping near surface (Martinez and Klinghammer, 1995)
	Pool rub	Dolphin is rubbing side/ventral, back area on bottom (Herzing, 1996)
	Stand	Dolphin is lying motionless (Herzing, 1996)
	Rest	The animals floated at the surface of the water without any body movements, the blowhole only was exposed to the air, the breathing frequency was reduced and the small eyes appeared to be closed (Renjun *et al.*, 1994)
	Arch	Bends head and peduncle towards back or belly (von Streit and von Fersen, 1996)
	Flexion	The tail, and also the head, moved ventrally (the tail approached an angle of 45 degrees from the horizontal); the body form an arch and the muscle appeared taut. Then the animal relaxed and the tail was raised dorsally (Tavolga and Essapian, 1957)
	Open mouth	The mouth is opened either partially or fully for some time; the tongue may be extended (Martinez and Klinghammer, 1995)
	Shaking flipper	Shaking the flippers (von Streit and von Fersen, 1996)
	Somersault	Tail ventrally/dorsally over head in a somersault [*Anonymous at Monkey Mia (Australia), 1990]
	Roll	The body is rotated through 360° on the longitudinal axis to either side of the dolphin (Renjun *et al.*, 1994)
	Jaw clap	An animal clap his jaws together forcefully to produce a sharp loud sound, as form of intimidation or displeasure (Tavolga and Essapian, 1957)
INTER ALE	Contact	Any behaviour which involved physical contact between two animals; a "bout" of interaction began when one dolphin touched the other and continued until they moved greater than one body length apart (Nelson and Lien, 1994)

	Rub	Strenuous action in which one dolphin swimming at a fast pace advanced upon another and rubbed part of his body vigorously against his; vigorous contact of the two bodies along their length (Tavolga and Essapian, 1957)
	Chase	In varied form, but characteristically when chasing is in progress the animals swim inverted at high speed just below the surface (Saayman *et al*., 1973)
	Bite	Open-jawed sparring and mock threats between two opposing animals and rake marks were sometimes left on the head and torso; flukes, peduncle and dorsal fin were target areas (Saayman *et al*., 1973)
	Tail hit	A dolphin strikes another violently whit its flukes / peduncle [*Anonymous at Monkey Mia (Australia), 1990]
MOTHER/CALF INTERACTION	Beack-genital propulsion	One dolphin uses its rostrum to nudge the genital area of another dolphin who is lying stationary on its side (Shane, 1990)
	Clasp	Taking between flippers [*Anonymous at Monkey Mia (Australia), 1990]
	Hold down	Dolphin, or group of dolphins, holds another down on bottom (Herzing, 1996)
	Contact	Any behaviour which involved physical contact between two animals; a "bout" of interaction began when one dolphin touched the other and continued until they moved greater than one body length apart (Nelson and Lien, 1994)
	Rub	Strenuous action in which one dolphin swimming at a fast pace advanced upon another and rubbed part of his body vigorously against his; vigorous contact of the two bodies along their length (Tavolga and Essapian, 1957)
	Bond	Actor dolphin rests its pectoral on the flank of another, behind the other's pec and below or just posterior to his dorsal fin [*Anonymous at Monkey Mia (Australia), 1990]
	Chase	In varied form, but characteristically when chasing is in progress the animals swim inverted at high speed just below the surface (Saayman *et al*., 1973)
	Bite	Open-jawed sparring and mock threats between two opposing animals and rake marks were sometimes left on the head and torso; flukes, peduncle and dorsal fin were target areas (Saayman *et al*., 1973)
	Push	Pushing with the beak, the side or ventral part another animal (Pilleri, 1986)
	Unsuccesful suckling	When there isn't cessation of infant body movements (Peddemors *et al.,* 1992)
	Suckling	When the calf insert its lower jaw into the mother's uro-genital groove and the upper jaw is in contact with the lateral skin of the mammary gland, it suffens its neck as if bracing , with a cessation of tail flexing (Peddemors *et al*., 1992)
	Bumping	The calf swims in close proximity to the mammary glands often touching the glands with a part of its body (Peddemors *et al*., 1992)
	Nurturant behaviour	Mother appears to reprimand her calf for transgression and remove him from impending danger (Cockcroft and Sauer, 1990)

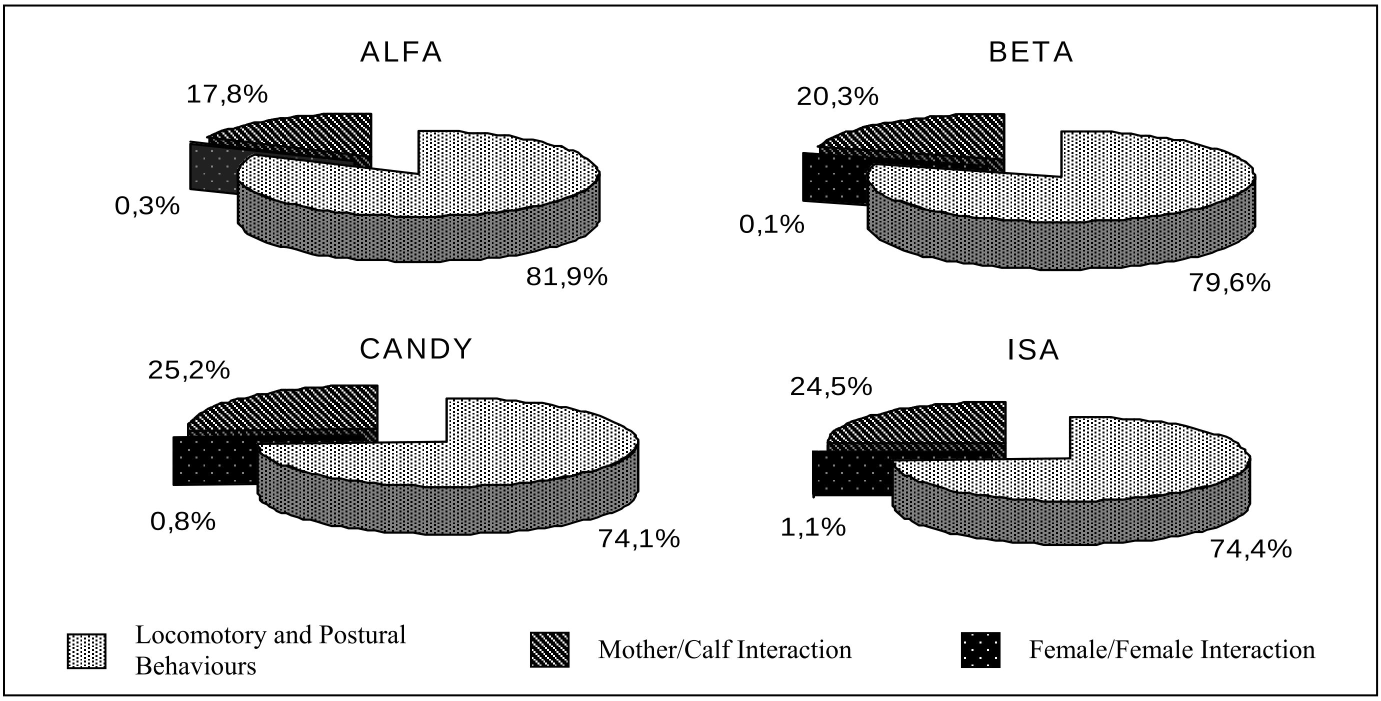

Fig. 1. Behavioural categories frequency distribution

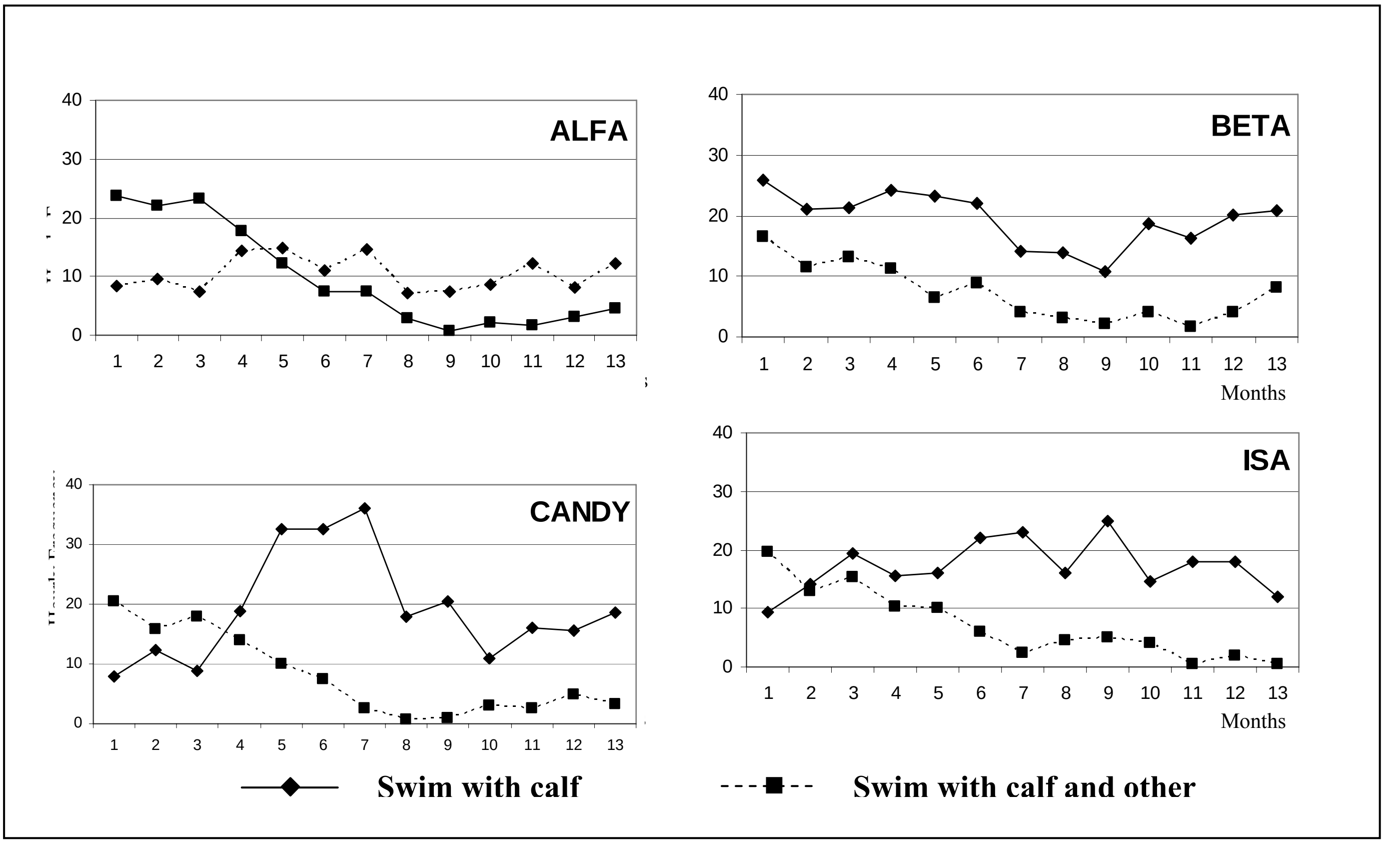

Fig. 2. Swim in association monthly trend

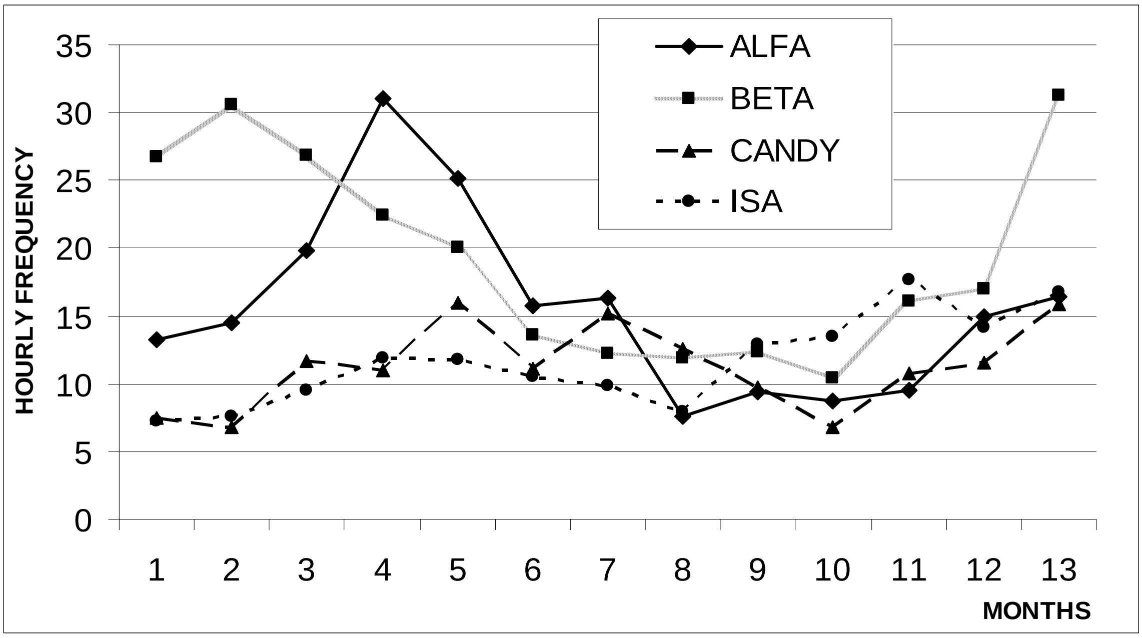

Fig. 3. "Mother/calf" interaction monthly trend

MINKE WHALES RESPOND TO FOOD STRESS IN A MAIN FEEDING GROUND

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INTRODUCTION The St. Lawrence estuary in Eastern Canada is a main feeding ground for rorqual whales offering rich concentration of krill and fish during the summer months while supporting an extensive whale-watching industry. Minke whales (*Balaenoptera acutorostrat)* exhibit site tenacity in feeding sites (Dorsey, 1990; Gill and Fairbairns, 1995) with a high degree of multiple-site tenacity and multiple-area fidelity aggregating along the 50 to 100 m bathymetric line of the Laurentian Channel headwaters (LCH) (Zeppelin, 1998; Tscherter and Lynas, 2001) where euphausiids and fish is abundant (Simard, 1986a; Bailey *et al.*, 1977).

Thus, the distribution of minke whales relates to the abundance of schooling fish which in turn is largely predicted by the distribution and density of euphausiids. Therefore the spatio-temporal distribution of individuals is likely to reflect the concentration of prey.

METHODS From June to September 1999 – 2002, minke whales were daily (weather permitted) photographed and identified according to natural markings along their dorsal fins (DEM method), (Tscherter *et al.*, in submission). GPS technology was used to locate and plot the sightings of each animal.

Spatial distribution Only identified minke whales have been used in the analyses of the spatial distribution counting all sightings of the individuals per month (n = 1987). In 1999, similar to previous years, 97.4% (n = 385) of the minke whales aggregated along the slopes of the Laurentian Channel Head where strong upwellings and tidal currents entrap the prey. There were only rare sightings in the Saguenay mouth area (personal communication). In the following years, sightings within the LCH decreased steadily; 76.8% in 2000 (n = 607), 31.9% in 2001 (n = 464), and 28.6% in 2002 (n = 531) (Fig. 1). The shift of sightings outside of the LCH started in mid-August 2000 maybe in response to a decrease in food productivity in the estuary. Certain individuals left the estuary, while the remaining minke whales moved into shallower waters south of the Saguenay mouth (2000), as well as into the Fjord itself (2000 - 2002) and further upriver (2002) (Fig. 3).

Temporal distribution Only identified minke whales have been used in the analyses of the temporal distribution counting one sighting per individual per month (n = 800). The number of sighted and identified whales in 1999 – 2002 (corrected for study effort and logarithmically transformed) is significantly different in the monthly progress (Generalised Linear Model: for interaction year and month, n = 20, df = 11, $\chi^2 = 130.8820$, p = 0.0001). The missing value was estimated with the mean of the October counts of the other years. The graph shows that the sighting numbers increased steadily throughout the season 1999 with a peak in September. In following years the peak shifted to August (2000) and July (2001, 2002) with a continuous decrease afterwards (Fig. 2).

Adapting to a different environment Animals which moved into the Saguenay Fjord adapted their feeding behaviour to this habitat where physical and oceanographic characteristics such as visibility, tidal currents, and fronts, strongly differ from the ones in the LCH environment. This was evident in their long phase of entrapment manoeuvres with multi-directional surfacings, lateral chin-up blows, underwater blows and frog lunges, finally ending in one feeding strike which was always a lateral arc right side down. Such visible entrapment manouevres have never been observed in the LCH where only the final feeding stikes (lunges and arcs in different planes) can be observed.

DISCUSSION Since summer 2000, the temporal distribution of the most ichthyophagous minke whales has changed significantly and the spatial distribution has shifted markedly indicating a change in prey availability (quantitatively and qualitatively) within the Laurentian Channel Head. While individual minke whales and most of the second abundant rorqual species, the finback whales, responded by leaving the area, certain individuals moved into new areas. In addition, changes in feeding techniques, lower feeding strike rates, higher breathing rates, and an above-average number of groups and undernourished animals have been recorded.

We predict that minke whales will react to a normalisation of the food productivity by moving back into the Laurentian Channel Head adjusting their temporal and spatial distribution. On the other hand, if the low food productivity continues, the long-term effects on the minke whale population will be studied by measuring their distribution, the cost of foraging (blow and strike rates) as well as the effects of the increase of whale-watching boats present due to the lack of other whale species and the more confined area of distribution.

ACKNOWLEDGEMENTS These data presented, among others to follow, could never have been collected, analysed and described without the the passion of Ned Lynas, who has dedicated his life to a better understanding of whales, specifically of minke whales. Funding and infrastructure has been provided by the ORES Foundation for Marine Environment Research in Switzerland. Numerous students enroled in the field study courses (Eco-350) at the ORES Centre for Marine Environment Research, Bergeronnes, during the summers 1999 - 2002 have helped to collect the data as boat drivers, photographers, spotters, and recorders. Others encouraged and supported this presentation, in particular we want to mention Sven Krackow, Chuck Schom, Andreas Boldt, and René Imhof.

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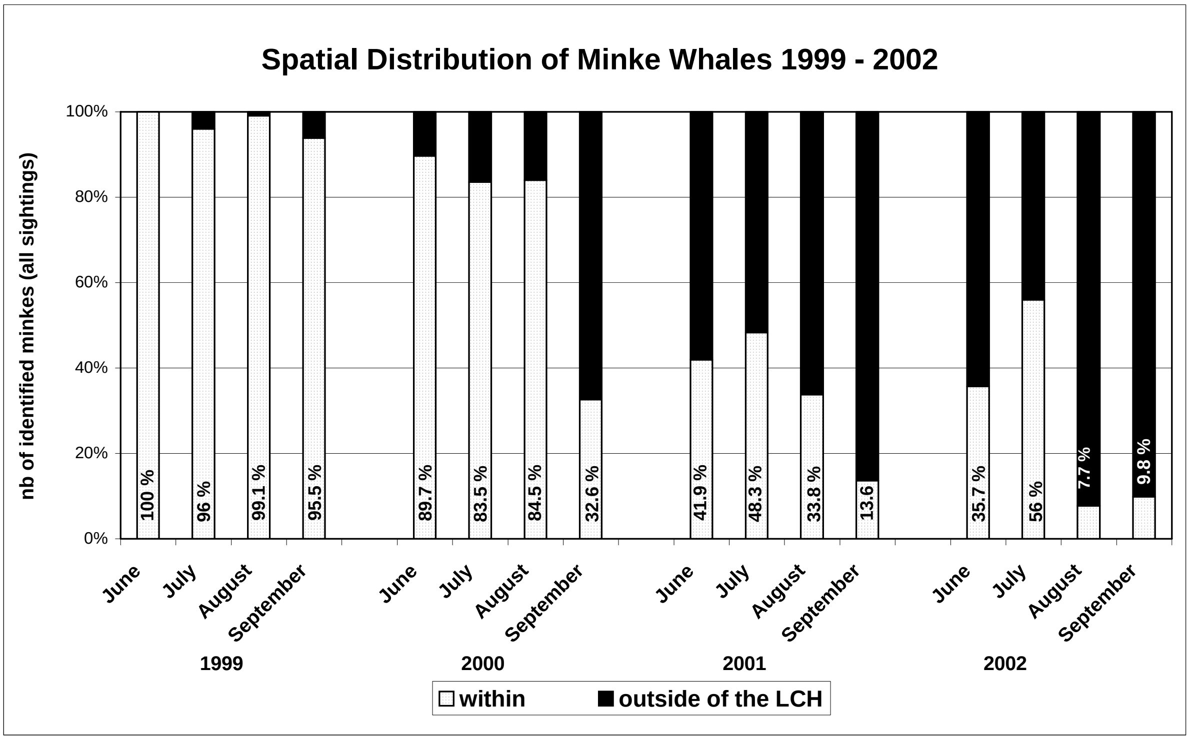
Spatial Distribution of Minke Whales 1999 - 2002
nb of identified minkes (all sightings)
100%
80%
60%
40%
20%
0%
100 %
96 %
99.1 %
95.5 %
89.7 %
83.5 %
84.5 %
32.6 %
41.9 %
48.3 %
33.8 %
13.6
35.7 %
56 %
7.7 %
9.8 %
June
July
August
September
1999
2000
2001
2002
within
outside of the LCH

Fig.1.

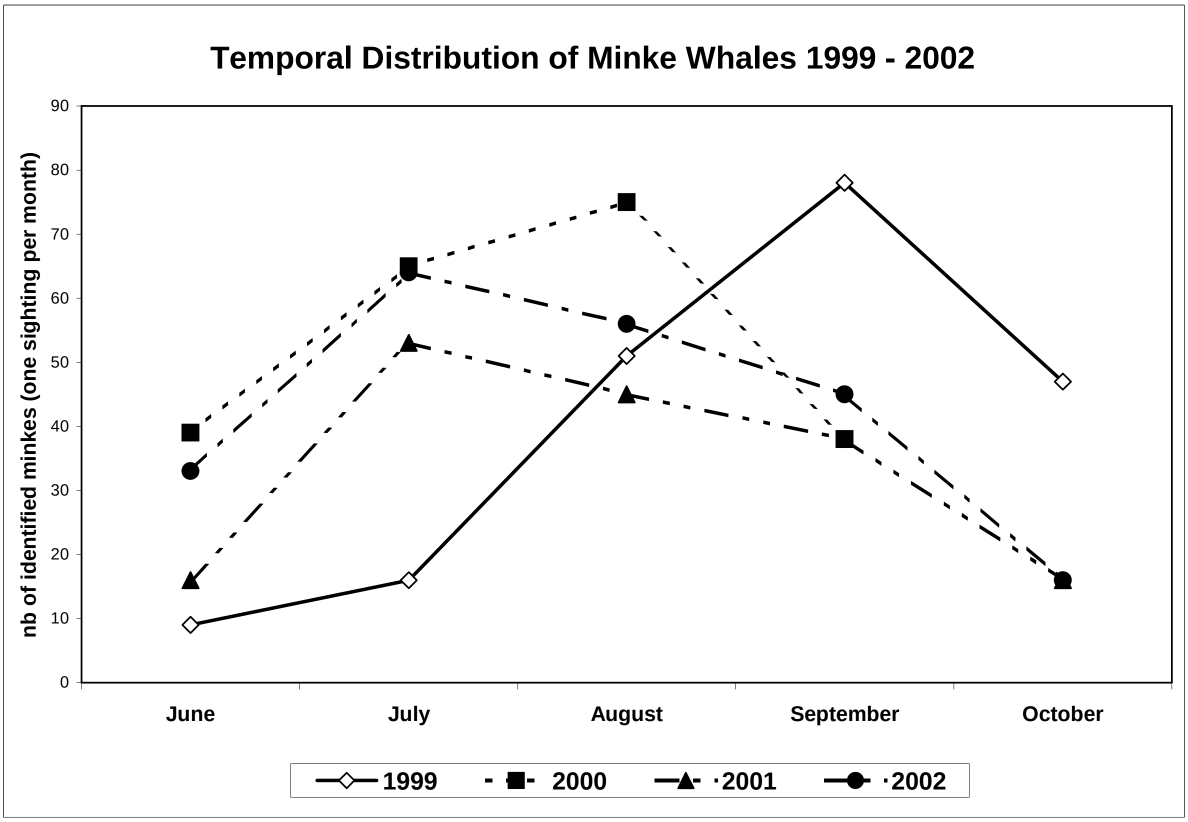
Temporal Distribution of Minke Whales 1999 - 2002
nb of identified minkes (one sighting per month)
90
80
70
60
50
40
30
20
10
0
June
July
August
September
October
1999
2000
2001
2002

Fig. 2.

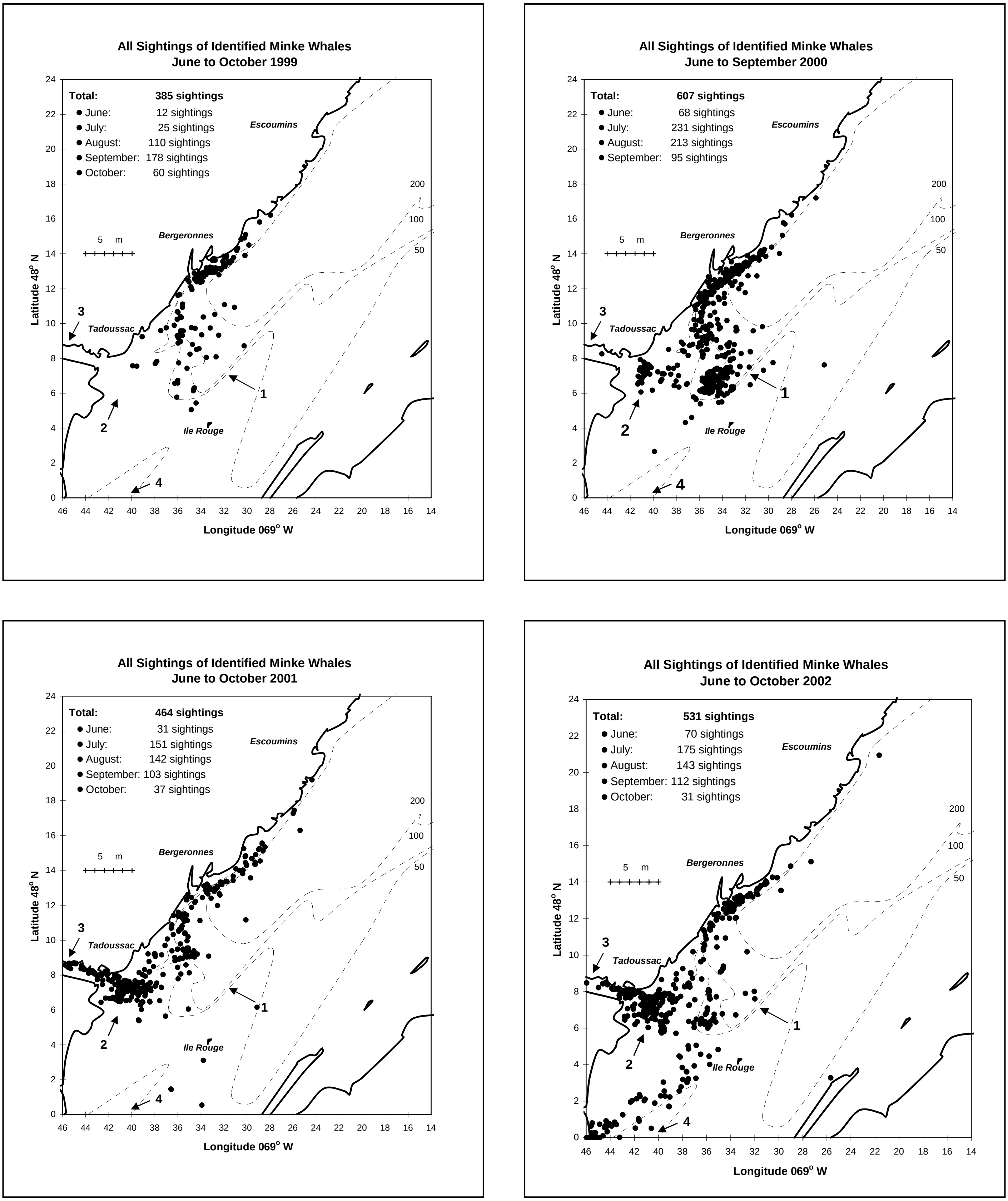

Fig. 3. Annual distribution of minke whales in the LCH (1), Saguenay mouth (2), Saguenay Fjord (3), and Upriver (4)

ACOUSTIC AND DIVING BEHAVIOR OF SPERM WHALES (PHYSTER MACROCEPHALUS) AS RECORDED FROM A DIGITAL ACOUSTIC RECORDING TAG

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This paper summarises results from three years of tagging sperm whales in the Ligurian Sea (Sirena cruises of the Saclant Undersea Research Centre) and Gulf of Mexico (SWAMP and SWSS cruises sponsored by the US Minerals Management Service). During this time 40 sperm whales have been tagged with the digital acoustic recording tag (DTAG) developed by Mark Johnson of WHOI with ONR support (see Johnson abstract), providing data on more than 100 dives. The DTAG records sound, depth, pitch, roll, and heading of the whale. As a tagged whale starts its dive, it is either silent or may produce codas. A minute or more into the dive, the whale starts producing regular clicks. The first clicks often have a long inter-click-interval (ICI) of 1.5-2 sec, but then often rapidly drop to a shorter interval that decreases as the animal dives at a rate consistent with the round trip travel time to some horizontal layer. Oscillations in the ICI during this period may correlate with the pitch angle of the diving whale, and can be consistent with the slant range to the final depth of the dive. Sperm whales are not a sit-and-wait predator: they move continuously during the bottom phase of the dive. Sperm whales during this bottom phase produce bouts of regular clicks that end with either a pause or a rapid series of clicks, called a creak. The end of each creak is marked by an increase in the rotation of the whale; this appears to represent a pre-capture foraging movement. The ascent phase of each dive is either silent or marked by coda vocalizations. Exchanges of codas between whales are usually ended by bumping sounds of the tag indicating tactile contact between the whales.

PATERNAL CARES IN FRANCISCANA DOLPHINS? MOLECULAR CLUES SEEM TO SUGGEST SO

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The franciscana dolphin (*Pontoporia blainvillei*) lives in coastal waters and estuaries of the central portion of the Atlantic coast of South America and is poorly understood and secretive. Four members of a presumed putative social group, including a lactating female, an adult male, a juvenile male and a male calf, together with other 11 other franciscana dolphins were genetically typed in order to obtain insights into the social organisation of this poorly known dolphin species. Samples were screened for 10 nuclear markers (microsatellites) and sequenced for 269bp of the mitochondrial DNA control region. Unexpectedly, the genotypes of the four members of the same pod were consistent with the two adults being the parents of the calf. The juvenile was compatible with both adults individually, but not together. Both a simulation approach performed on several alternative scenarios and the estimation of the paternity probability (p=99.84) suggest that the adult male could indeed be the calf's father.Therefore our results showed that franciscana dolphins may travel in kin groups which might include, besides mothers with their calves or juvenile offspring, also also the fathers of the youngest group members, thus providing the first direct evidence of extended paternal associations in a marine mammal. Interestingly this unexpected finding finds some morphological supports: the franciscana dolphin exhibits small testicles and females who are larger than males, both features which are evolutionary correlates suggestive of monogamy and paternal care.

A SIMPLE METHOD TO REVEAL THE IMPACT OF ENVIRONMENTAL AND INDIVIDUAL PARAMETERS ON KILLER WHALES (*ORCINUS ORCA*) BEHAVIOUR IN CAPTIVITY

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This paper aims to present a method based on simple behaviour observations and multivariate analysis to estimate the impact of environmental and individual parameters on killer whales (*Orcinus orca*) in captivity. We examined behaviours in a population of 6 captive killer whales at the Marineland park of Antibes (France). One male and 2 captive females were wild caught in Island; 2 males (4 and 7 years old) and 1 female (1 year old) were born at Marineland. Individual and social behaviours were recorded on a written ethogram as well as other parameters such as respiratory frequencies. Different combinations of conditions were compared: (i) size of the group (between 1 to 6); (ii) structure of the group (adults vs. juveniles); (iii) presence or absence of trainers; (iv) period of the day; (v) impact of the basin (size, position, etc.) Differences between individuals and/or environmental conditions were formalised using distance calculation methods (e.g. cosine distance) on behaviour frequencies and clustering methods. Our results demonstrate that adult individuals present contrasting behaviours according to the presence or the absence of trainers while juveniles present a more homogenous behaviour. Moreover, in presence of trainers, the method clearly separates adults and juveniles. On the basis of these results, we suggest that this simple method is a good way to reveal the impact of environmental (e.g. presence/absence of trainers) and/or individual parameters (e.g. age) on individual behaviours.

VOCAL DEVELOPMENT IN A CAPTIVE BELUGA (*DELPHINAPTERUS LEUCAS*) CALF

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Knowledge about the ontogeny of cetacean vocalizations is scant. Even less is known about the amount of learning involved in the acquisition of vocal repertoires. Ontogenic studies of repertoire development may shed light on the role of learning and imitation in the structural and contextual development of calls and can provide clues about the mechanisms of sound production in odontocetes. A male beluga calf was born on July 20, 2002 at the Vancouver Aquarium Marine Science Centre, and is housed with his mother and two other adult females. We have performed systematic audio recordings of this calf, concurrent with behavioral observations, since the day of his birth. To our knowledge, this study will provide the first account of the early stages and timing of vocal acquisition in a beluga whale. To date, there are several salient results: the initial vocalizations of the calf were produced within the first 12 hours after birth and consisted exclusively of series of low frequency short duration pulses, or click-trains. By week four, short, narrow band tonal signals (whistle-like) began to appear mixed in with the click trains. By week five, longer whistles were incorporated, not always accompanying click trains. Those were characterized by an unsteady quality and low frequency modulation. Lastly, the structure of the click trains changed markedly with age: peak intensity increased, and inter-pulse intervals decreased, so as to conform "buzzes". Our findings suggest that belugas can produce burst pulsed sounds almost immediately after birth, but that the mechanisms of whistle production may require further maturation of the sound production apparatus and vocal learning.

CONSERVATION/MANAGEMENT

BOTTLENOSE DOLPHIN AND ARTISANAL FISHERIES OF THE BALEARIC ISLANDS: A GLOBAL VISION OF THE CONFLICT

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INTRODUCTION The existence of interaction and conflicts between the population of bottlenose dolphin (*Tursiops truncatus*) and fishing activities is well documented around the Mediterranean Sea (Consiglio *et al*., 1992; Bearzi *et al*., 1992; Casale, 2002). In the Balearic Islands, this interaction has been known for many years (Prats, 1997; Silvani, 1991). The cost of this, according to previous data, is very high (Silvani, 1991; Soler, 1998).

On one hand fishermen are affected by the catches predation from dolphins and the damage to their fishing gears (Brotons, 2002; Fernández, 2002). On the other hand, the loss of dolphins and, sporadically, others cetaceans is severe because of direct attacks by fishermen and by-catch (Abad *et al.*, 2002; Valeiras and Camiñas, 2002).

The development of investigation is absolutely necessary for both, the correct evaluation of the extension and nature of the population loss and the search of solutions. This study would include both aspects and establish the existing relations between them.

In order to answer to the need of suitable solutions for the fishing activities and the population of bottlenose dolphin, the "Direcció General de Pesca" (DGP) began a project in October 2000. The study was structured in four parts: 1) continue control of artisan fishery boats, 2) photoidentification of different herds from dolphins, 3) the analysis of the strandings, and 4) interviews to the fishermen. Everything completed with different bibliographical researches.

MATERIALS AND METHODS

Strandings The "Conselleria de Medi Ambient, Govern Balear" (Environmental Council, Balearic Government) has followed systematically the strandings occurred in Balearic Islands since 1988. The strandings of bottlenose dolphins has been specially attended since 2000 in narrow collaboration with the "Conselleria de Medi Ambient". The main objective is the observation of possible aggressions or interaction with fishing by means of external examination and collection of different samples. In addition, the review of the data and samples of previous years has also been made.

Interviews Fishermen of the Islands have been interviewed in order to obtain data on accidental captures, direct aggressions and any other general performances of interactions. These interviews were especially designed to filter lies or erroneous information. The 60% of the total fleet was interrogated.

Boardings A systematic boarding of an observer in each island has been done with the objective to gather information about artisan fisheries in the totality of the Balearic Sea (Fig.1). Usually in the local fisheries the same boat uses different types of gears according to the time of the year (Llabrés and Martorell, 1984). For that reason an observer on board has recorded these changes. Occasionally there have been increases in the number of observers to adjust the sampling. These observers collected information about location of net sets, data of fishing interest 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 record of the deterioration of the gear and its captures will allow obtaining the economic losses derived from the reparation and substitution of the gear and the reduction of efficiency.

Photoidentification The photoidentification of different groups of dolphins has been made in two areas (Fig.1); moreover an analysis of patterns of behaviour related to the fishing practice has also been carried out .All the data on position and movement of the groups, activity, location of fishing methods etc., have been introduced in tables to be analysed by means of GIS (MapInfo Professional 4.5).

RESULTS During the period 98-02 the percentage of bottlenose dolphin on the total of strandings presents a negative temporal tendency (Fig. 2). The proportion of which due to interactions with fishing is important, although a temporal tendency to arise is not clear (Fig. 2). In the last decade in the Balearic Islands, a reduction of the captures of target species described in Western Mediterranean Sea to bottlenose dolphin by Blanco *et al.* (2001) is observed (Fig. 2). These data make suspect a reduction of the population of botlenose dolphin. The weight of the deaths caused by interaction with fishing in this reduction cannot be quantified but seems important. This theory is reinforced with the data collected in the interviews. With 60% of the 479 fishing boats interviewed, in 2002, from the 18 dolphins died by interaction with fishing, all entered themselves (13 by accidental capture and 5 by direct aggressions). Extrapolating to the total of the fleet a loss of around 30 annual animals is stimated. This number, on a population considered in 1991 for Majorca and Menorca (Silvani, 1991) of 235 individuals (630-88), seems untenable.

At the moment, 859 operations of fishing by means of systematic boardings have been surveyed. 115 (near 13.40%) attacks were registered. Their characteristics and classification are summarised in Table 1.The attack frequency is similar in the four types of fishing gears controlled. Nevertheless, its effect differs much according to the type of net. Thus, and although the difference between the deteriorated surface of the net with/without attack is significant in all the cases, the process of acceleration of deterioration of the fishing method is very variable (Table 1). In this aspect, the fishing of the red mullet is the one that more affected is, whereas for the lobster the deterioration is not appreciable in the normal activity. The damage fishing method acceleration index has been calculated interrelating the differences between affected surfaces of net without and with attack and the frequency of such event (ratio*frequency). The presence of bottlenose dolphins in the nets affects the total of the capture in complex ways modifying its composition in species. In order to calculate how it affects the activities, the captures have been transformed into their economic value. Value that varies according to the species captured. As it is observed in Table 1, the losses are not significant for the capture of lobster. The percentage of losses on the total of the capture is similar in the rest of fishing methods, although for the red mullet gill net its significance is not so clear.

The process of photoidentification of animals began in 2002 July. Unfortunately an adverse meteorology has delayed much this part of the project. Nevertheless the preliminary results are interesting and promising. In spite of the low number of sightings it has been possible to state one narrow relation between certain herds and certain arts of fishing. However, it is soon to concude anyhing and it will be necessary to obtain more data.

CONCLUSIONS The impact of the interferences between the population of bottlenose dolphin and the artisan fisheries in the Balearic Islands is very high for each one. On one hand, the population of dolphins seems to decrease because of the fishing sobreoperation or accidental capture and aggressions (up to 30 ind/year). This situation is untenable for dolphin population. On the other hand, the fishermen economic losses are important in certain fishing-nets. The deterioration of the fishing equipment is accelerated until a maximum of 600% (red mullet gill net). The losses in all captures are around 5%. Only the fishing of the lobster is not seriously affected by the presence of dolphins. These effects for the small artisan familiar operations are highly detrimental for their subsistence. Therefore the development of investigation than can generate solutions is as essential to dolphin´s future as to fishermen´s.

ACKNOWLEDGEMENTS Many people have collaborated in one form or another in this project. Our greater gratitude to all of them. But specially to Carles, Vicenç i Javi for their boardings and their data, indispensable for this study. To Gloria Fernandez for her contribution to the data on strandings. To Pep Coll for his commentaries on statistic. To Alvaro, Mikelet and Cati for their essential aid with the text in English. And finally, to those collaborating fishermen of the project without whom nothing would have been able to go ahead.

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Table 1. Boardings characteristics and analysis

	N	Net Monitored	Net mesh size	Average time of net in the water	Selectivity	Interactions/frequency	Differences by 50 m of net and ratio surfaces affected with attack-no attack/ significance (Mann-Whitney U-test)	Damage art acceleration index	Differences (in €) by 50 m of net captures and ratio with no attack-attack/ significance (Mann-Whitney U-test)	Percentage economic losses captures total
Red mullet gill net	51	66 Km	45-57 mm	9,10 h (+/-1,13)	45%	8/15,68%	1,82 m^2/39,55/z=-2,973 p=0,02946	6,04464	0,95 €/1,30/z=-1,78858 p=0,07369	4,70%
Red mullet trammel net	189	262 Km	45-57 mm	10,25 h (+/-0,96)	33,83%	29/15,34%	2,06 m^2/10,28/z=-6,839 p=0,0000	1,4235	1,90 €/1,63/z=-3,46803 p=0,000525	6,08%
Cuttlefish trammel net	500	498,5 Km	65-100 mm	17,74 h(+/-0,31)	20%	63/12,60%	0,67 m^2/4,81/z=-7,056 p=0,0000	0,48	1,91 €/1,41/z=-3,31449 p=0,000919	5,13%
Lobster trammel net	119	109,8 Km	100-200 mm	2 days (+/-1)	41%	15/12,60%	0,45 m^2/2,47/z=-2,4 p=0,0000	0,18522	0,59 €/1,05/z=-0,132698 p=0,894433	0,60%

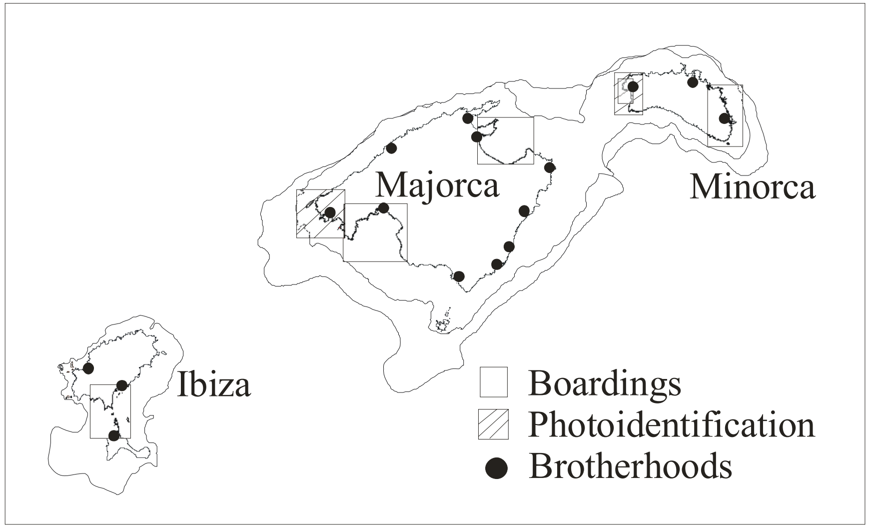

Fig. 1. Location zones

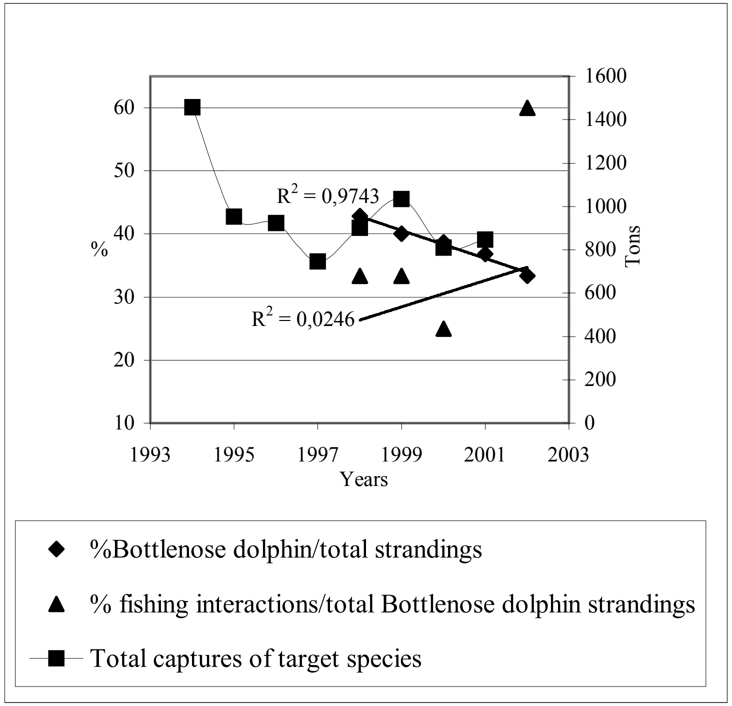

Fig. 2. Temporal trend in the strandings of Bottlenose dolphin and the catches in the Balearic Sea

ANALYSIS OF VARIATIONS IN THE HOME RANGE OF PILOT WHALE, *GLOBICEPHALA MACRORHYNCHUS*, PODS AS AN AID TO MANAGING THE WHALE WATCHING INDUSTRY IN TENERIFE

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The resident population of *Globicephala macrorhynchus* off the South West coast of Tenerife has been estimated at 350 individuals (Godfrey, 2000). It was hypothesised that disturbance from whale watch boats could result in changes in the home-range of *G. macrorhynchus*, with directional movement of pods away from centres of high whale watching activity, and/or range extensions of pods due to increased disturbance. This report uses photo-ID data including GPS readings, collected year-round by the Atlantic Whale Foundation and Proyecto Ambiental Tenerife from 1997 to 2001, to determine variations in the home range of distinct pods of *G. macrorhynchus* between years, as an indication of boat impact. Five distinct pods of *G. macrorhynchus* were determined based on individual associations. The home range of each pod was plotted, and then broken down to show annual variations. The home ranges of all five pods were centred around an area just outside the major whale watching harbours of Los Cristianos and Puerto Colon. The positions and sizes of the home ranges of all pods varied significantly between years, but no trends in these variations could be found. The hypothesis is rejected on the grounds that the home ranges of *G. macrorhynchus* pods off Tenerife show random variations in both position and size between years. Pods 1-5 continue to persist within the same areas of intense whale watching activity from 1997 to 2000. In 2001 there is an absence of confirmed sightings for any of the individuals from pods 4 or 5, with pods 1-3 still persisting within the same area as in previous years. Continued assessment of the home range of *G. macrorhynchus* pods should be used to aid management decisions that affect the operation on Tenerife's whale watching industry.

RELATING THE EFFECTS OF UNDERWATER SOUND ON MARINE MAMMALS TO ENVIRONMENTAL VARIABILITY

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INTRODUCTION There are increasing concerns about the rising levels of man-made sound in the underwater environment and the corresponding impact on marine life. As a consequence, designers and operators of underwater acoustic sources face a growing need to mitigate against the potentially harmful effects that the introduction of such energy can cause. In common with other pollution problems, the assessment of the effects of underwater sound on marine life can be best accomplished through a 'source-pathway-receptor' model. The critical role of the pathway in assessing the potentially adverse effects of high intensity underwater sound on marine mammals is addressed in this paper. The question of how animals are affected by sound has been addressed elsewhere (e.g. Richardson *et al*., 1995; Heathershaw *et al*., 2001) and the need to model the source of the sound accurately, is self-evident. The key to determining sound pressure levels in the ocean is an understanding of the path over which sound propagates between source and receptor. For short ranges, it is possible to estimate the distance at which these occur using simple geometrical spreading arguments, such as spherical or cylindrical spreading. However, as attention focuses on long-range behavioural effects occurring at lower received sound pressure levels, the question of how sound propagates in the environment becomes increasingly important. Regions of high intensity may occur in acoustic convergence zones far removed from the source while acoustically shadowed regions may also be encountered. Seasonal and atmospheric effects, oceanographic features and seabed sediments will significantly modify sound propagation. Using behavioural impact criteria, it is shown that the environmental impact assessment and subsequent mitigation strategy changes with spatial and temporal variation in the ocean environment and the assessment of the zone of influence can, at times, be dominated by uncertainty in this area.

Environment Two locations in the Southwest Approaches to the United Kingdom have been selected to exemplify the problem. The first site, at 51°00N 016°00W, is located on the abyssal plain in water depths of 4500 m. In contrast, the second site is situated on the continental shelf at 49°30N 010°00W in water 100 m deep. The extremes of oceanographic variability over the course of the year can be represented by the February and August sound speed profiles, which are shown in Fig. 1. The nature of the profiles during these two months has a considerable influence on the subsequent distribution of acoustic energy. Absorption of acoustic energy is also influenced by the type of seabed sediments. For the purpose of this investigation, a mud sediment overlying a mudstone basement rock has been modelled for the deep water site and a sand sediment over a mudstone basement has been applied to the shallow water site.

Underwater sound propagation modelling Ray trace modelling has been undertaken to determine the sound pathway along tracks radiating out from the two locations in the Southwest Approaches. Two frequencies have been assessed, 1 kHz and 4 kHz, at a number of source depths. The source depths have been chosen to exploit the sound channels and surface ducts which may enhance the sound field.

Impact thresholds A joint National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NMFS) sponsored workshop was held in connection with the stranding of beaked whales in the Bahamas during March 2000 (NOAA, 2002). The workshop concluded that a behavioural impact threshold could tentatively be set at a sound pressure level of 160 dB re. 1µPa, and this value has been used as a suitable threshold in this study. It is acknowledged however, that this threshold may be adjusted in the light of future research.

DISCUSSION The results are given in the form of 'web' plots (Fig. 2) and sound pressure level plots (Fig. 3). The web plots show the critical distance at which the sound pressure level in the water has fallen below the value at which a behavioural impact might arise and this is given as a function of azimuthal angle about the source. The contour plots show the sound pressure level in the water as a function of depth and range. In each case, the results clearly show the influence of spatial and temporal environmental variability on the critical distances.

Fig. 2a shows the distances at which the behavioural impact criterion is met at the deep water location in February for both deep and shallow source depths. There is seen to be some dependence on critical distance with azimuth. At 1 kHz, the distances vary between 19 km and 22 km for the shallow source and between 17 km and 23 km for the deep source. Fig. 3a shows sound pressure level as a function of depth and range for the deep source and it shows that at all ranges, the surface layer has the highest sound pressure levels; this is a consequence of the upwardly refracting nature of the sound speed profile. In terms of marine mammals, those whales and dolphins that are either shallow-diving or else spend most of their time in the upper layers of the ocean are most likely to be impacted by such a sound source.

Fig. 2b shows the web plot for the deep and shallow sources at the deep water site during the month of August. The critical distances are much reduced compared with those computed using the February sound speed profile. At 1 kHz, the distances range from 4 km for the shallow source to 5-10 km for the deep source. Hence in terms of critical distances, it would be preferable to undertake operations at sea during the summer rather than the winter. In this example, the sound has been directed towards the seabed as a result of the downwardly refracting nature of the sound speed profile, and this is clearly illustrated by the sound pressure levels in Figures 3b and 3c. Fig. 3b shows the sound pressure level distribution for the shallow source and it can be seen that there is a large acoustically quiet zone down to a depth of 2500 m and out to a range of 30 km. For the deeper sound source illustrated in Fig. 3c, the acoustic shadow has become filled in and the quiet zone is no longer present.

At the shallow water location, the critical distances tend to be somewhat longer than those at the deep water site, and the nature of the bathymetric profile and the seabed sediment has more of an influence on subsequent acoustic propagation. During the month of February, the critical distance for the shallow source at 1 kHz varies between 25-28 km while this is reduced to lie in the range 19-25 km for the deeper source. Fig. 2c shows that the shortest critical distances lie at a bearing of 300° and Fig. 3d shows that the highest levels of sound tend to become trapped behind an underwater knoll while beyond this, much of the water column is nevertheless, fairly well insonified. For those animals that inhabit the continental shelf sea, there is seen to be no safe zone from which they may evade any potentially harmful effects from the acoustic energy. Critical distances are reduced during the month of August as seen in Fig. 2d, because of the downwardly refracting nature of the sound speed profile. The influence of the relatively lossy seabed plays a greater part in attenuating sound levels underwater and the critical distances vary between 20-23 km for the shallow source and 16-21 km for the deep source at a frequency of 1 kHz. However, this variation is somewhat less than in deep water, so in terms of critical distances, there is less of an advantage to undertaking summer-time operations. Furthermore, varying source depth does not significantly influence subsequent critical distances.

Critical distances at 4 kHz are generally less than those at 1 kHz. This is attributed to the greater absorption of acoustic energy at the higher frequency. A summary of all the results produced for this study is given in Table 1.

CONCLUSION In order to achieve a realistic determination of the underwater sound pathways, it is essential to carry out detailed acoustic propagation modelling at each location where sound is to be introduced into the water column. An improved understanding of the underwater acoustic environment can therefore lead to a more robust mitigation strategy during activities at sea. Consequently, there is a requirement for site-specific and time-specific data to characterise adequately the acoustic environment. This requires high-resolution databases and charts containing information on ocean sound speed profiles, bathymetry and geoacoustic data. Such data could be updated using *in-situ* measurements.

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Table 1. Summary of all results produced for this study

Location	Month	Frequency	Source depth (m)	Range (km)
Deep water	February	1 kHz	30	19 - 22
			170	17 - 23
		4 kHz	30	11 - 14
			170	12
	August	1 kHz	30	4.0
			170	5.0 - 10
		4 kHz	30	4.0
			170	4.5 - 7.5
Shallow water	February	1 kHz	10	25 - 28
			30	19 - 25
		4 kHz	10	15 - 17
			30	14 - 15
	August	1 kHz	10	20 - 23
			30	16 - 21
		4 kHz	10	13 - 16
			30	12 - 16

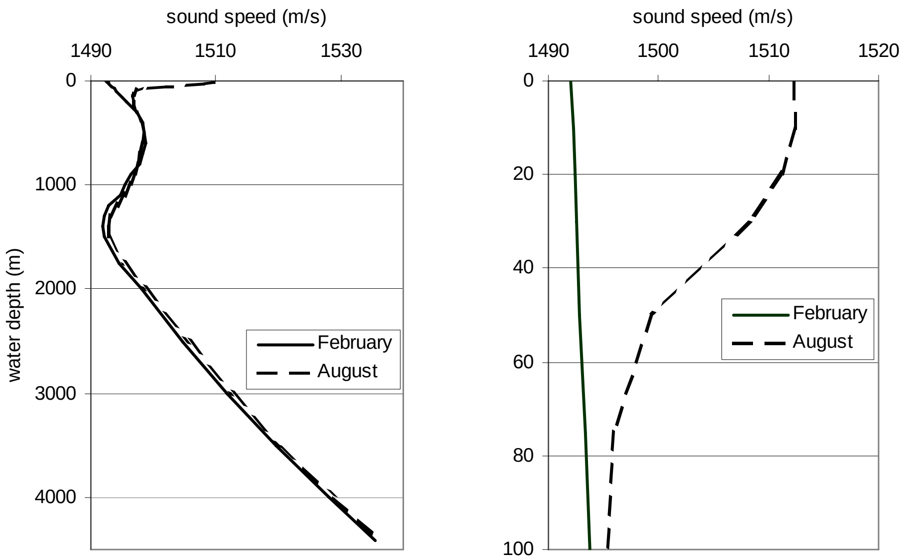

Fig. 1. Sound speed profiles for the (a) deep water and (b) shallow water location

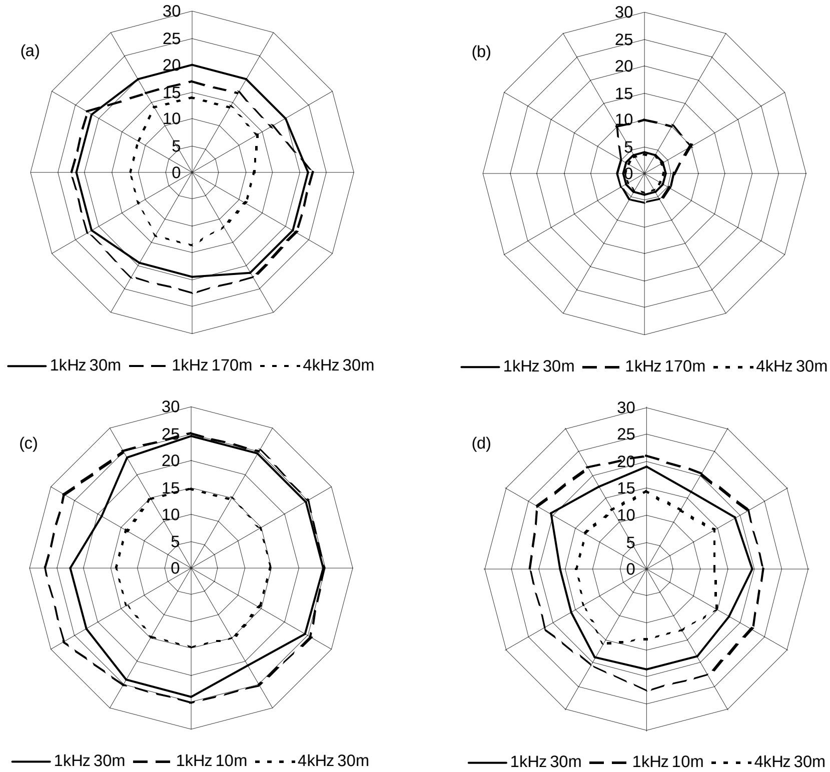

Fig. 2. Range in km from the sound source at which the sound pressure level has fallen to below the behavioural impact threshold for (a) deep water in February, (b) deep water in August, (c) shallow water in February, and (d) shallow water in August

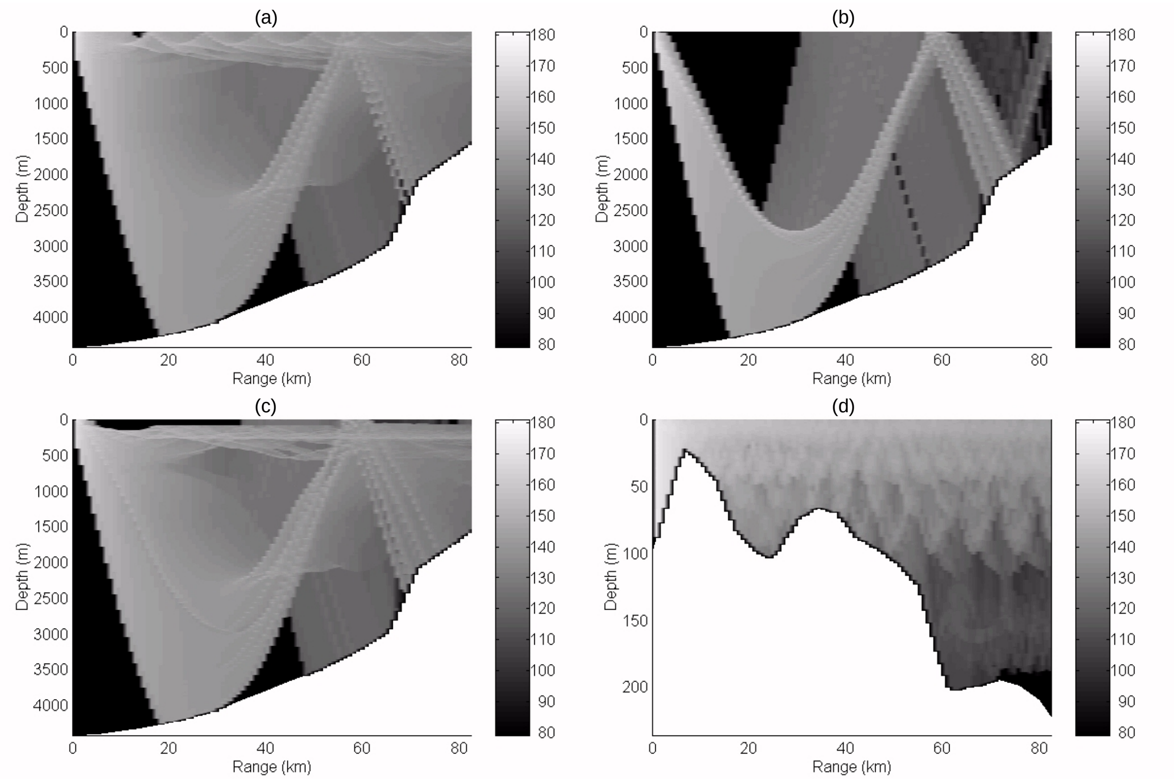

Fig. 3. Plots of sound pressure level at 1 kHz as a function of depth and range for (a) deep source in deep water during February, (b) shallow source in deep water during August, (c) deep source in deep water during August, and (d) shallow source in shallow water during February

USING STANDARD RISK ASSESSMENT PROCEDURES TO EVALUATE HEALTH RISKS ON LOCAL CETACEAN POPULATIONS

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It is general stated that the health status on marine mammals populations is being affected by anthropogenic contaminants, which potential effects may vary according to exposure level, contaminant flux in marine environment, and the specific biological receptor characteristics.Currently, standard European Union Risk Assessment Procedures are offering a practical tool to analyse and characterizes the risk in both aquatic and terrestrial compartment, considering different receptors (microorganisms, invertebrates, plants, arthropods, birds and mammals). However, no specific approaches have been developed for marine environments and marine mammals, mainly due to: (1) wide activity patterns and population dynamics, (2) poor samples from stranded animals, (3) lack of models to mimetic contaminant flux.When risk assessment is applied to marine environments risk assessment, main uncertainties associated are: too limited information about effluents characterization, no direct relation between exposure concentrations in the food web and contaminant source and, no direct correlation between effects and exposure concentrations.A real approach to develop this risk assessment could be based on the comparison between contaminant concentrations in food versus acute and chronic effects on marine mammals. Both parameters should be derived from information about specie behaviour, bioconcentration factor and monitoring data between control and exposed individuals. This specific risk approach is being applied to three cetacean species living in the Canarias Islands (CICYT project 2002-2005) in order to contribute to the development of scientific criteria to establish safety levels in food or monitoring levels in tissues that could be employed as management tools.In a first step, 18 different contamination sources have been characterized using best available methologies (adapted WET, TIE, etc procedures) to identify anthropogenic contaminants of concern. Additionally, results about a screening on the contaminant concentrations on different tissue of the selected species are also presented.

INTERACTIONS BETWEEN BOTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AND AQUACULTURE ACTIVITIES IN THE SPECIAL AREA OF CONSERVATION OFF THE SW COAST OF TENERIFE

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Aquaculture sites have proliferated in the Canary Islands in recent years. In Tenerife a majority are within the Special Area of Conservation declared under the EU Habitat Directive. Although bottlenose dolphins were noticed occasionally around these aquaculture sites as early as 1996, since summer 2001 dolphins have frequently appeared to feed around the cages. Aquaculture workers began hand-feeding these dolphins in Autumn 2001. The dolphins became progresively habituated, started begging for food and became attracted to human presence and swimmers. An on-going study to examine the relationship between aquaculture activities and dolphins was launched in March 2002. In the initial 60 days of effort, a total of 1234 behavioural observations were made of dolphins inside aquaculture sites, parameterized in terms of their level of attraction or indifference to the activities therein. Results show significant attraction from dolphins when workers seined the cages as compared to other human activities (ANOVA, $p<0.001$). The dolphins also showed significant attraction to: 1) presence of divers/swimmers, 2) human calls, and 3) feeding activities (throwing fish to the dolphins or hand-feeding). In addition, instances of unusual behaviours were recorded such as aggression of dominant dolphins towards juveniles and calves in competitions for food, calves unaccompanied for extended periods, and physical approaches to swimmers.Using photo-identification, it has been established that almost all of the dolphins are present on multiple occasions, suggesting fidelity towards the aquaculture sites as an alternative food resource. Moreover, a predominance of mother-calf pairs and juveniles, as compared to open-water groups, indicates an increased reliance on food from aquaculture sites by more energetically-constrained animals. In recognition of this problem, the Canaries Government is instigating policies to restrict feeding of, and human association with, dolphins in aquaculture sites. Our observation study will continue to evaluate the effectiveness of these policies in dishabituating the dolphins.

AN ASSESSMENT OF WHALE WATCHING IN THE BAY OF FUNDY, CANADA

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The aim of this study was to gain an understanding of commercial whale watching from Grand Manan island in the Bay of Fundy, Canada, in order to improve cetacean conservation in this unique habitat and to promote the protection of the endangered Northern Right whale (*Eubalaena glacialis*). The socio-economic, educational and management aspects of whale watching were assessed to provide a baseline from which to monitor the development of the industry and assess its impacts on cetaceans. Data was collected during the tourist season of 2002 from a series of questionnaires distributed to key groups; whale watch tour operators, whale watchers, general tourists and local businesses. Personal observations and informal interviews were also documented. Results show that the whale watching industry on Grand Manan is well established, contributes to the local economy, is an important part of the tourist industry and acts as a major incentive for people to visit the island. Whale watching activities contribute to public education by raising awareness about the conservation of cetaceans. However, current levels of interpretation are not uniform amongst tour operators and many educational opportunities are being lost, particularly regarding the Northern Right whales found in the area. Previous studies indicate that whale watching vessels may adversely affect marine mammal behaviour. Therefore, to reduce disturbance caused by whale watching, tour operators have created voluntary guidelines for appropriate boat handling in the presence of cetaceans. There is, however, a distinct lack of specific, enforceable regulations to control the industry. In conclusion, this study highlights the need for the implementation of a more effective management plan for conserving cetaceans in the Bay of Fundy. Specifically, increasing public education and awareness, ensuring appropriate conduct of whale watch vessels, increasing the protection of Northern Right whales and improving the overall monitoring and regulation of the industry.

ARE SPECIAL AREAS OF CONSERVATION APPROPRIATE FOR HARBOUR PORPOISES IN NW EUROPE?

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Under Article 4 of the 1992 EC Habitats and Species Directive, member states of the EU are requested to submit a list of candidate Special Areas of Conservation for priority habitats and species including the harbour porpoise. Spatio-temporal analyses were conducted upon combined databases from North-west Europe, comprising 100,000 hours of effort data and 17,200 porpoise sightings collected between 1980 and 2001. Emphasis was placed upon whether the following criteria could be fulfilled: 1) the continuous or regular presence of the species (subject to seasonal variation); 2) high population density in relation to neighbouring areas; and 3) high ratio of young to adults during certain periods of the year. Sightings rates were first standardized by sea state, and partitioned into grid cells at a scale of 15’ longitude by 15’ latitude using ARC-INFO. Inverse Distance Weighting was applied in interpolation of sightings rate data. Principal Components Analysis and Classification were used to test for clumping and to identify areas of concentration. An analysis of long-term monthly means revealed that concentrations of porpoises persisted in a number of areas, although the results were influenced by the level of effort available for any particular grid cell. The size of area identified by this method varied by orders of magnitude (with St George’s Channel being the largest, and the eastern seaboard of Shetland the smallest). Most localities highlighted were close to a coastline although several offshore areas have not yet received sufficient survey effort for proper evaluation. Some threats facing harbour porpoises (e.g. fisheries by-catch) are best managed on an activity basis rather than by demarcating protected areas. However, we conclude that SACs can serve a useful function particularly in the coastal zone where human activities like recreation, and industrial development may impose pressures upon the local environment.

CETACEAN BYCATCHES IN COASTAL FISHERIES OFF NORTHERN PORTUGAL

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Since January 2000 the coastal area between Figueira da Foz and Aveiro (Northern Portugal) has been systematically monitored for marine mammal strandings, in particular those associated with bycatches in artisanal fisheries. This coastal area stretches along 50 Km of sand dunes, and its importance as a major fishing area is demonstrated by two main fishing harbours and several small fishing villages where beach purse seines are widely used. During the period between January 2000 and October 2002, a total of 77 cetacean strandings were recorded, involving 7 different species. The common dolphin was the species most commonly recorded with 60% (n= 46) of all strandings reported, followed by the harbour porpoise with 19% (n= 15). Confirmed bycatch was responsible for 34% of all strandings and up to 18% of the deaths was suspected to have been caused by interactions with artisanal fishing gear. Earlier observations have shown that this coastal area is used by harbour porpoises as important feeding and breeding sites, thus making bycatch a serious threat to the species. Preliminary results seems to indicate that beach purse seines may play an important role on the overall mortality of harbour porpoises. In fact, up to 53% of all harbour porpoise strandings recorded involved animals caught in this type of fishing net. Common dolphins and harbour porpoises may also be accidentally caught in gill nets set close to the coast, but bycatches in beach purse seines must be carefully monitored in order to assess the real impact on the overall mortality inflicted to the community of small cetaceans using this coastal area of Northern Portugal.

EFFECTS OF ENDOCRINE DISRUPTERS IN MARINE MAMMALS

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In the last few decades various studies have shown that marine mammals are sensitive to the toxicological effects of certain xenobiotic compounds, including the large class of Endocrine Disrupting Chemicals (EDCs). Since some EDCs, particularly organochlorines, tend to bioaccumulate and biomagnify in the aquatic food chain, various marine mammals, particularly those high in the food chain, such as pinnipeds and odontocete cetaceans are potentially "at risk" in relation to the presence in the marine environment of these chemicals. The main aim of this presentation is to define the state of the art on the potential effects of endocrine disruptors in marine mammals, whit a particular attention to species in "hot spot" areas such as the Mediterranean cetaceans. A second aim is to formulate recommendations for future research in this field (e.g. non-invasive monitoring techniques) and finally to define what can be done internationally for hazard/risk assessment and communication of the findings.

BOTTLENOSE DOLPHIN CONSERVATION PROBLEMS IN THE LA MADDALENA ARCHIPELAGO NATIONAL PARK

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Status and population trends of Bottlenose Dolphins in the Mediterranean are poorly known, consequently the species is included in the "D.D." category of the 2000 IUCN Red List. In 1999, the Nature Conservation Department of the CTS started a long term monitoring programme to study the Bottlenose Dolphin population in the La Maddalena National Park, resulting in the creation of a Dolphin Research Centre in spring 2000. Between June 1999 and November 2002, 195 days were spent surveying with a total of 840 hours spent at sea and 107 sightings. Research, carried out through boat surveys and the use of photo-identification techniques, has increased the knowledge on the dolphins' population size and their habitat use. Population size is estimated of 30-50 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 with calves. An additional monitoring programme was started in summer 2002 aiming at quantifying the amount of nautical traffic through daily counts from three observation points. Major threats to the species in the park's waters have been identified as (1) nautical traffic, with more than 5000 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 interaction between dolphins and fisheries (netting) and the over-exploitation of fish stocks. To protect Bottlenose dolphins in the area it is recommended to adopt a management plan as part of the National Park regulations, thereby applying the EU Habitats Directive, and to increase the amount and scope of awareness programmes.

INTRODUCTION Being home to a range of important seabird colonies and threatened habitats, the Maddalena Archipelago is one of the most important nature and wildlife areas in the Western Mediterranean. In order to protect it, it was designated as a National Parl in 1996 and it has also been included in the south-eastern part of the International Cetacean Sanctuary. Because of the abundance of preferential habitats and food reseources, the archipelago appears to be an important area for bottlenose dolphins (Macciocu, 1994). Because of their position at the top of the food chain, bottlenose dolphins are a vital component and a good indicator of a healthy marine environment. As outlined in Leatherwood and Reeves (1994) and in the EU Habitats Directive in Marine and Coastal Areas (Coffey, 1998(it is also a priority species which should be the target of specific Action Plans for its conservation. However, due to the lack of Knowledge on the coastal cetaceans living in the park's area, there is a need to collect information to ensure proper conservation of the species within the protected area. The archipelago has been selected as one of the locations for the CTS "Bottlenose Dolphin Project" in order to census its almost unstudied dolphin population and to start regular monitoring and awareness programmes in the area.

Study area The Maddalena Archipelago, located in north eastern Sardinia, is made up of 7 main islands and numerous islets. The research was originally carried out in the northern part of the marine park. In 2001, they study area was extended to the east, west and south to include all waters within and surrounding the park up to 7 nautical miles from the coast. The northernmost limits are the Corsican Islands of Lavezzi and Sperduti, whereas the southern, western and eastern limits are respectively, the islands of Mortorio, the Marmorata coast and open sea waters up to the 7 nautical mile limit. For the purpose of the research, the waters within the sudy area have been arbitrarily divided into several subareas (A to M) (Figure 1).

METHODS The research period covers summers 1999-2002, plus spring and autumn 2001-02 (Table 1). Boats surveys following standard routes were undertaken on calm sea days (Beaufort scale 3 or less). Day times were arbitrarily subdivided into 4 time categories (dawn, 06.00-10.00, morning 10.01-14.00, afternoon 14.01-18.00, sunset 18.01-21.00). As far as possible, but highly dependent on weather conditions, boat outings were equally distributed between these different categories and the different subareas. In the summer months, on average 8 observers were present, of which 2-4 were members of the research team and the others were volunteers. Survey routes were recorded with a GPS and then downloaded on the computer and each outing lasted between 3-6 hours. When sighted, dolphins were photographed for later identification following photo-identification techniques and guidelines described in Wursig and Jefferson (1990) and Hammond *et al* (1990). In order to minimise disturbance, the dolphins were never approached closer than 20-25 metres and females with clfs were never followed for longer than 30 minutes. During summer 2002 an additional monitoring programme was started and nautical traffic was counted daily from three fixed observation points.

RESULTS monitoring: From June 1999-November 2002, 195 days have been spent surveying with a total of 840 hours spent at sea and 107 sighting. Population size in the wider archipelago area has been estimated to be of 30-50 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. Most noticeably, the avoidance of busy coastal areas and the use of more distant feeding areas in 2001 were recorded, whereas quiet coastal areas were shown to represent preferentail nursing habitats (Fozzi *et al*., 2001a and 2001b).

Prensent and potential threats. On the basis of the IUCN Red List 2002 (**www.iucn.org**), the major threats to the species in the park's waters are listed below
1) Habitat loss:
- Present threats: Housing developments ("urban" encroachment and pollution from untreated effluent discharge); harbour construction.
- Potential threats; Fish-farming in nearby areas

2) Direct threats:
- Potential threats: Direct persecution (fishermen); poaching (illegal trade for restaurants); disturbance from unregulated "dolphin watching" activities; disturbance linked to presence of military installations

3) Indiract threats:
- Present threats: Tourism and leisure activities (reduction in habitat availability, food resources and therefore carrying capacity of the area- Bain *et al*, 2001); disturbance from unregulated research activities; indirect mortality (death in fishing nets).
-Potential threats: Indirect mortality (death in fishing nets- Arcangeli 2000); habitat degredation (*Posidonia* seagrass bed destruction); reduction of prey species (over-fishing).

4) Atmospheric pollution
- Potential threats: Global warming

5) Water Pollution
Potential threats: Pesticides and chemical pollution (must be quantified); oil pollution (transit of cargo ships carrying hazardous substances in the Strait of Bonifacio)

Action plan. Suggestions for priority actions for the conservation of the species in the park's area and its surroundings are identifiec in tables 2-4.

CONCLUSION Long-term monitoring of cetaceans in a marine protected area auch as the Maddalena Archipelago National Park must be encouraged on:
1) A Biological/ecological basis- as only through medium to long term monitoring projects it is possible to undertake accurate life studies evidencing population dynamics and trends, providing information on the health of given cetacean populations.
2) A Conservation basis- as such activities are encouraged at international levels under the EU Habitat Directive and the IUCN guidelines for cetacean conservation
3) A Social basis- as several years are needed to obtain a consensus from the local populations, to acquire credibility and be accepted by the local fishermen who are generally hostile to marine researchers. It is also important for the set up of appropriate awareness programmes. In the Maddalena National Park's case, the dolphin research centre has a strategic location within the park's environmentla education buildings.

Overall, implementing a species-specific conservation approach, in this case targeting bottlenose dolphins, will benefit the whole marine ecosystem. Because they are at the top of the food chain, protecting the dolphins will have positive effects on the entire ecosystem they rely on for living. Also, being an excellent flagship species, dolphin conservation projects can also promote awareness on the conservation needs of less obvious but greatly threatened marine fauna and flora.

ACKNOWLEDGEMENTS The research staff would like to thank all of the CTS volunteers, the Maddalena Archipelago National Park, its President and its Guides. Helmar Schenk for his supprt in this research. Special thanks to Bassetti (first Research Centre sponsor), BWA (official boat), Nikon (official camera and optical equipment) and Compaq (computer).

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Table. 1. Research effort in 1999-2002

Year	Days of	Hours	Sightings (S)	Frequency (S/H)
1999	27	112	5	0,044
2000	33	153	23	0,150
2001	55	219	28	0,108
2002	80	316	51	0,161
Total	195	840	107	0,127

Table. 2. Acquiring a deeper insight on the ecology of the species

Objectives	Actions	Priority	Time-Scale (yrs)
Survey and monitor the population	Monitoring programme	High	10
Obtain data on dolphin demography and mobility	Photo-identification (album) Sampling ectoparasites Assessing summer interactions (tourist/boat and dolphins)	High High High	10 6 5
Undertake diet and food availability studies	Assessing food availability Studying the effects of fishing policies and regulations	High High	6 10
Assess the impact of sea pollution	Monitoring pollutants in tissues (both in *Tursiops truncatus* and its prey species)	High	10

Table.3. Managing the area

Objectives	Actions	Priority	Time-scale (years)
Protect the dolphins in their home range	Designate feeding and nursery sites as “Zone A” (Integral Reserve)	High	10
Minimise disturbance by field research activities	Plan and co-ordinate research by priorities	High	10
	Define a low impact research protocol	High	6
Prevent sea pollution	Sample pelagic and coastal sea waters	High	6
	Regulate the traffic in the Strait of Bonifacio	High	10

Table. 4. Public awareness

Objectives	Actions	Priority	Time-scale (years)
To increas awareness (conservation of the marine environment and aims of the action plan)	To increase awareness among politicians, decission makers and NGO’s	High	3
	Organise events and presentations (directed to schools and the general public)	High	5

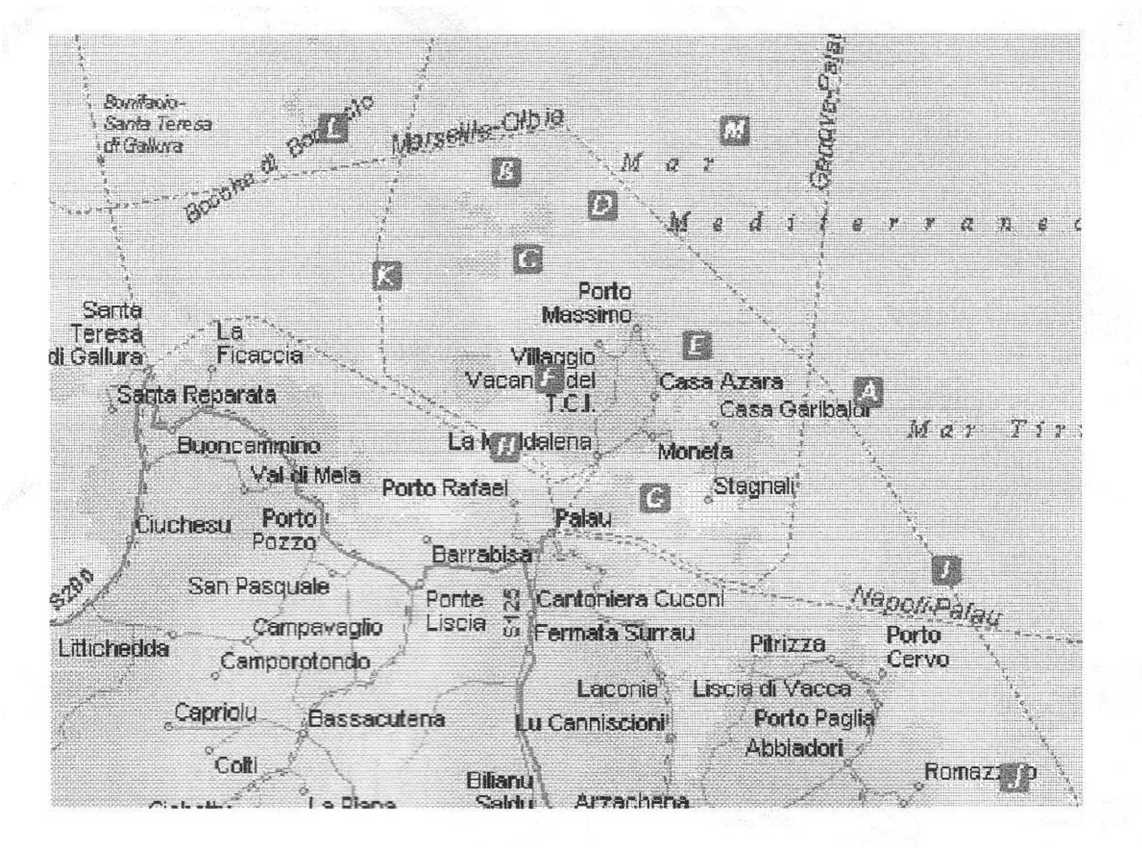

Fig. 1 . Study area

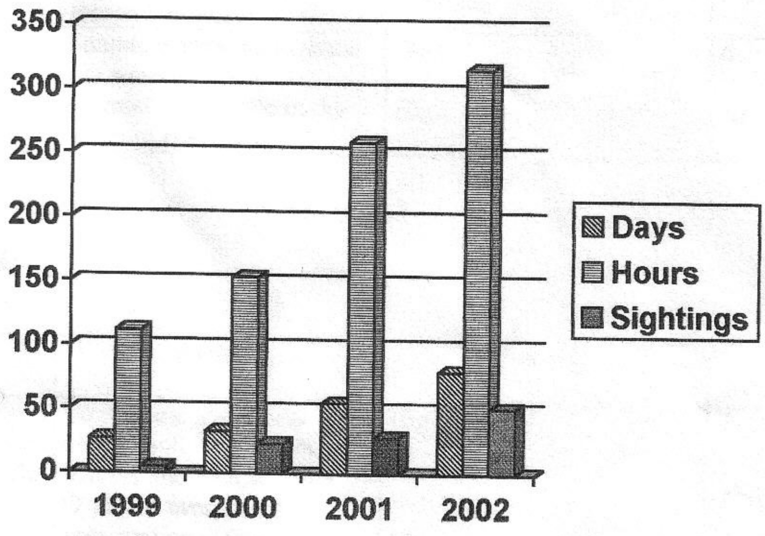

Fig.2. Research effort in 1999-2002

RESEARCH TO DETERMINE THE CAUSAL MECHANISMS OF SONAR-RELATED BEAKED WHALE STRANDINGS

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We are learning more about the relationship between military sonar use and strandings of beaked whales, but we do not yet have a good understanding of how sonars cause the physiological and behavioral effects observed in recent strandings. Knowledge of the mechanism(s) by which sonars contribute to beaked whale strandings is a key part of designing effective conservation measures. The Office of Naval Research is supporting investigations of beaked whale distribution and habitat, anatomical studies, and development of tools for improved monitoring of beaked whales (e.g. passive acoustics): these research efforts will be briefly reviewed. The research community also has demonstrated the ability to apply more challenging research approaches, including Controlled Exposure Experiments (the subject of a discussion session at the Rome 2001 ECS conference), and bringing beaked whales into a lab environment for testing of a variety of physiological, hearing, and behavioral parameters. These and other proposed research approaches present risks as well as potential benefits. A list of possible research efforts, along with their respective risks and benefits, will be presented for the purpose of stimulating discussion among the interested research and conservation community. Our goal is to build a clearer sense of what the marine mammal research community sees as its most important and readily achievable contributions this issue, so that limited research resources can be put to the most effective use.

BEHAVIOURAL RESPONSES OF THE SHORT-FINNED PILOT WHALE, *GLOBICEPHALA MACRORHYNCHUS*, IN RELATION TO THE NUMBER OF SURROUNDING WHALE WATCHING VESSELS

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The presence of whale watching vessels can potentially cause short-term disturbance in the natural behaviours of several cetacean species (Corkeron, 1995; Nowacek *et al.*, 2001). This study assesses the behavioural responses of *Globicephala macrorhynchus*, to increasing numbers of whale watching vessels along the South West coast of Tenerife. Behavioural data were collected between July and September 2002, when annual whale watching activity is at its maximum. Eight different commercial whale-watching vessels were used as platforms for research. Changes in frequently observed behaviours such as logging, milling and travelling, and the occurrence of avoidance behaviour such as diving or directional movements away from vessels, were used as an indication of the impact from increasing numbers of vessels around *G. macrorhynchus* pods. Pod behaviour was classified into one of three categories: logging, milling or travelling. 200 sightings with defined periods of interaction were used in this analysis. The number of vessels and the number of *G. macrorhynchus* present during each observation period was recorded as well as the categorised behaviour and additional avoidance behaviour (directional movement away, diving). For the purpose of analysis, data was divided into behaviours observed around one, two and three or more vessels. No significant differences were found between the proportions of categorised behaviours observed and increasing numbers of vessels (X2=3.941, P=0.414). However, there were significant differences between the number of vessels around a pod, and G. macrorhynchus avoidance behaviour (X2=13.818, P=0.001). In the presence of one or two vessels, 28% of sightings involved avoidance behaviours, rising to 62% of sightings in the presence of three or more vessels. Tenerife's resident population of G. macrorhynchus is estimated at 350 individuals (Godfrey, 2000), and any impacts from whale watching vessels should be minimised until it is shown that they are not detrimental to the status of the population.

THREE YEAR'S WORK TO PROPOSE AREAS FOR THE CONSERVATION OF CETACEANSOF EAST SPAIN

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INTRODUCTION The Spanish Ministry of the Environment conducted a three year research programme, from January 2000 to December 2002, for the identification of special interest areas for cetacean conservation in the Spanish Mediterranean waters. This project was performed to implement the international policies of the Habitat Directive, the Barcelona Convention and ACCOBAMS agreement as well as the Spanish National Biodiversity Strategy in relation to cetaceans species. Several Spanish research teams were involved in this programme: The University of Barcelona, The University of Valencia and the NGO ALNITAK. The University of Valencia covered the waters of the regions of Valencia and Murcia (Fig. 1). In order to obtain the information to identify the areas, basically density and distribution of cetaceans, we carried out seasonal aerial surveys following the transect line methodology (Buckland *et al*., 2001). This method is the most adequate to survey certain animals over extensive areas, such as cetaceans, and have proved successful for these objectives in other areas (Hain *et al.,* 1992; Kenney and Winn, 1986; Hammond *et al.,* 1995). In addition, we have also recorded opportunist cetaceans sightings, which can be specially useful in areas that could not been surveyed such as, for instance, the areas close to the coast.

The present study describes the zones proposed to the Ministry of Environmental as most interesting areas for cetacean conservation in the central eastern waters of Iberica Peninsula. These areas were selected based on the information of three year aerial surveys and the opportunist sightings. Furthermore we also proposed conservation measures, having in mind the cetacean species present, the habitat use and the threats affecting these species.

MATHERIALS AND METHODS The study area comprised the coastal waters of the Valencia and Murcia communities, from Delta del Ebro (40º41'N- 0º53'E) to Aguilas (Murcia, 37º22'N- 1º38'W). We surveyed from the coastline to between 17 and 55 nautical miles (nm) in width, depending on the depth (an overall area of 9,100 nm^2). We used a push-pull aircraft (CESSNA-337) flying at an airspeed of 90 knots and at an altitude of 150 m. Surveys were undertaken following the transect line methodology (Buckland *et al*., 2001). Line transects were designed in a zig-zag pattern with a random start point. The standard crew consisted of the pilot a recorder and two observers on each side of the plane. The following data were recorded: species, number of animals, location (obtained with 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.

In order to analyse the distribution we divided the study area into boxes of 10 minutes of latitude by 10 minutes of longitude and calculated in each box the relative density of the different cetaceans species. We used the number of individuals observed per nautical mile navigated as a value of the relative density.

In addition, we recorded all opportunist sightings since 1990. This data proceeded mainly from three sources:
- Data from ships surveys carried out every year, during the cooler month, in the Murcia Region by ALNITAK.
- Data from aerial surveys carried out during the last three summers in relation to fisheries activities.
- Other data from land or from recreational ships

For the identification of the areas, we accounted the information from the sightings; abundance, presence of calves and animal behaviour, as well as the socieconomic information and the detected threats. Furthermore, we gave more importance to the bottlenose dolphin (*Tursiops truncates),* because it is the most Mediterranean threatened cetacean species according to the Habitats Directive.

RESULTS Ten surveys, were performed in 35 flights, with a total effort of 8,444 nm navigated. A total of 140 sightings (4,430 individuals) of 7 cetacean species were recorded (Table 1). Fig. 1 shows the sightings of the different species recorded during all the flights (on and off effort). From the most to the less frequent, the species observed were: striped dolphin (*Stenella coeruleoalba)* , bottlenose dolphin, common dolphin *(Delphinus delphis),* Risso's dolphin *(Grampus griseus)*, fin whale (*Balenoptera physalus)* , Cuvier´s beaked whale *(Ziphius cavirostris)* and long-finned pilot whale *(Globicephala melas)* (Table 1).

Fig. 2 shows the opportunist sightings of the different cetacean species recorded. We accounted 338 sightings of the same cetaceans species observed in the aerial surveys, plus one more, the sperm whale (*Physeter macrocephalus)* (Table 1). The information from these sightings is less precise than dedicated surveys because the different effort throughout the area. For this reason, we have used opportunistic sightings only to support or complement the aerial surveys.

When we studied the relative density of the cetacean species most common during aerial surveys we obtained that: For the stripped dolphin, there is a high density area at the north of the Ibiza channel. For the bottlenose dolphin, there are two areas of high density, one around the Columbretes islands and another around Tabarca Island. And, for the Risso's dolphin, the area at the south of Murcia region shows a high density.

DISCUSSION This is the first study of density and distribution patterns of cetaceans in the waters of Valencia and Murcia region. Our results show that cetaceans occur throughout the study area all over the year, being the stripped dolphin the most abundant and widespread species. Another seven species occur in the study area, indicating that this is a high diversity area for cetaceans and that it requires conservation measures.

We propose five areas of special interest for cetaceans conservation in the Valencia and Murcia region (Fig. 2):

1) The area around the Columbretes Marine Reserve: This area is proposed as SAC due to its importance for the bottlenose dolphin. In these waters many bottlenose dolphin schools have been detected all over the year, both in the aerial surveys and in opportunistic sightings. Then, there is probably a resident population of this species here. Furthermore, in these waters it have also been observed other species such as the stripped dolphin, the Risso's dolphin and the fin whale. The latter is detected during spring on its migration to the Liguro-Provenzal basin, so this area would be of interest to protect its migration routes.

2) Oceanic waters north of the Ibiza Channel: This area is proposed as ZEPIM due to its high diversity (encloses almost all of the cetaceans species recorded), and also because it is an important zone for migratory species like the fin whale. Furthermore, this zone shows the highest density of stripped dolphins, with a mean of 2.7 individuals/nm.

3) and 4) The coastal waters in northern Alicante province and the waters south of the Tabarca Island Marine Reserve, both because bottlenose dolphins have been observed in these areas all year round, some times with calves. Thus, we proposed these areas as SACs.

5) The coastal and Oceanic waters south of the Murcia region. We have found a high diversity of species, both in number (seven) and abundance. We have also found calves and concentration of schools for most of the species recorded. Thus it is a very important zone as a nursery and as a socialization area. For these reasons, we proposed this area as SACs and ZEPIM.

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Table 1. Number of sightings and number of individuals of the different cetaceans species recorded in the study area. Global relative density (total number of individuals/ total nautical miles navigated) of each species estimated from aerial surveys

Species	Origin	no sight.	no indiv.	% sight.	% indiv.	Relative density
Sc	Aerial surveys	98	3872	70,00	87,40	0,4600
	Opportunist	124	4670	36,69	55,20	
Tt	Aerial surveys	17	241	12,14	5,44	0,0290
	Opportunist	71	519	21,01	6,13	
Gg	Aerial surveys	10	135	7,14	3,05	0,0150
	Opportunist	14	209	4,14	2,47	
Dd	Aerial surveys	4	158	2,86	3,57	0,0012
	Opportunist	47	2367	13,91	27,98	
Bp	Aerial surveys	6	10	4,29	0,23	0,0190
	Opportunist	49	75	14,50	0,89	
Zc	Aerial surveys	3	6	2,14	0,14	0,0007
	Opportunist	1	1	0,30	0,01	
Gm	Aerial surveys	2	8	1,43	0,18	0,0009
	Opportunist	19	583	5,62	6,89	
Pm	Aerial surveys	0	0	0,00	0,00	0,0000
	Opportunist	13	36	3,85	0,43	

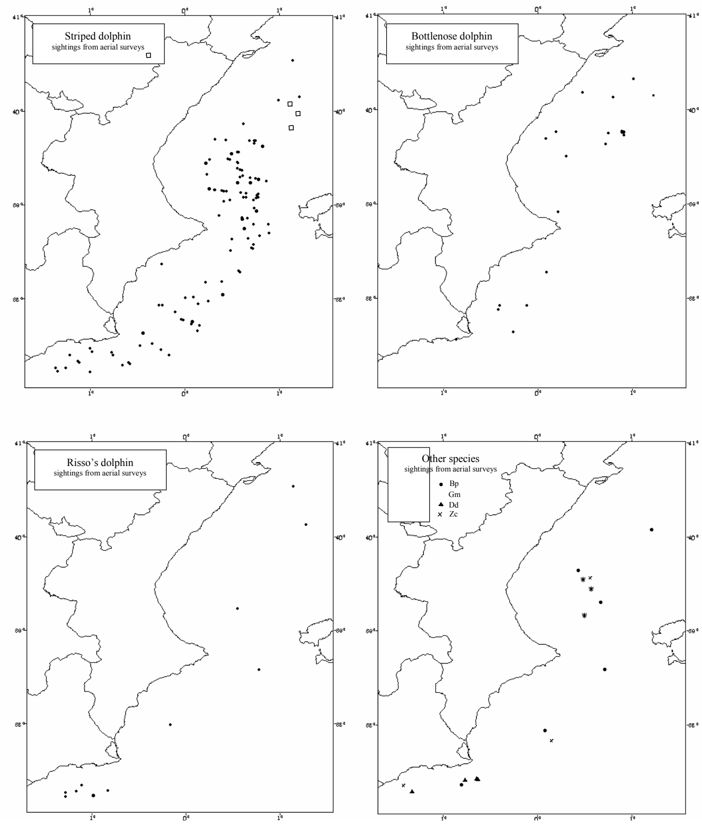

Fig. 1. Sightings of the different cetacean species recorded in the study area during aerial surveys

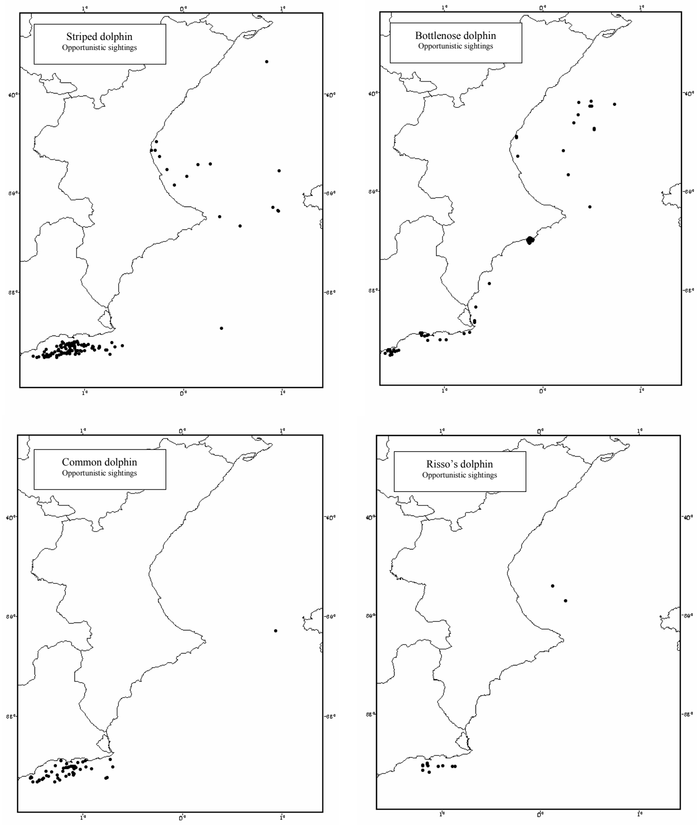

Fig. 2. Opportunistic sightings of the different cetacean species recorded in the study area since 1990 to 2002

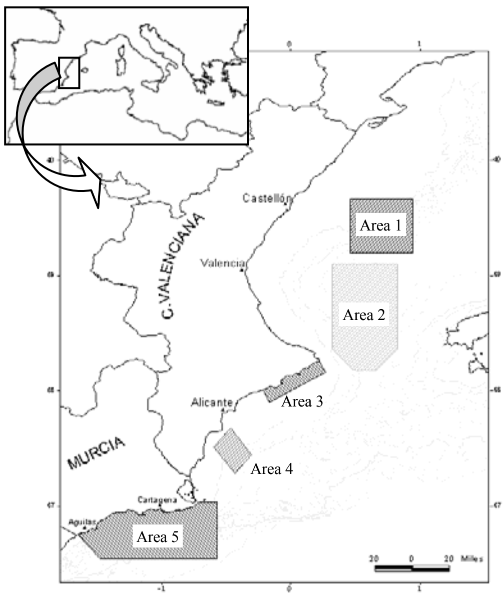

Fig. 3. Areas of special interest for cetacean conservation, in the Valencia and Murcia regions, proposed to the Spanish Ministry of Environment

UK'S FIRST NATIONAL WHALE AND DOLPHIN WATCH – 27 & 28 JULY 2002

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The National Whale & Dolphin Watch was organised by Sea Watch in July 2002. The objective of the event was to raise awareness of the diversity of whales, dolphins and porpoises in the UK. Furthermore, the sightings from the event gave a snapshot picture of the relative abundance and distribution of cetaceans in coastal waters of the UK. During the two days, experienced observers watched from 219 sites around the UK coastline. The public was informed about the event via our website, the media and leaflets distributed across the UK. Here the public were invited to join the experienced observers in a watch and thereby learn observation methods and identification techniques. Furthermore, eleven marine wildlife operators participated by carrying information material about the event onboard and forwarding their sightings to Sea Watch. In addition to the organised observers, the public participated by emailing or phoning in their sightings to Sea Watch. In total, 373 sightings were received during the event and a total of 1683 cetaceans were seen. Eight species were reported, the harbour porpoise and the bottlenose dolphin being the most common, with 176 and 160 sightings, respectively. Minke whales were reported on 20 occasions and common dolphins on nine. A few sightings were, furthermore, reported of killer whales, white-beaked dolphins, Risso's dolphin and long-finned pilot whales. An interesting result from the event was that bottlenose dolphins were seen over most of the UK, except Northern Ireland, Shetland, Orkney and eastern England. Traditionally, coastal bottlenose dolphins have been thought to exist predominantly in populations off Wales, NE Scotland and SW England. The results show that at this time, bottlenose dolphins have a wide distribution in UK waters. The event has helped to raise awareness of cetaceans in British waters and plans are to make it a yearly event.

OBIS-SEAMAP: MAPPING GLOBAL MARINE MAMMAL DISTRIBUTIONS

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Upper trophic-level predators are not distributed uniformly across the world's oceans. Instead, species ranges mirror large-scale patterns of ocean productivity and water masses. Nevertheless, relatively little is known about the mechanisms that restrict large marine vertebrates to specific ocean domains, and the extent to which species distributions are influenced by seasonal, interannual and longer-term oceanographic variability. A thorough understanding of the patterns of marine biodiversity and species abundance are necessary foundations for effective management and conservation of marine systems. For marine mammals, these data may be particularly useful to guide fishery closures and marine protected areas designed to set aside important habitats (e.g., foraging areas, migration corridors) and to mitigate anthropogenic impacts (e.g., ship strikes, noise pollution). As part of the Ocean Biogeographic Information System (OBIS), the SEAMAP (Spatial Ecological Analysis of Megavertebrate Populations) initiative is compiling geo-referenced data on marine mammal at-sea surveys, movements, strandings, and population counts at hauling out sites into a coherent and standardized format. To facilitate the research applications of this global database, SEAMAP is also developing a web-based system equipped with data analysis and visualization tools. This publicly-available database will allow users to display, query, subset, and summarize data on marine vertebrate distributions in conjunction with environmental information. This presentation will showcase the SEAMAP database within the context of a novel data model designed to depict species distributions and animal movements in a fluid oceanic system. This dynamic global database of marine vertebrate distribution and abundance will enhance the understanding of the biogeography and the ecology of marine mammals by: (1) facilitating the study of potential impacts on threatened species; (2) enhancing our ability to test hypothesis about biogeographic and biodiversity models, and (3) supporting modeling efforts to predict distributional changes in response to environmental change.

EVALUATION OF THE KNOWLEDGE ABOUT CETACEANS OF THE GALICIAN FISHERMEN (NW DE SPAIN) USING AN INTERVIEW PROGRAMME

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The work with the professionals of the sea is basic to know the interaction between cetaceans and the human being. The fishermen spend long periods of time in the sea observing cetaceans in their element. They are witness of the accidental captures and of the treatment given to these accidentally captured cetaceans. The strandings contributes data of these captures, but they are not enough. It is necessary the interaction between fishermen and scientists to get a better knowledge about the incidence of the accidental captures in cetaceans populations. Three hundred interviews had been carried out to the fishermen of the Galician ports. The interviews are about the identification of the species, interaction grade, accidental captures and sensations and aptitudes towards these animals. Finally the results were analyzed and the incidence of the accidental captures was evaluated observing that the fisherman of Galician fleet had great confusion and ignorance about cetaceans species.

HIGH RISK AREAS OF COLLISION BETWEEN FIN WHALES AND FERRIES IN THE NORTHWESTERN MEDITERRANEAN SEA

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Fin whales occurring in the Mediterranean sea are genetically distinct from the Atlantic ones. Collisions with ferries has been identified as a major potential threat for this finwhale population, mainly through the summer period in the liguro-provençal sea where they gather to feed on Meganycthiphanes norvegica. In order to evaluate the degree of exposure of their favourable habitat to ship traffic, we compile all the information available on ferry routes and time tables and built a map of traffic intensity. We separated ferries (£29 knots) from High Speed ferries (³ 37 knots). Finwhales data come from the previous study "Poseidon 95-98": 19250 MN and 307 finwhales. Line transect method was applied, and the relative abundance estimates of finwhales (nb/MN) were calculated in 20' latitude/longitude squares, in which at least 20MN were to be cruised on-effort. We used a simple probabilistic model to determine areas of high risk of collision, based on the relative abundance of finwhales and on the number of ships crossing that given area. Two areas were identified through the summer period : on the west border (between Toulon and north Sardinia) for ferries only, and in the NNW of Cap Corse for ferries and HSf. Regarding the period, the highest risks are likely to be in august due to high fin whales numbers and ferry traffic. If we superpose the ferry lines were collisions occurred from the seventies until 2002, they crossed these high risk squares. Risks seem negligible in the Gulf of Lions through the summer. The results should help managers to take decision to minimise these risks. Solutions could be firstly to assure a permanent and specific watch for whales during the cruise, and get real time information about concentration of whales. In second it could be to reduce partly the speed of the vessel crossing these high risk areas.

SHORT-TERM EFFECTS OF THE "PRESTIGE" OIL SPILL IN MARINE MAMMALS, SEA TURTLES AND SEA BIRDS OF THE GALICIAN (NW SPAIN) COAST

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November 13, 2002: The oil tanker Prestige suffered an accident in stormy conditions and sank in the Atlantic coast off Galicia (NW Spain), taking down with it at least 77.000 tons of fuel. Almost 20.000 tons of oil leaked from the vessel half month after the sunk. Although the Prestige was towed 140 miles offshore to prevent more oil reaching the coastal areas, about 1400 km of Galician and other northern Spain regions have been affected by the spill. Around 60.000 tons of oil now rest in the ship's tank, which is now resting on the sea floor, more than 3.200 meters deep. The marine vertebrate populations in Galician waters include records of 19 cetacean species, 4 of sea turtles, 4 of seals and 55 of sea birds. The NW Spanish coast is a very important area for the migration of seabirds, including the Balearic Shearwater or the Guillemot which are qualified as critically endangered species in Spain. Half month later the sunk, at least 18 different species of seabirds had been affected by the spill, as well as the loggerhead sea turtle (*Caretta caretta*) and 3 cetacean species: common dolphin (*Delphinus delphis*), bottlenose dolphins (*Tursiops truncatus*) and the striped dolphin (*Stenella coeruleoalba*). Moreover, the presence of grey seals (*Halichoerus grypus*) in the northern Spain is between December and April. Until now, the degrees of affectation observed were from small spots adhered to the skin to death due to severe oiling. The presence of thousands of floating barriers to prevent the entrance of the oil in the Rias represents another potential factor of risk for the large coastal bottlenose dolphin herds.

DISTRIBUTION AND HABITAT USE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE COASTAL WATERS EAST OF ABACO ISLAND, BAHAMAS

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A central issue in ecology is how wildlife distributions are influenced by the biological and physical characteristics of their environment, and whether active selections of particular habitat types occur. This information is also essential for effective conservation. A growing body of work has utilized both global information system (GIS) techniques and generalized linear models (GLMs) to model the spatial distributions of species with respect to habitat variables; however this method has predominantly been employed for terrestrial species. In this study the distribution of bottlenose dolphins (*Tursiops truncatus*) in the shallow coastal waters of Abaco Island, Bahamas was modeled as a function of water depth and distance from shore. Data were collected from random line transect surveys and opportunistic surveys. The efficiency of each method was compared using encounter rates; data were then combined for analysis. GIS tools were employed to produce distribution maps and sub-divide the region into habitat "types". GLMs were then developed and used to investigate whether dolphins showed preferences to certain habitat types. Results show the habitat type most significant ($p=0.00167$) to dolphin distribution comprised those areas close to the shore and with a water depth of 3 –3.9m. Inadequate data on habitat variables within the region limits the usefulness of the results from the GLMs in explaining bottlenose dolphin distribution patterns for this particular study. Nevertheless, this work demonstrates a useful methodology for investigating distribution patterns in cetaceans in relation to their environment, which could be used as a decision making tool for conservation and management.

A PRELIMINARY ASSESSMENT OF DOLPHIN BYCATCH IN TRAWL FISHERIES IN THE ENGLISH CHANNEL

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A high proportion of the common dolphins that strand on the south coast of England in winter months bear evidence of fishery interactions. It is not known which fisheries are involved, but the number of stranded by-caught dolphins has raised concerns for their conservation status. A monitoring and mitigation programme has been established in order to estimate the number of animals taken in UK fisheries in this area, to identify times, areas and methods of fishing most likely to have dolphin bycatch, and to investigate potential methods of minimising bycatch by the UK fleet. The UK fleet consists of around ten boats fishing for mackerel, bass, pilchards and occasionally some other species. There are seasonal and spatial differences in how these fleets operate. Observers have monitored 149 days at sea since 2000, and have recorded 61 common dolphins taken in trawl nets. All of these animals were recorded in trawl tows targeted at bass. These observations have been used to predict possible total dolphin takes by the UK fleet, which vary depending on assumptions made during extrapolation. Comparisons of differences in trawl types and methods of use do not provide any obvious clues as to why dolphins are taken in one fishery and not apparently in the other UK fisheries. Data are not yet sufficient to determine the extent to which bycatch events are determined by spatial and temporal components. Preliminary mitigation trials using pingers were not effective, with no reduction in dolphin catch rate when pingers were deployed around the mouth of the trawl. Current work is focussed on using exclusion grids to allow dolphins to escape from the sleeve of the trawl. Further work involving other European fleets will be required to address this issue if fishery-related dolphin mortalities are to be reduced.

REDUCING THE IMPACT OF ACOUSTIC DISTURBANCE ON MARINE MAMMALS: A PRELIMINARY INVESTIGATION INTO THE EFFICACY OF VISUAL OBSERVERS

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Anthropogenic noise from important human activities, including seismic exploration and naval sonar, is known to have a potential disturbance affect on cetaceans. As protected species under National and International law, the UK government is committed to providing effective mitigation of disturbance for all cetaceans. Current mitigation and research survey practises rely predominantly on the visual detection of marine mammals. However, to date there has been no research published on the efficacy of marine mammal observer programmes or the factors that influence observer performance. The feasibility study quantitatively investigated visual observer efficacy against targets of known timing, type, range, bearing and size. The project used a full-mission ship's bridge simulator to overcome the limitations of field research by providing a known baseline against which to measure performance. The population sample (n = 13) were categorised into trained/experienced (n = 7) and untrained/ inexperienced (n = 6) observers to investigate the role of training and experience on performance. The findings indicated that (a) observer efficacy improved significantly and consistently with training and experience from 14.28% to 43.00% (p = 0.038) representing a threefold increase in efficacy with training and experience; (b) trained / experienced observers provided significantly more accurate identification of target type (p = 0.021); (c) untrained /inexperienced observers inaccurately detected targets 8 times as often as trained / experienced observers (p = 0.039), presenting a very significant cost implications due to unnecessary stoppages and interruptions of industry activities. The findings confirmed that observer efficacy could be reliably assessed using a simulator programme.

CETACEAN STRANDINGS ON THE MEDITERRANEAN COAST OF ITALY: ACTIVITIES OF THE ITALIAN CETACEAN TISSUE BANK AFTER ONE YEAR

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The Italian Tissue Bank (BIT) formally started its activity at the beginning of 2002 at the Department of Experimental Veterinary Sciences of the University of Padua, with the financial support of "I.C.R.A.M" and in collaboration with the Italian stranding network "Centro Studi Cetacei". During its first year of life the BIT has fulfilled some of the set goals and has developed cooperation protocols with several Italian researchers working on stranded animals. Upon receival of tissues sampled from stranded cetaceans an analysis is performed, involving anatomical, histo-pathological, parasitic, stomach content, toxicological and genetic studies, to assess the causes of stranding and death. Such data, if collected on a long-term scale, is crucial for a comparative analysis involving the effects of environmental pollutants and human-derived threats on cetacean conservation. At the moment, the bank stores over 550 samples (fixed in 10% neutral buffered formalin, paraffin, DMSO, alcohol or frozen) from 40 specimens belonging to 9 different species: *Delphinus delphis, Stenella coeruleoalba, Tursiops truncatus, Grampus griseus, Kogia sima, Globicephala melas, Steno bredanensis, Ziphius cavirostris, Physeter macrocephalus*. Some of the sample analysis have reached a satisfactory level (preparation of the histological samples and their examination as well as the determination of causes of death where possible). Other activities such as stomach contents analysis, examination and identification of parasites, establishment of a photo archive per stranded animal and an atlas of normal and pathological histology of marine mammals, are currently underway. The Cetacean Tissue Bank is an on-line service, accessible to the scientific community through the site: http://digilander.libero.it/cetaceantissuebank. It is hoped that a continuously increasing collaboration with the Mediterranean marine mammal community will ensure an ever more useful and efficient service to scientists involved in cetacean research.

ESTIMATED SIZE OF THE POPULATIONS OF PILOT WHALE *(GLOBICEPHALA MACRORHYNCHUS)* AND BOTTLENOSE DOLPHINS *(TURSIOPS TRUNCATUS)* IN THE SAC ES-7020017. TENERIFE

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INTRODUCTION The populations of bottlenose dolphins (*Tursiops truncatus*) and short finned pilot whales (*Globicephala macrorhynchus*) in the SW of Tenerife show a particular fidelity for such a reduced area. Their presence throughout the year is known, they live very close to the coast and their habitat coincides with one of the areas of highest tourist development in the Canaries. More than 30 whale watching boats visit them daily and it has been estimated that the number of passengers every year reaches a million.

In order to establish efficient polices that guarantee the viability of the populations of tropical pilot whales and bottlenose dolphins, in the SW of Tenerife, it is imperative to know exactly what the current situation is and the evolution in time of both populations. Quantifying the population abundance continuously and systematically is one of the procedures that makes it possible to assess in an efficient manner changes in the size of the populations (Gerrodette, 2000).

MATERIALS AND METHODS The design and execution of the pilot study established the minimum effort that should be employed to obtain an appropriate coefficient of variation (>900 nm). The pilot study provided valuable information for the execution of the main study and improved the design by adjusting better to the characteristics of the area of study and the populations.

Study Area The study carried out covered an area of 136-nm^2 (446km^2). We can not say that this is the real area of distribution of the populations in the SW of Tenerife. From previous photoID and genetic studies (Escorza *et al.*, 1992; Heimlich-Boran *et al.*, 1993; Carrillo *et al.*, 2000; Hildebrandt and Afonso, 2000) we can in fact conclude that without any doubt the SAC of Tenerife represents only a part of the distribution range of the populations of both species, and that the real area of distribution is larger than the sampling area.

Searching effort The abundance study was developed between December 2001 and September 2002 with the boat "Monachus". It is necessary to state the fact that the wind conditions in the southern limit (Pta. Rasca) and northern limit (Pta. Teno) of the area of study prevented us from sampling these areas correctly.

Nevertheless, as long as there is not a correlation between the wind conditions and the population density in these areas there is no bias in the estimate (Hammond, 1986).

Under good weather conditions we covered the area with line transects at 6 knots. When an individual or group of cetaceans was sighted, the distance to the group and the angle with the line transect was determined. The distance from the group to the line transect was determined from the centre of the group.

Analysis With the use of the distance data obtained it is possible to model mathematically the detection probability of the groups as a function of the distance from the groups of animals to the transect line. This probability function can be then transformed into an estimate of group density (of each species) in the study area. The group density can be transformed then into animal density and average number of animals in the study area (Buckland *et al.*, 1993).

Group Size To estimate animal density in the area it was necessary to estimate the average group size (E(S) for each species). Some factors can lead to bias in the determination of this variable. Therefore, several methods were used to achieve a reliable estimate for the average number of groups in the area.

* The estimate of group size used only the group size obtained by the best sightseer instead of the estimate of all the sightseers. It was accepted that the rest of the sightseers were in a position of their learning curve not close to the

asintote. If a correction factor was introduced for the estimates in order to use all the sightseers, the evolution in time of their estimates would lead to misleading results.

* It is well known that the group detection probability decreases with distance and may increase with increasing group size. Therefore, there could be a tendency to detect only larger groups at long distances. To avoid the overestimation of the average group size, the group size logarithm was regressed against the detection function (g(x)). If the regression was significant at 0,15 level, the group size estimate would have been used as E(S) (Buckland *et al.*, 1993). If the regression was not significant the arithmetic average would be used as a group size estimate.

RESULTS **Transects effort and sightings** Having selected 43 days of effort in good weather conditions that covered 1057.75 nm (1957 Km), the number of sightings per day of effort ranged from 0 to 12, with a total of 229 sightings during the sampling period.

The number of sightings of pilot whales per day ranged from 0 to 10, with a total of 166 sightings and an average of 3.86 sightings per day. The number of bottlenose dolphin sightings per day ranged from 0 to 4, with a total of 63 sightings and an average of 1.47 sightings per day.

Pilot whale population size (gm): Detection probability The probability function was adjusted with the use of a hazard-rate function and a polynomial expansion series. The detection probability for a transect width (AT) of 0.69 nm has been estimated in 0.34, with a CV of 17.46 (Table 1).

Encounter Rate The encounter rate of the groups (n/L) was 0.15 with a CV of 10.47(Table1).

Average Group size The regression test carried out upon the size of the groups of Gm was not significant at 0,15 level (r-p=0.28). The average group size was determined from the arithmetic average of the sizes of the groups sighted (E(S)= 8.39) (Table 2)

Density and Abundance The estimate group density of Gm in the study area was 0.32 with a CV of 20.36. The estimate animal density was 2.66 nm^2 (CV=20.93). This result multiplied by the study area led to an estimate of 362 animals (95% Confidence Interval 241-544) (Table 2).

Bottlenose dolphin population size (TT): Detection Probability The probability function was adjusted with the use of a uniform function and a cosine expansion series. The detection probability for a transect width (AT) of 0.89 nm has been estimated in 0.28, with a CV of 12.19 (Table 3).

Encounter Rate The encounter rate of the groups (n/L) was 0.60E-01 with a CV of 10.47 (Table 3).

Average Group size The regression test carried out upon the size of the groups of Tt was not significant at 0,15 level (r-p=0.30). The average group size was determined from the arithmetic average of the sizes of the groups sighted (E(S)= 7.43) (Table 4).

Density and Abundance The estimate group density of Tt in the study area was 0.12 with a CV of 17.79. The estimate animal density was 0,90 nm (CV=23.30). This result multiplied by the study area led to an estimate of 122 animals (95% Confidence Interval 78-193) (Table 4).

DISCUSSION Not knowing the real distribution of the tropical pilot whales and bottlenose dolphins in the SW of Tenerife (Heimlich-Boran *et al.*, 1993; Escorza *et al.*, 1992; Carrillo and Martín, 2000), these population estimates can be better understood as an estimate of average number of animals in the area during the period of study. The estimates are therefore referred only to the area searched, that is only a part of the real area of distribution of both species. These estimates can be a good indicator to assess the evolution of the populations, because indexes of abundance are more commonly used than abundance estimates to detect numerical trends (Evans, 1996).

In the Canary Islands, as well as in other regions of the world there seem to co-exist oceanic and coastal populations of bottlenose dolphins in the same area (Hansen, 1990). Around the SW coast of Tenerife it is possible that, at least seasonally, animals of different populations of bottlenose dolphins co-exist, as it is suggested by genetic studies of live animals (Hildebrandt and Afonso, 2000) and morphological studies of stranded animals (Martin and Carrillo, 1992). If this is the case, this study quantified average number of individuals of both populations in the area.

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Table 1. Detection probability and encounter ratio of pilot whale

	Estimate	%CV	df	Confidence Interval 95%	
Hazard/Polynomial					
P	0.34264	17.46	155	0.24334	0.48247
ESW	0.23553	17.46	155	0.16727	0.33164
n/L	0.14936	10.47	41	0.12095	0.18444

Table 2. Average group size, density and abundance of pilot whales

	Estimate	%CV	df	Confidence Interval 95%	
Average group size					
	8.3924	4.86	157	7.6242	9.2380
Hazard/Polynomial					
DS	0.31707	20.36	192	0.21308	0.47181
D	2.6610	20.93	214	1.7692	4.0021
N	362.00	20.93	214	241.00	544.00

Table 3. Detection probability and encounter rate of bottlenose dolphins

	Estimate	%CV	df	Confidence Interval 95%	
Uniform/Cosine					
P	0.27906	12.19	60	0.21886	0.35582
ESW	0.24568	12.19	60	0.19268	0.31326
n/L	0.59536E-01	12.95	41	0.45884E-01	0.77250E-01

Table 4. Average group size, density and abundance of bottlenose dolphins

	Estimate	%CV	df	Confidence Interval 95%	
Average group size					
	7.4286	15.05	62	5.5083	10.018
Uniform/Cosine					
DS	0.12117	17.79	95	0.85353E-01	0.17201
D	0.90010	23.30	157	0.57158	1.4174
N	122.00	23.30	157	78.000	193.00

Terms:

n - Number of groups sighted (or individuals).
L - Total length of the line transect (∑ of all the transect lines).
k - Number of transect lines (=days).
n/k - Group encounter rate.
AT - Transect width.
p.-. Detection probability in the area.
ESW.- Effective width strip.
m.-. Number of parameters in the model.
AIC.-. Akaike information criterion.
r-p.-. Probability of the regression test.
E(S).-. Average size of the groups.
DS.-. Estimated density of the groups.
D.- Estimated density of the individuals.
N.- Estimated number of individuals in the study area.
Nmin.-. Minimum population size.

AN ASSESSMENT OF DAMAGE TO FISHING NETS CAUSED BY DOLPHINS IN A TRAMMEL NET FISHERY IN GREECE

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Damage to fishing nets is a widespread problem in the Mediterranean that has been attributed to dolphins, but which has been little studied. This study aimed to monitor damage levels in a trammel net fishery in the Greek Island of Paros. The intentions were to test fishermen's claims that dolphins are responsible for damaging their nets, if possible to identify the species of dolphin involved, and to determine the levels of this damage. Standardised nets, fitted with dummy acoustic deterrent devices, were monitored for signs of damage as part of a project also looking at the effects of active acoustic devices on dolphin predation. Three boats were sampled over a six-week period in May and June of 2002. Nets were individually marked and new holes were identified each time a net was hauled. Four categories of net damage were noted and described, the most numerous of which were holes referred to by fishermen as 'dolphin holes'. 76 net-hauls were monitored, of which 41 had a total of 338 new 'dolphin holes'. A bottlenose dolphin was caught accidentally during the experimental period in a trammel net that had 6 'dolphin holes'. This animal was found to have a piece of net matching the trammel net in its stomach, together with 6 pandora fish. Dolphins were sighted on 18 occasions, and were positively identified as bottlenose dolphins (*Tursiops truncatus*) 8 times. There was a correlation between dolphin sightings and subsequent 'dolphin-hole' damage to nets. We conclude from this that it is likely that most if not all of the 'dolphin holes' are indeed caused by bottlenose dolphins, that net damage rates are high, averaging over 4 holes per km of net set per night, and that these holes and the associated fish depredation may represent a significant loss to this fishery.

BEHAVIOURAL INTERACTIONS BETWEEN BOTTLENOSE DOLPHINS AND GILL NETS IN NORTH CAROLINA, USA

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We studied fine-scale behavioural interactions between bottlenose dolphins (Tursiops truncatus) and a gill net fishery for Spanish mackerel (Scomberomorus maculatus) near Beaufort, NC in June 2002. Our objective was to determine how dolphins become entangled in gill nets. To monitor dolphin behaviour we used an overhead digital video camera, suspended from a helium-filled aerostat, which was tethered to a commercial fishing vessel. We observed dolphins around a gill net, set perpendicular to shore and extending from the bottom to the water's surface. The net was 200 m long, with a stretched mesh size of 80 mm. We defined the following behaviours: encounters, in which dolphins approached within 500 m of the net; interactions, in which dolphins came into physical contact with net, changed course to avoid it, or begged for fish; and depredation, in which dolphins removed captured fish from the net. We observed 30 sets (mean duration 1.0 h). Dolphin encounters (n=36) and interactions (n=27) were observed in most sets, although we did not observe any entanglements. Individual dolphins differed in their response to the net. Most (n=15) interactions involved course changes around the net, but on nine occasions we observed dolphins in physical contact with the net, usually engaging in depredation. We also examined the stomach contents of 18 dolphins that stranded, with evidence of entanglement, between May and October (1993-2001), when this fishery occurs. None of these dolphins had Spanish mackerel or other species taken by this fishery in their stomachs. We conclude that interactions between dolphins and these gill nets are common and that many of these interactions are food-based. Surprisingly, however, dolphins engaging in depredation do not appear to become entangled; instead it seems more likely entanglement occurs as a result of dolphins failing to change course around the net.

INTERACTIONS BETWEEN DOLPHINS AND SMALL SCALE FISHERIES ALONG THE LIGURIAN COAST: A FIRST APPROACH

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This paper describes the preliminary results obtened from a national projet organized by ICRAM-Rome, on dolphins and fishery interactios along the Ligurian coast. The conflicts between small cetaceans and fisheries can be summarized into two categories: those where the marine mammal is causing problems for the fisheries and those where the fishery is causing problems for the marine mammals. The 90% of the Ligurian fisheries are carryed out as small-scale, mulpipurpose and on coastal species. Data from 121 interviews, as representative of the 710 ligurian fishermen working at small-scale level, show that dolphins have been met at least one time during 2001 fishing season. In spite of in the past conflicts among bottlenose dolphin (*Tursiops truncatus*), short-beaked common dolphin (*Delphinus delphis*) and gill-net fisheries were regularly reported, during our study no event were recorded. Likely both kind of interactions are rare along the Ligurian coast, at present, even if bottlenose dolphin is the most recorded species by fishermen, followed by striped dolphin during spring and fall. Pilot whale (Globicephala melas) and fin whale (*Balaenoptera physalus*) encounters must be added to the above mentioned species off the Western Riviera.

THE FELUCA BOAT OF THE STRAIT OF MESSINA: A PLATFORM OF OPPORTUNITY FOR CETACEAN SIGHTINGS

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INTRODUCTION The swordfish (*Xiphias gladius*, Linnaeus 1758) fishery is one of the main fishing activities carried out in Sicilian waters (Di Natale *et al*., 1996). The most ancient swordfish-fishing gear still used in the Strait of Messina is the harpoon (Cavaliere, 1962; Cavallaro *et al*., 1996; Sisci,1984). Every summer, fishing boats called "*feluche*", survey the area daily from dawn to sunset to hunt swordfish off the coasts of Sicily, Calabria and the Aeolian Islands (Romeo *et al*., 2001). The *feluca* boat features a sighting platform (antenna) 25 m above sea level and a 25-30 m long bow plank (passerella) from which swordfish are harpooned. The presence of the high antenna makes these boats ideal platforms to spot marine vertebrates. In summer 2002, the possibility to conduct a study on presence and distribution of cetaceans from these platforms was assessed.

MATERIALS AND METHODS Between May and August 2002, 47 fishing surveys were performed with sea conditions ≤ Beaufort 3 (necessary to spot swordfish under the sea surface) following courses dictated, on the basis of, sea currents, surface conditions and time of day. Boats moved at speeds ranging between 6 and 8 Knots. The survey was carried out in the waters that comprised the Strait of Messina (included) and the Aeolian Islands (Fig. 1). The entire area was divided into four smaller areas: the Calabrian Ionian Sea, the Strait of Messina, Cape Rasocolmo, and the Aeolian Islands. Geographic coordinates and depth were GPS-surveyed at each sighting. Data were analysed in relation to depth and distance to the nearest shore (Fabbri *et al*., 1992). The best estimates of the number of samples per group were also obtained. The Frequency of Occurrence (F.O. = number of sightings/sighting hours X 100) was then calculated.

RESULTS Fifty encounters of four different cetacean species were recorded: *Stenella coeruleoalba* (58%), *Tursiops truncatus* (20%), *Balaenoptera physalus* (4%), *Physeter macrocephalus* (2%). Groups of small and big unidentified cetacean species (respectively 12% and 2%) were also encountered (Fig. 2). Data on sample for species and related frequency are listed in Table 1. The striped dolphin was the most sighted species with the highest number of individuals (85.70%). Data on each of the four areas are given in Table 2. The distribution of cetacean sightings among different areas is represented in Fig. 3. The area between Cape Rasocolmo and the Aeolian Islands had the highest frequency of occurrence, accounting for 28.95% and 19.12%, respectively. Although the effort was limited at 8-15% of the total hours, such frequencies indicated a higher encounter rate compared to the Strait of Messina (Fig. 3), which totalled 296 hours of observation. Distance from the nearest coast and depth of encounters for all groups are reported in Fig. 4 – 5. Table 3 shows the range of the distance from the nearest coast for bottlenose and striped dolphins.

CONCLUSIONS The presence of various cetacean species concentrated in a limited area was previously noted in a preliminary survey done in summer 2001. In relation to the distance from the coast and to the range of depth at which the largest number of sightings occurred, bottlenose dolphin and striped dolphin sightings still reflect their ecological preferences, even if this area is characterised by a reduced continental shelf.

Results indicate the existence of important cetacean habitat between the Strait of Messina and the Aeolian Islands. Various factors, including physio-chemical characteristics of the water, morpho-bathymetry and food availability are part of this complex ecosystem in which top predators, including marine mammals and large pelagic fishes such as swordfish, tuna and spearfish, find favourable conditions (that allow them to dwell in the observation area during the summer months).

Traditional swordfish-fishing in this area is not only a maritime heritage but is also a highly selective fishing activity and is also ecologically sustainable in that it has a low impact on local fishery resources (Romeo *et al*., 2002). The height of the "antenna", designed to spot large pelagic species, is a platform of opportunity for sighting cetaceans. The development of sighting protocols combined with GPS technology (e.g., LOGGER software developed by IFAW) allows continuous tracking of the boat routes and can provide important data to estimate the sighting effort.

Data emerging from these results may lead to further collaboration efforts between fisheries and research. This unique "hunt for swordfish", the highly developed small-scale fishery industry, the rich cetacean fauna and widespread tourism could make this region of Sicily a likely area for the whale watching industry in Italy.

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Table. 1. Number of individuals for each species and prevalence			
Fishing days	**Species**	**N° for species**	**Prevalence (%)**
47	**Stenella coeruleoalba**	1,235	85.70
	Tursiops truncatus	150	10.41
	Physeter macrocephalus	1	0.07
	Balaenopthera physalus	3	0.21
	Undetermined small cetacean	51	3.54
	Undetermined large cetacean	1	0.07

Table. 2. Effort, number of encounters, encounter rate for each area			
Area	**Effort (h)**	**N° encounters**	**Encounter rate**
Cape Rasocolmo	38	11	28.95
Aeolian Islands	68	13	19.12
Calabrian Ionian Sea	44	4	9.09
Strait of Messina	296	22	7.43
Total	**446**	**50**	-

Tab. 3. Range of distance from nearest coast and depth for bottlenose dolphin and striped dolphin						
	Bottlenose dolphin			**Striped dolphin**		
Distance from	min	max	mode	min	max	mode
coast (km)	2.50	4.80	0.93	0.40	26.90	8.70
Depth (m)	10	1000	100	23	1480	150

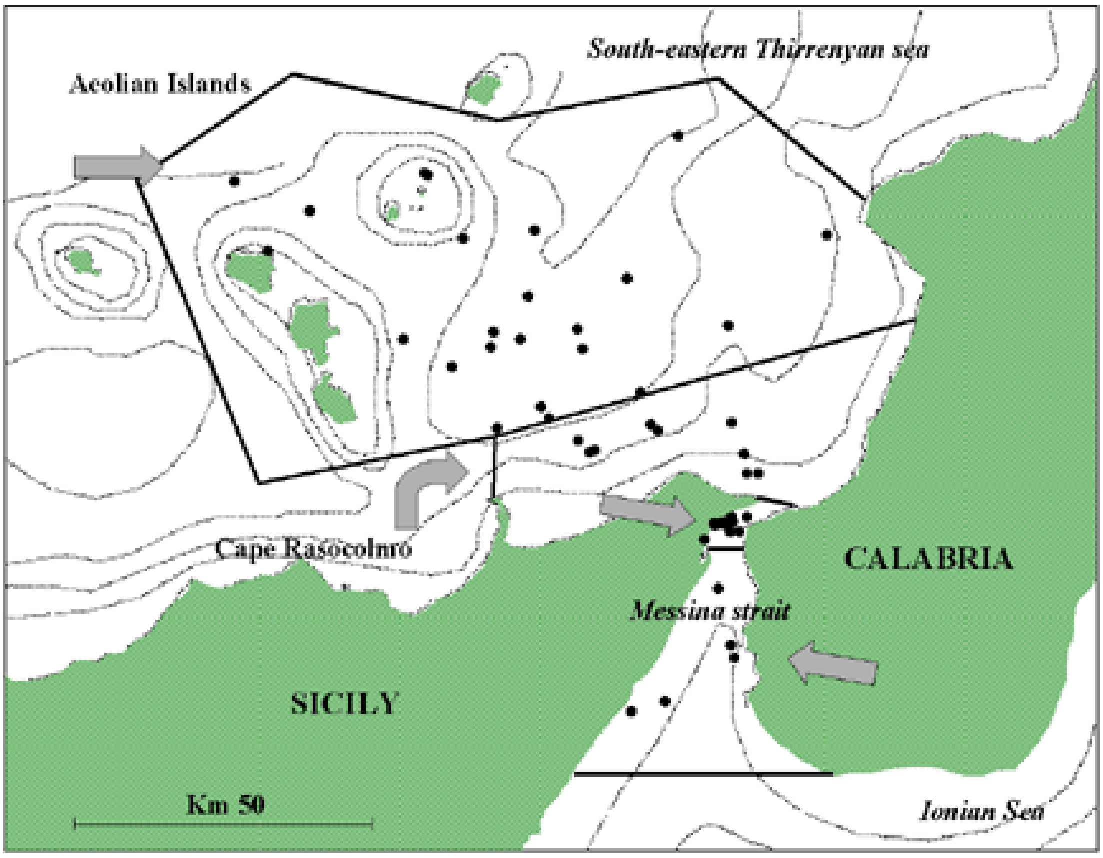

Fig. 1. Study area

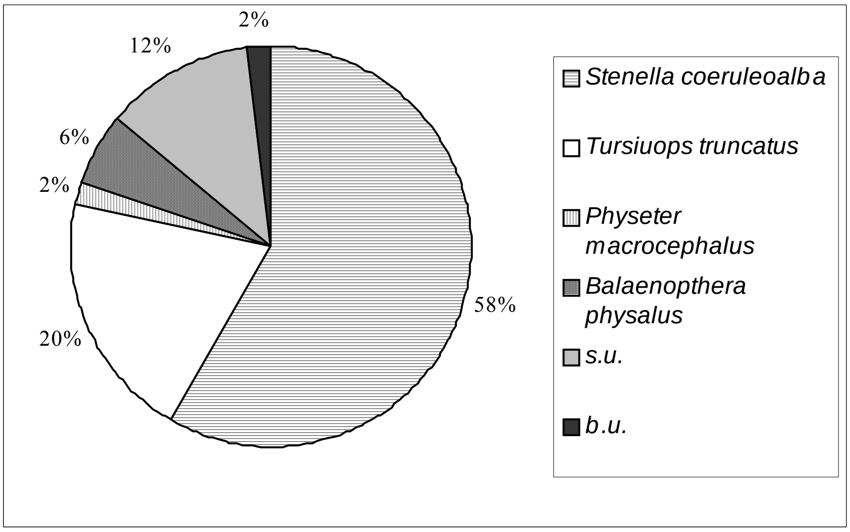

Fig. 2. Frequency of encounters for species

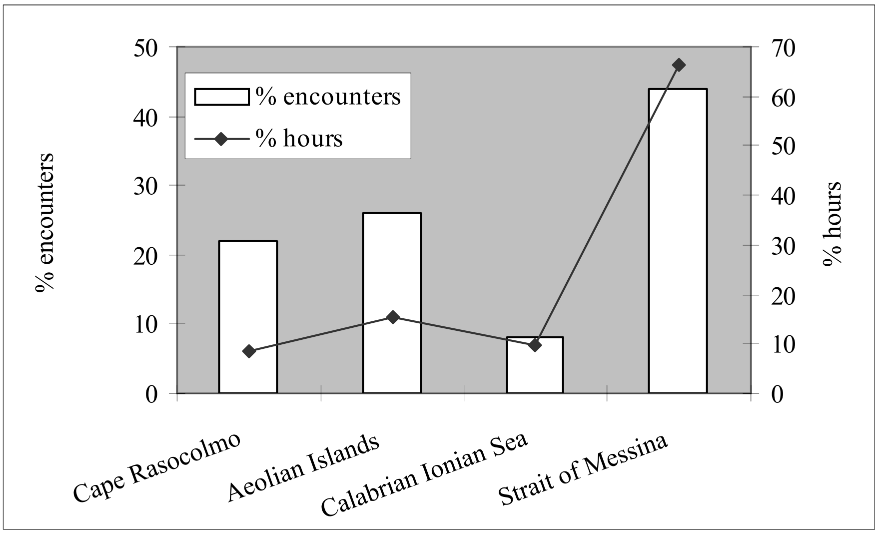

Fig. 3. Total effort and total number of sightings duration for area

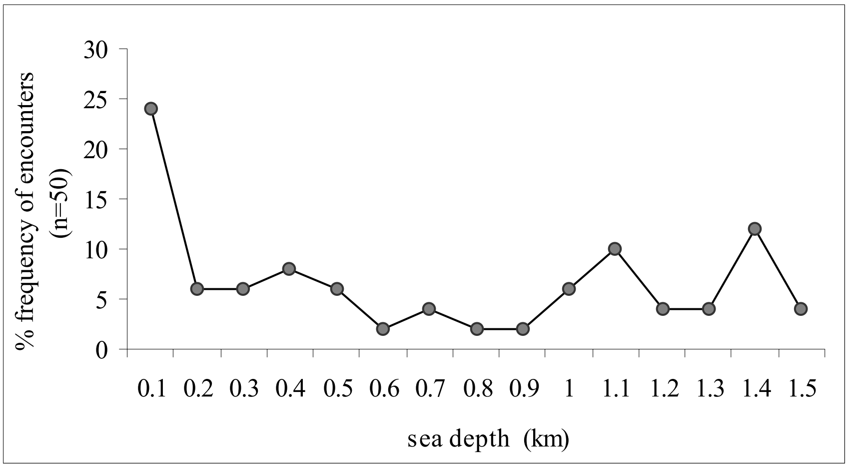

Fig. 4. Frequency of encounters in relation to the sea depth

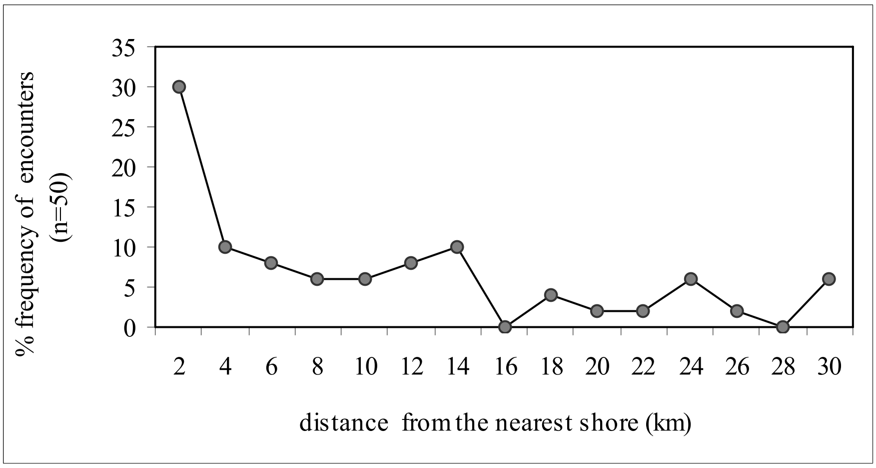

Fig. 5. Frequency of encounters in relation to the distance from the nearest shore

FIRST GENETIC CHARACTERISATION OF THE POPULATION OF THE BOTTLENOSE DOLPHINS *TURSIOPS TRUNCATUS* ALONG THE ISRAELI COASTLINE AND A MOLECULAR COMPARISON WITH A POPULATION FROM THE BLACK SEA

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This study's main aim was to fill the information gap on the genetic structure of cetacean populations in the eastern basin of the Mediterranean Sea. Towards this aim, a molecular analysis was performed on muscle/skin samples of 11-beached members of the population of the bottlenose dolphins (*Tursiops truncatus*) along the entire Israeli coastline, using microsatellite markers. As part of a feasibility study of the use of such markers on skin-scrubbed samples, the occasion rose to include 7 captive Black-Sea bottlenose dolphins (*Tursiops truncatus ponticus*), living in the Eilat "Dolphin Reef", in the analysis. A new protocol was created to extract nuclear DNA from the skin tissues, since there is a lack of information about this procedure in the literature. Nine microsatellite markers (EV01, EV14, EV94, TexVet03, TexVet05, TexVet07, D14, D22 and D28), taken from the literature, were applied on the combined study group. The results showed that the Mediterranean coastal dolphins might be divided into 2 subpopulations, northern and southern. When comparing the Black-Sea dolphins to Mediterranean dolphins using cluster analysis, a clear difference is demonstrated. The above results lend support to the genetic isolation of Tursiops truncatus ponticus and, if further substantiated, may help to implement specific management plans In order to adopt international agreements, such as the recently-failed attempt to move it from Appendix II to I for better local protection.

MONITORING GREY SEALS (*HALICHOERUS GRYPUS*) IN WALES, UK

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For over 20 years, staff of the Skomer Island Marine Nature Reserve, the Countryside Council for Wales and their contractors have been conducting population surveys of Grey Seals (*Halichoerus grypus*) in Wales (UK). In 1995, the all-age population in West Wales was estimated at 5000. The importance of the Grey Seal populations in Wales has led to the species being a designating 'feature' for the Pembrokeshire Marine candidate Special Area of Conservation (cSAC) in West Wales; the Pen Llyn a'r Sarnau cSAC in North Wales; and the Cardigan Bay cSAC in Mid Wales. We describe aspects of our monitoring methods and procedural trials, and present results in relation to determining Grey Seal population abundance, dynamics (recruitment, mortality and emigration), age structure, and habitat requirements (breeding and feeding distributions) in Wales. These, in turn, are expected to facilitate the development of conservation objectives and the determination of 'favourable conservation status' as defined by the 1992 EC Habitats Directive.

FACTORS INFLUENCING THE SEASONAL DISTRIBUTION OF SIGHTINGS OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) ALONG THE DORSET COAST, UK

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INTRODUCTION Marine mammals are an important part of British fauna, with cetaceans accounting for approximately one quarter of the mammal species that have been recorded (Leaper, 1995). However many of the cetacean populations around the U.K are believed to be in decline. One such species, a 'top predator', the Bottlenose dolphin (*Tursiops truncatus*), ranges far during its lifetime and thus comes into contact with a wide variety of ecological pressures (Evans, 1990). Threats to Bottlenose dolphins include depletion of resources as a result of over-fishing, incidental entanglement in fishing gear, pollution and disturbance (Simmonds, 1994). These conservation concerns have been formalised under U.K and international legislation requiring the establishment of marine protected areas for the species.

Since dolphins are highly variable and locally adapted, local research is crucial for effective conservation strategies (Wilson *et al.*, 1997). The Durlston Marine Project has co-ordinated a research programme focused on the Bottlenose dolphin population that frequents the Dorset coastline (Fig. 1) and to date has used systematic visual surveys, photo-identification and behavioural observations. Past studies have identified seasonal peaks in the frequency of dolphin sightings in spring and autumn (Fig. 4). In addition, anthropogenic factors, including boat traffic and underwater noise levels, have been shown to significantly influence peaks in sightings, but did not account entirely for the observed seasonal changes in distribution. To meet current legislation and to protect this population there is a need for flexible protection measures specific to the south coast of England (Owens *et al.*, 2001). The aim of this preliminary study was to identify those variables that best predict the seasonal distribution of sightings of Bottlenose dolphins along the Dorset coast. Variables investigated included salinity, sea surface temperature, chlorophyll *a* (an indicator of primary productivity; Smith *et al.,* 1986), and prey distribution (inferred from landing catch data sets).

METHODS The Durlston Marine Project provided a dataset of opportunistic dolphin sightings made along the Dorset coast between 1988 and 2001. The variables salinity, sea surface temperature and chlorophyll *a* were sampled off Durlston Head, between July and December 2001, at a longitude and latitude of 50°34.9'N, 001°56.62'W (Fig. 1) using standard sampling techniques (Dipper *et al.*, 1998; Parsons *et al.*, 1984). Historical datasets were obtained for sea surface temperature (1988 to 2001) and salinity (1995 to 2001). Data for historical chlorophyll *a* concentrations were extracted from remote sensing satellite images provided by SEAWIFS (1997 to 2001). The Department for Environment, Food and Rural Affairs (DEFRA) provided landing catch data (wet weight tonnes) for the Dorset ports for the period 1991 to 2000 since direct sampling of prey stocks using trawling techniques (Dipper and Tait, 1998) was not feasible. A limitation of the landing catch data is that records are not made of the location where each prey species is caught; to justify the use of landing catch data for determining the importance of the Dorset coast for the dolphins, all prey species were confirmed to have significant populations in Dorset waters (Alan Lander, local fisherman; Neil Richardson, District Fisheries Officer). Locally sampled data were significantly correlated with the historical data sets, using Spearman's Rank Correlation test (N=10), for the variables sea surface temperature ($r=0.906$, $P<0.0001$), salinity ($r=0.757$, $P<0.01$) and chlorophyll *a* ($r=0.7$, $P<0.05$). This validated the use of historical data sets for further analysis to determine whether the variables could be used to predict the frequency of dolphin sightings.

RESULTS Using a stepwise multiple regression analysis, we found that chlorophyll *a* and prey distribution were the main factors influencing the seasonal distribution of dolphin sightings. Of the prey species investigated (N=21) Brill, Cuttlefish, Plaice, Pollack, Red and Grey Mullet, Sole, Sprat and Spurdog were found to be significant predictors and could explain 87.63% (R^2 (adj)) of the frequency of dolphin sightings. Stepwise multiple regression also identified historical chlorophyll *a* as a significant predictor of sightings, explaining 13.5% (R^2 (adj), N=27) of the frequency of dolphin sightings. Table 1 shows the results of the statistical tests and Fig. 2 the relationship between the seasonal distribution of dolphin sightings and the seasonal variation in chlorophyll *a* concentration. The relationship between prey species and frequency of dolphin sightings clearly shows peaks in sightings in spring and autumn (Fig. 3).

DISCUSSION Chlorophyll *a* explains only 13.5% of the frequency of dolphin sightings; this is presumably because the relationship is not causal (Selzer *et al.*, 1988). Chlorophyll *a* influences the distribution of dolphins through links in the food web; in addition, the effects of high concentrations of chlorophyll on the density of prey species are temporally and spatially discrete. Vinogradov (1981) demonstrated that the development of all trophic levels between phytoplankton and large squid takes 4 months, and thus a peak in chlorophyll concentration is temporally separated from peaks in squid density (Jaquet *et al.*, 1996). Phytoplankton blooms occur to the southwest of Dorset, off the Cornish coast, and as the chlorophyll disperses further into the Channel the peaks in prey density in Dorset will become spatially and temporally separated from the initial bloom.

In addition to the influence of chlorophyll, 8 species of prey, Brill, Cuttlefish, Plaice, Pollack, Red and Grey Mullet, Sole, Sprat and Spurdog, were found to be significant predictors of dolphin sightings. These findings suggest that the availability of prey is an important factor affecting the distribution of Bottlenose dolphins along the Dorset coast, a region with the potential to provide beneficial bottom substrates, topography and tidal currents to aid capture of prey (Browning, 1997). Food resources are one of the most important factors affecting dolphin movements (Shane *et al.*, 1986), and although dolphins feed opportunistically (Young *et al.*, 1994; Santos *et al.*, 2001; Shane *et al.*, 1986), they have clear preferences when given a choice of food items (Santos *et al.*, 2001). Optimal foraging models suggest that high quality prey species should be preferred (Defran *et al.*, 1999) because dolphins need to be near to a sufficient concentration of high-quality prey in order to meet their high demands on energy (Gannon *et al.*, 1997; Young *et al.*, 1994). Sprats have the highest energy content per gram in European waters (Evans, 1990); other fish such as Mackerel and Mullet are also known to have a high-energy content (A. Lander and C. Owens, personal communication). Analysis of stomach contents of Common dolphins (*Delphinus delphis*) stranded on the Plymouth coast revealed bones of Sprat and Mackerel, species that are common shoaling fish in the shallow waters off both Plymouth (Pascoe, 1986) and the Dorset coast. In Scotland, Sprat and Plaice have been found in the stomachs of stranded and by-caught Bottlenose dolphins (Santos *et al*., 2001). Dolphin diet changes with geographical area and according to seasonal fluctuations in the abundance of preferred prey (Silva, 1999). The prey species in this study are therefore likely to have been the preferred diet in the local area. Some confirmation of this is provided by the discovery of numerous Cuttlefish beaks in the stomachs of Bottlenose dolphins washed up on the Dorset and Cornish coasts in the spring of 2002. Spurdog and other piscivorous species such as Pollack may have non-causal relationship with the seasonality of dolphins since they also feed on schooling fish such as Herring, Sprat and Whiting (Wheeler *et al.*, 1992). Thus the results implicate prey availability, and therefore feeding, to be the dominating force influencing dolphin seasonal distribution along the Dorset coast. This theory is supported by behavioural studies where the most prominent behaviour observed has been 'tight association formation', which is thought to be a mode of foraging activity (Coelho, 2001).

Results such as these have important conservation implications. If we know what factors influence dolphin seasonal distribution and can understand the specific uses of coastal areas then we can begin to formulate how best to protect their resources. Critical to this is the identification of the animals' 'home range', or 'natural range', defined as the distinct region where they live and perform biologically important activities throughout their lifetime (Defran *et al.*, 1999). The study has highlighted the importance of the Dorset coast for the natural range of Bottlenose dolphins. These areas are required to be protected under the EC Habitats Directive (1992) as marine Special Areas of Conservation (SACs) (Simmonds, 1994) and in accordance with this legislation the Bottlenose dolphins inhabiting the waters off the Dorset coast require protection that is currently not provisioned. The success of designated areas depends critically on the quality of information available (Wilson *et al.*, 1997) and in light of the importance of the Dorset coast for the population of Bottlenose dolphins it is crucial that observational, behavioural and photo identification studies continue.

Long-term research is required to assess Dorset's prey stocks more effectively so that accurate information is available; this could be done by sampling prey stocks directly using trawling techniques (Dipper and Tait, 1998). Research is also required to measure environmental variables over a long time scale in order to build data sets that are locally accurate. Molecular techniques could be used to estimate genetic variation and to identify the extent to which breeding groups are discrete (A. William, personal communication). Such studies would benefit not only the effective management of the population (Goodwin *et al.*, 1996) but also its conservation status.

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Table 1. Results of Stepwise Multiple Regression.

Variable	*T-value*	*P-value*	*N*
Brill	-20.0	< 0.003	21
Cuttlefish	-0.74	< 0.0001	21
Plaice	5.27	< 0.0001	21
Pollack	-3.3	0.032	21
Red and Grey Mullet	-0.35	0.011	21
Sole	3.25	< 0.001	21
Sprat	0.316	< 0.0001	21
Spurdog	22.4	< 0.0001	21
Chlorophyll *a*	2.25	0.034	27

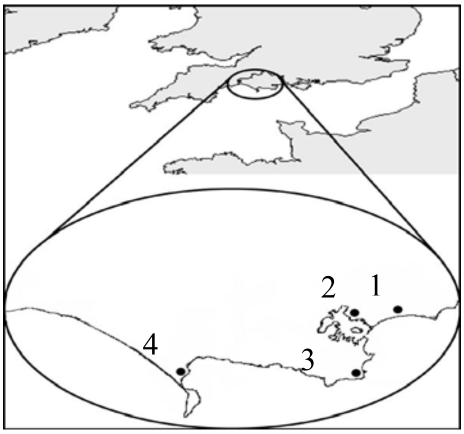

Fig. 1. UK (top) and Dorset coastline (bottom):
1. Bournemouth
2. Poole
3. Swanage, Durlston Head
4. Weymouth

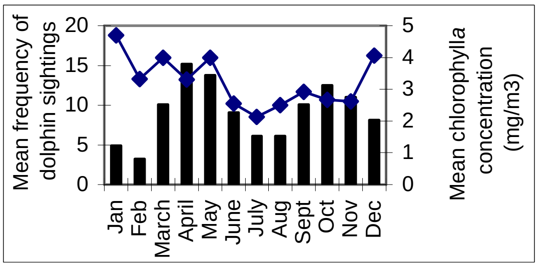

Fig. 2. Seasonal variation in mean monthly dolphin sightings and mean monthly chlorophyll *a* concentrations.

Frequency of bottlenose dolphin sightings.

Chlorophyll *a* concentration (mg/m^3).

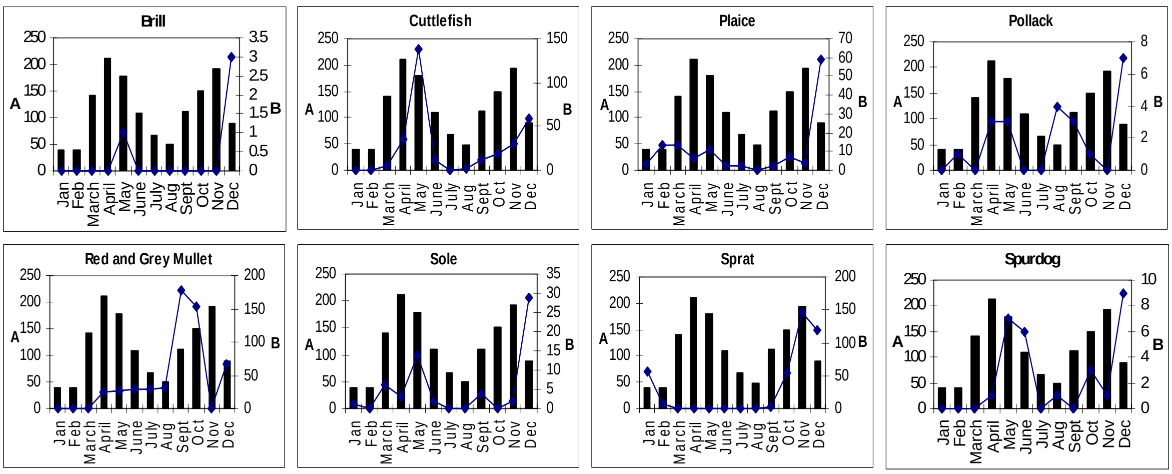

Fig. 3. Seasonal variation in frequency of bottlenose dolphin sightings (axis A) and prey catch (wet weight in tonnes, axis B). Each graph is for one of the eight prey species established as significant predictors of the frequency of dolphin sightings.

Frequency of dolphin sightings between 1988 and 2001.

Prey catch (wet weight in tonnes) between 1991 and 2000.

STATUS OF THE SHORT FINNED PILOT WHALE (*GLOBICEPHALA MACRORHYNCHUS*) AND BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) AFTER 10 YEARS OF WHALE WATCHING IN SOUTH WEST COAST OF TENERIFE

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INTRODUCTION The sw coastal shelf of Tenerife, with an area of only 136 sq. miles (440,64 sq. km), is one of the most important locations for whale watching activities in the world. The touristy growth, with an increase in whale watching from 40.000 in 1991 to 1 million in 2000 (Urquiola *et al*., 1999; Carrillo and Martín, 2000; Martín and Urquiola, 2001), has not been related to the increase in the scientific knowledge about the status of the cetacean populations in the area. The low statistical power and the uncertainty associated with the studies carried out, make it impossible to determine the long term impact of the activity in the resident populations. The short term impact has been well researched (Montero and Martín, 1993; Brito *et al*., 2000). The CETCAN project, funded by the Canarian Government, has developed as a part of their objective the monitoring of the main population parameters of the resident bottlenose dolphin (*Tursiops truncatus*) and tropical pilot whale (*Globicephala macrorhynchus*) populations in area SAC ES-70200017. A comparative analysis of the results with those obtained by other authors (Heimlich-Boran, 1993; Montero and Martín, 1993; Montero, 1997; Carrillo and Martín, 2000) may be a useful tool to detect changes in population parameters.

MATERIALS AND METHODS The study was carried out between sep/2001 and ag/2002, covering the area (SAC ES-7020017 of the west coast of Tenerife) with the boat Monachus, following the line transect methodology. This area of 136 sq. miles has been divided in grids of 1 sq. mile so they can be separated according to the sighting frequency: high, medium and low density. In each sight the position, depth (digital echo sounder- 2000m), group size, structure and group composition was recorded.

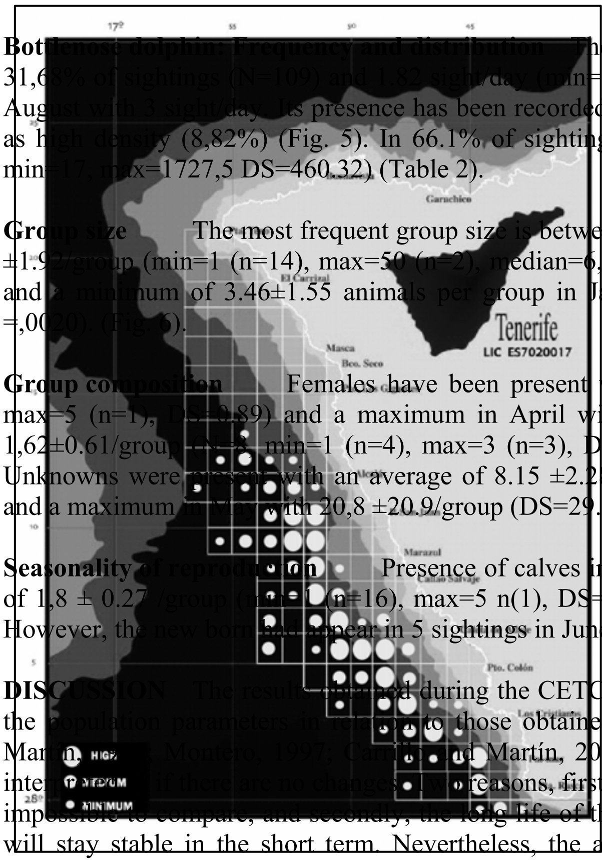
RESULTS **Effort** Out of a total of 108 days, 60 days with good weather conditions were selected in order to homogenize the data for the analysis. 1570,19 miles were travelled in these conditions in 266,83 hours which led to 344 sightings. The sightings per unit effort (APUE) have been 5,73/day, 0,22/mile and 1,52/hour, finding the highest group abundance during the months of February (8,43/day; 0,31/mile) and May (7,2/day; 0,31/mile).

Short-finned pilot whale: Frequency and distribution The short finned pilot whale, present throughout the study with 62,20% of sightings (N=214) and 3,57 sight/day (min=0 (n=5), max=10 (n=1)) had its highest frequency sighting in February with 6,42 sight/day. Its presence has been recorded in 61 squares (44,8%) from which 15 have been recorded as high density (11,03%) (Fig. 1). In 65,42% of sightings (n=140) depths exist of between 800-1200 m (average=1065.6 ±34.2, min=380, max=1740, DS=254.07) (Table 1).

Group size The most frequent group size is between 6 and 10 individuals (45.32%, n=97), with an average of 8,33 ±0,64/group (min=1 (n=1), max=26 (n=1), median=7.5, DS=4.78) and an increase between the months of June (with a maximum of 11,16 ±3.12/group) and September, and a minimum in May with 6,4±1.6/group (Kruskal-Wallis test: H (9, N= 214) = 17,60583 p=,0401) (Fig. 2)

Group composition Males have been present with an average of 1.84±0,3 /group (N=95, min=1 (n=46) max=8 (n=1), DS=1,49) and a maximum in December with 2,4±0,9 /group (DS=2.17). Females, with an average of 2.07±0.2 /group (N=148, min=1 (n=61), max=6 (n=3), DS=1,24), showed the maximum in June with 2,9±0,7 (DS=1.45). Juveniles present an average of 1,5±0.31/group (N=34, min=1 (n=23), max=5 (n=1), DS=0,89), with a maximum of 2 in December. The unknowns were present with an average of 5 ±0,52/group (n=182, min=1 (n=21), max=19 (n=2), DS=3.58) and a maximum of 6,64±1,75 (DS=4,25) in December (Fig. 3).

Seasonality of reproduction Presence of calves in 137 sightings (64,01%) throughout the study, with an average of 2.24±0.24 /group (min=1 (n=54), max=9 (n=1), DS=1,43) and a maximum of 3,6/group in June (Kruskal-Wallis test: H (9, N=137)= 19,97752 p=,0181). The presence of new born, with 1 per group, had a peak during December and September (n=4). (Fig. 4).



Bottlenose dolphin: Frequency and distribution The bottlenose dolphin, present throughout the study with 31,68% of sightings (N=109) and 1.82 sight/day (min=0 (n=7), max=5 (n=1)), had its highest frequency sighting in August with 3 sight/day. Its presence has been recorded in 57 squares (41,91%), from which 12 have been recorded as high density (8,82%) (Fig. 5). In 66.1% of sightings (n=72) depths exist of first 200m (average=357,4 ±87,4, min=17, max=1727,5 DS=460.32) (Table 2).

Group size The most frequent group size is between 3 y 10 individuals (51.4%, n=56), with an average of 9.16 ±1.92/group (min=1 (n=14), max=50 (n=2), median=6, DS=10,11) and an increase in May with 17.6 ±13.65/group and a minimum of 3.46±1.55 animals per group in January (Kruskal-Wallis test: H (9, N= 109) = 26,04618 p =,0020). (Fig. 6).

Group composition Females have been present with an average of 1.8 ±0.28/group (N=44, min=1 (n=18), max=5 (n=1), DS=0.89) and a maximum in April with 3.5 ±19.06 (DS=2.12). Juveniles showed an average of 1,62±0.61/group (N=8, min=1 (n=4), max=3 (n=3), DS=0.74), with a maximum of 3 animals per group in June. Unknowns were present with an average of 8.15 ±2.28/group (N=108, min=1 (n=16), max=94 (n=1), DS=11.95), and a maximum in May with 20,8 ±20.9/group (DS=29.21). (Fig. 7).

Seasonality of reproduction Presence of calves in 39 sightings (35,8%) throughout the study, with an average of 1,8 ± 0.27 /group (min=1 (n=16), max=5 n(1), DS=0.84) and a maximum in April with 3.5 ±19.06 (DS=2.12). However, the new born had appear in 5 sightings in June (n=3) and September (n=2) with a 1 per group. (Fig. 8).

DISCUSSION The results obtained during the CETCAN project have not shown significant differences in any of the population parameters in relation to those obtained in previous studies (Heimlich-Boran, 1993; Montero and Martín, [illegible] Montero, 1997; Carrillo and Martín, 2000). Nevertheless, the absence of differences should not be interpreted as if there are no changes. Two reasons, firstly the different methodologies used in the studies make them impossible to compare, and secondly, the long life of these animals can not assure that some population parameters will stay stable in the short term. Nevertheless, the application of this standardized methodology during further studies will allow comparable results that could give information about the evolution of these populations more efficiently.

ACKNOWLEDGEMENTS The authors would like to thank to the Environmental Agency of the Canary Government for the interest in cetacean conservation and for the financial support of the research. Special thanks are due by the collaboration of Port Authority of all wharfs we were to provide all the "Monachus" team needed. Tenerife Conservación is especially grateful to all friends that were both in bad and in good situations.

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Table 1. Depth range of short-finned pilot whale

DEPTH RANGE	COUNT	PERCENT
200 – 400	1	0.46
400 – 600	3	1.40
600 – 800	22	10.28
800 – 1000	74	34.58
1000 – 1200	66	30.84
1200 – 1400	23	10.74
1400 – 1600	14	6.54
1600 – 1800	11	5.14

Fig. 1. Distribution range of short-finned pilot whale.

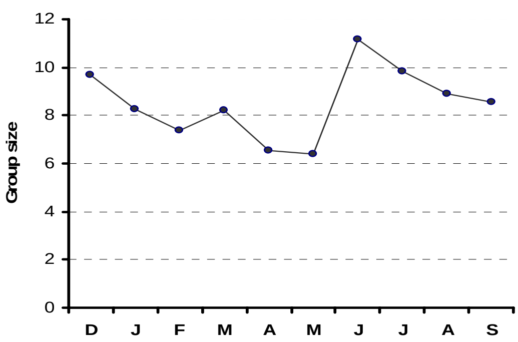

Fig. 2. Group size for short finned pilot whale in the research area throughout the study

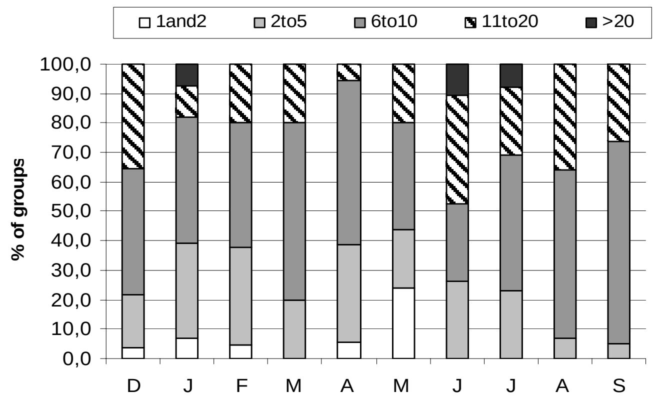

Fig. 3. Share of the group size ranges in the overall amount of sightings of short finned pilot whale throughout the study

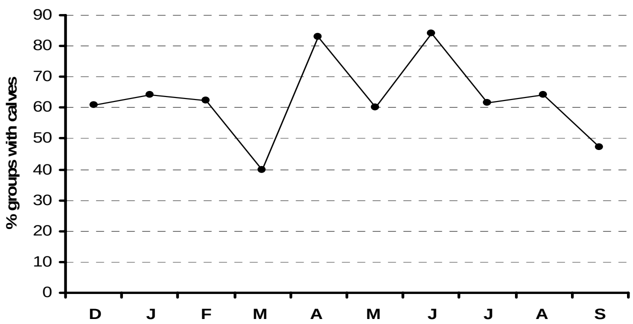

Fig. 4. Percentage of groups with calves for short finned pilot whale throughout the study

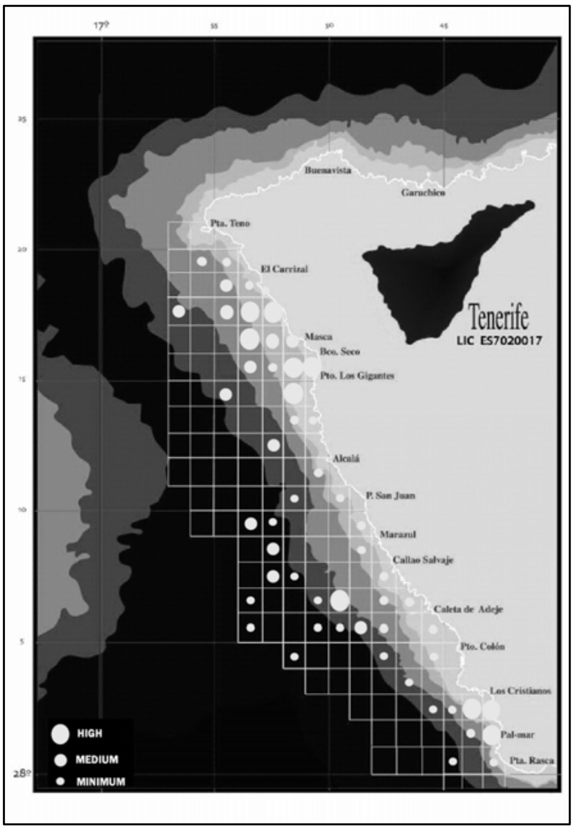

Fig. 5. Distribution range of bottlenose dolphin

Table 2. Depth range of bottlenose dolphin.

DEPTH RANGE	COUNT	PERCENT
0 – 200	72	66.1
200 – 400	3	2.8
400 – 600	4	3.7
600 – 800	10	9.2
800 – 1000	6	5.5
1000 – 1200	7	6.4
1200 – 1400	4	3.7
1400 – 1600	0	0
1600 – 1800	3	2.8

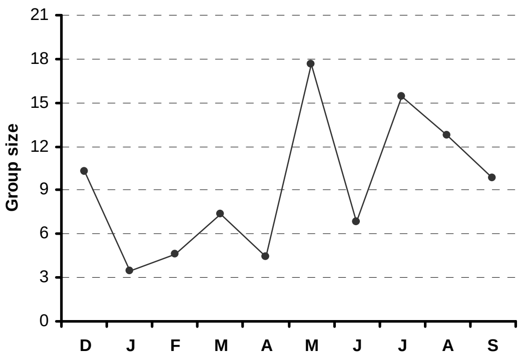

Fig. 6. Group size for bottlenose dolphin in the research area throughout the study

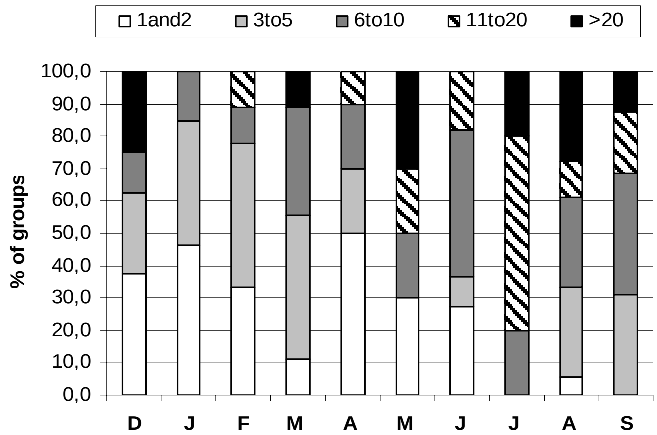

Fig. 7. Share of the group size ranges in the overall amount of sightings of bottlenose dolphin throughout the study

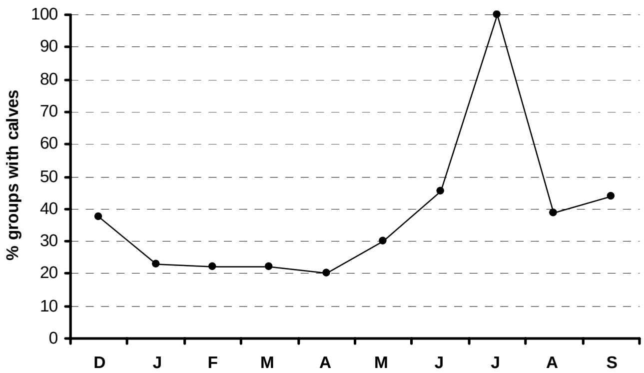

Fig. 8. Percentage of groups with calves for bottlenose dolphin throughout the study

DESCRIPTION AND INTERPRETATION OF PRECOCIOUS STRANDINGS AFFECTIG PUPS OF A PERIPHERAL HARBOUR SEAL COLONY

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The most important French harbour seal (*Phoca vitulina*) colony occurs in the Somme estuary, on the eastern French Channel coast, in northern France (n max. of 76 ind. in 2001). This colony has increased in number for at least ten years and currently produces more than half of the pups born along the French coast. The estuary is exposed to strong human pressure, with mass summer tourism and recreational activities inducing habitat reduction and disturbances. To study the interactions between harbour seals and human activities in this area, a conservation and study programme was set up in 1990 by the association Picardie Nature. This permitted the observation and follow up of reproduction and pups born within the estuary. From 1992 to 2001, 59 pups were studied. During this period, 52% of pups were naturally weaned, 32% stranded alive and 16% stranded dead. Despite births being regular temporally and on the increase, pup production stayed low (12% ±0.06), notably compared to other French harbour seal colonies. Strandings accounted for up to 52.9% of pups produced in a year. This phenomenon –combining low pup production and precocious strandings relatively important during the summer period – underlines two hypotheses, the second one induced by the first one. The absence of high tide haul out sites in saltmarsh areas, provoked by a massive utilisation of upstream parts of the estuary by recreational activities, potentially prevents births and good pup production. In addition, human pressure and the development of tourism seems also to prevent the efficiency of the pups weaning with recurrent disturbances in summer. This shows that this peripheral group is highly vulnerable despite the designation of the estuary as a Nature Reserve in 1994. The implementation of specific management strategies of the Habitat Directive should consider this phenomenon.

RISING STRANDING RATES OF SMALL CETACEANS IN THE SOUTHWEST OF ENGLAND

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Recorded strandings have risen increasingly steeply since 1970 with no sign of any ceiling. We examined the strandings data for Cornwall and Devon to look for pointers to the nature of this rise. Several species in this area are well known to be subject to bycatch in pelagic trawls or gill nets. The data comprises 1791 animals stranded over 700 years. 90% of records are since 1950. Data used was from 1910 onwards with exclusion of reports of doubtful quality. There are few reports from the 40s and 50s. The only species with a significant fall in prevalence among strandings is Risso's dolphin. The seasonality of strandings shows a low during summer. For both common dolphins and porpoises there is a disproportionate increase in the first four months of the year since 1970. Pilot whales were rarely stranded before 1940. Since 1970 recorded strandings of this species show a progressive fall in length. Common dolphins and porpoises do not show this, but in each species a small, non-significant, fall in male length and a similar increase in female length is recorded. We discuss the findings and suggest that -~ strandings are still substantially under-reported. ~ a recent real rise in common dolphin bycatch is likely.~ a mark-recapture or body loss rate approach to strandings might provide a useful basis for assessing true strandings rates.~ rigorously recording the reliability status of species, length, and sex data will enhance the long term value of these records.~ marking of discarded cetaceans by fisheries observers would be immensely valuable but is still not routinely practised. ~ accessible data on fishery location, effort and method would be valuable.~ local pilot whales deserve more study as they may come from a small sub-population using this area.

A COMPARISON BETWEEN THE 2001-2002 W W F'S RESEARCH CAMPAIGN IN THE LIGURIAN SEA

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During the summer 2001-2002 took place the fourth and the fifth WWF's whale-watching campaign within the "Santuario dei Cetacei", with the scientific support of WWF Liguria and in co-operation with "Cooperativa Battellieri del Porto di Genova" and the Ass. Altamarea. The aim of this work is to compare the sightings of cetaceans occurred during the summer 2001 with those of the summer 2002, in the same period, in the same area, and collected in the same way. The trips were carried out from June to September 2001 and from June to September 2002, twice a week and focused its attention on the area between Savona and Capo Mele, one of the richest of cetaceans. For the research one 14m sailing boat and a 32m motorboat "Superba" was used. The percentage of sightings per species puts at the first place *Stenella coeruleoalba* with 54,26 %, then *Ziphius cavirostris* with 14,89%, *Balaenoptera physalus* with 13,83 %, *Tursiops truncatus* 8,51%, *Delphinus delphis* 3,19%, *Grampus griseus* with 2,13%, *Physeter catodon* with 2,13% and *Globicephala melas* 1,06 %. We noted that Striped dolphins are better distributed than the other species and are constantly and abundantly present within the Santuario. The data collected suggest that the studied area and, generally speaking, the whole Ligurian sea enjoys quite a good health because of the presence of all different cetaceans species met: 8 out of 8 of the indicated species. We want to remark that everytime *Delphinus delphis* was in association with *Stenella coeruleoalba* and that the number of second species was always lively major.

MULTIPLE STRANDING, MASS STRANDING AND THE POSSIBLE SOCIAL BASIS FOR COMMON DOLPHIN BY-CATCH SELECTIVITY

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Natural and incidental mortalities are supposed to impact dolphin populations differently according to age and sex. Age or sex related ecological segregation or behavioural differences could explain differential by-catch risk. If the recurrent peaks of multiple strandings observed along the French Atlantic coast were mostly due to incidental instead of natural mortality, then these peaks should be characterised by specific age and sex compositions. Here we compare common dolphin bio-demographic structures between multiple and chronic strandings. The age and reproductive status of 378 individuals were determined from teeth and gonad examination. During peak strandings, the sex ratio was in favour of males (68% vs 51%). Weaned immature individuals (age 2+ to 6) were more exposed during peaks, whereas older adults (10+) and nursed calves (0 to 2) were less exposed. We used 145 animals with marks of by-catch as a reference sub-sample for incidental mortality : bio-demographic structures of this set were identical to those observed during multiple stranding peaks. We used published survival rates at age for the Atlantic common dolphin to establish a theoretical age structure of the population and compare it to observed age structures. During peaks, the proportion of weaned immatures was twice as high and that of older adults was only a quarter of expected values, demonstrating a strong age-dependant by-catch selectivity. Finally, we used a mass stranding of 53 common dolphins to document social structure in the common dolphin. This group was constituted of adult breeding females from 7-21 years old accompanied by nursed calves under 2, with a marked gap from 3 to 6 inclusively. This was in line with previous concepts of social segregation in pelagic dolphins in which weaned immatures dwell separately. We suggest such a social structure could be the basis for the age-related by-catch selectivity observed during peak strandings.

CANISIUS AMBASSADORS FOR CONSERVATION: A UNIVERSITY/AQUARIUM COLLABORATION TO PROMOTE THE CONSERVATION OF MARINE MAMMALS

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It has been argued that marine-life parks play an invaluable role in introducing ocean species to large numbers of people who would not otherwise gain experience with wildlife. It was the goal of this project to provide two parks with specially trained individuals who would convey a passion for marine mammals stemming from their own emotional connections derived from their field experiences. In the first phase of this project, 24 university students were taken to Northern California and British Columbia to make first hand observations on the impacts of ecotourism and land-based deforestation on local cetaceans, pinnipeds, and otters. Upon their return to Western New York State, the students were employed in delivering a three-pronged pro-conservation message to the public: poolside educational presentations at local aquariums; classroom presentations in secondary schools; and web page development. Over the span of two years, the team of university students made personal contact with 64,000+ members of the public. Post contact evaluations revealed a 106% increase in accuracy on factual questions related to wildlife and a 52% increase in pro-conservation attitudes in members of the public following contact with our program. It is reasonable to assume that the conservation of marine mammals in the future will depend in large part upon public support and a willingness for people to take active steps to promote conservation. Millions of lay persons visit marine-life parks each year. It is incumbent upon these facilities to take advantage of public interest by educating their visitors about marine wildlife and instilling in them a pro-conservation attitude. On the argument that people will only conserve what they care about, and that public concern stems from understanding, we offer this program as a model for effectively promoting conservation via university/aquarium collaboration.

AN EXPERIMENTAL APPROACH TO LIMIT DOLPHIN DAMAGE TO NETS IN A TRAMMEL NET FISHERY IN GREECE

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We tested the efficacy of a newly available acoustic deterrent device (SaveWave 'Saver') that has been developed to deter bottlenose dolphins from depredating fishing nets in Greece. Our study was based on the Island of Paros where we monitored trammel nets being fished by three boats over a 6-week period. We used standardised lengths of nets, and randomly assigned either five dummy devices or five visually identical active devices at 200m intervals along each string of nets as it was being set. All strings were set overnight, and neither the skipper nor the crew knew whether a string was fitted with active or with dummy devices. As each string was hauled we marked and noted any new net damage, and categorised such damage as either 'dolphin damage', 'rock damage', 'eel-damage' or 'seal damage', based on fishermen's explanations of the damage types. We also identified and counted all fish, and monitored the time taken to mend nets. We then compared each of the damage types between nets with active and nets with dummy devices. Overall we monitored 147 net-hauls and recorded 471 'dolphin holes' in 63 of these net-hauls, as well as 8 'eel holes', 39 'rock holes' and 4 'seal holes'. There were significantly fewer 'dolphin holes' in the 71 strings with active devices compared to the 76 strings with dummy devices. There was no significant difference in the number of other categories of hole between the two net types. Strings with no 'dolphin holes' had significantly more fish than strings with one or more 'dolphins holes'. Net mending took an average of 1.5 hours per hole. We conclude that these devices were effective in reducing the number of 'dolphin holes' in these nets by up to 77%. We discuss the implications to the fishery and to the dolphins.

THE DISTRIBUTION, ABUNDANCE AND PUP PRODUCTION OF GREY SEALS (*HALICHOERUS GRYPUS*) IN NORTH WALES, UK

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Presented here are the methods and results of a census of Grey Seal (*Halichoerus grypus*) abundance, distribution and pup production in North Wales (UK) for 2001 and 2002. The coast between Aberystwyth and the Dee Estuary was surveyed by foot, boat and paddle-ski. Haul-out and nursery sites were identified and surveyed at least twice a month. 102 and 109 pups were born in 2001 and 2002 respectively with peak pupping occurring in September and October. A maximum count of 547 adult seals was made at West Hoyle Bank. Seals were present year-round, in greater numbers and of wider distribution than previously thought. Data from this census and long-term seal surveys from West Wales (Skomer Marine Nature Reserve) will provide an indication of how the conservation objectives and targets for Grey Seal populations might be expressed on Welsh Special Areas of Conservation (SACs).

CRITICAL HABITAT

THE USE OF HABITAT SELECTION MODELS TO IDENTIFY AREAS OF SPECIAL INTEREST FOR THE CONSERVATION OF CETACEANS, WITH EMPHASIS ON MEDITERRANEAN COMMON DOLPHINS (*DELPHINUS DELPHIS*)

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INTRODUCTION Effective conservation and management of wild populations depends to a large extent on our ability to understand and predict relationships between those populations and their habitats. As part of a research project to identify the areas that should be designated as marine protected areas in Spanish Mediterranean waters, habitat selection models have been developed for seven odontocete species in southern Spain (common – *Delphinus Delphis* -, striped – *Stenella coeruleoalba* -, bottlenose – *Tursiops truncatus* -and Risso's dolphins – *Grampus griseus* -, long-finned pilot whales – *Globicephala melas* -, sperm whales – *Physeter macrocephalus* - and beaked whales – family *Ziphiidae*).

METHODS A total of 19,629 nm were sailed on effort in the Strait of Gibraltar, Alboran Sea and Gulf of Vera between 1992 and 2002. The habitat selection models, which are also an index of relative abundance, were applied in two steps: first presence/absence was modelled using GLMs taking into account availability of habitat types and secondly numbers given presence were modelled using a multiple linear model. The final prediction was obtained by combining the results of both models and applying it to the whole research area. The variables used in the models were: longitude, latitude, depth, slope, sea surface temperature (sst) and temporal variability of sst. The research area was divided into grid cells of 2 x 2 minutes of latitude - longitude, which were used as sampling units. The effort unit being each time the survey track passed over a given grid cell. The models were tested for significance with a test for likelihood comparing the distribution of frequencies of the real data with 1000 frequency distributions of random data.

RESULTS A total of 2,636 sightings of the seven odontocete species were recorded, the most encountered species being the common and striped dolphins, followed by long-finned pilot whales and bottlenose dolphins (see Table 1 for numbers of sightings and encounter rates). The most important areas for bottlenose dolphins were the Strait of Gibraltar, southern Almería and the Island of Alborán (Fig. 1). Common dolphins showed preference for shallower and cooler waters, and were associated with some hydrological features of the Alboran Sea. Their preferred areas were southern Almería, coastal waters of Granada, the bays of Málaga and Estepona and the Strait of Gibraltar, with decreasing relative abundance northwards in the Gulf of Vera (Fig. 2). For the other species, the areas of greatest interest were the waters off southern Almería (the remaining five species) and the Strait of Gibraltar (striped dolphin, pilot whales and sperm whales). The low number of sightings in the Gulf of Cadiz did not allow model predictions for that area.

CONCLUSIONS As a result of this study, three Special Areas of Conservation (SACs) under the EU Habitats Directive have been proposed for bottlenose dolphins as well as one SPAMI (Specially Protected Areas of Mediterranean Importance) considering the high diversity and the oceanographic, biological, cultural and scientific interest of the Alboran Sea. Additionally, one oceanic area for deep sea odontocetes has been proposed for some degree of protection (Fig. 3). The results of this study constitute the starting point for the LIFE project "Conservation of Cetaceans and Turtles in Murcia and Andalucía" LIFE02NAT/E/8610.

ACKNOWLEDGEMENTS This work was co-funded by the Spanish Ministry of the Environment through the "Programme for the Identification of Areas of Special Interest for the Conservation of Cetaceans in Spanish Mediterranean Waters" and the Earthwatch Institute. Special thanks are due to the CREPAD service of INTA (National Space Agency) for the contribution of the satellite images of sst. We are also very grateful to the Alnitak staff and assistants in the field Susana García, Pilar Marcos, María Ovando, Mar Padilla and José Antonio Fayos. Many thanks also to Jason Matthiopoulos and Bernie McConnell (Sea Mammal Research Unit, University of St. Andrews) for their advice and help.

Table 1. Number of sightings and encounter rates of seven odontocete species in southern Spain. The encounter rates are calculated as number of groups or individuals encountered per nmi sailed on effort

Species	Sightings	Enc. Rate groups	Enc. Rate individuals
Striped dolphin	958	0.0440	2.5797
Common dolphin	796	0.0384	2.3043
Long-finned pilot whale	362	0.0178	0.5158
Bottlenose dolphin	273	0.0126	0.3134
Risso's dolphin	73	0.0032	0.0407
Sperm whale	131	0.0066	0.0090
Beaked whales	43	0.0021	0.0044
TOTAL	2636		

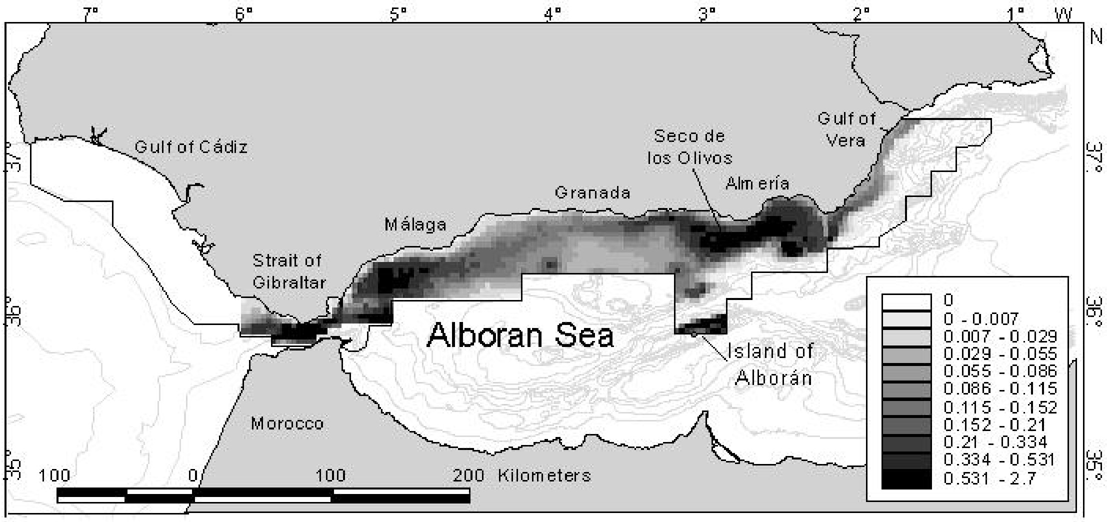

Fig. 1. Prediction of relative density of bottlenose dolphin in the research area

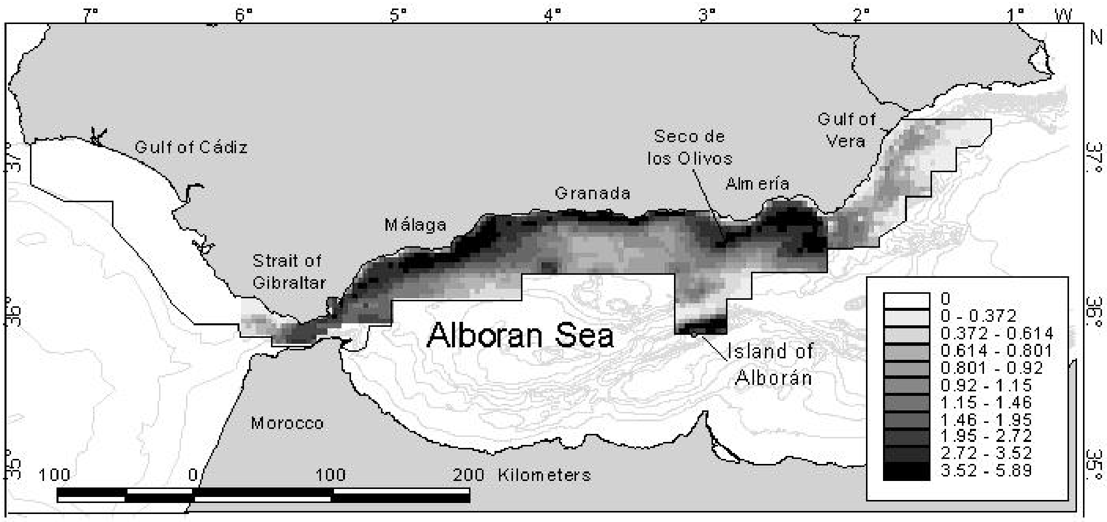

Fig. 2. Prediction of relative density of common dolphin in the research area

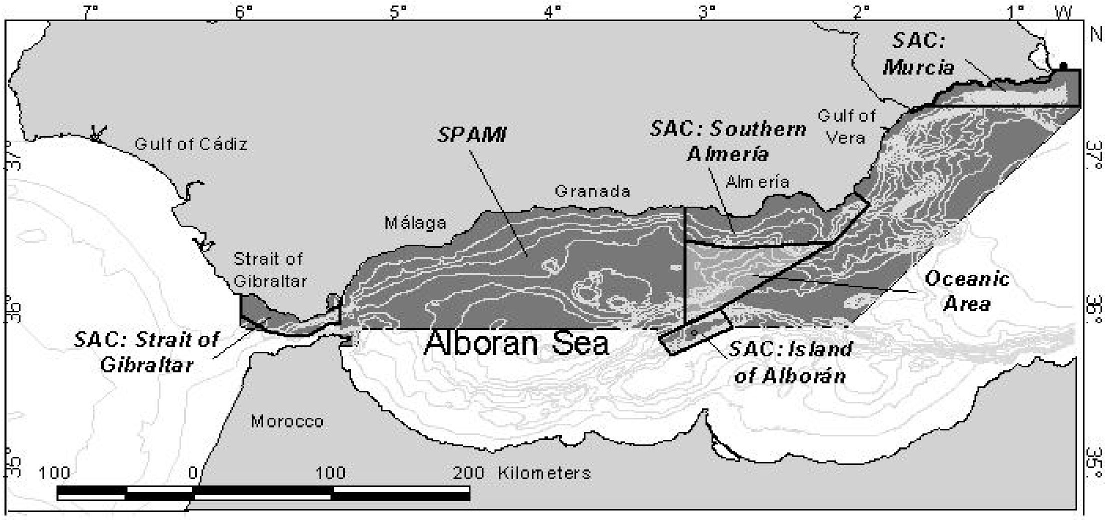

Fig. 3. Proposed Marine Protected Areas: SPAMI (dark grey area), Oceanic Area (light grey), and the 3 SACs: Strait of Gibraltar, Island of Alborán and Southern Almería. In the north-eastern section of the map the existing SAC for bottlenose dolphins in the contiguous area of Murcia is shown

MARINE POLLUTION: AN ADDITIONAL THREAT TO MONK SEAL SURVIVAL

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INTRODUCTION The Mediterranean monk seal (*Monachus monachus*) is the most endangered pinnipedian worldwide, classified as critically endangered by the I.U.C.N. Its remaining world population is located mainly in Greece, where 234-300 individuals out of less than 550 survive. They breed in marine caves, and because peak pupping in Greece occurs in September and October, breeding seals are very linked to the nearshore habitat in autumn and winter (Cebrián, 1998).

The weight of marine pollution on the degradation of Mediterranean monk seal habitat is a subject not addressed until now. The roles played by oil pollution and marine debris on the suitability of monk seal caves was evaluated in a wide sample area of Greece.

MATERIALS AND METHODS Inspections of 126 monk seal shelters on the Ionian and Aegean Islands were conducted from 1990 to 2002 in the Greek Seas. Regular inspections were done every ten days in a yearly average. Since care was taken not to disturb the animals, the caves were approached by boat but entered always by swimming, while checking that seals were not inside. When seals were present data collection was suspended and the place left.

A total of 26 caves were regularly visited in the Ionian along thirty-six months. Regular inspections in the Aegean were conducted to 28 caves along 36 months. Other 72 caves were sporadically visited. All the caves were mapped on marine charts and their shapes drawn on scale paper. Presence of rubbish and other debris was recorded together with other scientific data.

RESULTS At least ten caves showed marked alterations generated by debris or oil pollution, three of them in a Ionian sample of 26 suitable caves (11.54%) and other seven in an Aegean sample of 100 caves (7%) (Fig.1). These results indicate an incidence much higher than cave destruction directly provoked by man, which affected one cave in each area (3.8% and 1% respectively; Fig. 2). Monitoring showed that two caves polluted by tar were not used for years by monk seals in their respective areas, in spite of having characteristics that make them suitable for the species. Also floating debris of big size plays an important negative role, provoking the obliteration of passages and accesses to beaches and even generating changes in the sedimentation balance of the cave beach. Debris capable to alter cave suitability can have long lasting effect and included plastic and wooden boxes (Fig.3), a tree branch, a fender, a plastic sac, an oil barrel and a refrigerator (Fig. 4). Debris capable to act as traps for the seals body or fins is found very frequently in the caves, being the most usual ones fragments of long-lines.

DISCUSSION Most debris-originated changes could be easily solved through removal, and all the recorded problems regarding debris-induced cave unsuitability might be reverted with the appropriate equipment, suggesting that mitigation of this additional threat to monk seals survival could be achieved through periodical monitoring of important monk seal areas. This is also important with regard to the presence of long-lines on cave beaches, since in this case the seals, and not just their resting sites, can be physically affected.

Fragments of long-lines are frequently found trapped among the cave floor rocks. Cases where the lines hold many hooks are not rare and they also form loops, which could be deadly traps for seals hauling out on those caves. Whenever these cases are found the lines are cut with knives. Pups could be more vulnerable to long-lines, since they remain for months within the caves where they are born and are also playful animals, which are attracted by floating objects and have been observed playing with them. Henderson (1985) found that 41% of weaned Hawaiian monk seal (*Monachus schauinslandi*) pups were affected by entanglements in marine debris of diverse origin. He also reports (Henderson, 1990) 34 entanglements, including four deaths for this reason along a four-year period. Entanglements were reduced after introducing campaigns to remove hazardous debris from haul-out beaches at all North-western Hawaiian Islands (Henderson, 1985). We did not find so far entanglements on marine debris in the Mediterranean species, although an adult male was released in the late 80s in Chafarinas Islands, Spain, from a circular belt that had been embracing its belly for years and had penetrated its skin and blubber. The problem created by debris pollution is that the survival of the Mediterrranean seal is becoming even more human-dependent along the last years. The fact is strongly aggravated by the resistance to biodegradation that characterizes most of the debris affecting this species.

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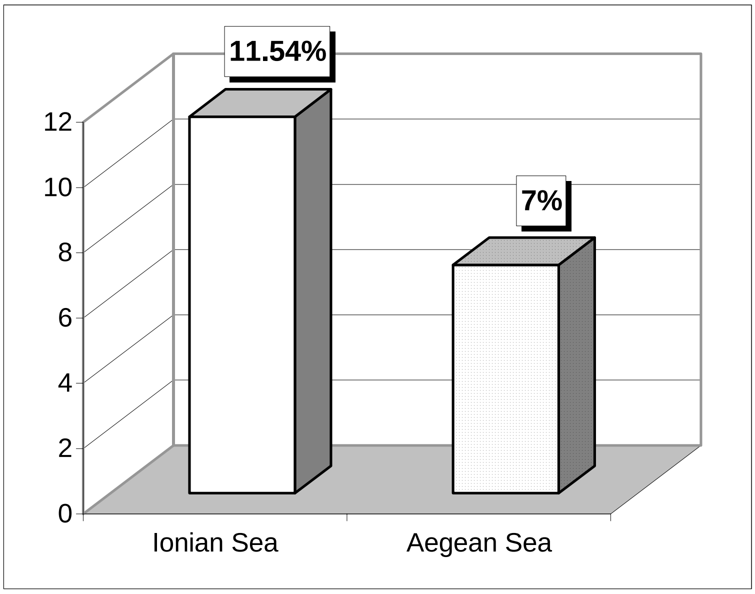

Fig. 1. Percentage of monk seal caves affected by debris or oil pollution

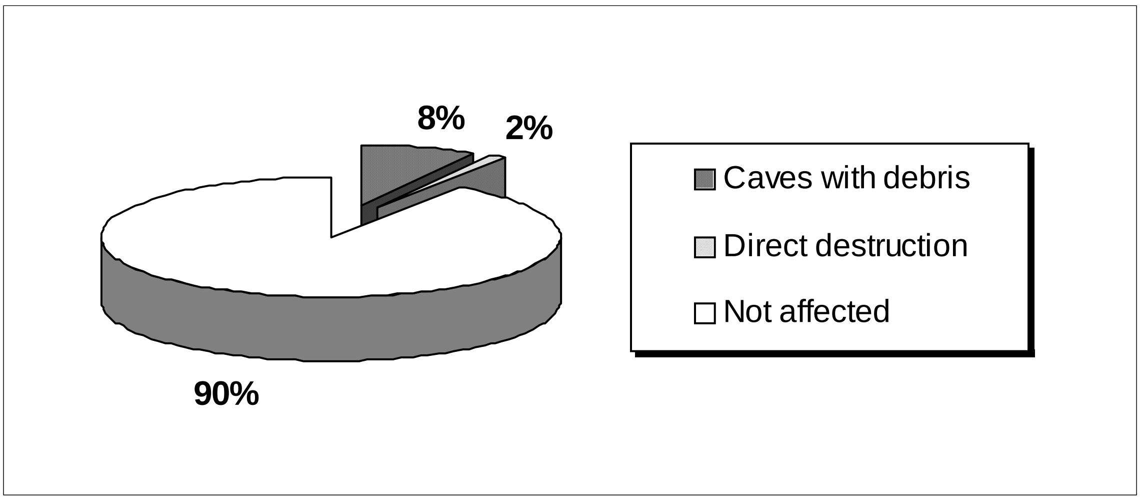

Fig. 2. Direct and indirect negative impact by man over 126 controlled caves

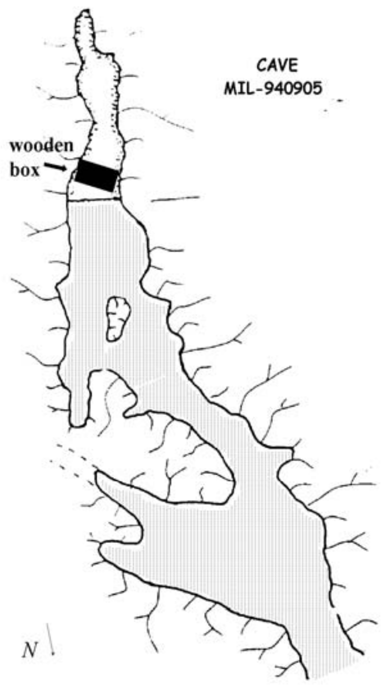

Fig. 3. Monk seal cave beach access artificially blocked by a wooden box

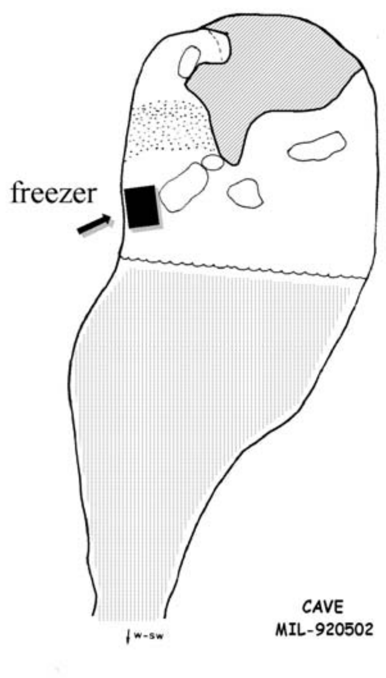

Fig. 4. Monk seal cave access to left half of the beach artificially blocked by a refrigerator. Barred and encircled areas on beach show sectors not accessible naturally to seals (fallen ceiling, high rocks, etc)

DEVELOPMENT OF A BEAKED WHALE GLOBAL DATABASE TO DETERMINE HABITAT PREFERENCES

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The family Ziphiidae, beaked whales, are generally found in deep water and are often recorded in association with areas of complex seabed topography, such as seamounts, escarpments, drop-offs and gullies. Beaked whales are found in all the world's oceanic waters from the equator to the edge of the ice. As compared to the other species of cetaceans, sighting data is relatively sparse, as beaked whales generally live off-shore and have long dive/short surfacing times making visual observations difficult. Much of the current knowledge of beaked whales relies on stranding data. This project aims to use available beaked whale records to analyze relationships between beaked whale occurrence and a number of oceanographic variables – bathymetry, slope, sea surface temperature (SST), oceanographic fronts and chlorophyll a concentrations - to better understand the preferred habitat for Ziphiidae. The ultimate goal is to predict their occurrence based on these environmental parameters. Data used in this analysis will be based on a geo-referenced database of global beaked whale records (both sightings and strandings), which is currently under development. To date, almost 4000 records from around the world have been located and collated and we aim to have over 6000 records in the final database. The beaked whale database will be input into a geographic information system and overlaid with oceanographic datasets. This analysis will be output to a statistical software package for the development of algorithms. The statistical algorithms will be used to predict areas of beaked whale occurrence, based on environmental parameters. Preliminary analysis shows that specific 'hotspots' for beaked whale occurrence and diversity can be identified. The final output will be a global map identifying known and predicted beaked whale distribution. This will allow Navy environmental compliance personnel to make informed decisions when selecting at-sea test sites and minimize the potential for environmental impact.

COLLISION BETWEEN A FERRY AND A SPERM WHALE (*PHYSETER MACROCEPHALUS*) IN THE STRAIT OF GIBRALTAR

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The Strait of Gibraltar is a critical place in terms of maritime traffic. Every year more than 80 000 vessels cross the Strait. There are different navigation routes, which endure a very high density of traffic. Big vessels are found in the route East-West while ferries and fast ferries travel North-South. This converts the Strait in a dangereous area, beeing the colision risk one of the most important issues for some cetaceans. On September the fifth, 2002, at 11:02 am, the research team of CIRCE was doing photo-identification work with sperm whales in the centre of the Strait of Gibraltar (four miles away from the Spanish coast) when they saw a ferry, which was around 95 metres long, going towards a sperm whale approximately 13 metres long. A few minutes later, the team could see how the sperm whale was run over by the ferry. After this, the sperm whale was breathing around 26 minutes until it died. This poster describes the potential risk the maritime traffic means in the Strait of Gibraltar for the cetacean species that either inhabit or travel trough its waters, aswell as the external lession suffred by the sperm whales

AN APROACH TO THE SPATIAL INTERACTION BETWEEN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AND FISHERIES IN SOUTH-EAST SPAIN USING HABITAT SELECTION MODELS

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Direct interactions, including hunting and net damage, between bottlenose dolphins and fisheries are regularly in the Mediterranean Sea, but off the southern coast of Spain such direct interactions are uncommon at present. However, this does not preclude the occurrence of indirect interactions, such as competition for food or habitats. In this presentation, habitat selection models are used to explore the degree of overlap between the habitats preferred by dolphins and by fishing boats (trawlers). Surveys were conducted in the study area, from the Strait of Gibraltar to Cabo de Palos (Murcia), between 1992 and 2002 covering 19,864 nautical miles. Data were collected from 226 encounters with bottlenose dolphins and 330 fishing boats. The area was divided into 3008 grid cells of 2 x 2 minutes of longitude - latitude. Oceanographic variables (sea surface temperature obtained from satellite images), physiographic variables (depth, slope) and geographic variables (latitude, longitude, distance to coast, distance to nearest port) were used to characterize each grid cell and as predictor variables in GLM models constructed for both "species": bottlenose dolphins and trawlers. Results from the models were used to predict presence and density of dolphins and trawlers in all grid cells of the survey area. Overlap between preferred habitats for both "species" was analysed using correlations. The models showed significant active habitat selection by both dolphins and trawlers. A positive correlation was found between the habitats preferred by dolphins and trawlers. These results were used to develop the first guidelines for management schemes for the Marine Protected Areas that have been proposed for bottlenose dolphins to the Spanish Ministry of Environment as part of a research project for the identification of areas of special interest for the conservation of cetaceans in Spanish Mediterranean waters.

INSHORE CETACEANS AND ANTHROPIZED ENVIRONMENT. "DELFINI METROPOLITANI": 18 MONTHS OF DATA

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INTRODUCTION The coastal zone in front of Genoa is very interesting from an ecological point of view. The activities of the city and its big harbour may have a negative impact on the coastal marine environment. "Delfini Metropolitani" is a long-term project of the Acquario di Genova, in collaboration with CIBRA, Università di Genova and Centro Studi Cetacei. The primary aim of this research is an evaluation of the presence of Cetaceans in the study area with special reference to the bottlenose dolphin. Under water acoustic recordings were collected in order to draw a first acoustic map of the zone.

Goals

- Value the presence of Cetaceans in the study area, with special reference to the bottlenose dolphin.
- Collect data related to the interaction with human activities.
- Draw a first acoustic map of the study area.

Study area The study area (Fig. 1) lies between Pegli in the West (44°24,332'N; 08°49,000'E) and Nervi in the East (44°21,429'N; 09°05,100'E). The open sea boundary is situated around 3 nautical miles along the entire length of the area. The study area's shared in 2 zones (Zone 1, on the east and Zone 2 on the west) and covers a total surface of about 42 square nautical miles.

METHODS Visual data are collected through observations on an inflatable boat of 4.20 m length with a 4 stroke 25 HP engine, following both standard transects (about 30 nautical miles for each zone) and free surveys ("hunting"). For acoustic data collection, we've identified 5 "acoustic stations" along each transect. Each "acoustic stop" for data recording lasts 5 min. We've used the hydrophone also to detect the presence of Cetaceans (Manghi *et al*., 1999). 35 mm reflex cameras are used for photo-identification (Defran *et al*., 1988). A digital camcorder is used to get video sequences of sighted animals. Acoustic and video data are stored on PC.

MATERIALS
Garmin 12XL
Oziexplorer (GPS PC software)
Omni directional hydrophone OFFSHORE ACOUSTICS with 20 m cable. The hydrophone has been recently calibrated by SACLANTCEN (NATO) La Spezia.
Portable DAT recorder Sony TCD-D100.
RolandED UA-30 USB audio interface.
SeaWave 1.0 (Acoustic analysis software, developed by G. Pavan CIBRA).
Canon T70 and Nikon F 90 reflex cameras, equipped with zoom (70-300 mm and 28-70 mm) auto-focus\manual.
Slide films (Fuji and Kodak: 100\200 ASA) and B\W films (Ilford HP5 400 ASA).
Canon XM 1, digital camcorder

RESULTS Four species have been sighted: bottlenose dolphin (*Tursiops truncatus*) 19 sightings, striped dolphin (*Stenella coeruleoalba*) 8 sightings, fin whale (*Balaenoptera physalus*) 2 sightings and Risso's dolphin (*Grampus griseus*) 2 sightings.

The unprocessed data (from April '01 to October '02) are the followings:
Surveys from boat: 124 - 326 h at sea
Sightings: 31 (Fig. 1):
Time spent with the animals: ~ 25 h
Photo identified dolphins (bottlenose dolphin): 15
Report of Cetacean from trusted observers in the study area: 35
Acoustic record: ~ 20 h

The monthly distribution of sightings per specie is showed in Fig. 2. For the two mostly sighted species we also report the water depth in the first sighting waypoint (Fig. 4 - bottlenose dolphin and striped dolphin) and the moving direction, considered as the line linking the first and the last sighting waypoint on the map (Fig. 5 - both species). The Fig. 3 shows the mean number of individuals and calves per group per month (bottlenose dolphin only).

DISCUSSION Cetacean sighting has been more frequent in spring and summertime (see also Bonsignori *et al.*, 2000) (Fig. 2) with spikes in July 2001, March and June 2002. The sightings of bottlenose dolphin show the same annual trend.

The analysis of the geographical position of bottlenose and striped dolphin sightings in relation to the bathymetry (Fig. 1 and 4) shows that all but one sightings of *T. truncatus* occurred within the 100 m isobaths, while all but one sightings of striped dolphin occurred outside the same isobaths.

The analysis of moving routes of bottlenose dolphin during sightings gave interesting results. The animals seem to move in prevalence to west. There is no evidence of this attitude in striped dolphin movement (Fig. 5).

The preliminary analysis of the acoustic data showed an important presence of human noise in all the study area (80% of the sample), mainly related to the harbour activity (Fig. 6). Zone 1 (the eastern) appears noisier than Zone 2, especially in relation to low frequency noise (Fig. 6). This may be due to the eastern entrance of the port of Genoa (more busy than the western one) and also to the presence of an area destined to the anchorage of merchant vessels. In all the area we also recorded sounds from medium and small engines, producing high frequency noise (up to 7.5 kHz).

CONCLUSIONS Despite the noise produced by human activity, the study area is visited by at least four species of Cetaceans.

Bottlenose dolphin is the most common specie in the area. The bottlenose dolphins seem to leave mainly within the 100 m isobaths and they show a strong tendency to move mainly from east to west.

During spring and summertime the bottlenose dolphins form bigger groups. This tendency is associated with the presence of calves (Fig. 3).

The photo identification work, together with the movement analysis suggest the presence of a resident or a semi-resident group of bottlenose dolphins moving along the ligurian coast line (see also Ripoll *et al.*, 2001).

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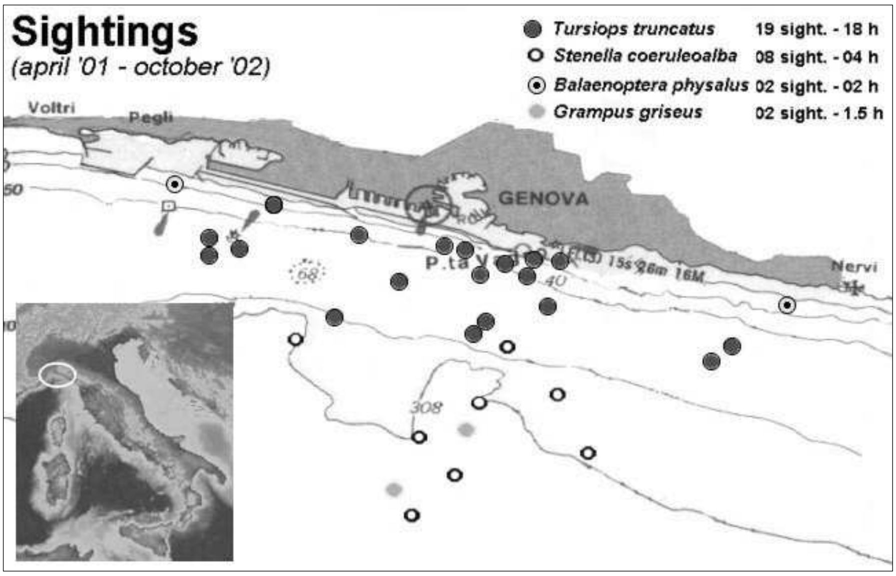

Fig. 1. The study area and sightings

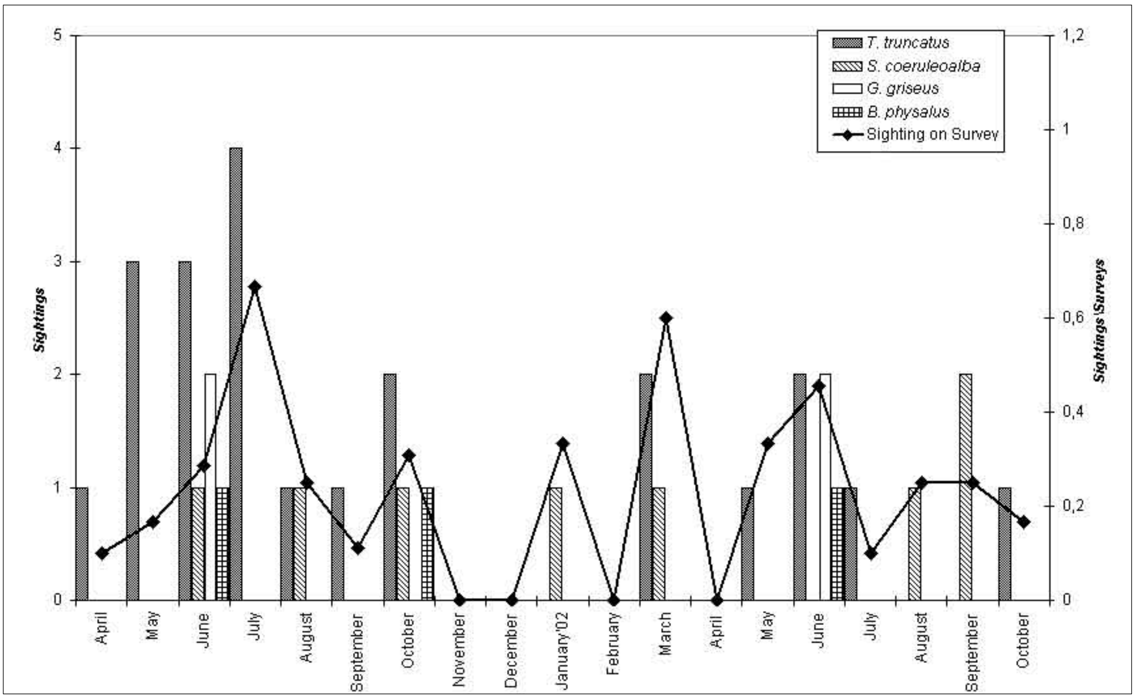

Fig. 2. Monthly species distribution

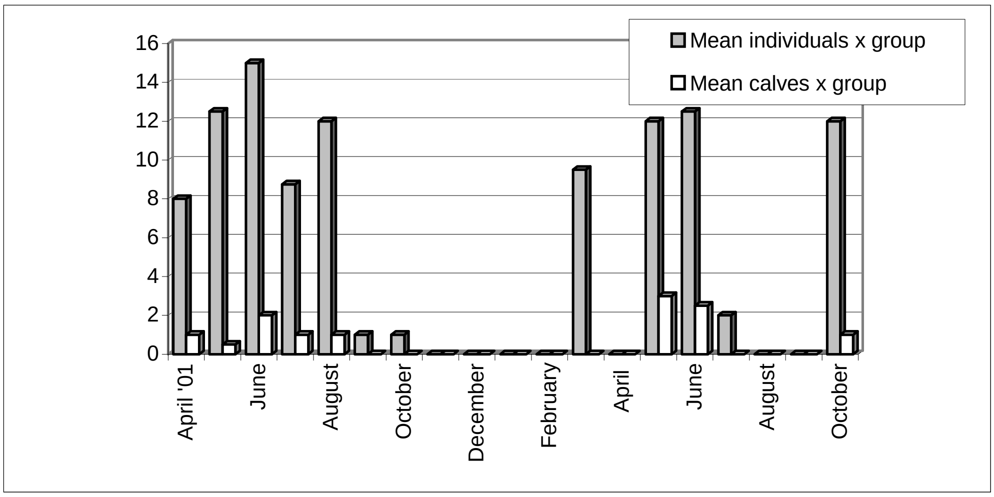

Fig. 3. Average of individuals and calves per month (bottlenose dolphin)

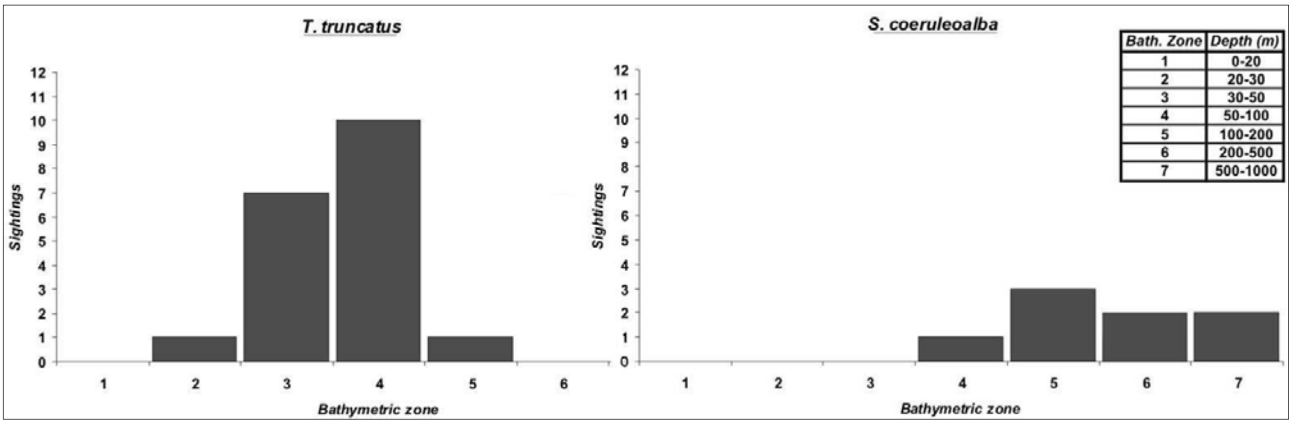

Fig. 4. Bottlenose dolphin and striped dolphin: Sightings\Bathymetry

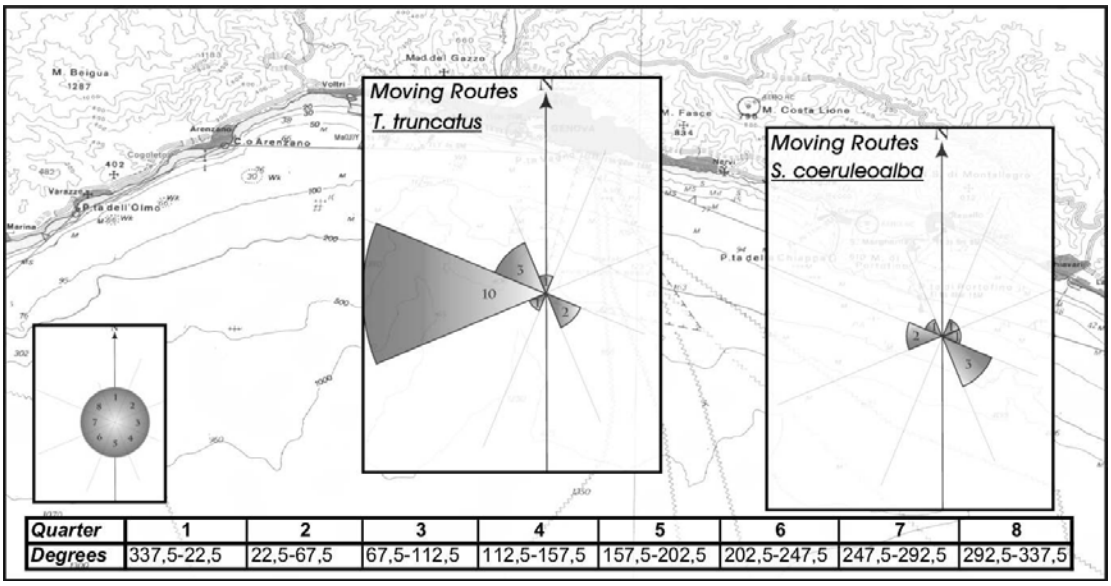

Fig. 5. Moving routes of bottlenose dolphins and striped dolphins

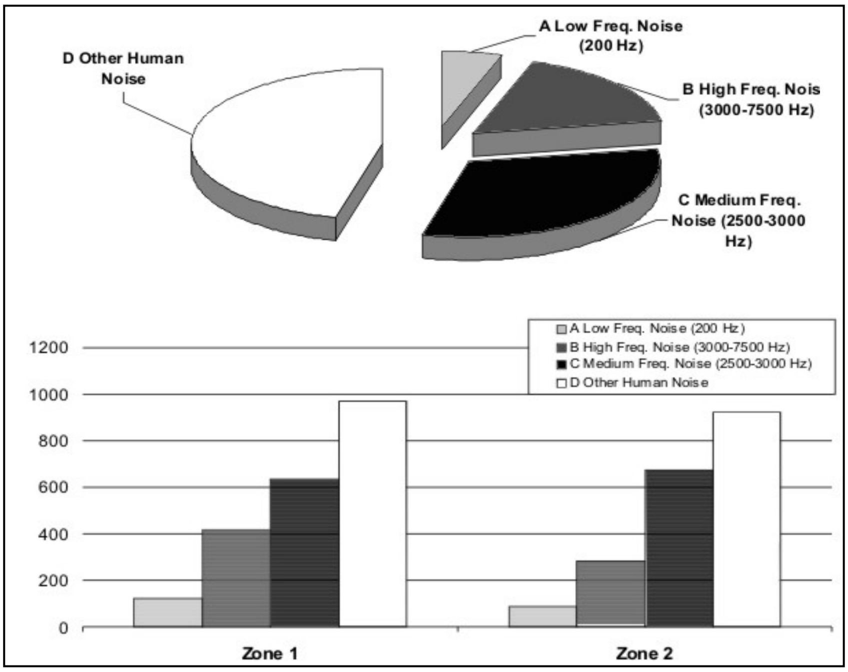

Fig. 6. Human noise composition (above) and its distribution (below) in Zone 1 and 2 (data until April '02)

ENVIRONMENTAL DIAGNOSIS AND ACTION PLAN FOR THE CONSERVATION OF CETACEANS IN THE SW OF TENERIFE, CANARY ISLANDS

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INTRODUCTION The SW coastline of Tenerife, with only 23 nautical miles and 440.64 km^2, shows ecological and oceanographical characteristics that favour the presence of several well preserved marine ecosystems that are representative of the biodiversity in the macaronesic area. Among the most exceptional fauna of these waters we must highlight the presence of 21 cetacean species (Table 1) with resident populations of tropical pilot whales (*Globicephala macrorhynchus*) (Heinnlich-Boran, 1993) and bottlenose dolphins (*Tursiops truncatus*) (Escorza *et al*., 1992; Carrillo and Martin, 2000; Carrillo *et al*., 2002). The presence of these resident cetacean populations and the well preserved ecosystem of the area led to the proposal and later declaration of the area as a Special Area of Conservation ES-7020017 within the Natura 2000 network of the European Union. Nevertheless, in the last 7 years the touristy activity has increased and the coastline has been built to a great extent. These are important threats for the conservation of this special habitat and the species that inhabit it (Montero and Martín, 1993; Brito *et al*., 2000). Although there is no scientific certainty about the effects of these threats on the populations, applying a precautionary approach, both species have been included in the national and the Canarian catalogue of endangered species. For the same reasons, the whale watching activities are regulated in the Canarian waters (Plasencia *et al*., 2001). This work is part of the results obtained in the study that target the tropical pilot whale and bottlenose dolphin species between 1999 and 2002. This work identifies the use and activities that nowadays threat the populations and presents a management plan whose aim is to preserve the natural characteristics of the sw of Tenerife and the conservation of its biological resources.

Environmental diagnosis The effects of the touristic and socioeconomic development of the SAC on the environment are varied, probably interact and are difficult to assess. We have divided them in two types: a) those that have an effect on the quality of the environment, which includes the dumping of sea wage and drifting residues (Luque, 2000), noise pollution (Aguilar, 2002) and the setting up of large scale aquiculture farms; and b) those that have a direct effect on the behaviour and normal activity of the cetaceans and therefore an effect of the conservation of the populations. Within the latter group we include the intense activity of whale watching (Montero and Martín, 1993) and maritime traffic, mainly the use of high speed boats for the transport of passengers between islands (Tregenza *et al*., 2000; Herrera *et al*., 2001). It is important also to highlight as a threat, the sporadic interaction with tuna fisheries and coastal pelagic fisheries (*Scomber japonicus* and *Sardina pilchardus*).

Urban sea wage The more than 3 million of tourists that visit the sw of Tenerife every year have led to a noticeable increase of urban sea wage. The infrastructures for collecting and treating this residues are not sufficient or don't work correctly, and therefore a high percentage of this residues ends up untreated in the sea. Every year different areas area closes for swimming due to the dumping of urban sea wage (Fig. 1).

Drifting solid residues Weather the drifting garbage arrives to the coast or not is a matter of the currents and tides. Nevertheless, in the area of study we have observed an increase in the frequency and composition of these residues. There is an increase in the quantity of plastics, which cause the deaths of a large number of turtles, are a danger for the cetaceans, and cause an important visual impact.

Noise pollution There is no doubt that the increase in the number of motor boats that operate daily in the SAC leads to an increase in the anthropological noise emission, whose effect in the environment if not well known. The levels of threshold for acoustic emission to produce disturbance and physical damage are only known for people, not for animals. Nevertheless, acoustic studies developed in areas where there is drilling for oil show effects on the natural resources of area (Aguilar, 2002).

Aquiculture farms In the SAC there are nowadays 9 authorized companies and there are various projects waiting for a licence. The farming is carried out in floating cages of between 8 and 19 meters in diameter and the species are sea bream and sea bass. The estimated fish production is more than 1000 Tm. per year (874 Tm of sea bream and 157 Tm of sea bass). The contribution of organic material produced by the metabolism of the fishes and mainly by the non-consumed feeding stuffs leads to eutrophyzation of the influence area of the cages. This is the reason why several fish species concentrate around the cages (*Boops boops*), or on the bottom, with species of the family *Dasyatidae*, family *Gymnuridae* and family *Myliobatidae.* Although this situation does not have, in general terms, an effect on the cetaceans, some dolphins are getting accustomed to the cages and concentrating around them. The opportunistic behaviour of the bottlenose dolphin, the easiness of capturing prey and the offering of fish from the cages favours the presence of small groups of bottlenose dolphins around the aquiculture farms. This concentration of bottlenose dolphins and the offering of food favour the taming effect, undesirable for natural populations (Fig. 1).

Whale watching In 1991 it was estimated that 40.000 visitors participated in this activity (Hoyt, 1992) and 13 boats were working in the area (Urquiola and Stephanis, 2000). It increased to 50 boats in 1997, showing the evolution of the activity (Martín and Urquiola, 2001). Nevertheless, with the Decree 178/2000, the number of authorized boats has decreased (Fig. 2). The new regulations establish a bond and environmental requirements which have made that boats with licences in previous years, whose main income is not whale watching, have not requested a license anymore. Nevertheless this should not imply that the pressure on the resident populations of cetaceans has decreased. Due to the lack of surveillance in the area, an without advertising, sport fishing boats, parascending, jet skies and scuba diving centres carry out whale watching activities continuously. At the moment there are 32 authorized boats that carry out 2 excursions daily (15.000-20.000 per year) with a total of about 1.000.000 passengers a year (Urquiola, Martín and Iani, 1999; Carrillo and Martín, 2000; Martín and Urquiola, 2001). Various studies in the area have shown the short time impact produced by the presence of boats (Montero and Martín, 1993). The long term effect that this activity might impose on the population dynamics of the species is unknown. Although the conduct and sensitivity of the boat crews has improved, this behaviour is not guaranteed and the inadequate surveillance favours the violation of the code of conduct. Among the most frequent violations is the inappropriate approach to the groups in terms to speed, direction and distance, and the lack of licence to carry out the activity.

Maritime traffic The leisure nautical activities, grouped into sport navigation carried out by individuals, the sea excursion boats, the renting of jet skies, the parascending and the scuba diving have in the sw of Tenerife about 800 berth points. In addition, in Los Cristianos, 2 low speed ferries work together with 2 high speed boats for the transport of passengers between islands. This leads to a high degree of sea traffic especially on weekends and summer holidays. Nowadays the harbours can not cope with the demand and to solve the problems originated by this increase of demand and improve the infrastructure there is an important project to build a large harbour in the coastline of Guía de Isora.

The negative effects of the increase of sea traffic are an increase of acoustic pollution and direct dumping of oil leftovers and organic residues. In addition, there is also a potential danger of collision between fast ferries and cetaceans, especially with pilot whales and bottlenose dolphins. Although the fast ferries have been operating for more than 2 years in the SAC area, there are still not enough data to assess the real impact of this type of boats on the resident populations.

Interaction with fisheries In the SAC of Tenerife there are 3 types of fishing activities with can accidentally interact with the cetacean populations. Firstly, the tuna fish boats interact with the animals due to the attraction of the bait on the dolphins. Some times, the arrival of the dolphins scare the tuna fish. To avoid the dolphins getting close to the boast unthinkable measures are taken, from firework artefacts to sharpen objects. Several dolphins have been found stranded showing this type of interactions (Carrillo *et al*., 2002). For the same reason, the pilot whales do not have a good reputation among fishermen. Although to a leaser extent, some incident can also happen with traditional fishing methods for coastal pelagic fishes. Some bottlenose dolphins can get into the net and get entangled. This could be the cause of death of some of the individuals of the resident population.

Action plan From a preventive perspective we propose several actions that undertaken simultaneously and continuously could allow the obtaining of enough information on the population dynamics of the bottlenose dolphin and pilot whale populations as well as a better understanding and control of dangerous activities in the area. The aim is to minimize the impacts identified and improve the use and management of the SAC ofTtenerife.

A.- Monitoring of the population dynamics of the pilot whale and bottlenose dolphin: If the aim is the conservation of the populations of cetaceans in the sw of Tenerife and specially the populations of bottlenose dolphins and pilot whale it is imperative to have estimates of abundance and the monitoring of the evolution of this parameter. Not having these estimates it could happen that the population may decrease to a level from which it could not recover before showing any noticeable signs of decrease.

B. - Control of dumping: Having as a main objective the implementation of an efficient plan of use and management and after the identification of different origins of pollution, it is important to quantify this pollution: location, type and volume of the sea wage, type of drifting solid residues and acoustic pollution.

C. - Interaction with human activities: In order to achieve the conservation objectives proposed for the SAC it is necessary to get the participation of the different users of the area. The whale watching activities carry out from boats, the potential risk of collision with high speed boats, the taming of bottlenose dolphin around the aquiculture farms and the fishing activities have a directing impact on the resident populations. This impact must be counteract with the broadcasting of general information in the harbours, with proper training of the crews, and without any doubt, with an efficient service of surveilance.

D. - Protected areas: In the SW of Tenerife various areas have been propoused to be declared protected areas which can be used as a legal framework for the development of use and management plan that must be adjusted to the characteristics of the area. The SAC´s of the SW of Tenerife are expected to be declared "*Parque Natural Marino de las Ballenas*" and new areas have been proposed as Marine Reserves to favour the recovery of the fishing and biological resources of the area. The Marine Reserve of Teno and the Marine Reserve of Rasca (Bacallado *et al.*, 1987).

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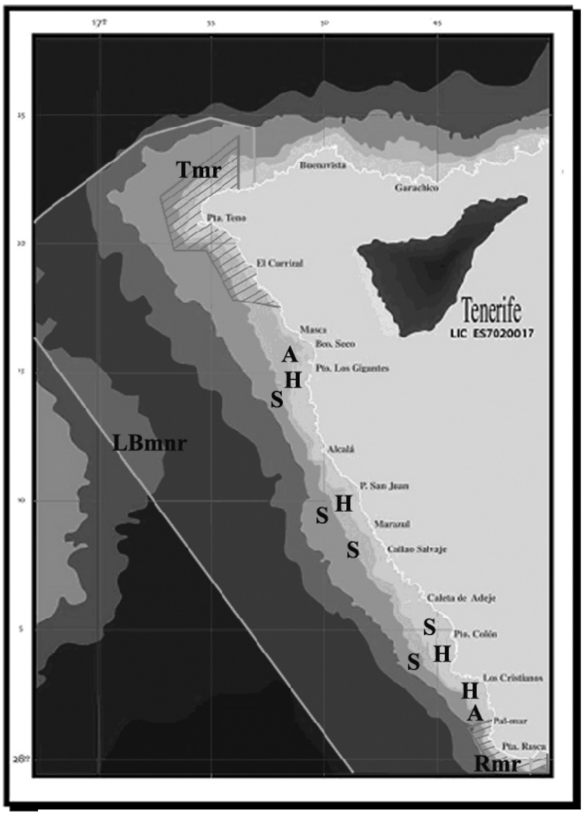

LBmnr- "Las Ballenas" Marine Nature Reserve
A- Aquaculture
H- Harbours
S- Urban sewage
Tmr- Teno Marine Reserve
Rmr- Rasca Marine Reserve

Fig. 1. Location of the main threatens and the protected areas inside the SAC ES-7020017

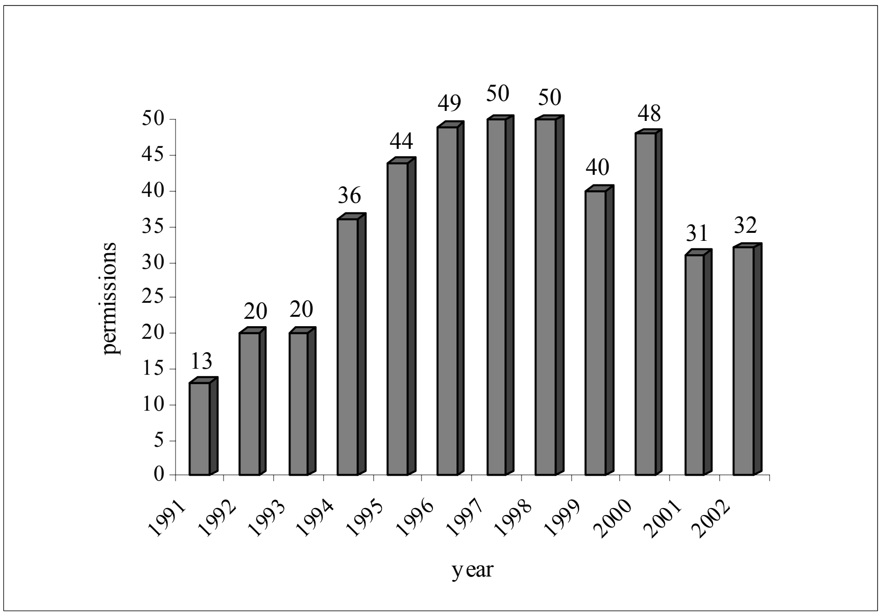

Fig. 2. Annual evolution of the number of authorized boats

HARBOUR PORPOISE BYCATCH IN POLAND

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Sixty two reports on bycatch, strandings and sightings of harbour porpoises (*Phocena phocoena* L.)in the Polish Baltic waters were collected in the years 1990-1999. Forty five (72.6%) reports referred to bycaught specimens, 10 (16.1%) individuals were observed at sea, and 7 (11.3%) found stranded. Bycatch took place mostly from December to April with maximum (11) in March. 1-3 bycaches were reported per month in the rest of the year with no reports in June. Of all animals bycaught in Polish waters a considerable part got entangled in semi-drift salmon nets (40.0%) and bottom cod set nets (33.3%). As many as 22 animals (42.2%) were bycaught in the fishing grounds of Puck Bay, constituting 1.1 % of the Polish exclusive fishing zone. According to those data, the region was chosen as the study area where fishing effort data have been collected to assess the danger from different fishing gears. The method of obtaining data in situ was used. In two courses of boat inspections various types of fishing gear were identified and their geographical positions were marked. In the autumn course 1069 nets were identified. The majority (92%) consisted of salmon nets, which corresponds to the high percentage of bycatch in those nets – 84%. In summer 140 nets have been identified with the majority of trap nets in which no bycatch was reported. Occasional bycatch was reported from bottom set nets, the density of which in the area was over 20 times less than that of salmon nets. Salmon nets appeared to pose the greatest threat to harbour porpoises within the area considering their high density.

DISTRIBUTIONS, MIGRATIONS AND BOTTLENECKS: IMPLICATIONS FOR ANTHROPOGENIC IMPACTS ON BEAKED WHALES ON THE ATLANTIC FRONTIER

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Two species of beaked whale have been recorded on the Atlantic Frontier, an area of deep water to the north and west of Scotland. These are the northern bottlenose whale (*Hyperoodon ampullatus*) and Sowerby's beaked whale (*Mesoplodon bidens*). Beaked whale sightings were analysed and the relationship between sightings and oceanographic variables was examined. A PCA-based model used data from these sightings to produce predictive occurrence maps based on three variables (depth, seabed gradient and latitude). These maps showed that there are two important areas for beaked whales on the Atlantic Frontier: The Shetland-Faroes Channel and an area to the south-west of the Faroes, including the northern end of the Rockall Trough. These areas are linked by a corridor of suitable beaked whale habitat approximately 80 km long and 50 km wide at its narrowest point. Evidence of migratory movements of beaked whales in the north-east Atlantic was obtained from an examination of historical strandings data from the United Kingdom and the Republic of Ireland, and from whaling records from the Faroes, Iceland and the Norwegian Sea. There is strong evidence to suggest that beaked whales, particularly northern bottlenose whales, undertake regular migrations, moving south-west in late summer and autumn and moving north-east late winter and spring. During movements between the Shetland-Faroes Channel to the area south-west of the Faroes, or visa versa, the narrow corridor of suitable beaked whale habitat which connects these two areas may form a 'bottleneck' through which the beaked whales must pass. Due to the restricted area of suitable habitat, beaked whales may be particularly vulnerable to anthropogenic impacts at this point. In particular, noise pollution, which has the potential to impact a large area simultaneously, in this bottleneck area during migrations may have a disproportionately large impact on beaked whales on the Atlantic Frontier.

GEOGRAPHIC INFORMATION LAYERS AS A TOOL TO ASSESS MARINE PROTECTED AREAS IN THE WESTERN MEDITERRANEAN WATERS

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INTRODUCTION Geographic Information Systems (GIS) are a powerful tool to define relationships between species and habitat in large marine ecosystems. GIS offers an inexpensive method to examine marine mammals in relation to environmental and oceanographic features which affect their life. As part of the three year monitoring program (2000-2002) of the Spanish Ministry for the Environment "Identification of areas of special interest for the conservation of cetaceans in Spanish Mediterranean waters" a data base and GIS coverages were created. Using GIS enables us to control and redo all the information created by means of relational databases and Metadata sets (Moreira, 2001), permitting a dynamic link between databases and maps so the data updates to be created within the project LIFE02NAT/E/8610 (2002-2006) will be automatically reflected into our data management system.

METHODS The Southern area of the project enclosed Andalusian waters and was divided in three regions, due to the different oceanographic characteristics of them (Universisad Autónoma de Madrid, 2002). These sectors allowed us to analyze GIS data sets in six different areas, Fig. 1.

We divided each area in grid cells of 2 x 2 minutes of latitude and longitude (about 13.7 km^2). This defined an area of 3008 discrete grid squares. Within that study area we assumed that each grid cell could be visited by 9 monitored cetacean species: bottlenose (*Tursiops truncatus*), common (*Delphinus delphis*), striped (*Stenella coeruleoalba*) and Risso's dolphins (*Grampus griseus*), long-finned pilot whale (*Globicephala melas*), orca (*Orcinus orca*), sperm whale (*Physeter macrocephalus*), fin whale (*Balaenoptera physalus*), common porpoises (*Phocoena phocoena*) and beaked whales (fam. *Ziphidae*).

During field surveys GPS connected to a laptop allowed us to collect information directly into electronic databases every 60 seconds through the IFAW Logger software. Bibliographic data on cetacean strandings and sightings was also collected (Fig. 2).

In the GIS developed, the variables used in the habitat selection model were assigned to the midpoint of the 2' x 2' cell. The variables and data used for the different coverages were: effort (kilometres of track line searched per cell, Fig. 3), sightings (Fig. 4), depth (metres), slope (m/km), sea surface temperature (SST, annual average temperature in Celsius degrees extracted from satellite images), temporal variability of the SST, human activities (different types of ships sighted in the area as well as acoustic pollution noise detected by a 200Hz- 20KHz Hydrophone, Fig. 5) and the results of different analysis (encounter rates, probability of occurrence, prediction of density, etc).

RESULTS AND DISCUSSION Because all the species modelled presented a different scale of relative densities, (i.e. common dolphin has a higher presence than sperm whale in the researched area), the value of each cell was classified with a 10 ranked index for each specie as follows: a value 0 was assigned to the cells with a relative density lower than 0.0001. For the rest of the cells a value 10 corresponded to the 10% most important area and a value 1 corresponded to the 10% less important area. In between 1 and 10, other 8 values were given corresponding each to the 10% of the area, see Fig. 6.

Additional difficulties are given if we want to assess a relationship between our biological data and human activities. GIS proves to be an effective technology for the understanding of the results obtained. The related human activities analysis on the area permitted to overlay a grid with the same areas shared with the cetaceans.

With the spatial analysis results we obtained the preferred areas for cetaceans, the areas with highest densities of fishing and commercial boats, the areas with higher SST variations, the percentage of strandings per area, see graphic 1. Such information (75 layers) when mapped together, created 173 maps in the Geographic Information System Arc View® of ESRI (Environmental System Research Institute, Inc.). We followed the standards of the Bern's Convention, the Habitats Directive of the European Union, the Barcelona Convention and the Bonn Convention of Migratory Species (ACCOBAMS), for designing over the GIS, the areas to be proposed as Marine Protected Area (mainly Special Areas of Conservation, SAC's and Special Protected Area of Mediterranean Interest, SPAMI's).

Our proposal handed in to the Spanish Government delimited three SAC's (Fig. 7):

- Marine Zone of Southern Almería (midpoint: 2º 32' W lon. and 36º 06' N lat.), with a total extension of 2534 km^2.
- Marine Zone of the Alboran Island (midpoint: 3º 02' W lon. and 35º 56' N lat.), with a total extension of 774 km^2.
- Marine Zone of the Gibraltar Straight (midpoint: 5º 42' W lon. and 36º 58' N lat.), with a total extension of 1120 km^2.

CONCLUSIONS With the results of the Project, we obtained a data dictionary in digital cartography. Before that, the cetacean research in the Alboran Sea was only examined in two dimensions. GIS has allowed us to collect data from a variety of sources and layer them for spatial analyses. We are fully integrating our data management system by creating base maps for the project LIFE02NAT/E/8610. The performance of the system will depend on the roles of the people involved. This "people" comprises 2 categories: Doers and Users. Doers are GIS specialists involved in the GIS creation and maintenance. Users are decision makers and scientist who are interested in analyzing the GIS data that have been created. We will full integrate our GIS with the information shared with the SinambA (Environmental Information Network of the Junta de Andalucía), Nature and Fisheries of the Regional Government of Murcia and the Spanish Institute of Oceanography with the Spanish Cetacean Society data.

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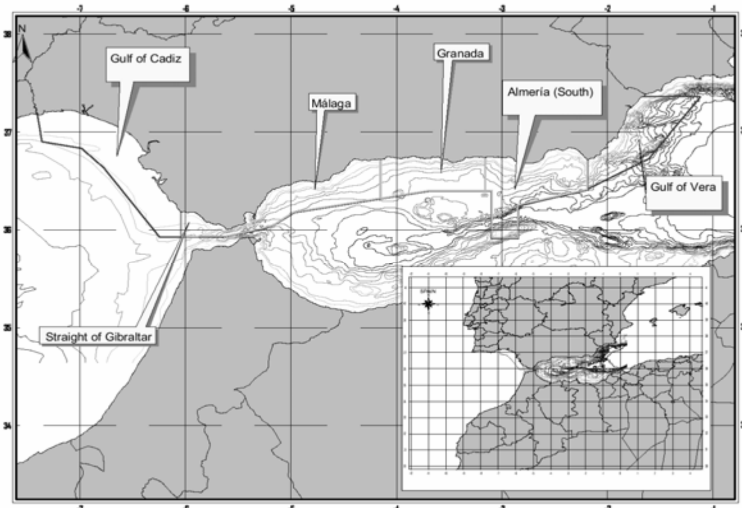

Fig. 1. The study area was divided into six different areas

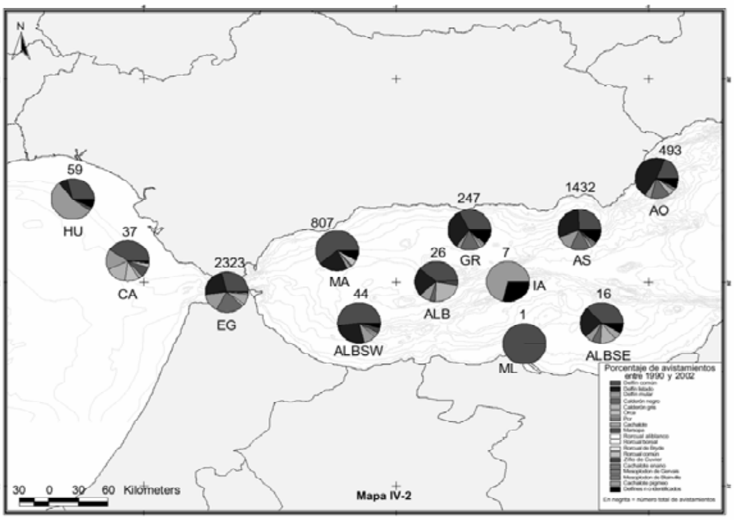

Fig. 2. Sightings in the area between 1990 and 2002. Each color matches a cetacean species

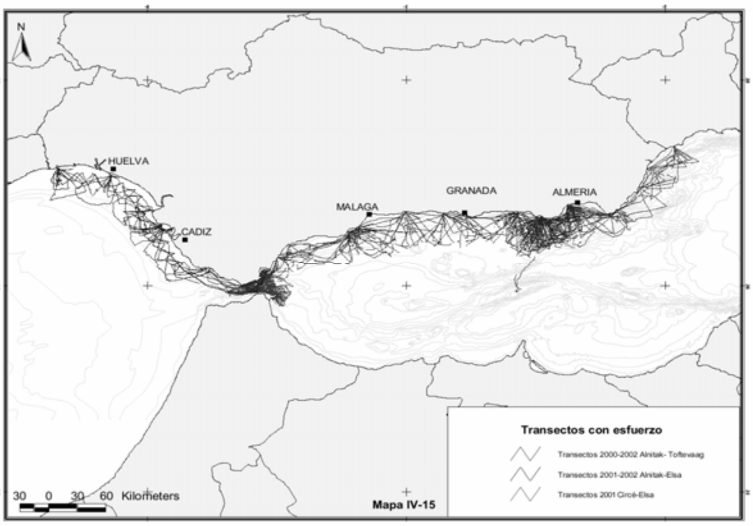

Fig. 3. Track sailed with effort by the boats of Alnitak and CIRCE, between 2000 and 2002. The tracks were plotted with the IFAW's Logger software

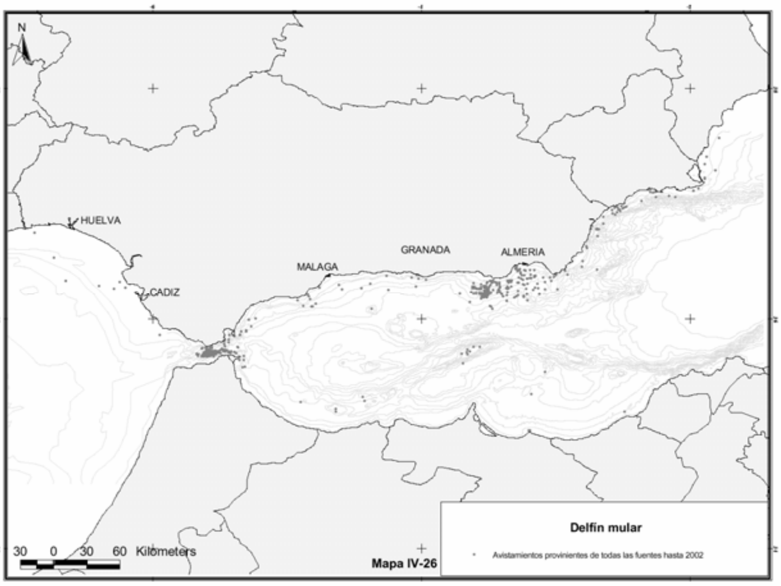

Fig. 4. Sightings of bottlenose dolphin

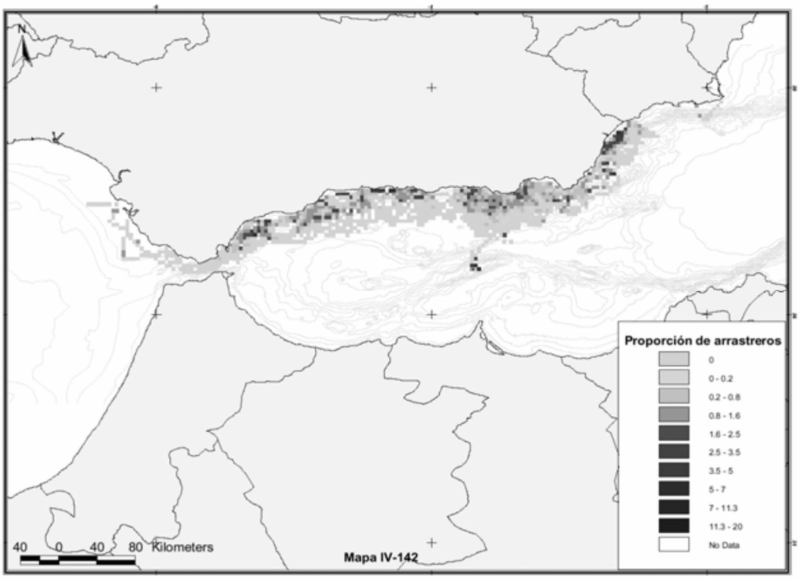

Fig. 5. Trawling densities in the researched area

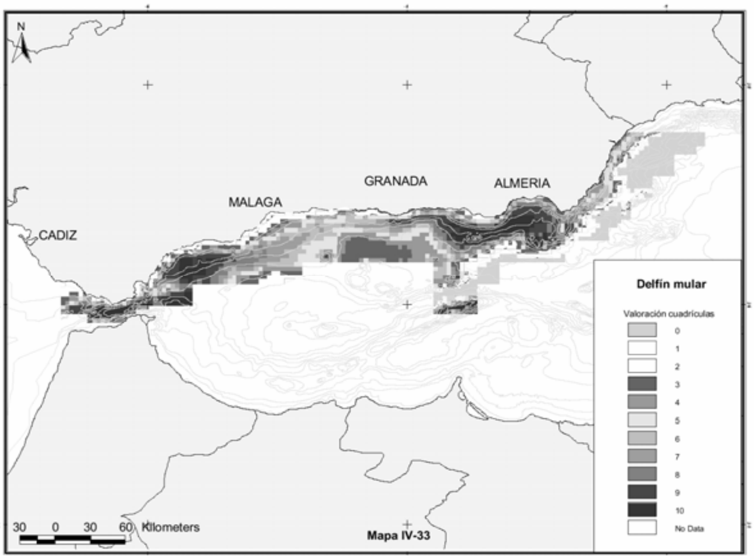

Fig. 6. Total value of 10 times ranked index for bottlenose dolphin.
Higher relative densities were shown in red

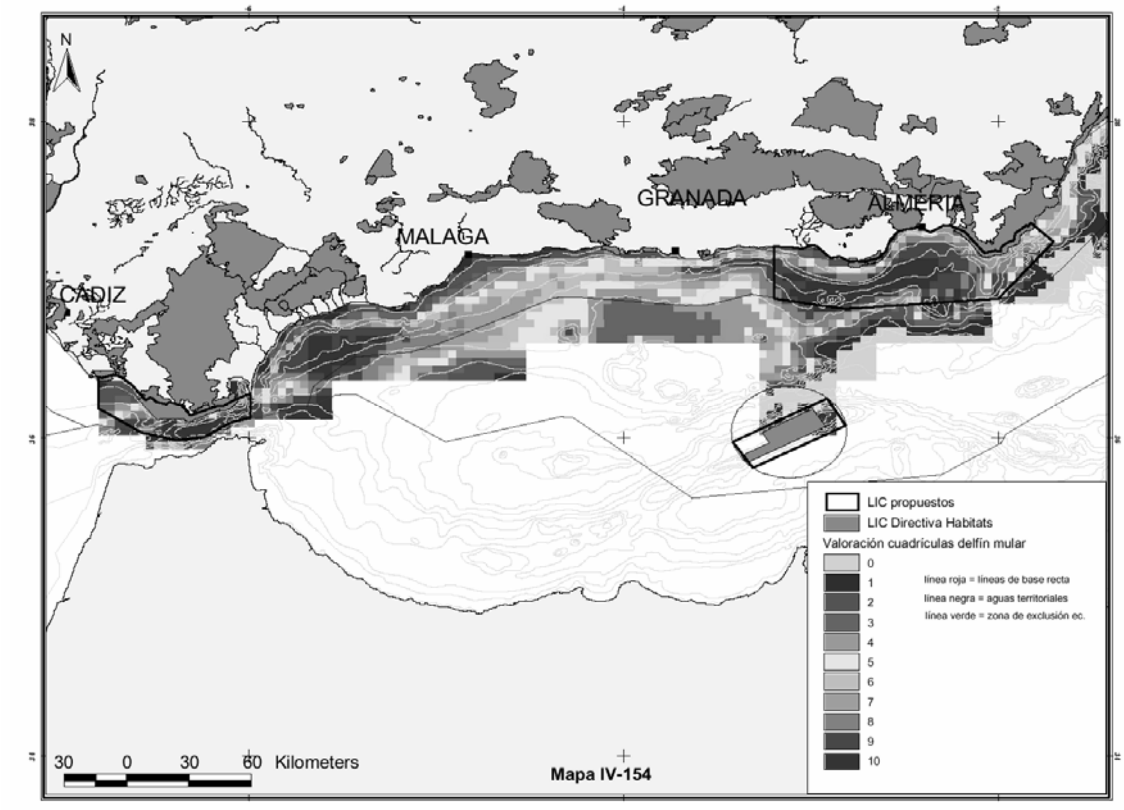

Fig. 7. Proposal of the three areas to be protected in the western mediterranean waters (named in Spanish: Lugares de Interés Comunitario)

AN AREA OF SPECIAL INTEREST FOR BEAKED WHALES IN THE ALBORAN SEA: IMPLICATIONS FOR CONSERVATION

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INTRODUCTION The Alboran Sea offers important feeding habitats to several species of odontocete, among which several species of beaked whales. The complex physiography of this region aggregates several species of deep sea cephalopods that are an important prey to these odontocetes. However, this region is also strategic at an economic and military level, which is why seismic surveys and military excercises are common here. The results presented are part of the "Programme for the Identification of Areas of Special Interest for the Conservation of Cetaceans in Spanish Mediterranean Waters" of the Spanish Ministry for the Environment. Considering certain odontocetes as species specially vulnerable to specific types of sound emissions, an analysis was made of the distribution of beaked whales with the aim of identifying regions of higher risk of conflict between these and human made sounds.

METHODS A total of 19,629 nm were sailed on effort in the Strait of Gibraltar, Alboran Sea and Gulf of Vera. Habitat selection models have been developed for beaked whales among other odontocetes species. Presence/absence was modeled using GLMs taking into account availability of habitat types. The research area was divided in grid cells of 2 by 2 minutes of latitude - longitude, which were used as sampling units. The effort unit being each time the survey track passed over a given grid cell. The variables used in the model were: longitude, latitude, depth, slope, sea surface temperature (sst) and temporal variability of sst. A prediction of occurrence was then applied to the whole research area given the results of the model. The models were tested for significance with a test for likelihood comparing the distribution of frequencies of the real data with 1000 frequency distributions of random data.

RESULTS Forty-two sightings of beaked whales were recorded, none of them in the Strait of Gibraltar or western section of the Alboran Sea (Fig. 1). At least two different species of beaked whales were encountered: Cuvier's beaked whale (*Ziphius cavirostris*) and northern bottlenose whale (*Hyperoodon ampullatus*, in 4 occassions). Additionally, a sighting of three animals still remains unidentified due to their non-common characteristics. The encounter rate was 0.002 groups and 0.004 animals per nautical mile sailed on effort. These whales showed preference for deeper waters south of the region of Almería (eastern Alboran Sea) and only depth, longitude and their interaction were significant, both variables up to the quadratic function (Table 1). See the prediction of occurrence in Fig. 2.

CONCLUSIONS The area shown as preferential for the beaked whales in the Alboran Sea is an area that showed great interest also for other teutophagic species as sperm whales, long-finned pilot whales, Risso's dolphins and striped dolphins during the same study. As a result, this oceanic area, where frequent naval exercises occur, has been proposed to the Spanish Ministry for the Environment and to the local Government of Andalucía as marine protected area (Fig. 3). Furthermore, the Hydrographic Office of the Spanish Navy, having knowledge of this study, has asked the authors a report about the proposed oceanic area and has proposed themselves, and agreed, the non-use of active sonars in this area, an initiative of great importance for the conservation of beaked whales in the area.

ACKNOWLEDGEMENTS This work was co-funded by the Spanish Ministry of the Environment through the "Programme for the Identification of Areas of Special Interest for the Conservation of Cetaceans in Spanish Mediterranean Waters" and the Earthwatch Institute. Special thanks are due to the CREPAD service of the INTA (National Space Agency) for the contribution of the satellite images of sst. We are also very grateful to the Alnitak staff and assistants in the field Susana García, Pilar Marcos, María Ovando, Mar Padilla and José Antonio Fayos, and to Renaud de Stephanis for the contribution of his effort data from the Strait of Gibraltar. Many thanks also to Phil Hammond, Jason Matthiopoulos and Bernie McConnell for their advice and help.

Table 1. Results of the habitat selection model (GLM) applied to the beaked whales. Lon = longitude, depth = bottom depth. The symbol '^' indicates the power of the polynomial function of the variable, and the symbol ":" means an interaction between both variables.

AIC = 77.778		Standard error	Z value	Pr(>|z|)
Intercept	-27.410	7.186	-3.815	0.000136
lon	-8.551	4.832	-1.770	0.076787
lon^2	-2.128	0.810	-2.628	0.008580
depth^2	0.0000037	0.0000017	2.215	0.026741
lon:depth^2	0.0000050	0.0000016	3.156	0.001602
lon:depth	-0.009801	0.002616	-3.746	0.000179

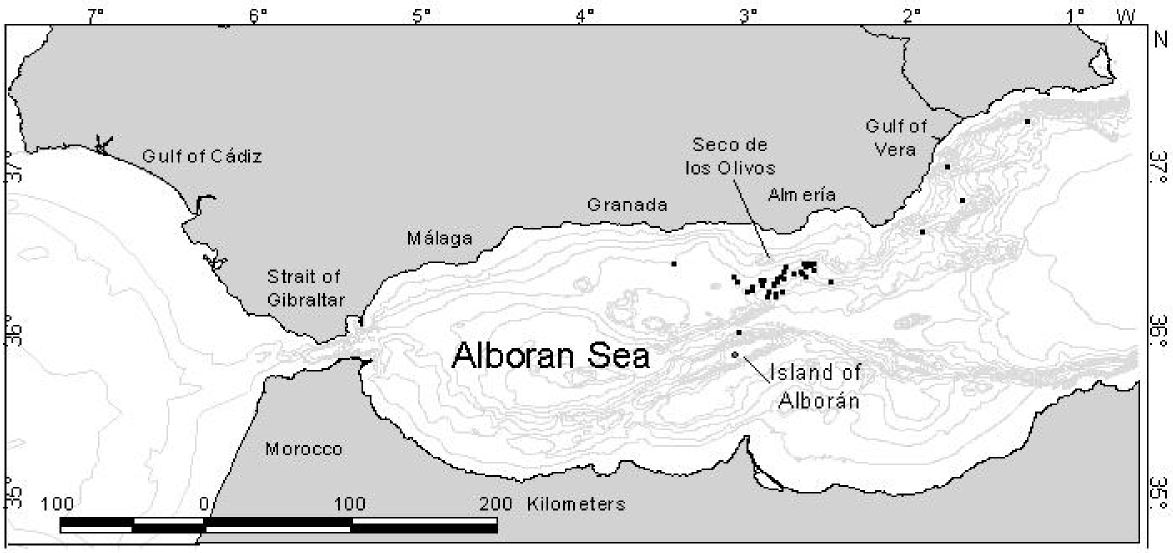

Fig. 1. Sightings of beaked whales

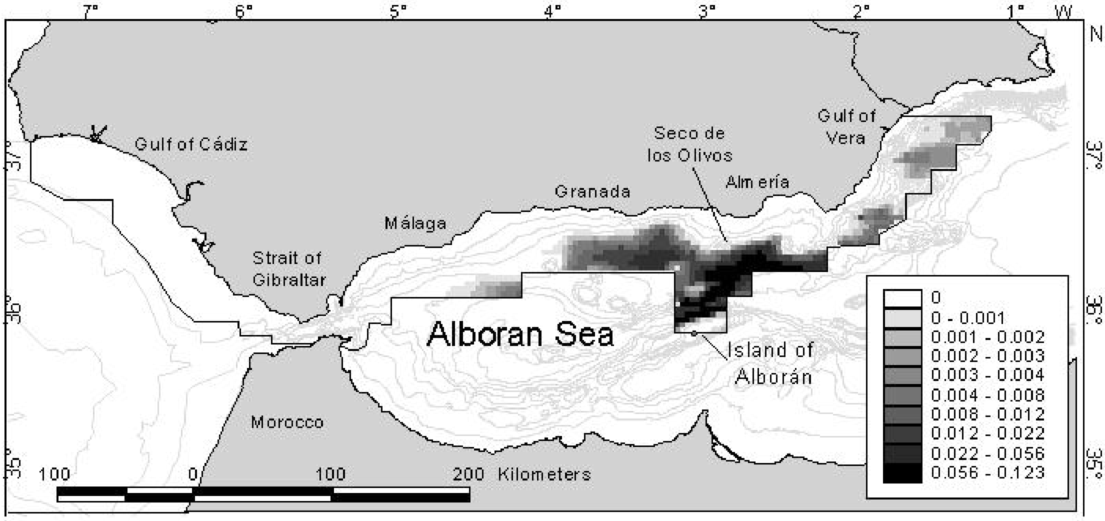

Fig. 2. Prediction of occurrence of beaked whales in southern Spain

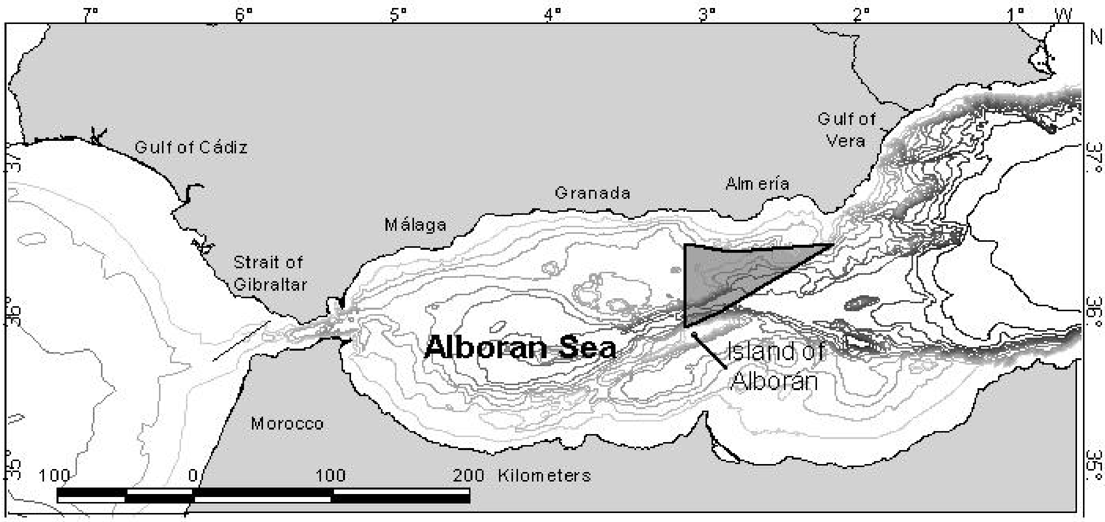

Fig. 3. Proposed Marine Protected Area: Oceanic Area

SOUNDING THE HEART OF AN ECOSYSTEM HOTSPOT FEEDING WHALES IN NORTHWEST ATLANTIC

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INTRODUCTION The Gulf of St. Lawrence is a large marine ecosystem (LME) enclosed in an Inland Sea of the North American continent (Fig. 1). It connects with the Northwest Atlantic through two straits at its north-eastern and south-eastern limits, which provide passages for Atlantic water and migrating whales. It receives the large freshwater runoff of the 1.3 M-km^2 watershed of the St. Lawrence (Fig. 1). This drives a strong two-layer estuarine circulation over the whole Gulf, where the freshwater is flushed to the Atlantic through the surface layer and the dense salted water from the Atlantic is entering in the deep layer through the 1000-km long Laurentian channel (El-Sabh and Princenberg, 1990; Therriault, 1991). All these stable large-scale features appear to be involved in the making of a persistent "hot spot" of this LME, intensively frequented by whales since centuries. This ecosystem hot spot is located at the head of the Laurentian channel, the main channel of the eastern Canadian continental shelf (Fig. 1). This is a traditional whale feeding ground that is part of the first Canadian marine park and one of the most intensive whale-watching sites in the world (Hoyt, 2000). The basic oceanographic processes responsible for the persistence of this ecosystem hot spot were investigated in a recent multidisciplinary research program. This paper summarises some knowledge acquired up to now.

METHODS Oceanographic measurements of water mass characteristics (temperature, salinity, current) and two-frequency (38 and 120 kHz) hydroacoustics combined with fishing were used to investigate the abundance and three-dimensional (3D) distribution of whale preys in the area, over repeated surveys in the summer (c.f. Simard and Lavoie, 1999). The krill and fish echoes (i.e. capelin) were objectively separated using their different relative backscattering at the two acoustic frequencies (c.f. Simard and Lavoie, 1999). The biomass maps and global estimates were computed according to geostatistical methods (ibid., Simard *et al*., 2003). Outputs from a high-resolution 3D tidal circulation model of the area (Saucier and Chassé, 2000) were used to analyse whale prey distributions and their relation with the water masses properties and displacements.

RESULTS AND DISCUSSION The two krill species found in the hot spot, *Thysanoessa raschi and Meganyctiphanes norvegica*, were surprisingly represented by 2-year old individuals only. This is a persistent characteristic of the local krill aggregation that is resulting from the two-layer estuarine circulation. The larvae, inhabiting the surface layer, are rapidly exported downstream by the flushing surface flow. The adults, spending their daytime in the deep layer that is moving in, are slowly imported upstream, up to the channel head. The total cycle of this conveyor belt takes two years. The total krill biomass reached 100 kt over an area of 1319 km^2 (Fig. 2), which makes this hot spot the richest krill aggregation in the Northwest Atlantic (Simard and Lavoie, 1999). The persistent estuarine pumping of waters from the krill-rich cold intermediate layer bring the adult krill in the area, where it concentrates under regular strong tidal upwelling and downwelling (Fig. 2). The tendency of krill to swim down under upwelling, to avoid being transported in the high light levels of the upper layer in daytime, has the effect of concentrating them at their barrier isolume. This is further enhanced by piling of the krill scattering layers during downwelling (see Lavoie *et al*., 2000). The control of the 3D tidal circulation by hydrodynamic blocking at the 3 sills separating the Laurentian channel from the upstream basins is responsible for recurrent mesoscale patterns of the aggregation and for the horizontal location of its core (Lavoie *et al*., 2000). In contrast to krill, capelin concentrated at the channel head banks and along the slopes (Fig. 2, Simard *et al*. 2002). Flooding currents and upwelling were aggregating them at the slopes, and along the fronts (Marchand *et al*. 1999) that formed at the interfaces between water masses (Fig. 3). Whales take advantage of the cyclical aggregation of capelin along the slopes at the channel head and of the richest krill concentrations further downstream (Michaud *et al*., 1997, Michaud and Giard, 1998). The capelin and the krill *T. raschi* are two whale preys that belong to a cold water ecosystem community whose southwesternmost extension is located at the head of the Laurentian channel (Fig. 1).

CONCLUSION The fundamental processes responsible for the making and persistence of this whale-food hot spot of this LME are the strong two-layer estuarine circulation of the Gulf of St. Lawrence, the intense upwelling at the head of its main channel, the negative phototactism of krill and the large-scale general productivity of the whole LME. This hot spot is one of these unique critical areas where special assemblages of habitat properties sought by whales are met regularly and predictably. It appears that it is how the ocean feeds the whales, by concentrating food in special time-space locations. Because the system involved in this particular hot spot is strongly dependent on freshwater runoff and a cold water community, this hot spot is therefore subject to climate variability and change.

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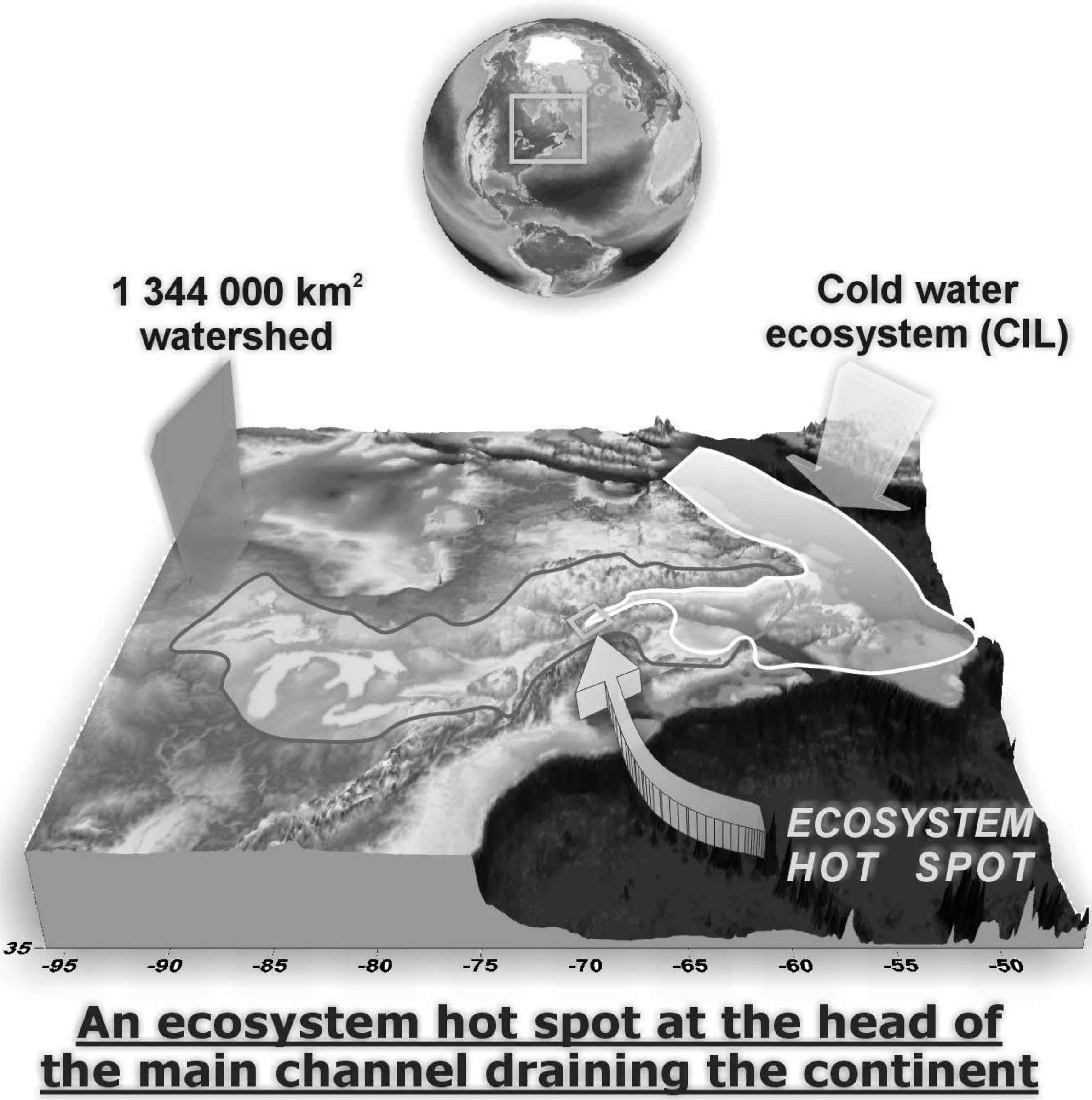

Fig. 1. Localisation of the head of the Laurentian channel in the Saguenay—St. Laurence Marine Park, and two fundamental components of the Gulf of St. Lawrence large marine ecosystem that are relevant for the making of this rich and persistent whale feeding ground

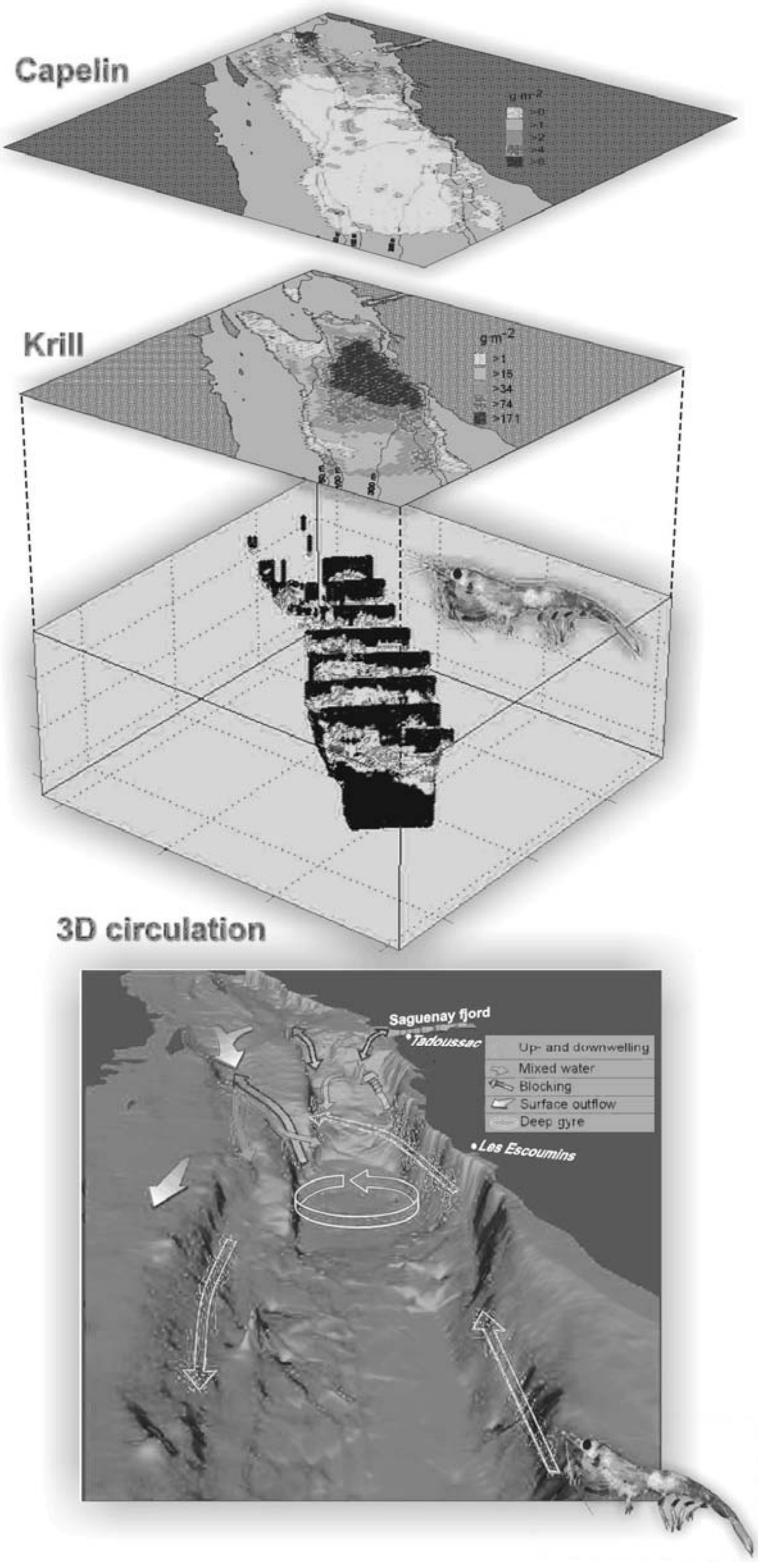

Fig 2. Example of the distribution of krill and capelin aggregations at the head of the Laurentian channel from an hydroacoustic survey (upper panels) and the 3D current structure schematic (lower panel) summarizing the features involved in making the persistent krill aggregation (see text). The strong two-layer estuarine circulation of the large St. Lawrence system pumps the cold-water krill at the head of the channel, where a dense aggregation is formed by tidal currents interacting with topography and upwelling combined with the negative phototactism of krill. Capelin aggregate just upstream of this rich krill aggregation that is pushed towards them during flooding tides.

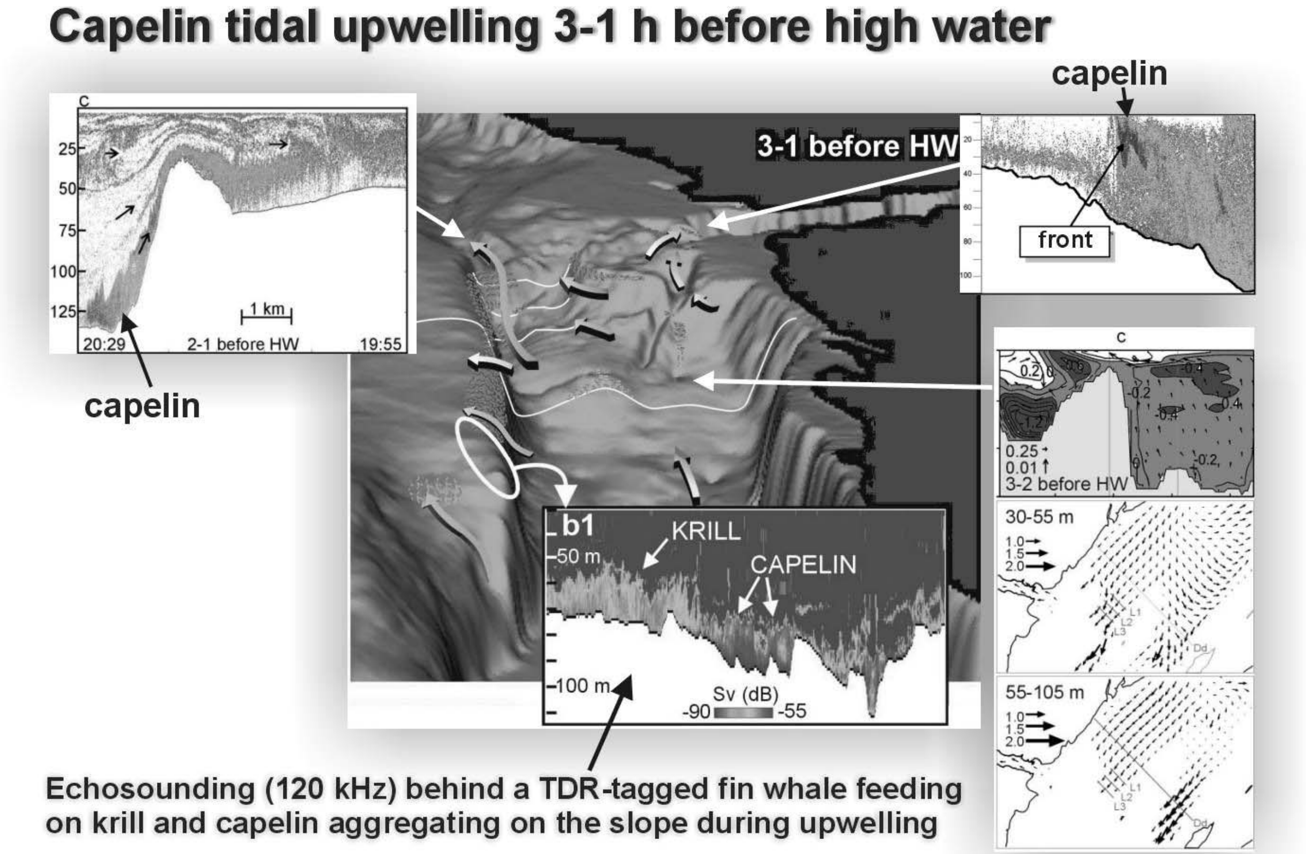

Fig. 3. Summary of the capelin aggregation at the head of the Laurentian channel at the end of the flooding tide. Currents are directed upstream over most of the water column (bottom right panel) and capelin is forced along the slope and above shallows (top left panel) during maximum flood. Frontal aggregations often form at the interface between the upwelled cold water and the surrounding warmer surface waters (e.g. top right panel). Whales take advantage of these predictable aggregations of their food, as indicated by the echogram b1 (bottom center panel) obtained while following a TDR tagged fin whale during this tidal period (see text)

ECOLOGY

CUVIER'S BEAKED WHALE (*ZIPHIUS CAVIROSTRIS*) HABITAT USE AND DISTRIBUTION IN THE GENOA CANYON AREA (SIRENA'02)

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Cuvier's beaked whales are a cosmopolitan species, yet very little is known about their ecology and distribution. Much of the present information, in fact, comes from stranded specimens, as live sighting data for this deep-diving species is not readily available. Moreover how closely the distribution of stranded specimens matches the real distribution is poorly known, as ocean currents my carry the animal away from its primary habitat. The Genoa Canyon area, in the north western region of the Ligurian Sea Sanctuary for Cetaceans, is a known habitat of Cuvier's Beaked Whales. During the SACLANT Undersea Research Centre Sirena '02 cruise, conducted from 15-23 July, 2002, temperature, salinity, chlorophyll-a, turbidity measurements were taken at 21 oceanographic stations in the canyon region. The aim of this work was to correlate the oceanographic and physiographic characteristics combined with data on the main biological features of the canyon, with Cuvier's beaked whale sighting data taken on the same spatial-temporal scale, within an area of about 10,600 km2. The seventeen Cuvier's beaked whale sightings have been integrated with the environmental measurements using a Geographic Information System. Multivariate statistic techniques (Multidimensional scaling techniques, Principal Component and Logistic Regression Analysis) have been applied to the biological/hydrographic/cetacean dataset in order to identify the driving forces affecting Cuvier's beaked whale use of the habitat as function of bathymetry and oceanographic features. The final goal of this present research is the development of predictive models of the species presence.

FACTORS INFLUENCING THE OCCURRENCE OF CETACEANS IN THE MINCH, SCOTLAND. MAY TO JULY 2002

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INTRODUCTION Hebridean waters are amongst the most productive marine areas in Britain, and are home to a high diversity and abundance of cetaceans (Evans, 1992). To investigate the relationship between cetacean occurrence in this area and oceanographic variables, regular surveys were conducted from the Caledonian MacBrayne passenger ferry 'MV *Isle of Lewis*' during the summer of 2002.

Aims and objectives The principle aim of this study was to determine the spatial and temporal variations in the occurrence of cetaceans in Hebridean waters, and to investigate the relationship between sightings and a number of variables, such as month, tidal cycle and lunar cycle.

METHODOLOGY Data were collected during 16 shipboard surveys carried out between the 3rd of May and the 18th of July 2002 between Ullapool and Stornoway (Fig. 1). At 15 minute intervals environmental parameters and the position of the ship were recorded. The position of cetacean sightings were estimated using range finding binoculars and the formulae described by Lerczak and Hobbs, 1998. Data on each sighting were plotted using ArcView software, as were the ships tracks. Data analysis was restricted to sightings and effort carried out in sea states of Beaufort three or less and visibility of five kilometres or more to ensure that no groups of cetaceans were missed due to poor sighting conditions.

RESULTS A total of 97 sightings of six species of cetacean, comprising of 154 animals were recorded in the study area over the summer months (Fig. 2). Cetaceans were sighted throughout the study area, although harbour porpoises were concentrated in the near shore areas and minke whales in the western half of the Minch. The number of cetacean sightings differed significantly from expected (X^2=47.6,d.f.=2, P<0.01), with most sightings occurring during July. Sightings of harbour porpoises, *Phocoena phocoena*, were greatest around high and low tide, minke whales, *Balaenoptera acutorostrata*, numbers were greatest during the flood tide (Fig. 3). This difference in occurrence was significant (X^2=14.2,d.f.=5,P<0.01). There was no relationship between sightings and neap and spring tides (X^2=0.06,d.f.=1). However, there was a significant difference in the number of sightings between the first and second halves of the lunar cycle for all cetaceans, (X^2=59.3, d.f.=1, P<0.01), harbour porpoises (X^2=34.0, d.f.=1, P<0.01 – Fig. 4) and minke whales (X^2=13.5, d.f.=1, P<0.01).

CONCLUSIONS Cetacean distribution in the Minch is related to month, tidal cycle and lunar cycle. Their occurrence is related to prey availability. Cetaceans were sighted in areas were aggregations of favoured prey species are known to occur, e.g. in areas with a sandy seabed where sandeels occur. Peak sightings occurred during months when prey are more readily available e.g. schools of spawning herring in July. Harbour porpoises and minke whales may be temporally segregated across the tidal cycle to avoid competition for the same prey such as sandeels and herring.

The relationship between cetacean occurrence and the lunar cycle may also relate to changes in prey availability, e.g. spawning aggregations at certain phases of the moon. This research will continue in 2003 to investigate whether these relationships change between years and will expand to use other ferry routes to see if similar relationships occur in other parts of the Hebrides.

ACKNOWLEDGEMENTS We would like to thank Caledonian MacBrayne Hebridean and Clyde Ferries for their assistance during this study. This project was undertaken for an M.Res at the University of Aberdeen, Scotland, funded by NERC and was supervised by Dr. Graham Pierce. Additional funding was provided by the John Ray Trust.

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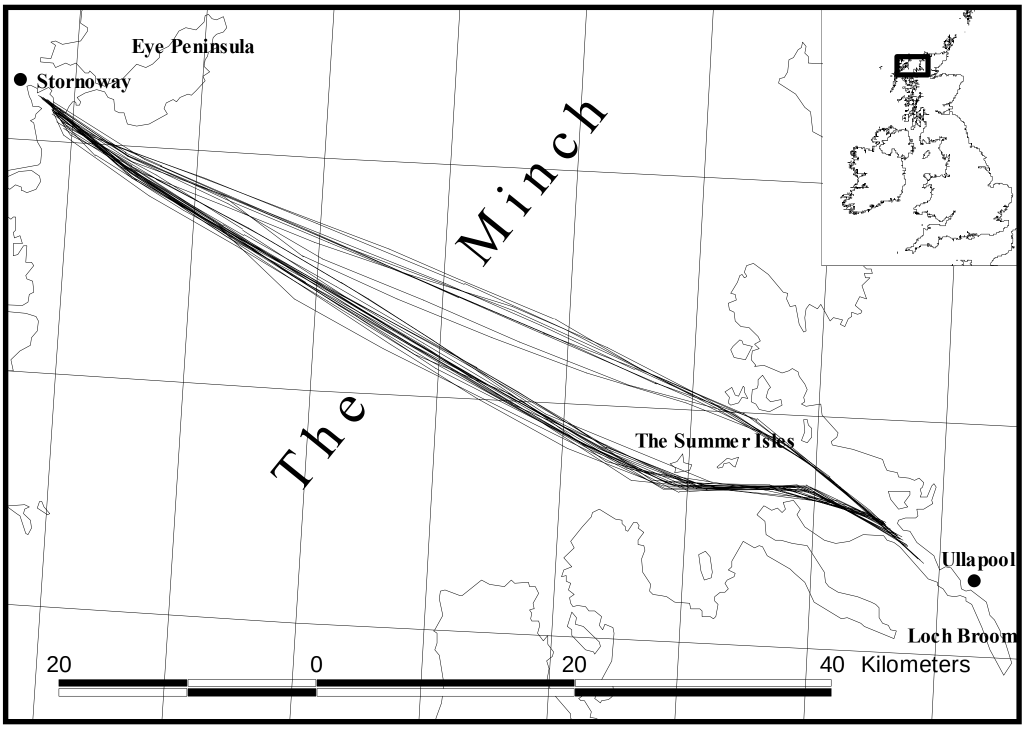

Fig. 1. The Minch, northwest of Scotland, UK.
Transect lines of the ferry between Ullapool and Stornoway are shown

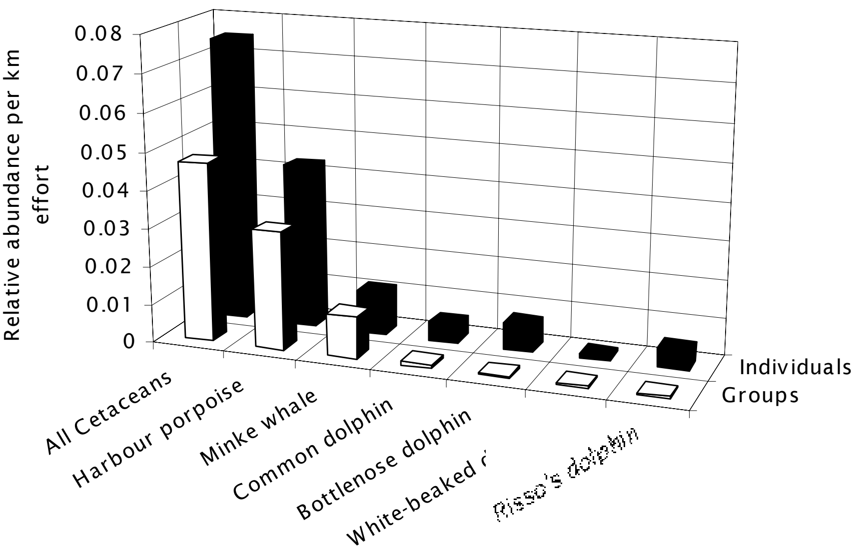

Fig. 2. Sightings rate and relative abundance of cetaceans in the Minch, May to July 2002

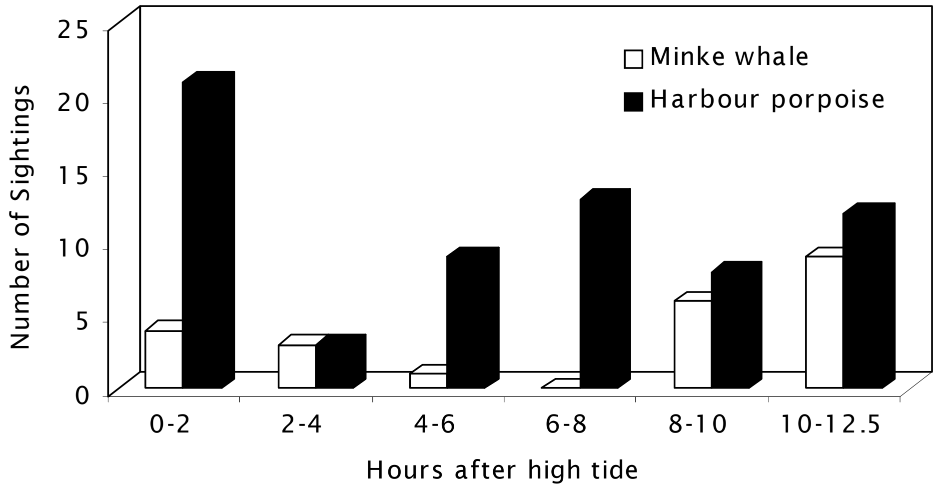

Fig. 3. Total number of harbour porpoise and minke whale sightings throughout the tidal cycle.

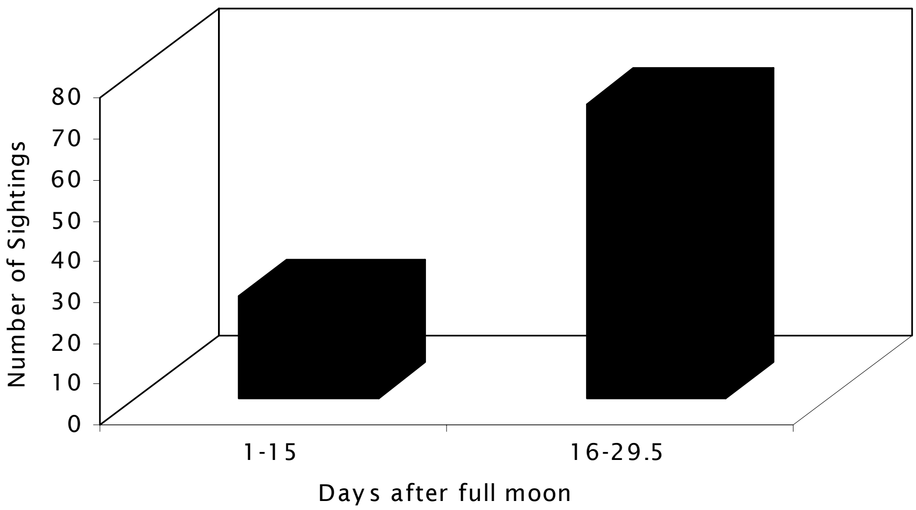

Fig. 4. Sightings of harbour porpoise during the first and second half of the lunar cycle

POSSIBLE REASONS FOR THE GEOGRAPHIC VARIATIONS IN THE WHISTLES OF SPINNER DOLPHINS (STENELLA LONGIROSTRIS) OF THE PACIFIC OCEAN

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INTRODUCTION In some animals geographically separated groups can be identified by differences in their acoustic emissions. The existence of such differences may indicate that "vocal" learning is the likely mechanism for adopting a particular sound repertoire (Kroodsma, 1982). Differences in the acoustic repertoire may develop so as to discourage the intermixing of groups of a species that have adapted to local ecological conditions (Marler, 1958).

Bazúa-Durán (2001) compared the whistles of spinner dolphins recorded within the main Hawai`ian islands, at a microgeographic scale, and found that the differences in the whistles were larger within than between main Hawai`ian Islands. The differences found tended to agree with the geographic distance and possible movement of spinner dolphins between islands. Hawai`ian whistles could be categorized by whistle-specific subgroups and some of the whistle-specific subgroups of an island are similar to those of other islands. The concept of whistle-specific subgroup was created to explain the similarities found between groups of spinners dolphins within an Island. A whistle-specific subgroup could consist of individuals having similar whistles that may regularly spend some time together. Kaua`i whistle-specific subgroups seem to be more unique than those of the rest of the main Hawai`ian Islands, indicating that the movement of spinners could be greater between O`ahu-Lāna`i-Maui-Hawai`i than between Kaua`i (the furthest island) and the rest of the main Hawai`ian Islands. The home range of Hawai`ian spinner dolphins does not seem to be limited to a single island and the dolphins do not seem to belong to different populations but may be part of a "super population". It seems that more mixing occurs than previously thought and that the movement of spinner groups is somewhat reflected in their whistles.

In this study, "macrogeographic variation" (Krebs and Kroodsma, 1980) was used to describe differences between whistles of spinner dolphins occurring over long distances. Spinner dolphin whistles from the Eastern Tropical Pacific (ETP) were compared to those recorded off Midway Atoll, Northwestern Hawai`ian Islands, the island of O`ahu, main Hawai`ian Islands, and Mo`orea, French Polynesia. Spinner dolphins from Mo`orea do not intermix with Hawai`ian spinner dolphins, and spinners from Midway Atoll and ETP presumably do not intermix with dolphins from the main Hawai`ian islands. Macrogeographic differences in the whistles of spinner dolphins seem to be larger than microgeographic differences (Bazúa-Durán, 2001), suggesting that spinner dolphins develop changes in their whistle characteristics as a result to the adaptation to their habitat or due to isolation. Differences in the whistles should be inversely correlated with the degree of mixing. Geographic variations have been found for killer whales (Dahlheim, 1980), sperm whales (Weilgart and Whitehead, 1997), and bottlenose dolphins (Wang *et al*., 1995).

MATERIALS AND METHODS From 1998 to 2000 spinner dolphin whistles from the coastal and oceanic locations shown in Fig. 1 were recorded. Coastal recordings were made using a spherical hydrophone and a portable DAT recorder (frequency response of the recording system was flat to 24 kHz) and recordings made in the ETP were done with a hydrophone array connected to a personal computer (frequency response of the recording system was flat to 40 kHz). The oceanic recordings were filtered to be consistent with the coastal recordings and obtain a maximum frequency of 24 kHz. The Canary© software 1.2.4 was used to generate the spectrogram of each whistle and to extract 10 whistle parameters: 1) beginning frequency, 2) ending frequency, 3) peak frequency, 4) maximum frequency, 5) minimum frequency, 6) duration, 7) peak time, 8) center time, 9) number of turns, and 10) number of steps. These parameters were used in a discriminant function analysis (DFA) in STATISTICA© to evaluate differences. Canonical correlation was also calculated to obtain the relative degree of distances between groups. The Mahalanobis distance (D^2) between each pair of areas was used to evaluate the differences in the whistles of several areas. The larger the D^2 value the more different the groups are.

RESULTS AND DISCUSSION A total of 4882 whistles were selected for analysis: 925 from Midway, 2646 from O`ahu, 597 for Mo`orea, and 714 for the ETP. Statistically significant differences were found between the whistles of Midway, O`ahu, Mo`orea, and the ETP ($p<0.001$), however, the differences found in the whistles from each area by the DFA are very small ($0.53<D^2<1.13$). Whistles from Midway were very different from those of O`ahu ($D^2=0.70$), Mo`orea ($D^2=0.75$), and the ETP ($D^2=1.13$), as well as whistles between Mo`orea and the ETP ($D^2=1.10$) (see Fig. 2 and 3). Differences in the whistles from O`ahu and both Mo`orea ($D^2=0.53$) and the ETP ($D^2=0.54$) were the smallest (see Fig. 2 and 3). Differences in the whistles were not determined by factors such as general location (island or region), spinner pod, and habitat (oceanic versus coastal) (see Fig. 3 for the comparison of the whistles from each spinner pod recorded from which more than 100 whistles were analyzed), nor by pod size and general behavior state (social-rest-travel). Spinner pods are larger in Midway and the ETP (more than 150 dolphins) than in Hawai`i and Mo`orea (usually less than 100 dolphins). Midway whistles were the more different ones possibly because the spinner society in this region is relatively stable. O`ahu and Mo`orea spinners live in a fission-fusion society, which may be the cause that their whistles were more similar. The reasons why O`ahu and ETP whistles were similar are still to be investigated. The spinner society in the ETP may also be fluid. Spinners from the ETP presumably do not intermix with dolphins from the main Hawai`ian islands, but the possibility of mixing should not be ruled out.

CONCLUSIONS The results of the DFA suggest that macrogeographic variations exist in the whistles of spinner dolphins, but that they are very small. It seems that more than 75% of the whistles of spinner dolphins are shared between geographically separated areas. O`ahu groups were very similar to ETP and Mo`orea groups, suggesting that there are no great differences between oceanic and coastal spinner dolphin whistles. The distinctiveness of Midway whistles could be due to the stability of spinner groups in that area. These results indicate that geographic differences may not occur solely due to geographic isolation. Other factors, such as differences in the fluidity of spinner groups (population structure characteristics) may be more important when looking at macrogeographic differences in the whistles of spinner dolphins and from other delphinid species, such as *S. plagiodon, S. attenuata, S. clymene, Delphinus delphis, Lagenorhynchus albirostris,* and *Sotalia fluviatilis*. Studies that investigate how much mixing exists between the main Hawai`ian Islands, Midway, and the ETP need to be carried out in order to substantiate the results obtained by this study. The existence of differences in the whistles of different populations of spinner dolphins, however, suggests that "vocal" learning is the possible mechanism for the acquisition of these acoustic emissions.

ACKNOWLEDGEMENTS Project sponsored by a Leonida Memorial Scholarship, a UH Seed Money Grant, a UH Foundation Grant, and NOAA. CBD was a Fulbright-García Robles-CONACyT and DGAPA, UNAM fellow. We thank Oceanic Society, Marc Lammers, Joe Mobley, Michael Poole, Jay Barlow, Shannon Rankin, the visual observers, acousticians, officers and crew of the NOAA ships McArthur and David Star Jordan and the R/V Endeavor, and all the volunteers for their help during data collection. Daniel Blaine and Leticia Gracia helped with the statistical analysis.

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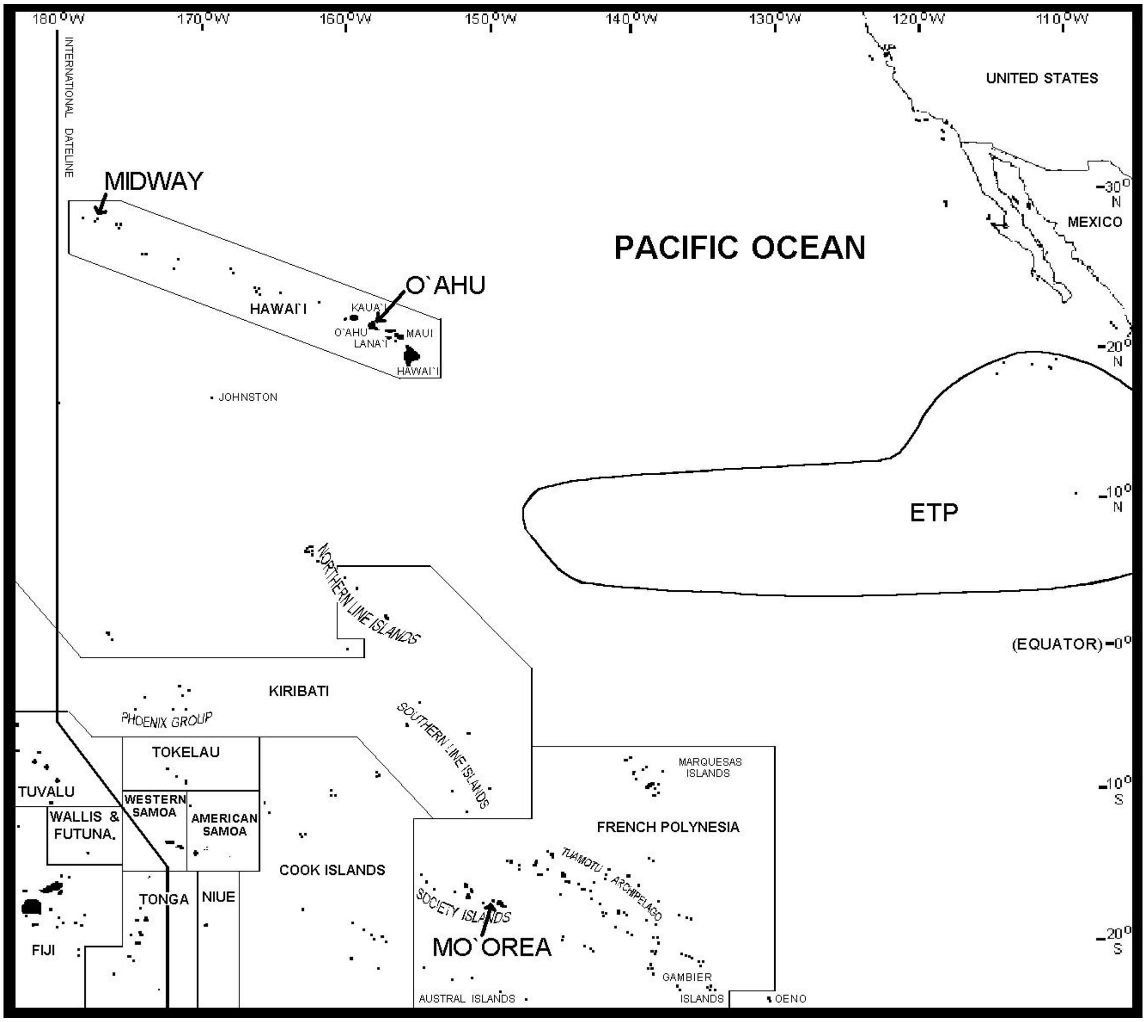
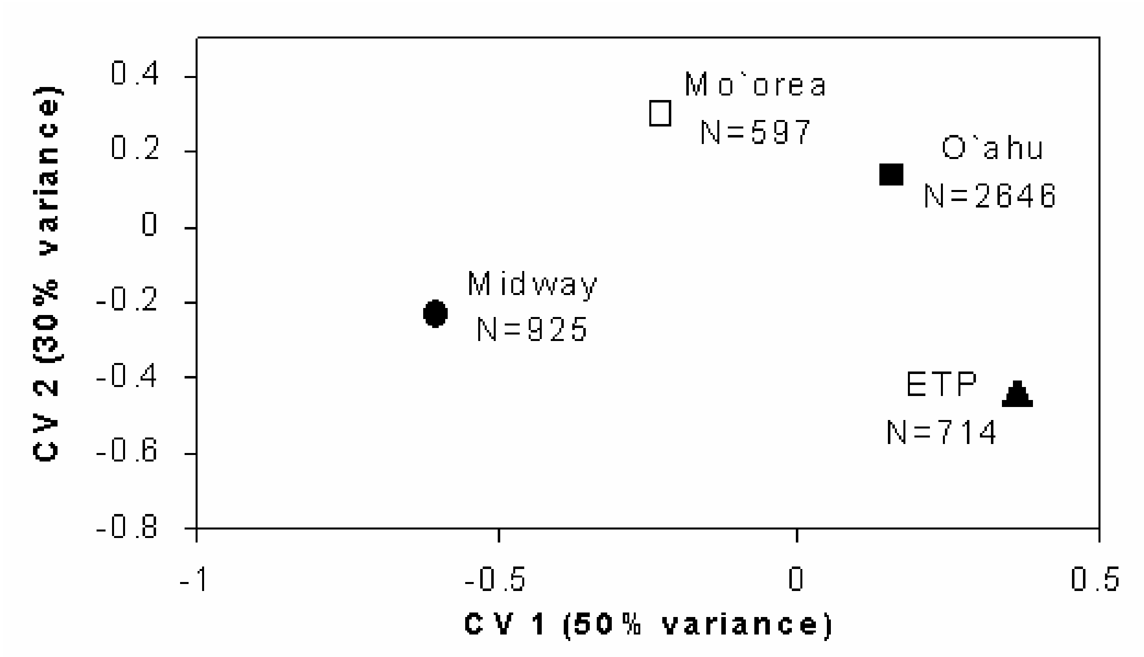


Fig. 1. Map of the Pacific Ocean showing the locations where spinner dolphin whistles were recorded: Midway Atoll (Northwestern Hawai`ian Islands), the island of O`ahu (main Hawai`ian Islands), Mo`orea (French Polynesia), and Eastern Tropical Pacific (ETP).

Fig. 

2.

Means of canonical variates for the comparison between all spinner pods recorded in Midway, O`ahu, Mo`orea, and the Eastern Tropical Pacific

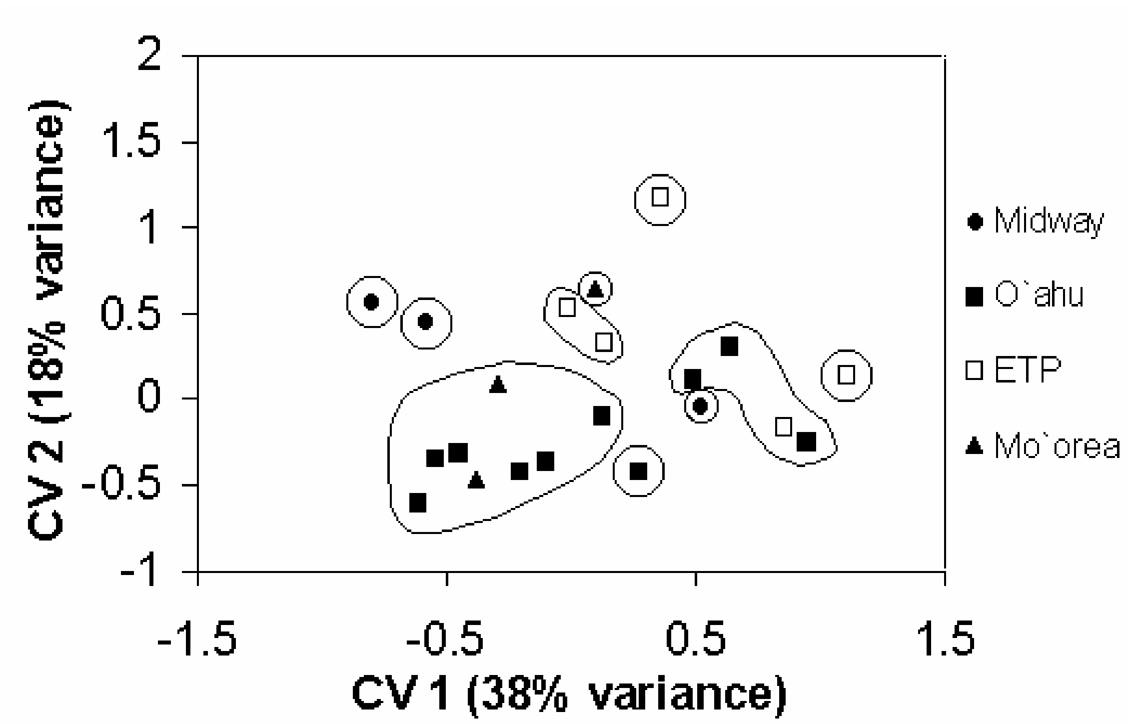


Fig. 3. Means of canonical variates for the comparison between each spinner pod recorded in Midway, O`ahu, Mo`orea, and the Eastern Tropical Pacific. Groupings indicate spinner pod whistles with differences of $D^2<1.0$

COMMON DOLPHINS (*DELPHINUS DELPHIS*) OFF PATAGONIA: A PARASITOLOGICAL APPROACH

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The common dolphin (*Delphinus delphis*) is one of the small cetaceans that are incidentally killed in pelagic trawl nets along the coast of Argentina. In this work we describe the helminth community of this species in terms of prevalence, abundance, mean intensity and diversity, besides comparing it with other Patagonian cetaceans within a context of habitat use. Eighteen common dolphins (12 males, 6 females) were incidentally caught in trawl nets in northern Patagonia during January 1999. All organs were examine and parasites were only found in the gastrointestinal tract. A total of 1101 helminths were recovered. Prevalences and mean intensities (±sd) for each species present were: *Corynosoma cetaceum* 88.9%, 39.75 (±45.36); *Braunina cordiformis* 72.22%, 25.8 (±29.95); *Anisakis simplex* 50%, 5.22 (±3.83); *Pholeter gastrophilus* 16.7%, 3 (±1.73); *Oschmarinella rochebruni* 22.22%, 5.5 (±3.15). No difference was found in prevalences (Fisher's exact p>0.05) and mean intensities (p>0.05) of all the species between hosts' sex. All parasites showed an aggregated distribution within the host sample. Species diversity and evenness were low both at the component (H'=0.94; E=0.58) and infracommunity (H'=0.75; E=0.74) levels. This is the first time *O. rochebruni* is reported for the area. Common dolphins share three parasite species (*A. simplex, B. cordiformis* and *P. gastrophilus*) with the dusky and Commerson's dolphins from the Southwestern South Atlantic Ocean. The occurrence of *C. cetaceum* and *O. rochebruni* is related to availability of intermediate hosts (prey) in northern Patagonia rather than to host specificity. Among the most abundant prey items are the argentine anchovy *Engraulis anchoita* and the Patagonian squid *Loligo sanpaulensis*. This paper is the first reporting results on parasites of common dolphins off the Argentine shelf and it enlarges the scarce parasitological information for cetaceans of Argentina.

DIET OF RISSO'S DOLPHIN IN WESTERN MEDITERRANEAN

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The Risso's dolphin, *Grampus griseus* (Cuvier, 1812) is a cosmopolitan dolphin species in deep tropical and warm temperate oceanic waters for which biological data are fairly unknown. The data analysed in the present work came from twenty stranded Risso's dolphins on the west Mediterranean coast between 40º25'N 00º32'W and 37º35'N 00º45'E from April 1987 to april 2002. Only thirteen specimens, eight females and five males, were available for this study, due to the poor condition of some carcasses; the age from dentinal layers made from sections of teeth were read in eight individuals. We may attribute a exclusively cephalopod diet to Grampus griseus with only cephalopod remains being found in their stomachs; 25 species belonging to 13 families were found in the total number of analysed stomachs; families most represented were Argonautidae, Ommmastrephidae, Histioteuthidae and Onychoteuthidae. Despite the numerical importance and high frequency of small pelagic octopods, mainly Argonauta argo, we assume that greater nutritional content came from of ommastrephids, mainly *O. bartrami* and *T. sagittatus* because of their larger size of some specimens. Prey are mainly oceanic and pelagic species with a muscular mantle.According distribution records of prey in western Mediterranean this cetacean species more frequently inhabits the outer continental slope and shelf break region; the preference for this habitat may be explained by the high marine productivity which enhanced feeding opportunities; this agrees with results from other countries and sightings in the area. The high number of A. argo in contrast with the scarcity of their catches and the presence of Mastigoteuthis and Megalocranchia genera corroborates the importance of teuthophagous predators as cephalopod collectors.

MIGRATORY TIMING OF HUMPBACK WHALES IN THE CENTRAL NORTH PACIFIC

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Humpback whales (*Megaptera novaeangliae*) migrate seasonally between high-latitude summer feeding grounds and low-latitude winter breeding grounds. Biologists who examined humpback whale carcasses caught mainly in the southern hemisphere suggested that migrations were loosely segregated on the basis of age, sex and reproductive condition. However, this issue has never been addressed directly with live humpback whales. Using identification photographs of humpback whales collected off two different Hawaiian islands between 1976 and 1995, we investigated whether their sighting dates varied with sex, reproductive status or age class. Analyses revealed that (a) off the Big Island, mean dates of first identification were significantly earlier for juveniles and females with no calf than for males and females with a calf, while mean dates of last identification were significantly earlier for juveniles and females with no calf than for males and females with a calf; and (b) off Maui, mean dates of first identification were significantly earlier for juveniles than for females with no calf, males, and females with a calf while mean dates of last identification were significantly earlier for females with no calf than for males and females with a calf. A within-subjects comparison showed that the date of first identification tended to be later for individual females in the years when they had a calf than in the years during which they had no calf. It was concluded that (a) migratory timing of central North Pacific humpback whales varies as a function of age, sex and reproductive status, (b) migratory timing is intimately connected with reproductive success and (c) migratory timing has important consequences for our understanding of humpback whale behaviour on the winter grounds.

RECOVERY OF THE SOUTH AMERICAN SEA LION POPULATION IN NORTHERN PATAGONIA

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South American sea lions population (*Otaria flavescens*) along the Argentine coast was dramatically reduced between the 30´s and the 50´s and did not show signs of recovery until 1990. The purposes of this paper are to estimate the size and trend of the population located in northern Patagonia, and to analyze changes in the distribution, size and structure of the rookeries and haul-out sites. Total counts were made during the reproductive season from field or by photographs during the period 1983-2002. Standard regression models were used to examine trends in population size as well as age and sex classes. Counts were log-transformed. During 2002, sea lions were present in 19 rookeries, and the total number counted was 24,912 (SD=484), estimating the population size in 44,842. Pups represented around 40% of the total counted and there were no significant differences between the rate of change of pups and non-pups ($n=7$, $p>0.05$) during the whole period. Some rookeries showed higher rates of change of pups than non-pups. Pups trend at oldest rookeries was significantly positive and equal to 0.034 but they were increasing at higher rates at new rookeries. Considering the precision and the contribution to the abundance of each rookery by adjusting each trend and variance by empirical Bayes methods, the trend was estimated in 0.069. The occupancy of new areas for hauling out as well as for breeding may represent represent potential colonization areas and the key in the recovery of this population. The most important features in this process would be higher survival rates of juveniles combined with available habitat for individuals entering to reproduction and then establishing in new rookeries. This hypothesis could explained the higher rates of increase of the number of pups in the periferic breeding groups while reproductive rates and adult sex ratio remain unchanged.

"BOTTOM GRUBBING": THE ULTIMATE CHALLENGE FOR AN ECHOLOCATING PORPOISE?

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The short-range, narrow-band sonar of porpoises is supposedly adapted to the acoustically complex coastal habitat they live in, but is very different from the broad-band sonar of other delphinids like Tursiops living in similar habitat. Little is known on the porpoise way of dealing with clutter, but the bottom grubbing behaviour observed in shallow waters would seem to be an archetype of this problem. Porpoises search for prey in a vertical position, the snout at the bottom, with both vision and sonar focussed on the seabed. On sandy as well as rocky bottom, echoes from prey are much weaker than background echoes, yet porpoises are observed detecting and catching fish. This behaviour was studied under controlled conditions using direct observations, video filming and sound recordings (both click detectors and broad band) at the Fjord&Bælt, Denmark. The behaviour was initiated in front of an underwater window in a sea pen housing three porpoises, by releasing live fish at the rocky bottom. During bottom grubbing bouts, the porpoises used their sonar intensively, producing typical porpoise clicks. The repetition rate varied dramatically (200-400cps, peaks over 600cps), and the animals frequently made upward head jolts synchronised with sudden repetition rate oscillations. They also squirted water through their mouth. These repetition rate variations could not be a function of the almost constant distance to target, but may be a function of received information density. The low frequency component of the clicks, detectable by prey at close distance, and the sudden amplitude changes associated with the repetition rate oscillations may elicit a startle response in the fish. An escaping fish moving above the bottom allows porpoises to use their sonar horizontally, avoiding the cluttered background. The EU and the Danish Nature and Forest Agency funded this project.

TRACE ELEMENT CONCENTRATIONS IN BY-CAUGHT NORWEGIAN HARBOUR PORPOISES (*PHOCOENA PHOCOENA*): SOURCES OF VARIATION AND INSIGHTS IN THEIR FEEDING ECOLOGY THROUGH STABLE CARBON AND NITROGEN MEASUREMENTS

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Great concern raised from the populations decline observed for the harbour porpoises in the North Atlantic but Norwegian populations remain poorly characterized. Trace elements concentrations (Zn, Cu, Cd, Se, total Hg) have been determined in liver, kidney and muscle of 23 harbour porpoises (*Phocoena phocoena*) caught in fishing nets along the Norwegian coast. Sources of variation have been examined with a special interest on geographic location and diet modifications analysed through stable isotopes of carbon (δ13C) and nitrogen (δ15N). This study further intend to complete previous feeding ecology knowledge with a combined approach of stable isotopes ratios and metals concentrations as dietary tracers. Norwegian porpoises display mean hepatic concentrations of Zn, Cu and total Hg (96 ± 18; 25 ± 6 ; 15 ± 10 µg.g-1dw respectively) among the lowest in the North-Atlantic. These results suggest that porpoises from this region are less exposed to these metals than others sites such as the North Sea. The low burdens of certain metals (Zn, Cu, Hg) observed make the Norwegian populations suitable to be used as reference level for future ecotoxicological studies on this species. However, renal Cd concentrations (6.7 ± 4.1µg.g-1dw) are twice higher than those from the Southern North Sea. They probably reflect dietary modifications of the porpoises through their range. The low isotopic composition (mean muscle values: d13C=-18.5 ± 0.6 0/00 and δ15N=13.5 ± 1.2 0/00) suggests that Norwegian porpoises feed on more oceanic preys as confirmed by variations of hepatic Hg and renal Cd concentrations. Given that teutophagous marine mammals present higher concentrations of Cd than piscivorous ones. The results obtained lead to the conclusion that the Norwegian porpoises rely on more oceanic squids than those from the North Sea.

MASS STRANDING OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA RELICTA*) AT THE COAST OF THE SEA OF AZOV IN 2002

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25 stranded harbour porpoises, an unusually large number, were found dead on 1-2 July, 2002, during a coastal monitoring survey at the 30-km strip of the southern (Crimean) coast of the Sea of Azov. At least 1 of them stranded not later than July 2; 11 ones – not later than July 1. 10 animals were found in localities where no strandings had been registered during all the observation period (since 1999). Three animals were determined as by-caught; the rest had no marks of by-catch or ship collision. The cause of death was not determined. However, it does not seem to be connected with geophysical or meteorological conditions (unlike in June 2000 in the same region) or associated with the annual peaks of mortality in seabirds (which fell to early June and late July) and fishes; any facts of water pollution were not reported either. In one animal (male, 4 yrs, 140 cm, mature) there were some macroscopic pathological findings. In the sex composition of the stranded animals the males dominated (ratio 11:5). The age composition included animals from neonates to 10 yrs old (among them 9 neonates and 4 1-year old animals). High percentage of immature specimens (ratio immature: mature was 17:8) was observed. Such a large number of simultaneously stranded neonates have not been recorded at the Crimean coast since 1989-90; so it is an outstanding event. Among the stranded porpoises some animals were extremely large in terms of their sex and age. One of them was a female, 7 yrs, 160 cm long, about 90 kg weight (estimated), which is the longest specimen of harbour porpoise found in the Black Sea basin during the last decades.

A PILOT STUDY ON THE PRESENCE AND THE DISTRIBUTION OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) IN THE ARCHIPELAGO OF KORNATI (CROATIA)

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INTRODUCTION In previous decades the Adriatic Sea has been frequented by a number of cetacean species (Notarbartolo di Sciara and Bearzi, 1992; Bearzi *et al.,* 2000), particularly the bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*). Little is known about the occurrence and distribution of bottlenose dolphins in the Central Adriatic Sea; however, at present the bottlenose dolphin appears to be the only species regularly sighted in the northern Adriatic sea, with sporadic encounters of the striped dolphin (Bearzi and Notarbartolo di Sciara, 1995; Bearzi, 1996; Bearzi *et al.,* 1998; Pribanic *et al.*, 1999).

During the Summer of 2002, a feasibility study was undertaken in the area of the Kornati National park in order to identify the ideal area for conducting a long term study in the presence of cetaceans in central Adriatic.

The aims of this pilot study were:
to understand the occurrence and distribution of bottlenose dolphins in the area of Kornati National Park;
to assess if photo-identified animals from the Kvarneric are extending their home range to areas of the Central Adriatic Sea;
to investigate the possibility to conduct a long-term study (the Kornati Dolphin Project, KDP) on cetacean species in this area, with the aim to outline suitable conservation measures, based on the best available scientific knowledge.

The long-term plan of the KDP is to provide national and local managers with information on:
habitat use (critical habitats);
population structure and association;
reproductive and survival rates;
the impact of human activities on the marine environment and their sustainability.

The KDP will attempt to identify the functions that this geographic area provides to cetaceans, the potential benefits that the National Park can provide for cetaceans and in turn the benefits that cetacean presence may bring to the National Park.

Data derived from this project will be compared with the Adriatic Dolphin Project archives, in order to achieve a better understanding on the status of Cetacean species in the Northern and Central Adriatic sea.

MATERIALS AND METHODS The study area includes the Kornati National Park and its neighbouring zones (Fig. 1). This archipelago consists of about 140 islands and islets which are scattered over an area over some 300 km^2. The external limit of the park extends towards the open sea to one nautical mile. The archipelago consists of four island chains running strictly parallel with Dinaric range (North-West/South-East). They are named after the largest island in the group, Kornati, which provides a backbone around which the archipelago is formed. The archipelago is 25 km long and 13 km at its widest point. The total monitored area, territory of the Park and its neighbouring areas, is approximately 580 km^2.

Between July and August 2002, a total of 17 daily surveys were conducted from a sailing boat.Standard research procedures included the collection of:navigation data, using GPS, fishfinder and nautical chart;environmental data, using fishfinder and log;photo-identification data;notes on behaviour.The boat-based surveys were randomised, in order to cover the entire study area. No fixed routes were followed.

RESULTS A total of 528.56 km were surveyed in this period. Bottlenose dolphins were observed 6 times (Tab. 1). All sightings occurred outside the borders of the National Park. The sighting frequency, of 0.01 sightings/km, was lower than the frequency of 0.02 sightings/km recorded in the Kvarneric during the same year. From the photo-identification data collected in Kornati National Park 14 dolphins have been classified (Fig. 2). Comparisons with the 160-catalogued dolphins of the Kvarneric area did not show any match. Among all of the groups encountered, some individuals were re-sighted two or more times, including two mothers with their calves (in Fig. 2 T006 and T011). The number of dolphins encountered per group ranged from 6 to 20.

CONCLUSIONS Taking into account the small sample size of classified individuals in the study area and the length of the research period (only 17 days), we can highlight the following:
the only species encountered was the bottlenose dolphin;
all sightings occurred outside the borders of the National Park;sighting frequency in the study area was half of that recorded in the Kvarneric during the same period;
some individuals were re-sighted two or more times; no match was found between dolphins from our area and the ones from the Adriatic Dolphin Project.

The future objectives of this study are:
to clarify if there are movements of individual bottlenose dolphins between the Kornati and the Kvarneric areas;
to collect acoustic data on cetaceans;
to verify whether the intense Summer nautical traffic in the channel inside the Kornati National Park negatively affects bottlenose dolphin distribution; to create a GIS database, interfaced with the Adriatic Dolphin Project.

ACKNOWLEDGEMENTS We are grateful to Marta Azzolin for her precious assistance in the preparation of Kornati Dolphin Project. Special thanks to Blue World and Adriatic Dolphin Project for their continuous help to Kornati Dolphin Project, and to Croatian Environment Ministry and Kornati National Park, especially conservation manager Vladislav Mihelcic, which made the Kornati Dolphin Project possible. Finally, we thank all the people who benevolently participated in the surveys.

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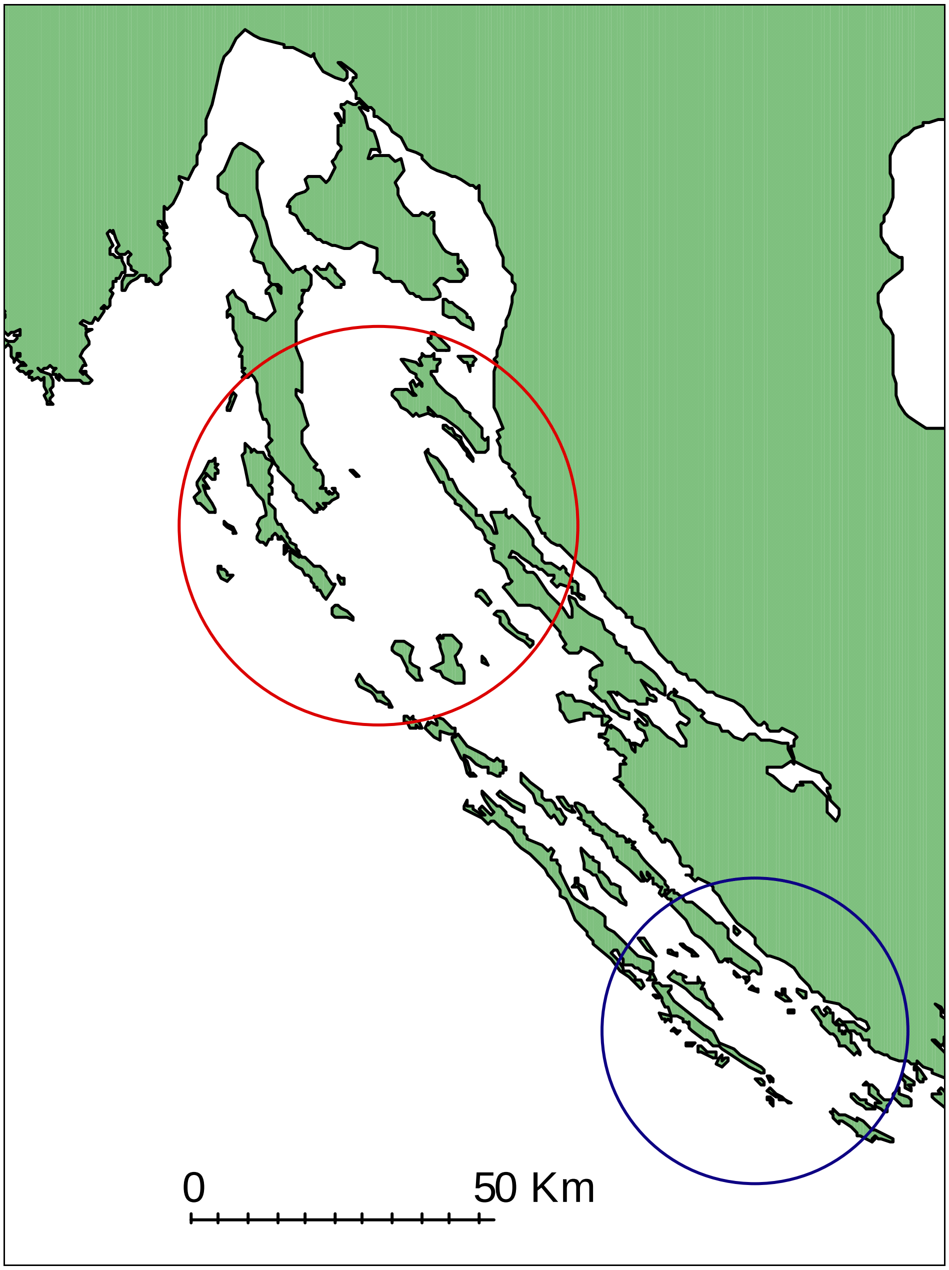

Fig. 1. ADP study range (red) and KDP study range (blue)

Table 1. Results of the surveys

Number of day of surveys	Effort (Km)	Sightings	Photo-id dolphins	Encounter rate (no./km)	Relative density (dolph./km)
17	528,56	6	14	0.01	0.03

Fig. 2. Dolphins photo-ID

ISLAND IN THE STREAM: MARINE MAMMALS FORAGE IN AN ISLAND WAKE IN THE BAY OF FUNDY, NB, CANADA

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Marine mammals and other upper trophic level predators often associate with fine-scale tidally-induced oceanographic features, presumably because these features facilitate foraging. Grand Manan Island, in the Bay of Fundy, NB Canada, functions as a large physical obstruction to the flow of strong tidal currents and produces a complex system of upwellings and eddies at its northern tip during flood tides. During 1999 and 2000 we documented a significant increase in the abundance of harbour porpoises (Phocoena phocoena) and finback whales (Balaenoptera physalus) in the vicinity of this feature during flood tides. In 2001 and 2002 we conducted oceanographic surveys to study the physical processes that force this system. Using a combination of Eulerian and Lagrangian oceanographic observations, and RADARSAT remote sensing imagery, we confirmed that this physical system functions as an island wake. During flood tides, water flowing rapidly (over 2m s-1) past the northwest side of the island separates from the boundary layer at it's northern tip. This predictable flow separation produces a relatively large anti-cyclonic eddy, and associated smaller eddies and upwellings, along a sharply delineated velocity front downstream in the tidal flow. The large eddy forms adjacent to the island approximately 1 hour into the flood tide and then moves slowly offshore to be shed by the system at high tide. The velocity front extends throughout the water column and is approximately 8-10m wide, where currents change from a rapid eastward flow (north of the separation) to a relatively quiescent northwest flow south of the separation zone. We hypothesize that this predictable island wake system physically aggregates zooplankton through a complex pattern of secondary flow, which attract large numbers of herring (Clupea harengus), mackerel (Scomber scombrus) and other fish. The regular occurrence of this feature provides a predictable aggregation of food for marine mammal and seabird predators.

SIGHTINGS OF CETACEANS FROM A FERRY TRANSITING BETWEEN OBAN AND BARRA, SCOTLAND, SUMMER 2002

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The aim of the study was to identify the main species of cetacean inhabiting the waters between Oban and Barra, on the west coast of Scotland and correlate their occurrence and distribution to oceanographic variables and time of year. A Caledonian MacBrayne passenger ferry was used as a platform of opportunity to conduct surveys once a week between July and September 2002. The route covered shallow, enclosed coastal waters between mainland Scotland and the Isle of Mull, as well as the deep, open waters of the Sea of Hebrides. Over the summer, 89 groups of cetaceans were sighted. Sightings of all species were most common in August. Three species were identified: Harbour porpoises (*Phocoena phocoena*), common dolphins (*Delphinus delphis*) and minke whales (*Balaenoptera acutorostrata*). Harbour porpoise were most commonly found in the more sheltered waters of the Sound of Mull, and generally occurred in small groups of one or two individuals. Common dolphins were most commonly sighted in the deep, open waters of the Sea of Hebrides, although they were occasionally sighted in more shallow, enclosed channels such as the Sound of Mull. Group sizes of common dolphins (five to seven animals) were larger than other species sighted. Minke whales were only sighted in open waters of the Sea of Hebrides and were most commonly seen as single individuals and sometimes in pairs.

DAY AND NIGHT-TIME DIVING BEHAVIOUR OF FIN WHALES IN THE WESTERN LIGURIAN SEA

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Mediterranean fin whales concentrate in the Ligurian Sea during the summer to feed on large swarms of the euphausiid Meganyctiphanes norvegica, known as one of their principal prey in the Northern Hemisphere. The diving behaviour of 15 whales was studied, within a long-term study on the habitat use of this species, between 1999-2002 by using suction-cup attached tags, equipped with velocity-time-depth-recorders. Here we report the results of three successful taggings, during which the tag remained on the whales for a minimum of 6 hours (mean time = 8h 9min), and during which the whales reached depths of at least 468 m (estimated maximum depth 565 m). The diving behaviour performed by the 3 tagged individuals differed considerably. Two whales started to perform deep dives (>400 m) after 5 PM, in coincidence with the presumed upward migration of the deep scattering layer, while until 5 PM they remained close to the surface performing 45 dives shallower than 100 m (mean depth = 27.8 m, SD = 19.0). The third whale was tagged at 11:50 AM and till 6 PM performed a series of 19 deep dives (mean depth = 449.0 m, SD = 22.5). One of the deployed tags remained on the whale till 10 PM, and showed a steady decrease in diving depth, dropping from 400 m at 7:40 PM to less than 50 m at 9:50 PM. The data presented here suggest that Mediterranean fin whales are unlikely to dive deeper than 600 m. The different depths reached by the tagged whales at the same time of day in different days, indicate that prey distribution throughout the water column changes from time to time. Moreover, the diving behaviour performed by the third whale suggests that fin whales in the Ligurian Sea follow the deep scattering layer's diel upward migration.

SPERM WHALE DISTRIBUTION AND HABITAT USE IN THE WESTERN LIGURIAN SEA: FIRST INSIGHT

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Sperm whales (*Physeter macrocephalus*) are known to occur in the western part of the Ligurian Sea and particularly along the continental slope of the shelf-edge area. However, very little is known about their distribution. A total of 54 sperm whale sighting data, collected during 11 summer shipboard surveys (1990-2000), were analyzed, using a Geographic Information System, to investigate habitat use relative to bathymetric and oceanographic features. Position and group size data were recorded for each sighting, whereas photoID, faecal and skin samples were collected when possible. Surveys covered a squared area of approximately 24,000 km2, situated between Saint Raphael, CapoMele and Saint Florent. Effort was recorded by means of the LOGGER data logging system (IFAW). The study area was subdivided into three homogeneous zones considering both the effort amount and the bathymetry, encompassing the Ligurian continental slope, the pelagic realm and the Corsican continental slope areas. Sperm whales were found mostly (53,7% of all sightings) along the edge of the Ligurian continental slope, although some encounters (40,3% of all sightings) occurred in deeper waters (>2,000 m) or close to the Corsican shelf-edge. Sperm whale occurrence (number of sightings weighted on effort) was significantly higher in the Ligurian slope area with respect to the pelagic area (Mann-Whitney U: 115, $p<0.05$; N = 44). Evidence of a differential habitat use was also found on a month-by-month basis (Kruskal-Wallis ANOVA month c2: 13.83, $p<0.01$; N = 54). No evidence was found of a variation in sperm whale yearly occurrence (Kruskal-Wallis ANOVA year c2: 4.05, $p>0.39$; N = 41). Moreover, a total of 25 individuals were photo-identified, with some re-sightings occurring along the Ligurian continental slope.

DIFFERENTIAL DIGESTION RATES OF DOLPHIN PREY: OBSERVATIONAL AND EXPERIMENTAL BASES FOR AN IMPROVED DIETARY ANALYSIS PROCEDURE

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A major issue of trophic relationship modelling is to obtain representative diet compositions, commonly described from stomach content analysis. However, some remains of digested prey can accumulate in marine mammal stomachs leading to biased results. It has been proposed that analysing the most recent component of stomach contents would produce a less biased picture. The aim of our study was to assess the biases due to differential digestion, and define a digestion scale to distinguish fresh parts from the digested fraction. We first examined dietary data from common dolphin stomach contents (N=92), and compared the reconstituted diets from fresh versus digested fractions. Relative abundance and prey length distributions were significantly different (c^2, $p<0.05$) between accumulated and fresh fractions. To compare digestion rates of different prey types, we took prey of different lengths from nine species and immersed them in a 1/100 pepsin solution at 37 C and pH2, for 12h. Every hour, weights and digestive states were recorded. The digestion rate of each species was quantified using the time at which a prey had lost 50% and 100% of its original body mass. On this basis, four groups of species were defined: small lean fish, other fish, squids and crustaceans, with half digestion times of 3-5, 4-9, 3-5 and 9-10 hours and full digestion times of 7-10, ³12, >7 and >12 hours, respectively. In summary, reconstituted diet appeared to be strongly influenced by the digestive state of the remains considered in the analysis. Less biased results were obtained from the fresher parts. Using the digestion scales for each prey type, criteria are proposed for segregating prey remains based upon the period of time spent in the stomach. These results are incorporated into an improved procedure of stomach content analysis.

WHAT MAKES WALTON SEALS RED?

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INTRODUCTION During studies to investigate the ecology of a small but slowly increasing (Fig. 1) sized breeding colony of harbour seals, (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) found in the Walton backwaters located on the Essex coastline in England, observations show a high incidence of red coloured pelage, see Fig. 2.

Pups of both species are born the normal colour but; from 28 days begin to develop the red / russet colouration which is well defined in adults, although the red colouration is lost during the annual moult.

The russet colour is not apparent in seals immediately following moult and takes several weeks to develop. (pers. obs., 2001) Although it is not uncommon to find harbour seals with some red colouring. (Allen *et al.,* 1993), report 4-32% of the total count had red hair from the head down to the shoulders in San Francisco Bay, California.

Other species, notably bearded *(Erignathus barbatus)* and ringed seals *(Phoca hispeda)* with similar colouration have been reported in Svalbard, Norway (Lydersen *et al.,* 2001). The seals of both species found in Walton are found to have pelages coloured in varying shades of red/russet. The extent of the occurrence ranges from 85-100% of the population.(pers. obs., 2002).

The red pelaged grey seals are believed to be unique to the Walton backwaters with no other documented cases reported or cited in scientific literature.

The study area is located within an embayment on the Essex coast, known collectively as the Walton backwaters, comprising of Hamford water, Walton channel, The twizzle and many islands, see Fig.3.

The whole area is salt marsh encompassing 40 km^2 (Boorman and Ranwell, 1977) from N 51 52 00, E 01 12 00 to N 51 54 00, E 01 12 80.

Hamford water is classified as a mesotidal embayment estuary having a tidal range of between two and four metres, this means that the estuary is dominated by strong tidal currents rather than freshwater influence. There are only four mesotidal embayment estuaries in the United Kingdom (Davidson *et al*., 1991). This area is within SSSI, SAC, NNR, SPA and ramsar protection.

METHOD Hair samples from 30 'red' pelaged seals of both species were collected between July 2001 and October 2002 from the haul out sites during the annual moult. The samples were air dried and kept frozen until required for use. Ten samples of 'normal' coloured pelage were collected from dead/sick seals during the PDV outbreak in 2002 and supplied by The Sealife Centre, Hunstanton, Norfolk, England from animals rescued during the same period. Soil samples were also taken from the study area haulout sites.

The hair was observed through a photomicroscope as seen in Fig. 4.

The samples were coated with 400 nanometers of gold (Au) in an Emitech sputter coater, then analysed in a Scanning electron microscope as shown in Fig. 5.

Chemical analysis was also carried out to determine the levels of contaminant using the following method:

The soil and fur samples were extracted, using ambient temperature 0.5N nitric acid (HNO_3), by shaking for 10 to 15 minutes on a mechanical flask shaker (Lydersen *et al*., 2001). The leachate was filtered and analysed for iron by ICP-AES.

RESULTS Levels of iron measured in the haulout site soil were between 1674-1953µg/g dry weight.

The average (+/- SE) levels of Fe in the hair taken from harbour seals in the study area with red pelage were 3270 µg/g, compared to 605 µg/g in the normal coloured hair (Fig. 6).

Further analysis shows that the iron precipitates are of both, Ferric (FeIII) oxides and Ferrous (FeII) oxides.

CONCLUSIONS We have identified the staining compounds responsible for the colouring using chemical and x-ray elemental analysis.

Scanning electron microscopy (SEM) confirms the iron oxide contamination is adsorbed onto the hair surface. The levels of iron in the leachate from both the soil at the haulout and the red hair samples are notably higher than the normal coloured hair, indicating initially that the environmental contamination is adsorbed from the soil at the haulout site.

DISCUSSION The colouration is an aid to both the identification of individual seals and to studying population movements along the Essex coast, which is being undertaken as part of a PhD programme at APU, Cambridge.

The seal populations diet preferences and foraging habits are being studied in the area of the Walton Backwaters, unusual feeding, breeding and other social behaviours have not been observed amongst the Walton Backwater seals, suggesting that the russet pelage colour is not detrimental to either species.

Chemical analysis of the shellfish found in the scats will undergo chemical analysis to establish if the levels of ferrous contaminant are amplified in the animals of this region in comparison to other U.K. haulout sites.

ACKNOWLEDGEMENTS We thank Leon Woodrow, Nature Warden for Tendring District Council for his invaluable local knowledge. Ian Black of English Nature for the permission to sink a mooring in the SSSI area enabling the mooring of a boat used during the study. Bob Thomas, Darren Bond and Malcolm Braithwaite of Exchem Organics for access to their foreshore and the haulout sites on their land. Levington Laboratories for their contributions to the analysis of the hair and soil samples.

We also thank the SeaLife Centre, Hunstanton, Norfolk for supplying control samples, and finally Clare Rutson-Edwards for being so understanding and letting Andy spend so much time away from home collecting data.

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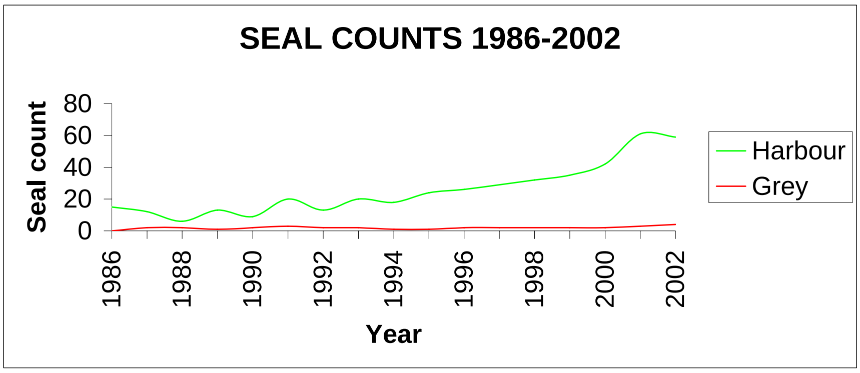

Fig. 1. Increasing seal numbers in the Walton Backwaters

'Walton' harbour seal 'Walton' grey seal

Fig. 2. Waltons "Red" seals

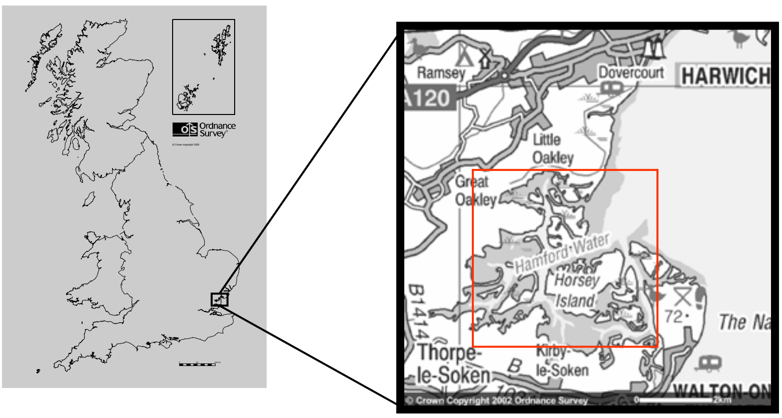

Fig. 3. The Study Area

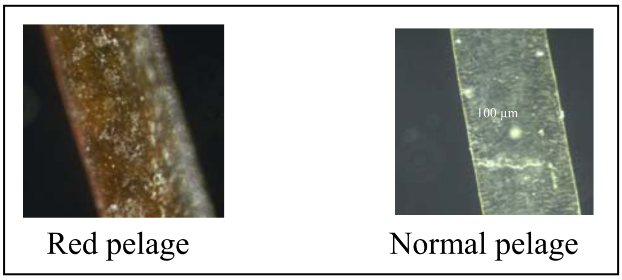

Fig. 4. Photomicrographs of the Red and normal hair

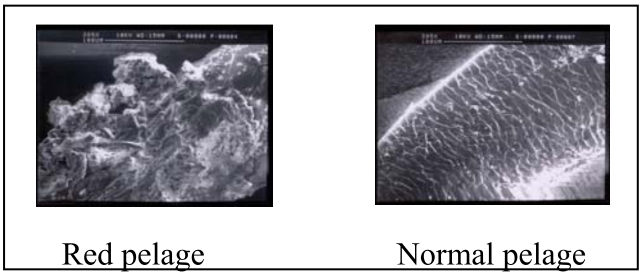

Fig. 5. Scanning electron microscope image of red and normal hair

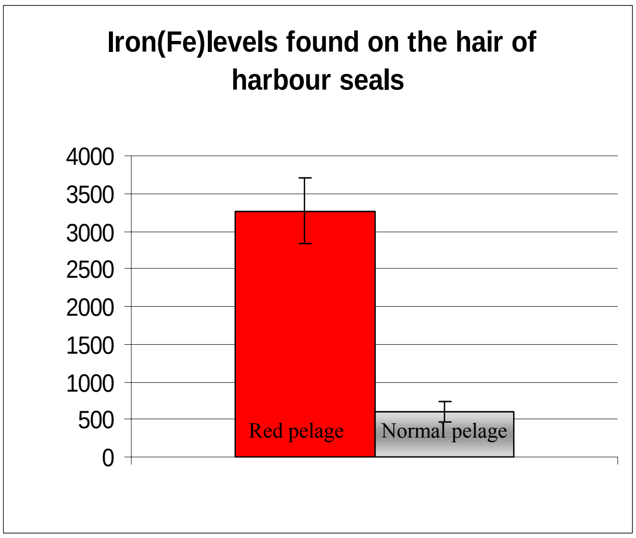

Fig. 6. Levels of Iron adsorbed onto red and normal hair

TRACK OF FIN WHALE IN THE WATERS OF MALAGA, ANDALUSIA, SOUTHERN SPAIN

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The Alboran Sea is the transition chamber between the Mediterranean and the Atlantic ocean. An important area for resident and non resident species. The coast of Málaga is one of the most productive areas of the Alboran sea due to the formed upwellings generated by the special hydrodynamic characteristics influenced by the Atlantic ocean. During the campaigns in this area along the summers of 2000 and 2001, there were done six tracking of eight Fin whales (Balaenoptera physalus) of over sixteen hours on the research vessel of the Cethus Project. During those 16 hours it had been taken different data as read: time, position, angle, distance from the boat, photo – identification, etc. It had been done in two consecutive days one of the longest tracking on the same animal of 5 and 9 hours reflected in a digital map related with a layer of oceanographic parameters.

DIFFERENCES IN AREA USE AND MOVEMENTS OF NORWEGIAN KILLER WHALES IN NOVEMBER – JANUARY

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Killer whales (*Orcinus orca*) have been photoidentified in October- January in the wintering grounds of Norwegian spring-spawning herring (*Clupea harengus*) since 1989. The identification data indicates differences in the occurrence pattern of individuals but due to limited possibilities for surveying the whole wintering grounds this has not been investigated in more detail. To study the range and movement pattern of killer whales, seven whales were satellite tagged in November-December 2000 – 2001. 140 good quality locations were received from six whales in November – January. The Kernel home ranges (95 % isopleth) of the individuals varied from 3566 km2 to 288 284 km2 in November-January, the largest ranges far exceeding the previously known range for these whales during this season (13 583 km2, minimum convex polygon). The main factor affecting the range of five of the whales were "scouting trips" away from the wintering grounds. There were also substantial differences in the area use of the individuals within the herring wintering grounds. Two whales spent 90 % of their time within the core photoidentification study area, one whale spent approximately half of her time in this area and three whales spent most of their time away from the core photoidentification study area. These differences were not related to herring distribution and the long-term photoidentification data indicates they represent persistent differences in the habitat use of these individuals. The average minimum distances travelled by whales varied from 7.18 km/day to 45.17 km/day. The shortest average distances were travelled by individuals spending most of their time in the core study area. This study is the first to use satellite telemetry in studying killer whales and the results show that this technique is a powerful tool in understanding range and movement pattern of killer whales, especially in combination with a long-term photoidentification data set.

MAY CHANGES IN THE DIET OF STRIPED DOLPHINS (*STENELLA COERULEOALBA*) FROM THE BAY OF BISCAY REFLECT TRENDS FROM GROUNDFISH SURVEYS?

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INTRODUCTION The diet of top predators varies according to food availability both in quantity and species composition. Marine resources have changed due to numerous factors such as fishing or climatic variations. We hypothesise the diet of marine mammals reflects long term changes in marine resources. To test this, we compared stomach contents from striped dolphins stranded on the coast of the Bay of Biscay during the early 1980's and between 1999 and 2002. Do observed variations in the diet of striped dolphins correlate with trends in species abundance indices provided by Ifremer groundfish surveys?

MATERIALS AND METHODS **Stomach contents** In this study, 23 stomachs of striped dolphins stranded on the Atlantic French coast from May 1999 to July 2002 were analysed. Fig. 1 shows the location of striped dolphins strandings. Each sample, after opening, were flushed through a 0,2 mm mesh sieve. The undigested hard parts (fish otoliths and bones, cephalopod beaks and crustacean cephalotorax) were recovered and identified to the lowest taxonomic level using published guides (Clarke, 1986; Härkönen, 1986) and our reference collection. Prey body length and body mass were reconstructed using allometric relationship on these hard parts (Clarke, 1986; Härkönen, 1986; Spitz, unpublished). Thus, the diet of striped dolphins in the neretic Bay of Biscay is described by standard indices: occurrence, number, mass and body size for each prey. Dietary data for 80's are from Desportes, 1985 who analysed a sampling of about twenty stomachs from strandings on the Atlantic French coast too.

Ifremer groundfish survey Data were collected during the thirteen groundfish surveys carried out by Ifremer in the Bay of Biscay from October to December since 1987. The survey area was located between 48°30' N and the northern edge of Gouf of Cape Breton in the south (Fig. 1). The sampling scheme was stratified according to latitude and depth. A 36/47 GOV trawl was used with a 20 mm mesh codend liner. The haul duration was 30 minutes with a towing speed of 4 knots. Fishing was mainly limited to daylight hours. Catch weights and catch numbers were recorded for all species, and all finfish and a selection of shellfish were measured. About 70 to 130 hauls per survey provided data on the occurrence and abundance of the two selected species. Abundance was given by the mean number of individuals per km^2, and the occurrence of each species was expressed as the relative number (in %) of positive hauls in a survey.

RESULTS Table 1 lists the identified species and their descriptive indices ; the diet of striped dolphins is principally composed with demersal species. The major part of species is present in the two studies ; only few species, which don't represent a significant part of the dolphins diet, were founded in only one study. The most striking result was the opposite temporal trend of two fish species: silvery cod (*Gadiculus argenteus*) and sand smelt (*Atherina presbyter*). The first species was not found in stomach contents from 1999 to 2002, whereas it was the second most abundant species in the early 1980's (28,2% by number and 13,5% by mass). The second species was the second most prominent fish in the diet of striped dolphins between 1999 and 2002, representing 19,4% by number and 13,5% by mass, compared with 8,2% and 4,4% respectively in the 1980's. So, we have focused on these two species for the comparison with the groundfish survey. Thus, the abundance of silvery cod decreased from 1992 and has remained at a very low level since 1997 (Fig. 2). Its spatial distribution reduced during the same period (Fig. 3). By contrast, the abundance of sand smelt (Fig. 2) recently increased, notably in 1995, 1998 and 1999, with a three-fold increase in its occurrence in groundfish surveys trawls since 1994 (Fig. 3).

CONCLUSIONS The striped dolphins does not usually stay in neretic habitat. However, it sometimes wanders close to the coast where it feeds on demersal species. Appreciable shifts in the relative importance of silvery cod and sand smelt in the diet of this dolphin correlate with their abundance trends from groundfish surveys. These two species occur in quite distinct habitats; sand smelt is a very coastal species whereas silvery cod is associated with deeper part of the continental shelf and slope. The coexistence of inshore and mesopelagic species in stomach contents indicates that striped dolphins are able to successively exploit these different resources. Indeed, both habitats are within daily swimming distance for a pelagic delphinid.

ACKNOWLEDGEMENTS The CRMM would like to thank the Ministère de l'Ecologie et du Développement Durable and the Communauté D'Agglomération de La Rochelle for their financial support. Many thanks to all participants of the French national stranding network for their everyday help on the field and the crew of the oceanographic vessel "Thalassa".

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Table 1. Prey found in the stomach of striped dolphins

	Our study, 1999 - 2002						Desportes, 1985	
	Occurrence	**Abundance**		**Length**	**Mass**		**Mass**	**Abundance**
	%	N	%	Mean	Mean	%	%	%
FISHES								
Blue Whiting / *Micromesistius poutassou*	23,5	156	**18,5**	153,3	20,5	**28,9**	**28,4**	**29,1**
Silverside */ Atherina presbyter*	23,5	164	**19,4**	84,9	9,1	**13,5**	**4,4**	**8,2**
Whiting / *Merlangius merlangus*	5,9	15	**1,8**	161,0	33,2	**4,5**	**1,3**	**0,8**
Bib / *Trisopterus spp*	29,4	91	**10,8**	67,4	3,9	**3,2**	**6,7**	**9,5**
Hake / *Merluccius merluccius*	5,9	5	**0,6**	202,4	45,5	**2,1**	**1,2**	**1,0**
Other Gadidae	17,6	1	**0,1**	-	-	**1,3**	**0,0**	**0,0**
Goby / Gobiidae	23,5	269	**31,9**	37,1	0,3	**0,9**	**0,0**	**0,0**
Lanternfish / Myctophidae	9,5	19	**2,3**	55,0	2,0	**0,5**	**0,0**	**0,0**
Silvery pout / *Gadiculus argenteus*	0,0	0	**0,0**	-	-	**0,0**	**13,5**	**28,2**
Pilchard / *Sardina pilchardus*	0,0	0,0	**0,0**	-	-	**0,0**	**6,3**	**2,3**
Mullet / Mugilidae	0,0	0,0	**0,0**	-	-	**0,0**	**5,3**	**6,1**
Horse-mackerel /*Trachurus spp*	0,0	0,0	**0,0**	-	-	**0,0**	**3,1**	**2,6**
Others Fishes	-	21	**2,5**	-	-	**0,3**	**2,0**	**5,0**
CEPHALOPODS								
Flying squid / Ommastephidae	11,8	6	**0,7**	159,3	347,0	**18,8**	**7,8**	**1,4**
Gonate squid / *Gonatus steenstrupi*	5,9	15	**1,8**	172,3	153,0	**20,7**	**5,1**	**0,5**
Inshore squid / *Loligo spp*	11,8	4	**0,5**	166,8	118,0	**4,3**	**11,2**	**1,7**
Others cephalopods	-	44	**5,2**	-	-	**-**	**3,7**	**3,5**
CRUSTACEANS								
Shrimp	29,4	5	**0,6**	45,0	2,0	**0,1**	**0,0**	**0,0**

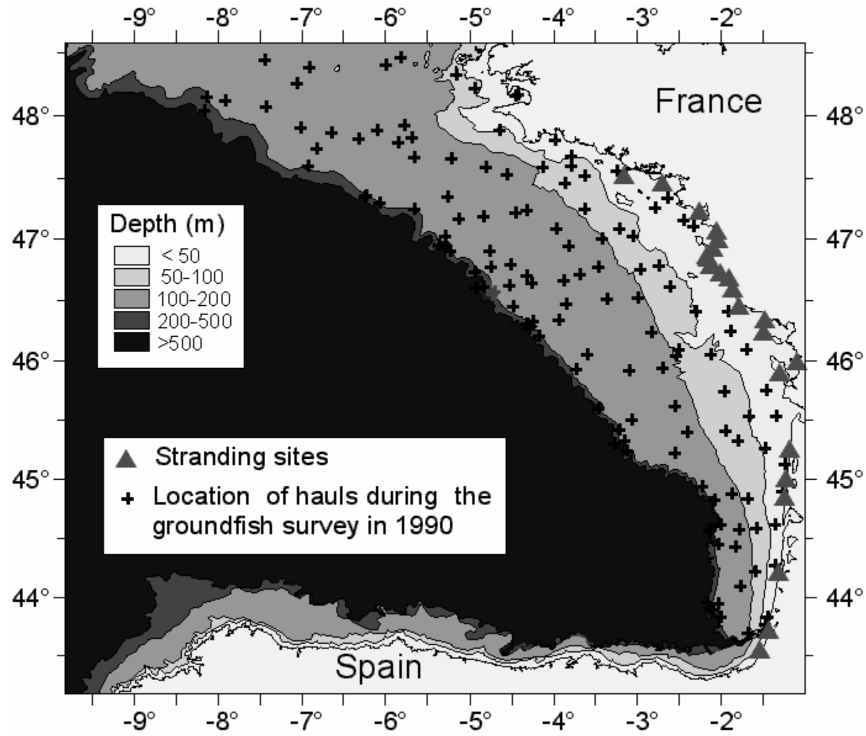

Fig. 1. Stranding sites and trawling stations

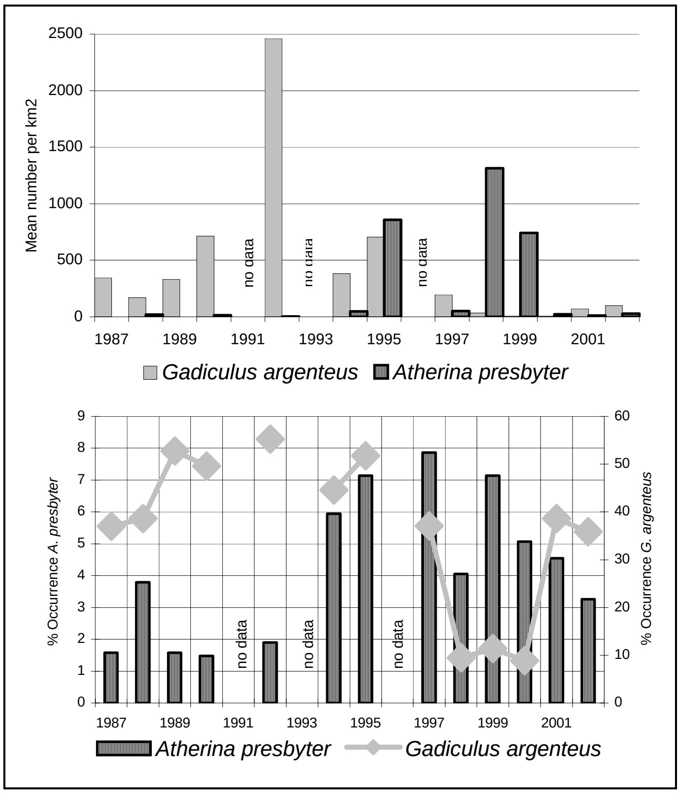

Fig. 2. Yearly changes in the abundance and occurrence of silvery cod and sand smelt for the period 1987-2002

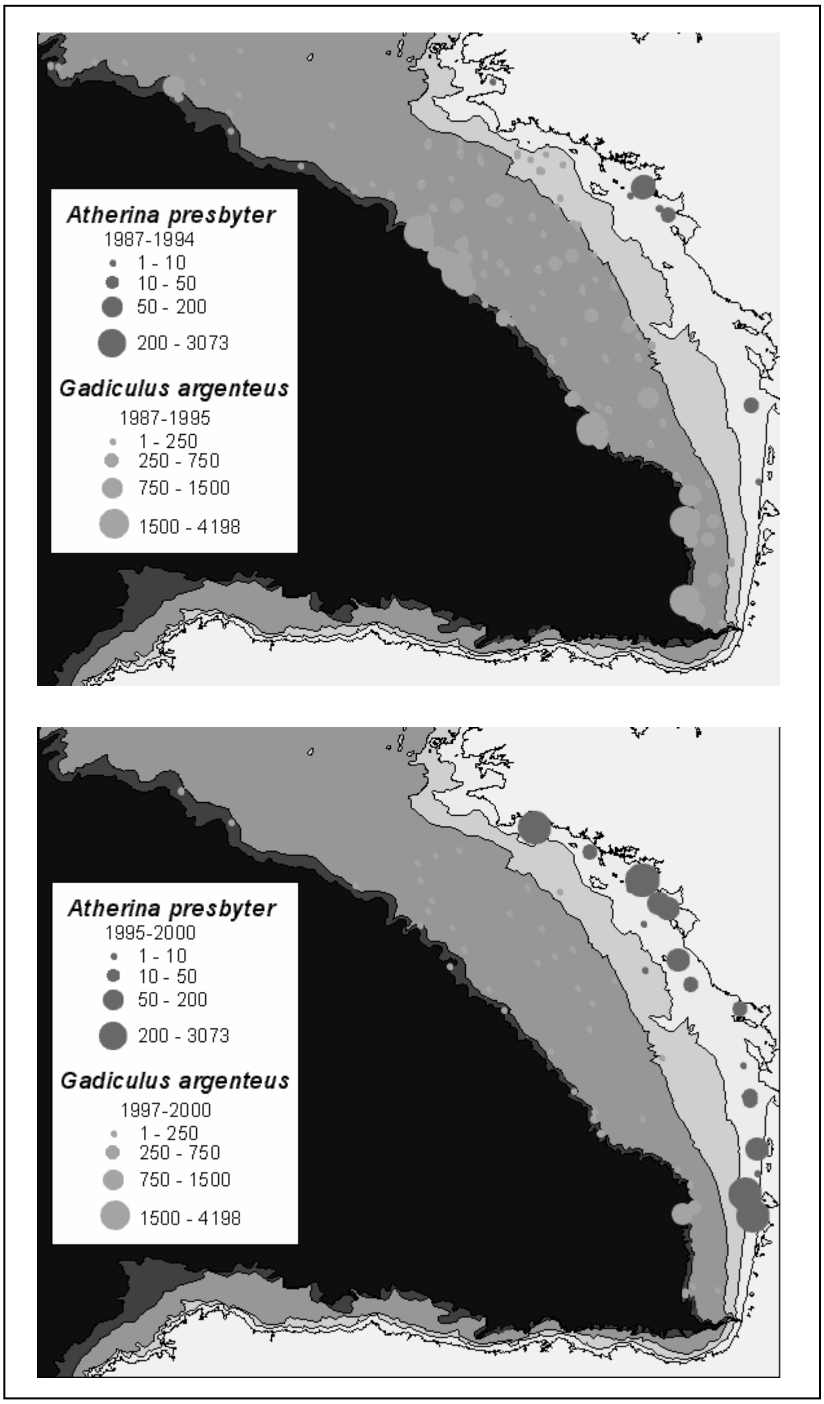

Fig. 3. Changes in the distribution of silvery cod and sand smelt between 1987-95 and 1995-2000

A CETACEAN SURVEY IN NORTH ADRIATIC SEA: PRELIMINARY RESULTS

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INTRODUCTION The area between Marina di Ravenna and Cesenatico (North Adriatic Sea, Italy) is a marine region highly exposed to anthropogenic activity.

The presence of several gas drilling platforms may pose some threats to its ecosystem, including an increased ship traffic as well as chemical and floating pollution. On the other side, the submerged parts of these constructions offer a valid substrate for the settlement of many marine organisms and provide shelters and nourishment for fishes. As for cetacean species, the presence of dolphins in the zone has occasionally been reported by local fishermen.

In addition, the study area hold a particular importance for the presence of the "Paguro" wreck, a platform sank in 1965 and here located. In 1995 the Italian Government set up this site as a biological reserve since it represents an interesting example of an artificial reef characterised by high biodiversity and complex ecological community (Ponti *et al.*, 1998).

To evaluate the cetaceans distribution in the area and address the potential impact of the human activities on their population, in 2001 Oceanomare Association started a first survey primarily focused on bottlenose dolphin (*Tursiops truncatus*).

MATERIALS AND METHODS This study covered an area of approximately 280 square miles situated in the northern Adriatic sea between Marina di Ravenna and Cesenatico. The maximum distance from the coast was 17 miles and the mean depth was about 20 m. with a maximum of 30 m. The surface water temperature fluctuated between 15 and 30 °C, depending on the season (summer and fall).

Observations were performed from June to October 2001 and 2002 twice a week depending on weather conditions. Sightings of bottlenose dolphins were recorded using local sailing vessels and motorboats that formerly accepted to take part into the project. Animals were photographed and subsequently identified using standard photo-identification techniques by means of a 35mm camera equipped with 35-80 mm lenses. Details of location and environmental conditions were also recorded.

RESULTS *Tursiops truncatus* was the only cetacean species observed in the area during the study period. Individuals were reported within the zone on 36 occasions (n=19 in 2001; n=17 in 2002) (Fig. 1). About 400 animals were encountered during the surveys (n=257 in 2001; n=142 in 2002).

Bottlenose dolphins were constantly found nearby gas drilling platforms in shallow waters at an average depth of 22 m. (s.d.=5.6 m.). All sightings occurred between 2.7 and 15 miles from the nearer coast (mean value=8.5 miles; s.d.=3.0 miles).

During summer 2001 a total number of 19 individuals were photo-identified. The uncomfortable conditions on board did not allowed a better photo-identification work, and no animal were added to the catalogue in 2002.

A significant difference between 2001 and 2002 group size was found (Fig. 2), with a clear decrease of aggregation in the second year of the study (2001: mean group size=14,2; s.d.= 11,8; 2002: mean group size=8,3; s.d.=9,4).

CONCLUSIONS The present census allowed to quantify the bottlenose dolphin's presence and distribution in the study area, suggesting that the ecosystems created around the gas drilling platforms is suitable for invertebrates and fish-biomass as well as for marine mammals. Bottlenose dolphins could be possibly attracted by the favourable environment in the proximity of the platforms, consisting of abundant and clumped living species as potential food resources for individuals. In addition, the area nearby the platforms is relatively calm in terms of boat traffic and fishing activities, allowing dolphins to remain in a safer environment. In fact, both transit and fishing operations are forbidden within five hundred metres around each artificial construction. According to Würsig and Richardson (2002), the droning of drilling platforms appears to be ignored by animals due to habituation or sensory adaptation.

In the summer 2002, the study area was affected by a relevant presence of mucilage filaments. This phenomenon could have played an important role both in dolphins distribution and group size. However, this hypothesis has to be confirmed through a longitudinal integration with other ecological data and more observation on this topic are needed.

The survey will continue in the 2003 summer, in order to obtain a better knowledge about a) the ecology and behaviour of bottlenose dolphins, and b) the interactions between animals and drilling operations.

ACKNOWLEDGMENTS We thank Comune and Provincia di Ravenna, Cirsa, Daphne-Arpa, Farvest, Paguro Association, and Rimini Delphinarium for their support. Special thanks to all the vessels who took part in the research, particularly to "Lady Anana" (Faustolo Rambelli) and "Lucifero" (Roberto Ciappini).

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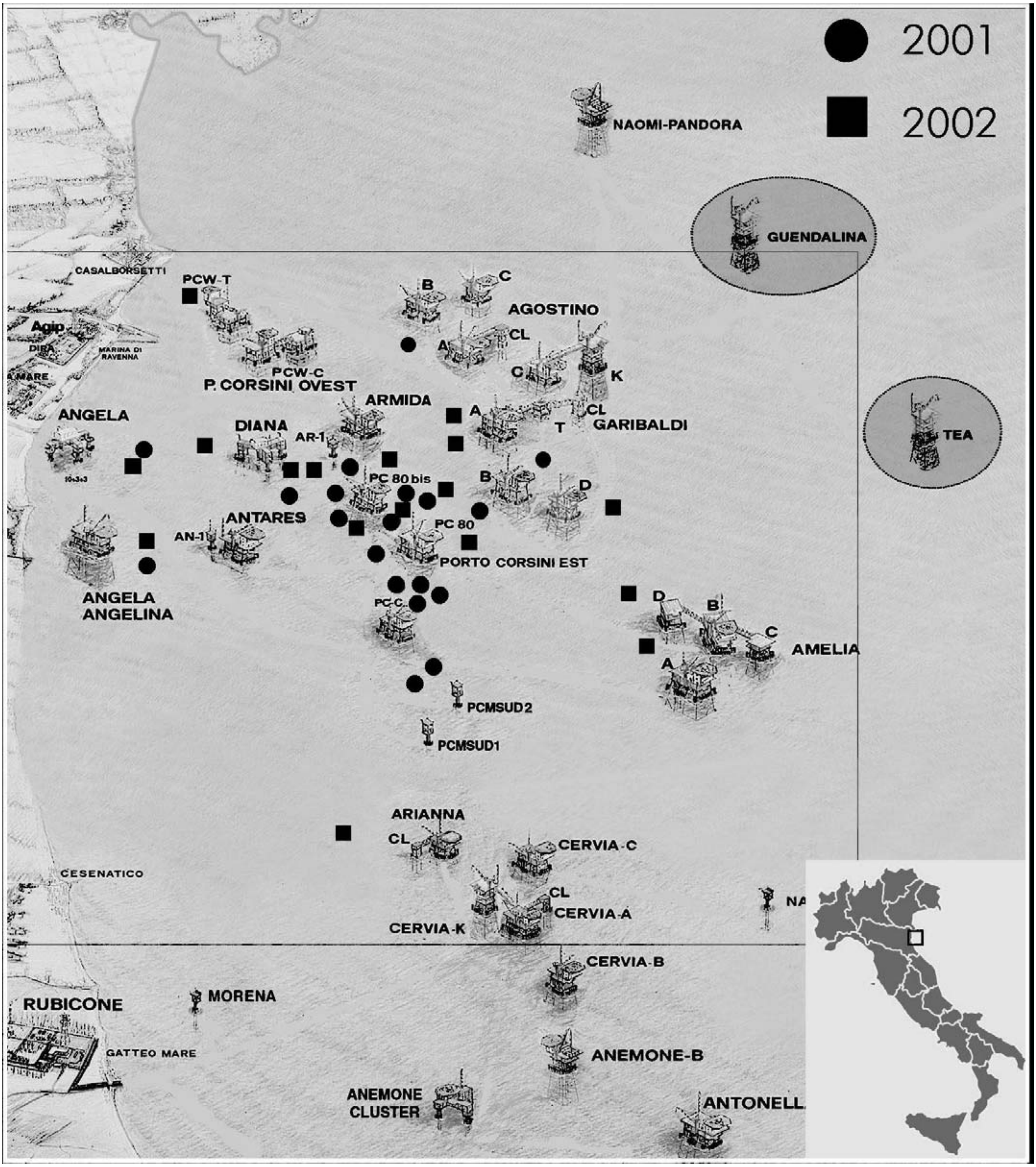

Fig. 1. The sightings in the study area

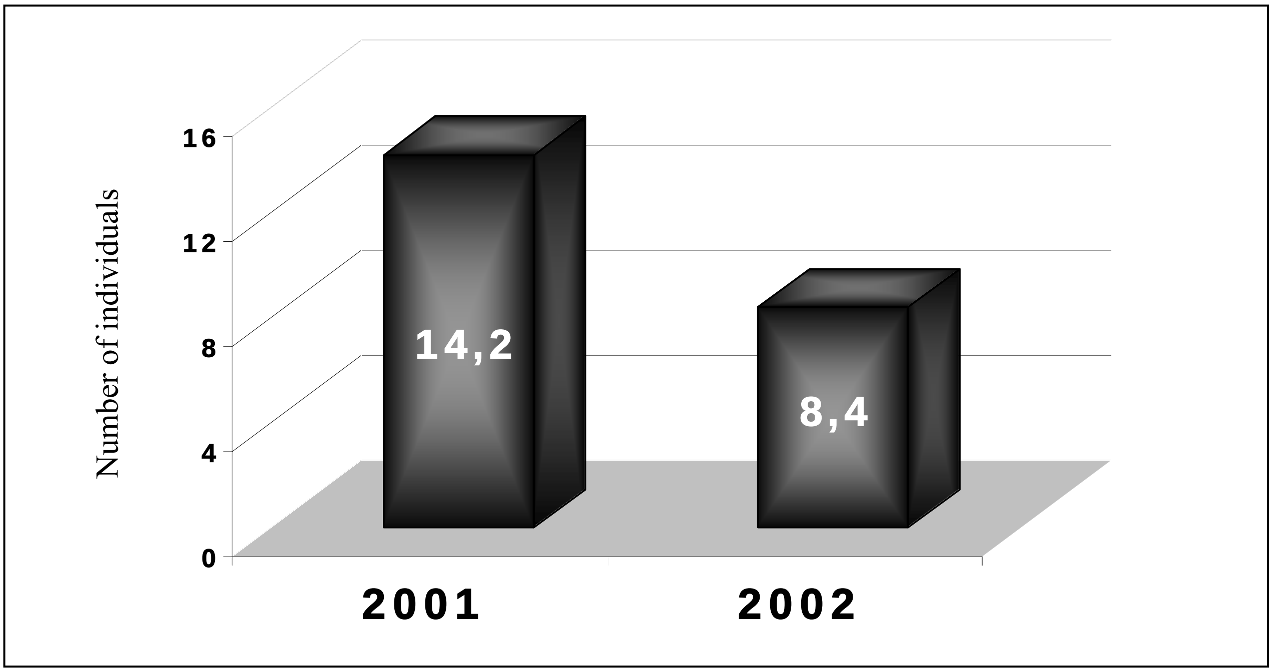

Fig. 2. Mean group size in 2001 and 2002

FEEDING

RELATION BETWEEN STRIPED DOLPHIN DIET ITEMS AND THEIR OWN PREY ALONG THE FRENCH MEDITERRANEAN CONTINENTAL COASTS

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INTRODUCTION Striped dolphins are known to feed on fishes, cephalopods and crustaceans, but each kind of prey plays a variable role in the diet, both at a spatial and temporal scales. This study compares the results of striped dolphins stomachs contents from two regions along the french mediterranean continental coast: the gulf of lions and the provençal basin. These areas are geographically close but topographically, hydrologically and biologically different. This study is a first attempt to describe the relation between striped dolphin preferred preys and their own main food items.

MATERIALS AND METHODS The stomach contents of 14 striped dolphins stranded in autumn and winter along the French coasts (6 from the Gulf of Lions and 8 from the Provençal basin) during the period 1993-2000 were provided by the Groupe d'Etudes des Cétacés de Mediterranée, the La Rochelle Natural History Museum, Mr Tardy, and by the team of Ecole Pratique des Hautes Etudes of Montpellier (France).

The total length of the dolphins ranged between 164 and 222 cm. 4 specimens were males, and 5 were females, the remaining 5 were not sexed.

When possible preys were identified to species and their number estimated by counting lower beaks for cephalopods, mandibles or cephalothorax for crustaceans, and otoliths or dental bones for bony fishes. For otoliths and dental bones it was assumed that the number of preys was equal to half the number of the remains paired by size. The length and weight of cephalopods were computed by measuring the rostral length (LRL) or the hood length (LHL) of the lower beaks, according to the regression equations reported by Clarke (1986) and Würtz *et al*. (1992). Bony fish total length and weight were estimated by the relationships of otolith length given by Fitch (1968) and Härkönen (1986) and by comparison with the specimens in our collections.

The role of each food item in the diet was assessed by the Index of Relative Importance (IRI) according to Hyslop (1980): IRI = (N% + W%) * F%, where N% is the percentage number of a prey in relation to the total prey number, W% is its weight expressed as percentage of the aggregate prey weight and F% (occurrence) is the percentage number of stomachs in which a food item occurs.

RESULTS The estimated number, weight and occurrence of cephalopods, crustaceans and fishes found in 14 striped dolphin stomachs are reported in Table 1 (Gulf of Lions) and Table 2 (Provençal basin). In total, 34 food items were identified to species or genus and 585 specimens counted, corresponding to about 29 kg total weight.

Cephalopods. In 6 stomachs (frequency of occurrence 100%) from the Gulf of Lions, 83 cephalopods lower beaks corresponding to 4.8 kg wet weight were present. 15 species belonging to 8 families were identified. Among these, Loliginidae, mostly Loligo vulgaris, represented 18 % of the total number and 34 % of the total weight of cephalopods. The largest specimen also belonged to this species; its estimated DML was 250 mm and its weight 303 g.

In the 8 stomachs (F 100%) from the Provençal basin, twelve species belonging to six families were detected. 87 cephalopods lower beaks were counted, corresponding to 9.4 kg. The most common family was Ommastrephidae, mainly *Todarodes sagittatus* represented by 15% of the total number and 54.8% of the total weight of cephalopods. The largest specimen, estimated at 380 mm DML and 1.26 kg in weight belonged to *T. sagittatus*.

The mantle length distributions of cephalopod preys are shown in Fig. 1A and Fig. 3A. As it can be seen, more than 90% of these preys measured less than 200 mm DML.

Bony fishes In 5 stomachs (F 83%) from the Gulf of Lions 98 bony fishes were identified, corresponding to 9.1 kg estimated weight. Seven species belonging to six families were identified. Merluccius merluccius was the most important fish, comprising 39.8 % by number and 96.2 % by weight of fishes eaten. The largest fish in the stomachs was a specimen of this species, estimated at 540 mm in length and 1.3 kg in weight.

In 4 stomachs (F 50%) from the Provençal basin 192 bony fishes corresponding to 5.3 kg weight were present. Eleven species belonging to seven families were identified. Among these, Merluccidae, mainly *Merluccius merluccius*, represented 38.5 % of the total number and 51.2 % of the total weight of bony fishes. The largest specimen also belonged to this species; its estimated total length was 360 mm and its weight 355.6 g.

The computed body lengths of all fishes are shown in Fig. 1B and 3B.

Crustaceans In the Gulf of Lions, only one specimen of the shrimps Phasipaea multidenta and Pasiphaea sivado were present in the stomach contents.

In the Provençal basin, the shrimp *Sergia robusta* was the main prey species in this group, with 68.3 % of 123 crustaceans specimens identified in the two stomachs (Fig. 3C).

Prey comparison The Index of Relative Importance is shown in the last column of Tables 1 and 2. In the Gulf of Lions, M. merluccius is the most important species in the striped dolphin diet (IRI=51.5), followed by L. vulgaris (IRI=12.3). The other preys shown a IRI less than 6.6. In the Provençal basin, the most important species is T. sagittatus (IRI=34.1), followed by M. merluccius (IRI=11.3). The other species show low IRI values from 0.2 % to 8.4%. Crustaceans can be considered an occasional food items by their low frequency of occurrence in the two areas.

DISCUSSION Of the 18 cephalopods species reported in this study, 13 (72%) correspond to negatively buoyant squids, having muscular bodies with high caloric values, and five (38%) to ammoniacal squids, having gelatinous bodies with low caloric contents. Muscular squids represent 36.6 % of the total number and 23.4 % of the total weight of specimens ingested in the Gulf of Lions, and 20 % and 58.5 % respectively in the Provençal basin. The autumn and winter high presence of muscular squids in the diet agrees with the results from data of the Ligurian Sea where striped dolphin feed mainly on bony fishes during the summer, and muscular cephalopods (*T. sagittatus*, and Onychoteuthidae) during autumn and winter (Würtz and Marrale, 1993; Würtz, *pers. comm.*).

In the two areas, *M. merluccius* (Mediterranean hake) is the main bony fishes species, with different mean total length as seen in Figures 2A and 4A (27.5cm +/-2.3cm in the Gulf of Lions and 16.4cm +/-1.8cm in the Provençal basin). Hake is present in the whole Mediterranean basin, and distributed from 20 to 700 m and sporadically below this depth. The presence of largest specimens in the Gulf of Lions than in the Provençal basin may be explained by the season: during autumn and winter, the hake move to the continental shelf to spawn. Juveniles are generally found above the continental shelf and feed on crustaceans, whereas adults (total length > 25 cm) live in deeper waters of the shelf and slope and feed on fishes and cephalopods (Bozzano *et al*., 1997). The European squid (*L. vulgaris*) (Fig. 2B) is a muscular squid moving offshore in autumn and winter towards the 90-120 strata, after reproducing and spawning nearest the coasts in spring. Individuals smaller than 15 cm ML feed mainly on crustaceans. With the increase of size appears a progressive decrease of crustaceans consumption, associated with an increase of bony fishes and cephalopods, mainly of their own species (Mangold-Wirz, 1989). The European flying squid *(T. sagittatus)* (Fig. 4B) is a muscular squid feeding mainly on fishes, crustaceans and cephalopods (Quetglas *et al*., 1999). A change in the diet as the squid grows was observed, since juveniles feed basically on fishes and appeared mainly from 100 to 400 m, while adults (individuals longer than 15 cm ML) prey more actively on crustaceans and occur in deeper waters, until 800 m.

The majority of striped dolphin diet items are preying on a wide variety of preys, proving the opportunistic character and how adaptable they are. Prey spectrum in the diet is related to the most readily available preys and, in general, pelagic species tend to prey mainly on fishes while crustaceans predominate in the benthic species; and hugde individuals feed mainly on largest preys and also on a wide range of prey sizes.

CONCLUSIONS In view of the results obtained, the main striped dolphins diet is *Merluccius merluccius*, associated with *Loligo vulgaris* in the Gulf of Lions or *Todarodes sagittatus* in the Provençal basin, two common species in each area waters. The high number of low IRI values for the other preys shows the opportunistic character of striped dolphin diet, and the variability in the species composition related to the prey availability in nature. The preys show a wide depth distribution range, may be linked to their own versatile diet.

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Table 1. Food items found in 6 striped dolphins stomachs from the Gulf of Lions

Species		Numbers		Occurrence		Wet weight		IRI
CEPHALOPODA		N	%	F	%	Wt (g)	%	%
Lologinidae	*Loligo vulgaris*	15	8,2	2	33,3	1645,4	11,8	12,3
	Alloteuthis media	1	0,5	1	16,7	15,9	0,1	0,2
Onychoteuthidae	*Onychoteuthis banksii*	25	13,7	1	16,7	267	1,9	4,8
	Ancistroteuthis lichtensteini	3	1,6	1	16,7	145	1	0,8
Ommastrephidae	*Todarodes sagittatus*	5	2,7	1	16,7	211,9	1,5	1,3
	Todaropsis eblanae	3	1,6	1	16,7	372	2,7	1,3
	Illex coindetii	1	0,5	1	16,7	24,6	0,2	0,2
	Ommastrephidae sp.	6	3,3	2	33,3	557,7	4	4,5
Octopoteuthidae	*Eledone cirrhosa*	2	1,1	2	33,3	38	0,3	0,8
Sepiolidae	*Sepietta sp.*	1	0,5	1	16,7	6,2	0,04	0,2
	Sepiola sp.	1	0,5	1	16,7	2,4	0,02	0,2
	Sepiolidae sp.	6	3,3	1	16,7	9	0,1	1,0
Chiroteuthidae	*Chiroteuthis veranyi*	3	1,6	1	16,7	28,7	0,2	0,6
Histioteuthidae	*Histioteuthis reversa*	8	4,4	1	16,7	1397,9	10	4,4
Cranchidae	*Cranchidae sp.*	3	1,6	2	33,3	116,5	0,8	1,5
Total cephalopoda		**83**	**45,4**	**6**	**100,0**	**4838,1**	**34,7**	**34,1**
OSTEICHTHYES								
Clupeidae	*Sardina pilchardus*	17	9,3	2	33,3	209,2	1,5	6,6
Merluccidae	*Merluccius merluccius*	39	21,3	2	33,3	8736,4	62,7	51,5
Gadidae	*Micromesistius poutassou*	1	0,5	1	16,7	8,1	0,1	0,2
Myctophidae	*Hugophum sp.*	32	17,5	1	16,7	8,6	0,1	5,4
	Notoscopelus sp.	7	3,8	1	16,7	4,9	0,04	1,2
Muraneidae	*Muraneidae sp.*	1	0,5	1	16,7	100	0,7	0,4
Cepolidae	*Cepola macrophtalma*	1	0,5	1	16,7	10	0,1	0,2
Total osteichthyes		**98**	**53,6**	**5**	**83,3**	**9077,2**	**65,1**	**65,5**
CRUSTACEA								
Pasiphaeidae	*Pasiphaea multidenta*	1	0,5	1	16,7	9,2	0,1	0,2
	Pasiphaea sivado	1	0,5	1	16,7	9,2	0,1	0,2
Total crustacea		**2**	**1,1**	**1**	**16,7**	**18,4**	**0,1**	**0,4**

Table 2. Food items found in 8 striped dolphins stomachs from the Provençal Basin

Species		Numbers		Occurrence		Wet weight		IRI
CEPHALOPODA		N	%	F	%	Wt (g)	%	%
Lologinidae	*Loligo vulgaris*	27	6,9	1	12,5	2456,7	16,1	7
	Loligo sp.	1	0,3	1	12,5	146,9	1	0,4
Onychoteuthidae	*Onychoteuthis banksii*	15	3,8	2	25	283,2	1,9	3,5
	Ancistroteuthis lichtensteini	12	3,1	3	37,5	433,8	2,8	5,4
Ommastrephidae	*Todarodes sagittatus*	13	3,3	3	37,5	5159,9	33,8	34,1
	Illex coindetii	3	0,8	2	25	327,5	2,1	1,8
	Ommastrephidae sp.	1	0,3	1	12,5	93	0,6	0,3
Sepiolidae	*Sepiola sp.*	2	0,5	2	25	2,6	0,02	0,3
	Sepietta oweniana	6	1,5	2	25	31	0,2	1,1
Histioteuthidae	*Histioteuthis sp.*	1	0,3	1	12,5	117,9	0,8	0,3
	Histioteuthis reversa	5	1,3	2	25	321,8	2,1	2,1
Cranchidae	*Cranchidae sp.*	1	0,3	1	12,5	38,8	0,3	0,2
Total cephalopoda		**87**	**22,3**	**8**	**100**	**9412,99**	**61,6**	**56,4**
OSTEICHTHYES								
Clupeidae	*Sardina pilchardus*	4	1	2	25	132,7	0,9	1,2
Merluccidae	*Merluccius merluccius*	74	19,0	1	12,5	2742,1	18	11,3
Gadidae	*Micromesistius poutassou*	1	0,3	1	12,5	92,1	0,6	0,3
Sparidae	*Boops boops*	17	4,4	2	25	1430	9,4	8,4
Stomiatidae	*Stomias boa*	14	3,6	3	37,5	59,5	0,4	3,7
Chauliodontidae	*Chauliodus sloani*	5	1,3	1	12,5	199	1,3	0,8
Myctophidae	*Lobianchia gemellarii*	18	4,6	1	12,5	111,8	0,7	1,6
	Lampanyctus crocodilus	17	4,4	1	12,5	527	3,5	2,4
	Ceratoscopelus maderensis	13	3,3	1	12,5	2,6	0,02	1,0
	Myctophidae sp.	6	1,5	1	12,5	39,3	0,3	0,5
	Notoscopelus sp.	23	5,9	1	12,5	16,1	0,1	1,8
Total osteichthyes		**192**	**49,2**	**4**	**50**	**5352,2**	**35**	**32,9**
CRUSTACEA								
Pasiphaeidae	*Pasiphaea multidenta*	32	8,2	1	12,5	293,8	1,9	3,1
	Pasiphaea sivado	2	0,5	1	12,5	18,4	0,1	0,2
Oplophoridae	*Acanthephyra pelagica*	5	1,3	1	12,5	26,0	0,2	0,4
Sergestidae	*Sergia robusta*	84	21,5	1	12,5	168,0	1,1	6,9
Total crustacea		**123**	**31,5**	**2**	**25**	**506,1**	**3,3**	**10,7**

Fig. 1. Length frequency distributions of the prey found in six striped dolphins stomachs from the Gulf of Lions. DML, cephalopod dorsal mantle length; TL, fish total body length

Fig. 2. Length frequency distributions of the two main prey found in striped dolphins from the Gulf of Lions

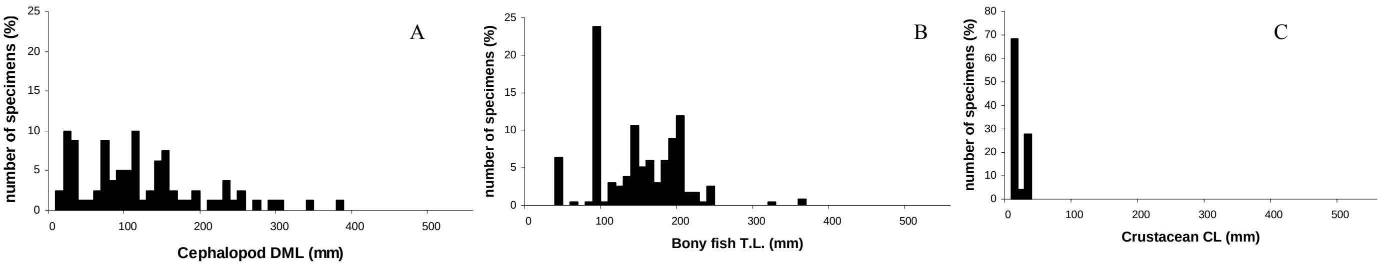

Fig. 3. Length frequency distributions of the prey found in eight striped dolphins stomachs from the Provençal Basin. DML, cephalopod dorsal mantle length; TL, fish total body length

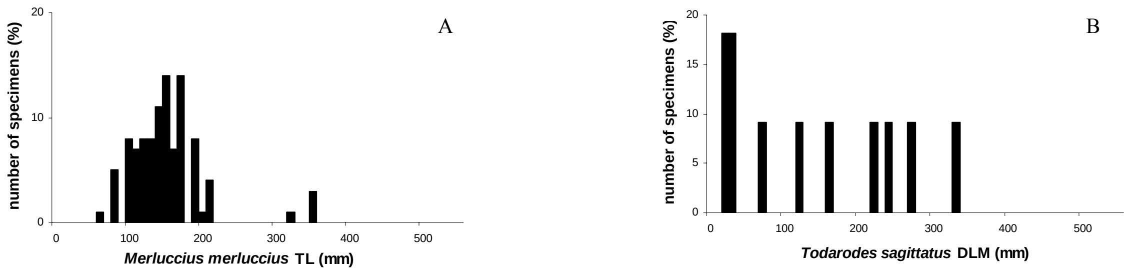

Fig. 4. Length frequency distributions of the two main prey found in striped dolphins from the Provençal Basin

DOLPHIN-HUMAN INTERACTION: THE ROLE OF VOCALISATIONS THAT BOTTLENOSE DOLPHINS PRODUCE ABOVE WATER

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When interacting with familiar humans, bottlenose dolphins may produce sound patterns that obviously are not part of their species specific signal repertoire, but a result of training manoeuvres under human direction or of learning by imitation. Typically, such sounds are given as 'vocalisations above water' surface, and thus in the following termed 'VAW'. Since VAW often serve as components of public shows, we have studied this behaviour as a model case of dolphin-human interaction. Our central objective was to examine whether the use of VAW conditioned by a human trainer would differ from the performance of VAW that individuals had acquired by imitating other dolphins. We investigated, for instance, basic features of VAW structure and production and also their relation to biological and social variables. The study was conducted on a group of 10 bottlenose dolphins (*Tursiops truncatus*) living semifree in a large open-sea enclosure (Dolphin Reef, Red Sea). The group comprised four adults (three of them females) and six juveniles born in this site. The young imitated VAW by learning from the adults. All individuals produced VAW during regular shows that were open to the public. Sound productions were rewarded by hands-clapping of observers. Both the acoustical and the non-acoustical behaviours of dolphins and people (including trainers) were recorded on tape (videocameras plus external stereomicrophones), and examined by audio-visual analyses (methods in Todt and Hultsch, 1996, *Europ. Res. Cet*. 9: 287-291). Three main results can be summarised as follows: Individual parameter differences were more marked among conditioned VAW than among VAW acquired by imitation. Collective performances of VAW were well coordinated and more frequent than solitary ones. Although VAW production was executed by the blow-hole, it was nevertheless escorted by an open-mouth display. Our general conclusion was that properties of VAW performances can help to elucidate dolphin-human relationships.

WHALES ON THE ROCKS: AN UNUSUAL FEEDING BEHAVIOUR OF HUMPBACK WHALES (*MEGAPTERA NOVAEANGLIAE*) IN NEWFOUNDLAND

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Consideration of foraging costs as well as benefits appear to play a dominant role in determining dive patterns of whales while feeding. A cost-benefit analysis of an apparent risky feeding behaviour of humpback whales observed in Newfoundland, Canada was performed. The behaviour was observed and documented on five different occasions during the month of September 2002. Whales were observed feeding on herring (*Clupea harengus*) in shallow waters (0-6m) at the edge of very steep cliffs. Herring was positively detected by sounder and also identified visually. Three photo-identified individuals repeatedly stranded themselves during instances of lunge feeding. In few occasions whales were bounced against the rocks by heavy swells and ended up high and dry. Environmental parameters, boat parameters and fish distribution were also recorded. Indexes of humpback whale behaviour including diving time, surface time, blow rates, number of blows, blow intervals and flucking up instances were analysed. The results were compared with records of behaviour of the same individuals when engaged in other kinds of feeding, and with a baseline of humpback whale behaviour collected by the same authors in previous years. The results showed that number of blows was lower and diving time and interval between blows were shorter when whales were feeding on the rocks ($p < .05$). Also the ratio surface time/diving time was lower (0.52 versus 0.9) when feeding on the rocks. Blow rate increased ($p <.05$). Flukes-up only occurred 19% of the time. Feeding next to steep shores, whales appear to be corralling bait with the aid of a three sided trap (bottom- rocks walls and surface). This seems to be reducing searching and feeding times, which could maximise benefits and minimise the energetic costs of foraging. The energetic advantage of this kind of behaviour may outweigh the risks of feeding in potentially dangerous waters.

DIET OF THE LEOPARD SEAL IN PRYDZ BAY, EAST ANTARCTICA

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This is the first multi-year, leopard seal, diet study conducted over the whole austral summer on the Antarctic continent. Leopard seals are one of the top order predators found in the Southern Ocean and are distributed right around the Antarctic continent. 72 leopard seal scats were collected in Prydz Bay, East Antarctica over three consecutive summers. Scat analysis showed that Adelie penguins were the dominant prey item occurring in 92% of the scats. Fish was found in 20% and seal fur in 15% of the scats. Krill was found in only two scats. Amphipods were found in 12% of the scats, however their appearance may be due to secondary consumption as they were also found in the Adelie penguin stomachs. Predation on penguins included fledglings as well as adults. There were significant differences in predation between years (x^2=15.604, p<0.001, d.f=2) and between months. (x^2=95.310, p<0.001, d.f=3;). There were also some sex related differences in diet (x^2=242.9941, p<0.001, d.f=3). More females than males were consuming seals and fish. Some species of fish were found which had not been previously described in the diet. Three leopard seals stomachs were also collected and each contained a varying amount of penguin feathers. A method is also being developed to identify seal species from hair samples using scanning electron microscope techniques. This will allow us to identify which type of Antarctic seals were consumed from an examination of fur found in leopard seal scats.

FIN WHALES SUMMER GROUPING AND SATELLITE REMOTELY SENSED ENVIRONMENTAL CONDITIONS: RESULTS WITH NORTHWESTERN MEDITERRANEAN SEA FOR SUMMERS 1998 TO 2002

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Few studies have tried to explain the summer distribution pattern of fin whales *(Balaenoptera physalus)* in the Northwestern Mediterranean basin, an area characterized with heterogeneous and transient hydrobiological features. Satellite imagery was used to gain knowledge on primary biomass over large time and space scales and to process environmental variables of significance to the problem of fin whale distribution.

The area of study was divided into 30'x 30' latitude/longitude spatial cells for which long term fin whale distribution was obtained from survey data and expressed into sightings per unit of effort for 8-days period. A relevant model was used to estimate a net primary production, NPP, (gC/m²/day) from 8-days averaged pigment concentration as obtained from satellite measurements (SeaWIFS scanner), at the same spatial scale. A total of five environment variables were generated to be correlated with fin whale sighting rates obtained from boat surveys. NPP was integrated over different temporal scales, related to primary production cycles in the area. Additional variables were derived from sea surface temperature (AVHRR/NOAA sensors).

Multiple cross-correlation coefficients were calculated between these environmental parameters and the fin whale summer distribution from 1998 to 2002. A predictive model, the Potential Grouping Index, was developed from this statistical approach to locate and to count areas potentially favourable to the whale presence. The model was tested to compare predictions and fin whale actual distribution during the summer 2002.

Results enabled a better understanding of space and time variability of the first trophic levels, including in aspects such as medium scale heterogeneities (between regions) and interannual variability. For instance, the mean carbon fixation rate for the whole basin was about 33.9 gC/m²/22 weeks in 1998, and about 48.5 gC/m²/22 weeks in 1999.

Correlations between remotely sensed environmental variables and in-situ whale distribution clearly appeared, notably between spring biomass levels and summer whale presence. During years of high primary production (1999 and 2000), the number of whales is more related to the spring production, a long-term environmental process. During years of low primary production (1998 and 2001), the number of whales (ROR) is more closely related to short-term environmental processes such as thermal fronts. The significance of the correlation also varies with the season and the hydrological characteristics of the different provinces of the basin.

This study enhanced the comprehension of the variability of the fin whale summer distribution. The results suggest that fin whales adapt their feeding strategy to environmental variations. The use of remote sensing affords a new methodological approach owing to the chronological account of water masses available. The relationship validity could be improved by the consideration of additional parameters such as wind conditions which influence sighting, prey vulnerability and reproduction success, and perhaps fin whale vertical localization.

LONG-TERM CHANGES IN THE FOOD OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) IN RELATION TO FISH STOCKS IN THE BAY OF BISCAY

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Most of the exploited fish stocks in the North-east Atlantic are also used as a food supply by marine mammals. During the last decades, the abundance of several commercial species declined due to overfishing, leading to disturbances in ecological communities. As small cetaceans are known to be opportunistic predators, their diet could reflect changes of prey availability in the ecosystem. This work aims at investigating changes in dietary composition of the common dolphin in the Bay of Biscay, at 2 distinct time scales: long-term and seasonal variations. 74 stomach contents from stranded common dolphins in the Atlantic French coast during the period 1998-2002 were analysed, and compared with a similar study carried out in the early 80's. Significant differences of prey composition appeared between the 2 periods (c2, $p<0.01$). Sardine, sprat, and anchovy increased their contribution by mass, to the detriment of bib and hake essentially. However, the sizes of consumed prey were similar except for bib which was caught at a bigger size in the recent set of stomachs. For the period 1998-2002, significant seasonal variations were revealed between spring-summer and fall-winter (c2, $p<0.01$). Small pelagic fishes were more important in the diet in spring-summer during the 2 periods, except for the sardine, essentially caught in winter during the last period. These long-term variations could reflect the predator adaptability due to changes in prey availability. An hypothetical scenario could involve ecological processes operating at the 2 time scales: In a context of general overfishing, short-lived species (e.g. small pelagics) have more potential than long-lived ones (e.g. hake) to recover from low stocks and therefore become more available for dolphins. At a smaller scale, the differential seasonal proportions of small pelagic fishes could be the combined effect of both migrations of preys and predators in the Bay of Biscay.

DO DOLPHIN FEEDING "HOT SPOTS" OCCUR IN A HIGHLY DYNAMIC COASTAL SYSTEM?

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The hypothesis that bottlenose dolphin distribution is related to prey movements remains untested, in part due to the lack of data on spatial and temporal variation of fish and to limitations on sampling scales of bottlenose dolphins. The Galveston Bay Estuary (GBE) comprises areas with distinct physiography, known to influence fish occurrence or prey capture. Most of the fish species in GBE are migratory. The main goals of our study were to determine if densities of dolphins and amount of feeding differ spatially and temporally, and if these variables are related to habitat and seasonal features that may be linked to prey distribution. We also investigated if densities and feeding of seabirds, recorded at 22 fixed stations, can be used as an indicator of distribution of dolphins. From October, 2000 to July, 2001, we conducted 26 boat surveys in five areas, totaling 464 km of effort. We used the salinity seasons of the GBE: decreasing, low, increasing and high. We followed pre-defined routes and recorded number of dolphins and behavior by scan sampling. Behavior was classified into feeding, mixed feeding (some group members feeding), other, and undetermined. We found that total and mixed-feeding densities of dolphins, and total and feeding densities of birds, differed significantly with area. Densities were higher in channels than in shallows. For dolphins, densities differed significantly by season, but for birds they did not. Increasing and high salinity seasons comprised 86% of total dolphins and 76% of total birds. Total and mixed-feeding densities of dolphins were correlated with total and feeding densities of birds, respectively. Therefore, specific features and seasons in the GBE (and possibly other estuaries) provide better feeding opportunities for dolphins, and birds are relevant in predicting these "hot spots".

DIET OF PYGMY SPERM WHALE (*KOGIA BREVICEPS*) IN THE NE ATLANTIC

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Very little is known on the feeding ecology of pygmy sperm whales (*Kogia breviceps*) in the NE Atlantic. Results are presented on the stomach contents of four whales stranded on the Galician coast (NW Spain) between 1995 and 2002. These results are compared with those obtained from the stomach contents of two pygmy sperm whales (a pregnant female and her calf) stranded on the Scottish coast in 1999, the first record of the species in Scotand. All food remains consisted almost entirely of cephalopod beaks although some crustacean and fish remains were also present. In all the Spanish specimens, the identified prey were oceanic species: the cephalopods Histioteuthis reversa, H. bonnellii, Todarodes sagittatus and the fish Chauliodus sloani. The same cephalopod species were found in the stomachs of the whales stranded in Scotland, although both whales had also consumed neritic cephalopod species such as Rossia macrosoma and sepiolids. Results from the present study are consistent with those found by other authors in the Azores and the Canary Islands.

GENETICS AND EVOLUTION

POPULATION GENETIC STRUCTURE OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN ICELAND

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The harbour porpoise (*Phocoena phocoena*), one of the smallest cetaceans, has a circumpolar distribution, occurring in most temperate waters of the Northern Hemisphere. In general it is considered to be a coastal species and hence is subject to incidental take in commercial fisheries. It is therefore of utmost importance to identify which areas should be considered as different management units. Although Tolley et al (2001), using mtDNA, found Icelandic porpoises from the North and West of the country to be more similar to porpoises from the West Atlantic than to those from Norway, no other information has been published on the genetic population structure of the Icelandic harbour porpoise. In the present study, 169 animals from around the coast of Iceland (including animals from the Southeast never before genetically analysed), 77 Norwegian animals and an outgroup of 49 Irish individuals, were analysed using 10 microsatellite loci. Pairwise FST values, analysis of molecular variance (AMOVA) and assignment tests, all proved that these three areas were genetically distinct. More interestingly however, samples from the Southeast coast of Iceland were showing more genetic similarity to the Norwegian sample than to other Icelandic individuals (from the North and West). It is hypothesised that this could be the result of animals migrating to the Southeast coast of Iceland from other areas (possibly the Faroes) in pursuit of the capelin migration. A second hypothesis is that these Southeast Iceland samples could be the remnants of a Northward expansion after the last glaciation. This would have occurred in the East Atlantic along the European coastline to Norway, the Faroes and Southeast Iceland. Either way, these results will affect future management plans for the Icelandic harbour porpoise.

MITOCHONDRIAL DNA DIVERSITY OF THE COMMON DOLPHIN (*DELPHINUS DELPHIS*) IN THE CANARY ISLANDS

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The short-beaked common dolphin (*Delphinus delphis*) population of the Canary Islands is non-resident and can mainly be found in the archipelago between January and May. Nevertheless nothing is known about the geographic origin of this population. With this aim, 398 bp of de mitochondrial control region of 28 samples from stranded as well as free ranging animals, where sequenced and compared with those sequences described for populations from California, the Eastern Tropical Pacific, the Black Sea and the Mediterranean. For the 28 common dolphin samples, 21 haplotypes were described, being one of them identical to another one detected in the Black Sea. The nucleotide diversity values for the D-loop was 1.5% for the Canarian population.This population was found to be subdivided in two groups which were genetically closer respectively to the Mediterranean / Black Sea samples and to the California / Pacific samples than to one another suggesting different geographical origins of the animals found in the Canarian archipelago. However, the genetic distance value between those two groups is of the same order of magnitude as the one defined between the Californian sympatric morphotypes D. delphis and D. capensis, so that there is no support for the theory of them being different species.

CONTRASTING RELATEDNESS PATTERNS IN MALE BOTTLENOSE DOLPHINS (*TURSIOPS* SP.) WITH DIFFERENT ALLIANCE STRATEGIES

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Male bottlenose dolphins in Shark Bay have one of the most complex male societies outside humans. Two broad male mating strategies have been identified. In the first strategy, there are two types of alliances: stable 'first-order' pairs and trios that herd individual females in reproductive condition, and 'second-order' teams of two first-order alliances (five to six individuals) that join forces against rivals in contests for females. In the alternative strategy, a 'super-alliance' of approximately 14 individuals, males form pairs or trios to herd females, but in contrast to the stable alliances, these trios are highly labile. Here I show that males in stable first-order alliances and the derived second-order alliances are often strongly related, so that they may gain inclusive fitness benefits from alliance membership. By contrast, members of the super-alliance are no more closely related than expected by chance. Further, the strength of the association of alliance partners within the super-alliance, as measured by an index of joint participation in consorting a female, was not correlated with their genetic relatedness. Thus, within one population and one sex, it appears that there may be simultaneous operation of more than one mode of group formation.

GENETIC RELATIONSHIPS AMONG SPECIES OF GENUS *ANISAKIS* (NEMATODA: ANISAKIDAE) PARASITES OF CETACEANS, INFERRED FROM DIFFERENT GENETIC MARKERS: EVIDENCE FOR CO-SPECIATION?

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The objective was to analyse and compare genetic relationships among species of the genus *Anisakis* based on different genetic markers and to study the extent to which phylogeny among related anisakid species is congruent with that of their hosts. Genetic relationships were analysed at both nuclear (20 allozyme loci) and mitochondrial DNA (cytb gene sequence) level, in species of the genus *Anisakis* from cetaceans of boreal and austral hemispheres, including: *A. simplex* sensu stricto, *A. pegreffii*, *A. simplex C* (from various cetaceans belonging to the Family: Delphinidae, Phocoenidae, Monodontidae, Balaenopteridae); *A. typica* (from *Stenella coeruleoalba*, *Sotalia fluviatilis*); *A. ziphidarum* (from the beaked whales, *Ziphius cavirostris*, *Mesoplodon layardii*); *A. physeteris* (from the *Physeter catodon*, Fam. Physeteridae); *A. brevispiculata* (from *Kogia breviceps*, Fam. Kogiidae) and *Anisakis sp.* (from *Mesoplodon mirus* and *M. gragy*). Data were analysed by tree inference methods: MP, NJ. Trees obtained by both allozyme and mitochondrial sequencing data sets showed concordant topologies. *A. typica* is the most related species to the three sibling species of the *A. simplex complex*, whereas, *A. ziphidarum* and *Anisakis* sp., genetically related to each other, form a separate branch; *A. physeteris* and *A. brevispiculata* join in a well distinct clade. Topologies were supported by high bootstrap values. Average genetic distance values, based on enzyme loci, ranged, on average, from DNei =0.35 between sibling species, to DNei=2.8 among species morphologically differentiated (i.e. *A. simplex complex* vs *A. physeteris*). Similarly, haplotype divergence, ranged, on average, from 0.05 to 0.60 among the same group of species. The high genetic heterogeneity of the genus *Anisakis* is discussed, with particular regard to the deep separation between anisakid species parasitizing dolphins and beaked whales and those having physeterids as definitive hosts. Such divergence parallels that found between their cetacean hosts. Co-speciation and host-switching events among *Anisakis* species and their definitive hosts are discussed.

PHYLOGEOGRAPHY OF THE MEDITERRANEAN BLACK SEA AND EAST NORTH ATLANTIC BOTTLENOSE DOLPHIN POPULATIONS

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In the Mediterranean Sea the bottlenose dolphin is one of the most common cetaceans. Mainly considered a coastal species, it is widely present along most of the coastal areas of the Mediterranean Sea and Black sea. However, little is known about the movement of the species across different areas, and therefore, if the Mediterranean population should be considered as a single population or as fragmented, perhaps isolated, populations. The assessment of phylogeography and the identification of different stocks at the intraspecific level are fundamental to the development of effective conservation and management programmes of this species. The aim of this study is to determine the population structure of the Mediterranean and Black sea bottlenose dolphin population. In addition the study examines the population structure of the bottlenose dolphin population off the straits of Gibraltar along the East North Atlantic coast to determine the extent of any gene flow between the Atlantic population and the Mediterranean population. Analyses of 9 microsatellite loci and sequences from the mitochondrial DNA control region were carried out on 143 samples coming from 9 different areas of the Mediterranean Sea, Black Sea and East North Atlantic. Patterns of differentiation revealed in phylogenetic reconstructions and measures of population structure (Fst) indicate a significant level of divergence between Mediterranean and Black sea populations. Moreover, significant population differentiation is observed within the Mediterranean population and between the Mediterranean and the East North Atlantic populations. The level of isolation of these individual populations has far reaching implications for the conservation management strategies adopted in different regions.

DEMOGRAPHIC HISTORY OF HARBOUR PORPOISES IN THE SOUTHEASTERN NORTH ATLANTIC INFERRED THROUGH mtDNA SEQUENCES

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The harbour porpoise (Phocoena phocoena) experiences high rates of incidental mortality in commercial fisheries, and in some areas these rates are sufficiently high to justify concern over population sustainability. Given this high mortality, the resolution of population structure will be important to facilitate conservation and management actions. To investigate population structure in southeastern North Atlantic, variation in the mitochondrial DNA of 110 porpoises was compared among five locations corresponding to several putative populations (Belgium, Netherlands, France, Portugal, W. Africa). The first 342 base pairs of the control region were sequenced and genetic variation investigated by analysis of molecular variance (AMOVA) and nested clade analysis. Porpoises from Belgium and the Netherlands could not be distinguished from each other by AMOVA (FST & FST), but all other regions showed substantial genetic population structure. Furthermore, the nested clade analysis points to the occurrence of multiple isolating events, probably caused by repeated range contractions and expansions throughout Quaternary glaciation events within the North Atlantic. Mismatch distributions show distinct expansion waves, suggesting that an oceanic population expansion has occurred in the past. Such a population expansion could be the result of recolonisation into regions previously unavailable during global glaciation events. In all, these results suggest that harbour porpoise populations within the southeastern North Atlantic are distinguishable on a fine scale, and their historical biogeography can be interpreted in light of evolutionary patterns observed in the mitochondrial DNA sequences.

LIFE HISTORY

MATERNAL AND NEWBORN LIFE-HISTORY TRAITS DURING PERIODS OF CONTRASTING POPULATION TRENDS: IMPLICATIONS FOR EXPLAINING THE DECLINE OF HARBOUR SEALS, *PHOCA VITULINA*, ON SABLE ISLAND

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Understanding the factors affecting population trends is central in both population and conservation biology. Annual censuses of the number of harbour seal pups born on Sable Island, Canada showed an increasing trend during the 1980s, but a rapid decline through the 1990s from 625 pups in 1989 to only 32 by 1997. Weekly surveys of the north beach of the island over the course of the 1991-1998 breeding seasons showed that the number of adults and juveniles also declined during the 1990s. Despite the dramatic demographic changes, maternal postpartum mass, pup birth mass, relative birth mass, lactation duration, pup weaning mass, and relative weaning mass showed no significant trends over the period 1987-1996. However, two traits did change. The age structure of parturient females increased significantly, indicating reduced recruitment to the breeding population. Mean birth date increased by 7 d during the early 1990s, suggesting nutritional stress of females and later implantation dates. This nutritional stress may in turn have been caused by increased competition from the rapidly increasing grey seal population on Sable Island. Although shark-inflicted morality can account for perhaps half of the decline, evidence suggests that food shortage arising from inter-specific competition may have also played a role in causing the population decline through effects on fecundity and juvenile survival.

SOCIAL CHANGES OF SOUTH AMERICAN SEA LIONS AT PUNTA LEON, A PATAGONIAN BREEDING ROOKERY, IN THE CONTEXT OF AN INCREASING POPULATION

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The sea lion population in northern Patagonia increases annualy at a rate of 4%. Out of 19 rookeries and haul out places, Punta León is one of the most important with 2000 pups (17% of the pups born at Península Valdés). In the early 80's there were born 900 pups (25% of the total). In addition to the increase of the pups born, it was observed an expansion of the rookery from 4 to 7 km to the south. Social composition in the expanded rookery show different characteristics with regard to those of old breeding areas. The objective of this work was to test the null hypothesis that some variables remain constant when comparing old breeding areas (zone a: north) and new ones (zone b: south). These variables included: a) age composition, b) pup mortality during the breeding season and c) rate of increase calculated separately for zone a and b. The proportions in zone a were 8.4% adult males holding females, 5% solitary adult males, 29.7% females + juveniles and 56.9% pups. In zone b the proportions were 4.5 adult males holding females, 7.5 solitary adult males, 55.5 females + juveniles and 32.5 pups. Zone b holds a larger proportion of solitary males and juveniles between the females. Out of 2,033 pups, 1,592 were born in zone a and 441 in zone b. Zone a showed 2% of pup mortality while zone b 3.6% ($p<0,05$), which could be explained in part to the absence of the typical breeding structure which gives protection to the pups from solitary males. Finaly, zone a showed a rate of increase of 3% for the period 1983-2002, while zone b increased at a rate of 21% for the period 1990-2002, in agreement with a theoretical decrease in high density conditions.

RECONSTRUCTING INDIVIDUAL FEMALE REPRODUCTIVE HISTORIES FROM THE EXAMINATION OF OVARIAN SCARS IN CETACEANS: CHALLENGING RESULTS FROM THE COMMON DOLPHIN

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INTRODUCTION The instantaneous reproductive status and the reconstruction of individual reproductive histories are central to many ecological approaches, such as demographic modelling, impact of man-induced mortality and ecotoxicology. In cetacean studies, it has been assumed that ovarian scars accumulate with age and provide a record of female reproductive history.

According to general mammalian terminology, follicular atresia and *Corpora artretica* correspond to the degeneration of follicles before ovulation, whereas *Corpora albicantia* are specifically defined as the scars resulting from the regression of *Corpora lutea* of either an infertile ovulation or a pregnancy. It has been reported that *Corpora albicantia* persist indefinitely and accumulate with age while *Corpora atretica* disappear. Consequently, it is considered that ovarian scars can provide a record of female reproductive history (Perrin *et al*., 1984).

Similar to all mammals, it is often considered that, in cetaceans, *Corpora albicantia* of gestation and *Corpora albicantia* of infertile ovulation cannot be distinguished from one another (Laws, 1961; Best, 1967; Kasuya, 1972; Perrin and Reilly, 1984; Perrin and Donovan, 1984). However, a distinction has been proposed by some authors from partial, and still discussed, histological evidence (Kasuya *et al*., 1974; Perrin *et al*., 1976; Marsh and Kasuya, 1984; but see Perrin and Donovan, 1984). Furthermore, it was agreed that the size of scars alone cannot be considered as an indicator of the original nature of the structure (*albicantia* of gestation *vs albicantia* of infertile ovulation) (Perrin and Reilley, 1984; Perrin and Donovan, 1984).

The ovulation rate is tentatively estimated from the number of CAs at a given age. The literature shows variations in ovulation rate among species and areas based on CAs counts (Perrin and Reilly, 1984) and discusses their ecological and demographical significance. From captive delphinids, it was proposed that ovulation could be triggered by the presence of males and therefore most often followed by gestation. (Harrison, 1969; Harrison *et al*., 1972; Kirby and Ridgway, 1984). However, spontaneous ovulations have been also observed, in delphinids, and multiple instantaneous ovulations have been reported as well as repeated ovulations during the same year (Collet and Harrison, 1981; Kirby and Ridgeway, 1984; Wells, 1984). Finally, a captive dolphin of known reproductive history (gestations and ovulations) showed ovarian scar counts at death well below the number of ovulations during life (Brook *et al*., 2002).

There is a widespread idea that ovarian scars persist with age and it is intuitively accepted that ovarian scar counts provide a record of individual reproductive history. However, a careful examination of small delphinid literature suggests that the experimental or observational basis for such a use is limited or controversial. Consequently, the relationship between the number of scars and the number of past pregnancies is unclear, which impedes the assessment of demographic variables (*e.g.* Annual Pregnancy Rate (APR); Calving Interval (CI); Gross Annual Reproductive Rates (GARR)). In this study ovarian scar counts and size distributions were investigated as a function of age and reproductive status in common dolphins. Two hypothesis were tested: if ovarian scars observed after death represent ovulations during the life of the animal, they should accumulate with age after puberty and if scars of gestation are larger and more persistent than scars of infertile ovulation, there should be a shift in scar size distribution with age.

MATERIALS AND METHODS The material comes from a mass stranding of common dolphins *Delphinus delphis* which occurred on the eighteen February 2002 in Brittany, Western English Channel. Age was determined from decalcified stained slides of teeth (Neilsen, 1972; Perrin and Myrick, 1980). Individual reproductive status was determined from the examination of entire reproductive tracts with organ biometry as well as counts and measurements to the nearest 0.01mm of all *Corpora* (Perrin *et al*., 1976; Perrin and Donovan, 1984). Age, reproductive status, ovarian scars counts and size were compared among these 53 mass-stranded common dolphins.

RESULTS AND DISCUSSION The group was comprised of only one nursed male and 52 females of which 47 were between 6 and 21 years old and included individuals of all reproductive status (non-breeding, pregnant and lactating) irrespective of age (Fig. 1).

The age distribution of the 47 mature females covers the published range of the common dolphin life span. The 5 juveniles still being nursed were all under 3 years old and there was no specimens from 3 to 6 years old (Fig. 1). It appears that there are significantly more pregnant females among 13+ years old individuals than among younger mature females (p=0.02; Chi2 test).

The number *Corpora* as a function of age shows no significant trend among 7+ year old individuals (r^2=0.01) (Fig. 2). The ovarian scar diameters for each age class showed no trend either in number or modal size with increasing age (Fig. 3).

This result shows that there was no accumulation of ovarian scars with age suggesting that the number of scars at any given age results from the combination of the frequency of ovulation and the rate of healing.

The pregnant females offer a quasi-experimental situation in which healing rate alone can be examined, since ovulation stops during that period. This allows a third hypothesis to be tested: if healing occurs, pregnant females should show less scars than resting females.

The *Corpora* size distribution for each reproductive status displayed that pregnant and pregnant lactating females have around 12 *Corpus* on ovaries instead of 20 scars in resting and lactating females. In fact, pregnant females show less than 50% of scars present in non-pregnant females (Fig. 4).

These findings were integrated into a model of delphinid reproductive cycle (Fig. 5). This basic reproduction cycle starts with the resting status when a female reaches maturity. Here we the observed average number of *Corpora albicantia* were indicated in the boxes corresponding to each reproductive status. The pregnant females have about half the number of scars observed in non pregnant ones. This suggests that during different period of the reproduction cycle, the ratio between ovulation and healing rates of scars changes. The Ovulation rate would be higher than healing during resting and lactating periods, in contrast, healing would persist but ovulation would stop during pregnancy (Fig. 5).

CONCLUSION Ovarian scars are unlikely to be permanent in the common dolphin. They appear and disappear very fast as a function of individual reproductive status. In fact, they have no potential for documenting complete individual reproductive history. Only the determination of basic instantaneous reproductive state is still possible from ovarian scar examination. The age at sexual maturity can be determined transversally at the population level from instantaneous reproductive status of many individuals, but not longitudinally along the life span of one individual. Finally, Pregnancy rate, gross annual reproductive rate and calving interval are not possible at individual level.

Instead of, we must be careful with this findings because it’s always difficult to investigate longitudinal processes from transversal approaches ; because we have no access to longitudinal reproductive records of wild individuals. Futhermore the generalisation to other delphinids, small cetaceans, other cetaceans is still premature and would certainly deserve a careful analysis. However uncertainty about GLG and ovarian scar counts alone cannot explain the lack of trends in scar counts with age or current reproductive status.

At last, this suggest that we must repeat as much as possible the transversal studies on wild animals from by-catch or stranding networks to confirm these preliminary results.

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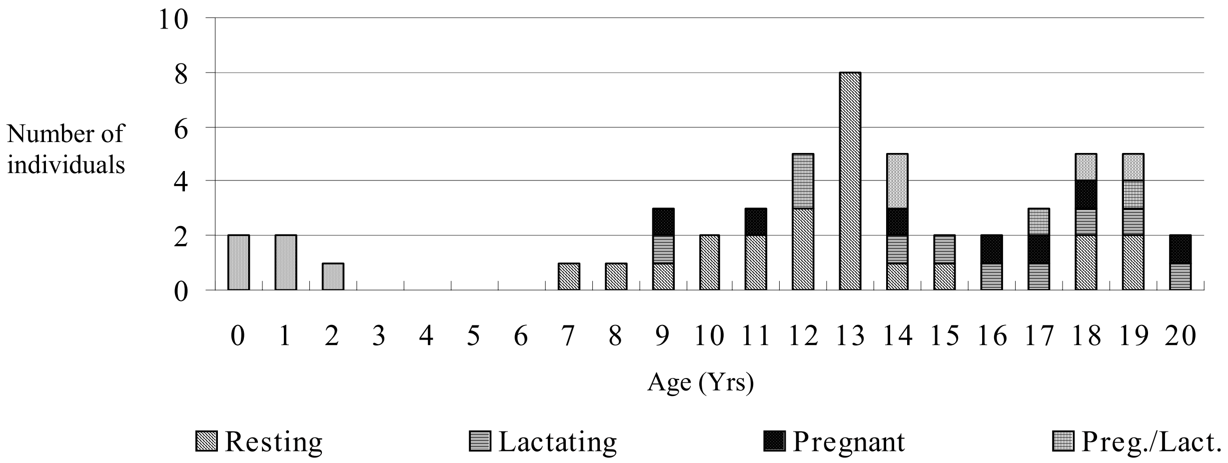

Fig. 1. Age structure and reproductive status.

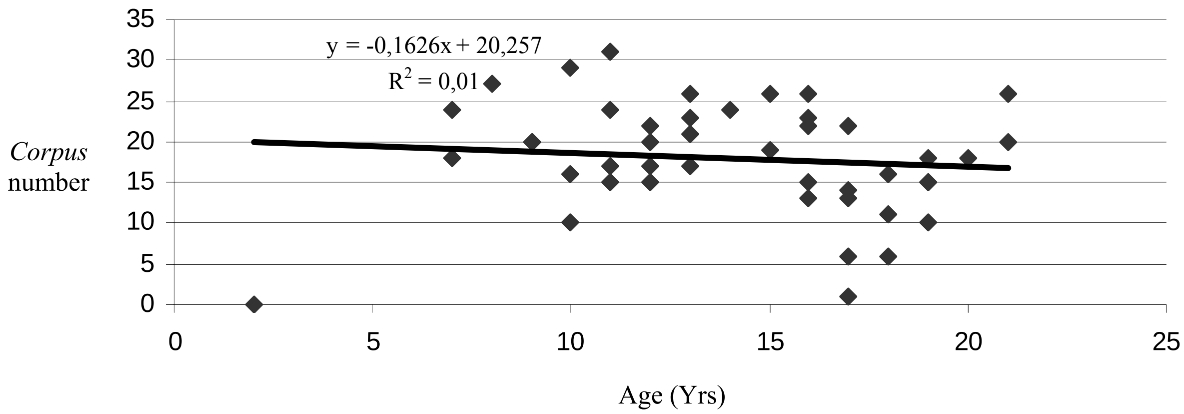

Fig. 2. *Corpus* number as function of age.

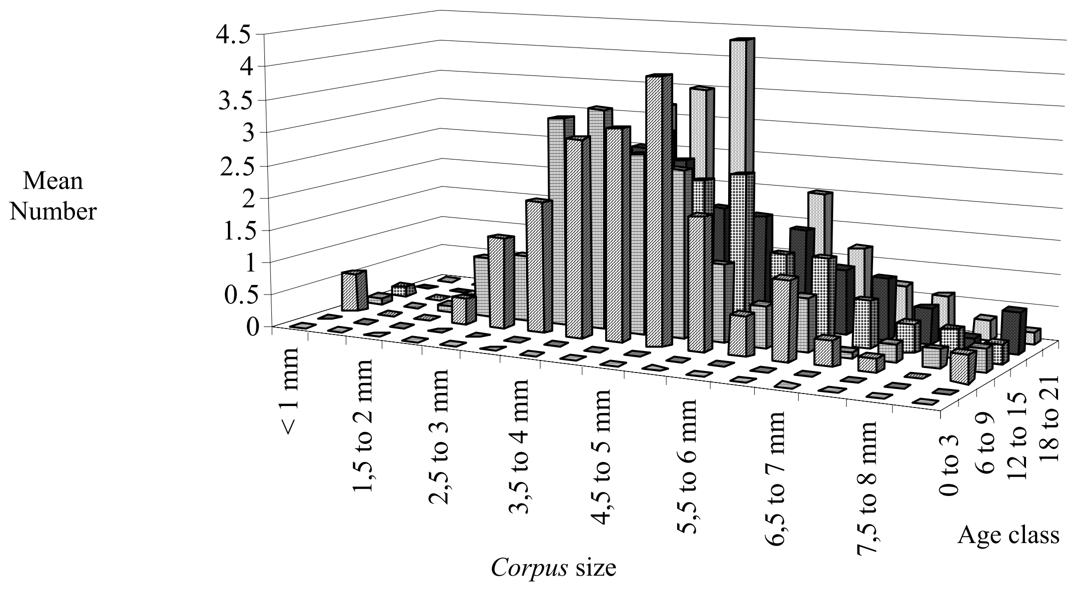

Fig. 3. *Copora* size distribution with age class

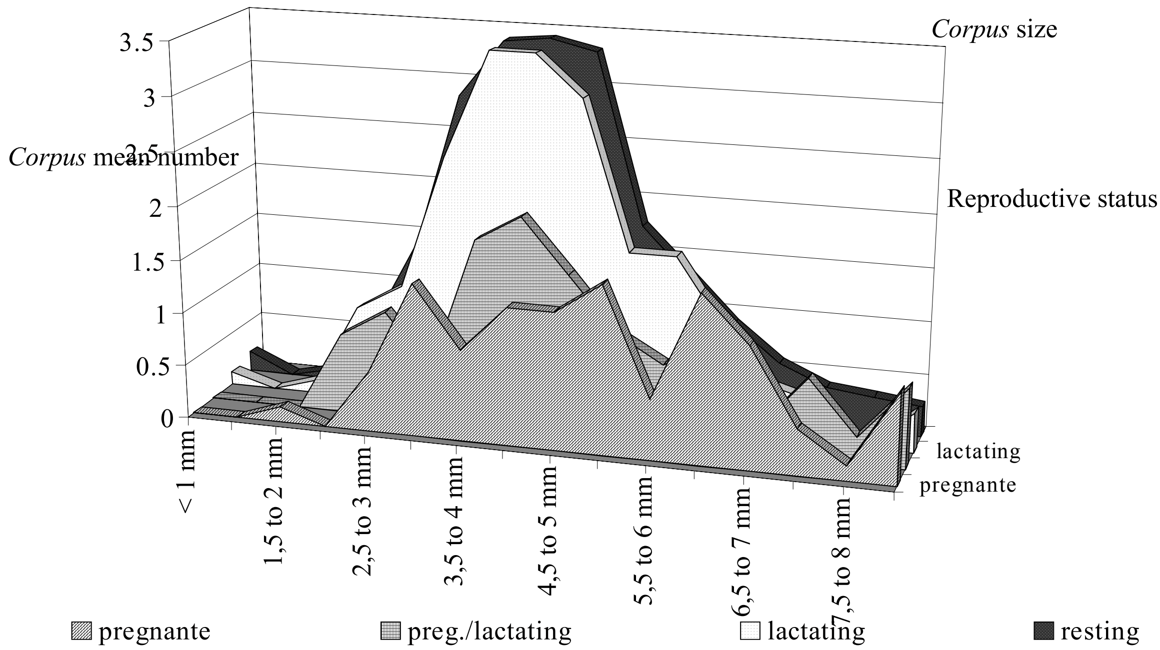

Fig. 4. *Copora* size distribution as a function of reproductive status

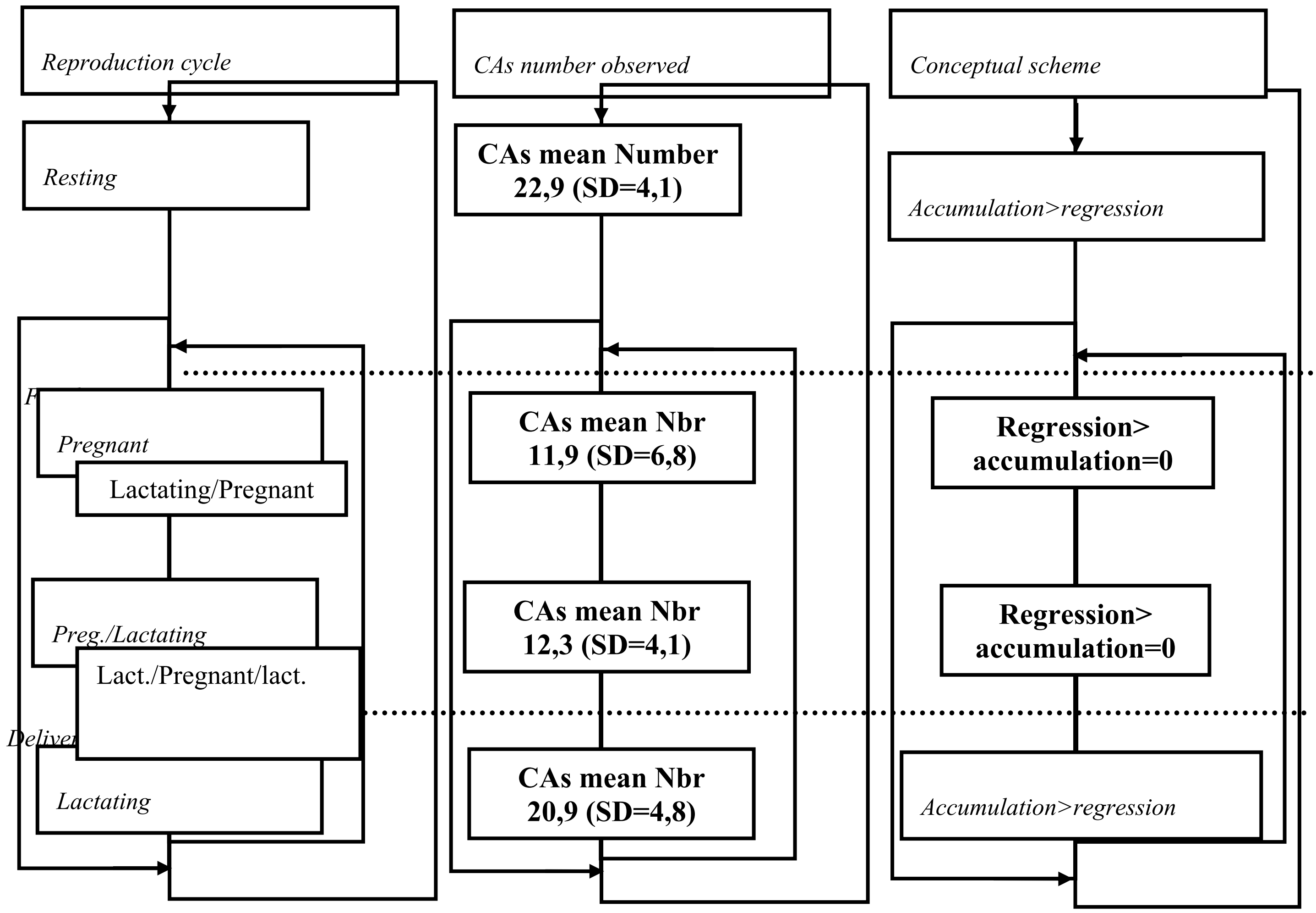

Fig. 5. Proposed scheme of ovarian scars formation and healing

ANKYLOSIS PATTERNS IN THE SKELETONS OF WHITE-BEAKED DOLPHINS (*LAGENORHYNCHUS ALBIROSTRIS*) FROM DANISH WATERS

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The onset and progression of epiphyseal ankylosis in the vertebral column and flippers and ankylosis of the hyoid and sternal bones were studied in 31 skeletons of the white-beaked dolphin (*Lagenorhynchus albirostris*) originating from Danish waters and held in the collections of the Zoological Museum, University of Copenhagen. Epiphyseal ankylosis in the vertebral column started in the anterior cervical region, then initiated in the posterior caudal vertebrae. The progression of ankylosis in the vertebral column eventually terminated in the thoracic and lumbar regions. Males generally exhibited full ankylosis of all vertebral epiphyses (physical maturity) at body lengths of 270 cm or more, while females generally did so at lengths of 250 cm or more. Epiphyseal ankylosis in the flippers began at the distal end of the humerus and the proximal ends of the radius and ulna, terminating with the distal epiphyses of the radius and ulna. Ankylosis in the flippers seemed to slightly precede vertebral ankylosis. Complete fusion of the thyrohyals to the basihyal bone was rare, occurring in 3 specimens, one of which did not show complete ankylosis of the vertebral epiphyses. Complete fusion of the sternal bones seemed to coincide with physical maturity.

A REVIEW OF *ZIPHIUS CAVIROSTRIS* STRANDINGS IN THE MEDITERRANEAN SEA

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Cuvier's beaked whale *(Ziphius cavirostris* G. Cuvier, 1823), is the only species of beaked whales commonly found in the Mediterranean Sea, a deep, semi-enclosed basin. Beaked whales generally live off-shore and are often found in regions characterized by canyons and/or steep escarpments, typically found in this basin. Much of the current knowledge of this species has been derived from stranding data. Historically, stranding data in the Mediterranean Sea has been collected by individual researchers. More recently, in the last two decades, by national stranding networks. We have reviewed stranding data collected by stranding networks in Italy, Greece, Spain and France. Additionally, we have compiled stranding information gleaned from the literature, personal communications, regional newspapers and the world wide web from the countries that border the Mediterranean Sea. We have reviewed nearly 100 papers concerning this species in the Mediterranean Sea. While this list is almost certainly not exhaustive, it has allowed us to create an extensive geo-referenced basin wide data base using a geographic information system (GIS) of over 200 stranding events. For completeness, we have included several stranding events from the genus Mesoplodon in the data base. The acquired data permit us to make some general observations about the distribution and chronology of stranding events, dating back to 1803, as well as to classify them according to different rules, and as such, document the number of mass stranding events. Analysis shows that specific geographic stranding areas can be identified, even though the level of effort undertaken in the different countries may vary.

LIFE HISTORY AND DECLINE OF KILLER WHALES IN CROZET ARCHIPELAGO, SOUTHERN INDIAN OCEAN

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Killer whales (Orcinus orca) occurring in the coastal waters of Possession Island, Crozet Archipelago were photographed for individual identification in 26 non consecutive years between 1964 and 2000. The photo-identification effort was highly variable (from 1 to 783 pictures/year). We only considered years with at least 15 pictures (1977, 1980, 1982, 1985-1990, 1998-2000) to apply mark-recapture models. Robust Design models estimated a decrease in abundance by over 50% and a reduced parameter Cormack-Jolly-Seber model provided global (all age classes included, except neonates younger than 1 yr. old) survival rate estimates decreasing from 0.979 (SE=0.016) in 1977 to 0.815 (SE=0.048) in 1999. However this decrease in survival may be partly apparent if the missing individuals from different pods have left the coastal waters of Possession Island. Nevertheless the low and decreasing observed fecundity supports the idea that the population is presently under demographic stress. Several factors may combine and result in the decline of the killer whale number around Possession Island: 1) their low and decreasing fecundity; 2) the decline of their main preys: large baleen whales due to past whaling, and southern elephant seals (Mirounga leonina) from the 60's to the 80's; 3) the possible mortality induced by recent interactions with the Patagonian toothfish (Disostichus eligenoides) longline fishery; and 4) the possible dispersion of individuals or groups from the coastal waters.

GONADAL DEVELOPMENT IN THE MALE STRIPED DOLPHIN *STENELLA COERULEOALBA*

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Knowledge of male mating strategies among the odontocetes is sparse or non-existent for most species. Some predictions can be made about the mechanisms of male competition that might be operating based on the pattern of sexual dimorphism and characters such as testis size. In this study, we examine the reproductive status of male striped dolphins *Stenella coeruleoalba* in the NE Atlantic using a combination of morphometric and histological techniques, to determine age and size at sexual maturity. Testicular measurements in forty-six animals, which were either stranded on the Irish coastline or incidentally caught in fishing gear between 1991 and 2001, are described. Of these, 29 individuals were suitable for histological analysis. Measurements included combined testes weight, length and a ratio of weight to length. Using these methods, testes of sexually mature animals were found to vary in weight from 29.8 to 305g and in length from 40 – 161mm. There was overlap in the latter measurement with pubescent animals. Histological analysis gave more accurate information on stage of sexual maturity. Based on the presence of spermatogonia, spermatocytes, spermatids and spermatozoa the testes were categorized into Immature, Pubertal and Sexually mature stages. This classification system was used to determine relationships between testicular development and body size: males were classified as immature 1 when they had a body length of <170cm and immature 2 if the body length was < 198cm. Mature males always exceeded 201cm in length and were greater than 10 years. A transitional group, which was regarded as pubertal, had body lengths between 174 – 201cm. Apparent lack of sexual dimorphism and relatively small testes size suggest that striped dolphins may have a promiscuous mating strategy.

MEDICINE AND DISEASE

DIOXINS, FURANS AND COPLANAR PCBS IN JUVENILE HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM THE BELGIAN COAST

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Dioxins, furans and PCBs are lipophilic anthropogenic contaminants that have found their way into marine food webs and accumulate in top predators such as marine mammals, adding a stress factor to an already vulnerable population.In this study 7 congeners of dioxins (PCDDs), 10 congeners of furans (PCDFs) and 4 congeners of coplanar PCBs (cPCBs) were determined using high resolution gas chromatography and mass spectrometry in the blubber of 19 juvenile harbour porpoises (*Phocoena phocoena*) stranded along the Belgian North Sea coastline between 1995 and 2001. These results were contrasted with nutritional status (emaciated or not), sex and trophic level (through stable carbon and nitrogen isotope analysis). Mean blubber concentrations of SPCDD/Fs were 12.8 pg/g lw (lipid weight) and mean related toxicity 1.84 pg TEQs/g lw (TEQs = TCDD toxic equivalents). Mean cPCB concentrations were 223,5 pg/g lw and mean related toxicity 4,47 pg TEQs/g lw. The levels detected in these individuals were of the same order as those found in a previous study in the Wadden Sea (Bruhn, 1999). Both sexes show rather similar levels. No significant relationship was observed between stable carbon or nitrogen isotope values and pollutant levels. Concentrations and toxicity show a tendency to be higher in emaciated individuals than in non-emaciated ones. This could indicate a possible relationship between the nutritional status of the animals and dioxin-like pollutants (which could participate in weakening the animal). This situation should be further studied on adult individuals in order to obtain a more global view of the possible effects on the population.

PARASITIC INFESTATIONS IN NEWBORN PILOT WHALES, *GLOBICEPHALA MELAS*, STRANDED ON THE FRENCH ATLANTIC COAST

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Long-finned pilot whales, *Globicephala melas*, are gregarious animals of temperate and subpolar marine waters. These animals often strand in mass but newborns separated from their mother can strand isolated. Parasitic infestation of wild animals, particularly cetaceans, is a most usual finding. The massive presence of internal parasites, especially worms, is a potential indicator of compromised health status. Cetaceans are often heavily infested by nematodes. Larvae, present in fishes (larval stage L3), are released in the gastro-intestinal tract and cross the intestinal wall. They are distributed via blood in organs where they transform into adults. In addition, there is evidence that larvae can pass from mother to offspring. Two newborn pilot whales stranded on the French Atlantic coast: a 172 cm female weighting 50kg in July 2001and a 169 cm female weighting 56 kg in August 2002. Whales were necropsied and sampled using a standard protocol. Parasites were collected and preserved in 70% ethanol with 5% glycerin. Both animals had a massive nematode infestation in respiratory tract, at various larval stages as well as adults. Nematoda were free, others were attached by their distal end to the parenchyma. Slight bronchopneumonia was associated with the infestation. The larvae found in the 2001 pilot whale could be not identified (L3 or L4 larval stage). Parasites of the pilot whale stranded in 2002, some being adults were two species of the Pseudaliidae family: *Torynurus convolutus* and *Stenurus globicephalae*. The presence of larvae and more importantly adults, in the respiratory tract of newborns is confirms the transplacentar infestation or through the milk.

PERSISTENT ENDOCRINE DISRUPTERS IN MARINE MAMMAL RESIDENTS IN CANARIAN ISLANDS

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Canary Islands represent an area of great abundance and diversity of cetaceans. Their location in the route of a lot of migratory species and oceanographic characteristics let the establishing of resident population. There are several resident populations such as: short-finned pilot whales (*Globicephala macrorhynchus*), bottlenose dolphins (*Tursiops truncatus*), and sperm whales (*Physeter macrocephalus*). A tissue bank recovering samples of last ten years stranded animals let the study contaminant storage of each individual and their ranges in the specie. This study can offer some data of the specific zone and let us to compare them with other geographic areas. This study has been focused on the detection of some compounds, considered as endocrine disruptors, in blubber and liver of 18 cetaceans. Main effects produced by these compounds are a consequence of endocrine system and hormonal secretion alteration: reproduction disorders, immunodeficiency, and growth or development related pathologies. Cetaceans involved in the study were: 9 bottlenose dolphins, 5 short-finned pilot whales, and 5 sperm whales. GC/MS analysis was performed to detect 13 chlorinated pesticides, 11 biphenyl polychlorinated congeners and 3 organotin compounds. Bottlenose dolphins presented higher levels than sperm whales and short-finned pilot whales. Four chlorinated pesticides (DDTs, chlordane, dieldrin, hexachlorobenzene) and ten PCBs congeners were detected in 100% of animals. DDTs presented highest levels of organochlorinated. 60% of animals presented DDTs levels between 1-10 µg/g fw. Main concentration range of PCBs was 1-10 µg/g fw. 153 congener represented 32% of tPCBs. Among organotin compounds, DBT were detected in liver of 83% of animals, showed a highest concentration of 150 ng/g fw. We can assume that obtained concentrations of contaminants should be considered intermediate or low if they are compared with concentrations obtained in these species from other geographical areas.

RACE METALS IN THE HARBOUR PORPOISE FROM THE NORTH SEA AND ADJACENT AREAS: RELATIONSHIP WITH STABLE ISOTOPE MEASUREMENTS, THE NUTRITIONAL STATUS, LESIONS OF THE RESPIRATORY SYSTEM AND PARASITISM

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Growing concern has been raised about the status and the long-term viability of the harbour porpoise (Phocoena phocoena) in the North Sea and adjacent areas. Sources of trace metal variations were investigated using a multidisciplinary approach. Porpoises from the Belgian coasts were compared to individuals from the German North Sea and Baltic coasts, Denmark, Norway and Iceland. Toxicological results (Hg, Zn, Cu, Cd and Se) were confronted to most common pathological findings, namely emaciation, lesions of the respiratory system or parasitism. Influence of diet through stable carbon and nitrogen analysis (d13C and d15N), age and sex have also been considered. As expected, the nutritional status of stranded harbour porpoise from the Southern North Sea is poor compared to by-caught individuals from Norway and Iceland, as reflected by their blubber thickness, weight to length ratio and hepatic to total body mass ratio. The porpoises collected along the Southern North Sea coast display higher Zn and Hg concentrations compared to individuals collected in more preserved areas from the North Atlantic. Moreover, significant Zn, Hg and Se levels were observed with increasing emaciation severity. Porpoises displaying severe bronchopneumonia also have higher Zn concentrations probably due to the association previously described of emaciation and bronchopneumonia. Hg is clearly linked to parasitism. These increasing concentrations are not related to a shrinking of liver mass as it remains unchanged during the emaciation. As a result, hepatic trace metal load increases also. These observations tend to indicate a general redistribution of heavy metals within the organs (muscles to livers), which results from protein catabolism. Such a re-distribution could well be an additional stress for porpoises already experiencing stressful conditions (organochlorines, etc…). In contrast, Cu and Cd were never associated to emaciation. Other parameters such as age class or diet are more likely to be involved.

POSTMORTEM EXAMINATIONS OF BY-CAUGHT COMMON DOLPHINS IN THE UK

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Between January 1991 and December 2002, 324 common dolphins (*Delphinus delphis*) found stranded around the coastline of the UK were examined at postmortem as part of an ongoing government funded project. Of the 262 where a cause of death was established, 172 (97 males, 74 females and one of unknown sex) were diagnosed to have been fatally entangled in fishing gear (by-catch). This represents the single largest cause of mortality of UK stranded common dolphins and is thought to result from interactions with pelagic (mid-water) trawl fisheries. The by-caught dolphins examined comprised 94 adults, four sub-adults and 73 juveniles, a pattern dissimilar to that found with harbour porpoises (*Phocoena phocoena*) where more juveniles than adults are by-caught. This reflects the different fishing methods that affect each species. Typical findings on postmortem included good nutritive condition, evidence of recently ingested prey, muscle tearing, haemorrhage and penetrating wounds within the body wall. High numbers of by-caught dolphins were recorded in 1992, 1994 and 2001-2, although this was thought to be primarily a result of strong onshore winds. An extremely seasonal pattern was noted, with 135 (78.4%) of the by-caught dolphins stranding in the first three months of the year. In addition, by-catch appeared to be highly localised with 154 (89.5%) stranding in Cornwall and Devon, reflecting the south-west's proximity to pelagic fisheries. Accurate estimates of population size and management units in both UK and European waters are difficult to gauge. This, together with the removal of a large number of sexually mature adults through by-catch each year, means that the true scale and long term effects of this annual mortality are uncertain.

PRELIMINARY EAR ANALYSIS REPORT OF THE 2002 CANARY ISLANDS *ZIPHIUS* MASS STRANDING

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The analysis of the ears has become a challenging research in the post-mortem study of any stranded cetacean. Its importance and repercussion in cetacean stranding and/or death may exceed any estimation regarding cetacean acoustic impairment. In September 2002, a massive stranding of 14 animals belonging to three different ziphidae family species took place in the Canary Islands. The spatio-temporal coincidence of this event with NATO maneuvers, also reported in other historical mass strandings, made specially relevant an exhaustive study of the individuals acoustic apparatus in order to confirm or discard the implication of specific sound sources in the cetacean death. Necropsies on ten carcasses were performed between 24 and 72h postmortem following standard procedures. The ear regions of seven animals were carefully examined by extracting either a block with surrounding bone, the isolated ear complex or the periotic bone. Fixation was further performed either by immersion or by injection through the inner ear windows. The ears were analyzed by imaging techniques like CT and MRI and processed for routine H/E staining histopathology after decalcification. The paraotic sinuses did not show other alterations than being swollen with air and foam with partially empty surrounding venous plexuses. Except for three cases presenting slight peribullary and acoustic fat hemorrhages, the periotic complex and middle ear were not affected macroscopically. The middle ear rete mirabile was depleted with a certain degree of congestion. The most remarkable features were inner ear hemorrhages and edema starting in the VIIIth cranial nerve and extending into the spiral ganglion and the cochlear channels. In addition, inner ear structural damages were found. These findings are consistent with the lesions observed in other organs, in particular the brain, confirming as the only non-discarded cause of death, an acoustically induced trauma.

BIOACCUMULATION OF VANADIUM IN LIVER AND KIDNEY OF SMALL CETACEANS ALONG THE FRENCH COASTS AFTER THE ERIKA OIL SPILL

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INTRODUCTION The Erika oil spill occurred on the 12 of December 1999, 70 km off south Finistere coast in Brittany, France. About 20 000 tonnes of heavy fuel oil were spilled in the ocean. A few days later, 400 km of coastline were impacted. Erika heavy fuel oil was not very volatile and soluble, and can not be dispersed (Oudot, 2000). A long oil slicks drift was observed and then pelagic ecosystems were on a long-term exposed.

Visual effects of oil are an increasing of mortality rates ; then oil may change ecosystem's structure by mortality of the more exposed species. Pathological effects can be observed due to chemical exposure. To assess the effects of the Erika oil spill on cetaceans, we can observe first changes in abundance and distribution due to reduced prey resources. Secondly, we can detect changes in the diet's composition because of changes prey availability. Then we can observe an increasing of oil compounds in tissues. This third aspect, using marker of oil, constitute the aim of our study.

The Erika oil was composed of hydrocarbons and metallic elements. As hydrocarbons do not accumulate in tissues due to a quick biodegradation through the marine food web and metabolism in top predators, we can't use them as markers of pollution. By contrast, metallic elements, contained in oil, are generally accumulated through the food web, and then constitute good markers of eventual oil's exposition through contaminated food. The metallic marker we chose was the main metal component of the oil, the vanadium.

Both volcanic activity and erosion of the earth's crust are the natural sources of vanadium in the ocean (Nriagu, 1990). Environmental levels of vanadium are increasing because of the injection of vanadium from anthropogenic sources (Nriagu and Pirrone, 1998). The main anthropogenic source of vanadium is combustion of fossil fuels, industrial and domestic effluents as well as leaks during extraction, manipulation and transport are also possible sources.

Marine mammals and their preys are potential targets of elements present in their environment (André, 1988). Their contamination can occur directly or by trophic way. This last contamination, by food, remains the main way of exposition of mammals to metals (Aguilar *et al.*, 1999). In our study, we want to underscore a potential exposition by oil and not toxicity.

MATERIALS AND METHODS **Samples** Two species of small cetaceans, common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*) were used in this study. Liver and kidney samples were collected from 132 common dolphins and 26 striped dolphins found dead along the French coasts between 1999 and 2002. These animals were supplied by the CRMM (Centre de Recherche sur les Mammifères Marins, La Rochelle, France) and his RNE along the littoral (Réseau National d'Echouage). Three geographical zones were defined according to the impact of the oil spill (Fig. 1). The spatial and annual distributions were reported in Table 1.

Age determination of the animals from witch the samples were taken was done by means of counting the annual growth layers in dentine of tooth (Perrin and Myrick, 1980).

The following information about the animal was recorded at the time collection: sex, morphological parameters (length, weight, etc.), manner of death, date time and location of collection.

Chemical analysis The samples kept frozen at –20°C until analyses. The tissues were dried then ground to a powder. 200 mg of dry tissue was weighted and digested with 5mL of pure nitric acid (Merck, Strasbourg, France). Samples were digested in Corning (conic tubes of 50 mL, pierced on the top) using a microwave digester (MARS 5, CEM Corporation, USA). The microwave parameters were 1200W power, a ramp time of 20 minutes and a hold time of 10 minutes at 115°C. Then the digested contents made up to 50 mL with ultra pure water and subjected to ICP/MS analyses (Inductively Coupled Plasma Mass Spectrometry; Ultra-Mass 700, Varian). Measurement conditions of ICP/MS were shown in Table 2.

The analytical method was checked by analysing standard reference materials. Accuracy of the analysis was calibrated using Tort-2 (hepatopancreas of lobster, CNRC). Method reproducibility was 106% ± 2.31%. The limit of detection in 200 mg sample of dry weight was 0.0025 $\mu g.g^{-1}$ dry weight.

Statistical methods Data were analysed with ANOVA one factor or two factors (parametric test) and with Mann-Withney-Wilcoxon test or Kruskall-Wallis test (non parametric test), using Minitab 1.20 and XLSTATPro 5.1. Even after transformation the data could not consider normally distributed, hence non-parametric tests have been used (Sherrer, 1984; Quinn and Keough, 2002).

RESULTS Vanadium levels in small cetaceans along the French coasts Our first results focused on the study of distribution of vanadium concentrations. The concentrations of vanadium in the liver and the kidney of 132 common dolphins and 26 striped dolphins are listed in table 3. All our results are expressed in $\mu g.g^{-1}$ of dry wet unless otherwise noted.

Hepatic concentrations are higher than kidney concentrations. Additionally, with almost the same mean age, vanadium in the liver is higher in common dolphin than in striped dolphin.

The vanadium distribution is similar to previous results in marine mammals (Frank *et al.*, 1992; Mackey *et al.*, 1996; Tsiani and Fantus, 1997; Saeki *et al.*, 1999).

Correlation of vanadium concentrations with age and sex We investigated the relationship between age and vanadium concentrations in the liver and the kidney of the two cetaceans species studied (Figures 2 and 3).

Hepatic concentrations show a logarithmic increase. Until 5 years old, concentrations rise linearly with age. Then we can consider the curve reaches a plateau for adults in spite of the important variation in adults' concentrations. Therefore we can conclude that hepatic vanadium concentrations in these two species were significantly correlated to age ($F = 31.46$; $p < 0.001$ for common dolphin and $F = 7.07$; $p = 0.002$ for striped dolphin). Some authors reported linear correlation with hepatic vanadium concentrations and age, observed in cetaceans and seals (Frank *et al.*, 1992; Mackey *et al.*, 1996; Saeki *et al.*, 1999).

Whatever the age, vanadium concentrations in the kidney stayed in the same range. That's why we can consider that the accumulation of vanadium in the kidney is not correlated to age. This suggests that this element is regulated in this tissue. To confirm this, we study the relationship between vanadium concentrations in liver and those in kidney (Fig. 4). Even if vanadium concentrations in liver increased, concentrations in kidney stayed relatively constant. So vanadium may be regulated in the kidney, and for the following results, we only considered vanadium concentrations in the liver.

When compared the accumulation of vanadium against age and sex, no significant difference in accumulation could be observed between males and females for common and striped dolphins neither in the liver and nor the kidney. Since no variation with sex was observed, males and females have been grouped together for the next analyses.

Effects of the Erika oil spill on cetaceans Having considered the biological factors that influence vanadium accumulation in tissues, we could examine possible effects of the Erika oil spill on cetaceans.

We have chosen our most represented species in our sampling, common dolphins, which also happen to have an even distribution in space and time (Table 4). Based on this sampling of common dolphins, comparisons of vanadium concentrations according to the period (before and after the spill) and according to the three geographical zones could be investigated.

Vanadium concentrations found before and after the oil spill are reported in table 5. The mean age was not significantly different between these two periods. Concentrations were 0.53 $\mu g.g^{-1}$ of dry weight before and 0.45 after the oil spill. No significant difference was observed before and after the Erika oil spill ($F = 2.25$; $p = 0.11$). This result suggests that in this study no acute exposure to vanadium of Erika has occurred by trophic way.

When compared concentrations measured in specimens of impacted areas and those of non impacted, significant differences were observed for adults' concentrations ($F = 3.85$; $p = 0.006$). The specimens stranded in north and south had higher concentrations than those stranded in the impacted area. Therefore, north and south French coasts seemed more contaminated, reflecting the degree of contamination of environment. And this may reflect anthropogenic input to the marine environment.

Levels of vanadium contamination between geographical areas Vanadium concentrations in the liver tissues of 132 common dolphins and 26 striped dolphins are listed in table 6 together with concentrations reported in the literature for other species of marine mammals. Vanadium concentrations of common and striped dolphins are ten times higher than those measured in the North-West Atlantic. But they are in the same range than those reported in Alaska. Thus, vanadium concentrations along the French coasts are similar to levels observed in regions characterised by chronic oil contamination (Mackey *et al.*, 1996; Mochizuki *et al.*, 1999).

CONCLUSION Our study has not revealed any acute contamination of the pelagic food web as a consequence of the Erika oil spill. Besides, high levels of vanadium contamination were found, suggesting chronic exposure to vanadium from oil or other source. These high levels may have masked acute exposition to vanadium of Erika oil spill. In spite of high levels, north and south French coasts seemed more contaminated, reflecting the degree of contamination of environment. And this may reflect anthropogenic input to the marine environment. Further analyses must be done in hard tissues. Vanadium accumulates at long term in sites of mineralization and teeth can constitute storage tissue. With these analyses, it could be easier to detect acute exposure. Next, we suggest vanadium measurements be made in preys in order to explain differences of contamination levels between areas. And at last, we would have to correlate stranding areas and habitat areas of small cetaceans in order to be sure that stranding areas is related to the areas where they live.

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Table 1. Sampling before the Erika oil spill (1999), during the year *Erika* (2000) and after the Erika oil spill (2001 and 2002). (N: north and S: south)

		Delphinus delphis		***Stenella coeruleoalba***	
		Male	Female	Male	Female
1999	N. non impacted zone	0	0	0	0
	Impacted zone	3	3	3	2
	S. non nimpacted zone	8	2	4	1
2000	N. non impacted zone	0	0	0	0
	Impacted zone	14	17	2	2
	S. non nimpacted zone	5	9	1	1
2001 - 2002	N. non impacted zone	0	30	0	0
	Impacted zone	5	4	5	1
	S. non nimpacted zone	18	14	2	2

Table 2. Measurement conditions of ICP/MS (Ultra-Mass 700, Varian)

Mass spectrometer and interface	**Data acquisition parameters**
RF power: 1,25 kW Auxiliary flow: 1,15 L/min Nebulizer flow: 0,98 L/min Plasma flow: 15,0 L/min Pump rate: 18 rpm Sampling and skimmer cones: nickel	Automatic mode Peak hopping Data acquisition for the scanning mode: - number of point per peak: 1 - number of scan per replicate: 15 - number of replicates per sample: 5 - analysis time for the replicates: 7,02 s - dwell time: 50 000 µs Data acquisition for sample: - time sample-plasma: 45 s - quick speed of pomp for taking sample and rinse. - stabilization time: 20 s - rinse: 60 s

Table 3. Vanadium concentrations (in $\mu g.g^{-1}$ of dry weight) in marine mammals liver and kidney tissues. (n: number of samples ; SD: standard deviation)

Species	**n**	**Age**	**Liver**	**Kidney**
		mean ± SD range	mean ± SD range	mean ± SD range
Common dolphin ***Delphinus delphis***	132	7.52 ± 5.45 0.1 - 19	**0.46 ± 0.27** 0.04 - 1.27	**0.13 ± 0.09** 0.04 - 0.90
Striped dolphin ***Stenella coeruleoalba***	26	8.08 ± 7.30 0.2 - 23	**0.32 ± 0.28** 0.03 - 1.36	**0.09 ± 0.05** 0.02 - 0.24

Table 4. Distribution of common dolphin samples according to geographical zones and years of location

	1999	2000	2001	2002
North non impacted zone	-	-	1	29
Impacted zone	6	31	5	4
South non impacted zone	10	14	17	15

Table 5. Hepatic vanadium concentrations (µg.g^{-1} dry weight) in common dolphins before and after the Erika oil spill. (n: number of samples; SD: standard deviation)

	n	age mean ± SD range	vanadium mean ± SD range
Before Erika	16	7,7 ± 5,6 0,2 - 19	0,53 ± 0,26 0,08 - 0,93
After Erika	116	6,4 ± 4,3 0,1 - 17	0,45 ± 0,27 0,04 - 1,27

Table 6. Vanadium concentrations in µg.g^{-1} of dry weight in marine mammal liver tissue. Comparison of results of this work with literature values. (*): values reported in µg.g^{-1} of wet weight were converted to dry weight for this comparison using a ratio of 0.25 wet to dry weight

Species	Location	n	Vanadium mean ± SD range	References
Common dolphin *Delphinus delphis*	North-East bAtlantic	132	0,46 ± 0,27 0,04 -1,27	This study
Striped dolphin *Stenella coeruleoalba*		26	0,32 ± 0,28 0,03 - 1,36	
Long-finned pilot whales *Globicephala melas*	North-West Atlantic	9	- < 0,04 - 0,08 (*)	Mackey *et al.*, 1995
Common porpoise *Phocoena phocoena*		6	- < 0,04 - 0,09 (*)	
White-sided dolphin *Lagenorhynchus acutus*		4	- < 0,04 - 0,10 (*)	
Beluga whale *Delphinapterus leucas*	Arctic (Alaska)	15	0,49 ± 0,11 (*) 0,12 - 0,76 (*)	Mackey *et al.*, 1996

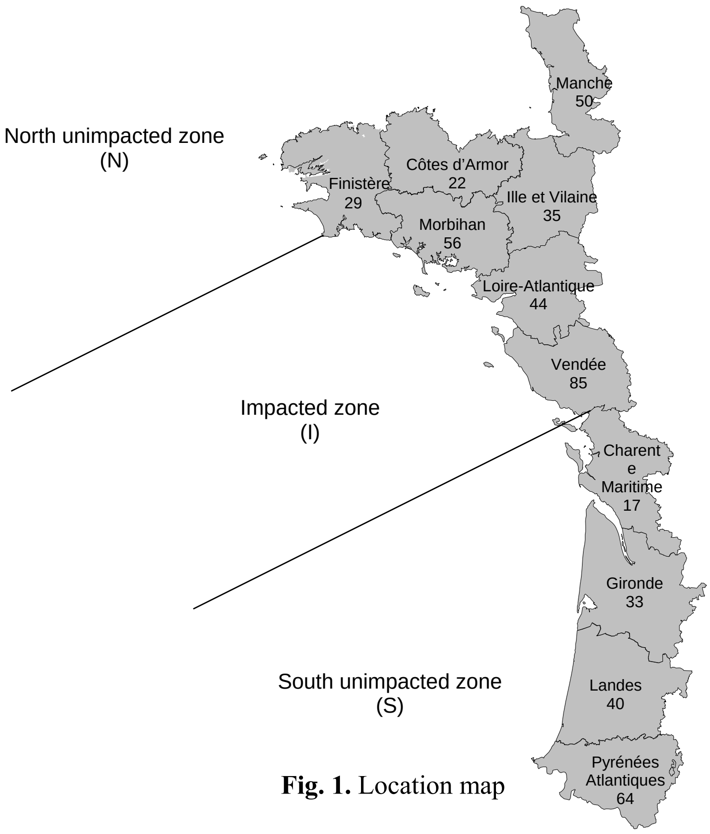

Fig. 1. Location map

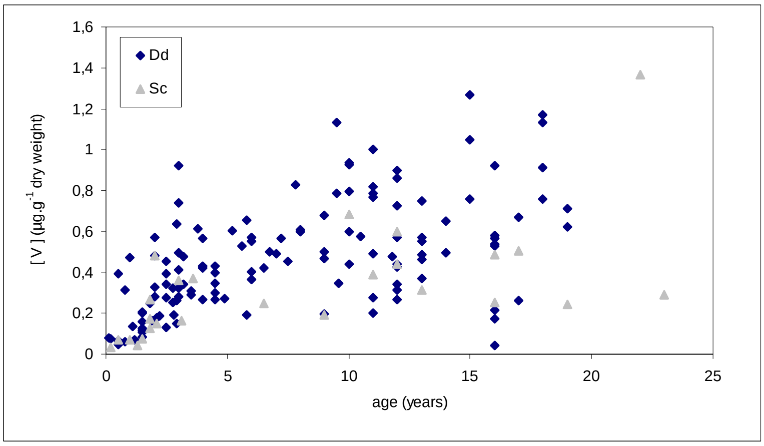

Fig. 2. Relationship between age and hepatic vanadium concentration

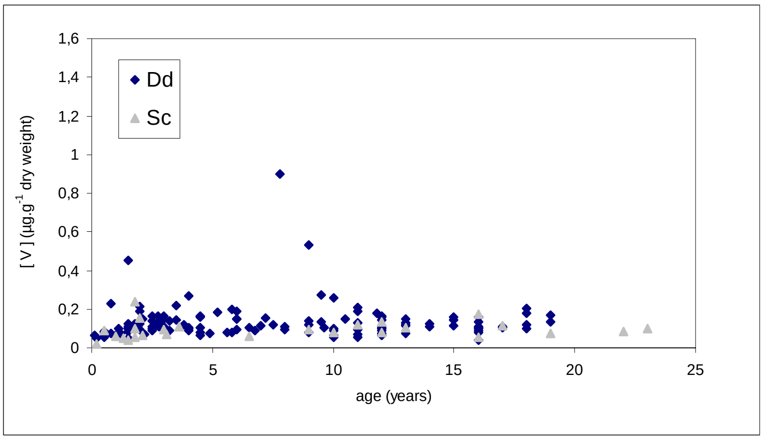

Fig. 3. Relationship between age and renal vanadium concentration

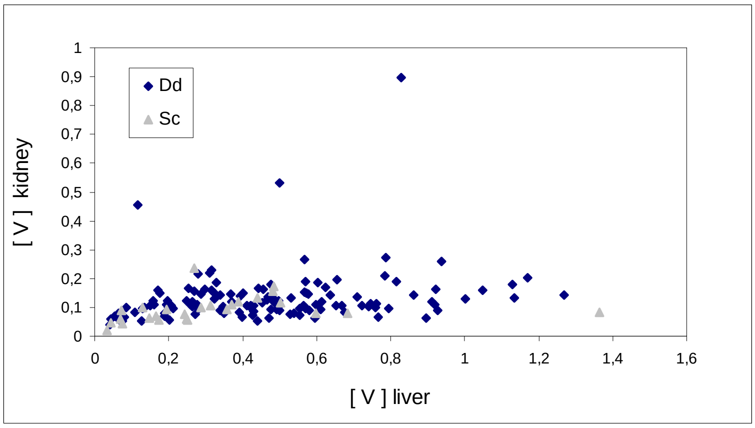

Fig. 4. Relationship between hepatic and renal vanadium concentrations (in µg.g^{-1} of dry weight)

MICROFLORA OF THE BLACK SEA BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) DURING THE DIFFERENT PERIODS OF ADAPTATION TO CAPTIVITY

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INTRODUCTION A study of a specific composition of the Black Sea Bottlenose dolphin microflora at the different periods of adaptation to captivity conditions represent an important and unlearned problem. It is known, that the specific composition of microbial associations in animal and human organisms in directly dependent on physiological state of macroorganism. Under adaptation to captivity conditions the marine mammals are subjected to an influence of a lot of unfavorable factors, in that number, a high microbial pollution of the new for then noogenic (created by a human being) environment. Besides, a specific composition of this microflora is drastically different from the natural to aphalines microbial background. By knowing the composition of organism microflora of adapting animals it is possible to determine a degree of their adaptivity and, hence, to present the disease and death of dolphins because of bacterial infections during adaptation process. Except that, at recent time an active pollution of the World Ocean waters with industrial, agricultural and gutter flowings, which leads to a lifted microbial pollution index of natural environment of wild marine mammals, is noticed. Under study of aphaline adaptation process to noogenic microflora in captivity the obtained data may serve as a model of analogical adaptation process in native populations of animals under getting worse ecological state of environment.

MATERIALS AND METHODS The study was led at the Microbiological and Immunological Department of K.I. Scryabin MSAVMandB and Utrish marine station of A.N. Severtsov IEEP RAS during 2000-2002. Dolphins of the Black Sea Bottlenose dolphin species (*Tursiops truncatus*) of different age and sex, being at various stages of adaptation to captivity were the objects of our explorations.

All studied dolphins were divided in to groups according to their time in captivity. The first group - included bottle-nosed dolphin being in captivity for one week. The second group represented the bottle-nosed dolphin of one month, the third one embraced animals of two months of captivity, the fourth one – 3-4 months of captivity, the fifth one – 6-12 months of captivity and, finally, the 6th group consisted of completely adapted animals, being in captivity more than three years, clinically healthy by the moment of the study.

For bacteriological study the following materials were obtained: smears from the upper respiratory tract (Figure 2), from the cutaneous covering, breathed - out air, blood, excrements. Sampled of bath water and air above the bath were used as controls. Material picking, transportation and study were led under aseptic conditions. Preparations for microscopy were stained according to Gram, Cyle-Nilsen, Romanovsky-Giemsa. Seedings were performed on the following mediums: meat-peptonic agar and broth, blood meat-peptonic agar with 5% sheep, bovine and dolphin blood, saline agar, Ceysslers, Kitta-Tarrocis, Saburo's agars. Biological features, namely morphology, tinctorial, cultural, enzymatic, antigenic ones, pathogenic factors, sensitivity to drugs of obtained cultures were investigated. Except that the quantitative ratio of microorganisms in materials from animals was examined.

RESULTS 8 species of microorganisms and yeast-like mycoceteae in that number were obtained from completely captivity – adapted dolphins (Table 1). Bacteria of genera Enterobacteriaceae were predominating ones, the main quantity of which was represented by *E.coli* (54%) and *Enterobacter* (19%). The rest specieses of microorganisms were isolated at less extent. All obtained bacteria were non-virulent for white mice and didn't show hemolytic activity towards sheep, bovine and dolphin erythrocytes.

From adapting animals of different stages of adaptation to captivity 22 specieses of microorganisms were isolated. Besides, specious composition of microflora of the upper respiratory tract and cutaneous coverings differed in dolphin of different groups (Table 2 and Figure 1). On the first week of adaptation to captivity gram-positive coccus (primarily *Staphylococcus*) predominated, bat *Enterobacteriaceae, Pseudomonas* and other microorganisms constituted approximately 20%; the total amount of isolated specieses was 14 ones. By the end of the first month of adaptation specious diversity of microorganisms increased by 19 species. Porall that the quantity of gram-positive coccus reduced till 60%, apart of this, the number of enterobacteria increased by 25% and *P.aeruginosa* by 14%. This microorganism ratio was maintained till the 3 months of captivity. After this period microflora specious diversity of the upper respiratory tract and cutaneous coverings of dolphins were represented by 17 species of microorganisms.In six months of captivity microflora specious composition was identical to that of completely adapted (group 6), in other words became stable by this time. For the first time *Streptococcus pneumoniae*, *Salmonella choleraesuis*, *Yersinia kristensenii*, *Campylobacter* were isolated from the Black Sea bottle-nosed dolphin by us (Figures 3 and 4).

Many microorganisms species (*Streptococcus, Staphylococcus, E.coli, P.aeruginosa*) isolated from adapting dolphin, proved to be virulent for white mice and showed hemolytic activity towards sheep, bovine and dolphin erythrocytes. The maximum sensitivity all isolated cultures demonstrated to antibiotics cyprofloxacinum and enrofloxacinum.Under study of materials picked fro the sick dolphins in 66,7% of cased the streptococcosis, in 16,7% of cases the staphylococcosis and in 16,6 of cases the escherichiosis were diagnosed.

CONCLUSIONS

1. Specious and quantitative composition of microbial associations of the upper respiratory tract and cutaneous coverings of the Black Sea bottle-nosed dolphin are reliable index of animal adaptation to captivity.
2. According to our data the animals may be considered adapted ones only after 6 months of captivity.
3. Bacteria isolated from adapting dolphins and sick animals possess virulence for white mice and hemolytic activity.
4. For the first time *Streptococcus pneumoniae*, *Salmonella choleraesuis*, *Yersinia kristensenii*, *Campylobacter* were isolated from the Black Sea bottle-nosed dolphin by us.
5. In the sick dolphins in 66,7% of cases wear diagnosed streptococcosis, in 16,7% of cases the staphylococcosis and in 16,6% of cases escherichiosis were identified.

Table 1. Microflora of the dolphins clinically healthy, completely adapted to captivity

MICROORGANISMS	Upper respiratory tract (n = 7), %	Cutaneous covering (n = 7)	Water in bath (n=11)
Escherichia *coli*	57,7±4,12	54,6 ± 4,25	62,3±5,43
Providencia	14,6±0,92	16, 3 ± 1,06	7,3±0,96
Enterobacter *aerogenes*	19,8±0,25	21,2 ± 0,93	17,54±1,04
Proteus *vulgaris*	5,3±0,13	4,81 ± 0,21	6,21±0,87
Proteus *mirabilis*	--	--	--
Hafnia *alvei*	--	--	--
Yersinia *kristensenii*	--	--	--
Citrobacter *braaki*	--	--	3,74±0,77
Salmonella *choleraesuis*	--	--	--
Salmonella *sv.*	--	--	--
Staphylococcus *epidermidis*	0,7±0,08	0,8 ± 0,02	0,12±0,05
S. *saprophyticus*	--	--	--
S. *aureus*	--	--	--
Streptococcus *pyogenes*	--	--	--
S. pneumoniae	--	--	--
S. *iniae*	--	--	--
Pseudomonas *aeruginosa*	--	--	0,41±0,03
Bacillus *cereus*	0,5±0,03	0,45 ± 0,03	0,36±0,03
Micrococcus *luteus*	0,8±0,11	0,8 ± 0,07	0,71±0,05
Campylobacter	--	--	--
Clostridium *perfringens*	--	--	1,31±0,43
Candida *albicans*	0,6±0,04	1,04±0,05	--

% - percentage of microorganism species.

Table 2. Microflora of the upper respiratory tract and cutaneous coverings of the dolphins of different adaptation terms to captivity

Microorganisms	**GROUP**				
	1. %,* n=49	**2.** %, n=98	**3.** %, n=63	**4.** %, n=56	**5.** %, n=49
Escherichia *coli*	1,4±0,07	1,9±0,15	6,3±0,32	6,5±0,33	56±2,83
Providencia	0,3±0,02	0,5±0,03	0,6±0,03	1,2±0,06	13,5±0,7
Enterobacter *aerogenes*	1,0±0,1	1,5±0,13	1,7±0,09	3,7±0,19	26±1,31
Proteus *vulgaris*	1,4±0,12	2,0±0,1	2,4±0,12	5,3±0,27	3,7±0,23
Proteus *mirabilis*	0,9±0,05	1,4±0,08	1,6±0,04	3,5±0,18	--
Hafnia *alvei*	2,4±0,12	3,4±0,17	4,0±0,02	8,8±0,45	--
Yersinia *kristensenii*	--	0,4±0,02	--	--	--
Citrobacter *braaki*	--	1,0±0,05	1,7±0,14	2,5±0,13	--
Salmonella *choleraesuis*	4,4±0,22	4,1±0,21	5,2±0,26	11±0,56	--
Salmonella *sv.*	--	0,8±0,04	0,5±0,03	1,5±0,08	--
Staphylococcus *epidermidis*	26±1,30	18,1±0,9	16±0,81	5,0±0,24	0,2±0,01
S. *saprophyticus*	3,0±0,15	9,0±0,45	8,0±0,4	--	--
S. *aureus*	48±2,40	28,1±1,4	13±0,65	3,5±0,18	--
Streptococcus *pyogenes*	1,3±0,09	0,8±0,05	3,0±0,15	--	--
S. *PNEUMONIAE*	0,7±0,04	4,0±0,18	18,7±0,9	1,0±0,05	--
S. *iniae*	--	--	0,3±0,02	--	--
Micrococcus *luteus*	--	1,0±0,11	1,0±0,05	0,5±0,03	0,2±0,01
Pseudomonas *aeruginosa*	8,2±0,4	14±0,71	7,0±0,35	35±1,75	--
Clostridium *perfringens*	--	--	3,5±0,18	4,5±0,23	--
Bacillus *cereus*	1,0±0,05	5,0±0,3	1,5±0,12	1,5±0,08	0,1±0,01
Campylobacter	--	3,0±0,02	--	--	--
Candida *albicans*	--	--	4,0±0,21	5,0±0,24	0,3±0,02

% - percentage of microorganisms specieses

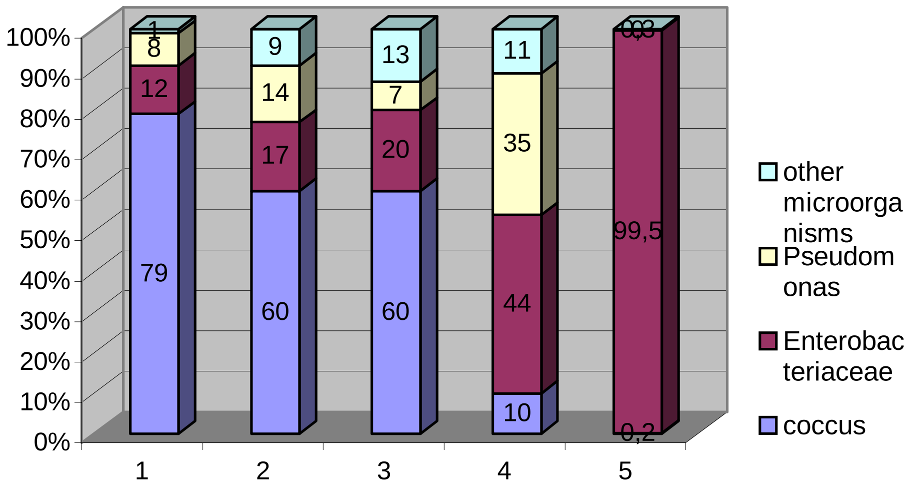

Figure. 1. Microorganism ratio in microbial associations of the upper respiratory tract and cutaneous coverings of adaptation to captivity

Figure. 2. Sampled smears from the upper respiratory tract

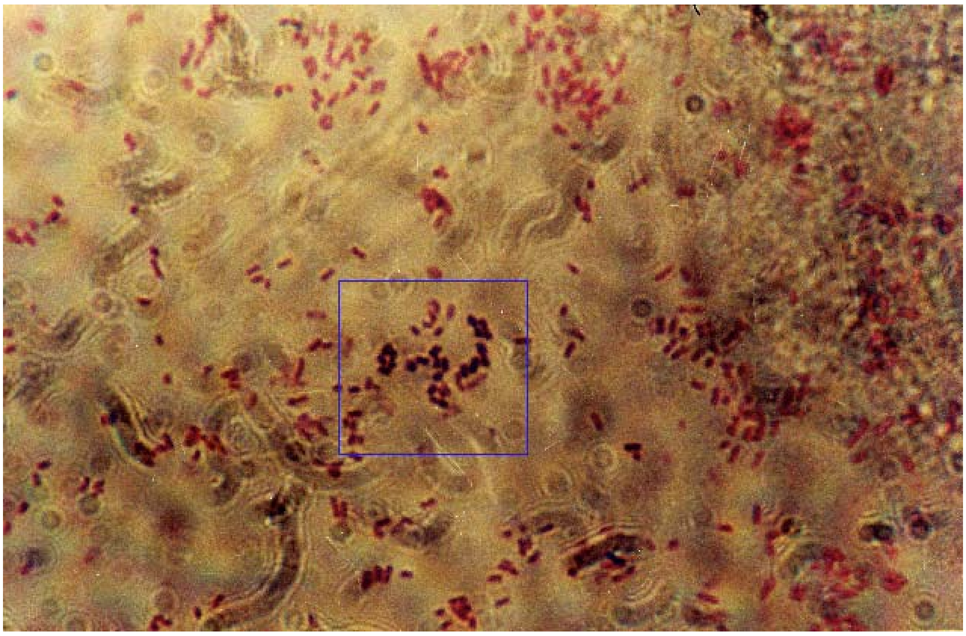

Figure. 3. Streptococcus pneumoniae in lungs the dolphin (Gram-stained, x 900)

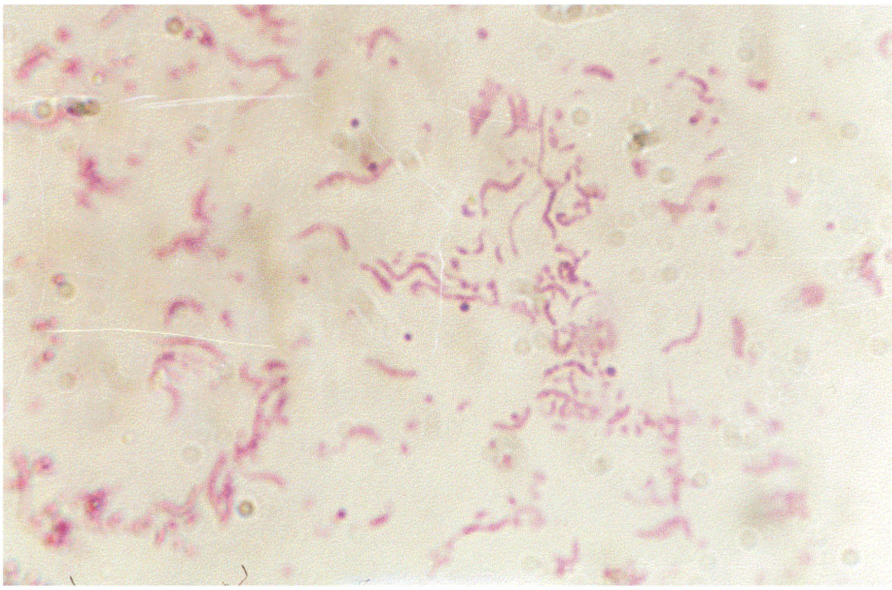

Figure. 4. Campylobacter (Gram-stained, x 900)

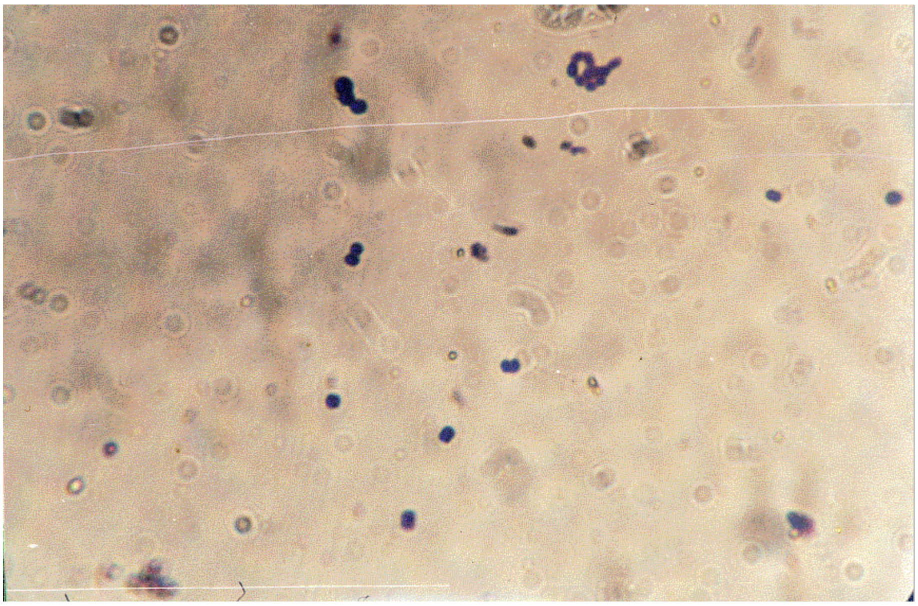

Figure. 5. Streptococcus pneumoniae (Gram-stained, x 900)

DECREASED PRODUCTIVITY AND INCREASED PUP MORTALITY AMONG NEW ZEALAND SEA LIONS (*PHOCARCTOS HOOKERI*) IN 2002

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The NZ sea lion is a threatened species and two unusual events contributed to an alarming decrease in recruitment in 2002. The first was a marked reduction of 20% in the number of pups born at the principal rookeries on the Auckland Islands. Counts of females at rookeries indicated that the lowered productivity was due to lowered fecundity rather than a reduced number of females. Hypotheses for reduced fecundity include, (1) reduced body condition of females as a result of inadequate nutrition caused foetal death and resorption, or (2) infection resulted in foetal death or abortion. In support of the former was the poor growth rate of pups in 2002 with male pups (n = 50) the lightest recorded for the previous eight years. The second hypothesis was supported by evidence of foetal death in a bycaught adult female. In addition to low pup production, the mortality rate for pups was significantly elevated and was 33% by the end of February. This is almost three times the mean for this time of year. Necropsies were conducted on 126 of 133 pups that died at Sandy Bay and for many the cause of death was multifactorial and included stillbirth, trauma, malnutrition, and severe anaemia caused by hookworm infection. However, the unusual disease syndrome that elevated mortality this season was characterized by systemic bacterial infection. This was often manifested by a variety of presentations including suppurative polyarthritis, severe necrotizing fascitis, myositis and osteomyelitis, suppurative peritonitis, pleuritis, or meningitis. For 41 pups, this syndrome was the primary cause of death and for an additional 16 pups it was a contributing factor along with hookworm infection or trauma. A consistent isolate has been *Klebsiella pneumoniae* with frequent isolations of *Salmonella* sp. Further investigations into sea lion foraging ecology and health are underway.

HISTOPATHOLOGICAL FINDINGS AND LEVELS OF TRACE ELEMENTS AND POP'S IN BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) STRANDED IN CANARY ISLANDS

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A retrospective study among 1997 and 2001, was made on resident populations of bottlenose dolphins (*Tursiops truncatus*), stranded in the Canary Islands (Spain). None of the dolphins studied (9) died with physical trauma. Histopathological studies after necropsy were realized, and toxicological studies were performed in blubber, liver and kidney from frozen samples of the tissue bank. Trace elements (Cu, Zn, Al, Cr, Cd, Pb) and organic compounds (PCB's, OC's, PAH's and organotins) were measured in blubber, liver and kidney. Other studies carried out on terrestrial mammals suggested the relationship between organochlorines and PCB's compounds and chronic pathologies such as: reproductive disorders, immunosuppressive conditions and neoplasia, affecting populations of these species and then having deleterious effect as their destabilization. Among whole values can be remarkable the following individuals: cet 78 with high levels in liver and blubber of PCB's and tDDT's, respectively (liver tPCB's: 52374 ng/g f.w.; blubber tDDT's: 15592 ng/g f.w.), and cet 124 with high levels in blubber of tPCB's and tDDT's (blubber tPCB's: 33212 ng/g f.w.; blubber tDDT's: 21050 ng/g f.w.). General histopathological findings on these individuals were related to a reactive non specific hepatitis, chronic intersticial nephritis and parasitic bronchopneumonia.With the exception of two specimens above related, tissue levels of compounds were similar to other geographical areas considered low and intermediate exposed. Although these levels of contaminants are not high, residuals are important in order to offer basic information about its potential relationships with cetacean mortality and morbidity, especially in those processes related with immune response and presence of infectious agents. In this way, further studies are being carried on to determine the presence of infectious agents (especially viruses), and its role in the pathogenicity of some histological findings.

HEPATOSPLENIC IMMUNOBLASTIC LYMPHOMA IN A BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

A. Espinosa de los Monteros[1], A. Fernández[1], J. Pérez[2], P. Herráez[1], M. Arbelo[1], T. Fernández[1], F. Guisado and J. R. Jaber[1]

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The gross, histopathological, immunohistochemical and ultrastructure features of an immunoblastic lymphoma are described in a bottlenose dolphin (*Tursiops truncatus*) found stranded alive in the coast of Gran Canaria (Canary Island, Spain). The spleen and liver were moderately enlarged because of diffuse infiltration of round neoplastic cells in splenic cords and sinuses and in hepatic sinusoids, but they were not found in other organs. Tumour cells showed scant lightly eosinophilic or basophilic cytoplasm with distinct cell boundaries and hyperchromatic nucleous with one or more nucleoli. Mitoses were common. The immunophenotype of tumour cells was IgG+ and CD3-. The ultrastructural examination revealed features of malignancy among these cells. Based on the histopathological, immunohistochemical and ultrastructural features the tumour was classified as an immunoblastic lymphoma. A possible association with high levels of polychlorinated biphenyls (PCBs) is discussed.

PATHOLOGICAL FINDINGS IN BEAKED WHALES STRANDED MASSIVELY IN THE CANARY ISLANDS (2002)

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From 24 to 27 September 2002, a mass stranding of 14 beaked whales occurred on the beaches of Fuerteventura and Lanzarote islands (Canary Islands-Spain). Seven animals (one female *Mesoplodon densirostris*, one female *Mesoplodon europaeus* and five male *Ziphius cavirostris*) were found dead the 24th of September, while the rest of the cetaceans were returned to deeper waters alive. Four more beaked whales were found dead the following days (25th and 27th). The necropsy of six fresh animals was performed the 24th, preserving the heads at 4ºC, until they were carefully analysed the 25th, in the Department of Veterinary Pathology (Veterinary School-University of Las Palmas de Gran Canaria). One male *Ziphius cavirostris* moderately autolitic was completely necropsied the 25th in Fuerteventura and three autolitic carcasses of two males and one female *Ziphius cavirostris* were analysed the 25th (Lanzarote) and 27th (Fuerteventura) respectively. We systematically took samples from all necropsied cetaceans and all of them were processed for their corresponding histopathological study. The epidemiological data, the gross and the histopathological results revealed that the ten animals died within the 24 hours period which would span a 6-12 hours prior to and after the appearance of the first stranded beaked whale, at around 7 am, 24th of September, 2002. At necropsy, all animals but one were in very good condition, and the macroscopic and microscopic studies of organ and tissue samples discarded previous existence of either degenerative, inflammatory and neoplastic processes or lesions related to injury caused by ships, fishing gear or other objects. On the other hand, the amount of gastric content, its freshness and digestive status reinforce that the period between the action of the "death-causing agent" and the death itself was short. We describe a mass stranding involving beaked whales showing a very characteristic and unusual pathological picture that coincided temporally and spatially with ongoing naval military manoeuvres.

BRUCELLA SEROLOGY OF HARBOUR PORPOISE *PHOCOENA PHOCOENA* STRANDED AND BYCAUGHT IN DUTCH WATERS (1995-2002)

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In this study 71 harbour porpoises were tested using serum/blood and pericardial fluid. Other samples, e.g. milk, were used when available. Two indirect and a competitive ELISA were routinely performed using sera and pericardial fluid from marine mammals. A *B. melitensis* LPS antigen was used in an indirect and in the competitive ELISA, a *B. abortus* LPS antigen for the second indirect ELISA. All conjugates are horseradish peroxidase labelled, the indirect Elisa's use a protein A and the competitive ELISA a monoclonal anti M antibody. Diagnostic thresholds are set for marine mammals with uncertainty, but are based on experience gained from routine testing of a wide range of terrestrial species. Of 71 porpoises tested 22 showed a titer (31%). Divided by sex 25% of males had a titer against 33% of females. Dutch porpoises show a low pregancy rate, evidence of a high pollutant burden, and a high level of diseases. Exposure to *Brucella* may have an additional negative influence on reproduction in this population.

PROFILE OF PORPOISES BYCAUGHT IN DANISH POUND NETS IN 1997-2002

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Harbour porpoises by-caught live in pound nets were examined in 1997-2002 in the framework of the Danish satellite tagging program, for determining their health status. Standard length, weight, girth and blubber thickness measurements were taken along with blood sample. Results are compared with data from by-caught animals and long term data from the porpoises kept at the Fjord&Bælt. A total of 67 porpoises were examined between April and November. Of these 45 (67%) were <130 cm, and most were males with an overall sex ratio of 1,4. This compares well with the picture obtained from the 149 porpoises by-caught in Danish waters in the period 1986-89, with a sex ration of 1,37 and immature animals (less than 3 years old) totalising 76,5 % of the porpoises. In pound nets, small animals (<130 cm) are caught in April and May with the large females, whereas the large males are caught in August. Weight, girth and blubber thickness are inversely related with sea temperature in captive porpoises, indicating that one role of blubber is insulation, and the overall thickness of the blubber decreases with age. The male and female porpoises exhibited their thickest blubber in their first winter of captivity (35 and 42 mm, respectively), with the winter thickness decreasing since. Summer thickness is around 15-20 mm. Small pound-net porpoises have thicker blubber than larger individuals. The thickest blubber (35 mm) is seen in small animals in April and the lowest values are from larger animals in June and August (15 mm). Overall, nothing indicates that the porpoises by-caught in pound nets are any different from porpoises by-caught in gillnets in terms of external measurements. Contrary to previous findings, they appear as normal and generally healthy individuals, which likely got entrapped when searching for or following prey into the pound net.

HEPATOSPLENIC IMMUNOBLASTIC LYMPHOMA IN A BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

P. Herráez[1], A. Fernández[1], J. Pérez[2], A. Espinosa de los Monteros[1], M. Arbelo[1], T. Fernández[1], F. Guisado and J. R. Jaber[1]

[1]*Departamento de Morfología, Facultad de Veterinaria de Las Palmas de Gran Canaria.Trasmontaña s/n. Arucas. 35416. Canary Islands. Spain.*
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The gross, histopathological, immunohistochemical and ultrastructure features of an immunoblastic lymphoma are described in a bottlenose dolphin (*Tursiops truncatus*) found stranded alive in the coast of Gran Canaria (Canary Island, Spain). The spleen and liver were moderately enlarged because of diffuse infiltration of round neoplastic cells in splenic cords and sinuses and in hepatic sinusoids, but they were not found in other organs. Tumour cells showed scant lightly eosinophilic or basophilic cytoplasm with distinct cell boundaries and hyperchromatic nucleous with one or more nucleoli. Mitoses were common. The immunophenotype of tumour cells was IgG+ and CD3-. The ultrastructural examination revealed features of malignancy among these cells. Based on the histopathological, immunohistochemical and ultrastructural features the tumour was classified as an immunoblastic lymphoma. A possible association with high levels of polychlorinated biphenyls (PCBs) is discussed.

IMMUNOHISTOCHEMICAL CHARACTERISATION OF THE INFLAMMATORY INFILTRATE OF HEPATIC LESIONS AND LYMPH NODES OF STRIPED DOLPHINS

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This study describes the immunophenotype of the inflammatory infiltrate associated to hepatic lesions observed in 10 striped dolphins (*Stenella coeruleoalba*). The distribution of T lymphocytes (CD3), plasma cells producing IgG, macrophages, MHC class II antigen and S-100 protein was analyzed both in hepatic lesions and lymph nodes. Non specific chronic reactive hepatitis was identified in 8 dolphins, whereas chronic parasitic cholangitis with lymphoid proliferation and portal-portal bridging fibrosis was observed in two other dolphins. Non specific chronic reactive hepatitis showed variable numbers of CD3+ T cells in portal spaces and hepatic sinusoids. The majority of plasma cells observed in portal areas and in less degree in hepatic sinusoids expressed IgG+. Some macrophages located in portal areas, as well as Kupffer cells, and circulating monocytes were lysozyme+. Lymphonodular aggregates observed in chronic parasitic cholangitis showed a cellular distribution similar to that found in lymph nodes. Thus, lymphoid follicles showed a sparse number of CD3+ T lymphocytes, however, interfollicular tissue areas were composed mainly of CD3+ T lymphocytes. Stellate cells similar to follicular dendritic and interdigitating cells expressing S-100 protein and MHC class II antigen were found in lymphonodular aggregates, suggesting that those inflammatory infiltrates are highly organised to enhance antigen presentation to B and T cells.

CAUSES OF DEATH OF SMALL CETACEANS AND PINNIPEDS ON CONTINENTAL COASTLINES OF THE SOUTHERN NORTH SEA

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The multidisciplinary research group MARIN (Marine Animals Research and Intervention Network) is in charge of necropsies of marine mammal stranded along the coasts of Belgium and Northern France and identification of death causes. Between 1990 and 2000, 55 porpoises were necropsied and the most common findings were severe emaciation; acute bronchopneumonia; and extended and severe internal parasitosis. By-catch in fishing nets was considered to be the cause of death of 18 % of porpoises. The gastro-intestinal tract was usually empty, without evidence of recent feeding. Bronchopneumonia was frequently associated with parasitosis, emaciation, or both. These are two chronic, debilitating processes that might favor fatal bronchopneumoniae. No evidence of morbillivirus or other viral infection was identified by immunohistochemistry or cell cultures. Thirty-four seals were necropsied; the main findings were emaciation, acute broncho-pneumonia and enteritis. Additional lesions were traumatic such as haemorrhages, multiple rib fractures and cases of peritonitis associated with gastric perforation by foreign body. Between 1998 and 2000, 12 seals were infected by a morbillivirus starting in 1998 when an unexpected stranding of 16 seals within a month. Diagnosis was based on immunohistochemistry and RT-PCR. Two separate causes of death were identified on carcasses: those related to an acute morbid process, usually associated with non-infectious lesions (haemorrhages, rib fractures) and those related to a chronic morbid process, usually infectious and frequently associated with morbillivirus infection. Distemper among seals stranded on the Belgian and northern France coastline seems to be the first cases reported in the North Sea since the 1988-1989 outbreak. At that time, 18.000 harbour seals died on a population of 25.000. So far, in the 2002 epizootics, a mortality of over than 21.000 individuals was observed in less than 6 months.

NOVEL CETACEAN GAS BUBBLE INJURIES: ACOUSTICALLY INDUCED DECOMPRESSION SICKNESS?

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Although marine mammals are widely considered to have evolved adaptations to avoid decompression sickness (DCS), a theoretical risk of a DCS-like condition being induced by exposure to acoustic activity such as underwater military sonar has recently been established. However, evidence of in vivo gas bubble formation, whether acoustically driven or naturally occurring has never been demonstrated in a marine mammal. The novel pathological findings in this study provide the first empirical evidence of a DCS-like condition in seven UK-stranded cetaceans. Three Risso's dolphins (Grampus griseus), two common dolphins (Delphinus delphis), a Blainville's beaked whale (Mesoplodon densirostris) and a harbour porpoise (Phocoena phocoena) had gas bubbles in a variety of parenchymatous organs and within blood vessels. The liver was most severely and consistently affected, with combinations of microscopic gas bubbles, macroscopic gas-filled cavitary lesions (0.2 - 6.0 cm in diameter) and peri-cavitary fibrosis occupying up to 90% of the liver volume. One case also had multiple gas bubble-associated renal infarcts. We propose that generation and expansion of nitrogen bubbles in nitrogen-supersaturated tissues (decompression sickness), potentially initiated by acoustic activation of nitrogen bubble nuclei following exposure to high-intensity anthropogenic underwater sound, as the most likely cause of this novel DCS-like disease of cetaceans.

PARASITOLOGICAL FINDINGS IN HARBOUR SEALS (*PHOCA VITULINA*) AND GREY SEALS (*HALICHOERUS GRYPUS*) STRANDED ALONG THE COASTS OF SCHLESWIG-HOLSTEIN, GERMANY, DURING THE PDV-EPIDEMIC IN 2002

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As part of a monitoring programme in Schleswig-Holstein, Germany, seals are investigated for their health status. Special attention is given to parasites as major agents of infection.Samples included in this investigation originated from dead harbour seals and grey seals collected along the coast in 2002 during the seal-epidemic. Parasites were collected during necropsies, preserved in 70% Ethanol and identified according to scientific literature after preparation in Lactophenol under the microscope. Pathological alterations of organs due to parasites were considered. Several species of parasites could be isolated from the investigated organs, including endoparasites (Cestodes, Nematodes, Acanthocephalans) and ectoparasites (Anoplura). Harbour seals showed mixed infections with different species of lung nematodes, which often induced secondary bacterial infections and bronchiopneumonia. Frequently found lung nematode species in harbour seals were *Otostrongylus circumlitus* and *Parafilaroides gymnurus*. Prevalence of infection with *O. circumlitus* and *P. gymnurus* was 29%, prevalence of the Acanthocephalan *C. strumosum* in the intestine was 58% in the investigated harbour seals. The intensity of infection with parasites in the lungs of seals decreased with age. This could signify that infection with these lungnematodes in young seals plays an important role as natural cause of death in North Sea seal-populations. Infection with *C. strumosum* increased with age. Only one seal investigated which was infested with lice also showed an infection with *D. spirocauda*. Nearly 50% of the investigated seals were tested PDV-positive. No difference in parasitic infestation between PDV-positive and –negative animals was seen. This suggests that the condition of seals infected with morbillivirus is deteriorating very fast so that no infestation with lungnematodes can occur prior to death. The comparison of parasitic infection in animals from previous years proves difficult because - in contrast to the last years - the majority of the investigated animals consisted of adult seals.

PULMONARY ALVEOLAR HYPOPLASIA IN A STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

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This is the first case of pulmonary alveolar hypoplasia described in cetacean pathology. It was described in a striped young female dolphin (*Stenella coeruleoalba*). The necropsy was performed at the Department of Public Health of the Faculty of Veterinary Medicine of the University of Padua, following the guidelines of the ECS protocol. The main finding were symmetric and severe areas of pulmonary alveolar hypoplasia, localized in the dorso-medial lobes of the lungs: these portions were characterized, both macroscopically and histologically, by a progressive loss of the alveolar and interstitial components and the maintenance of the bronchiolar and saccular structures. Other important findings were serious parasitic infestations in various organs and tissues associated with various reactions lesions: a lot of ectoparasites, *Penella* sp. localized in the belly, ano-genital and flanks areas; a severe infestation of the blubber and abdominal walls by *Phyllobothrium* sp. and of peritoneal cavity by *Monorygma* sp.; trematode ova and flukes, possibly identified as *Pholeter* sp. Trematode ova were find in the glandular and pyloric gastric compartments; trematode ova were find also in sections of gastric lymphonodes associated; another finding was an interstitial parasitic bronco-pneumonia. The subject appeared emaciated. Pulmonary alveolar hypoplasia has a low incidence. Usually it's due to congenital causes that inhibit the physiological growth. The partial loss of alveolar component is probably due to a factor that inhibit the normal development of pulmonary parenchyma in the alveolar stage in the peri-partum. It determined a partial respiratory failure and a conseguent alteration of the physiological behavior. The animal became emaciated and this condition permitted a severe and diffuse parasitic infestations, that were the probable cause of death.

HOODED SEAL STRANDINGS OFF THEIR NORMAL DISTRIBUTION IN 2001: A CYCLICAL ANOMALY IN CRESCENDO?

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An unprescedented number of hooded seals (*Cystophora cristata*) stranded or were sighted during 2001 down the western and eastern coasts of the North Atlantic, off their normal arctic distribution. Hooded seal juveniles have been known to wander fairly large distances, and have been found far south in previous years; however, never before to the extent observed in 2001. By the end of the year, 134 individuals were reported from as far south as the Caribbean island of Antigua in the west and the Canary Islands in the east. We gathered hooded seal stranding and sighting records from stranding, wildlife and research centers on both sides of the North Atlantic and analyzed them for temporal, seasonal and geographical patterns, among others. In 2001, 66% of the seals were reported in or after July, also a unusual seasonal pattern, as most stray hooded seals arrive in the U.S. New England region, for example, during winter. The hooded seals found were mostly emaciated and dehydrated, many suffering from heat exhaustion. Three of the ones rescued farthest south and that survived (one in the Caribbean and two in the Canary Islands), were released up north, and one is at present being tracked with a satellite transmitter. The stray records of 2001 constituted about 26% of all stray records for this species documented since the early 1900s. After the mid 1990s, the events appear to be cyclical in nature, with high-peak strandings in 1996, 1998 and 2001. Furthermore, the number of strandings in these peak years increased significantly from 62 to 110 to 134, respectively. The reasons for these anomalous events are still unknown, but an increasing number of strandings and sightings of arctic seals have been reported in the past six years. Before this, sightings and strandings of these arctic seals were infrequent.

CASES OF MORBILLIVIRUS INFECTIONS AMONG SEALS (*PHOCA VITULINA*) AND FIN WHALES (*BALAENOPTERA PHYSALUS*) STRANDED ON THE BELGIAN AND NORTHERN FRENCH COAST FROM 1997 UNTIL 2002

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MARIN is the Belgian stranding network working from the Schelde Estuary to the north of France (to Le Havre). Since 1990, stranded marine mammals are necropsied and sampled following standard procedure at the University of Liège. The most frequent species are common seals (*Phoca vitulina*) and harbour porpoises (*Phocoena phocoena*) but a few fin whales (*Balaenoptera physalus*) have also been reported. All animals were tested for morbillivirus infection using immunohistochemistry (IHC) and RT-PCR. To specify the type of morbillivirus involved, various specific monoclonal antibodies were used (IHC), as well as two specific primers sets (RT-PCR) amplifying 250 pb of the gene of the phosphoprotein, respectively from the distemper virus and from the cetacean morbillivirus (CMV). The specific primers were unable to cross-react with another type of morbillivirus. From 1998 to 2002, sixteen seals were positive: eight in 1998, two in 1999, two in 2000, one in 2001 and five in 2002. In addition, two fin whales, respectively stranded in 1997 and 1998 were positive, while other species were negative. The cDNAs amplified by RT-PCR were sequenced and show that most seals were infected by a virus similar to CMV, this being the first report of this virus among common seals. Our tests also showed two individuals carrying a virus similar to the Canine Distemper Virus (CDV). The two positive fin whales seemed to be infected by a virus similar to the Cetacean Morbillivirus, representing the first evidence of such a virus infection among baleen whales.

RE-EMERGENCE OF PHOCINE DISTEMPER IN THE HARBOUR SEAL POPULATION OF NORTHERN EUROPE

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In the spring of 2002, increased mortality of harbour seals (Phoca vitulina) was observed in Northern Europe, with a total of 1160 dead seals along Scandinavian coasts, and over 50 in the Netherlands by the end of June. Clinical signs included those of respiratory and nervous disease. Samples from necropsied animals were examined for evidence of phocine distemper virus (PDV) infection by RT-PCR, virus isolation, serology, histology, and immunohistochemistry. The results showed that PDV was present in both areas. Based on these findings, together with the known severity of this virus infection in harbour seals, we concluded that PDV infection was the primary cause of mortality of seals in Northern Europe, with over 20.000 seals reported dead. Monitoring of the seal population in the Netherlands for the past ten years by serology and RT-PCR indicated that PDV has not been circulating in this population after the 1988 outbreak. The mortality of harbour seals during the 1988 outbreak in the above areas was estimated at 40 to 60 % of the population. Different factors, including specific immunity (less than 5 % seropositive animals in The Netherlands), pollutant load, and general health status, may have influenced the mortality rate during the 2002 PDV epidemic.

IMMUNOPHENOTYPIC CHARACTERIZATION OF THE HEPATIC INFLAMMATORY CELL INFILTRATES IN COMMON DOLPHINS (*DELPHINUS DELPHIS*)

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This work describes the cellular distribution of T lymphocytes (CD3), immunoglobulin-bearing plasma cells, macrophages, MHC class II antigen and S-100 protein in hepatic lesions observed in 14 common dolphins (*Delphinus delphis*). Non specific reactive hepatitis was identified in 12 dolphins, whereas chronic parasitic cholangitis with lymphoid proliferation was observed in three other dolphins. Non specific reactive hepatitis showed small clusters of CD3+ T cells either in portal areas and hepatic sinusoids. The anti-S100 polyclonal antibody reacted with a variable number of lymphocytes from portal areas and hepatic sinusoids, as well as with Kupffer cells and epithelial cells of the bile ducts. The majority of plasma cells observed in portal areas and hepatic sinusoids were IgG+. In lymphonodular lesions of chronic parasitic cholangitis, the distribution of immunoreactive cells was similar to that found in the cortex of lymph nodes. The presence of stellate cells similar to follicular dendritic and interdigitating cells expressing S-100 protein and MHC class II antigen in lymphonodular lesions suggested that these are highly organized structures developed to enhance antigen presentation to B and T cells.

EPIDEMIOLOGY OF TATOO SKIN DISEASE IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) FROM THE SADO ESTUARY

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We report on the epidemiology of tattoo disease in a very small community of resident bottlenose dolphins (*Tursiops truncates*) inhabiting the Sado Estuary, Portugal. Presence of tattoos and tattoo-like lesions was examined in 586 photographic records from 35 dolphins taken between February 1994 and December 1997. Images were rated into three categories: good, average and poor. The dolphins were divided into three age classes: calves, juveniles and adults. The percentage of good images was significantly higher (c2= 16.246, df= 2, 0.01>P>0.001) in juveniles than in calves or adults. A low to high minimal density of small to very large tattoos and tattoo-like lesions was observed on the flanks, back, tailstock, head and dorsal fin of the dolphins. To detect temporal changes in the prevalence of lesions the study time was divided into two periods: 1994-1995 and 1996-1997. All juveniles had tattoos in both periods. There was no significant variation in prevalence of the lesions among adults and calves between the two periods (Fisher's test, P= 0.123). In 1994-1997 prevalence of tattoo disease was 48.57%. It varied according to the age category, being the highest in juveniles (100%). The minimal persistence time of the disease fluctuated between three and 45.5 months. When healing the lesions converted into light grey marks. Recurrence may occur. The high prevalence of tattoos and tattoo-like lesions among Sado dolphins, their long persistence in some individuals as well as their higher frequency in juveniles indicate that the disease is endemic in this community. Five of the nine dolphins that died during and after the study period had tattoo disease. The contribution of this ailment to the decline and low juvenile survival of Sado bottlenose dolphins needs to be further investigated.

PERFLUOROOCTANE SULFONIC ACID (PFOS) IN MARINE MAMMALS STRANDED ALONG THE NORTH SEA COAST

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Over the last decades little work has been conducted on the environmental behaviour and effects of perfluorinated organochemicals (FOCs). These chemicals are commonly used as solvents, surfactants, cosmetics and are applied in fire foam extinguishers. Recent findings have shown that FOCs (with perfluorooctane sulfonic acid - PFOS - as the most important representative) are detected in organisms living in industrialized as well as in remote areas. The fact that PFOS is hardly biodegradable, clearly accumulates in the liver and blood of top predators and the fact that little information is available on the toxic properties of PFOS, makes this chemical an environmental pollutant of primary concern. In the present study we measured PFOS concentrations in seven marine mammals stranded on the Belgian, French and Dutch North Sea coast between 1994 and 2000. PFOS concentrations were measured in liver and kidney tissue using combined liquid chromatography-mass spectrometry (LC-MS/MS). Detectable PFOS concentrations (up to 820.60 ng/g) were found in harbour porpoises, white-beaked, white-sided and striped dolphins, sperm whales and harbour seals. In fin whale and hooded seal concentrations were below the detection limit of 10 ng/g. PFOS levels in female porpoise livers were significant higher than those in males. The present results show clearly the difference in accumulation pattern of PFOS compared to that of persistent organochlorine chemicals. In order to evaluate the interspecies differences, we developed PFOS-trophic level relationships based on stable nitrogen and carbon isotope ratios. Animals that display the highest trophic positions (highest d15N) have the highest PFOS levels. The different feeding ecology of these species (inshore versus offshore) also seems to contribute to differences in PFOS concentrations. Next to the presentation of PFOS concentrations in marine mammals of the North Sea, the possible toxicological effects of perfluorinated compounds are discussed.

A SPATIAL INVESTIGATION OF THE 2002 PHOCINE DISTEMPER VIRUS OUTBREAK AFFECTING SEALS IN SCOTTISH WATERS

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During a previous outbreak of phocine distemper virus (PDV) in the North Sea during 1988, around 18,000 harbour seals (*Phoca vitulina*) died as a result of PDV infection. In May 2002, PDV was identified as the cause of mortality in a number of seals in the Danish Kattegat area. On 13 August 2002, five cases of PDV were confirmed in harbour seals in England. In response to this, between August 2002 and January 2003, 84 seal carcasses from around the coast of Scotland were examined post mortem to determine cause of death. PDV was confirmed by pathological examination and polymerase chain reaction (PCR) or Immunoperoxidase test (IPX). The first case of PDV in Scotland during the 2002 outbreak was confirmed on 11 September in a harbour seal found on the northeast coast. During this study, we examined the spatial distribution of stranded harbour and grey (Halichoerus grypus) seals around the coastline of Scotland during the PDV outbreak. A GIS system was used to examine the spatial and temporal distribution of stranding events. Results have shown that unlike the previous morbillivirus epizootic, where harbour seals were the primary species affected, a significant number of grey seals in Scotland have also been affected during the 2002 outbreak. Comparisons with the 1988 outbreak and implications for the patterns of distribution during this outbreak are discussed.

EPIDEMIC RE-OCCURRENCE OF PHOCINE DISTEMPER IN THE GERMAN SEAL POPULATION

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INTRODUCTION In May 2002 a high mortality among common harbor (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) was first noted in the Kattegat which then spread subsequently along the Danish and Swedish coast. In the Netherlands mass mortality among seals started in June 2002. One month later, the disease was first noted among the German seal population (Waddensea Secretariat, 2002). Phocine distemper virus (PDV) was identified as the cause of the epidemic (Jensen *et al.,* 2002). Approximately 7500 harbor seals died due to the epidemic along the German wadden sea coast and Helgoland. The seal die-off at the German coast was considered to be over in November 2002 (Waddensea Secretariat, 2002). This paper describes the morphological lesions, distribution of virus antigen and molecular and sero-epidemiological data in affected seals collected from the German coast.

MATERIALS AND METHODS This investigation was carried out on animals, which were found dead or were euthanatized due to severe clinical illness. The stranded seals were collected from different places of the wadden sea coast of Schleswig-Holstein and Lower Saxony, and from Helgoland. Necropsies were performed on 95 harbor seals. 23 animals were male, 45 female, and the gender of 27 individuals is unknown. They comprised 26 juvenile, 18 yearlings, and 23 adult animals. The age of 28 animals is not known.

Samples of different tissues and organs were either preserved deep frozen or fixed in 10% formalin. The latter samples were embedded in paraffin wax, cut at 3 µm, stained with haematoxylin and eosin (HE) and examined by light microscopy.

Immunohistochemistry was applied on selected formalin-fixed and paraffin-embedded tissue sections for the detection of morbillivirus antigen using a murine monoclonal antibody specific for the nucleoprotein, which cross-reacts with canine and phocine distemper virus.

As screening method a morbillivirus genus-specific PCR was applied on reverse-transcribed RNA extracts from blood leucocytes or different tissues (lung, spleen, lymph nodes) from selected animals. The primer selected were originally described by Barrett *et al.* (1993) and defined a 457 nucleotide fragment of the P gene. The screening PCR has been shown to generate specific amplificates from all morbillivirus species described to date. Furthermore, a number of animals positive in this screening PCR was subjected to a species-specific PCR, discriminating canine distemper virus, PDV, and dolphin distemper virus, by use of primers targeting sequence streches within the 457 bp P gene fragment which were unique to each of the listed viral species (Harder, in prep.).

Retrospective serological data obtained from continuous monitoring of the German seal population were available from previous years. Serum samples were screened for morbillivirus antibodies using the virus neutralizing test (?).

RESULTS Gross examination revealed congestion of the parenchymatous organs. The mediastinum was emphysematous in some animals. The lungs were poorly collapsed and heavy. Marked alveolar and interstitial emphysema was accompanied by oedematous changes. The consistency of the lungs was firm, and occasionally suppurative inflammatory lesions were found. The pulmonary lymph nodes appeared slightly enlarged and oedematous.

Besides these pulmonary lesions, single individuals suffered from catarrhalic enteritis. Various numbers and species of parasites were detected on the skin, and in both, the respiratory and digestive tract including Otostrongylus sp., Parafilaroides sp.

Histological examination of the lung revealed marked alveolar and interstitial emphysema and oedema. A gradually variable interstitial pneumonia was found with thickened interalveolar septae, which were hyperaemic and infiltrated with mononuclear cells (Fig. 1). In deeper airways and alveoli numerous desquamated alveolar epithelial cells and macrophages were found. Among the inflammatory infiltrate single syncytial cells were detected. In bronchial, bronchiolar, and glandular epithelial cells intracytoplasmic eosinophilic inclusions of variable size were observed. In numerous individuals, extensive areas of suppurative bronchopneumonia with closely packed neutrophils in distended alveoli were observed, occasionally accompanied by gradually variable extents of parenchymatous necrosis.

Tonsils, pulmonary and mesenteric lymph nodes, and spleen displayed generally a gradually variable extent of lymphocytic depletion (Fig. 3). Lesions in the brain were only found in single individuals in the cerebral cortices. They consisted of acute, focal, non-suppurative encephalitis with perivascular mononuclear cuffing and oedema of the neuropil (Fig. 5). In affected areas, some neuronal cells displayed eosinophilic necrosis, and scattered rod shaped microglial cells were found. Occasionally, intracytoplasmic and intranuclear eosinophilic inclusions were detected in neuronal and glial cells. In numerous cases a diffuse tracheitis with intra- and subepithelial lymphocytic infiltration and intracytoplasmic inclusions in epithelial cells was noted. The stomach mucosa displayed multifocal necrosis of mucus surface cells and chief cells, occasionally with intracytoplasmic inclusion bodies. In the intestine, the lymphatic tissues were extensively depleted and occasionally syncytial cells were found. Inclusion bodies were found in single crypt epithelial cells. Similar inclusions were detected in duct epithelial cells of the liver and pancreas, occasionally accompanied by necrosis of single cells. In the urinary tract, intracytoplasmic inclusion bodies were present in epithelial cells of the renal pelvis and the urinary bladder. In the genital tract similar inclusions were detected in epithelial cells of the endometrium, the vagina and the epididymal tubules. Histological examination of the eyes, thyroid and adrenal glands was unremarkable.

Immunohistochemistry revealed morbillivirus antigen in the lungs, tonsils, lymph nodes, spleen, and cerebrum, trachea, stomach, intestine, liver, pancreas, kidneys, urinary bladder, female genital mucosa, and epididymal tubules. Intracytoplasmic inclusions were stained dark brown and occasionally they were located in a cap-like shape close to the nucleus. Additionally, the cytoplasm and/or the nucleus was stained brown in a finely granular pattern. In the lungs of numerous animals, a high amount of morbillivirus antigen was found in bronchial, bronchiolar, glandular and alveolar epithelial cells, and macrophages (Fig. 2). In tonsils, mesenteric and pulmonary lymph nodes variable numbers of mononuclear cells of follicular and parafollicular areas, some of which resembling macrophages and/or lymphocytes, stained positive for viral antigen (Fig. 4). In the spleen, single cells of the follicles contained viral antigen. In the brain, specific staining was found in neurons and glial cells of morphologically affected areas. It was located in the nuclei, perikarya and cytoplasmic processes (Fig. 6). In the stomach specific staining was observed in mucus surface and chief cells. Low numbers of intestinal crypt epithelial cells and mononuclear cells of intestinal lymphoid tissues were positive for morbillivirus antigen. Duct epithelial cells of the liver and pancreas were specifically stained, occasionally with predominant accumulation of antigen along the apical cytoplasmic membrane. In the urinary tract, single epithelial cells of the renal pelvis and the urinary bladder were found positive for morbillivirus antigen. Specific staining was detected in epithelial cells of the endometrium, vaginal mucosa and epididymal tubules. The eyes were consistently negative. Except few thyroidal follicular epithelial and interstitial cells in one seal, thyroid and adrenal glands were negative for morbillivirus antigen.

Bacteriologically, among others *Bordetella bronchiseptica*, various Staphylococci and beta-haemolysing streptococci were isolated.

Virologically, PDV-specific RNA was detected in diseased seals from the German Wadden Sea by P gene RT-PCR from July 2002 onwards. The serum titers of antibodies against morbillivirus were below 1:10 in most cases, rarely 1:100, from 1996 until the outbreak of the epidemic in 2002.

DISCUSSION The morphological lesions, the specific immunohistochemical staining for morbillivirus antigen and the virological findings confirm a systemic infection with PDV. The pattern of morphological alterations is similar to those found in pinnipeds, which died during the epidemic in 1988 (Bergman *et al.,* 1990; Heide-Jorgensen et al., 1992; Heje *et al.,* 1988; Kennedy *et al*., 1989). Furthermore, the lesions share common features observed in morbillivirus infections of cetacean species, including porpoises and dolphins (Birkun *et al*., 1999; Domingo *et al*., 1992; Duignan *et al*., 1992; Kennedy *et al*., 1991). The principal morphological lesions are associated with a specific immunohistochemical staining indicating that the morbillivirus infection is the primary cause of the disease. However, secondary bacterial infections were predominantly observed in the lungs resulting in suppurative bronchopneumonia.

Immunohistochemistry revealed a systemic spread of the virus with different tropisms including epithelio-, lympho- and neurotropism simliar to findings in morbillivirus infections in other aquatic mammals (Kennedy, 1998). In the respiratory tract epithelial cells of the trachea, deeper airways, glandular epithelial and alveolar lining cells are the target cells of the virus. Additionally, it was detected in macrophages. The high quantity of virus antigen found in the respiratory system indicates that it is one major target of PDV. Damage to the epithelial cells of the airways with impairment of the broncho-alveolar clearance predisposes for secondary bacterial infections.

Lymph nodes, spleen, tonsils, and gut-associated lymphoid tissues (GALT) were affected by a lymphoid depletion. Detection of morbillivirus antigen confirmed the lymphotropism of PDV and is suggestive for a virus-induced immunosuppression and a consequently increased susceptibility to infectious agents.

In single individuals an acute non-suppurative encephalitis with high amounts of virus antigen was detected in the cerebral cortex. Cerebellar lesions, which are characteristic for canine distemper (Summers et al., 1994) were not observed. In contrast to other reports about central nervous lesions of PDV-infected seals of the 1988 epidemic, demyelination was not detected in the anmals investigated in thsi study. The pattern of specific immunohistochemical staining in cytoplasmic processes of neurons is indicative for an axonal spread of the virus within the neuroparenchyma.

In the digestive tract, morbillivirus antigen was detected in low to moderate quantities in epithelial cells of the stomach and intestine. Furthermore, it was detected in the GALT, which displayed a marked lymphoid depletion. Damage to this mucosa-associated lymphoid tissue is a common lesion in morbillivirus infection of marine mammals (Kennedy *et al.,* 1989; Pohlmeyer *et al.,* 1993). In the liver and pancreas virus antigen was found in ductular epithelial cells, occasionally accumulated along the apical cell membrane. This finding indicates that PDV may spread to a certain extent with bile and pancreas fluid.

In the uro-genital tract PDV antigen was detected in low quantities indicating that these tissues are not a major target for virus replication.

The molecular analysis of the recent virus isolate confirmed an almost identical virus population along the German coast during this epidemic. Sequence comparison however, displayed a small, but distinct difference to the virus isolated in 1988 (Jensen *et al*., 2002). The serological data obtained from regular monitoring of the German seal population documented a lack of protective antibodies during the years before the recent epidemic. Therefore, the seals along the German coast had to be considered as highly susceptible for a PDV infection explaining the high mortality rate.

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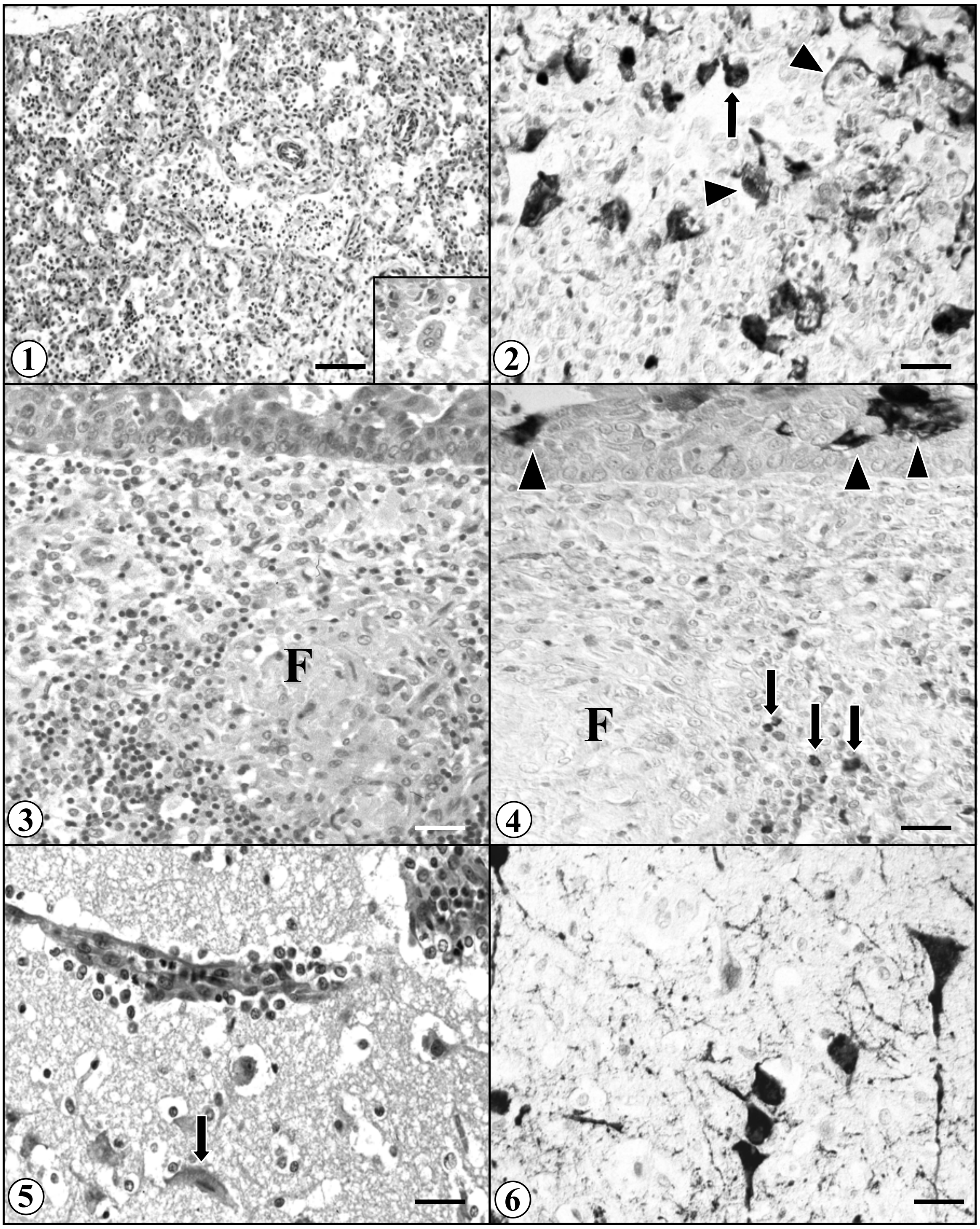

Fig. 1: Seal, lung, severe interstitial pneumonia; inset: syncytial cell; HE; bar = 150 µm
Fig. 2: Seal, lung, immunohistochemical staining of morbillivirus antigen in alveolar lining cells (arrowheads) and in macrophages (arrow); ABC method, bar = 50 µm
Fig. 3: Seal, tonsil, depletion of lymphoid follicle (F); HE; bar = 90 µm
Fig. 4: Seal, tonsil, immunohistochemical staining of morbillivirus antigen in epithelial cells (arrowheads) and in parafollicular cells resembling macrophages and lymphoid cells (arrows); bar = 70 µm
Fig. 5: Seal, cerebral cortex, non-suppurative encephalitis with lymphocytic perivascular cuffing and neuronal necrosis; HE; bar = 40 µm
Fig. 6: Seal, morbillivirus antigen in neuronal nuclei, perikarya and processes; ABC method, bar = 30 µm

NEW TECHNIQUES

DIVING BEHAVIOUR AND REACTIONS TO TAGGING OF LONG-FINNED PILOT WHALES IN THE CENTRAL MEDITERRANEAN SEA

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INTRODUCTION This study compares the diving behaviour of long-finned pilot whales (*Globicephala melas*), tagged by means of time-depth recorders (TDR) in the Ligurian and Tyrrhenian Seas (Fig. 1). Magnitude and duration of the behavioural response caused by the tagging attempts are also described.

MATERIALS AND METHODS Tagging operations were undertaken in 2000, 2001 and 2002 from two vessels of similar size (about 18m). Four individuals were tagged during three sightings (Table 1). V-TDRs tags (MK6 models produced by Wildlife Computers) were deployed from the boat by means of a 4.5 m long pole, and attached to the whales with a suction cup. Each TDR was coupled with a VHF radio transmitter produced by Advanced Telemetry Systems. The TDRs had a depth range of 0 -1,000 m (accuracy of 3% of the reading +/- 8 m). A total of 271 min of dive data were collected from three of the four tagged individuals. The surfacing intervals of the tagged whales were timed concurrently. One tag was lost at sea.

RESULTS AND DISCUSSION **Dive duration** During the daylight hours, all the tagged whales performed multiple short (<3 min) and shallow (0 -16 m) dives, or rested motionless at the surface. About 2h 30min before sunset (at 18:10 h on July 20th and at 16:24 h on October 11th) two whales tagged in the Ligurian Sea showed an abrupt change of behaviour, and started to perform long dives which ranged between 13min 50sec and 15min 50sec.

Dive depth One of the tagged individuals – an adult male - performed two deep dives of 776 and 824 m (Fig. 2). These are the deepest dives ever recorded for *G. melas* in the Mediterranean Sea. Baird *et al*. (2002) recorded a depth of 648 m for a sub-adult male tagged in the Ligurian Sea, and suggested that deep dives performed by long-finned pilot whales around sunset may be related to feeding towards the Deep Scattering Layer. Further evidence of deep diving in the late afternoon provided by this study sheds light on the feeding behaviour of long-finned pilot whales and on their amazing diving capabilities.

Reaction to tagging As pointed out by Scheneider *et al*. (1998) and White and Garrot (1990), the validity of the data obtained from the tagging can be questionable unless such studies incorporate investigations on the potential impact of tagging. This experience confirms that whale tagging can provide essential information to understand the ecology and behaviour of a poorly known species, disturbance to the animals is an issue that must be carefully considered. The three whales tagged in the Ligurian Sea showed moderate reactions to tag deployment. These included a tail flick followed by a series of "spy-hops" and rolling on their sides. The response of whales A and C (Table 1) lasted 18min and 25min, respectively. After this time the whales apparently resumed their previous behaviour. In whale B the tag was detached after only 4 min by a member of the group (see below). Whale D, a sub-adult male (about 3/4 the length of an adult) tagged in the Tyrrhenian Sea, showed a stronger reaction to tagging, performing vertical and horizontal leaps, high-speed surfacings and fast rollings, following tagging. The reaction lasted for the whole duration of the sample (152 min), until the tag detached. Diving data here were clearly biased by the presence of the tag. It is unknown why the reactions shown by this fourth whale were much stronger than those that had been previously recorded by us and by other researchers (Baird *et al*., 2002). A number of factors should be considered, possibly including small group size and sub-adult size, together with social, environmental and individual variables. Care should be taken in future tagging attempts to evaluate these and other factors before a tag is deployed, and to provide a detailed behavioural record following any tagging attempt. Remarkably, in three cases (whales B, C and D) other group members actively attempted to detach the tag by rubbing their bodies against the tagged individual, and in one instance they succeeded (whale B). This further indicates that the benefits of tagging (including understanding of key ecological needs by the whales) must be weighed against behavioural impact.

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Table 1. Summary of tags deployed on long-finned pilot whales

Whale	Area	Date	Group size	Initial time	Duration	Maximum depth (m)
A	Ligurian Sea	20 July 2000	60	-	Tag lost	-
B	Ligurian Sea	11 October 2001	5	15:00	4 min	8
C	Ligurian Sea	11 October 2001	5	15:17	115 min	824
D	Tyrrhenian Sea	08 October 2002	2	13:57	152 min	24

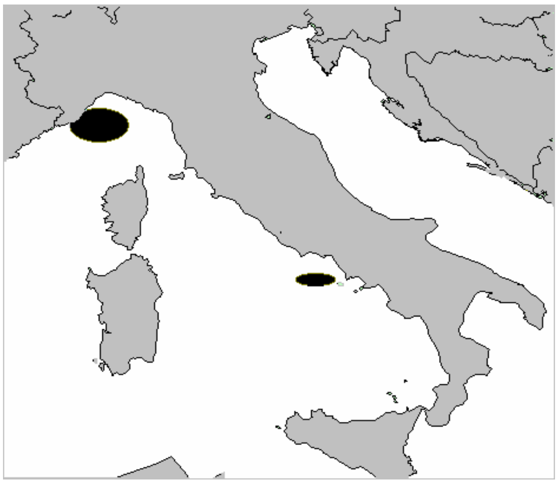

Fig. 1. Map of the study areas

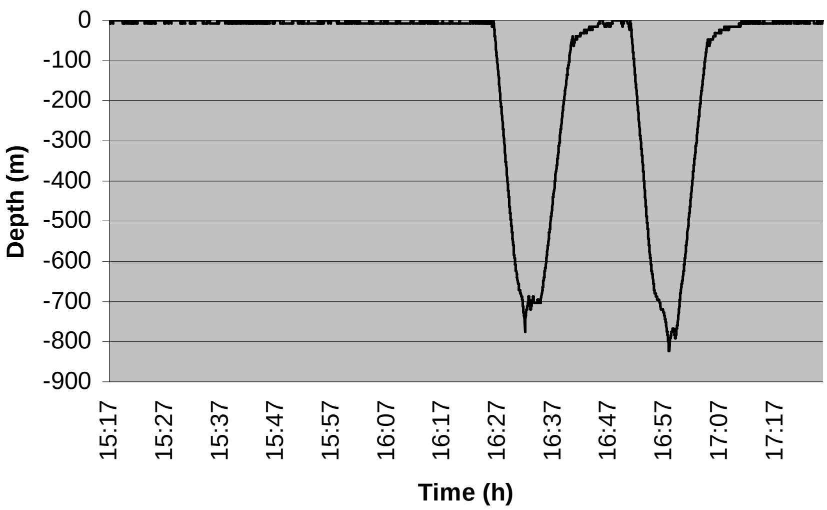

Fig. 2. Dive depth versus time for whale C (see Table 1)

PRELIMINARY STUDIES IN IDENTIFYING CETACEAN INDICATOR SPECIES TO MONITOR THE STATE OF MARINE BIODIVERSITY IN WEST EUROPEAN WATERS

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INTRODUCTION Many west European governments have recently made ambitious commitments to sustainable development and wildlife conservation as a result of signing up to the Global Convention on Biodiversity (Rio Earth Summit) in 1992. In the UK, for example, the Government has produced a Biodiversity Action Plan (BAP) which comprises a series of wide-ranging targets and actions for 436 priority (important/threatened) habitats and species (Anon, 1994). Now that a large number of countries across Europe have begun to implement the Global Convention on Biodiversity, and the period since relevant conservation policies have been in place has lengthened, measures that assess delivery of biodiversity conservation are required.

There are a number of issues associated with monitoring the biodiversity condition of the marine environment, especially offshore waters. The marine environment is less visible, less documented, less constrained (more open and dispersive), and less understood than terrestrial ecosystems. More than 30,000 species have recently been described for European waters, yet species lists for many marine taxa remain incomplete (European Register of Marine Species, 2002), whilst new species are still being discovered at a high rate (Costello *et al*., 1996). Given the impossibility of surveying biological diversity in its entirety, suitable policy-relevant indicator species need to be identified which can help (1) inform Governments on the state (biodiversity condition) of the marine environment, and (2) evaluate the role of protected areas in conserving marine biodiversity.

Cetaceans have considerable potential to be used as flagship indicators to monitor the changing state of the marine environment and marine biodiversity because they:

- are at or near the top of the food chain,
- occupy a wide range of habitats,
- are amongst the most popular of all wildlife taxa,
- are highly susceptible to environmental changes (e.g. anthropogenic noise, changing fishery practices, chemical pollution),
- and there is a growing body of annual population data available.

Monitoring total populations of pelagic marine species such as cetaceans is extremely costly and difficult. However, recent surveys utilising volunteers and platforms of opportunities have demonstrated that scientifically rigorous data can be collected at low cost over large inaccessible offshore localities and provide valuable new information on cetacean spatial and temporal distribution and abundance (e.g. Williams *et al*., 1999).

Since1995, the Biscay Dolphin Research Programme (BDRP) has carried out monthly, year-round cetacean surveys through the English Channel and Bay of Biscay along a fixed route from Portsmouth to Bilbao, using a standardised survey method. The BDRP dataset, comprises more than 2000 sightings, of 40,000 'individuals', and 22 cetacean species, made over approximately 100 four-day trips evenly distributed on a monthly basis over 8 successive years.

The BDRP monitoring programme, which is one of the few offshore projects to have collected annual population monitoring data over a continuous time-series, provides many opportunities to investigate the design of cetacean monitoring strategies. For biodiversity surveillance, annual population data of this type is potentially of high value, because it can enable the detection of early signs of species decline, when it is most appropriate to undertake conservation action and inform marine resource management policy.

An effective monitoring strategy for cetaceans requires consideration of the most appropriate cetacean species to monitor, and the location, frequency and intensity of sampling. Preliminary statistical analyses are undertaken to explore these issues in this paper.

METHODS **Study area and survey methods** Cetacean population data was collected between 1995 and 2003 from dedicated surveys onboard a commercial P&O cruise-ferry, the Pride of Bilbao which sails from Portsmouth, England to Bilbao, northern Spain. The ferry route runs between latitudes 43º to 51ºN and 0 to 8ºW, sampling 85 International Council for the Exploration of the Sea (ICES) rectangles, measuring 15' latitude by 30' longitude, A wide range of oceanographic features are sampled including shelf waters (50-200m deep), submarine canyons, sea mounts, the slope of the continental shelf (water depth 200-3000m deep), sea mounts and the abyssal plain of the Bay of Biscay.

On each (four-day) monthly trip, effort-based cetacean surveillance work was carried out by a team of three experienced volunteer observers, using standard survey methods developed for commercial ferries and other 'platforms of opportunity' by the Cetacean Group of the Mammal Society (Evans, 1995). Recording was made from a fixed position on the bridge of the ship, at a height of 32m and speed of 15-22 knots. Effort data was collected simultaneously with sightings data to enable the calculation of standardised relative abundance estimates for each species at various spatial scales (e.g. by ICES grid cell) in discrete areas of the survey route and region.

Trend and power analyses We conducted a number of statistical analyses to identify spatial, seasonal and inter-annual variations in abundance of each cetacean species recorded (from BDRP surveys) along the survey route through the English Channel and Bay of Biscay. Longer-term population trends were assessed by linear modelling (poisson regression), using the Dutch freeware program TRim (Trends in Monitoring Data) devised by Statistics Netherlands. Power analysis (using the freeware program 'Monitor', Gibbs, 1995) was used to help assess the sensitivity of current monitoring and to identify survey design improvements.

A composite 'cetacean' index A multi-species 'cetacean index' was calculated for each year following methods developed for populations of breeding wild birds in the UK by the RSPB/BTO/DEFRA (Gregory *et al*., 1999). The bird index is the UK Governments Headline Indicator of progress towards wildlife consevtaion as part of sustainable development (DETR, 1999). Applied to the BDRP datset, the method involved creating a simple (geometric) mean index across the five most frequent and abundant cetacean species (Fig. 2). Other species recorded on BDRP surveys were excluded due to their relative rarity.

RESULTS **Selection of monitoring species** The five most frequent species *Tursiops truncatus* (Bottlenose Dolphin), *Delphinus delphis* (Common Dolphin), *Balaenoptera physalus* (Fin Whale), *Globicephala melas* (Long-finned Pilot Whale) and *Stenella coeruleoalba* (Striped Dolphin) collectively accounted for more than 80% of positively identified sightings. Although 17 other species were recorded, for the majority of these there were too many surveys with zero counts for meaningful annual indices to be generated.

Trends in relative abundance between 1996 and 2002 were assessed for the five most frequent species. These are summarised in Table 1 and plotted in Fig. 1. The most precise trend estimate (lowest standard error) was derived for *B. physalus*, which decreased in abundance statistically significantly along the survey route over the seven-year period. For the other five species, the seasonal and inter-annual variations in numbers were too extreme to enable a trend to be detected.

Composite index The mean annual population trend for the five most frequently recorded is presented in Fig. 2. This indicated that cetacean abundance in sampled areas declined overall by 25% over the seven-year monitoring period, with relatively low indices generated for 2000 and 2002.

Power analysis of *Delphinus delphis* survey data Population trends were calculated for *D. delphinus* (the most abundant species) under a number of different survey scenarios (Tab. 2). The greatest level of precision (lowest standard error of trend estimates) was obtained by incorporating different oceanographic regions into the analysis. The lowest level of precision occurred when a single year count (sum of monthly counts) was used as the abundance index. None of the surveys scenarios were sensitive enough to detect a statistically significant trend.

Results of a Power Analysis indicated that in both the English Channel and northern Bay of Biscay (Armorican Shelf) there was a 90% chance of detecting a statistically significant trend with 18 years of monitoring data under the current survey intensity. Populations within the five regions were not fluctuating synchronously, and statistically significant variation was found between sites and years (two-way ANOVA). Consequently increasing the number of years rather than sites is more likely to increase the power to detect trends.

Timing of surveys 1 (seasonal and spatial considerations) The majority of sightings were made in low (<3) sea states (Fig. 3), which in the region, most predictably occurred between April and September (Fig. 4). Considerable variation was found in seasonal distribution for selected species, across the whole study area (e.g. *B. physalus* Fig. 5) and between different regions (e.g. Fig. 6).

CONCLUSIONS

- Due to their position at the tope of the food chain and high popular appeal amongst the general public, cetaceans have great potential to be used as effective bio-indicators of changes in and the overall health of the marine environment.
- Preliminary analysis of BDRP survey data provides valuable information to help inform the design of annual monitoring programmes of cetaceans.
- The time taken to detect population trends varies considerably between species, hence the need to tailor survey design to the target species.
- The best population trend estimates were obtained by using all the (area/day) data available.
- The timing and geographical location of surveys needs to be carefully considered for non-resident species
- In the study area, the summer months were the preferred monitoring period (greatest diversity of species, and most favourable recording conditions).
- However, a survey exclusively in this season in the study region, would miss important population's, (e.g. winter *D. delphis* populations in the English Channel)
- Power analysis of *D. delphis* data predicted the requirement for an 18-year monitoring period to detect a significant population trend with current survey methods.
- Developing a composite index (overall measure) should be considered as a way of describing change in cetacean populations.
- To further evaluate the role of low-cost data collected from fixed-route ferries for long-term cetacean monitoring, worthwhile research would include comparing relative population changes and trends identified through BDRP surveys, with absolute population changes and trends assessed by past and present SCANS surveys in the region.

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Table 1. Summary of population trends for the five main cetacean species 1996-2002

	No sightings (% tot no.)	No individuals (% tot no.)	Mean % change per year	SE of trend	Slope (+/- 95% C.L.)	Trend
Balaenoptera physalus	205 (12)	560 (2)	-25	0.050	0.75 +/- 0.01	Sig. inc.
Stenella coeruleoalba	228 (14)	8375 (23)	2	0.063	1.02 +/- 0.12	N.S.
Globicephala melas	124 (7.5)	962 (3)	1	0.063	0.99 +/- 0.12	N.S.
Tursiops truncatus	171 (10)	2737 (8)	0	0.065	1.00 +/- 0.13	N.S.
Delphinus delphis	651 (39%)	22251 (62)	7	0.068	1.07 +/- 0.13	N.S.

Table 2. Population trends in D. delphis under different survey scenarios

Period	Data	Mean % change per year	SE of trend
1995-02	Monthly counts - all areas	3	0.048
1996-02	Monthly counts - all areas	7	0.068
1997-02	Monthly counts - all areas	-5	0.056
1995-02	Monthly counts - all areas, sea state<4	1	0.036
1996-02	Monthly counts - all areas, sea state<4	4	0.051
1995-02	Monthly counts - in five regions	10	0.040
1996-02	Monthly counts - in five regions	4	0.039
1995-02	Yearly count	12	0.104
1995-02	Yearly count/no. trips	10	0.070
1995-02	Survey days - 3 per month, all areas	3	0.033
1996-02	Survey days - 3 per month, all areas	2	0.035
1997-02	Survey days - 3 per month, all areas	-5	0.039

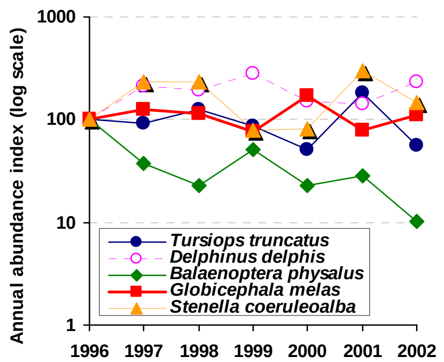

Fig. 1. Relative abundance indices for the five

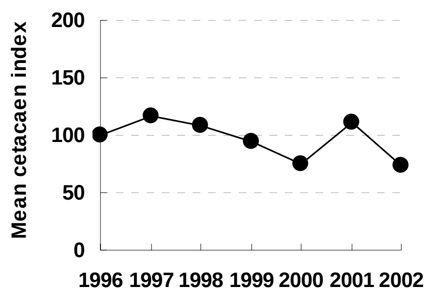

Fig. 2. Mean population trend for the five most frequent species

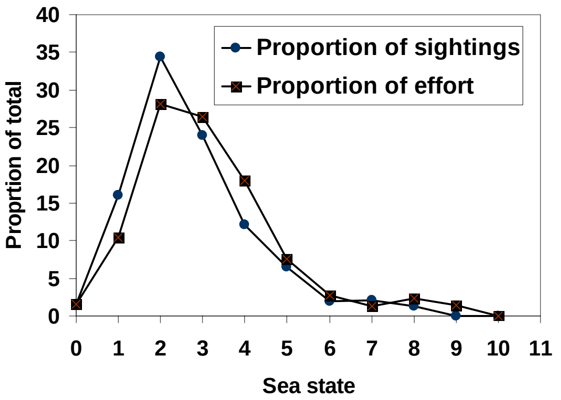

Fig. 3. Correlation between low sea states and high sightings rates

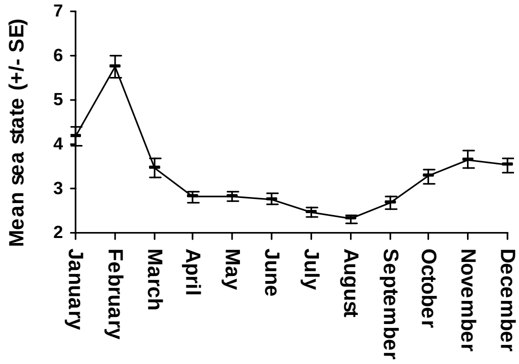

Fig. 4. Monthly mean sea states 1995-02

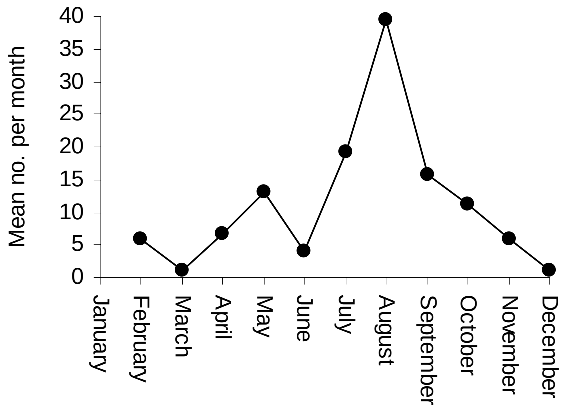

Fig. 5. Mean number *B. physalus* per month 1995-02

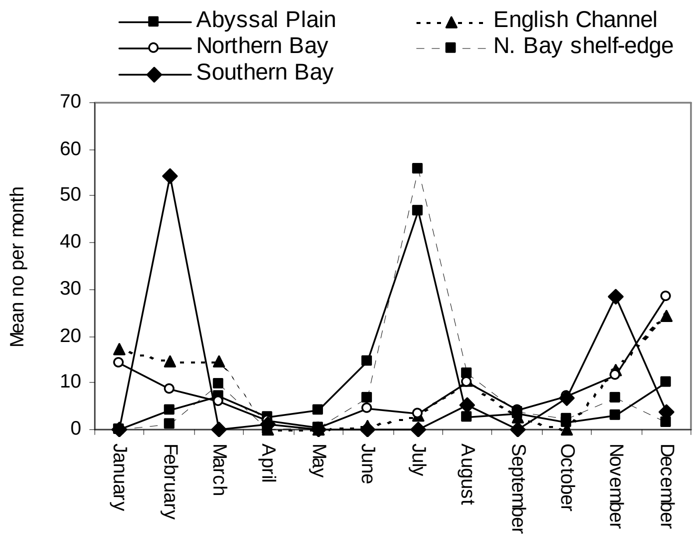

Fig. 6. Mean no. *D. delphinus* per month in five regions of the study area 1995-02

USING SPERM WHALE CLICKS TO DETECT SILENT WHALES

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In the Canaries, although all cetacean species are prone to collisions with fast vessels, the Sperm Whale (Physeter macrocephalus) is of highest concern. Sperm Whales are highly vocal and hence can be localised with passive sonar. However, when at or near the surface, Sperm Whales tend to stop vocalising, i.e. when they are most at risk. Localising them could in principle be carried out by a bi-static sonar system, which uses vocalising whales at depth as the acoustic sources and detects silent whales by their echoes. A simulation tool for 3D acoustic propagation is presented where a wideband 3D curved ray solution of the wave equation is implemented. This tool was designed to simulate a bi-static system formed of an active acoustic source, an illuminated object, and a receiver all positioned in 3D space with arbitrary bathymetry. The software recreates the resulting sound mixture of direct, reverberated and echoed signals arriving at the array sensors for any array configuration and any number of sources. One object can be placed in the water column and its impact on the acoustic field at the receiver is resolved. This tool is used to evaluate possible solutions for the Whale Anti-Collision System (WACS) project. WACS aims at preventing collisions between whales and fast maritime vessels. The software simulations demonstrate the concept viability but highlight the necessity of advanced space-time signal processing to resolve and identify the distant echoes produced by silent whales.

DO PORPOISE DETECTORS DETECT PORPOISES?

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A porpoise detector (POD) is a hydrophone that logs porpoise echolocation clicks (Tregenza, UK). PODs are recommended for use in Environtmental Impact Assessments (EIAs) concerning offshore wind farms in the german North Sea. At present there are no standards for deploying, setting and analaysing POD data in order to obtain reliable and comparable data. In summer 2002, we carried out a pilot study in the North Sea west of Sylt to investigate to what extent PODs can be employed to evaluate the impact of offshore wind farms on harbour porpoises within an area. The PODs were moored two metres up from the bottom of the sea floor and marked by a small buoy on the surface. The best indicator for porpoise activity is the daily click frequency. This is the number of minutes with porpoise activity in relation to all minutes recorded during a day. We observed a strong positive correlation between the click frequency despite experiencing a large variation in detection probability between the different PODs. We could subsequently produce a correction factor for every POD based on the most sensitive POD. Between July and October 2002, five PODs recorded 5.528 hours data. The results show a clear activity pattern both over the study period as well as over a 24 hour cycle with up to 40 click events per day and a mean click frequency of 8 %. The diurnal pattern in click activity was low during the night and high between early morning and afternoon. We cannot confirm the strong phenology observed by aerial observations. Although further studies are needed to better our understanding of echolocation patterns, PODs are considered to be a useful tool not only in detecting harbour porpoises but also in studying the potential effects of wind turbines on this species.

ENTICING SOUNDS: A POSSIBILITY FOR ALERTING PORPOISES INSTEAD OF DETERRING THEM?

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Porpoises cannot see gillnets early enough to avoid them. Acoustic mitigation methods, which have proved being effective in reducing by-catch in fisheries, use deterrent sounds. In the framework of a project funded by the Nordic Council of Ministers and looking at the possibility of using “interactive” pinger, captive and wild harbour porpoises were exposed to sonar-like click trains. Their purpose was to entice the porpoises to aim their sonar towards the device and trigger the deterrent sounds. Eight enticing sounds were tested, all being porpoise-like click trains with varying repetition rates, and with the clicks centred at 140kHz. The computer controlled test sounds were transmitted by two converted AquaMark100 units. The porpoises’ sonar clicks were picked up by a hydrophone and recorded by the computer programme. A click detector also made it possible to record them on a VCR or MD recorder. Forty trials, constituted of 5 min sound exposure and baseline and recovery period, were carried out in the sea pen of the Fjord&Bælt, which houses two porpoises. Trials were also conducted there in an induced bottom grubbing foraging situation. Field trials were carried out at Fyns Hoved, Fyn, Denmark, were the acoustic unit was moored at 160m from shore in an area of high porpoise density. During trials, enticing sounds were emitted for varying periods of time, alternated with baseline periods. In both the captive and wild situation, the echolocation activity aimed at the device increased significantly of about 70 % when the enticing click trains were emitted compared with the baseline. The enticing sounds apparently encouraged the porpoises to investigate the sound source: this result points to the possibility of using mitigation methods based on alerting porpoises, instead of deterring them. Practical ideas will be presented.

HIGH-FIELD NMR-MICROSCOPY OF PRENATAL DOLPHINS

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Nuclear Magnetic Resonance (NMR) Microscopy is a non-invasive, non-destructive imaging technique which provides a distinct and adjustable soft-tissue contrast. We acquired 3D NMR images of formalin- and ethanol fixed prenatal dolphins: One ethanol-fixed embryo of the spotted dolphin (*Stenella attenuata*) with a crown-rump length (CRL) of 12.5mm and one formalin-fixed fetus (CRL: 45mm) of the common dolphin (*Delphinus delphis*) were investigated. Both specimens were preserved by the U.S. government almost 30 years ago. The NMR experiments were performed with different birdcage coils on Bruker spectrometers at 11.7T and 17.6T (gradient strengths: 0.66T/m and 1.0T/m). 3D Spin-Echo experiments with image resolutions of up to $29.3 \times 29.3 \times 58.6 \mu m^3$ for the embryo and (39.1μm)3 for the fetus were performed. Due to the high resolution and the excellent contrast between the different tissues that could be achieved, these NMR images reflect the anatomy of the dolphins in great detail. The observed contrast is mainly based on spin-density and T1 differences. Various organs like heart, liver, kidney and lung and even substructures of the dolphins’ hearts were visualized. The fetal intestine protruding into the umbilical cord and the genital region are also clearly visible. In the head, the skull base bears the brain and merges into the blowhole area and the upper and lower jaws. Since the anatomy of the prenatal dolphins is well reflected in the acquired images, it was possible to perform a manual segmentation of the whole dolphins and their organs and to calculate volumes and surface areas of the different organs so that 3D reconstructions including movie sequences of the fetus can be presented. Thus, NMR application provides detailed insight into the organization of embryonic and fetal specimens and the prenatal development of dolphins without altering or damaging these rare museum specimens.

UNLOCKING EUROPEAN PHOTO-COLLECTIONS BY FEATURE-BASED RETRIEVAL

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The EC funded Europhlukes project brings together European collections of cetacean photographs used for individual identification. A total of c. 150,000 images of 19 cetacean species exist in 50 collections gathered by researchers throughout Europe. This project involves the scanning of representative images of as many individuals as possible, and the input of associated information for each image in an Access database linked to other databases that will use this information to investigate biological questions relating to population size and trends, stock identity and movements, life history parameters and social structure. Within the image database, it will be possible to search for photos of a particular individual by retrieval based on the identifying features. For species identified by the trailing edge of the fluke, like sperm whales, an algorithm has been developed that has been shown to be effective at picking out matches. For species identified by the dorsal fin, like the bottlenose dolphin, a prototype is under development both to identify marks in the trailing edge and for pattern recognition within the fin. Such matching algorithms should greatly improve the process of identifying individuals from within large image collections, and will facilitate useful collaboration between cetacean researchers in Europe.

CHARACTERISATION OF CETACEAN WHISTLES BY PARAMETRIC MODELLING

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INTRODUCTION Almost all of the previous efforts on whistle characterization have been based on a spectrogram representation. From this, the evolution of a whistle's instantaneous frequency with time, the *frequency contour,* is estimated, usually by following the ridge of peaks from the whistle (McCowan, 1995; Steiner, 1981; Datta and Sturtivant, 2002). To improve performance, prior to contour extraction one usually attempts to enhance the contrast between the whistles and other components of the recording, i.e. noise, clicks and other sounds.

This paper describes a model-based approach to the well-studied problem of whistle characterisation. This approach is fundamentally different from previous efforts and has several advantages over them, such as a simpler and faster implementation and better resolution. We investigate the use of different types of auto-regressive (AR) and auto-regressive moving average (ARMA) models for characterisation of whistle recordings. AR and ARMA models are long established and successful signal processing tools, which are ideally suited to the task at hand.

METHODS AND MATERIALS **Parametric modelling** With a parametric model-based method, we extract whistle information directly from the recording, without need for Fourier transformation or other processing. We therefore avoid the resolution and cross-term issues of the spectrogram and other time-frequency representations. Instead, we attempt to identify the recording with a model with a fixed structure, the properties of which are controlled by a small set of parameters.

During estimation, the parameters of the model are tuned so that the model output signal resembles that the whistles in the recording as closely as possible. This is accomplished by minimising the difference between the model output signal and the recording.

Because the model only attempts to match the whistles, the model-based method is robust to clicks and other sounds. Ocean background noise can reduce the matching performance, but the noise can also be included in the model so that it can cope with noisy underwater recordings.

Finally, when the model is tuned to match the signal, information about the whistles is contained in the model parameters. We can then extract this information in a straight-forward way to obtain the frequency contour(s).

AR and ARMA models We have chosen to use models of auto-regressive (AR) and auto-regressive moving average (ARMA) types. These can potentially provide a perfect model fit to a signal composed of multiple smoothly time-varying narrowband signal components, which is exactly what a whistle recording (with no other sounds) is.

An AR model is ideal for modelling a whistle recording without noise, but its performance is rapidly degraded in increasingly high levels of noise. To model a whistle recording in white background noise, a constrained ARMA model, with nearly equal MA and AR parts, is ideal (Nehorai, 1985). Of course, the ocean background noise is not white, but a pre-whitening scheme allows us to assume that it nearly is.
An AR model of order *P* of the signal *x(n)* can be written as

$$x(n) + \sum_{i=1}^{P} a_i(n)x(n-i) = b_0\delta(n) \qquad (1)$$

where $a_i(n)$ is the i'th AR coefficient at time *n*. The right hand side is zero except at the start of the signal at *n=0*.

Equation (1) defines a coefficient parameterised AR model. We will also investigate model parameterisations in terms of the AR poles. For sufficiently slowly time-varying signals, the poles $z=\lambda_i(n)$ are the roots of the AR polynomial:

$$1 + \sum_{i=1}^{P} a_i(n)z^{-i} = \prod_{i=1}^{P}\left(1 - \lambda_i z^{-1}\right) \qquad (2)$$

It can be shown that for an AR or constrained ARMA model fitted to a smoothly time-varying whistle signal, the pole magnitudes are very close to 1, and the angles of the (complex) poles are equal to the instantaneous frequencies of the narrowband signal components - the whistles. Keeping with the previous research tradition of recognising whistles based on their frequency evolution, deriving features is therefore straightforward from the poles of a fitted AR or ARMA model. Pole estimation also has several other advantages, but is more difficult than coefficient estimation.

In general, to model to a real-valued signal of narrowband components, the AR model order P needs to be at least twice the number of components. Given a recording, we will not know what is the number of components before analysing it, and will therefore need to estimate the model order. This is a difficult task, which will be discussed elsewhere. Here, we will assume that we know the number of signal components (whistles) present in a given part of a recording.

Adaptive models Among our models, there are two different ways of dealing with the non-stationarity of whistles.

The *adaptive* models assume that the whistle amplitude and frequency do not change much within a short time window, and then move this short window along the recorded signal. Here, we update the model parameters at each new sample. Therefore, as for the previous frequency contour-based recognition methods, before a final recognition step we would need to derive a few descriptive features from the parameter evolution (McCowan, 1995; Steiner, 1981).

The two adaptive models investigated here are an AR and a constrained ARMA model, that both use the poles as parameters. Nehorai developed the pole parameterised AR model (Nehorai and Starer, 1990), but the pole parameterised constrained ARMA model is new; it is our combination of the pole parameterised AR model and a coefficient parameterised constrained ARMA model (Nehorai, 1985).

Estimation of the parameters of adaptive models might sound tedious, since we need to estimate new parameters for each new data sample. However, the very efficient recursive prediction error (RPE) algorithms (Ljung, 1999), which define the short sliding window in which we assume stationarity in a clever way, enable us to very effectively update the parameter estimate when presented with a new data sample. The RPE method has previously been implemented in real-time for problems similar to the present one.

Block-based models The *block-based* models attempt to fit the model to a block of recorded data, for instance a complete whistle, at a time. Here, we assume that the temporal evolution of model parameters can be described as a linear combination of Q polynomials or other functions. We then estimate the basis coefficients in this linear expansion of the temporal evolution.

Here, we investigate a block-based coefficient parameterised AR model. This is the only kind of block-based (block processing) AR or ARMA model investigated so far. The commonly used least-squares method is used to estimate the weights in the basis expansion of the AR coefficients. The weights are obtained by solving a small linear equation system (Grenier, 1983), so the estimation is even simpler than for the adaptive methods.

Implementation In order to implement our parametric models on a whistle recording, we start with pre-whitening the signal to make the background noise as white as possible. As mentioned, this enables a constrained ARMA model to better fit the recording. The pre-whitening scheme employed here entails estimating the slowly time-varying background noise spectrum and dividing it out from the signal spectrum. Ideally, this gives a signal with a flat background spectrum of unit variance white noise.

Having pre-whitened the signal, we use the detection method of (Datta and Sturtivant, 2002) to detect whistles. This method is robust to noise and other sounds, but requires a lot of user tuning, several processing steps, and is based on spectrogram ridge following. However, developing faster or better detection methods is out of scope of our study.

Once a section of the pre-whitened recording containing whistles has been found, the parametric models are applied to it.

For the adaptive methods, we start with an initial guess at the parameters (which need not give frequencies that are close to the actual whistle frequencies) at the first sample, and then iteratively use each new data sample to derive a new and improved estimate of the poles of the model, using the RPE algorithm. After estimation, we then have P pole estimates at N times. The angles of the poles are calculated, and these give the frequency contour.

With the block-based model, we solve a linear matrix equation to obtain the weights of the linear expansion of the AR coefficient evolution in time. We use Legendre basis functions, which are polynomials defined in such a way that the basis system is orthonormal. The number of basis functions to use is determined manually to balance the requirements of a good model fit and a compact model representation.

To obtain the instantaneous frequency evolution, we expand the basis function sum to obtain the AR coefficient evolution in time, then root the AR polynomial at each time to obtain the pole evolution, and finally calculate the instantaneous frequencies from the pole angles.

RESULTS We have selected two underwater recordings, to be called A and B, to illustrate the performance of our methods.

Recording A contains a single whistle of duration 0.16 seconds in heavy background noise and with strong clicks present. The signal-to-noise ratio (SNR) is approximately 4 dB. There is one strong click in the centre of this signal – its amplitude is more than 25 times the whistle amplitude. This relationship between click and whistle amplitudes is not uncommon in recordings.

The results of modelling recording A are shown in Fig. 1. Here, the extracted frequency contours from our three different models are plotted as white lines on top of a grey-scale spectrogram of the recording. To model the single whistle component we have used a model order of $P=2$. For the block-based models the 6 first Legendre polynomials were used as basis functions.

Because they do not include the noise, the AR models work about equally poorly in this low SNR. The adaptive one gives a shaky estimate and is locally disturbed by the click, whereas the block-based one is forced to give a smooth frequency evolution. However, there appears to be no major difference in model fit.

On the contrary, the adaptive constrained ARMA model, which includes the noise, gives a stable instantaneous frequency estimate that fits the frequency contour given by the spectrogram, and is hardly disturbed at all by the click.

Recording B is longer at 0.33 seconds. Here, two whistles are present, and we also note a weak harmonic. The whistle frequencies change more in this recording, and the frequency contours also cross each other at one point early on in the section. At 18 dB, the SNR is higher here than for the first section. Also, there are no strong clicks present.

Fig. 2 illustrates that, as expected, the AR models work better in higher SNR. As long as the frequency contours of the two simultaneous whistles are not too close to each other, they give accurate estimates. However, when they do come close to each other, the models fail. Resolving tonals of similar frequency is known to be difficult, so a possible interpretation is that at this noise level, the AR model works as long as the estimation situation is not too difficult. The higher the SNR, the less the model is disturbed by noise, and the more difficult an estimation task can it successfully cope with.

Again, the adaptive constrained ARMA model works much better, giving a stable and accurate estimate except just around the contour crossing. Note that the method manages to track the whistles through the crossing.

Comparing adaptive and block-based models, remember that the adaptive models use P parameters per sample to model the signal, whereas the block-based ones use PxQ parameters for the whole signal. The block-based models therefore describe the whistles using far fewer parameters. This clearly favours the block-based AR model over the adaptive one.

The weak harmonic appears to cause no problems to any of the methods. If necessary, it can also be modelled.

CONCLUSIONS This paper demonstrates that parametric modelling with AR and constrained ARMA models is a useful tool for whistle characterisation. The AR models both perform well in low noise and for reasonably simple estimation situations. In increasing noise or for multiple whistles with crossing frequency contours, the constrained ARMA model far outperforms the AR models.

The block-based method is simpler and gives a compact feature representation, which speaks strongly for investigating other forms of block-based models. For instance, it would be very interesting to attempt to combine the noise-robustness of constrained ARMA with the compactness of the block-based approach in a block-based constrained ARMA model. Also, we will investigate whether it is possible to parameterise this model in the poles rather than in the coefficients. This would have numerous benefits, including the possibility to use the basis coefficients directly as features in a recognition system.

ACKNOWLEDGEMENTS We wish to extend our gratitude to EPSRC and ISVR for funding this research, and to QinetiQ for their interest and financial support.

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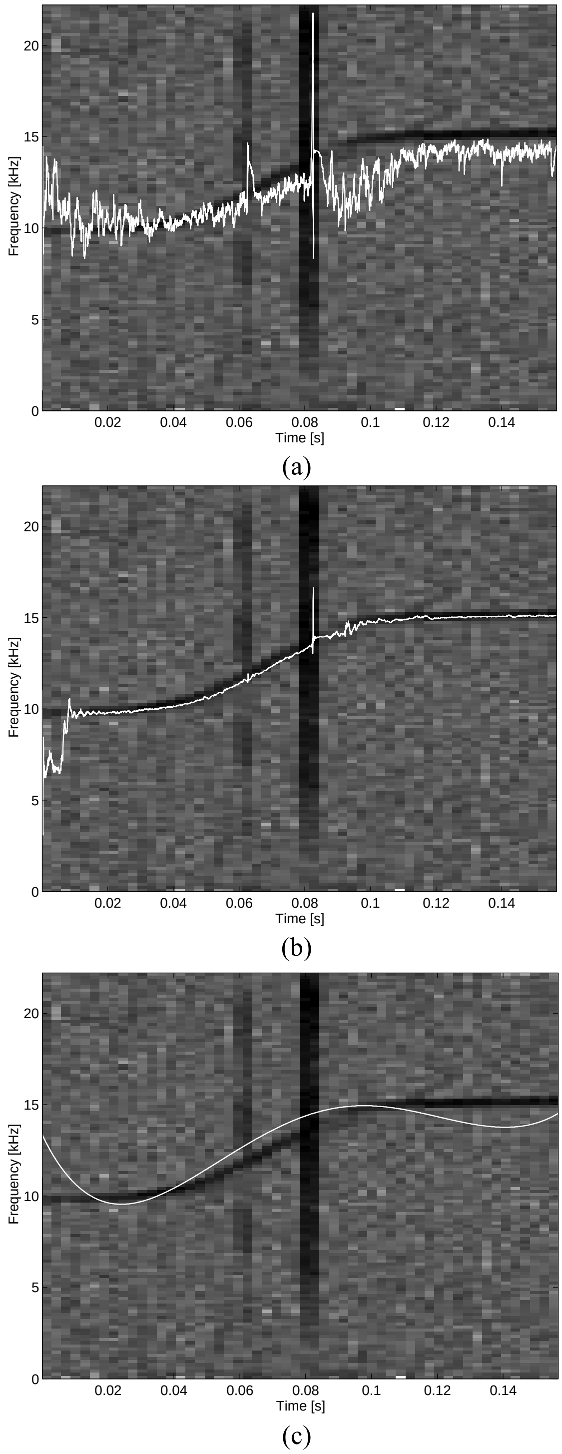

Fig. 1. Whistle frequencies extracted from parametric models applied to recording A. (a) Adaptive AR model. (b) Adaptive constrained ARMA model. (c) Block-based AR model.

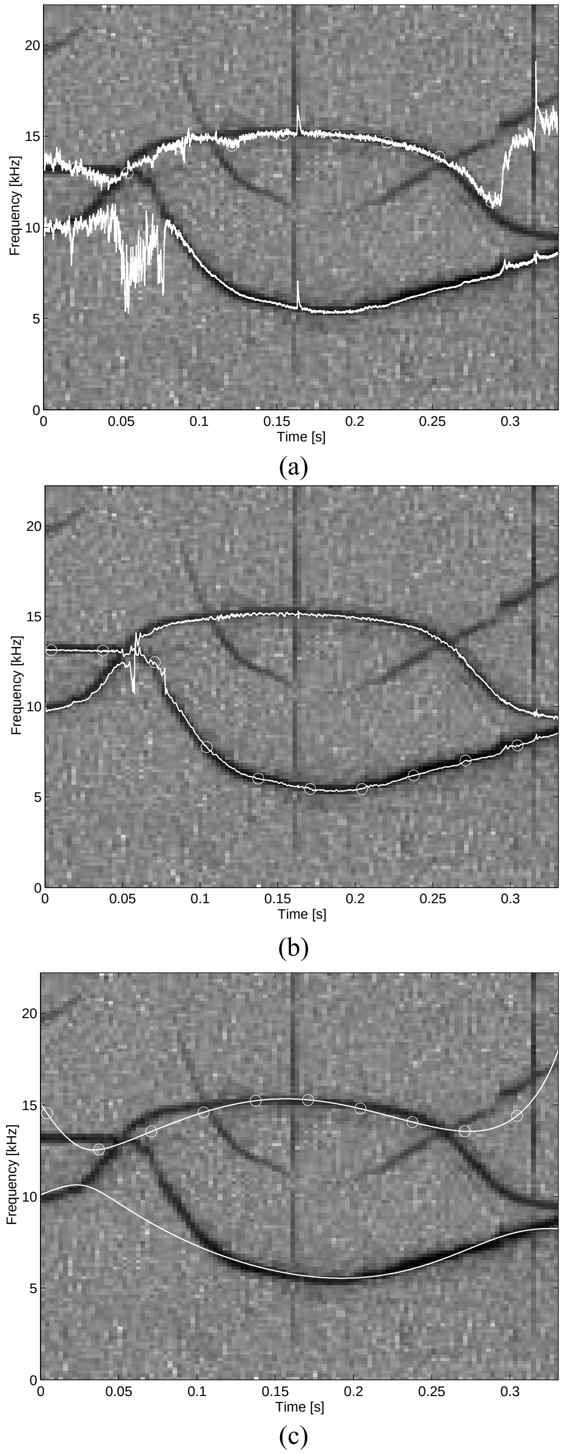

Fig. 2. Whistle frequencies extracted from parametric models applied to recording B. (a) Adaptive AR model. (b) Adaptive constrained ARMA model. (c) Block-based AR model.

PHONING HOME – A NOVEL MARK-RECAPTURE / TELEMETRY SYSTEM BASED ON GSM TECHNOLOGY

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Marine mammal mark-recapture survivorship studies are often limited by the effort required to recapture or resight marked individuals. We have thus developed a novel telemetry system in which seals are equipped (marked) with GSM mobile phone tags that automatically send text messages at regular intervals. The extensive coastal networks of GSM receiving cells (roaming agreements allow pan-European coverage) now undertake the 'sighting effort' required to relay text messages to the laboratory. The successful receipt of a text message ashore replaces the traditional visual resighting event. The analysis requires that live marked seals occasionally travel within the c. 20km coastal corridor of GSM reception – with a finite probability of reception. Tag failure and detachment is estimated through double marking and independent visual resighting surveys within a restricted geographical region. The phone tags are designed to minimise energy consumption and to last for one year. Incorporating mass-produced GSM circuitry, the tags are cheap to produce and the cost of text messages is minimal. Thus a high number of phone tagged individuals is financially feasible allowing sufficiently large sample sizes for hypothesis testing. Regular (every 4h) attempts to register with the GSM network are delayed while the tag is wet. Registration attempts timeout after two minutes if (as is often the case) the animal is outside the GSM coverage zone. In a 60-day trial study a phone tag attached to a free-ranging juvenile grey seal on the east coast of England sent an average of 3.1 messages per day. These messages contained detailed haulout records derived from interrogation of the wet dry sensor and the locations of the GSM cells with which the tag registered. This demonstration of the feasibility of GSM technology opens up the potential for two-way and very high bandwidth (GPRS) communication channels with marine mammals.

USING PARABOLIC EQUATIONS TO MODEL SOUND PROPAGATION IN MANATEE HABITATS

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INTRODUCTION The Florida manatee (*Trichechus manatus latirostris*) generally inhabits coastal rivers, estuaries, bays, streams, and lagoons of peninsular Florida and southeastern Georgia. Manatees are rarely found in deep ocean waters, as their herbivorous diet and dependence on freshwater restricts them to shallow, coastal waterways. Sound propagation in these shallow water regions is complex. The water column forms a sound channel in which the sound is trapped between the upper boundary of the surface and lower boundary of the bottom sediments. As sound is propagated through the environment, it is repeatedly reflected from both the upper and lower boundaries. This can cause the sound signal to become distorted in frequency, distorted in time due to multi-path interference, or generally weakened due to transmission loss (Urick, 1986).

The two major contributors to transmission loss (TL) are spreading and attenuation. Spreading in shallow water is typically cylindrical, as opposed to spherical spreading in deep ocean waters. Attenuation arises from a combination of sound absorption by the water itself, absorption by particles within the water column, acoustic scattering, and sound leakage from the system (Urick, 1986). In addition, environmental factors such as surface roughness, depth at the source/receiver, and bottom properties all affect sound transmission. The difficulty in characterizing the sound propagation loss in shallow water regions is due to the complex variability of these environmental conditions in space and time. Understanding how sound is propagated in different manatee habitats is critical in order to more clearly understand the impact of human activities on manatees and the manatee communication system. For example, watercraft collisions have become the leading cause of adult mortality (Reynolds, 1995; Ackerman *et al*., 1995). The question that naturally arises from this is whether or not manatees are hearing the noise produced from approaching boats in enough time to swim out of harms way? The root of this question is detection of sound signals. Quantifying how sound is propagated in different habitats between the source and receiver provides the necessary information for determining source levels and ultimately the probability of manatees detecting approaching sound sources.

METHODS Sound propagation loss was investigated in two critical manatee habitats: seagrass beds and dredged basins. These habitat types were chosen because of their biological importance to manatees. Animals typically feed in grassbeds and rest or socialize in dredged habitats. The Monterey-Miami Parabolic Equation Model (MMPE) was used to relate bathymetry, source depth, bottom properties, and sound speed profiles to transmission loss over a specified distance and frequency range. All models were run over a range of 1 km and covered a 7-octave frequency bandwidth (250 Hz –20 kHz). The rock basement depth was set at 50 m below the surface of the soft sediments, and sediment properties (sound speed, speed gradient, density, compressional attenuation, shear speed, and shear attenuation) were obtained from the Sarasota Bay National Estuary Program (Culter and Leverone, 1993). A constant sound speed profile of 1543 m/s was used in all models. A constant value was selected because water column profiles revealed the water was well mixed and relatively constant from site to site within Sarasota Bay. In all models the source was a point source at a depth of 0.75 m. This depth approximates the depth of an outboard motor engine.

MMPE models transmission loss according to a derivation of the wave equation (Smith, 2001). This model was selected for its accuracy in shallow water environments as well as deep waters. Output parameters include transmission loss at a single frequency vs. range and depth, transmission loss at a single range vs. frequency and depth, and transmission loss at a dingle depth vs. frequency and range. The remainder of this paper focuses on transmission loss at a single frequency vs. range and depth. Results are displayed as a both function of frequency vs. range and depth (Fig. 1), and as a depth averaged transmission loss at a specified frequency (Figures 2 and 3). During the averaging over the depth of the water column, transmission loss values were converted to raw intensity values and then averaged. The averaged values were then re-converted back to transmission loss in dB re 1m.

RESULTS The least efficient sound transmission occurred at frequencies below 2 kHz (Figures 1 and 2). Transmission loss at frequencies below 2 kHz was greater in ideal seagrass beds compared to dredged basins (Figures 1 and 2). The term "ideal" was used to acknowledge that the acoustic properties of the grass blades were not incorporated into the models. All grassbed models were generated based on the sediments the grasses were growing in. Minimum transmission loss in dredged basins was observed at 2 kHz, while the most efficient sound propagation in the grassbeds was 20 kHz. Transmission loss in seagrass beds and dredged basins was similar in the range of 2-8 kHz for distances up to 1km (Fig. 2).

The MMPE model sensitivity was investigated for 2 input parameters: bottom sediment properties and bottom shear. Fig. 3A displays the model output for two different sets of bottom sediment properties. Dredged basins typically have a finer sediment grain size than grassbeds, and the model run with the dredged basin sediment properties resulted in more transmission loss at all frequencies compared to the model run with grassbed properties. All other model parameters were the same. The largest difference (approximately 40 dB) was observed at 2 kHz, which is the most efficient frequency propagated in the dredged habitat. When bottom shear was incorporated into the model, and all other parameters were held constant, transmission loss increased by approximately 1 dB (Fig. 3B).

CONCLUSIONS Sound propagation is more efficient in dredged habitats than in grassbeds. Maximum transmission loss in both habitats occurs for frequencies below 2 kHz. This overlaps with the dominant frequencies of boat noise (Richardson *et al*., 1995). Understanding how these low frequencies propagate in shallow, coastal habitats will be crucial in providing an answer to the question of why manatee continually collides with boats. It is entirely possible that transmission loss is so great in some areas that manatees cannot detect boats until they are only a few meters away. The modeling of acoustic propagation loss and measurement of corresponding ambient noise levels associated with this project will be able to address whether or not this is a common circumstance.

The least amount of transmission loss was observed in dredged basins in the frequency range of 2-8 kHz. In grassbeds the least amount of transmission loss was at 8-20 kHz. The actual range of effective communication in the noisy, shallow-water areas manatees inhabit is dependent on the acoustic propagation loss characteristics of the area and the frequency and amplitude of the vocalizations being emitted. The most efficient sound propagation range in dredged habitats overlaps with the dominant frequencies of manatee vocalizations (Schevill and Watkins, 1965; Nowacek *et al*., in review). This suggests that manatees are highly adapted to their acoustic environment while in dredged habitats. Additional studies are needed in order to determine if vocalization structure is a function of habitat.

Compared to making numerous recordings in the field, MMPE modeling is a consistent, non-labor intensive technique for describing shallow water sound propagation. The MMPE model is sensitive to both bottom sediment properties and bottom shear, with bottom sediment properties having a greater effect on model output than shear. The software to run the MMPE model is user friendly and available on the web at http://oalib.saic.com/PE/mmpe.html.

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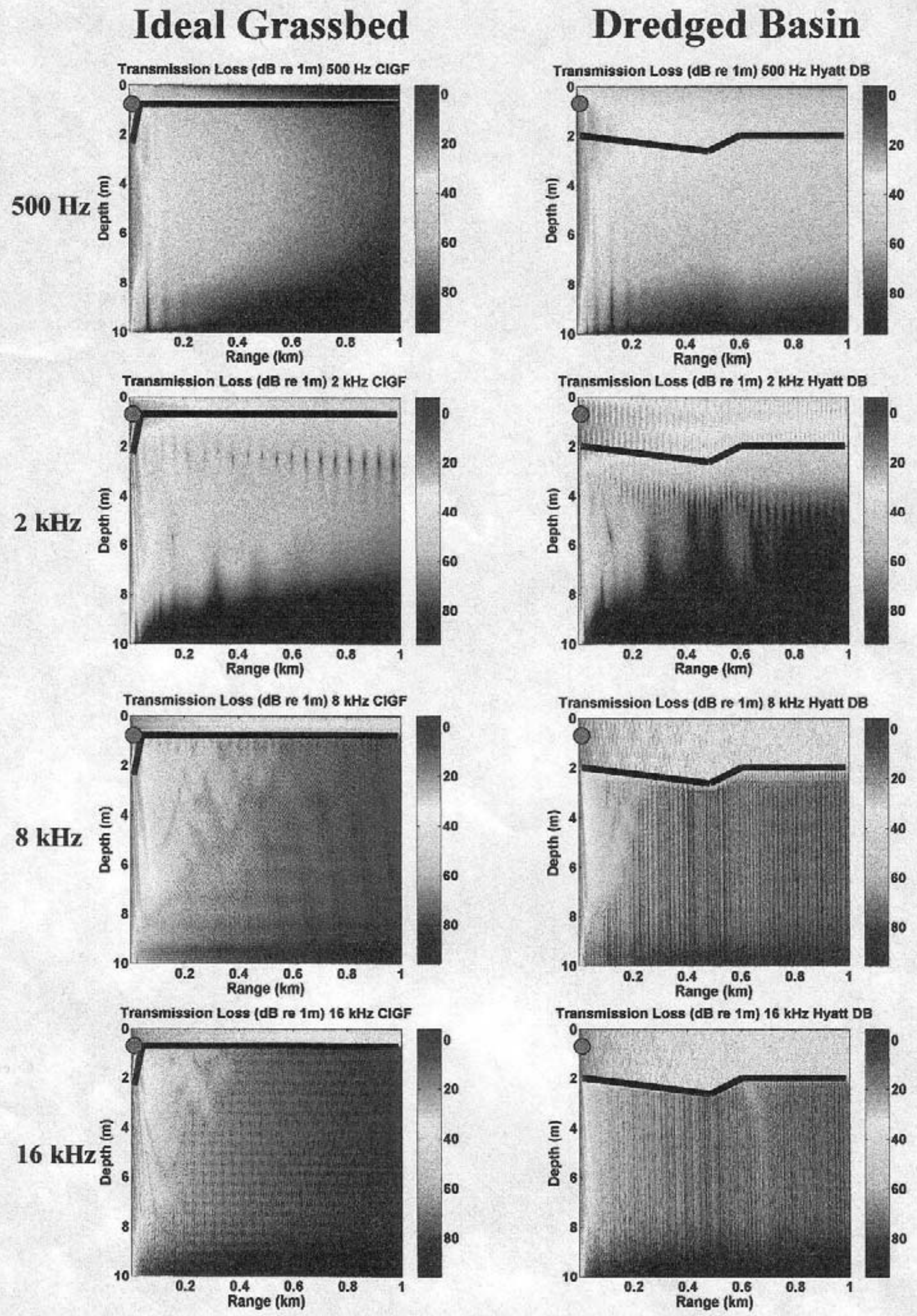

Figure 1. Transmission loss in the City Island Grass Flats (CGIF) compared to the Hyatt Dredged Basin (DB). Transmission loss is compared at 4 frequencies. The circle on the y-axis at 0.75 m indicates the source depth. The black bathymetry line divides the images into water column and bottom sediments with the water occurring above the line and the sediments below. Note that less sound is being absorbed by the sediments as the frequency increases.

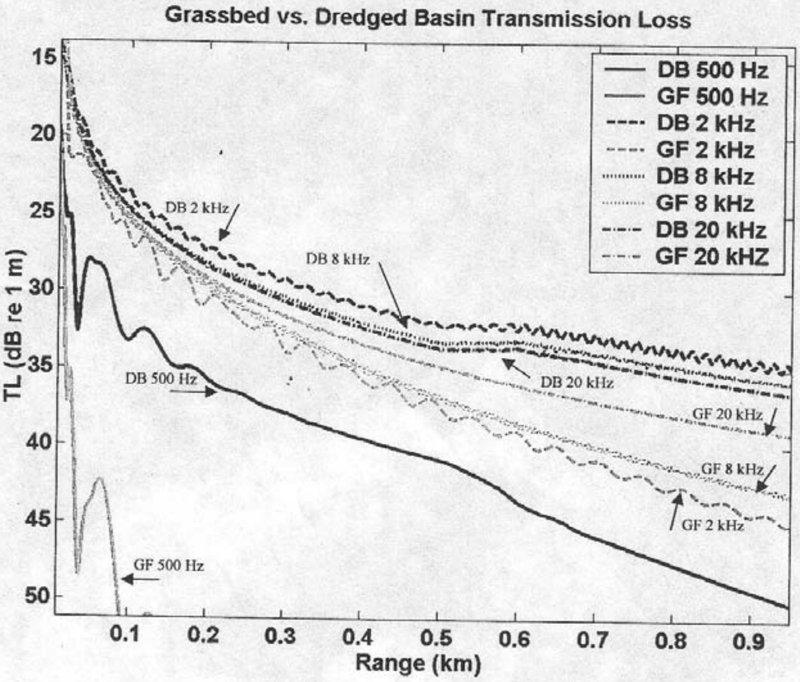

Figure 2. Depth averaged transmission loss in a grassflat (GF) compared to a dredged basin (DB). Sound is propagated most efficiently in the dredged basin at 2 kHz.

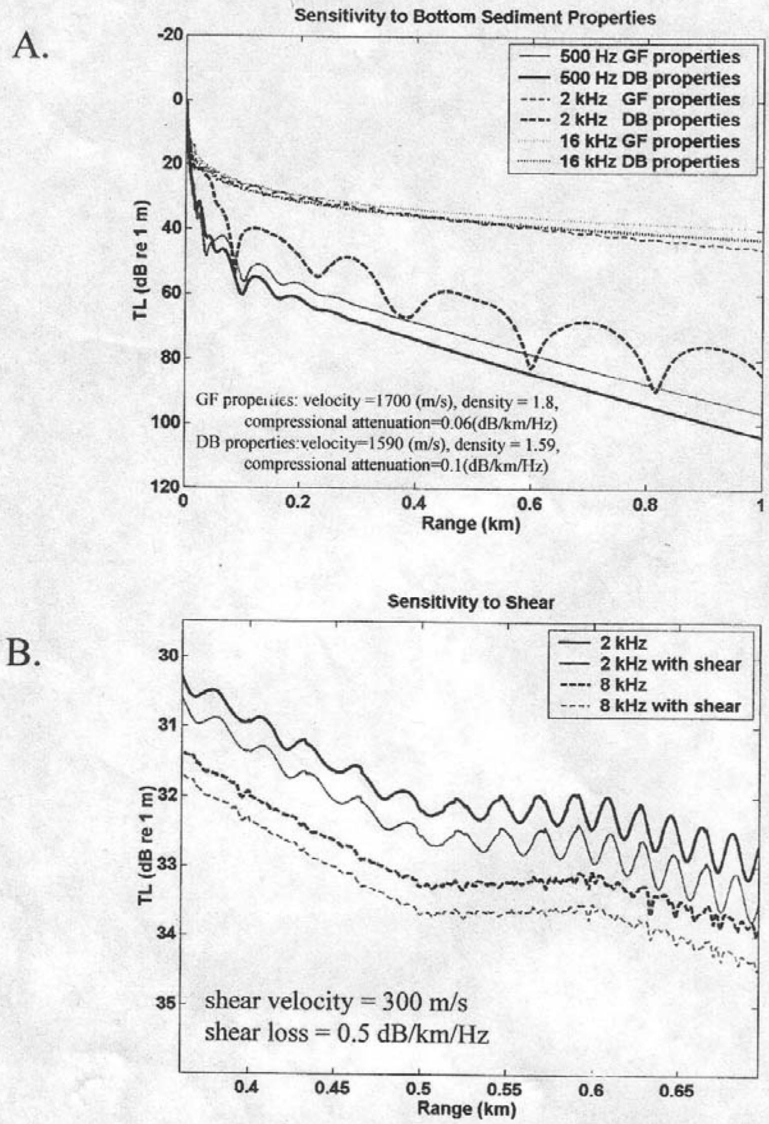

Figure 3. A. MMPE model sensitivity to bottom sediment properties. B. MMPE model sensitivity to the incorporation of bottom shear.

DETECTION, CLASSIFICATION AND TRACKING OF MARINE MAMMALS USING PASSIVE, ACTIVE AND AMBIENT NOISE TECHNIQUES

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There is an increasing need to be able to detect, classify and track marine mammals so as to better mitigate against undesirable negative impact by anthropogenic activity, be it from accidental shipstrike, or acoustic pollution of their environment. The United States has some of the strongest marine mammal protection legislation, and this is creating a powerful need for these technologies on behalf of such diverse interests as the Navy and seismic survey vessels. Initial developments have been in active and passive sonars to detect marine mammals, but active sonars increase the acoustic pollution of the seas and passive sonars detect only vocalizing animals. Ambient noise imaging, where the insonifying signal may come from other marine mammals, ships or other sources, holds out additional hope that non-vocalising animals might be detected without introducing yet more sound into the ocean. Signal processing advances, including the application of wide-aperture matched field techniques for transients, add power to the hardware in estimating position and depth. A sampling of systems and signal processing approaches under development to address these problems will be presented, and the ambient noise imaging approach discussed in the context of existing capabilities.

INTERACTIVE PINGER TRIED ON WILD "DANISH" HARBOUR PORPOISES: PRELIMINARY RESULTS

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A prototype of an interactive pinger (i.e. triggered by the porpoises' sonar), which had been successfully used on captive porpoises at the Fjord&Bælt, was tested on wild, naïve porpoises at Fyns Hoved, Denmark, in August-September as part of the NAPER project funded by the Nordic Council of Ministers. The aim was to identify the effect and deterrence distance of the interactive pinger unit by comparing the movements and behaviour of the porpoises between periods where the pinger unit was activated or de-activated. Observers situated on a cliff recorded porpoises sighting and movements, using naked eye, binoculars and a digital theodolite. The computer controlled test sounds were transmitted by two converted AquaMark100 units, deployed 3m below sea level, and 4 m above the sea floor from a small boat, moored at 160m from the observation point on land. The system included a hydrophone recording acoustic activity, i.e., the transducer emission (deterrent and enticing sound emission) and the echolocation of the porpoises. Thereby movements of individual porpoises and echolocation activity could be put in relation with each emission of the transducers. Technical problems and an unusual low density of porpoises impaired the experiment. Ten groups of porpoises entered the area close to the unit (150m radius) without being exposed to the deterring sounds (baseline). Six groups triggered the deterring sounds. In five cases, the first deterring sound induced a clear avoidance reaction with an immediate increase in swimming speed and dive duration, which lasted for a few dives until the animal was about 150m away from the deterrent device. The last group observed, however, continued echolocating towards the device,triggering new deterrent sounds. The results are overall promising and new trials will be carried out in May 2003.

CETACEAN SPATIAL DISTRIBUTION ANALYSIS WITHIN THE GULF OF CATANIA (IONIAN SEA) USING GIS TECHNIQUES OF SPATIAL ANALYSIS AND SPATIAL MODELLING

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Geographycal Information Systems are a powerful set of tools for collecting, storing, transforming and displaying spatial data. In this study, GIS techniques of spatial analysis have been used in order to analyse the spatial distribution of the Cetacean species within the Gulf of Catania in Sicily. In particular, this analysis was focused on the follow species: *Tursiops truncatus*, *Stenella coreuleoalba*, *Grampus griseus* and *Balaenoptera physalus*. The data collected during five years of surveys beginning in 1997 have been used for creating the spatial databases comprising: survey cruises tracks, sighted species, position of the animals (lat/long), observed behaviours, total number of animals and relative number of youth and adults. The animal positions and the cruises tracks have been taken during the surveys using GPS.The spatial distribution and the relationships between environmental parameters, such as coast distance and bathymetry, and species positions have been analysed using the Spatial Analyst extension of the ArcView 3.2a package while the spatial modelling has been used for creating the spatial distribution maps of each species. From the analysis of the obtained maps, the Bottlenose dolphin results the more represented species within the study area. It was normally observed very close to the coast and its distribution was strongly influenced by the fisher-boat positions. Striped dolphin showed a more concentrated distribution area located in the northern part of the Gulf while Risso's dolphin was always observed far from the coast in pelagic area. Even if the Mediterranean Fin whale presence is quite rare within the study area because this is a migratory species, some sightings have been made during the summer period.

DIVE FORM IN GREY SEALS HALICHOERUS GRYPUS: CALIBRATION AND PRELIMINARY RESULTS FROM THE USE OF THE TIME ALLOCATION AT DEPTH INDEX (TAD) IN SATELLITE TRACKING

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The Time Allocation at Depth (TAD) Index was recently devised in order to compress and analyse diving data obtained from Time Depth Recorders (TDR) and Satellite Relay Data Loggers (SRDL) deployed on marine mammals. This dimensionless, depth- and duration-independent index indicates the depths in which the animal concentrated its dive-time, given that a minimum time is necessary to reach the maximum dive-depth (referred to as travelling time). When most diving time is spent at the shallowest depths of the dive, the TAD tends to 0. It is 0.5 if the seal spends equal time at all depths encountered (V-shape dive), and tends to 1.0 when all time except travelling time is spent at the maximum depth (U-shape dive). This index was computed for the first time in SRDL's deployed on 14 grey seals in 1999 and 2002 in Brittany. We aimed at calibrating technical parameters for the use of the TAD in wild grey seals, and illustrating its usefulness for investigating diving behaviour. Over 50.000 individual dives were recorded. These records were first used to post-process the TAD, in order to describe the effect of different estimated travelling times on the calculated index. 7500 'detailed' dive records, including 4 time/depth points per dive, allowed reconstruction of each actual dive forms for comparison with the calculated TAD. Lastly, the TAD was used together with maximum dive-depth and sea bottom depth to investigate travelling and foraging behaviour. Most short localised trips at sea were characterised by periods of mid-water V-shape dives (TAD=0.5), deeper U-shape dives (TAD=1.0), and then V-shape dives again. In longer trips most seals performed repeated deep dives with TAD between 0.7 and 1.0. The first case indicates central place foraging behaviour while the second suggests either prospecting or actual feeding behaviour over longer trips between two haul-out sites.

COMBINING CETACEAN SIGHTINGS AND CONTEMPORANEOUS OCEANOGRAPHIC DATA TO DETERMINE THE PROBABILITY OF ENCOUNTER WITH CETACEANS AS A METHOD FOR MITIGATING ACOUSTIC IMPACTS

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It is hypothesized that combining long term replicate survey data with in-situ contemporaneous oceanographic data will produce fine scale predictive models of the movement and distribution of marine mammals useful in mitigating anthropogenic impact. In order to test this data from replicate surveys conducted by BDRP aboard the P&O Ferry Pride of Bilbao using standard scan sampling techniques with twice monthly year-round surveys were combined with. oceanographic data including salinity, sea temperature and Chlorophyll a obtained through placing sensors aboard the Pride of Bilbao. A flow through system with a Chelsea Technologies Group Minipack-CTD was fitted in the ships engine room. This data is complemented by data for sea surface temperature and chlorophyll extracted at positions along the ship's track from satellite images. The combination of data provides a unique opportunity rank the relative importance of oceanographic parameters in describing the presence and movements of cetaceans. Using a conditional probability approach the relative importance of each variable was determined and a probability distribution map produced for each species for every month. Maps for common dolphins have shown a well-demarcated range in the Bay of Biscay during July and August accurate to 0.79. Predictive mapping of the expected probability of encounter with Cuvier's beaked whales in the southern Bay of Biscay was tested during a summer field trip and predicted encounter probabilities were accurate to 0.85. Analysis of other species has shown significant value in recognizing important habitats and the relative importance of physical and biological oceanographic features. This method allows for a comprehensive assessment of areas intended for use by military or commercial areas for the relative importance to a given a species, the encounter probability both spatially and temporally allows operational planners to make sensitive judgments that are not based on historic, time limited surveys.

PRELIMINARY EVIDENCE INDICATE THAT *TURSIOPS TRUNCATUS* HAS A HIGHER BONE DENSITY OF THE ARM AND FOREARM THAN *STENELLA COERULEOALBA*

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A recent investigation performed in *Stenella coeruleoalba* showed that bone density of the arm and forearm is a reliable age indicator for stranded animals of this species (Guglielmini *et al*., 2002, Anat. Rec. 267:225-230). We are now studying whether this applies also to specimens of *Tursiops truncatus*. Preliminary evidence indicate that the global mineral density of the arm and forearm is 12.5% higher in the bottlenose dolphin than in the striped dolphin. This difference between the two Genera is present and even increased (20%) also if we compare the bone mineral density of the arm region only. General body volume and weight may explain higher mineral content of the bones of the thoracic limb in *Tursiops truncatus*. Interestingly, the global bone density of the arm and forearm of a specimen of *Tursiops truncatus* kept within confined water and sampled at necropsy resulted inferior (29%) to that of wild animals of the same species sampled at strandings. The region of the arm was also 32% less dense in the captive animal than in the group of bottlenose dolphins living in the wild. Further investigations are in progress to determine whether bone density can be a reliable age indicator also in the bottlenose dolphin, and whether captivity may lead to lower bone mineral content of the bones of the thoracic limbs.

PHYSIOLOGY AND ANATOMY

ODONTOCETE EAR ANALYSIS BY IMAGING TECHNIQUES

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The increasing level of knowledge on the effect of underwater noise on the marine environment has lead to the necessity of studying the odontocete ear. However, the complicated access of the ears in those species together with their structure make difficult the use of conventional invasive methods, implying complex processing and interpretation of the results. Non-invasive imaging techniques as computed tomography (CT) and magnetic resonance imaging (MRI) appear to be an alternative to analyze the odontocete middle and inner ear structures, and the viability of these techniques could be explored both in vivo and post-mortem studies. With the purpose of describing the odontocete ear morphology, general CT and MRI were performed in 4 dead stranded dolphins in extremely fresh conditions. The extracted ears were analyzed with two spectrometers Bruker of 200Mhz/ 4.7 Teslas and 400Mhz/ 9.4 Teslas respectively. As already described for these imaging techniques, bony structures and their boundaries, including middle ear and auditory ossicles, are better visualized with CT scans. High magnetic field MRI units allow an increase of the image resolution but imply consequent long acquisition times and small sample sizes. Inner ear major structures were identified with the latter techniques - i.e. the cochlear scalae, the spiral ganglion and ligament, the organ of Corti - although the scans did not provide a good microscopic structure image, meaning a necessary posterior histological analysis. Those limiting factors restrain to macroscopic lesions the possibility of using these techniques for the diagnostic of ear pathologies. The planned development of MRI and CT units – e.g. power increase, accurate process parameters definition and acquisition times reduction - will provide images at cellular level, reducing the artifacts associated with complex histological processing and confirming the possibility of using these non-invasive techniques as an objective diagnostic tool both in dead and live animals.

EXPLORING THE SOUND GENERATION APPARATUS IN THE HARBOUR PORPOISE, *PHOCOENA PHOCOENA,* USING DISSECTION, CRYOSECTION AND COMPUTER RECONSTRUCTION

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Sonar signal generation in dolphins has been shown to take place in the upper nasal passages, driven by air pressure in the bony nares. This paper provides a photographic view of the blowhole region in Phocoena phocoena, supplemented with 3-D computer graphics reconstructions of serial cryosections. Laterally on either sides of the blowhole, there are two large vestibular sacs. The roof of these sacs is thin-walled, and distensible. The floor has deep, connective tissue supported folds in a semi-concentric pattern around a central, straight, transverse fold, opening down to the spiracular cavity, where there are two pairs of lip-like structures. These lips are demarcated on both sides by a color change in the epithelium, from black above to pinkish grey below. The lips on the right-hand side are slightly wider than those on the left side. The surface of the right nasal plug follows the caudal wall ventrally, forming a smooth air passage for the whole width of the lips. The position of the lips is identical to the site where small bubbles have been reported being formed and tissue vibrations recorded in connection with sound production in dolphins and porpoises. We also find the dorsal bursae embedded within the "phonic lips", which have also been identified by means of CT-scanning. The dorsal bursae of Phocoena are approximately equal in size on both sides (left and right), in contrast to the dolphins (e.g. Tursiops), which have asymmetric dorsal bursae. Similarly, the phonic lips in porpoises are equal in size. The core of the porpoise melon does not branch as it does in dolphins, but ends abruptly near the midline. These and other differences in structure are apparently related to differences in the biosonar signals, although the correlation is not easily understood.

HEMATOLOGY IN PORPOISES, A CLUE TO THEIR DIVING ABILITIES?

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How long and how deep a porpoise can dive is not known. Visual observations, TDR results and most tagging data points to a few minutes, while a few tagging results open the possibilities for up to ten minutes. The latter results are, however, challenged by the possibilities of surfacings to be missed. Some blood parameters (a.o. red blood cell count, hemoglobin, hematocrit) express oxygen carrying capacity and correlate with diving abilities. Comparing those factors in porpoises with those from species for which diving abilities are better understood should therefore shed some light on the diving ability of porpoises. We compare different blood values from healthy porpoises with similar values taken from the literature in other toothed whales species, e.g., beluga, killer whale, tursiops and Pacific white-sided dolphin. The physiological factors, which influence these blood values, are presented. Porpoises have the highest average Red Blood Cells Counts (6 106/mm3) and have hemoglobin and hematochrit values slightly inferior to belugas (18 g/dl and 52 %) and higher than most other species. These results supports findings from tagging studies indicating that porpoises can probably dive longer and deeper than previously thought, i.e., to depth down to more than 100 meters and for longer than a handful of minutes. This project is supported by the Danish Nature and Forest Agency.

EMBRYOLOGY OF THE DOLPHIN BRAIN BY 3D-NMR MICROSCOPY

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INTRODUCTION Only little is known about the prenatal development of odontocete brains. This is due to the fact, that there are only very limited good microslide series of prenatal dolphins world wide. Nevertheless, in some collections we encounter intact cetacean embryos and fetuses kept in alcohol or formalin which have not been investigated yet. 3D-Nuclear-Magnetic-Resonance (NMR) images give us the opportunity to find out more about the morphology of these rare preparations without the time-consuming histological methods.

MATERIALS AND METHODS One ethanol-fixed late embryo of the spotted dolphin (*Stenella attenuata*, crown-rump length [CRL] 12.5 mm) and one formalin-fixed early fetus of the common dolphin (*Delphinus delphis*, CRL 38 mm were investigated. 3D-NMR microscopy experiments were performed on Bruker AMX 500 and Avance 750 spectrometers (for further information see: D. Haddad *et al*. „High-Field NMR-Microscopy of Prenatal Dolphins“ in this issue).

The 3D datasets were segmented manually to render surface reconstructions of the specimens using polygonal surface models and the Amira 3.0 Graphics software package by Template Graphics Inc. (TGS).

The NMR datasets are compared with series of routine histological sections of spotted and common dolphins of comparable size.

RESULTS AND CONCLUSION We examined brain ontogenesis in prenatal dolphins comparing NMR images with corresponding histological slides and graphic reconstructions of corresponding dolphin specimens. The brains of the two dolphins represent highly interesting stages in ontogenetic development: The embryo largely illustrates the generalized mammalian bauplan with a tubelike brain [Fig. 1a) and Fig. 3a), and b)]. The early fetus exhibits the transitional stage between the mammalian bauplan and cetacean organisation (olfactory bulb still visible, marked thickening of the brainstem tegmentum). Due to longitudinal growth and concomitant „telescoping“, the brain flexures are established [Fig. 1b) and Fig. 3c), and d)].

In addition, the main subdivisions of the brain are obvious in the NMR images [Fig. 2a) and 2c)]. Comparison of NMR images with histological slides of corresponding prenatal dolphins [Fig. 2b) and 2d)] shows that major brain features of the two developmental stages are clearly visible in the NMR slices.

NMR microscopy allows the non-invasive study of dolphin prenatal brain ontogenesis in small and rare museum specimens and opens the door for new insights into specifics of cetacean development and evolution.

ACKNOWLEDGEMENTS We deeply acknowledge the dedication of the dolphin specimens by the National Marine Fisheries Service (NMFS W.F. Perrin, Ph.D.) in San Diego, CA, U.S.A.

Sincere thanks go to Lars S. Kossatz[1)] and Stefan Huggenberger [1)] for helping with the segmentation of the NMR-data and the discussion of the structures.

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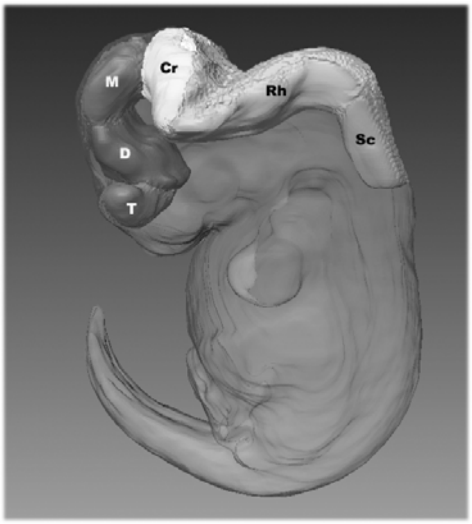

Fig. 1a. Reconstruction of the body and the brain parts via Amira 3.0, *Stenella attenuata* embryo

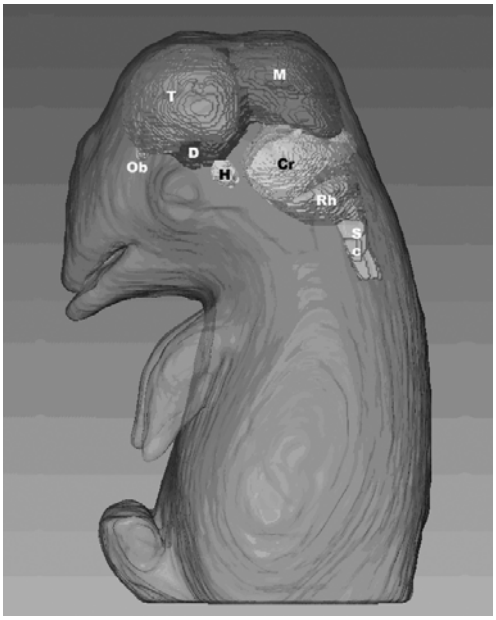

Fig. 1b. Reconstruction of the body and the brain parts via Amira 3.0, *Delphinus delphis* fetus

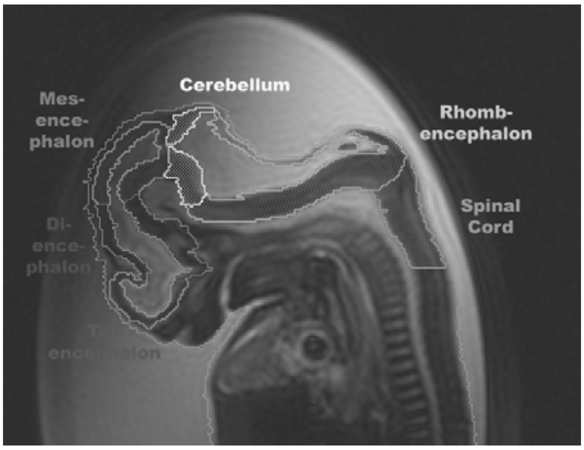

Fig. 2a. Segmentation fields of the brain parts, *Stenella attenuata* embryo

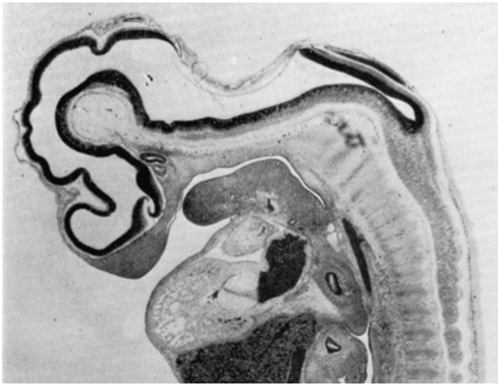

Fig. 2b. Histological slide of *Stenella coeruleoalba* embryo CRL 11 mm (Kamiya and Pirlot, 1974)

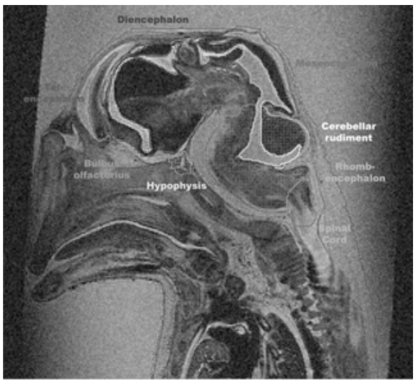

Fig. 2c. Segmentation fields of the brain parts, *Delphinus delphis* fetus.

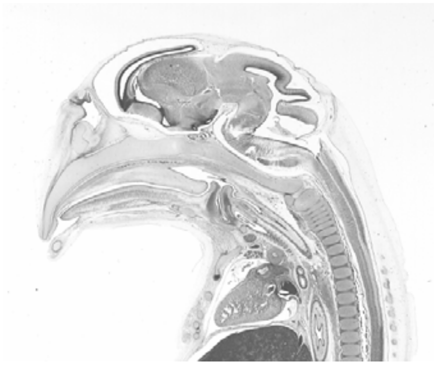

Fig. 2d. Histological slide of *Delphinus delphis* fetus CRL 40,5 mm (SAI-Collection No. Dd14/K50)

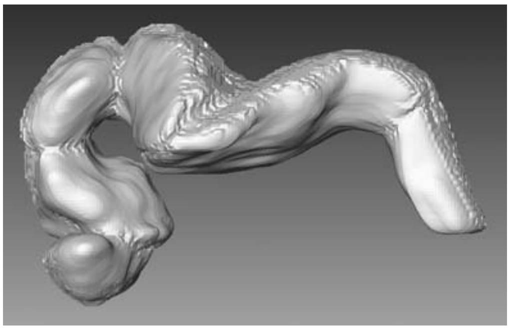

Fig. 3a. Reconstruction of the brain via Amira 3.0, *Stenella attenuata* embryo

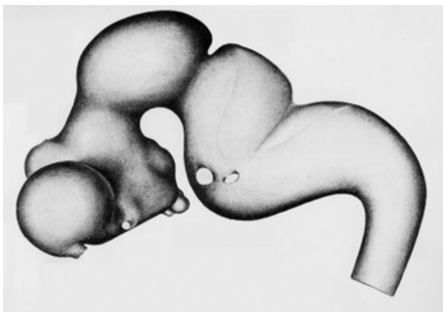

Fig. 3b. Drawing of the brain of a *Bos taurus* embryo CRL mm (Krabbe, 1947)

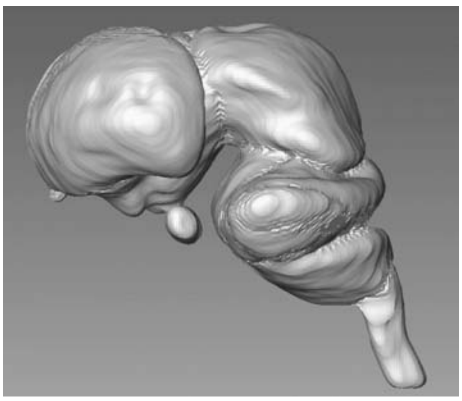

Fig. 3c. Reconstruction of the brain via Amira 3.0, *Delphinus delphis* fetus

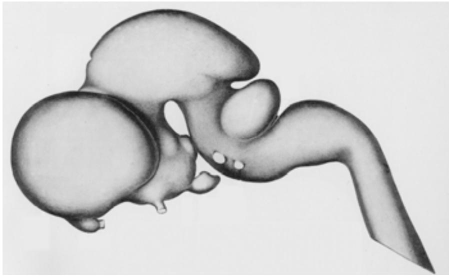

Fig. 3d. Drawing of the brain of a *Bos taurus* fetus CRL mm (Krabbe, 1947)

ABBREVIATIONS

D	Diencephalon
Cr	Cerebellar rudiment
H	Hypophysis
M	Mesencephalon
Ob	Olfactory bulb
Rh	Rhombencephalon
Sc	Spinal cord
T	Telencephalon

GROWTH & BODY CONDITION OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) PRELIMENARY RESULTS

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The two harbour porpoises (*Phocoena phocoena*) maintained in human care at the Fjord & Bælt in a semi-natural penned-off area of Kerteminde Fjord over a 6-year period show marked seasonal body weight fluctuations. The seasonal weight fluctuations were mirrored in the girth and blubber thickness and correlated with the food intake of the animals and sea temperature.We hypothesize that similar weight fluctuations would occur in the wild and that they correlate with water temperature and reproduction. To address this hypothesis the monthly or seasonal weight and growth variations were investigated in detail and compared with factors such as body condition measurements and girth. Furthermore, the energy budget of the porpoise was investigated to estimate if the weight fluctuations were likely caused by differences in prey, increased/decreased energy density or by allocation of energy. This may give an idea towards the porpoise physiology and their food preferences and possible food limitations. This study has been done mainly on the basis of standardized dissections of by-caught or directly caught porpoises in Danish waters. This includes age determination, diet investigations and fatty acid analysis. The results show that the seasonally and monthly fluctuations in weight, blubber weight & thickness in both genders are observed in the wild. These fluctuations are seen as low body weight, blubber weight and blubber thickness in the summer period and as higher weights and blubber thickness in the winter. The largest decreases in weight are seen around April/May and the maximum increase around October. The conclusion is that the investigated data show consistency with the hypothesis.

SOUND RECEPTION BY BEAKED WHALES AND PORPOISES: IMPLICATIONS OF VARIATION IN LIPID COMPOSITION OF JAW FATS

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It is assumed that sound is transferred to odontocete ears via fat channels in and around the lower jaws. However, the distribution of lipids responsible for transmitting received sound waves through these fat bodies is not well understood. We determined lipid composition at multiple sites in internal and external mandibular fats of adult harbour porpoises (P.phocoena), and Sowerby's (M.bidens) and Gervais' (M.europaeus) beaked whales. Porpoise fats were composed almost entirely of triglycerides (>95%), containing few wax esters (<5%) compared to beaked whale samples (18-94%). In beaked whales, the wax ester gradient increased on a cranio-caudal axis in external fat, but decreased along the same axis in internal fat. Jaw fats contained negligible quantities of dietary fatty acids, but high concentrations of endogenously synthesized branched iso-acids, thought to play roles in transmitting sound. Lipid structure may influence the characteristics of sound flow from the environment to ear, as sound travels more slowly through shorter, branched hydrocarbon molecules than through longer, straight chains. Porpoise jaw fats were high in iso5:0 (20-40%), but beaked whale samples were dominated by iso10:0 and iso12:0. Porpoise fat compositions were consistent between internal and external depots, and across cranio-caudal and dorso-ventral axes. In contrast, beaked whale jaw fats varied considerably intracranially. Iso12:0 concentrations were higher in internal than external fats. In a female M.europaeus, internal jaw fats and fats intimately connected to the ears had extremely high concentrations of iso10:0 (~10%) and iso12:0 (>30%). However, the jaw fats in a month-old calf contained very low levels of iso-acids (<3%) and were more typical of those in blubber. Similar patterns have been observed in P.phocoena. Thus, based on fatty elements potentially affecting sound conduction, young odontocetes may have sound reception dependent hearing differences from adults, suggesting that full-fledged echolocation requires both learning and physical development.

3D-RECONSTRUCTION OF THE EAR REGION IN THE EARLY FETAL COMMON DOLPHIN (*DELPHINUS DELPHIS*) BASED ON MRI

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INTRODUCTION Only few papers are published on the prenatal development of cetaceans (Reidenberg and Laitman, 2002). We examined the ear region of an early fetus of the common dolphin (*Delphinus delphis*, crown-rump length 38mm) by magnetic resonance microscopy. The fetus was taken from accidental bycatch of the tuna fishery in the seventies of the last century by officials of the U.S. Government and was donated to our institute by the National Marine Fishery Service (NMFS) in San Diego, California, USA. It was fixed and stored in 4% formalin. To get the 3D-NMR-dataset the fetus was scanned on Bruker Avance 750 spectrometer with magnetic field strength 17.6 T (gradient strengths: 1.0T/m) in an original birdcage coil. The 3D-dataset with a resolution of up to $39.1 \times 39.1 \times 39.1 \mu m^3$ was segmented manually to perform surface reconstruction using the Amira Graphics software package. Our aim was to detect and label as many structures of the ear region (e.g., periotic and tympanic bones, ear ossicles, cochlea, vestibulocochlear nerve, blood vessels, ...) with respect to cetacean ear development and specialisation to aquatic hearing.

RESULTS In Fig. 1 we get an overview of the structures and their position in an early fetal stage of the common dolphin (*Delphinus delphis*).

Fig. 2 gives a view from lateral-caudal to the leaving of the vestibulocochlear nerves. In this position the main substructures of the inner ear like membraneous labyrinth (cochlea, vestibular organ, endolymphatic duct) and the vestibulocochlear nerves are obvious.

Fig. 3 shows the membraneous labyrinth (cochlea and rudimentary region of vestibular organ) in the ventro-lateral aspect. This information allows us to define that the inner ear structures are already in an advanced stage of development.

Fig. 4 is a dorsal (left) and lateral aspect (right) of the perioticum. There is only one turn of the cochlea. The endolymphatic duct of the membraneous labyrinth ends in the meninges. The vestibular system has a rudimental resolution.

CONCLUSION Interestingly, not all structures of the ear region can be detected by NMR microscopy even if they are within the resolution properties of the MR method. The periotic, the cochlea [membraneous labyrinth] and the vestibulocochlear nerves can be detected easily. It is impossible, however, to distinguish between cartilaginous and immaturely ossified structures within but the NMR method as an non-invasive tool gives a good overview of the fetal structures in question. More detailed studies can be conducted only by "destroying" the original material through histological sectioning. In one of our next 3D-projects we want to analyse the ear region on the basis of histological data to get a better view of the details.

ACKNOWLEDGEMENT Sincere thanks go to Michaela Haas-Rioth[1] and Stefan Huggenberger[1] for helping with the segmentation of the MRI-data and the discussion of structures. W. F. Perrin, Ph.D., is thanked for the donation of prenatal dolphin material collected by the NMFS in San Diego, CA., U.S.A.

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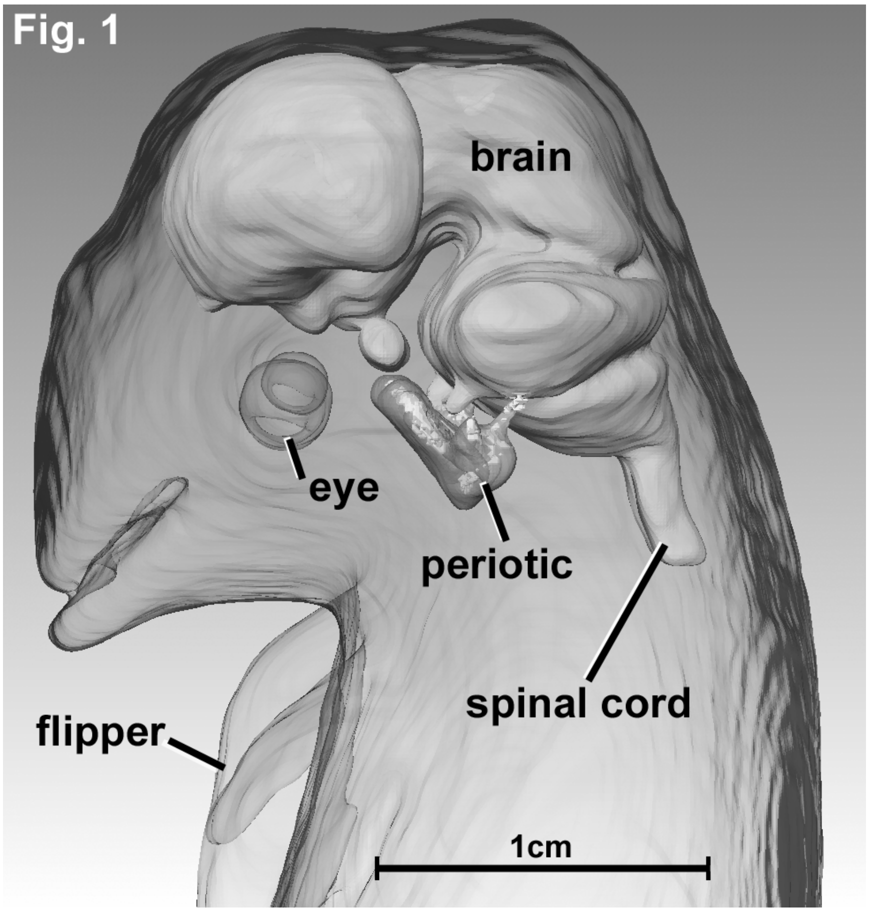

Fig. 1 An overview of the structures and their position in an early fetal stage of the common dolphin (*Delphinus delphis*)

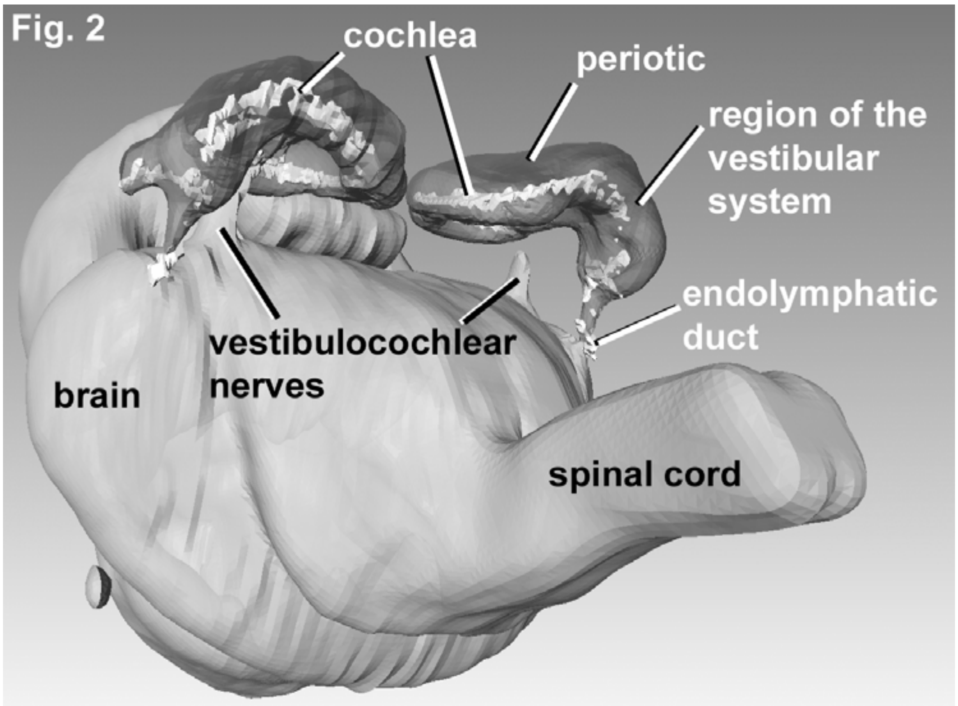

Fig. 2 A view from lateral-caudal to the leaving of the vestibulocochlear nerves. In this position the main substructures of the inner ear like membraneous labyrinth (cochlea, vestibular organ, endolymphatic duct) and the vestibulocochlear nerves are obvious.

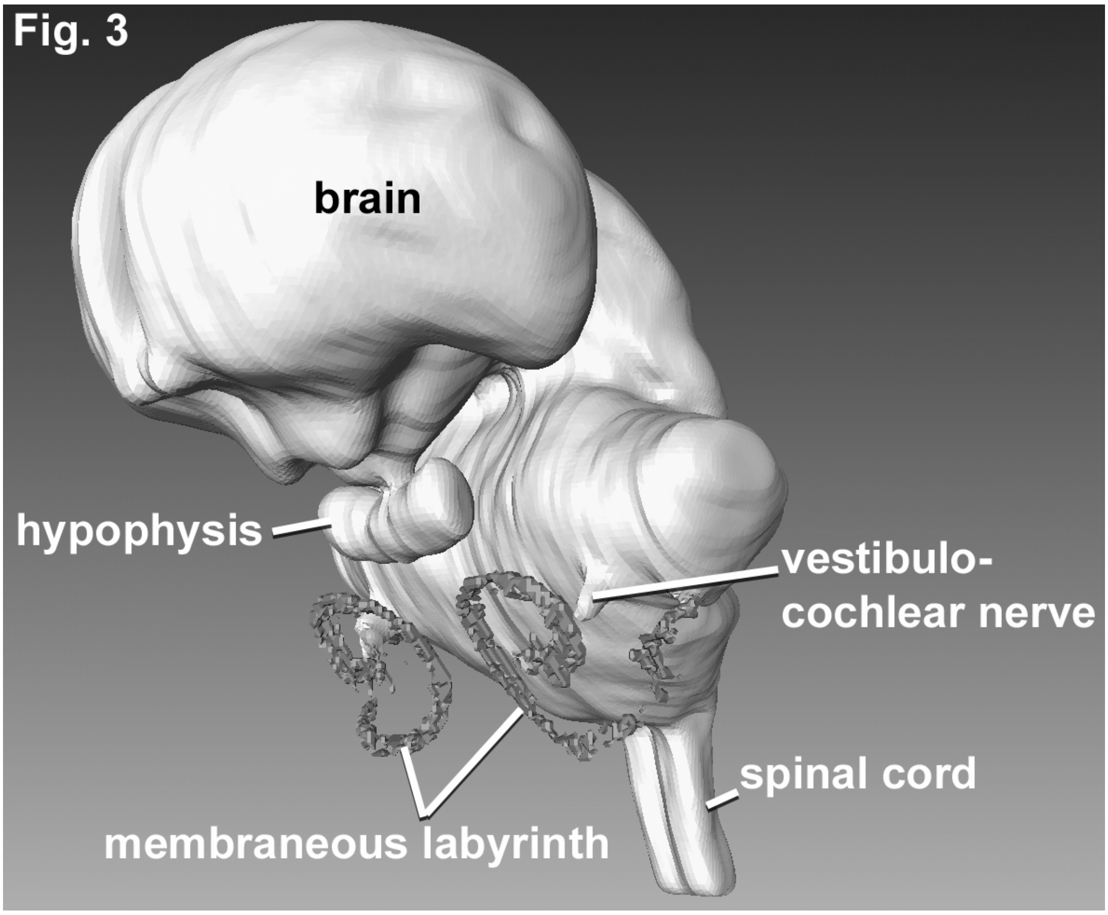

Fig. 3 The membraneous labyrinth (cochlea and rudimentary region of vestibular organ) in the ventro-lateral aspect. This information allows us to define that the inner ear structures are already in an advanced stage of development

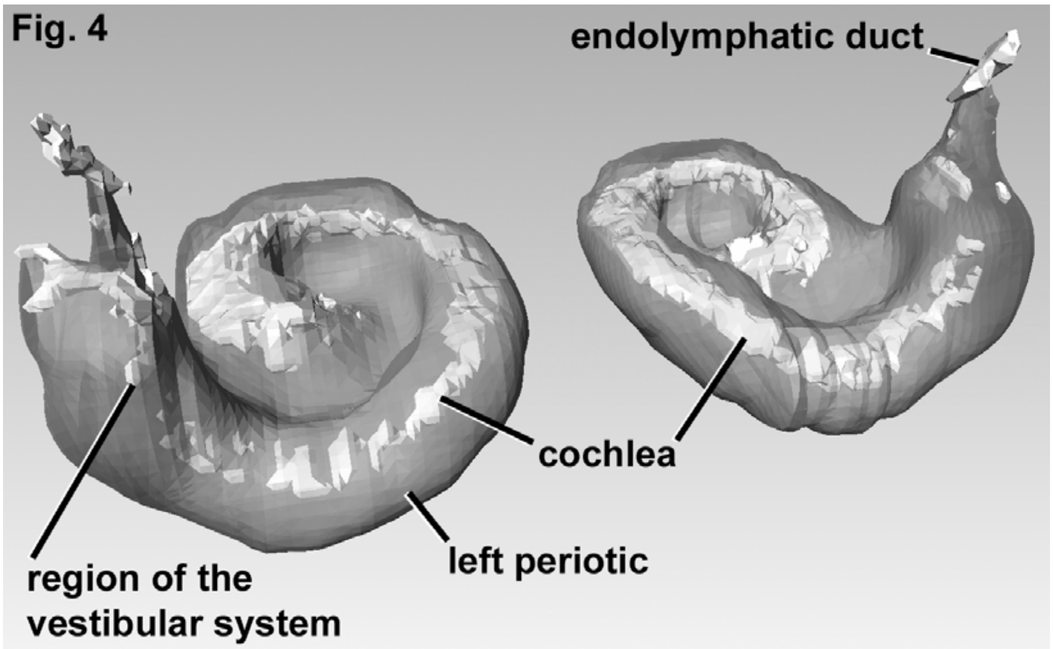

Fig. 4 A dorsal (left) and lateral aspect (right) of the perioticum. There is only one turn of the cochlea. The endolymphatic duct of the membraneous labyrinth ends in the meninges.
The vestibular system has a rudimental resolution

A HISTOLOGICAL AND NMR MOLECULAR APPROACH TO STUDY THE STRUCTURE OF THE MELON AND MANDIBLES IN THE STRIPED DOLPHIN *STENELLA COERULEOALBA*

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The chemical composition as well as the morphological and molecular properties of both the melon and the mandibles seem to have a relevant role in the biosonar sound emission and reception mechanisms in dolphins. To the end, we have studied the inner tissues from melon and mandibles of the striped dolphin *Stenella coeruleoalba* by the combined use of histological and NMR techniques. Samples obtained from various tissue depths and various locations of the melon and mandibles were processed in parallel by the two approaches. The NMR analysis was carried out by using the following probes: solid state 13C; liquid state 1H, 23Na and 129Xe. Tissue histological features were evaluated in light microscopy by using standard dyeing techniques.

ANATOMY OF LARYNGEAL SOUND PRODUCTION: DIVERGENT MECHANISMS IN ODONTOCETES AND MYSTICETES

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Cetaceans produce sounds at opposite ends of the frequency spectrum. These differences may be associated with divergent sound producing mechanisms. Odontocete high frequency echolocation sounds are attributed to specialized nasal structures, but the role of the larynx is unclear (it may generate communication sounds). Mysticete low frequency sounds are presumed to be generated by the larynx, but the production mechanisms are unknown. To address these questions, we examined larynges post mortem in 20 odontocete species representing 15 genera and 6 mysticete species representing 3 genera. Results indicate a divergence in laryngeal anatomy between odontocetes and mysticetes. The rostral portion of the odontocete larynx is elongated, narrow, rigid, and is normally positioned intranarially. The rostral portion of the mysticete larynx is relatively shortened, open, pliable, and may be retracted from its intranarial position at least in Megaptera. Internal laryngeal anatomy also differs, with odontocetes exhibiting a single, midline vocal fold and mysticetes exhibiting a pair of vocal folds. Fold orientation is also divergent, being oriented in a vertical plane in odontocetes, and in a horizontal plane in mysticetes. Odontocetes may erect the midline vocal fold into the airstream, passively vibrating the fold as air flows along its lateral aspects. Mysticetes appear to use the vocal folds as a valve, regulating airflow through the fissure between them and into a large laryngeal sac. Rorqual mysticetes potentially have a secondary sound source in the paired corniculate flaps. These may vibrate while regulating airflow though the laryngeal aditus and into the nasal region, perhaps creating pulsed sounds with each adduction/abduction. Laryngeal anatomy in mysticetes and odontocetes appears to be highly divergent. Their morphological differences may correlate to adaptations for low (mysticete) or high (odontocete) vocal frequencies, but this awaits further study.Support: ONR N00014-96-1-0764 & N00014-99-1-0815; American Museum of Natural History Speech Origins Fund.

ADAPTIVE CHANGES OF IMMUNOLOGICAL AND BIOCHEMICAL INDEXES IN THE BLACK SEA BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) DURING THEIR PROCESS OF ADAPTATION TO THE LIFE IN CAPTIVITY

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INTRODUCTION Nowadays a particular actuality is attained by the problems connected with unfortunate ecological situation all over the world. A special alert of ecologists and the world public is raised by an increasing accumulation of a great amount of various toxic compounds of anthropogenic origin (PCBs, DDT, heavy metal salines, radionuclides ets) in the World Ocean (1,2,3). As it is known, the toxicants possess an ability to move along trophic chains and to accumulate in human and animal organisms, occupying the top positions of nutrition chains. This induced the deep disorders of immune system and as a consequence, raises disease and death rate of animals, that in its turn, causes a sharp reduction of natural population number. Marine mammals are warm-blooded hydrobiontises, terminating trophic chains of the World Ocean and, hence, are particularly under dangerous influence of the factors listed above. They, consequently, may serve as indicators of the World Ocean biocenosis ecological condition (4).

Besides, an increasing interest to the peculiarities of *Cetaceae* immune system as a phylogenetically unique group of water-secondary animals should be noted.Specialists are interested in the changes that have taken place in immune system of cetaceans during the evolution process since the time 65 million years away back they had separated from the common with terrestrial mammals precursor, ancient Condylarthra and returned to ocean again.(5). This branch also gave modern Artiodactyla, Perissodactyla, Proboscidea and Sirenia.

According to the date of Michel C. Milinkovitch, Guillermo Orti and Axel Meyer (1993), the most close phylogenetic relative of *Cetaceae* among terrestrial mammals is considered to be the pair-hoofed one (6).

Noteworthy, in hypogravitational conditions a skeleton of *Cetaceae* has greatly changed. The tubular bones of extremities were reduced and transformed into the fins. And an organism supply with hemoglobin, the main function of the bone marrow was transferred to the muscle tissue (myoglobin) (7). A question arises, how did these evolutionary determined morphological changes within bone marrow of *Cetaceae* affect a lymphopoetic function of the skeleton? And as a consequence, what adaptive peculiarities in cetacean's immune system functioning may be noticed?

Immune status of marine mammals, *Cetaceae* in particular, has been studied not sufficiently at all compared to many terrestrial mammals (human beings, laboratory and domestic animals). The reason of this may be hidden in the difficulty to reach their places of location in wild nature, what increase labour expenditure in in vivo obtaining of morphological material, for example, blood lymphatic notes, bone marrow puncture and soon. On the whole it becomes possible in occeanarium conditions.

In connection with all this it seems possible to model ecological situations in the frames of research base, namely oceanarium. Besides it is necessary to emphasize that the possibility of adaptation of wild animals to captivity gives a way of saving and careful study of the rare and disappearing specieses. Except that, a successful reproduction of the rare animal specieses in captivity followed by replenishment of wild populations will promote the maintaining of planet bio diversity.

Captivity conditions represent a qualitatively new specific noogenic environment. A great complex of biotic and abiotic environmental factors, artificially created by man, through its negative influence on immune system leads to a high sensitivity of adapting dolphins to infections diseases of various ethiology, especially during the first months of staying in captivity. Accepting microflora ofnoogenic origin from a serving staff and another terrestrial animal specieses, which dolphins never meet in their natural environment, the animals are subjected to active influence of different pathogenic microorganisms. This in its turn makes a tremendous effect on immune system of dolphins by exhausting it and inducing destruction changes in lymphopoetic organs (8).

In connection to all sade alove, this work is devoted to a study of peculiarities of biochemical and cell immunity index changings in bottle-nose dolphin (*Tursiops truncatus*) under adaptation to noogenic environment. The first time the characteristic features of protective-adaptive mechanisms of phagocytosis and also T- and B- lymphocytic immune response towards microflora of noogenic origin at different terms of adaptation to captivity were under investigation.

MATERIALS AND METHODS The work was led in 2001-2002 at Utrish marine station of A.N. Severtsov IEEP RAS. 36 of wild bottle-nosed dolphins were examined. They were captured in the Black Sea and then adapted to captivity at Marine Station. During testing all dolphins were divided into 6 groups according to different terms of staying in captivity. Group number six was a control one. It included conditioned-adapted animals, being in captivity more then one year. In total 40 blood samples were examined. Four dolphins were studied repeatedly at different terms of adaptation. Dolphin peripheral blood (PB) samples of 10-15 ml served as examined material. Blood sample taking was made by vein puncture of the ventral surface of tail fin. Blood samples testing was performed immediately after material taking. Blood serum was frozen befor transportation to Moscow, where it was treated. Material processing was made in accordance with generally accepted in medical and veterinary clinical practice hematological, biochemical and immunological methods. A leucoconcentrate of mononuclear cells was obtained out of the whole blood by Ficoll-Paque (1077, Pharmacia) gradient centrifugation (30 min, 300g). For T and B subpopulation counting the following methods were applied:

1) determination of the total leucocyte quantity per'µl of blood by means of Goryaev's camera;

2) cell viability determination by staining with 1% solution of Trypane blue;

3) revealing of immune-competent cells composition, characterizing T and B immunity systems condition (absolute and relative T and B lymphocyte number, Table 1) by the method of T and B lymphocyte separation (9) in our own modification with the help of specific antisera to pig and bovine IgM and IgG (Ye. P. Kovalenko VIEV). The choice of antisera was based on phylogenetic kindred between *Cetaceae* and pair-hoofed mammals.

For a study of the functional phagocytizing PB leucocytic activity of dolphins in response to some species of conditioned-pathogenic microorganisms of terrestrial origin the absorbing and digesting activities of phagocytes were determined with several "test-microbes" according to Emelyanenko, 1980 (10). Absorbing ability was expressed by phagocytosis percentage (PP), i.e. a ratio of absorbing microbe leucocytes to the total leucocytic amount, and also phagocytic index (PI), by bacterial quantity absorbed by one leucocyte. Digesting ability of leucocytes was expressed by phagocytosis completeness index (PCI), i.e. by ratio of the number of digesting microbes to the total phagocytized microbe number(Table 2). As the “test-microbes” the strains of Staphylococcus aureus № 25923, Esherichia Coli № 35218 and №25922 from American Typical Cultural Collection (ATCC) and also E.Coli O-20 obtained from bovine and 4 strains of E.Coli (K.I. Scryabin MSAVMaB) isolated from pig were used (Photes 4-7).

Hematological and biochemical tests were made for the control of animal physiological condition (Table3 and table 4). Noteworthy, γ-glutamyletransferase enzymatic activity in dolphins was determined at the first time. Except that, GTP activity determin is the most sensitive and informative screening for testing of spleen diseases, which is considered to be preferable to transaminase and alkaline phosphatase determination (11).

RESULTS

1) A distinctive cross-reaction between dolphin B-lymphocytes and specific antisera to IgG and IgM of both bovine and pig origin was evident, 85-90% of the total amount of dolphin lymphocytes showed the immuno-reactivity. Under the separation of T and B lymphocytes the testing leucoconcentrate divided into two clearly distinguished under microscope fractions. Reacting with antisera B-lymphocytes adhered to the bottom of Petri dishes (photo 3), and non-reactive T-lymphocytes together with monocytic leucocytes remained in suspension (photo 2).
2) In viability test with Trypane blue before T and B lymphocytes separation 90-95% of lymphocytes were viable;
3) All data obtained in the study after corresponding statistical treatment in Microsoft Excel were represented in Tables 1, 2, 3 and 4, also in diagrams (Fig. 1, 2, 3,4). In all dolphin groups a marked a marked dispersion of indexes was seen. This might serve as an evidence to irregularity of adaptation course in dolphins under individual examination.

CONCLUSIONS

1) The first time applied method for dolphin T/B lymphocytic ratio determination, the method of T/B lymphocyte separation in our own modification with the use of specific bovine and pig antisera have led us to a good result. This allows to apply the developed method to a dolphin immune status evaluation, assuming that the data obtained with dolphin antiserum are the most reliable. Noteworthy, this method of in vivo diagnostics permits to follow up the development of an organism immune reactivity in dynamics;

2) Indexes of cell immunity (the total mononuclear leucocyte content in peripheral blood, T/B lymphocytic subpopulation ratio, PP, PI, PCI together with hematological and biochemical indexes) may be applied to dolphin adaptivity degree a determination to noogenic environment;
3) At the early phases of dolphin adaptation to captivity a depression of protective-adaptive mechanisms of cell immunity takes place. Except low PP, PI and PCI an appearance of histiocytes, a tissue transition form of monocytes, may be noted, that usually characterize an acute inflammation process. Hence, at the first months of adaptation, the total amount of the blood peripheral lymphocytes and especially B-lymphocytes, markedly reduces in dolphins, what is very likely to be a result of the different stress factors influence;
4) Underfurther successful adaptation of dolphins to noogenic environment a permanent increase of the total peripheral blood mononuclear leucocytes and, especially, the B- cell population occurs, the indexes of phagocytic activity rise,histiocytes are not revealed in peripheral blood and physiological blood parameters are within normal limits;
5) Upon choosing the optimal "test - microbe" the most preferable strains have been Staphylococcus aureus № 25923 (ATCC) and E. Coli №35218 (ATCC). It should be noted that the high phagocytic activity of dolphin peripheral blood leucocytes is observed towards all the offered strains, what is an evidence of the active protective-adaptive phagocytic reaction to diverse microflora of terrestrial origin;
6) The existence of distinct cross-reaction (85-90%) between dolphin lymphocytes and antisera to bovine and pig IgG and IgM is an additional confirmation of the close phylogenetic kindred between absolute hydrobiontises and terrestrial pair-hoofed mammals;
7) An active eosinophilic participation in phagocytosis in dolphins is also inherent to terrestrial pair-hoofed mammals, that also can serve as indirect evidence of a rather close phylogenetic kindred between these mammals.

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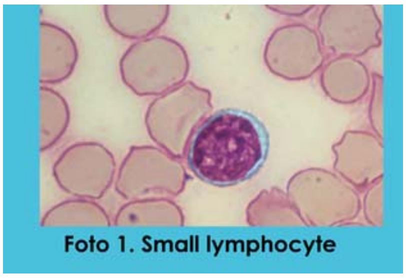

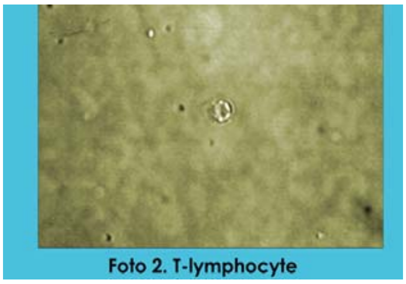

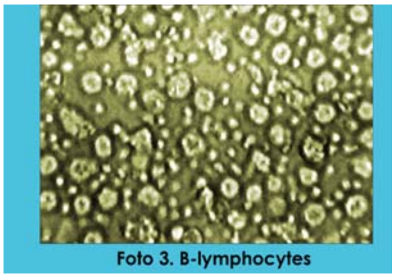

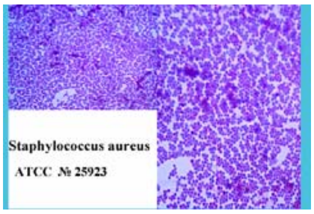

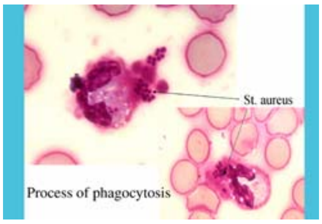

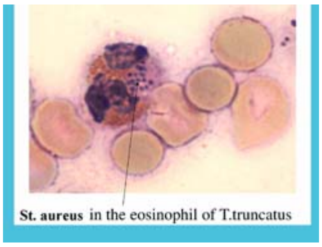

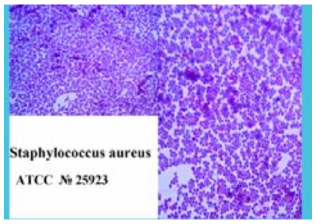

Photo 4 **Photo 5** **Photo 6** **Photo 7**

PHAGOCYTOSIS: PHOTOS 4-7

Table 1. Absolute and relative composition of T/B of lymphocyte subpopulations of peripheral blood in the black sea bottle-nose dolphin (*Tursiops truncatus*) at different terms of adaptation to captivity conditions (X±m). (O. V. Sokolova, 2003)

Terms of adaptation of dolphins	***Total quantity mononuclears, thnd/μl***	T-lymphocytes ***+ 0 cells, thnd/μl***	***B- lymphocytes, thnd/μl***	T-lymphocytes ***+ 0 cells, %***	***B- lymphocytes, %***
Group № 1 *FROM 2 TILL 3 WEEKS* **(n = 4)***	**1.613 ± 0. 283**	**1.423 ± 0.215**	**0.174 ± 0.074**	**90.06 ± 2.59**	**9.94 ± 2.59**
Group № 2 *from 5 till 7 weeks* (n = 12)	**1.561 ± 0.186**	**1.359 ± 0.156**	**0.180 ± 0.029**	**88.97 ± 1.04**	**11.03 ± 1.04**
Group №3 *from 8 till 9 weeks* (n = 7)	**2.122 ± 0.211**	**1.886 ± 0.152**	**0.317 ± 0.043**	**85.37± 1.99**	**14.63 ± 1.99**
Group №4 *from 11 till 12weeks* (n = 8)	**1.484 ± 0.255**	**1.258 ± 0.217**	**0.195 ± 0.043**	**87.48 ± 1.38**	**12.52 ± 0.24**
Group №5 *from 13 till 14 weeks* (n = 5)	**2.050 ±0.345**	**1.740 ± 0.348**	**0.288 ± 0.049**	**84.43 ± 3.07**	**15.57 ± 3.07**
Group №6 *more then year* (n = 4)	**2.455 ± 0.477**	**1.942 ± 0.376**	**0.477 ± 0.087**	**80.24 ± 0.71**	**19.76 ± 0.71**

*n - quantity of the investigations of the blood samples

Table 2. Indexes of phagocytosis in the black sea bottle-nose dolphins *(Tursiops truncatus)* at different terms of adaptation to captivity conditions. (X±m) (O. V. Sokolova, 2003)

	Phagocytosis percentage, %					Phagocytic index					Phagocytosis completeness index				
	Neutrophils	*Eosinophils*	*Monocytes*	*Histiocytes*	*TPLA**	*Neutrophils*	*Eosinophils*	*Monocytes*	*Histiocyte*	*TPLA*	*Neutrophils*	*Eosinophils*	*Monocytes*	*Histiocyte*	*TPLA*
Group №1 *FROM 2 TILL 3 WEEKS* ***(n = 4)***	**41.07 ±8.09**	**22.12 ±9.18**	**73.18 ±6.69**	**100 ±0**	**59.09 ±5.99**	**2.55 ±0.88**	**1.09 ±0.5**	**6.61 ±1.33**	**23.30 ±11.43**	**8.39 ±3.54**	**0.56 ±0.01**	**0.51 ±0.07**	**0.47 ±0.07**	**0.47 ±0.21**	**0.50 ±0.09**
Group №2 ***From 5 till 7 weeks (n = 12)***	**57.25 ±4.6**	**39.75 ±3.02**	**77.26 ±1.82**	**100 ± 0**	**68.56 ±2.36**	**5.88 ± 0.64**	**4.46 ±0.62**	**7.35 ± 0.74**	**26.35 ±7.76**	**11.00 ±2.44**	**0.59 ±0.01**	**0.52 ± 0.03**	**0.56 ±0.02**	**0.53 ± 0.03**	**0.55 ± 0.02**
Group №3 ***From 8 till 9 weeks (n = 7)***	**72.09 ±6.08**	**43.54 ± 2.52**	**84.57 ±2.59**	**0**	**66.73 ±3.73**	**8.66 ± 0.48**	**8.06 ±0.85**	**9.86 ± 0.27**	**0**	**8.86 ± 0.53**	**0.63 ±0.02**	**0.57 ±0.03**	**0.59 ±0.03**	**0**	**0.59 ± 0.03**
Group №4 ***From 11 till 12 weeks (n = 8)***	**72.14 ±4.69**	**54.62 ± 3.43**	**84.89 ±1.92**	**100 ± 0**	**77.91 ±2.51**	**10.39 ± 0.22**	**8.69 ±0.62**	**10.16 ± 0.16**	**34.57 ± 0**	**15.95 ± 0.23**	**0.65 ±0.10**	**0.68 ±0.01**	**0.66 ±0.01**	**0.67 ± 0**	**0.66 ± 0.03**
Group №5 ***From 13 till 14 weeks (n = 5)***	**76.99 ±2.61**	**69.18 ± 5.72**	**89.21 ±1.67**	**100 ± 0**	**83.84 ± 2.50**	**10.50 ± 0.21**	**9.31 ±0.45**	**10.32 ± 0.15**	**43.50 ± 0**	**18.41 ± 0.20**	**0.68 ±0.02**	**0.71 ± 0.01**	**0.70 ±0.02**	**0.75 ± 0**	**0.71 ± 0.01**
Group №6 ***More then one year (n = 4)***	**88.50 ±2.16**	**85.74 ± 2.91**	**94.71 ±3.35**	**0**	**89.65 ±2.81**	**10.61 ± 0.38**	**10.46 ±0.42**	**10.38 ± 0.23**	**0**	**10.48 ± 0.34**	**0.69 ±0.01**	**0.72 ±0.02**	**0.71 ±0.02**	**0**	**0.71 ± 0.02**

*TPLA - Total Phagocytic Leucocyte Activity

Table 3. Hematological indexes in the black sea bottle-nose dolphin *(Tursiops truncatus)* at different terms of adaptation to captivity conditions (X+m) (O. V.Sokolova, 2003)

Terms of adaptation *of dolphins*	***Eryth-rocy-tes*** **mln/μl**	***Hema-globin*** **g/l**	***ESR*** **mm/h**	***Leuco-cytes*** **thnd/μl**	***Leucoformula***							
					Neutrophils			***Eosino-phils***	***Baso-phils***	***Mono-cytes***	***Lym-phocy-tes***	***Others (histio-cytes)***
					Junior	***Rod-like* nuclear**	***Segment-like* nuclear**					
Group № 1 *FROM 2 TILL 3 WEEKS* **(n = 4)***	**3.64 ±0.21**	***174.50*** **± 1.79**	***25.75*** **±13.51**	***11.65*** **± 1.67**	***0.25*** **±0.29**	***3.25*** **±0.98**	***59.25*** **±2.96**	***19.50*** **±2.85**	***0***	***6.50*** **±1.10**	***9.50*** **±4.48**	***1.75*** **±0.29**
Group № 2 *from 5 till 7 weeks* (n = 12)	***4.02*** **±0.12**	***174.67*** **±3.49**	***9.75*** **±2.16**	***9.64*** **±0.70**	***0***	***3.08*** **±0.81**	***55.92*** **±2.62**	***23.42*** **±2.24**	***0***	***4.33*** **±0.76**	***12.75*** **±2.33**	***0.50*** **±0.20**
Group №3 *from 8 till 9 weeks* (n = 7)	***3.78*** **±0.13**	***165.57*** **±2.64**	***6.14*** **±1.10**	***10.81*** **±1.02**	***0***	***2.00*** **±0.69**	***47.71*** **±2.01**	***29.57*** **±0.78**	***0***	***2.43*** **±0.431**	***18.29*** **±2.48**	***0***
Group №4 *from 11 till 12weeks* (n = 8)	***3.65*** **±0.16**	***175.25*** **±5.71**	***12.31*** **±8.35**	***8.78*** **±1.10**	***0.62*** **±0.19**	***2.12*** **±0.51**	***56.50*** **±1.07**	***23.62*** **±0.73**	***0***	***2.75*** **±0.60**	***14.25*** **±1.75**	***0.12*** **±0.13**
Group №5 *from 13 till 14 weeks* (n = 5)	***3.55*** **±0.19**	***174.80*** **±9.86**	***15.60*** **±13.85**	***13.31*** **±4.29**	***1.00*** **±0.35**	***2.40*** **±1.15**	***57.80*** **±5.09**	***20.80*** **±4.29**	***0***	***3.40*** **±0.76**	***14.40*** **±2.17**	***0.20*** **±0.22**
Group №6 *more then year* (n = 4)	***3.77*** **±0.16**	***178.75*** **±4.65**	***3.50*** **±2.89**	***8.72*** **±1.74**	***0.50*** **±0.33**	***1.50*** **±0.58**	***57.50*** **±1.10**	***17.75*** **±2.18**	***0***	***2.50*** **±1.00**	***20.25*** **±2.42**	***0***

Table 4. Biochemical indexes of the peripheral blood serum in the black sea bottle-nose dolphin (*Tursiops truncatus*) at different terms of adaptation to captivity conditions (X±m) (O. V. Sokolova, 2003)

	Terms of adaptation					
Indexes:	**2-3 weeks (n = 4)**	**5 -7 weeks (n = 8)**	**8 - 9 weeks (n = 5)**	**11-12 weeks (n=6)**	**13-14 weeks (n=4)**	**More year (n=3)**
1. Total Protein, G/ l	**81,30 ± 4,75**	**77,67 ± 3,05**	**72,99 ± 1,61**	**70,34 ± 2,35**	**78,85 ± 1,81**	**72,60 ± 0,78**
2. Albumin, G/ l	**37,96 ± 1,33**	**33,98 ± 1,26**	**34,56 ± 0,75**	**30,39 ± 1,94**	**31,35 ± 1,59**	**29,40 ± 2,11**
3. Urea nitrogen, mmol/l	**14,09 ±2,25**	**12,42 ± 1,01**	**13,31 ± 0,57**	**11,89 ± 0,99**	**12,12 ± 0,96**	**12,03 ± 2,06**
4. Creatinine, μmol/l	**120,95 ± 4,17**	**120,43 ± 9,38**	**444,00 ± 368,42**	**85,35 ± 17,03**	**81,17 ±15,26**	**109,67 ± 17,61**
5. Cholesterol, mmol/l	**3,35 ± 2,41**	**4,35 ± 0,41**	**3,92 ± 0,54**	**4,05 ± 0,32**	**3,77 ± 0,28**	**4,37 ± 0,57**
6. Bilirubine total, μmol/l	**9,30 ± 0,85**	**8,49 ± 1,08**	**7,97 ± 1,53**	**10,20 ± 2,19**	**7,95 ± 1,48**	**10,27 ± 1,12**
7. Bilirubine direct, μmol/l	**1,80 ± 0,14**	**1,44 ± 0,28**	**1,30 ± 0,35**	**2,03 ± 0,72**	**1,90 ± 0,69**	**1,50 ± 0,46**
8. Ca, mmol/l	**0,88 (n=1)**	**1,45 ± 0,20**	**0,76 (n=1)**	**1,39 ± 0,11**	**1,68 ± 0,49**	**1,35 ± 0,15**
9. Магний, mmol/l	**0,87 (n=1)**	**0,84 ± 0,09**	**0,58 (n=1)**	**0,79 ± 0,13**	**0,95 ± 0,35**	**0,65 ± 0,01**
10. Fe, μmol/l	**43,85 ± 3,75**	**36,61 ± 2,36**	**39,60 ± 8,70**	**28,83 ± 3,91**	**35,59 ± 5,70**	**28,87 ± 10,29**
11. P, mmol/l	**1,75 (n=1)**	**2,80 ± 0,34**	**5,30 (n=1)**	**3,00 ± 0,34**	**3,17 ±0,61**	**3,22 ± 0,68**
12. γ- Glutamil-transpherasa, IU/L	**18,50 ± 0,71**	**18,20 ± 0,81**	**17,07 ± 0,67**	**18,20 ± 1,22**	**20,60 ± 1,60**	**21,47 ± 2,02**
13. Aspartatamino-transpherasa, (AST), IU/L	**78,75 ± 1,06**	**52,96 ±6,10**	**45,60 ± 7,30**	**50,45 ±10,94**	**59,25 ±11,80**	**66,40 ± 7,47**
14. Alaninamino-transpherasa (ALT), IU/L	**36,30 ± 10,61**	**25,67 ± 5,34**	**25,30 ± 8,07**	**21,65 ± 8,44**	**34,27 ± 20,08**	**47,60 ± 20,52**
15. Glucose, mmol/l	**5,00 ± 2,00**	**4,81 ±0,66**	**4,38 ± 1,60**	**4,17 ± 0,42**	**4,10 ± 0,50**	**4,47 ± 0,60**

MEASURING HEAT FLUX AND SKIN TEMPERATURE FROM SPOTTED DOLPHINS IN THE EASTERN TROPICAL PACIFIC

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It has been suggested that spotted dolphins in the Eastern Tropical Pacific (ETP) might undergo thermal stress while being chased during tuna fishing operations. Because dolphins use their dorsal fins as thermoregulatory surfaces we hypothesized that increases in their deep body temperatures during chase should be reflected by increased heat flux values (and skin temperature) at the dorsal fin. To test this we developed a heat flux/temperature logger that could be attached to the dorsal fin of spotted dolphins prior to their release from the tuna purse seine. The device consisted of a foam backed thermo-plastic saddle that had been vacuum molded to fit the contours of the "average" Stenella dorsal fin. The saddle contained the heat flux/temperature sensor, a VHF radio, data logging electronics and a time-depth/velocity recorder (TDR). The device was designed to be attached using two-7.0mm delrin pins and magnesium washers. We successfully deployed the heat flux logger on two spotted dolphins during tuna fishing operations in summer of 2001. Both dolphins were recaptured, the packages removed and the data retrieved. The first deployment (#1) occurred on September 19 and was on a 190 cm male. This deployment was 23 h 20m in duration. Heat flux data were collected over the entire deployment but a design failure in the saddle caused the TDR to be prematurely released. The second deployment (#2) occurred on September 22 and was on a 204 cm female. This deployment was 76 hours in duration. From this dolphin we collected a complete TDR and partial heat flux/temperature record. Heat flux and skin temperature both varied during the deployments, however, the results from deployment #2 (in which we obtained velocity and heat flux/skin temperature data) suggest that there was no direct relationship between the speed of the dolphin and heat flux or skin temperature.

STOCK IDENTITY AND DISTRIBUTION

THE DISTRIBUTION OF CETACEANS AROUND THE ISLE OF ISLAY (SCOTLAND) AND THEIR RELATIONSHIP WITH TIDAL STATE AND TIME OF DAY

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Little is known about the cetaceans around the Isle of Islay, in the southern Hebrides, Scotland, as the intensity of surveying effort has been very low. The lack of sightings in the waters around Islay, which lies just north of Ireland, has consequently led previous studies to propose that there may be a discontinuity in the distribution of cetaceans between the west of Scotland and Ireland. The purpose of this study was to test this hypothesis by conducting cetacean surveys around Islay throughout June-September 2002. These data were examined together with sightings from the public from 1997 to 2002. In addition, the cetacean sightings were analysed to test whether there was an association between the occurrence of cetaceans in different areas around Islay and tidal state and time of day. Approximately 300 cetacean sightings were recorded, therefore the hypothesis that there was a discontinuity in the distribution of cetaceans was rejected. A lack of sighting effort rather than cetaceans thus seems to be responsible for the previous paucity of sightings in this area. Bottlenose dolphins were seen uniformly over the tidal cycle and throughout the day in Loch Indaal and off the south-east coast of Islay. In contrast, harbour porpoises and minke whales in the waters north of Islay were seen more often during the flood tide and at 13:00-14:00 and 17:00-18:00. There was significantly more bird feeding activity in Loch Indaal during the flood tide suggesting an increase in abundance of prey during this period. This may also occur in the waters north of Islay. The effect of time of day may have been in response to diel activity cycles in the prey species.

SPECIES COMPOSITION AND ABUNDANCE ESTIMATES OF CETACEANS IN THE KERCH STRAIT AND ADJACENT AREAS OF THE BLACK AND AZOV SEAS: THE SECOND SERIES OF AERIAL SURVEYS (AUGUST 2002)

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Cetacean aerial surveys were carried out during 5 days from 12-17 August 2002 in the Kerch Strait (890km2, 353km of observation effort including 18 parallel tracklines separated by 2.5km), the contiguous portion of the Sea of Azov (7,560km2, 716km, 13 tracklines at regular 10km intervals), and the adjoining with the strait Black Sea shelf area not more than 200m deep (7,960km2, 791km, 34 tracklines, each of them was also spaced 10km apart). The study area was represented by Russian and Ukrainian territorial waters off the Caucasian and Crimean coasts between 45º52'N, 43º38'N, 35º52'E and 39º37'E. Line transect surveys have been executed under tolerable weather conditions (Beaufort 0-3) at an altitude of 50-200m by means of 3 high-winged twin-engine amphibians ‘Chernov-22’. Statistical analysis of results was conducted with the help of the ‘Distance 3.5’ program package. Harbour porpoises (*Phocoena phocoena*) were recorded in all water bodies under research including the Azov Sea (27 sightings/47 individuals), the Black Sea (8/15) and the strait (4/4), while bottlenose dolphins (*Tursiops truncatus*) were observed just in the Black Sea (15/35) and strait (10/37). The mean sizes of cetacean pods were 2.88±0.61 (*T. truncatus*) and 1.69±0.16 (*P. phocoena*); the biggest groups consisted of, correspondingly, 14 and 4 animals. In addition, 8 dead harbour porpoises and 1 big cetacean carcass - most likely, bottlenose dolphin - were sighted floating on the sea surface. The minimum abundance values, uncorrected for availability or detection bias, were estimated for bottlenose dolphins in the Kerch Strait (88±47 individuals) and adjacent Black Sea shelf area (823±395) as well as for harbour porpoises in the Azov’s stratum (936±361). In July 2001, during previous series of aerial surveys, a total of 871±485 porpoises were estimated for the same area. A number of localities of potential threats to cetaceans were recorded and mapped as concomitant information.

PECULIARITIES OF BELUGA'S BIOLOGY AND NUMBERS IN THE WHITE AND BARENTS SEAS

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It is thought that the numbers of the white whale in the White and Barents Seas are 15 – 20 thousand. These data have been based only on expert assessments. The problem of white whale abundance in the different regions has a great interest. It can be solved using the knowledge of the biology of the species and it population structure. Our studies of beluga of the White Sea in 1994 – 2002 revealed that in summer the population is divided into two practically equal parts. One part consists of females and calves of different age which are settled. They form eight reproductive gatherings, each numbers 80 –100 animals (total number is about 750 animals). The second part of the population is consist of nomadic males. They execute feeding migration and sometimes emerge in the Barentz Sea (and probably in the Kara Sea). So the total number of the White Sea beluga population is about 1500 animals. Reproductive gatherings were not revealed in the Barents Sea. On this basis it is possible to state that the local stocks are absent in the Barents Sea. Seemingly the White Sea is the common place of breeding for beluga of the White Sea and also southern and east parts of the Barents Sea. The number of this population is ten times as less than expert assessments. The maximal number of belugas in the Barentz Sea is observed in autumn-winter-spring. This coincides with feeding and season migrations of animals of the neighbour seas. Thereby the Barents Sea is a place of feeding and wintering for part of beluga populations of the White and Kara Seas which fluctuates in different years and seasons.

STUDY AND MONITORITATION OF THE CETACEAN POPULATIONS IN THE GALICIAN WATERS (NW SPAIN)

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From 1996, data about cetacean abundance and distribution in Galician waters was collected in opportunistic records obtained on board of fishing vessels and coastal observations. During 2002 a project with systematic shipments was programmed to confirm the data obtained. 1012 tracts were carried out along the Galician coast in 147 days. 229 tracts were carried in passage ships between the coast and the Atlantic Islands (Cíes and Ons) between June and September. 28 systematic shipments were carried out in tree areas of the coast. Opportunists sightings were also recoded. A total of 480 sightings were recorded, of which 40,8% came from systematic work. A total of 613 hours were carried out form the coast, obtained a total of 14,1% sighting time. The more frequent species recorded was *Tursiops truncatus* with a total of 85% of the sightings. A total of 165,2 hours were carried out form vessels, obtaining a total of 12,4% sighting time. A total of 129 hours came out from passage ship, corresponding the 12% of the sightings to *T. truncatus*. The average size observed in *T. truncatus* herds was 18,9 (2-65), the average number of calves was 1,9 (10%) and the density in the Ría of Vigo was 0,3 exemplary/ km2. The average size observed in *Delphinus delphis* herds was 19,6 (2-100), the average number of calves was 1,6 (8,4%). The average size observed in *Phocoena phocoena* herds was 3,2 (2-10), the average number of calves was 0,75 (23,4%). All the data recorded confirmed the opportunistic records obtained in previous studies that described the presence of three common species (*T. truncatus*; *D. delphis* and *P. phocoena*), two not frequent ones (*Grampus griseus* and *Globicephala melas*) and some rare ones (*Orcinus orca* and Misticetes).

RECORDS OF CETACEANS AROUND ILHÉU DAS ROLAS, S. TOMÉ AND PRÍNCIPE

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Ilhéu das Rolas is a small equatorial Atlantic island located in the south part of the S. Tomé and Príncipe archipelago. This area has been considered a breeding ground for the humpback whales (*Megaptera novaeangliae*), who have been the target of a whale hunt from the XIX century until late XX century. In the last years the sightings of humpback whales have increased in S. Tomé (information from fishermen and personal observations in 2001), which may indicate that the whales are returning to this breeding ground. In 2002, between August and December, boat-based surveys were conducted in order to study the occurrence of cetaceans off Ilhéu das Rolas. Sightings of humpback whales, bottlenose dolphins (*Tursiops truncatus*), pantropical spotted dolphins (*Stenella attenuata*) and orcas (*Orcinus orca*) were recorded, as well as the stranding of a dead sperm whale (*Physeter macrocephalus*). Data on the cetaceans' relative abundance and distribution, their group composition, habitat use and acoustic emissions were obtained to investigate their ecology and behaviour, and stock affiliation in the case of the humpback whales. This oceanic island seems to be an important area for cetaceans, probably due to large concentrations of prey as well as the existence of several small bays and shallow waters that constitute preferred rest areas. Efforts are being made to establish a careful and sensible whale-watching program.

POPULATION STRUCTURE OF WHITE SEA BELUGA (*DELPHINAPTERUS LEUCAS*). BEHAVIOURAL AND ACOUSTICAL APPROACH

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Several local herds represent White Sea population of belugas. Each local herd annually forms a reproductive gathering (RG) in a particular region. During 1999-2002 our studies concentrated on the southern part of White Sea with the aim to characterize distribution of belugas; to search for unknown RG; to obtain data on their acoustical activities and behaviour in different areas. We used 11m sailing boat with the special equipment for registration a hydroacoustic signals and detecting of belugas at a distance up to 5 km. The recordings were performed using digital recorder with 0,1-16 kHz frequency band. Recordings were analyzed using IBM software: CoolEditPro and SpectraLAB. We describe six local herds of belugas. Two RGs were detected for the first time. Three basic behavioural situations (RG, searching-hunting and migration) were distinguished. Acoustical activity was significantly different in these situations. All acoustic signals were classified into 30 classes according to time-frequency characteristics. "Bleat", "Chirp", "Creak" and "Whistle" were more common classes of signals in RG. However, we find out different percentage of this signal classes in different herds. The main differences were registered in the using of whistles. Echolocation, "Trill" and "Grumble" were more common during hunting. Whistle was the main signal class during migration, but these kinds of whistles are practically not found in RG. Formation of RGs is a major aspect in the belugas life. The habitat reduces to several sharply localized regions where birth and coupling take place; hierarchical relations and social contacts are established. These regions are extremely vulnerable from the viewpoint of negative anthropogenic impact and are critical habitat for this species. Our data on population structure of belugas and peculiarities of their use of different areas of the White Sea are vital for developing strategic plans for conservation of this endangered species during increasing anthropogenic stress.

DISTRIBUTION OF BEAKED AND SPERM WHALES ALONG THE FRENCH ATLANTIC COASTS: 30 YEARS OF STRANDING RECORDS

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INTRODUCTION Beaked and sperm whales (families *Ziphiidae*, *Physeteridae*, *Kogiidae*) are probably the least known group of large marine mammals in french waters. Recent developments of human acoustic activities have highlighted the need for a better knowledge of the distribution and relative abundance of these species, notably in the aim of identifying preferred habitats in a conservation perspective. In the context of such elusive species and given the paucity of at-sea data, long term stranding records can provide a useful picture of the prevalence of these species along a given stretch of coast.

MATERIALS AND METHODS The present work analyses 30 years of stranding records to assess relative abundance and distribution of beaked and sperm whales off the French coasts. These will be completed with species composition as well as age and sex composition.

RESULTS Nine species have been recorded so far, of which two are of regular occurrence (*Ziphius cavirostris*, n = 73; *Physeter macrocephalus*, n = 42), three are occasional (*Kogia breviceps*, n = 15; *Hyperoodon ampullatus*, n = 10; *Mesoplodon bidens*, n = 7) and four are exceptional (*K. simus*, n = 3; *M. densirostris*, n = 2; *M. europaeus*, n = 1). Three Sperm whales are stranded in English channel, 20 males exclusively are found in winter along the Bay of Biscay and 19 individuals with 80% of males are stranded in Mediterranean coast (Fig. 1). Cuvier's beaked whales stranded are present with 1 individual in the southern North Sea and 56 in the Bay of Biscay with 70% of males (mostly in the south in winter, Fig. 2). 16 other Cuvier's beaked whale (with 70% of females) are stranded in Mediterranean Sea and principally on the Ligurian basin.

Only the two formers were reported from the French Mediterranean coast, *H. ampullatus* and *M. bidens* were found along the coast of the English Channel and all the species have been reported from the Atlantic coast (Fig. 3 and 4).

CONCLUSIONS Sperm whale, Cuvier's beaked whale and Sowerby's beaked whale were reported from the whole French coast. Northern bottlenose whale were found along the coast of the English Channel and the Atlantic. Dwarf sperm whale, Pygmy sperm whale, Blainville's and Gervais' beaked whales were observed exclusively on the Atlantic coast. All species have been reported from the Atlantic coast with a trend to be more frequent in the southern Bay of Biscay. This area, where continental slope and oceanic habitats can be found close to the coastline, presents the highest relative abundance and diversity for these species. The Ligurian basin in the Mediterranean Sea also appears to be an area of importance for these deep-diving species. Main stranded are recorded in winter, this periodicity respond to an important wind which drive dead animals on the coastline.

The long term monitoring of strandings has allowed us to bring together the first preliminary data on the distribution of ziphiids and physterids. The recent cases of interactions with human activities using the low frequency active sonar, show that it is crucial to determine the preferential habitats of these species. Aerial or boat surveys would allow confirmation of stranding data.

ACKNOWLEDGEMENTS We would like to thank Dr. Duguy, for the creation of the French national stranding network (RNE) and his coordination until 1994. And we are grateful to all participants of the RNE for their everyday help on the field, and more particularly the organizations wich collected these data: GON, SPA, GMN, ONCFS, Océanopolis, SEPNB, Océarium, GREMMS, Réserve Naturelle du Banc d'Arguin, GECEM and Université de Corté. As well, we would like to thank the Ministère de l'Ecologie et du Développement Durable for their support.

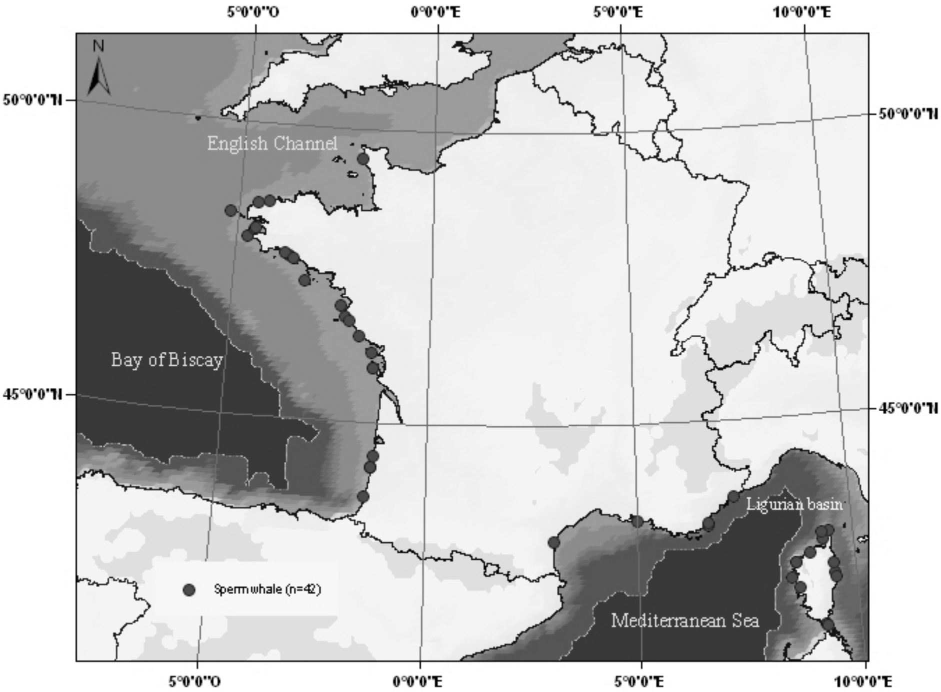

Fig. 1. Locations of sperm whale strandings

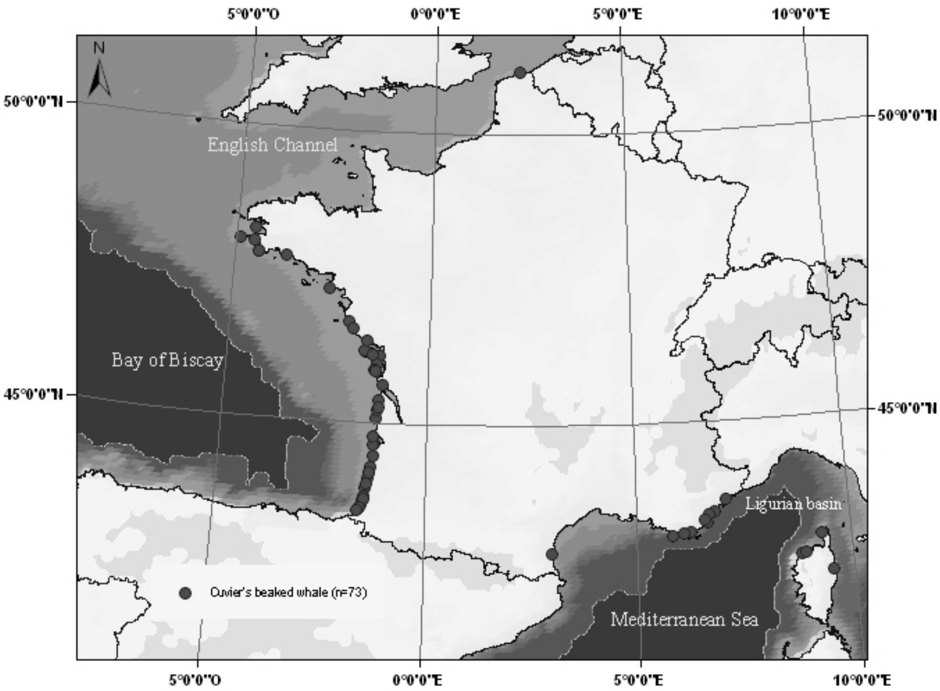

Fig. 2. Locations of Cuvier's beaked whale strandings

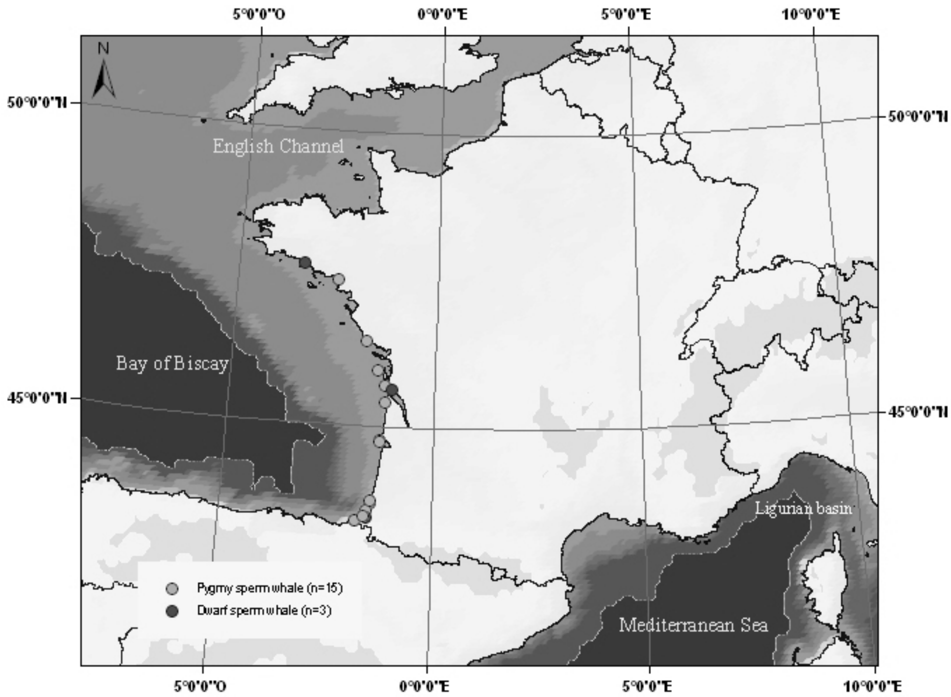

Fig. 3. Locations of pygmy and dwarf sperm whale strandings

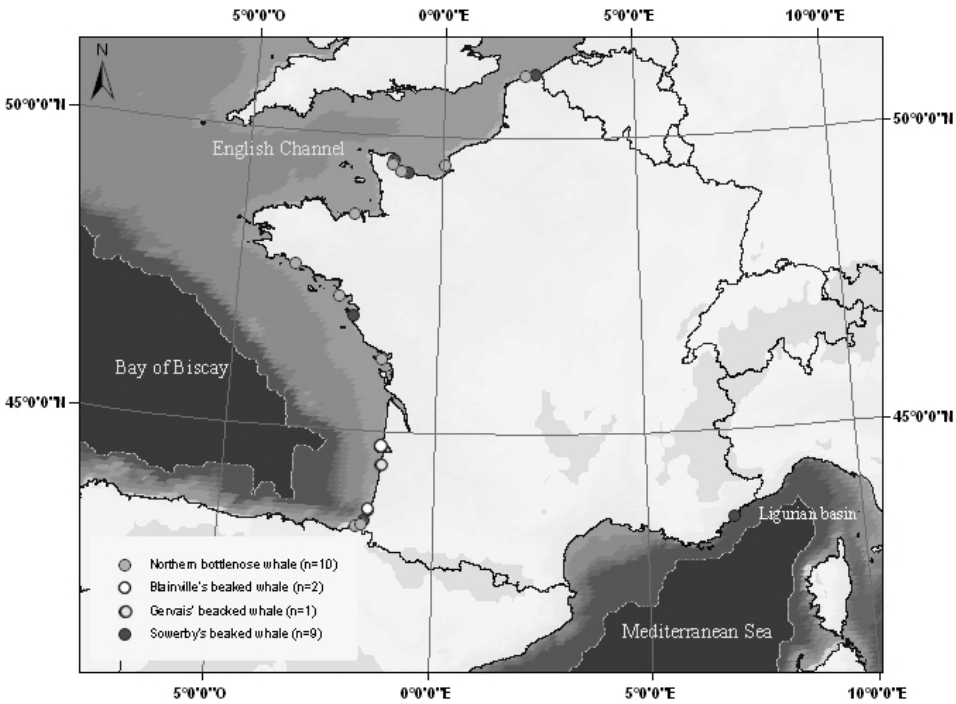

Fig. 4. Locations of northern bottlenose whale & *Mesoplodon* species strandings

SINGERS IN FRENCH POLYNESIA: HOW DO MALE HUMPBACK WHALES COPE WITH SPATIAL EXTENSION OF ARCHIPELAGOES?

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Combined acoustic and visual surveys made from 1997 to 2002 with a 37 foot sailboat have shown that humpback whales wintering grounds include all four archipelagos of French Polynesia (central Pacific ocean). Societies and Marquesas comprise about 10 islands spaced 20-100km, when the Tuamotu archipelago consist in more than 50 atolls spread over one million square kilometer and the Australes count 5 islands regularly lined over 1000km. Regularly spaced listening stations were performed with a towed hydrophone on 2069 occasions during 9018 km of sampling around 35 islands from September to November every year. Short recording were made on every occasion and longer (up to one hour) stations were allowed when high quality sound was available. Singers were heard and recorded from all islands in the Australes, Society and Tuamotu archipelagos, with an overall frequency of 22% (positive listenings/total listenings). The study revealed that songs did not differ between archipelagos. Singers were not located randomly: 94% of visually located singers were seen within 300 meter from shore and most of them were located within 1.5 km from a land head. Whenever position of singer was controlled during one full dive-surface cycle, coastal whales were either stationary or moving <1kt. Repeated acoustic sampling around some islands (either within a season or in successive years) showed the existence of favoured “singing sites” around several Society Islands. One to five singing sites were found around one given island whenever condition allowed sampling within 1-2 days. These results suggest that singers scatter over a very large surface (more than two million sq.km) at favourable sites. This might be due to purely acoustic reasons or to the position (or movement) of females whales. This might be different from situations occurring in other breeding areas world-wide, perhaps due to the low density of whales.

DISTRIBUTION, OCCURRENCE, AND CURRENT STATUS OF CETACEANS IN WATERS OFF CRIMEA: AN EXPERIENCE OF STUDY FROM STUDENT POLL

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INTRODUCTION The first experience of complex monitoring of the occurrence, geographical distribution, relative abundance, seasonal activity, migrations, and strandings of cetaceans in the Black Sea and the Sea of Azov using a student poll was carried out. The problem of creation and functioning of the active and stable information network in this field is critical not only for Ukraine but for all the Black Sea countries. The main tasks of planned structure are: regular collecting the data concerning marine mammals (1), evidences of relation of the local communities (first of all, connected with the coastal zone) to the animal conservation problems (2), realization of educational work in the wide public circles (3) and forming of public opinion in favour of wildlife conservation policy (4).

Questioning students of biological, veterinarian, and medical departments as a target group is a promising possibility to get relatively reliable information from this well-educated and active population group (many of the students come from coastal areas and much more regularly visit it). Our priority choice was fixed upon the student audience by the number of reasons: activity, observation and mobility of this social group (1), specialization in natural sciences (2) and skills of field work and applied science acquired in universities (3). As a result, many students reported their own observations, evidences of their parents, neighbours and friends, and expressed their position concerning the problems of cetacean status and conservation in the Black Sea region.

MATERIALS AND METHODS The study was carried out in Crimean State Agricultural University, mostly the Faculty of Veterinary Medicine in November 2002; 234 students participated in the poll (among them 46 living in coastal zone). Our questionnaire included the main personal data (age, site of residence or attendance in the coastal zone), frequency of sighting or stranding observations, their detailed description (date, time, geographical location, etc.), free-living animal characteristics (number, size, coloration, shape of head, fin, etc., manner of diving, behaviour, movement direction, flock composition), data about dead dolphins (suspected cause of the death, stage of decomposition, wounds and damages, detailed description of carcass or bones). Drawings of harbour porpoise, common dolphin and bottlenose dolphin were attached to facilitate species recognition. Besides the students were asked to answer the questions concerning the conservation problems. The special part contained questions about economy usage of animal carcasses by coastal local people (for human nutrition, for domestic animal feeding, cases of incidental and non-incidental take, etc.). The poll was confidential but students could assume their names in accordance with their desire.

RESULTS AND DISCUSSION The data were reported from the coastline of the Black Sea and the Sea of Azov from Skadovsk to Berdyansk taking about 1200 km, and also adjoining open sea areas. During the analysis of obtained information the studied area was divided into 10 regions: Karkinit Gulf (1), Southern coast of Tarkhankut Peninsula (2), Calamita Gulf and Evpatoria Bay (3), Heracleia Peninsula – Sevastopol (4), Southern Coast of Crimea (West part) (Balaclava – Alushta) (5), Southern Coast of Crimea (East part) (Alushta – Kiik-Atlama Cape) (6), Feodosia Bay (7), Southern Coast of the Kerch Peninsula (8), the Kerch Strait (9), the Sea of Azov (10) and the waters off Caucasus (11).

170 respondents (73.0%) reported about 177 sightings (min. 839 animals) and 82 strandings (110 animals) of harbour porpoise, common dolphin and bottlenose dolphin throughout the coast of Crimean peninsula and adjacent areas (Southern Ukraine and Caucasus) during 1989-2002 (Fig. 1); among them 45 sightings and 14 strandings in 2002, 25 sightings and 9 strandings in 2001 (Fig. 2). In reported sightings harbour porpoise (58 cases+5 doubtful; min 303+25 animals) and bottlenose dolphin (34 cases+9 doubtful; min 58+45 animals) prevailed.

The largest number of sightings was reported from Southern Coast of Crimea (West part) (34), Calamita Gulf (34), Southern Coast of Crimea (East part) (28), Karkinit Gulf (20). In strandings Calamita Gulf (24 cases), Sea of Azov (13), Southern Coast of Crimea (West part) (11) dominated (Fig. 1 and 2).

As seen in Figs. 1 and 2, harbour porpoise strongly dominated over bottlenose dolphin in sightings and strandings in the waters off Heracleia peninsula (Sevastopol) and slightly dominated off the Southern Coast of Crimea (West part). Bottlenose dolphin dominated or equaled the harbour porpoise in Calamita Gulf, off the Southern Coast of Crimea (East part) and in Feodosia Gulf. In Karkinit Gulf harbour porpoise dominated in strandings, but the ratio of two species was equal in sightings. In the Sea of Azov harbour porpoise contained all findings. In the other regions the number of reported findings was too small to make any conclusions on tendencies.

The changes of number of reported sightings and strandings vs time was characterized by exponential growth reaching maximum in the most recent year of findings (2002) that reflects the memory of audience. However, the peak of strandings in 1998 and the decline in 1999 at the Black Sea coast do not face this regularity. This corresponds to the high rate of by-catch in Crimea in 1998 reported by Ukrainian team within BLASDOL project (BLASDOL, 1999).

In 2001-2002 the ratio harbour porpoise: bottlenose dolphin in sightings changed in favour of the latter (21+5 vs 17+4 cases) that probably reflected an increasing tendency to replacing harbour porpoise by bottlenose dolphin in Crimean waters (Fig. 5-6). However, in reported strandings harbour porpoise (30+1 cases; 45+1 animals, among them in 2001-2002 – 8 cases) dominates above bottlenose dolphin (11+1 cases, 22+1 animals, among them in 2001-2002 – 3 cases).

The data of bottlenose dolphin frequent occurrence corresponds to the data by Agafonov *et al*. (1982) for the Karkinit Gulf, Kirilyuk and Zelenaya (1986) for the Calamita Gulf, Gol'din and Artov (2001) for the Soutern coast of Crimea (East part), Mikhalev (1981) for the Northern Black Sea. The regularities of distribution of harbour porpoise are less evident (Danilevsky *et al*., 1978). However, the problem of current distribution of cetacean species requires the further investigation.

Some of respondents (8.5%) reported about the facts of economy usage of stranded dolphin carcasses (Fig. 7). 172 respondents (73.5%) informed about their knowledge of current conservation status of Black Sea cetaceans, 88.5% of them support the conservation policies and practice of student polls in the future. The main sources of conservational information are school and university courses (25.5%) and TV (18.2%). Scientists (0.5%) and dolphinaria (2.6%) take over-modest positions in this process (Fig. 8).

CONCLUSIONS We can state that methodology of student polls is a promising method to initiate the cetacean monitoring network in the Black Sea region. It allows to obtain reliable data with time and funds economy and to form zero hypotheses about the important questions of cetacean biology.

ACKNOWLEDGEMENTS Our sincere thanks to Andrey M. Artov, the Executive Director of Non-Governmental Association "Ecology and Peace", for the support of this project.

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Columns on diagrams:
1 – total number of sightings (strandings)
2 – harbour porpoise

3 – common dolphin

4 – bottlenose dolphin
5 – doubtful or undetermined species

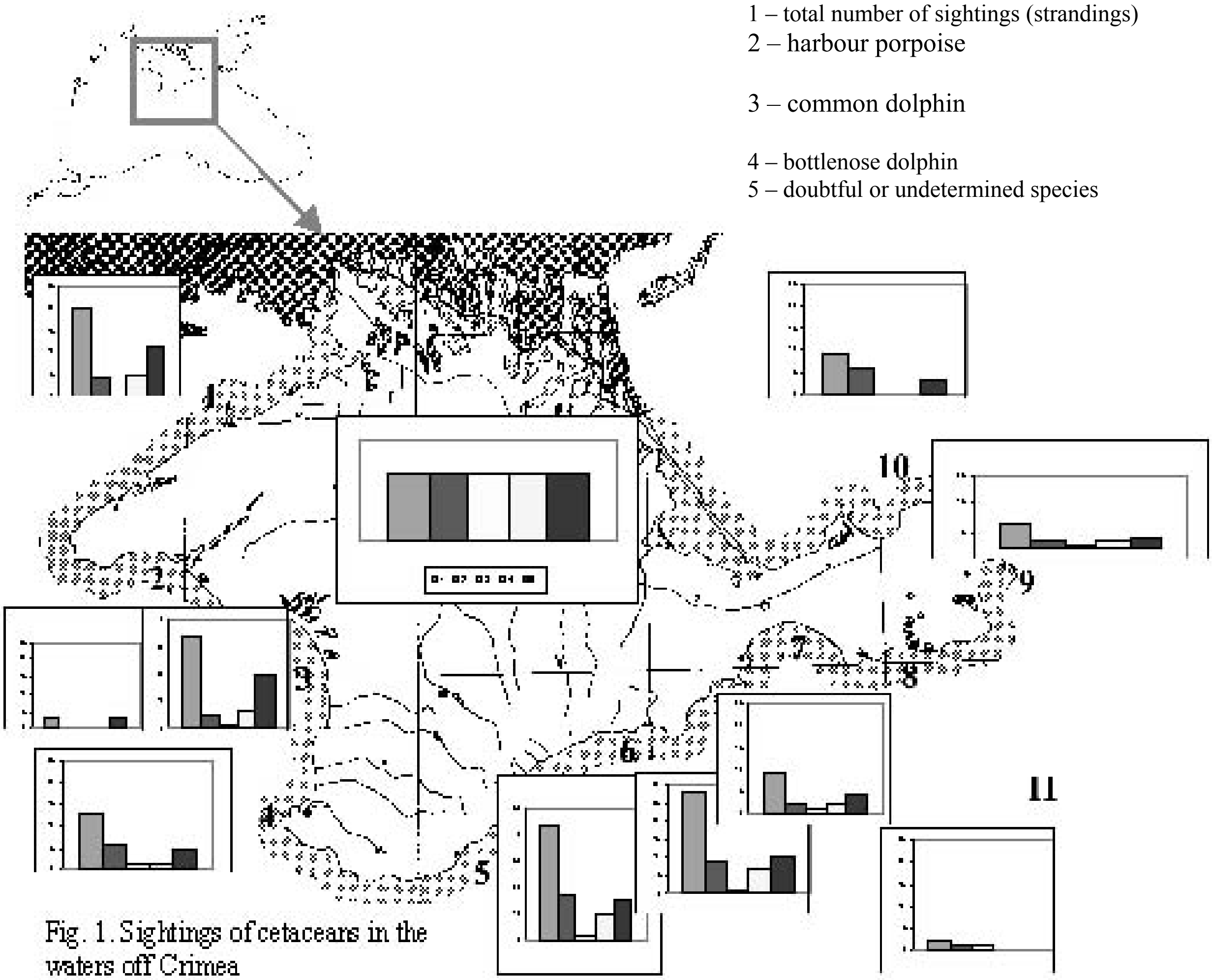


Fig. 1. Sightings of cetacears in the waters off Crimea

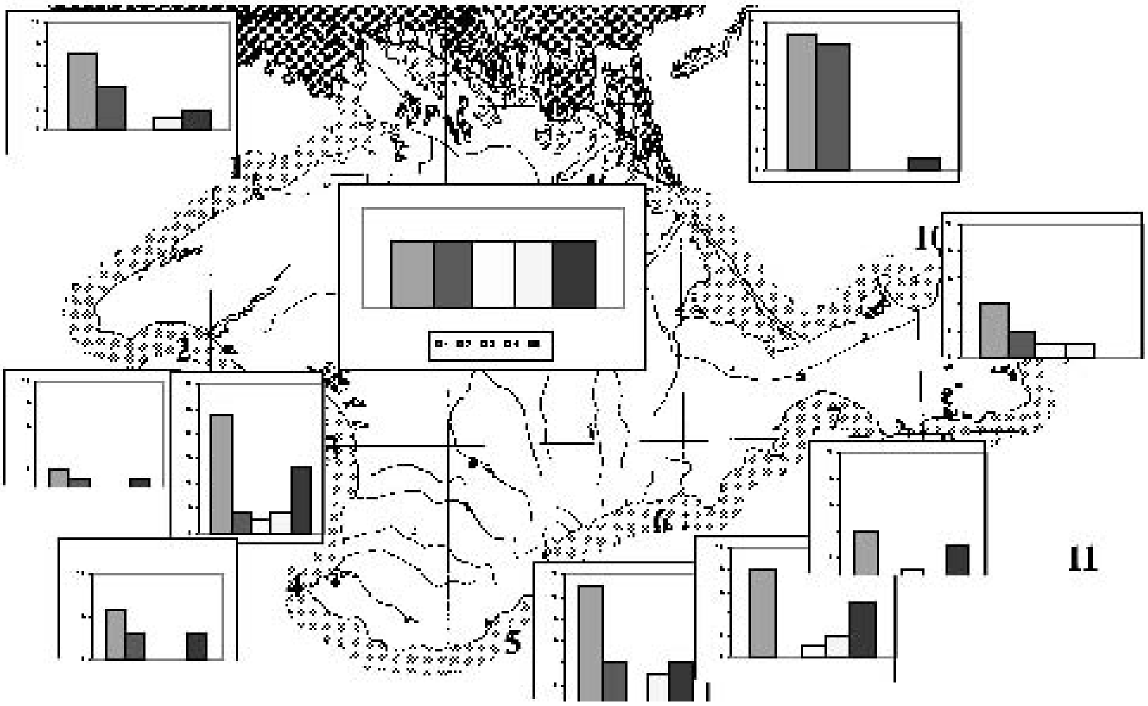
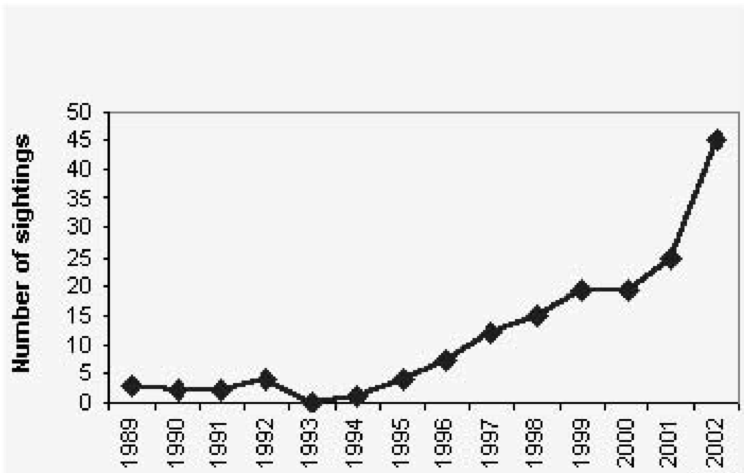


Fig.2. Strandings of cetacears at the coast of Crimea



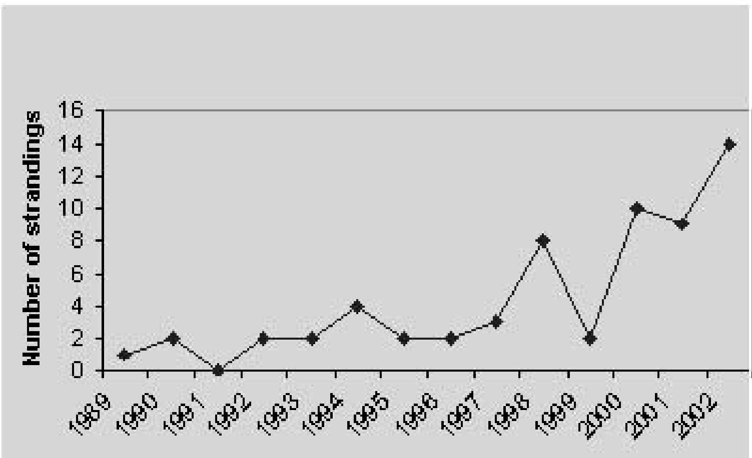


Fig. 4. Time distribution of strandings

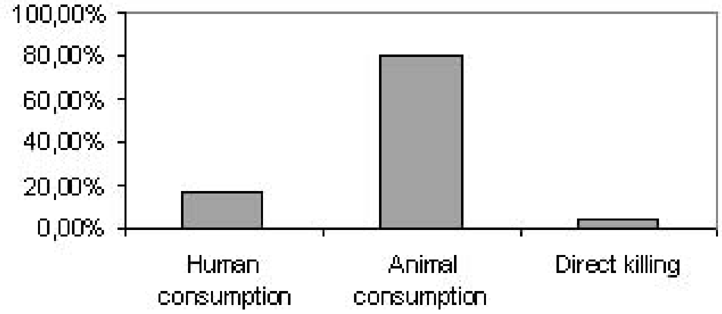
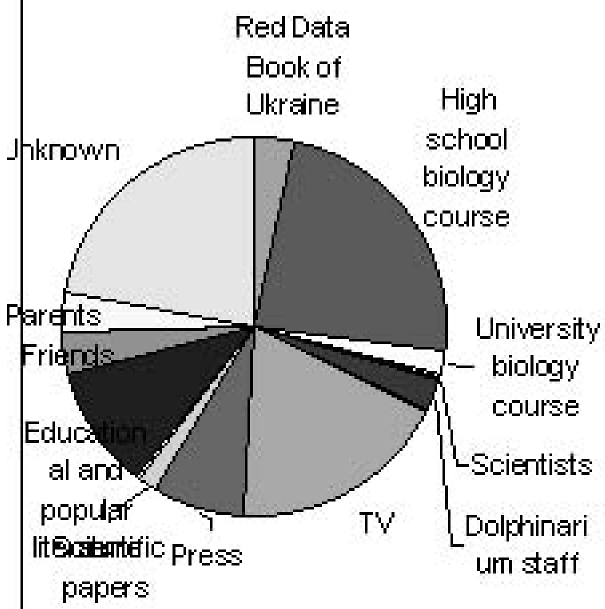


Fig. 7. Data on economic usage of cetaceans

Fig. 8. Sources of information about cetacean conservation in Ukraine



A LACK OF INTER-ISLAND MOVEMENTS OF BOTTLENOSE DOLPHINS IN THE MAIN HAWAIIAN ISLANDS

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Bottlenose dolphins are widely distributed in coastal areas, in the open ocean, and around oceanic islands, but information on population size, residency and movements in the open ocean and around oceanic islands is extremely limited. We photo-identified bottlenose dolphins around three island groups in the main Hawaiian Island chain (O'ahu, Maui/Lana'i, and Hawai'i) in April and May 2002, and compared photographic identities with dolphins identified off Maui/Lana'i in 2000 and 2001. These island groups are separated by only 50-80 km, though deep-water (>2000 m) channels are found between the island groups. Seventeen bottlenose dolphin groups (mean group size of 8.5 individuals) were encountered during 28 days of field effort, and 58 individuals with long-term markings were documented in the three areas in 2002. Of the 18 individuals identified off Maui/Lana'i, 11 of these had been documented in that area in 2000/2001, indicating that individuals show some residency to the area. Of the 40 individuals identified off the islands of O'ahu (29) and Hawai'i (11), none had been previously documented. Given a 61% between year resighting rate off Maui/Lana'i, if the dolphins were moving freely between islands we would have expected 24 of the 40 individuals from O'ahu and Hawai'i to have been previously documented individuals. Combined with an apparent preference for shallow (<200 m deep) areas, these data suggest that movements between islands, are extremely limited, if not absent. Concurrent biopsy sampling for collection of genetic samples (28 samples to date) may provide evidence of differentiation between islands, however sample sizes off the islands of O'ahu (6) and Hawai'i (4) are currently insufficient for such testing. Further work is planned to address this question in May and June 2003. More information on this research can be found in Baird *et al*. (2002).

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MIGRATORY ROUTES OF EASTERN NORTH ATLANTIC HUMPBACKS: SPECULATION BASED ON HISTORICAL AND PRESENT DAY DATA

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From the logbooks of the whaling ships of the 19th Century it appears that there was a concentration of humpbacks during winter and spring months in the eastern tropical North Atlantic, around the Cape Verde Islands. Several sightings recorded in the whaling manuscripts are suggestive of migration routes. In past 10 years there has been great research effort regarding the humpback whales of the Cape Verde Islands, revealing that the archipelago represents an important breeding and calving ground. In 2002 the fluke-picture one of the whales identified in the Cape Verde Islands could be matched with one taken in Icelandic waters: this is the first evidence for a feeding ground destination for a humpback whale from the Cape Verde Islands. Since 1996 the presence of humpbacks around the Canary Islands has been recorded as well. The humpbacks taken off northern Norway in the late 19th and early 20th centuries seem not to fit the model of a north-south feeding-breeding migration to and from the CVI, or for that matter to and from the West Indies. In the light of these facts a speculation on the migratory route taken by the whales wintering in the Cape Verde and Canary Islands is made.

THE HARBOUR PORPOISE AND OTHER CETACEANS STRANDING AND SIGHTING RECORDS FROM THE DOVER STRAIT AND ADJACENT AREAS: THE LAST THIRTY YEARS

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The Dover Strait and its adjacent areas represent a transition between the North Sea and the English Channel. These waters are known to be the most frequented by commercial ship traffic worldwide, notably because of their geographical position in relation to several of the largest ports in western Europe. From 1972 to 2001, harbour porpoise (*Phocoena phocoena*) and other cetacean stranding and occasional sighting records were collected in northern France (Nord-Pas-de-Calais and Picardy regions). A total of 174 data were collected, comprising 94 stranding and 80 incidental sighting records. The harbour porpoise was the commonest species (48.3%) with 49 stranding and 35 sighting records. Fourteen other species have also been recorded, among which, the commonest were long-finned pilot whale (*Globicephala melas*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*). Other delphinid as well as balaenoperid and ziphiid species were recorded but in minor part. Despite the fact that this area is frequently considered to be lacking cetaceans, it appears that at least four species are yearly or seasonally resident, e.g. the harbour porpoise, the long-finned pilot whale, the bottlenose dolphin and the white-beaked dolphin. The first one seems to be resident. Since the mid 1990's, we found that stranding records have tended to increase (r=0.72), like in other areas in the southern North Sea. Several calves have also beached, suggesting probable births at sea in nearby coastal waters. Delphinids occur only seasonally, with an intra-annual occurrence fluctuating according to the species. In conclusion, the Dover Strait area (at least the French side) is not a desert for small cetaceans. Nevertheless, more research are needed to improve on current knowledge of cetacean occurrence in this region. Improved constant effort methodology and international co-operation is being planned in order to achieve this.

DESIGNING STRATEGIES FOR MONITORING CETACEAN POPULATIONS: SPATIO-TEMPORAL PATTERNS OF DISTRIBUTION OF HARBOUR PORPOISES

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Cetacean populations vary in time and space over a range of scales. Studies of long-term patterns of variation (eg. seasonal or interannual) can be confounded by variation at shorter time-scales (e.g. tidal and diurnal cycles). Location-specific patterns of temporal variation can also make spatial comparisons difficult. This potentially limits the value of data collected for population assessment and management. Many cetacean species are protected and governments are obliged to designate and monitor areas for their conservation. For example, harbour porpoises *Phocoena phocoena* are listed on Annexes II and IV of the EU Habitats Directive.

In this project, the spatial and temporal distribution of harbour porpoises was investigated by means of a factorial sampling programme, comparing patterns of abundance at two locations in Anglesey (North Wales), at all possible combinations of tidal phase (spring versus neap), tidal state (high, ebb, low and flood) and time of day (morning, noon and afternoon). The results showed that abundance of porpoises at each location differed in patterns of variation in relation to the state of tide. There was also generally greater activity during neap tides than springs. These findings indicate that it will be necessary to take account of tidal state and tidal phase in designing monitoring programmes for harbour porpoises. The findings also demonstrate the value of sampling programmes of this type in elucidating location-specific patterns of activity as a basis for further study.

STUDIES ON OCEANOGRAPHIC PARAMETERS AFFECTING THE NON-UNIFORM DENSITY OF THE MEDITERRANEAN FIN WHALE POPULATION – THE CHOICE OF A SAMPLING DESIGN

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INTRODUCTION Space-time prediction models of cetacean distribution have recently been developed by Hamazaki (2002). These models could be, in the future, a useful tool to manage cetacean populations by meaning to protect them and their habitats. Nevertheless to improve the models, it is important to design an efficient way to observe them in the field. At present, ecologists are submitted to one main obligation, the high cost of the campaign at sea. So this parameter affects all the other aspects. The most used method is the random sampling. It allows to lead campaign without any knowledge of the studied population. Unfortunately, the search effort is distributed randomly even if the population is concentrated in specific area and this means a low efficiency of the sampling design. The aim of this work is to point out the possible advantage of another strategy, the stratified sampling. By dividing the whole area into different strata, the effort could be share to each stratum, with an improvement in efficiency, as Cochran (1977) has recommended for heterogeneous area.

MATERIAL AND METHODS *Delphis 99* campaign provides an interesting basis to define stratified sampling criteria, because of the great number of fin whale (*Balaenoptera physalus*) positions can be obtained from a single day observations. The principle of *Delphis* campaign is to realize a systematic sampling. A GPS position is given to each boat taking part to the event. Observers aboard have to detect cetaceans in the surrounding of each position. The sighting strip, between Hyères and Menton to 25 NM from the coast, has been divided into four nautical miles area squares. More positions were added to the area, depending on the random presence of other boats into the liguro-provencal basin.

Fifty-seven observations were established on July the 18th, in the Ligurian Sea (Fig. 1). The 114 sighted fin whales appear to be not randomly distributed in the whole area. Of course, this distribution depended directly on the GPS positions, where boats have made efficient search: when the search is considered to be constant, it is clear that animals were concentrated into specific areas. *A posteriori*, it is possible to determine parameters explaining the whale's aggregation and what criteria could be used to divide the area into different strata.

The first step is to choose one parameter affecting fin whale distribution. Gannier (2002) and Forcada *et al*. (1996) stressed that a majority of whales are concentrated in the area corresponding to deep waters (>2300 meters). *Delphis 99* data suggests a similar result: 7 % of the whales are located between the coast and 2000 m isobaths, 16 % between 2000 and 2400 m and 77 % where the bottom is deeper than 2400 meters (Table 1). This clearly implicates that the animals are not randomly distributed and, if you consider that most of the search effort was developed in depth waters less than 2200 m, this result appears much more meaningful. So the bathymetry could be used as the first parameter to determine strata.

The second step is to define the number of strata. It is important to define the strata by the easiest way. The bathymetry is useful because it do not change in time and in space. Map currently used isobaths are recommended to identify strata bounds. One stratum should represent exceptional whale sightings. According to *Delphis 99* data, this stratum could be set between the coast and 2000 m isobaths. The low sighting frequency stratum could be located from 2000 to 2400 m. And, a third stratum could be allocated where the deep is more than 2400 m, which characterizes most of whales' positions (Fig. 2).

The following step consists in determining the sampling design and in allocating the sample size in each stratum. The sampling design usually used is the linear transect. All animal detected during one transect are counted. The sampling finished, the search width is calculated to establish the effective prospected area. Other methods could be employed, for instance, the point sampling as performed during *Delphis* campaigns. The decision of allocation could be done in different ways, on one hand the number of units sampled is decided to be proportional to the stratum size, on the other hand, the dispersion pattern of the studied species could be also used. In a situation, the search effort is divided in function of strata weight. For example, the number of hypothetic boat allocations for each stratum has been calculated (Table 1).

The bathymetry is not the only criteria for dividing the Ligurian sea into strata. Of course, whales' population is not randomly distributed inside the third stratum. The thermal front may also be an indicator of whale's positions, as it was previously remarked by Viale (1991). By using satellite imagery analyses, new strata could be drawn. For example, sea surface temperature structure (SST) is usually observed to locate productive waters. If whales are concentrated into productive waters (Brown and Winn, 1989; Gill, 2002), satellite imagery should be really interesting.

Delphis 99 data suggests similar results: 68 % of sighted whales could be close to a thermal front (Table 3). This front area is a mean position of sea surface temperature gradient (8 n.m. width) (Fig. 3). It should be remarked this configuration of the front is not usual. The number of hypothetic allocated boats for each stratum has been also calculated (Table 3). Moreover, by over-laying these 2 parameters, new strata could be identified, by using a similar method (Table 3, Fig. 4). And finally, more parameters are employed; more aggregations' area will be precisely delimited. Furthermore, the size of the group should be used as an indicator. If aggregation of whale is suspected, this should indicate a favorable habitat. For examples, the krill *Meganyctiphanes norvaegica* concentration should have an effect on the whale distribution. In *Delphis 99* campaign, for the all area, the mean number of whales sighted together is exactly 2 whales. In correspondence of the thermal front, the mean association number is 2.2 specimens and outside the front, it is 1.7. This result demonstrates the aggregation pattern in specific area.

RESULTS The application of two methods (stratified sampling and systematic sampling) is compared (Fig. 2, Fig. 3 and Fig. 4). In all examples, 20 boats are allocated to the sampling design. This small number represents most of situations with a low budget given to ecological research. In the case of the systematic sampling, the estimated abundance of whales gives one result. This result could be compared to each stratified sampling strategy. Three examples of criteria to divide the Ligurian sea are presented. The first criteria is to use the bathymetry because whales are mostly distributed into deep waters. The sampling is developed in function of previous whale sightings. And if animals are concentrated into the stratum in which the boat number is greater (16 boats, Fig. 1), then the estimated abundance is improved and more representative. With the systematic theory, only a few boats (5, Fig. 1) might have sampled the area. Furthermore, others criteria could be used, as thermal front. Satellites could give information about SST with one square mile precision. The utilization of these data could permit to delimit strata based on frontal position. And, by sharing the number of boats between the two strata (14 boats inside/6 boats outside of the frontal area, Fig. 2) in function of the previously sighted number of animals, the estimated abundance should also be more precise. Otherwise, by using the systematic sampling, in the given example, 10 boats might sample the frontal area (Fig.2). If the results indicates that the stratified sampling improves the abundance estimation, then more criteria should be used. Bathymetric configuration overlaid to frontal area could permit to identify new strata, where both parameters are deduced to be correlated to whale abundance (Fig.3). In such a case, instead of the systematic sampling could not be representative of all strata; the stratified sampling might be more efficient. The great number of boats in the area where animals should be aggregated (9 boats Stratum IV) would improve estimations. This concentration of whale must be considered. The results of *Delphis 99* campaign prove that the size of animal group changes in function of their localizations.

CONCLUSIONS By randomly sampling the whole area without taking account of the oceanographic parameters, it is possible to not sampling specific areas where animals could be aggregated. On the contrary the stratified sampling can give an improvement of the abundance and the distribution estimations of the whale population. The main problem to apply this technique could be derived from the delimitation of strata, when the boundary parameters change a lot in time and in space. It imposes a daily delimitation of the frontal area, for example.

ACKNOWLEDGEMENTS We wish to thank all the *Delphis 99* participating staff.

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Table 1. Distribution of whales in function of the bathymetry

Stratum	0 to 2000 m	2000 to 2400 m	> 2400 m
Number of sightings	3	9	45
Number of whales	7	18	89
% of whales	6.14	15.79	78.07
Number of boats (T=20)	1	3	16

Table 2. Distribution of whales in function thermal front

Stratum	Inside the thermal front	Outside the thermal front
Number of sightings	35	22
Number of whales	77	37
% of whales	67.54	32.46
Number of boats (T=20)	14	6

Table 3. Distribution of whales in function of the bathymetry and the position of the thermal front

Stratum / depth	0 to 2000 m		2000 to 2400 m		> 2400 m	
Stratum / front	inside	outside	inside	outside	inside	outside
Strata	I		II	III	IV	V
Number of sightings	3	0	7	2	25	20
Number of whales	7	0	16	2	54	35
% of whales	6.14	0	14.04	1.75	47.37	30.70
Number of boats (T=20)	1		3	1	9	6

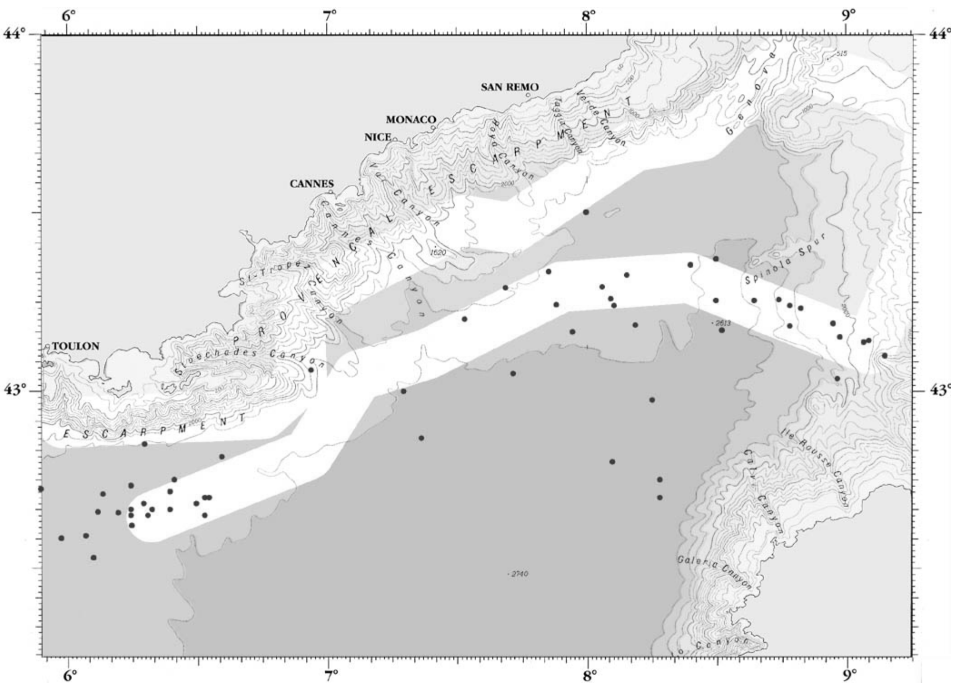

Fig. 1. Distribution of the sightings on a bathymetric map with the schematic thermal front on July the 18th

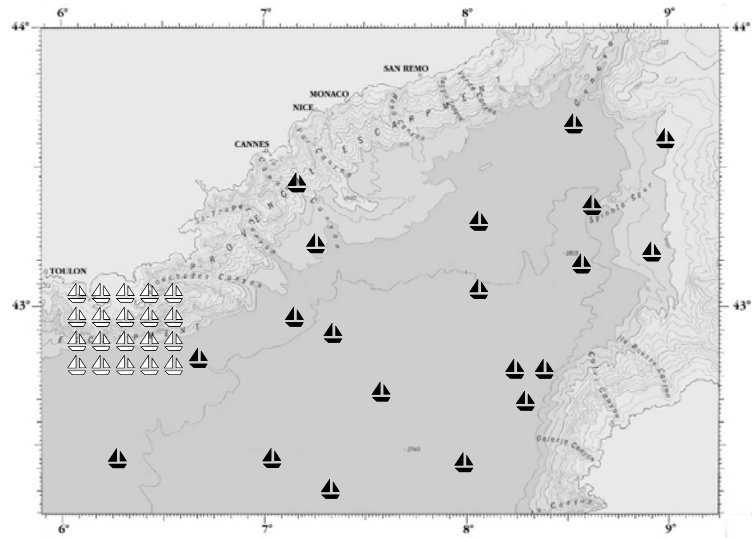

Fig. 2. Stratification of the Ligurian Sea in function of bathymetric data with 2 examples of sampling design: the systematic sampling (white) and the stratified sampling (black)

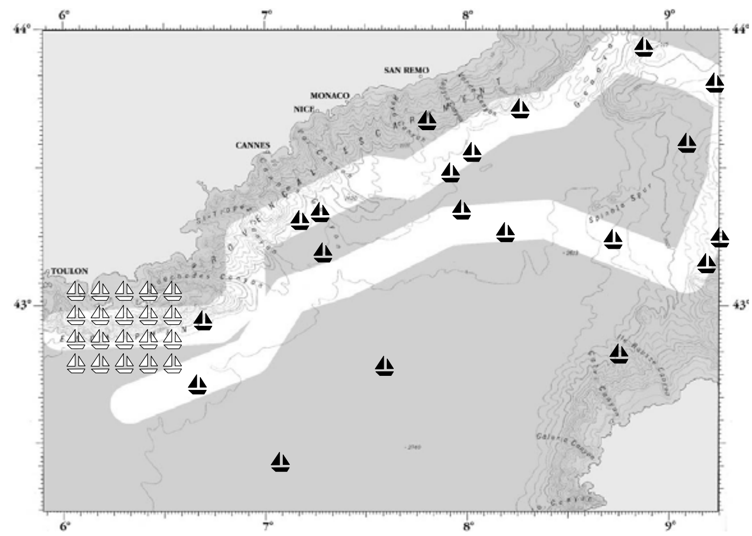

Fig. 3. Stratification of the Ligurian Sea in function of thermo-frontal area with 2 examples of sampling design: the systematic sampling (white) and the stratified sampling (black)

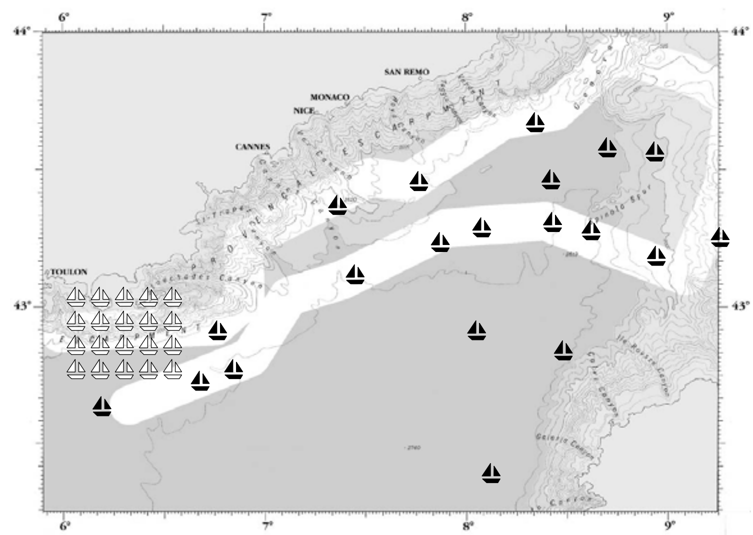

Fig. 4. Stratification of the Ligurian Sea by using 2 parameters (bathymetry and frontal area)

THE STRIPED DOLPHINS OF THE GULF OF KORINTH, 1996-2002 A COMPARATIVE STUDY

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A current study by an international team of researchers, under the auspices of the Cetacean Research Group of the University of Athens, determines the presence and high sighting frequency of the pelagic species, *Stenella coeruleoalba*, in the enclosed area of the Korinthiakos Gulf. The presence and abundance of the animals was assessed visually, acoustically using an IFAW type towed hydrophone array and by photo-identification using a digital camera. The results of the ongoing study verify the findings of previous research conducted during the summer months of 1996 and 1997. The 18 sightings made during October and November 2002 endorse the presence of the Striped dolphin population in the area not only during the summer months but in the fall period as well. Furthermore, individuals of the Common dolphin species, *Delphinus delphis*, were identified in 5 of the Striped dolphin sightings. The latter provide evidence for an interspecies association in the area. The continuation of the study at different seasonal periods would help ascertain the residence and home range of the striped dolphin population in the area.

HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE LITTORAL OF HUELVA, CADIZ GULF

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INTRODUCTION During the last decades, the harbour porpoise (*Phocoena phocoena*) population at the Atlantic Iberian littoral, has suffered a dramatic decline in its numbers. The principles causes of this decline are the degradation of its habitat, the over-exploitation of fish resources and incidental catches (Aguilar *et al*. 1999; Sequeira, 1996). Except for the coast of Galicia, it is considered extremely rare in all its distribution area along the Atlantic littoral. Some authors have even suggested that the species has disappeared from the Gulf of Cadiz (Aguilar *et al*. 1997), its most southern distribution area of the Iberian Peninsula. The critical situation of this cetacean urges for more precise data on its distribution and population size at the Atlantic littoral. This study offers information about the actual situation of the species at the littoral of Huelva (Gulf of Cadiz), stressing its importance as a foraging area.

Study area The coast of Huelva is located at the South Atlantic littoral, within the Gulf of Cadiz (Fig. 1). A strategic situation, with both Atlantic and Mediterranean influence, being an obligated passage for all cetaceans that make seasonal or migration movements between both seas. The continental platform is wide in comparison with the rest of the Iberian Atlantic coast, with shallow waters and sandy soils. At the same time, the high productivity of nutrients in the river deltas provides excellent food conditions for the marine fauna. The most relevant human activities than can affect the cetaceans, directly or indirectly, and more in particular the harbour porpoise, are fisheries and pollution from the chemical industry situated at the Huelva coast.

METHODS In 2000 a monitoring programme was started to collect all stranded cetaceans at the coast of Huelva. This programme has provided data on the actual situation of the harbour porpoise. Data taken from the animals collected are biometrics, age class, sex, season, localisation and cause of death. Whenever possible samples are taken to study diet, heavy metal levels and histopathology. Previous data available about the presence of the species in the study area were also collected.

RESULTS Between 1995 and 2002 nine strandings of harbour porpoise were recorded at the coast of Huelva. The general characteristics of the individuals stranded are shown in Table 1. A clear seasonal pattern is shown, obtaining all records between January and July (Fig 2). It also appears that during the month of March the majority of cases are recorded, representing 44% of the total records. During the seven years of study, no record was ever obtained in another period. On the other hand, although in the majority of the cases the cause of death could not be verified, at least in two cases a fishery incident was identified as the direct cause of death.

CONCLUSIONS Contrarily to suggestions made by other authors (Aguilar *et al*. 1997), the data obtained certify the presence of the species in the Huelva littoral, and beyond that, in the Gulf of Cadiz. The cases cannot be considered as exceptional, giving its regularity, though in low numbers, in appearance during the last 7 years, which indicate a continuous use of the area. Even so, its seems reasonable to assume that the population size is relativity small in this area.

The fixed period of appearance of stranded individuals (January – July, with a peak in March) suggest that the porpoises only are present at the coast of Huelva during these months. This situation could be due to an increase in or a greater availability of food resources which attracts the species from other areas. The origin of these animals could be the Portuguese coast. However, data are few to reject the possibility of the existence of a resident population during the whole year.

In relation to the exposed and given the similarities between the general characteristics of the littoral of Huelva and the ecological requirements of the species (Alís *et al*. 1999), the coast of Huelva could be considered as an important area for the conservation of the harbour porpoise within its distribution area at the Iberian Atlantic coast, which is used, supposedly, as an foraging area during periods of high productivity.

Although at the moment the information about interactions between the harbour porpoise and fisheries is insufficient, at least 22% of the stranded individuals were killed as a direct consequence of this activity. It is to be expected that this proportion is even bigger, given the fact that both fishing activities and the foraging area of the species coincide near the coast. Other possible risk factor for the species is the high contamination level in the Huelva delta, as a result of industrial activities.

It would be recommendable to start a monitoring programme of the species in order to estimate the population size and dynamics, as well as the extent of the impact of human activities on its conservation.

ACKNOWLEDGEMENTS The present study was executed within the monitoring project of stranded cetaceans at the coast of Huelva. We are grateful for the collaboration and support from the following institutions: Doñana National Park, Doñana Natural Park, the Doñana Biological Station, Natural Park of the Marismas of Odiel, the council of Almonte, the local police, the environmental police, the Red Cross. The Ministry of Environment sponsored the project. The agency Comala, S. A. collaborated voluntarily with the study. Also we are grateful to Guyonne Janss for the translation of the manuscript.

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Table 1. General characteristic of the stranding animals

Date	Sex	Age
02/04/95	-	Adult
15/03/96	F	Adult
19/01/98	F	Adult
08/03/98	M	Adult
04/03/99	M	Young
07/07/00	M	Adult
21/05/01	M	Adult
18/03/02	F	Adult
02/06/02	F	Adult

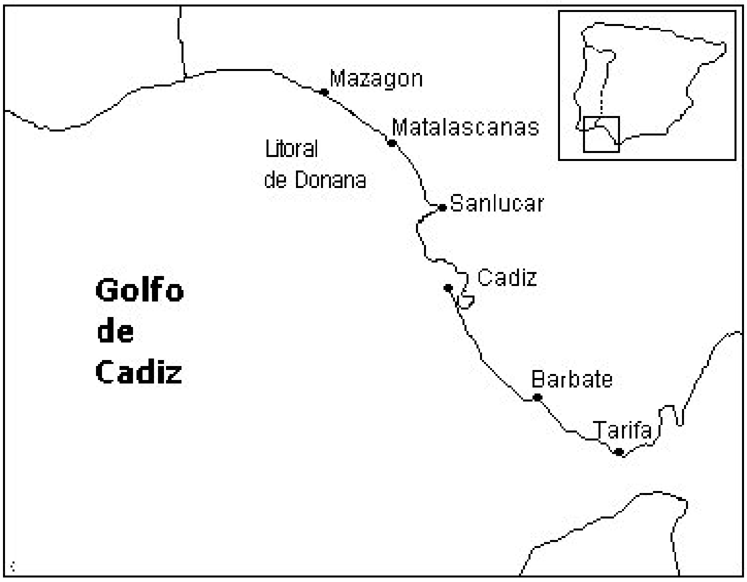

Fig. 1. Study Area

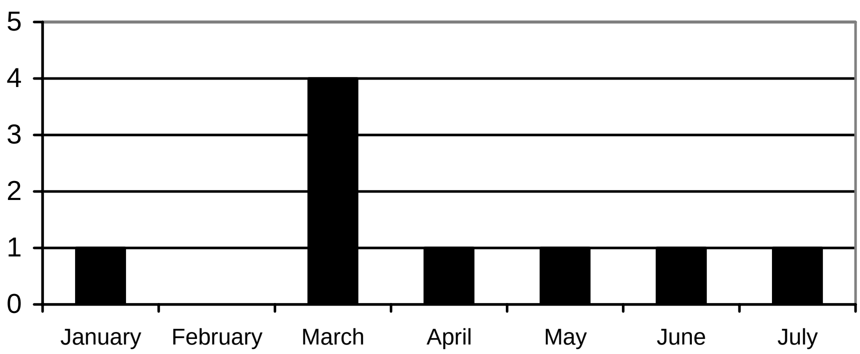

Fig. 2. Monthly distribution of the strandings (1995 – 2002)

SUMMER DISTRIBUTION OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN GERMAN WATERS

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Current plans to exploit German offshore waters as sites for technical constructions such as windfarms as well as the ongoing investigation of potential Natura 2000 areas have led to an increased research interest in local marine mammal populations. The aim of this study was a) to determine the spatial distribution of harbour porpoises in the EEZ (exclusive economic zone) of the German North and Baltic Sea and to b) define areas of high importance to harbour porpoises. Aerial surveys were conducted from May to August 2003 using standard line-transect methodology. A total of 21 days were spent flying and a total of 533 harbour porpoise sightings were made (758 animals). Using a Geographical Information System the study area was divided into a grid of 3' latitude x 6' longitude squares. Porpoise distribution was estimated as number of animals per flight km on effort in each square. Only survey data in good conditions (seastate 2 or less) were considered in the analyses. The results show a non-uniform distribution of porpoises within the study area. In the North Sea the highest relative abundance of porpoises was observed in the area of the Amrum Outerbank. In the Baltic Sea an unexpected high number of porpoises was sighted on the Oderbank. This study showed for the first time detailed distribution patterns of harbour porpoises in German waters with distinct concentrations in dedicated areas

SEASONAL MIGRATIONS AND POPULATION STRUCTURE OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE NORTH SEA AND INNER DANISH WATERS BASED ON SATELLITE TELEMETRY

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Population structure and movements of harbour porpoises in the North Sea and adjacent waters has been subject to great interest in recent years due to the high level of bycatch and little knowledge of the effect on populations. During 1997-2002, satellite transmitters were mounted on 53 harbour porpoises. The animals were live bycaught by fishermen in pound nets in Danish waters. 20 animals were tagged in Skagerrak/North Sea while 33 were tagged in the Inner Danish Waters. The animals were tracked for up to 355 days. Throughout the year there were no overlap in the home range of adult porpoises tagged in the two areas, respectively. We suggest a population boundary in the northern Kattegat across the Danish island of Læsø.. This population structure is confirmed by genetic studies of all ages during the summer season. In a few cases subadult porpoises tagged in the Inner Danish Waters moved into the Skaggerak/North Sea while only one of the tagged porpoises moved into the Baltic proper for a short visit. Seasonal migration between Inner Danish Waters and the North Sea was observed in one case when a subadult female tagged in the fall, spend the winter along the North Sea coast of Jutland and returned to the exact same area where it was tagged six months earlier. In the North Sea the porpoises preferred the Skaggerak and northeastern North Sea along the deep trench along Norway. However, all of northern North Sea between UK, Shetland Islands, Denmark and Norway were exploited. This long-term study has proven successful in following individuals for up to a year and elucidating seasonal movements and stock structure essential in the management of harbour porpoises in the eastern Atlantic.

LAND-BASED SIGHTINGS FROM THE BASQUE COUNTRY COAST (NORTHEAST SPAIN)

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INTRODUCTION Since 1996, AMBAR (Association for the study and the conservation of the marine fauna) is carrying out several projects on cetacean research in coastal waters of North-eastern Spain. In this study, we present the results of the land-based sightings project. The main objective of this study is to describe which cetacean species can be observed in Basque Country coastal waters, their frequency, and their spatio-temporal distribution.

METHODS In order to cover the 256 km of the Basque Country coast six observation points were chosen. During the period between February 2002 and January 2003, a total of 24 samplings were done, two per month. Every sampling with good weather conditions (wind force < 5 and visibility > 10 nautical miles) a maximum of 6 hours of observation distributed during the day (3 hours in the morning and 3 hours before the sunset in the afternoon). Every hour four scans of 10 minutes were done using 8x42 and 10x50 binoculars. The scans were alternatively carried out from East to West and from West to East. Effort data (hour, clouds coverage, visibility, wind force, wind direction, and waves height) and sighting data (angle, distance, first signal, specie, number of individuals, activity, direction and presence of birds) were recorded according with the methodology described in the protocols of the Spanish Cetacean Society (Cañadas *et al.,* 1999). Additionally, opportunistic sightings from Matxitxako cape supplied by ornithologists and "Marinero", a ship placed 7.5 km from coastline in the Gas Plataform "La Gaviota" were collected.

RESULTS During 469 hours of effort carried out in this study, a total of 43 sightings were recorded. The highest frequency of the four identified species; common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), pilot whale (*Globicephala melas)* and fin whale (*Balaenoptera physalus),* was registered for common dolphin with 37.2% of sightings, followed by bottlenose dolphin with 13.9%. Table 1 shows a clear trend in temporal variation in number of sightings, with maximum values during the period between December and April. In other to get a better idea of the seasonal pattern of sightings variation Table 2 shows the number of sightings in Matxitxako cape registered in this study (12 records) plus the opportunistic sightings supplied by ornithologist volunteers (Enrique Franco, Jon Maguregui and Gorka Ocio) and the "Marinero" ship since 2001 (67 records). These data show another short period of high number of sightings in summer (August). The opportunistic data include two more species recorded minke whale (*Balaenopstera acutorostrata)* and risso´s dolphin *(Grampus griseus*) increasing the total number of species sighted from land up to 6. In order to compare the results among the different observation points an encounter rate (number of sightings / hours of observation) was calculate. In Fig. 1 two curves are shown that represent the encounter rates taking into account the hole year (filled circles) and only the period between December and April (open circles). Independently to the period of reference, Matxitxako and Getaria are clearly the two places with higher encounter rates. The longer (> 60 minutes) and closer (< 3 km) sightings occurred in February and August. In this study, the general movement pattern observed was parallel to coastline, 64.40% westerly and 16.94% easterly. There was no evidence of relationship between movement patterns and tidal cycle. The most common group size range observed in the two more abundant species common dolphins and bottlenose dolphins, was between 5 and 30 individuals (60% and 83.32% of total sightings respectively). In 27.12% of the sightings the presence of cetaceans was associated with birds (gannets and gulls). Feeding behaviour was only consider when cetacean were associated with birds clearly fishing close to dolphins (18.64% of total sightings).

DISCUSSION The data presented here and previous data recorded by ornithologist (Jon Maguregui and Gorka Ocio, pers. com.) show that in Basque Country coastal waters 8 different species of cetaceans are present, 2 of them, common dolphins and bottlenose dolphins, frequently, and the other 6, risso´s dolphin, pilot whale, orca *(Orcinus orca),* fin whale*,* minke whale and humpback whale (*Megaptera novaeangliae*) occasionally. The spatial pattern of cetaceans distribution observed in this study suggest a differential distribution with higher encounter rates in Matxitxako and Getartia capes. It'll be necessary more studies in future in order to identify the reasons of this phenomenon. In this study, the seasonal pattern of distribution show two periods in which the presence of cetaceans is more common: from December to April, and in August. Brereton *et al.* (1999) described a marked seasonal pattern in the distribution of common dolphin in the Bay of Biscay, with wintering grounds in shallow waters of Brittany coast and English Channel, and larger numbers in deep waters of the middle of the Bay in spring/early summer. Our results support this general pattern of seasonal movements of common dolphins in the Bay of Biscay. Unlike this, De la Cigoña and Oujo (1999) observed minimal presence of common dolphins in coastal waters of Southwest Galicia (Northwest Spain) during autumn and winter. It seem to exist two main reasons that explain the presence of this specie in inshore waters during summer months; the migration of prey species towards this nutrient rich areas and the protection that this shallow areas offer to calves away from predators such us sharks or killer whales. Evidences of the presence of bottlenose dolphins in different in small estuaries of the Basque country have been recently documented by Vázquez *et al.* (2002). As in other parts of Europe, our data suggest the presence of a resident population of bottlenose dolphins in the Basque Country coast. However, it's necessary more detailed studies such us photo identification studies to confirm this hypothesis.

CONCLUSIONS

- The land based records of cetaceans in the Basque Contru coast include 8 different species, 5 species of odontocetes (common dolphin, bottlenose dolphin*,* risso´s dolphin, pilot whale and orca) and 3 species of mysticetes (fin whale*,* minke whale and humpback whale.).
- Common dolphins and bottlenose dolphins are the more common species in the Basque Country shallow waters.
- During the period of study Matxitxako and Getaria capes showed higher encounter rates than in the others observation points.

- There is a pattern of seasonal distribution with two periods of maximum presence of cetaceans: a longer one, during winter and at the beginning of spring (December – April) and a shorter one in summer (August).

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Table 1. Seasonal variation of number of sightings between February 2002 and January 2003

	D. delphis	*T.truncatus*	*Dolphin sp*	*G. melas*	*B. physalus*	*Rorcual sp*	**TOTAL**	**PERCENTAGE %**
Februrary-02	7		6	1			14	32,56
March-02	1						1	2,33
April-02			7				7	16,28
May-02			1				1	2,33
June-02							0	0,00
July-02		1	1				2	4,65
August-02			1				1	2,33
September-02			1				1	2,33
October-02							0	0,00
November-02						1	1	2,33
December-02		3			1	1	5	11,63
January-03	8	2					10	23,26
TOTAL	16	6	17	1	1	2	43	
PERCENTAGE	37,21	13,95	39,53	2,33	2,33	4,65		100

Table 2. Seasonal variation of number sightings from Matxitxako cape between January 2001 and January 2003. Data corresponding to sightings registered in this work and oportunistic sightings provided by ornithologist (Enrique Franco, Jon Maguregui and Gorka Ocio) and the "Marinero" ship

	D. delphis	*T.truncatus*	*D sp*	*G. melas*	*G.griseus*	*B. acutorostrata*	*Rorcual sp*	**TOTAL**	**PERCENTAGE %**
January-01	1							1	1,27
Februrary-01	4	1						5	6,33
March-01	3							3	3,80
April-01	1							1	1,27
May-01								0	0
June-01								0	0
July-01								0	0
August-01	1							1	1,27
September-01								0	0
October-01								0	0
November-01								0	0
December-01	3							3	3,80
January-02	3				1			4	5,06
Februrary-02	9	1	4			1		15	18,99
March-02	4		1			1		6	7,59
April-02		1	2	3				6	7,59
May-02								0	0
June-02			2					2	2,53
July-02		1	1					2	2,53
August-02	2	5		2				9	11,39
September-02	1							1	1,27
October-02	1	1						2	2,53
November-02	2		2	1	1			6	7,59
December-02	2	1					1	4	5,06
January-03	7	1						8	10,13
TOTAL	44	12	12	6	2	2	1	79	100
PERCENTAGE	55,70	15,19	15,19	7,59	2,53	2,53	1,27	100	

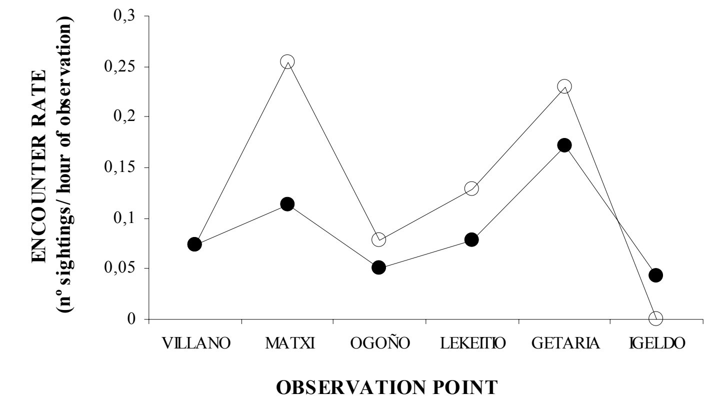

Fig. 1. Encounter rate (nº sightings / hours of observation) in each obervation point during the period of study (February 2002 – January 2003, fulled circles ●) and tacking into account only signtings recorded in December, January, February , March and Arpil (open circles ○)

MODELLING DISTRIBUTION AND ABUNDANCE OF ANTARCTIC CETACEANS FROM "PLATFORMS OF OPPORTUNITY"

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Cetacean abundance is typically estimated using either conventional distance-sampling techniques, such as shipboard line-transect sightings surveys, or from mark-recapture analyses of photo-identification data. Mark-recapture analyses to estimate abundance from identification photographs become highly complex when a study area spans an ocean basin. Line-transect surveys allow relatively fast abundance estimation even for poorly marked species, but it can be very expensive to conduct large surveys that give all areas equal probability of being covered. Recently developed spatial modelling techniques show promise in enabling abundance estimation from non-randomised survey designs. We collected line-transect data along 9650km of trackline aboard platforms of opportunity in the Southern Ocean during the austral summers of 2000-1 and 2001-2. We used generalised additive models to express heterogeneity of sightings of minke, humpback, fin and killer whales as functions of spatial and environmental variables, allowing us to predict density of these species throughout the study area. The techniques enable one to map density predictions. Areas where density is predicted to be high could then be targeted to make future photo-identification surveys more efficient. Similarly, the density gradient maps can be used to stratify subsequent line-transect surveys, thereby reducing cost by allocating less survey effort in the lower-density stratum. In a spatial modelling framework, it becomes much more informative to collect line-transect data from inexpensive survey platforms than to collect sightings alone. The techniques are likely to have wide application to areas where cetacean studies are just beginning.

SURVEYS AND ABUNDANCE

DISTRIBUTION OF *DELPHINUS DELPHIS* IN THE MEDITERRANEAN SEA: COMPETITION WITH STRIPED DOLPHIN OR FISHERIES?

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The short-beaked common dolphin has been found to be in decline in the Mediterranean, from a set of diverse data sources. During summer 1997 to 2001, a series of small boat dedicated surveys enabled to gather consistent effort-weighted distribution data in a variety of Mediterranean regions. Effective effort was 13,429km and 379 delphinid sightings were made including 294 on striped dolphins and 33 on common dolphins, the second species in terms of frequency. *D. delphis* was observed in eastern and western basins, with various sighting frequencies ranging from 40.2% in Alboran Sea to 6% in other regional seas. Common dolphins were more frequent in coastal and upper slope waters (26.7% and 56.7% of sightings) compared to more pelagic striped dolphins (50.0% of sightings in open sea and 32.1% in deep slope stratum). Furthermore, the mean depth for sighting was 1,759m for the striped dolphin (SD=751) and 479m for the common dolphin (SD=469) and this is confirmed by distance-to-200m-isobath variable. Common dolphins were likely to be observed in areas where the continental shelf had some extension and was delimited by a gentle slope, whatever the temperature, an habitat type also favourable to small epipelagic fishes such as anchovies and sardines. Stomach contents results available in the literature clearly indicate a preferendum of *D. delphis* for such prey, compared to the more teuthophageous and opportunistic striped dolphin. The apparent rarefaction of common dolphin in the Mediterranean Sea may be due to heavy exploitation of peri-coastal stocks of pelagic fishes. This suggests suitable conservation policies for the near future in regions were the species is still well represented.

PRESENCE AND DISTRIBUTION OF THE ZIPHIIDAE FAMILY IN THE SOUTH WEST COAST OF TENERIFE. CANARY ISLANDS

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INTRODUCTION The world wide distribution of the various species of the Ziphiidae Family is primarily known due to the data on the stranded animals and sporadic sightings (Mead, 1989; Odell, 1991; Early and McKenzie, 1991; Jefferson *et al*., 1993). The peculiar characteristics of the Ziphiidae family, which are a strict oceanic habitat, a discreet surfacing behaviour and small social units, reduce to a great extent the sighting probabilities and also reduce the data on strandings in continental areas with large coastal shelves. The volcanic origin and oceanic location of the Canarian Archipielago however promote oceanographical and geomorphological conditions that favour the stranding of well preserved animals and facilitate the observation of these oceanic animals near the coast line (Vonk and Martín, 1988; Carrillo and Lopez-Jurado, 1998; Carrillo and Martín, 1999). The study of stranded animals and sightings in the Canary Islands have allowed the identification of 5 species of 3 genera: 1) Cuvier´s beaked whale, *Ziphius cavirostris*: nowadays is the most frequently stranded species as well as in the 80s, due to the mass strandings that occurred in the coasts of Fuerteventura and Lanzarote in that decade (Martín *et al*., 1992; Martín and Carrillo, 1992; Martin, *pers. com*). The sightings of this species are well documented (Politi *et* al., 1996; Martín and Carrillo, LIFE Project 2000; Ritter, 1996). 2) Gervais´ beaked whale *Mesoplodon europaeus*: there are strandings in Lanzarote, Fuerteventura and Tenerife (Vonk and Martín, 1988; Martín *et* al., 1990; Martín and Carrillo, 1992; Martín *et al*., 1994) and only 2 sightings, 1 in Tenerife (Carrillo and Martín, 1999) and other in Gran Canaria (Martín and Carrillo, LIFE Project 2000). 3) Blainville´s beaked whale *Mesoplodon densirostris:* there are strandings in La Palma (Carrillo and Lopez-Jurado, 1998; Martín and Carrillo, 1999), Fuerteventura and Lanzarote (Vonk and Martín, 1988; Martín *et al*., 1994; Martín and Carrillo, 1999; Carrillo *et al*., 2002), and sightings in all the islands (Carrillo *et al*., 1998; Martín and Carrillo, LIFE Project 2000). 4) True's beaked whale *Mesoplodon mirus:* there is only 1 stranding in Lanzarote (Vonk and Martin, 1988; Martin and Carrillo, 1992) and no sightings of the species have been recorded. 5) Bottlenose beaked whale *Hyperoodon ampullatus*: there is only 1 stranding recorded in Fuerteventura in 1988 (Martín, V. *pers com*). A confirmed sighting in February 2002 in the south east of Gran Canaria.

This paper, developed as part of the project "Studies applied to the conservation of cetacean in the Canary Islands, funded by the Canarian government, analyses and provides geographical and biological data of two stranding events and 66 sightings of the Ziphiidae Family recorded in the Special Area of Conservation ES-7020017 off the coast of the sw of Tenerife between 1995 and 2002.

Study area The total study area is approximately 180 km^2. The sea bottom is characterised by a smooth and continuous slope reaching a 200 m in depth. Then, it falls abruptly as far down as 500 m deep. Most of the shelf departs from Los Gigantes cliffs, extending between 200 m and 2.5 miles offshore. On the other hand, and as it is expected in volcanic origin islands, there are large depths between neighbouring islands. The maximum depth between Tenerife and La Gomera, located 14 miles to the SW, goes beyond 1500 m. Oceanographically, the study area is subject to the called "Island Mass Effect" (Hernández-León, 1986). According to this effect, the island acts a wall against the relatively cold descending Current of the Canaries. Therefore the waters of the study area do mix very little with adjacent water masses, being warmer and thermically more stable. On the other hand, the constricted mixture zones are characterised by "cyclonic" and "anticiclonic" swirls that cause micro-upwelling events and an increase in local biological productivity, which are the causes of the thermic gradient of almost 1 degree centigrade that has been detected between the limits of the study area (Fig. 1).

MATERIALS AND METHODS The sightings recorded were opportunistic ones obtained during the field seasons carried out in the SW of Tenerife which targeted the resident populations of bottlenose dolphins (*Tursiops truncatus*) and tropical pilot whales (*Globicephala macrorhynchus*), as well as from the whalewatching boats working in the area. The use of several sighting platforms, the non homogeneous search in the area and the absence of a constant effort, make impossible the obtaining of abundance and density indexes of the species in the area. To a large extent, the best-searched area is the northern limit, from Playa de San Juan to the cliffs of Los Gigantes. The sea depths in the sighting points taken from commercial boats were obtained by extrapolating from the nautical charts of the Spanish army hydrographic Institute and the sightings from the R/S Monachus were obtained with sonar Furuno of 2000 m.

In order to identify the age class in Cuvier´s beaked whale, coloration patterns of the animals were used (Martín, 1999). In the sightings of this species we recorded as inmate animals those that showed a well defined eye patch and grey colour in the lateral and dorsal area, animals close to puberty those that showed a grey colour on the head and dorsal area and low level of contrast with the white colour of the throat and ventral region and adult animals those that presented a well defined white colour on the head. The gender was only registered in the case of adult males (teeth visible) and adult females if the animal was together with a calf. In Blainville's beaked whale we used the peculiar morphology of the head, the marks and scars on the skin and the size of the animal to separate: adult males, in which the mandible arch and the lowering of the skull are very acute generally visible teeth and many marks in the dorsal area. In older animals the teeth may not be visible due to erosion and seasonally can be covered with barnacles. This last factor leads to a peculiar external appearance of these males. Subadult males are those that don't have visible teeth, although they have a prominence in the mandible arch, skull lowering and some marks of teeth on the dorsal area; adult females, in which the cetacean is together with a small animal (calf) or those of large sizes that do not show males characteristics (Carrillo *et al*., 1998). The group composition data of the sightings was recorded following the protocol recommended by the beaked whale-working group of the European Cetacean Society.

RESULTS The 66 sightings recorded have made possible the identification of 3 species: 58 cases of Blainville´s beaked whale (88%), 4 records Cuvier´s beaked whale (5,9%), and 1 case of Gervais´ beaked whale (1,4%). In tree sightings was impossible to determine the specie (4,4%). The two stranding recorded were a Cuvier´s beaked whale, 1 female in advance state of decomposition and 1 male of 525 cm with signs of interaction with maritime traffic. The position of the sightings is shown in Fig. 2.

Cuvier´s beaked whale The 4 sightings were recorded in August/95, May/96, August/99 and October/99. The average depth was 384,7 m with a minimum of 150 m and a maximum of 700 m. (SD=265,738) (Table 1). 2 of the sightings were composed of only 1 animal, probably young male. 1 of the sightings was composed of 2 unknown animals and other group consisted of 4 individuals including 1 adult male. In all sightings there was an avoidance reaction of this specie in the presence of the boat. The stranding of 2 individuals of Cuvier´s beaked whale have been recorded: 1 individual in 1999 of sex and size unknown and advanced decomposition state, and 1 male of 525cm. in June 2002 with signs of interaction with marine traffic.

Gervais´ beaked whale One single recorded in January de 1999 at a depth of 1750 m. A group of 3 indeterminate animals that came to the prow of the boat. The excellent photographic material obtained from this sighting made possible the confirmation of the identification of the species. This is one of the few sightings of this species in the Atlantic Ocean (Carrillo and Martin, 1999).

Blainville´s beaked whale With 57 sightings (88%), this is the beaked species most frequently sighted in the SW of Tenerife. With the exception of the month of December, it has been present in the area all the years (Fig. 3) and months of the study. October, with 31% of the recordings is the month with most sightings (Fig. 4). The depth ranged from 75 m and 1630 m with an average of 462,15 m. (Table. 2). The distribution by depth ranks is shown in Fig. 5.

34% of the sightings were recorded as unknown groups. The average number of animals in the group (Table. III) was 4,59 animals with a maximum of 10 (SD=2,043). The distribution by size ranks (Fig.6) shows that the most frequent groups are composed of between 2 and 6 individuals (71%). Within the groups, 74% of the individuals were classified as unknown age and sex. There were adult males in 27 groups (47%, n=58), with a maximum of 2 per group. There were groups including both 1 adult male and 1 subadult male in 4 sightings. Adult females were recorded 19 times (33%, n=58) with a maximum of 2 per group. 10 groups were included calves/juveniles with the highest frequency in October with 5 recordings (Fig. 7).

Indeter. beaked whale 3 records:
- 1 in September 1996 at a depth of 120m. Group of 6-8 animals of similar morphology to Blainville´s beaked whale.
- 1 in September 1997 at a depth of 500 m. Group of 2 animals.
- 1 in October 1999 at a depth of 950 m. Group of 2 animals.

DISCUSSION There are recordings of sightings of Blainville´s beaked whale every year, although the yearly frequency sighting is very variable. During August, September and October, the months with the warmest temperatures, there is an increase in the frequency of sightings, and this could be related to a flux of animals coming from more tropical waters. The higher frequency of calves/juveniles in October, the presence of new-borns in August and November and the foetus in a late development stage studied in April 1998 in the nearby island of La Palma, make us believe that the summer months are the breeding season. Nevertheless, the information available is not enough to establish the degree of residence or seasonally of presence in the area of these species. The depth distribution shows an average of 462m., which seems to be too small if we take into account the oceanic characteristics described for the species. Nevertheless, this average depth is similar to that recorded in Bahamas (MacLeod, C. *com. per*). The high frequency of unknown individuals in the recorded group composition (74%) could be due to the short duration of the sightings. Most of the groups were composed of 1 adult male (475), 1-2 adult females (33%), 1 calf/juvenile (21%) and 2 to 3 unknown animals.

The reduction in the number of sightings in the last 3 years might be due to a certain seasonal factor affecting the presence of the species and the influence of unknown oceanographic factors. The high percentage of sightings and its wide temporal distribution shows the importance of the SW area of Tenerife for research and conservation of this species in the Atlantic.

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Table 1. Statistical analysis for the depth of the cuvier´s beaked whale sightings

	Valid	Mean	Confid.-95,0%	Confid.+95,0%	Median	Min.	Max.	Low. Quart.	Upp. Quart.	Quart. Range	Std.Dev.
DEPTH	4	384,75	-38,1	807,6	344,5	150	700	165	604,5	439,5	265,738

Table 2. Statistical analysis for the depth of the blainville´s beaked whale sightings

	Valid N	Media	Confid. -95,00%	Confid. +95,00%	Median	Minim	Maxim	Lower Quartile	Upper Quartile	Std. Dev.
DEPTH	58	462.15	365.52	558.78	426.50	75	1630	130	650	367.51

Table 3. Statistical analysis for the group size of the Blainville´s beaked whale sightings

	Valid N	Mean	Confid -95,0%	Confid +95,0%	Median	Minim	Maxim	Low. Quart.	Upp. Quart.	Quart. Range	Std.Dev.
GROUP SIZE	58	4,59	4,05	5,12	4	1	10	3	6	3	2,0437

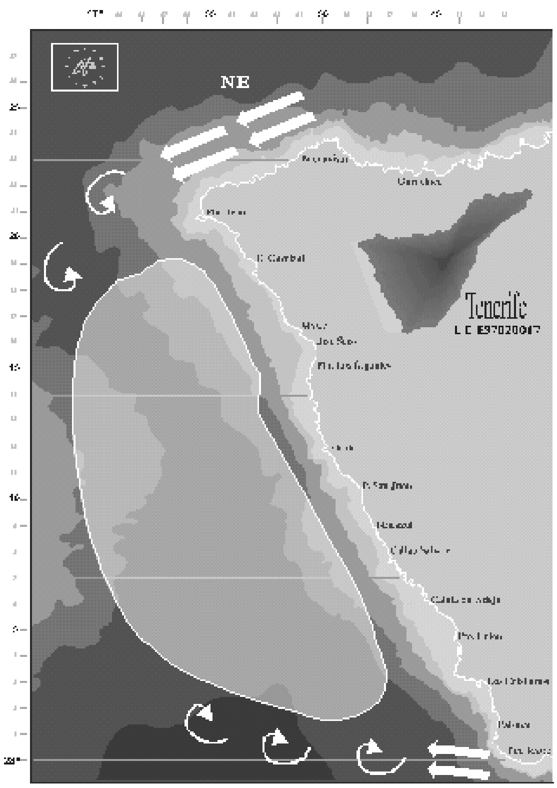

Fig. 1. Special Area for Conservation ES-7020017 of the coast of the sw of Tenerife

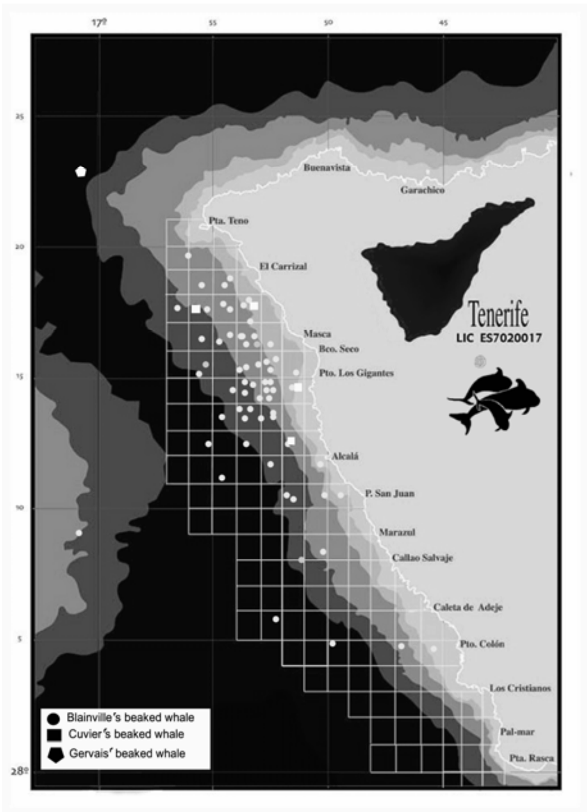

Fig. 2. Location of the sightings

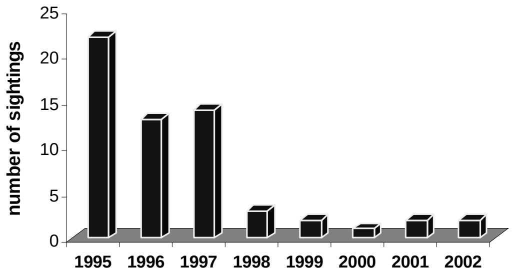

Fig. 3. Annual frequency of blainville´s beaked whale sightings

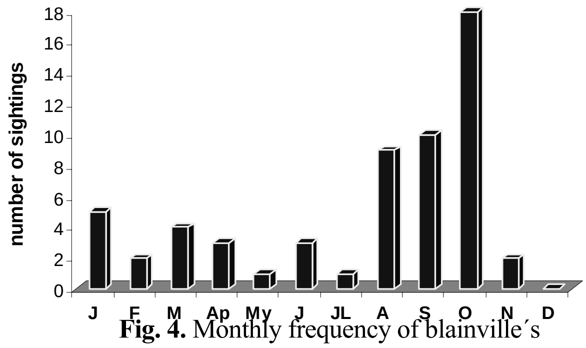

Fig. 4. Monthly frequency of blainville´s beaked whale sightings

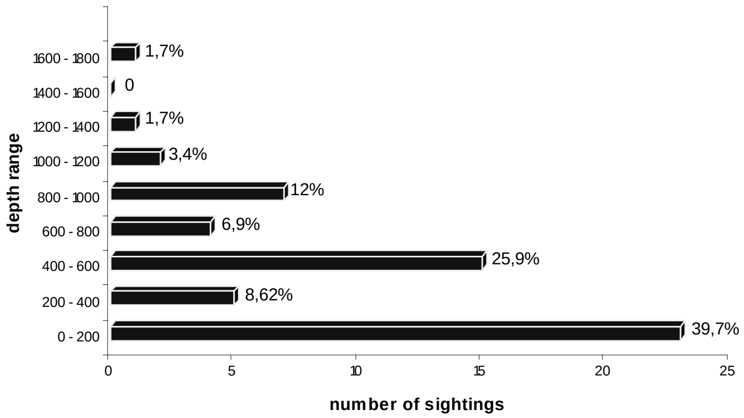

Fig. 5. Distribution by depth ranks and frequency of Blainville´s beaked whale sightings

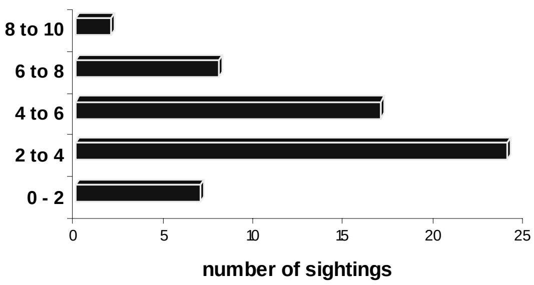

Fig. 6. Distribution by size ranks of Blainville´s beaked whale sightings

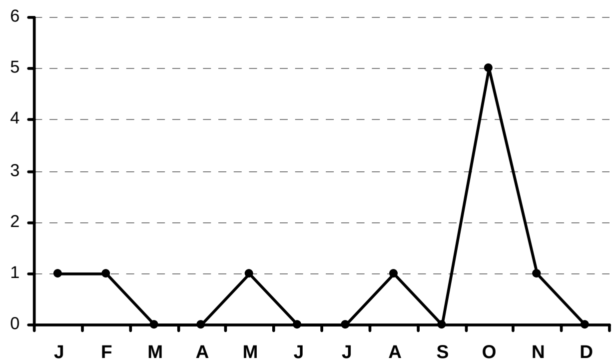

Fig. 7. Monthly frequency of the presence of calves in the groups of Blainville´s beaked whale

FIVE WEEKS OF SURVEY IN THE WESTERN LIGURIAN SEA. SUMMER 2002

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During summer 2002, five weeks of surveys has been conducted in the area between S. Remo and Cannes; the borders of the research area are included in the Ligurian sea Cetacean Sanctuary. The platform was a 12 m sloop with an 80 HP diesel engine. Routes were tracked in order to cross the 1500 m bathymetric line; ports of starting and arriving were fixed by a schedule. Every week the boat repeated the same transect. The boat has sailed 6 days a week and observations were done only under sea state less than, or equal to, Beaufort 4. Every day no less than 9 hours were spent at sea for a total amount of about 270 hours of observations over 28 days of navigation. Transects have been followed until a group was sighted; in case of sighting the group was followed as much as possible to assess species composition, group size, presence of calves and juveniles. Initial and final positions of sightings were recorded by a GPS. After leaving the group, the route of transect was resumed. About 600 miles have been covered with 13 sightings and three species met. *S. coeruleoalba* was found 11 times, with a mean group size of 21.27, *G. griseus* twice, with a mean group size of 8 and *D. delphis* twice, associated with *S. coeruleoalba*, with a mean group size of 2.5. Calves and youngs of *S. coeruleoalba* were sighted 7 times with a mean number of 4.1 per group. 6 hours and 26 minutes were spent with cetaceans with an average of 30’ 41” per sighting. As it can be seen from results, the most common species observed was *S. coeruleoalba* and a point of interest is the association between *S. coeruleoalba* and *D. delphis* occurred in every occasions.

DUAL USE TECHNOLOGY ON CETACEAN RESEARCH IN THE MEDITERRANEAN SEA: WIDE AREA AERIAL SURVEYS WITH AUDIO RECORDINGS FROM AIR-LAUNCHED SONOBUOYS

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Since 1999 CIBRA co-operates with SACLANT Undersea Research Center within SOLMAR project (Sound, Oceanography and Living Marine Resources), aimed at developing Acoustic Risk Mitigation Policies for NATO's Navies and testing dual use technologies.

During field research in summer 2000, the Italian Navy made available 3 sorties of a BR-1150 Atlantic aircraft, designed for anti-submarine operations. Main features of this plane are: long range/time operations, low flight level, excellent observer window (on the very nose of the plane), capability to determine the water column thermograph and so therefore underwater sound propagation, capability to drop sonobuoys and receive and record underwater sounds at different depths. This allows both acoustic and visual investigation of the area, approach that proved to be useful to maximize the results (Manghi *et al*., 1999; Martin and Mobley, 2003).

Missions were designed to cover the entire Ligurian basin – Central Mediterranean Sea - (Fig. 1) to get a snapshot picture of animals distribution in the area and to support NATO research vessel Alliance in tagging operations. 5 hours and 800 nm were spent on the research area on each flight. Survey speed was 160 knts at 1000 ft of altitude. Tracks were recorded on a GPS and on the aircraft's navigation system. Sightings and other relevant information were recorded on "checkbox-based" forms (Fig. 2). At least 5 out of the 8 species of cetaceans considered common in the area (Notarbartolo and Demma, 1994) were observed. Isolated or groups of animals were encountered 14, 20 and 15 times on the three flights respectively (Tab. 1), scoring an average of 1 sighting every 18 minutes. Even if the sample was low (3 flights), it was clear that major concentration of cetaceans occurred where other biological cues (fish shoals, sea turtles, sea gulls) were present as well.

Sonobuoys were launched to test their effectiveness for research purpose, and recordings were collected (0-20 kHz bandwidth). On the first flight, 4 sonobuoys were launched where two sperm whales (*Physeter macrocephalus*) nearby a group of dolphins (likely striped dolphins (*Stenella coeruleoalba*)) were sighted. Recordings' analysis resulted in three vocalizing sperm whales (only two sighted), vocalizing dolphins and fin whale's (*Balaenoptera physalus*) calls (not sighted). The on board radar, designed to find submarines' snorkels on sea surface, was tested as well, and proved to be effective to find even small animals.

The research has been carried out within the NATO Saclantcent's SOLMAR Project with ONR Grants N00014-99-1-0709 and N00014-02-1-0333.

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Table 1. Sightings' details

date	time	ref	lat N deg	lat N min	long E deg	long E min	species
Aug 29th 00	10.10	1	41	1	8	9	Fin whale 1
Aug 29th 00	10.12	2	41	7	8	5	Delphinidae 2
Aug 29th 00	10.24	3	41	33	8	16	Delphinidae 10
Aug 29th 00	10.28	4	41	39	8	6	Delphinidae 10
Aug 29th 00	10.33	5	41	39	7	49	Delphinidae 5
Aug 29th 00	10.50	6	42	6	8	7	Delphinidae 25
Aug 29th 00	10.53	7	42	7	7	56	Delphinidae 4
Aug 29th 00	11.52	8	43	45	9	37	Risso's dolphin 1
Aug 29th 00	12.13	9	43	7	8	40	Delphinidae 10
Aug 29th 00	12.42	11	42	31	7	27	Delphinidae 40
Aug 29th 00	13.17	12	43	20	8	28	Delphinidae 20
Aug 29th 00	13.57	13	42	41	7	15	Sperm whale 2 + Delphinidae 2
Aug 29th 00	14.30	14	43	16	7	48	Fin whale 4
Sept 1st 00	10.25	1	43	36	9	35,4	Delphinidae 5
Sept 1st 00	10.27	2	43	40,8	9	30,4	Delphinidae 05
Sept 1st 00	10.29	3	43	43,7	9	27,4	Delphinidae 1
Sept 1st 00	10.43	4	44	3,2	8	40,2	Delphinidae 20
Sept 1st 00	11.11	5	42	55	7	31	Delphinidae 15
Sept 1st 00	11.33	6	43	25	7	41	Delphinidae 10
Sept 1st 00	11.34	7	43	30,6	8	0	Delphinidae 10
Sept 1st 00	12.00	8	43	30	8	5	Delphinidae 10
Sept 1st 00	12.04	9	43	32,2	8	13	Delphinidae 35
Sept 1st 00	12.06	10	43	35	8	15	Delphinidae 20
Sept 1st 00	12.10	11	43	52,8	8	27,5	Delphinidae 2
Sept 1st 00	12.16	12	43	54,7	8	55,3	Delphinidae 30
Sept 1st 00	12.37	13	43	52,3	8	50,7	Delphinidae 4
Sept 1st 00	12.39	14	43	51	8	47,3	Delphinidae 30
Sept 1st 00	12.53	15	43	24,3	8	12,2	Delphinidae 5
Sept 1st 00	13.42	16	43	36,7	8	49	Delphinidae 3
Sept 1st 00	14.14	17	44	14,1	8	57,3	Delphinidae 5
Sept 1st 00	14.18	18	44	9,6	8	43,7	Delphinidae 50
Sept 1st 00	14.19	19	44	8,4	8	40,4	Delphinidae 30
Sept 1st 00	14.38	20	43	32,4	7	51,4	Delphinidae 4
Sept 3rd 00	10.44	1	44	2,2	8	56,6	Delphinidae 10
Sept 3rd 00	10.49	2	44	5,9	8	37,9	Delphinidae 10
Sept 3rd 00	11.15	3	43	33,4	7	40,2	Delphinidae 6
Sept 3rd 00	11.29	4	43	21,3	7	27,1	Delphinidae 7
Sept 3rd 00	11.33	5	43	12,9	7	18,4	Delphinidae 10
Sept 3rd 00	nn	6	nn	nn	nn	nn	nn
Sept 3rd 00	12.01	7	43	31,4	8	5,7	Delphinidae 5
Sept 3rd 00	12.09	8	43	20,5	8	3	Delphinidae 20
Sept 3rd 00	12.21	9	42	55,6	7	59,6	Fin whale 2
Sept 3rd 00	12.37	10	42	57,6	8	0,6	Delphinidae 30
Sept 3rd 00	12.58	11	43	25	8	17,2	Delphinidae 1
Sept 3rd 00	13.02	12	43	33,5	8	19,7	Delphinidae 5
Sept 3rd 00	13.03	13	43	37,6	8	22,2	Couvier's beaked whale 3
Sept 3rd 00	13.22	14	43	34,8	8	25,7	Delphinidae 5
Sept 3rd 00	14.35	15	43	44,3	8	17,1	Delphinidae 10
Sept 3rd 00	14.44	16	43	49,5	8	48,2	Delphinidae 35

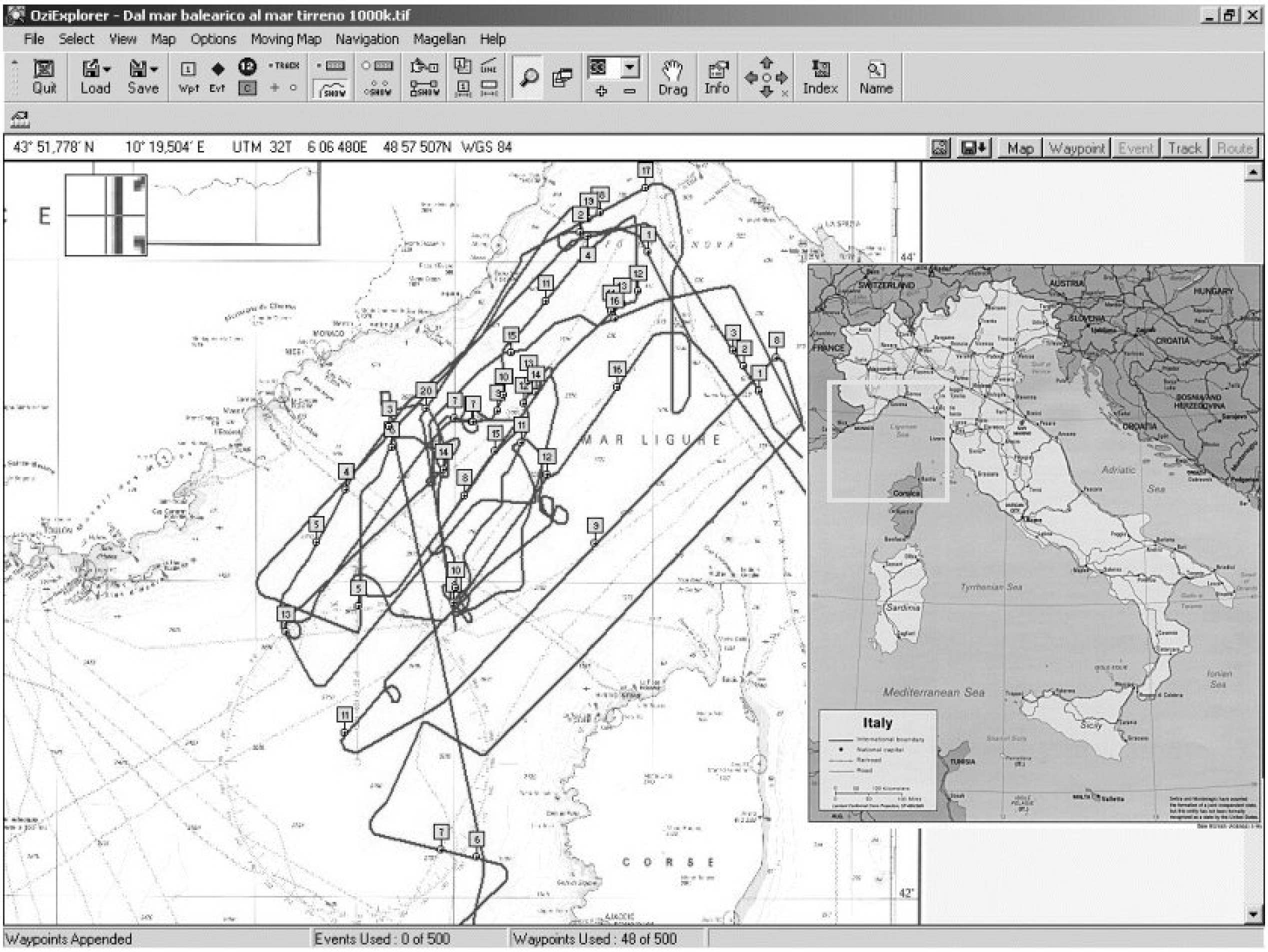
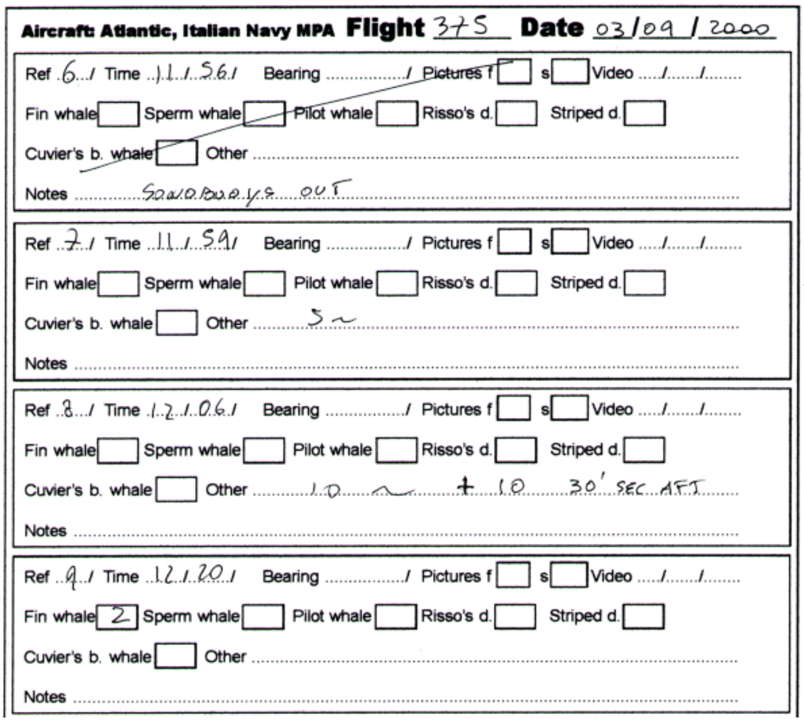


Fig. 1. Flight tracks with sightings



Aircraft: Atlantic, Italian Navy MPA **Flight** 375 **Date** 03/09/2000

Ref .6../ Time ..11../.56./ Bearing ..../ Pictures f ☐ s ☐ Video ..../......./........
Fin whale ☐ Sperm whale ☐ Pilot whale ☐ Risso's d. ☐ Striped d. ☐
Cuvier's b. whale ☐ Other ....
Notes .... Sonobuoys out ....

Ref ..7../ Time ..11../.59./ Bearing ..../ Pictures f ☐ s ☐ Video ..../......./........
Fin whale ☐ Sperm whale ☐ Pilot whale ☐ Risso's d. ☐ Striped d. ☐
Cuvier's b. whale ☐ Other .... 5 ~ ....
Notes ....

Ref ..8../ Time ..12../.06./ Bearing ..../ Pictures f ☐ s ☐ Video ..../......./........
Fin whale ☐ Sperm whale ☐ Pilot whale ☐ Risso's d. ☐ Striped d. ☐
Cuvier's b. whale ☐ Other .... 10 ~ + 10 30' sec aft ....
Notes ....

Ref ..9../ Time ..12../.20./ Bearing ..../ Pictures f ☐ s ☐ Video ..../......./........
Fin whale [2] Sperm whale ☐ Pilot whale ☐ Risso's d. ☐ Striped d. ☐
Cuvier's b. whale ☐ Other ....
Notes ....

Fig. 2. Checkbox based form to quickly mark sightings and relevant events

HABITAT CHARACTERISATION OF A HIGH DENSITY AREA OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE GERMAN NORTH SEA

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Recent aerial surveys using the line transect method in the North and Baltic Sea have revealed a non-uniform distribution of harbour porpoises. An area of especially high density is an area lying 50km west off the Northfriesian Island of Sylt („Amrum Aussengrund"). The aim of this study was to describe such a preferred habitat in a multi-disciplinary approach using additional information from biotic and abiotic factors that might affect or influence the distribution of harbour porpoises. In a research effort of 12.5h a total of 1991 km were surveyed in the months May, July, August, September and October 2002 in the described area. For each sighting information about the accurate position, pod size, number of calves, cue, declination angle, reaction of the animal to the plane and the behaviour were recorded. A GIS based software (ArcView) was used to analyse, describe and visualize the data. The distribution data and the environmental data (sea state, turbidity of the water, subjective observing conditions) were analysed using a grid with a total of 64 squares (10x10km). A total of 376 sightings (473 adult porpoises and 14 calves) were made. Additionally the area was characterised in terms of abiotic variables (salinity, temperature, bathymetry, hydrography, sediment type) and biotic variables (fish harvest, benthic communities). The analysis showed differences in the small-scale distribution over time (seasonal, from May to October) and over space. The relative densities (porpoises per km) varied between 0.50 in May, 0.10 in July, 0.22 in August, 0.22 in September and 0.05 in October. The results emphasise the need for further research using additional oceanographic parameters to understand habitat selection. This study is also especially important in view of the planned construction of windmill offshore parks in the German North Sea and their potential impact on harbour porpoises.

RELATIVE ABUNDANCE OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE BALTIC FROM ACOUSTIC AND VISUAL SURVEYS

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Harbour porpoises were once numerous in the Baltic Sea but today the population is estimated at only some hundreds of animals. To improve knowledge of the distribution of porpoises in the Baltic, aerial and boat-based porpoise surveys were conducted during 2002. This paper describes an acoustic and visual survey conducted between 8 June and 11 August 2002 from the research vessel Song of the Whale. Acoustic data were collected using an automatic high frequency click detector designed to detect and calculate bearings to porpoise vocalisations. During daylight hours, in sea states of Beaufort two or less, two observers were stationed on a platform at an eye height of 5.3 m. The survey area was divided into four blocks: the Baltic, Mecklenburger Bight, northern Kiel Bight and southern Kiel Bight. 4604 km of track were surveyed acoustically and 768 km visually. Porpoises were found to be widely distributed throughout the Kiel and Mecklenburger Bights; however, the relative abundance of porpoises was considerably lower in Baltic waters. Only three porpoises were detected in the Baltic block. Acoustic detection rates varied greatly, from 16.2 detections/100 km in the northern Kiel Bight, 9.2/100 km in the southern Kiel Bight, and 2.8/100 km in the Mecklenburger Bight to only 0.1/100 km in the Baltic. During visual surveys porpoises were only sighted in the Kiel Bight. The results are consistent with a survey of Polish coastal waters conducted in 2001 using the same equipment, which found 0.05 detections/100 km. These results support those of previous surveys, indicating that porpoises are now extremely rare in the Baltic. The current bycatch, known to be at least seven porpoises per year, is unsustainable and Baltic porpoises may become extinct in the near future unless actions are taken to prevent future anthropogenic mortalities.

ABUNDANCE AND DISTRIBUTION OF STRIPED DOLPHIN, *STENELLA COERULEOALBA*, IN SPANISH EASTERN WATERS

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Since June, 2000, we have been performing seasonal aerial surveys in the regions of Valencia and Murcia (east Spain) following the transect line methodology to determine the abundance and distribution patterns of the striped dolphin. The area surveyed was a strip coastline 17 - 56 nm wide (overall area: 28,883 km2). To date we have carried out 9 surveys, a sampling effort of 8,444 nm. A total of 105 sightings were recorded, group size ranging from 1 to 400 individuals (mean ± SD: 40 ± 52). The programme Distance 4.0 was used to estimate overall and seasonal changes in abundance. The high variability in group size affects sightability and increase estimation error and, therefore, we stratified data into three groups: 1-14, 15-50 and >50 individuals. The absolute density estimated was 0.416 individuals/km2 (95% CI: 0.322 – 0.537), and total abundance was 12,010 individuals (95% CI: 9,304 – 15,504). This estimated density is higher and more precise than that obtained by the 1991-92 ship survey in this area. We analysed patterns of distribution within the overall area using a grid of 10 x 10 minutes and comparing the relative density (number of individuals/nm) among squares. Mean relative density per square (± SD) in the whole area was 0.43 individuals/nm (± 1.12). We found a very high dolphin density area, at the north of the Ibiza channel containing the square with the highest relative density (9.2 individuals/nm) and furthermore, this square was surrounded by high-density squares. We did not find seasonal changes in either the absolute density or in the distribution of this species in the area. Further surveys and analyses will be carried out to better define these patterns.

DO ORCAS EAT BASKING SHARKS? OCCURRENCE PATTERNS OF LARGE MARINE ORGANISMS, OFF THE COAST OF SOUTHWEST BRITAIN, BETWEEN 1991 AND 2002

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INTRODUCTION We report an analysis of a sighting database of large marine animals off Southwest Britain. The database was started in 1990 as a record of reports from all sources. Records are screened by either Nick Tregenza or Ray Dennis, the database holders. This process eliminates any potential errors in species identification, sighting, or number estimates.

A number of questions were addressed in the analysis:

- Do species sightings vary between 1991 and 2002 ?
- Do species occurrences change seasonally throughout the year ?
- Are there any significant correlations between species ?

METHODS The data were analysed for the years 1991 to 2002 for all species identifications, within Cornwall, UK. In total over 50 sighting reports of the following species were examined: basking shark (*Cetorhinus maximus*), orca (*Orcinus orca*), harbour porpoise (*Phocoena phocoena*), pilot whale (*Globicephala macrorhynchus*), bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), risso's dolphin (*Grampus griseus*), ocean sunfish (*Mola mola*) and leatherback turtle (*Dermachelys coriacea*).

RESULTS The data were analysed using two separate analyses of variances (ANOVA); species with respect to year and for species in connection with month. Species were found to differ significantly between years $F_{(88,295)}=2.33$, $p<0.001$, Student Newman Keuls (SNK) pairwise contrasts indicated that bottlenose dolphins were significantly different from other species sightings up to 1997, when no significant difference was observed, however from 1998 basking sharks became predominantly different. Species were also found to differ significantly with respect to month $F_{(88,295)}=1.65$, $p<0.001$, here SNK tests indicate differences for bottlenose dolphins during Spring and Autumn, with basking sharks showing a pattern through late spring and summer, (See Fig. 2). Correlations were also calculated between average monthly sightings of each species. This demonstrated a strong correlation between the patterns of occurrence, of orcas and basking sharks (Correlation Coefficient = 0.81).

CONCLUSIONS Species sightings differ significantly in their seasonal occurrences throughout the year. There has also been a difference in sightings over the last 12 years, bottlenose dolphins appear to have decreased in numbers, whilst basking sharks have increased in numbers since 1997. When interpreting this result an important factor must be taken into consideration, observer effort. Further work is needed to assess whether the variation observed in particular species is an incident of observer effort, or an actual increase/decrease in numbers.

The results of the correlation in this study indicated a relationship between basking sharks and orcas. This is supported by an eye-witness account of orcas attacking and consuming a basking shark, 50 years ago off Porthcurno, Cornwall. Other accounts also indicate a relationship between the two species. A sighting in the Forth Estuary, Scotland, posted on the web (See Reference), indicated a basking shark and seven orcas in the same vicinity. Three other reports exist which indicate that orcas may actually be preying on the basking shark, two are from observed feeding accounts and one of stomach contents remains from, New Zealand, Southern California and the south subtropics respectively (Fertl, 1996).

Orcas are known to prey on a variety of marine vertebrates, including cetaceans, pinnipeds, sea otters, dugongs, seabirds and sharks (Jefferson *et al*., 1991, Pitman *et al*., 2001). We suggest that this correlation may reflect a previously unidentified predator/prey relationship between orcas and basking sharks.

ACKNOWLEDGEMENTS We thank P. Cotton and R. A. Coleman who provided advice on the statistical analysis

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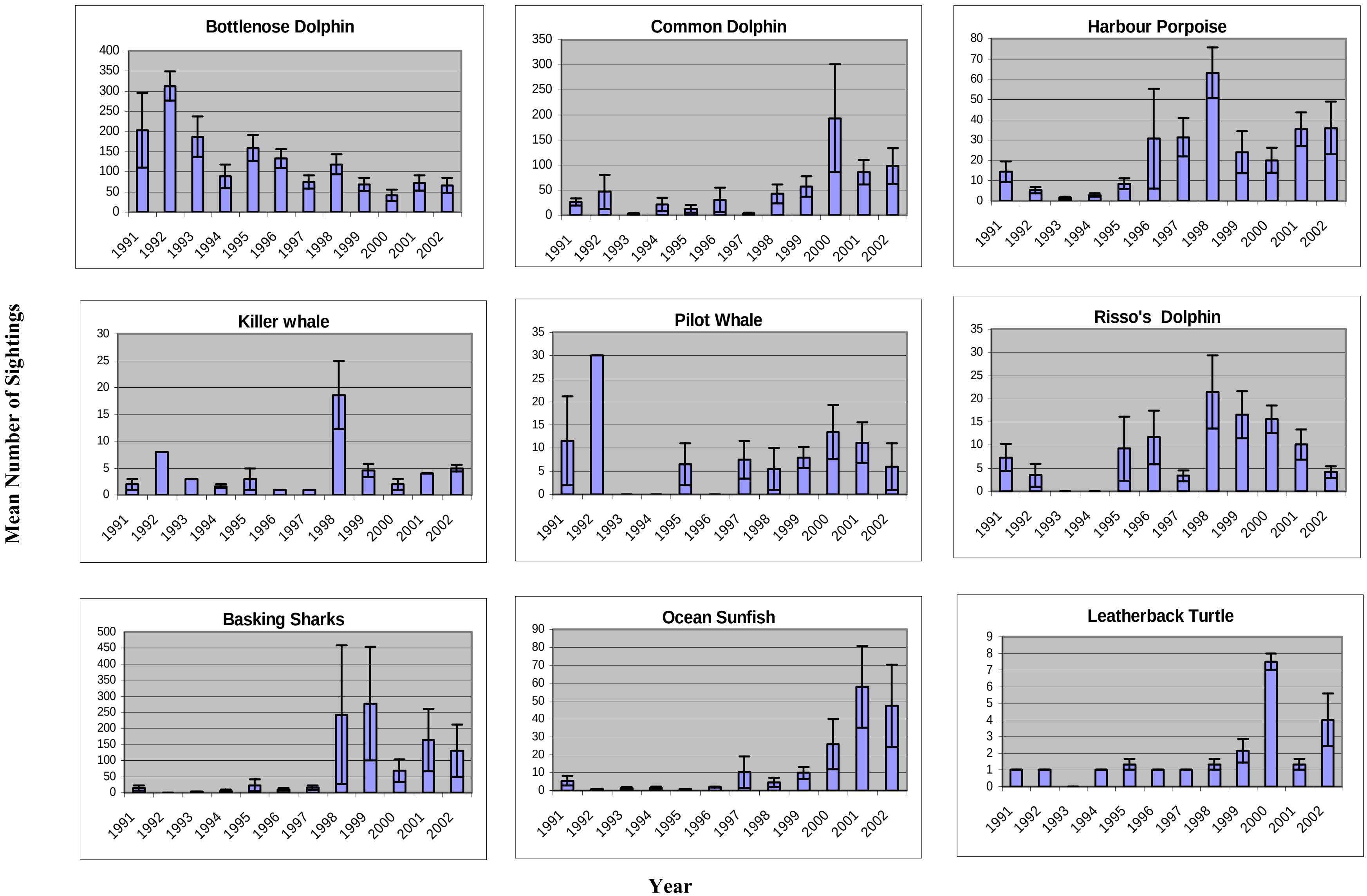

Fig. 1. Mean number of sightings between 1991 and 2002, for each species

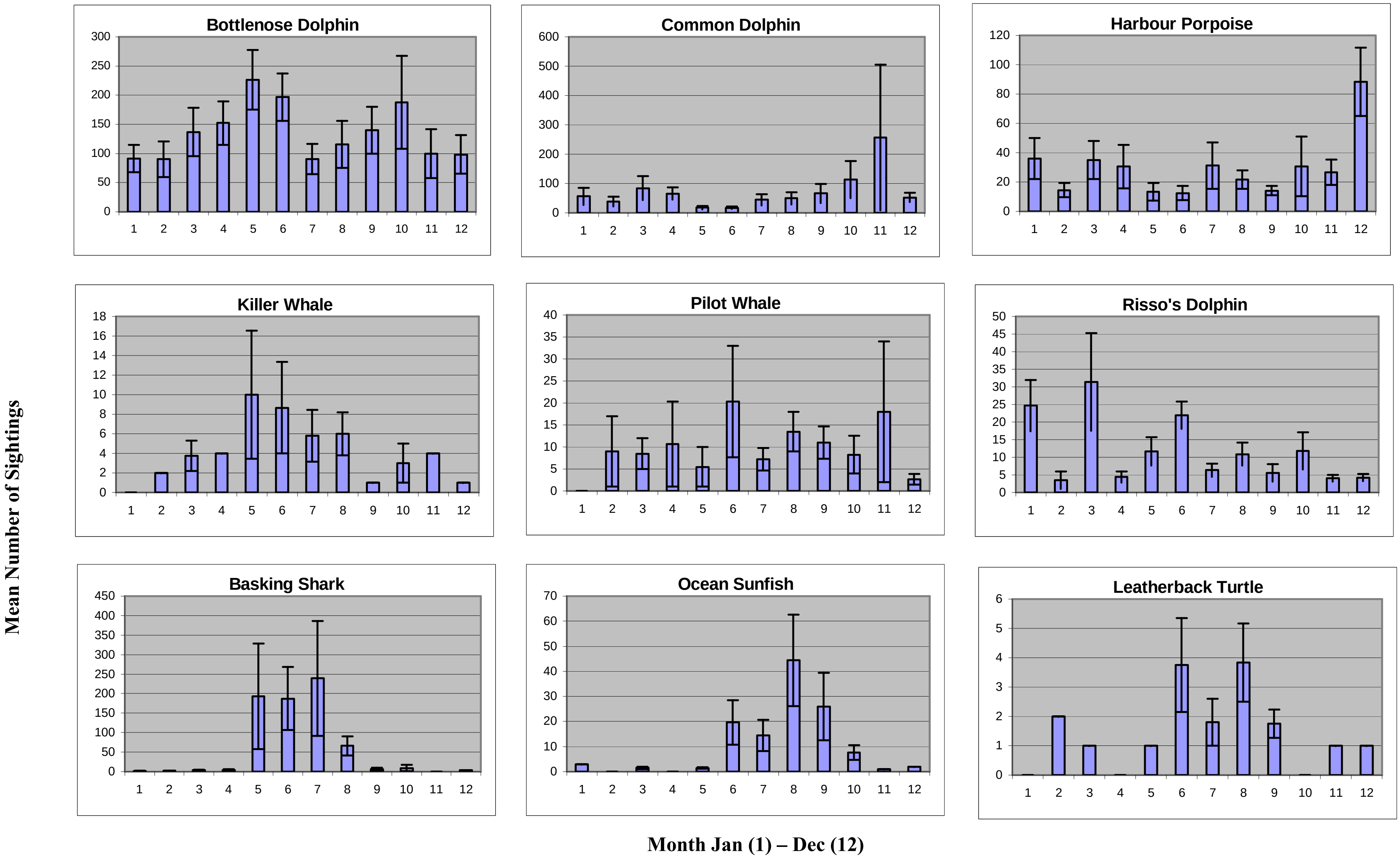

Fig. 2. Mean number of sightings for each month, for each species

SEASONAL DISTRIBUTION PATTERNS AND DENSITY OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE NORTH SEA OFFSHORE OF SYLT, GERMANY

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We carried out an Environmental Impact Assessment (EIA) study on behalf of Offshore-Bürger-Windpark-Butendiek GmbH for the construction of 80 wind turbines, each providing an output of 3 KW to be located 30 km offshore from Sylt. The principal aim of the study is to determine the spatial and temporal distribution patterns of Harbour porpoises within an area of 2.500 km^2. The number of calves present was of particular interest to us.

We used aeroplanes (line transect distance sampling method) and ships (strip transect method) as platforms. In 2001 and 2002 we carried out 22 aerial surveys on a monthly basis and 37 ship-based surveys. Nearshore (15 km from the coastline) sighting rates were lower than in offshore waters, where the species was randomly distributed. No area of consistent Harbour porpoise concentration or absence could be identified after the evaluation of all flights. School size (excluding calves) remained constant at 1.1 animals per sighting throughout the study period. In summer newborn calves increased the mean school size. The highest ratio (27%) of pairs of mother and calves occurred in July 2001. We estimated two different counting bias: 1. proportion of missed animals at the surface with the help of independent double counts and 2. proportion of deep diving animals by using literature time-at-depth logger data. By combining both counting bias, we subsequently generated a theoretical value of the detection probability g(0) near the transect line (0.3 on average). We identified 374 double sightings because of their temporal and spatial proximity, which enabled us to estimate the accuracy of different parameters (species distinction, number, age, time, distance). In each of the two years, the density of Harbour porpoises showed a pronounced annual cycle with low values of 0.5 and below in winter time and an annual spring migration into the area culminating in 4 animals per km2 on average.

DISTRIBUTION AND ABUNDANCE OF WEST GREENLAND HUMPBACK WHALES

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The West Greenland feeding aggregation of humpback whales has been subject to traditional subsistence hunting by native Greenlanders and to commercial whaling operations. Hunting was banned after 1985. During 1988-1993 (the final two years as part of project YoNAH), a photo-identification study was conducted with the aims of mapping distribution and (primarily) estimating abundance following the cessation of whaling. The survey area (~62 -66 N and out to the offshore margin of the banks) was systematically surveyed each year from early July to mid-August, resulting in 993 hours of searching effort. A total of 670 groups of humpbacks were encountered and 348 individuals were identified. Three zones of concentration were identified: off Nuuk; around ~63 30'N; and off Frederikshåb. Animals were mostly seen along the inshore edges of banks, particularly along the 200m depth contour. Analysis of area preference suggests that although individual animals feed in different zones in different years, there is a tendency for a preference for particular areas within West Greenland waters. To estimate abundance, the data were analyzed as consecutive pairs of years using a Petersen estimator modified to account for missed matches. These false negative errors are a function of photographic quality; data on this from project YoNAH were used in analysis. Results showed that false negative error correction eliminated this source of bias, allowing the inclusion of all photographs, thus increasing sample size and precision. The estimates for each pair of years were highly consistent (348-376) with one outlier (566 in 1990-91). This outlier had poor precision and may be positively biased because of the low number of recaptures. There was no evidence of a trend; average abundance for the period was estimated at 360 animals with a coefficient of variation of 7%. These results will be essential input to the IWC's developing Aboriginal Whaling Management Procedure.

HOW SEASONS INFLUENCE STRIPED DOLPHIN AND FIN WHALE DISTRIBUTION IN THE NORTH WESTERN MEDITERRANEAN SEA MARINE MAMMAL SANCTUARY?

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INTRODUCTION The Ligurian Sea, located in the north western Mediterranean Sea, is well known to be an attractive area in summer for a large number of cetaceans, particularly the fin whale. Hydrodynamic features and seasonal variations have been studied for a long time, field studies and satellite imagery underline a frontal area between 10 and 50 km from the mainland coast (Sournia *et al.*, 1990) and along the coast of Corsica (Goffart *et al.,* 1994). Eight species of cetacean are considered to be common in this area (Gannier, 1998) and several studies have contributed to describe distribution and abundance of cetacean in summer. Nevertheless, winter season still requires more investigations to understand residency patterns year-round. A monthly survey was conducted since February 2001 to estimate abundance and distribution of the cetacean populations during the four seasons in the Marine Mammal Sanctuary of the Mediterranean Sea.

MATERIAL AND METHODS Monthly surveys were invariably conducted along two parallel transect lines with a 12 meter motorboat. Transects were covered during a two-day round trip in good meteorological conditions (*i.e.* wind less or equal to 3 Beaufort). Three experienced observers were searching three frontal sectors, each with naked eyes (4 m above the water's surface). Observers were rotated every hour (one off-duty position being available). Two 7x50 reticulated binoculars were used for measuring sighting bearing and radial distance. During the first day, transect A (160km) was conducted between Cap d'Antibes and Calvi (Corsica) at a constant average speed of 10 knots. The second day, a 74 km anti-parallel transect called "B" (located 11 km apart from the central part of transect A) was cruised at 7 knots.

For all on effort sightings, distance from shore was measured with Oedipe software and nine classes of 10 n. miles were used between "Cap d'Antibes" and "Cap de la Revellata". Only data with sighting index 4 to 6 on transect A were used to calculated relative abundance indices. Results were computed with *Distance 4* software using samples of 10 n. m for striped dolphin (*Stenella coeruleoalba*) and 20 n. m for fin whale (*Balaenoptera physalus*). Two year data set was divided into 6 two-month periods. The large number of striped dolphin sightings allowed us to stratify the data into two sighting condition strata corresponding to sighting index 4 and index 5-6. Detection histograms were constructed for both strata and *esw* values (effective strip half-width) compared. For each period, a corrected encounter rate was produced to account for lower effective strip obtained with sighting index of 4 $(n/L)_4$. Relative abundance indices (individuals / km) were then calculated for the 6 periods using the mean cluster size obtained with sighting index 5-6.

$$Relative \cdot abundance_{cor} = \left(\frac{n}{L}\right)_{cor} \cdot E(s)_{5-6} = \frac{\left(\frac{n}{L}\right)_4 \cdot \frac{esw_{5-6}}{esw_4} \cdot L_4 + \left(\frac{n}{L}\right)_{5-6} \cdot L_{5-6}}{L_4 + L_{5-6}} \cdot E(s)_{5-6}$$

The sighting index correction was not applied to fin whale data due to an insufficient number of sightings. To compare high (10 knots) and low speed (7 knots), encounter rates were also calculated for the 74 km central portion of transect A, to match transect B (data truncation was the same as before). Results were only compared when both transects (A central and B) were available for a given survey.

RESULTS In 20 surveys a total effort of 3882 km was achieved in good to excellent conditions (sighting index of 4 to 6) including 25% of effort obtained at low speed. A total of 179 striped dolphin sightings and 88 fin whale sightings were obtained "on effort".

The seasonal variation of striped dolphin distribution did not show any clear pattern (Fig. 1). However, we noticed a preference for central area in winter due to some large pods, and for both frontal areas in spring. The average distance off sightings to shore was 43 km (Sd= 21.5), with a maximum seasonal variation of 5 km which was not significant. Significant different effective half-width (*esw*) values were obtained according to the sighting index (T= 5.24 ; p= 0.000): 294 m (Sd= 94.1) with index 4 (n=25) and 378 m (Sd= 71.3) with index 5-6 (n=84). Then, samples observed with sighting index of 4 were corrected by a factor 1.28. For striped dolphin relative abundance, a minimum value of 0.247 ind/km (Sd= 0.15) was obtained in March-April (Fig. 2) just before the peak of May-June

(0.792 ind/km). Mean relative abundance index of 0.646 ind./km (Sd= 0.14) from May to October was significantly superior to November to April period with a mean index of 0.367 ind./km (T= 2.51; p= 0.043).

Fin whale distribution showed clear patterns (Fig. 3). In autumn, animals were in the central area with 78% of individuals between 55 and 93 km from the continental coast. In winter, fin whales were located at more than 40 km off-shore. The spring period is characterised by a bi-modal distribution in frontal area. In summer, which represents 68% of the sightings, animals were spread in the north of the central area (37 to 111 km from continental coast). Data were truncated at 1400 m (*esw*= 961m; Sd= 259). Fin whale relative abundance index increased from 0.55 $x10^{-2}$ ind./km (Sd=0.4 $x10^{-2}$) in January-February to a maximum of 6.0 $x10^{-2}$ ind./km (Sd= 4.6 $x10^{-2}$) in July-August and decreased quickly to a null value in November-December (Fig. 4).

For striped dolphin, encounter rates were generally superior at lower speed than at 10 knots and difference was statistically significant (T= -4.29; p= 0.0001). The mean increase between high and low speed (as percentage of transect A result) was 39%. Results obtained for fin whales were not so clear. Encounter rates obtained at 7 knots were not significantly higher than those obtained at 10 knots (T= 0.74; p= 0.24).

DISCUSSION **Striped dolphin** relative abundance index show an irregular pattern. The significant decrease between November and April indicates a migratory trend, and the minimum value of 0.367 ind./km represents the fraction of the population that does not leave the area during the cold season. The May-June value of 0.79 ind/km (Sd= 0.22) is equal to the value obtained by Gannier (1998) in summer period in the Ligurian Sea. Nevertheless we obtained larger values in winter and spring than Gannier (1998), probably due to this author heterogeneity of sampling at these periods.

Fin whale relative abundance index seems close to zero between November and February, but in December one fin whale was observed on transect B. Average index for October to April is 1.1 $x10^{-2}$ ind/ km, in agreement with 1.4 $x10^{-2}$ ind/ km obtained between end of October and April by Gannier and Gannier (1993). Both species show a preference for frontal area during spring, which correspond to the bloom period in this area.

Speed effect is clear on striped dolphin sightings rate and not on fin whales, due to an easier fin whale detection (size and surfacing occurrence) than for dolphins. The possibility of a density gradient in the whale distribution might also be considered.

CONCLUSION Results obtained after two years show some general migratory trend for the two main species. In winter a few proportion of striped dolphin population remain in the North Western Mediterranean Sanctuary when most of fin whale population leaves the area. An additional year of survey will increase the number of data available and allow more analyses and a best understanding. This knowledge is necessary for an appropriate management of the Sanctuary area.

ACKNOWLEDGEMENTS We thank Marineland (Antibes), the Ministère de l'environnement and the Conseil Régional de Provence-Côte d'Azur for having funded this study, the GREC for the logistic help and observers.

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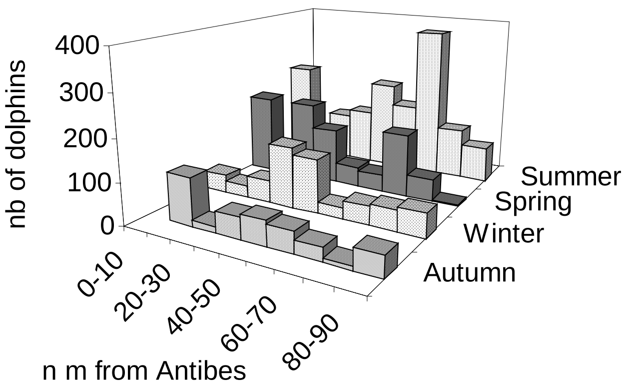

Fig. 1. Distribution of striped dolphins between Continent and Corsica

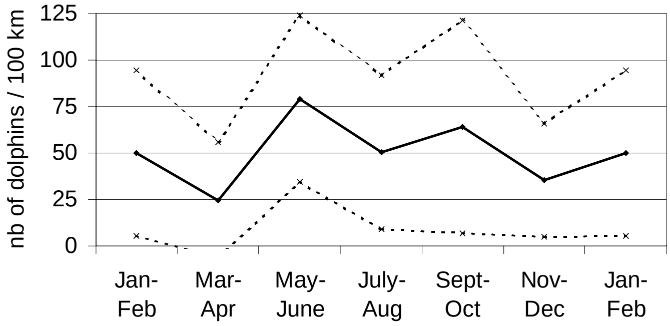

Fig. 2. Variation of striped dolphin relative abundance (individuals / 100km) and [+/- (2 x Standard deviation)]

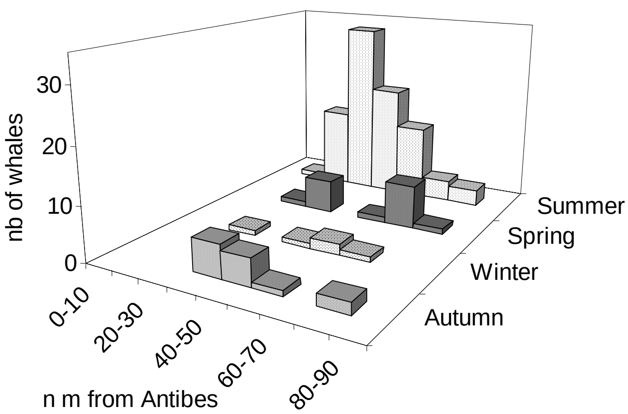

Fig. 3. Distribution of fin whales between Continent and Corsica

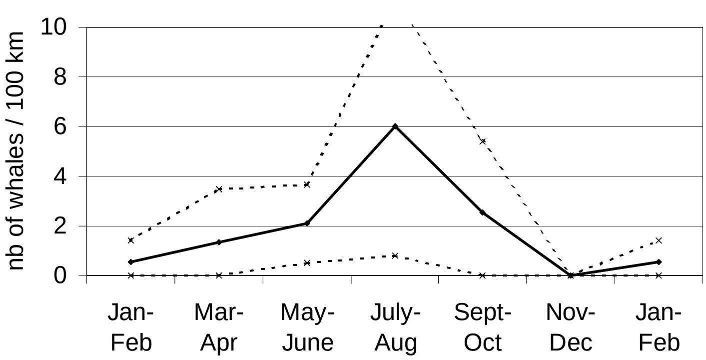

Fig. 4. Variation of fin whale relative abundance (individuals / 100km) and [+/- (2 x Standard deviation)]

OPPORTUNISTIC SIGHTINGS OF MEDITERRANEAN MONK SEALS IN THE EASTERN IONIAN SEA (1993-2002)

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INTRODUCTION The population abundance of the "critically endangered" Mediterranean monk seal (*Monachus monachus*), one of the most threatened of all marine mammals, is currently estimated at around 300-500 individuals partitioned between the Atlantic and the Mediterranean basins (Brasseurs *et al*., 1997). Its home range, once extending throughout the Mediterranean basin, has shrunk and fragmented in the last decades and today its distribution is mostly limited to the Greek and Turkish seas and portions of the north African coast (Panou *et al*., 1993). Considering only Greek waters, approximately 200-250 individuals may survive in the Ionian and Aegean Seas (Reijnders *et al*., 1993), distributed mainly in the Cyclades, in the Dodecanese, in the northern Sporades and in the Ionian islands (Aguilar, 1999).

MATERIALS AND METHODS Since 1993, the Tethys Research Institute has been conducting a long-term study on cetaceans inhabiting the Ionian Sea inshore waters around the island of Kalamos, within an area of about 500 km^2 (Fig. 1).

During *ad libitum* dolphin surveys conducted in the summers 1993-2002, monk seal sightings were opportunistically recorded. Sighting conditions were considered “favourable” when the sea state was less than 3 Beaufort (wind speed <5.4 m/sec) and at least one observer was scanning the sea surface.

Monk seal photos were examined to check for possible resightings, based on fur pigmentation pattern and presence of scars and marks (Forcada and Aguilar, 2000). We considered as “adults” all individuals longer than 2.0 m, and as “juveniles” individuals of less than 2.0 m.

RESULTS Over a total of 23,428 km of navigation under “favourable" conditions, 6 monk seal sightings were made. One more seal was spotted in 1995 while travelling in unfavourable conditions (Fig. 2).

Individual monk seals were sighted once in 1994, 1995, 1998, 2000, and three times in 2002. These encounters featured 5 adults and 1 juvenile that was sighted twice in 2002.During the sightings, lasting between 2-84 min, date, time, initial and final position and age categories were recorded (Table 1).

DISCUSSION As the Mediterranean monk seal is threatened with extinction, information on each individual is of great importance (Anonymous, 1999). Although the research cruises were not specifically designed for monk seal studies (e.g., caves were not monitored and specific coastal observation sessions were not conducted), this report provides information on the presence of adults and juveniles in an area where the research effort has been limited and is scarcely mentioned in available published scientific literature

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Table 1. Monk seal sightings between 1994-2002

Year	Date	Initial position	Final position	Initial time	Final time	Age category
1994	27/6	38° 32' N, 20° 51' E	38° 33' N, 20° 51' E	11:33	12:57	adult
1995	20/8	38° 36' N, 20° 47' E	38° 36' N, 20° 47' E	11:15	11:36	adult
1998	1/7	38° 34' N, 20° 53' E	38° 34' N, 20° 51' E	11:38	12:47	adult
2000	23/6	38° 33' N, 20° 51' E	38° 33' N, 20° 51' E	11:10	11:16	adult
2002	24/6	38° 38' N, 20° 58' E	38° 38' N, 20° 57' E	12:00	12:55	adult
2002	27/6	38° 38' N, 20° 58' E	38° 38' N, 20° 57' E	09:34	10:15	juvenile
2002	18/9	38° 36' N, 20° 55' E	38° 36' N, 20° 55' E	09:10	09:12	juvenile

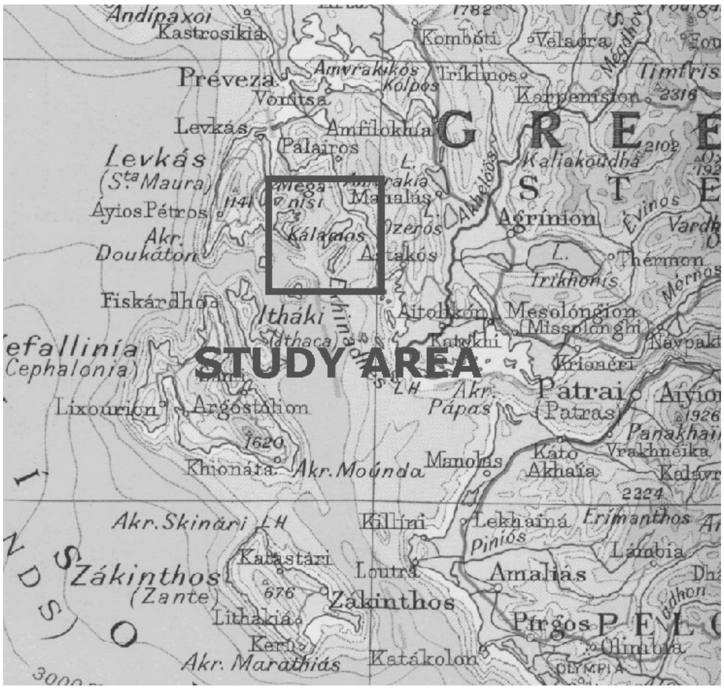

Fig. 1. The study area

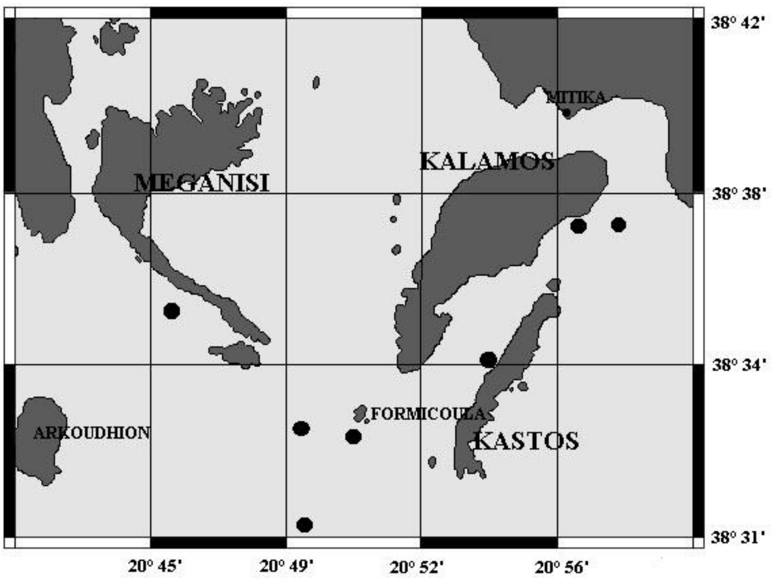

Fig. 2. Monk seal sightings in the study area in the period 1993-2002. Scale 1:250.000

PHOTO-IDENTIFICATION OF WHITE-BEAKED DOLPHINS IN ICELANDIC WATERS

M. H. Rasmussen and T. B. Jakobsen

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INTRODUCTION White-beaked dolphins (*Lagenorhynchus albirostris*) have different scars or marks on their body/dorsal fin that can be used for identification. Some individuals have different color patterns, probably from skin diseases, which also make them recognizably within a season. Photo-identification is a common technique when studying the movement of dolphins or estimating population size (e.g. Wilson *et al*., 1999).

MATERIALS AND METHODS White-beaked dolphins were studied off the coast of Keflavik (64.43° N, 22.40° W) in Faxaflói Bay (Fig. 1) during the summer months (approximately 15th of June until 15th of September) in the years 1998-2002. Most observations and photographs were taken on board a whale watching boat. Each trip was about three hours and mostly the same area was surveyed. Positions of the dolphins were noted as well as group size and the number of recognized individuals in a group. Photographs and / or drawings of left side of individuals or cuts in dorsal fin were used in the analyses. A very simple capture-recapture model (Lincoln-Petersen) was used to give an estimate of abundance. Similar methods were used for all years except for 2002, where more data were collected.

RESULTS The results are summarized in table 1.

DISCUSSION Only small percentage of white-beaked dolphins had recognizable markings (Table 1). The results show only few re-sightings of the same individual during a season, indicating that the dolphins do not seem to form a closed population in the area surveyed, which is a prerequisite for using the capture-recapture model. At any rate, 555 individuals were estimated for 2002. The total population of white-beaked dolphins have been estimated to 20444 (95 % CI 12714 -32874) (Pike *et al*., 2003). Thus, the study area, which is 1/10000 of the total area surveyed around Iceland, contains 1-4 % of the total population of white-beaked dolphins in Icelandic waters (Pike *et al*., 2003; Sigurjónsson and Vikingsson, 1995).

CONCLUSIONS The study shows the importance of Faxaflói Bay both as a feeding ground, and as a meeting and mating place for white-beaked dolphins during the summer months. Many dolphins pass through the area surveyed suggesting that the white-beaked dolphin moves frequently around, but we still don't know how large a home range they have.

ACKNOWLEDGEMENTS We thank Dolphin and Whale Spotting. KVAK, Oticon. Gisli Vikingsson at Marine Research Institute, Reykjavik, Jörundur Svarvarsson, and the Institute of Biology, University of Iceland.

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Table 1. Preliminary results of a white-beaked dolphin photo-identification project

Year	Days	Number of different individuals	Max. re-sightings of same individual	Total % seen only once (resightings)	Total % individuals with identifiable marks	% sightings in main area (see map)	Abundance estimate
1998	41	29	8	28 (72)	11.7	91	248
1999	31	52	9	69 (31)	15.8	83	329
2000	20	34	5	62 (38)	15.0	100	227
2001	25	38	7	45 (55)	17.8	82	214
2002	35	109	6	95 (5)	19.6	99	555

Fig. 1. Survey Site: Keflavik in Faxaflói Bay

QUESTIONNAIRE FEED BACK AND PRELIMINARY OBSERVATIONS OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN SLOVENIA

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INTRODUCTION Slovenian sea is part of the Northern Adriatic sea, with only 46,7 km of the coastline and the surface of 280 km^2. It is a portion of Trieste bay, with its deepest point of 33 m. On the one hand the area is burdened with two relatively big harbours - Koper in Slovenia and Trieste in Italy. On the other hand, there is a lot of tourist activity during the summer months. Inspite of these and some other facts (i.e. ecological), bottlenose dolphins (*Tursiops truncatus*) are regularly visiting Sloveian sea, present in nearly all months of the year. Being at the top of the feeding chain, bottlenose dolphins are good bioindicators for the ecological status of the sea. Nearly each year, in June or July, there is the so called "blooming of the sea" present in the area. This is the phenomenon, where a slime (a product of phytoplankton) is present in big courtains or hanks and is slowly sinking to the bottom of the sea. Within this time nearly no dolphins were sighted.

So far, there are no consistent data existing about the presence of bottlenose dolphins in Slovenian sea.

MATERIALS AND METHODS Questionnaires about the presence of the dolphins were delivered to different legal and physical persons, active at the sea: maritime police, captaincy office, staff at the Aquarium in Piran, Marine Biological Station, professional and recreational fishermen, sailors, skippers, divers etc. The collection of questionnaires was from January 2001 to December 2002.

Preliminary observations were done with fibreglass boat, powered with 25 HP outboard motor. The observations were conducted from February to December 2002.

RESULTS In collection of data from the questionnaires and observations, 320 bottlenose dolphins were sighted at different locations in the Slovenian sea (Fig. 1), including Savudrija and Umag, which are already slightly in the Croatian sea. There were single animals present, as well as groups of up to 40 individuals. In the time of 24 months these were on average 5,9 dolphins seen per one feed back information or 13,3 dolphins per month. The frequency of sightings at different locations are seen on the Fig. 2. There were 23 exits made with the boat, from where dolphins were seen 4 times, i.e. in 17% of all exits. 44,81 hours were spent on the sea and dolphins were observed for 1,99 hours, which is 4,4% of all the observation time. The highest number of dolphins seen was in June 2001 (106 animals) and March 2002 (62 animals), with another peak in July 2002 (25 animals).

CONCLUSIONS Bottlenose dolphins are regular visitors to the Slovenian sea in the most time of the year. They might be good bioindicator for the ecological state of the sea. Dolphins were not seen when "blooming of the sea" was present in the summer. Since these are questionnaires' data, it's not sure whether there were always the same individuals seen (observed), as well as it is not possible to estimate the fluctuation between the animals. Questionnaires feed back data also don't explain where the dolphins, which are transients, come from and how long are they present in the area. More exits to the sea are necessary to get better overview over the situation. ID data must be included into further studies. Comparison of ID data from other parts of the Northern Adriatic sea would be necessary to find out about the fluctuation of the dolphin individuals or groups.

ACKNOWLEDGEMENTS We would like to thank to all the people, willing to give back the feed back information on sightings of the dolphins, especially to the maritime police and Navigator sailing school, who have been most active. Slovenian Museum of the Natural History kindly helped us to collect questionnaires in the first year of the preliminary observation.

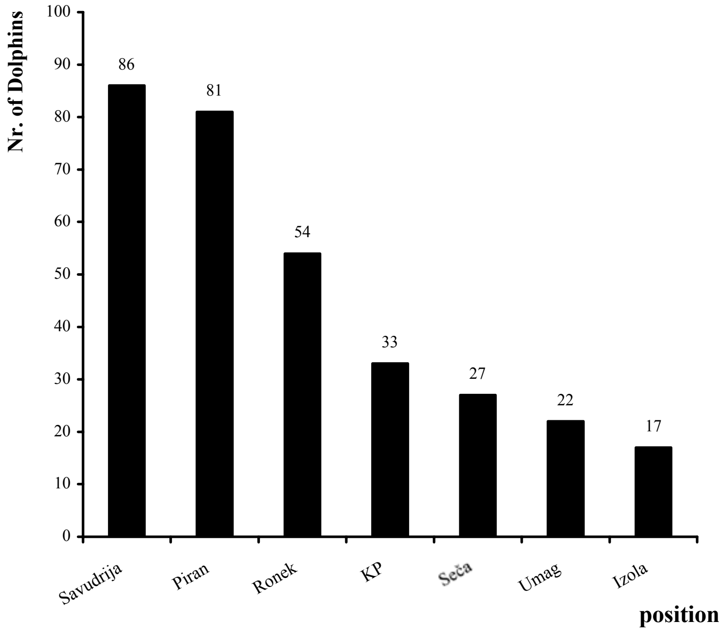

Fig. 1. Number of dolphins seen on different locations in the Slovenian sea and adjacent waters

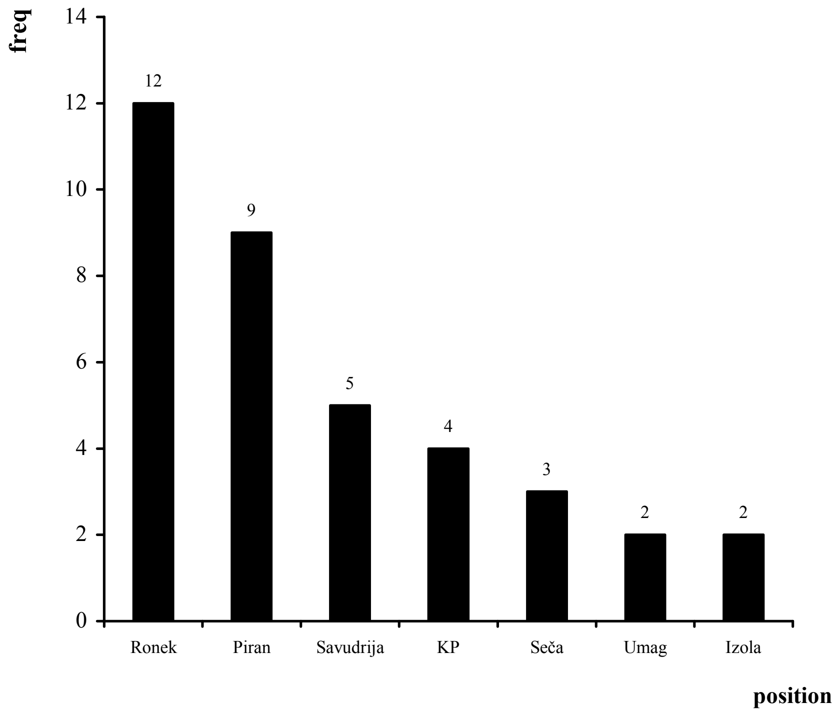

Fig. 2. The frequency of sightings of the dolphins on different locations in the Slovenian Sea and adjacent waters

MONITORING THE PRESENCE AND OCCURRENCE OF THE SHORT-BEAKED COMMON DOLPHIN (*DELPHINUS DELPHIS*) IN THE HAURAKI GULF, NEW ZEALAND

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INTRODUCTION Despite its widespread status, little is actually known about the ecology of the short beaked common dolphin, *delphinus delphis*. This is partially due to the pelagic nature of common dolphins, which often make them inaccessible and generally difficult subjects to study for ecological field research. As part of an ongoing three year study, data relating to the presence and occurrence of short beaked common dolphins in the hauraki gulf, auckland was collected.

The Hauraki Gulf, Auckland is a shallow, semi-enclosed body of water extending from Bream Head to Cape Colville, Coromandel Peninsula on the east coast of the North Island of New Zealand (approximate latitude 36 10^o S to 36 60^o S). The Hauraki Gulf was designated a Marine Park in February 2000 and has considerable diversity of cetaceans in its waters (Baker, 1983).

This paper presents the first systematic study of common dolphin ecology in the waters of the Hauraki Gulf, New Zealand.

MATERIALS AND METHODS Data was collected during the southern hemisphere seasons of autumn, winter, and spring between and including february and october 2002. Vessel based surveys were conducted aboard two platforms, a 5.5m 90hp 4 stroke rib, *aihe* and a 20m motor-powered commercial whale watch vessel, *dolphin explorer*. Dedicated vessel-based surveys (n=90) were conducted throughout the 1500 nm^2 of the hauraki gulf, resulting in 23,400 min (390hs) of dedicated survey effort in sea states of beaufort 3 or less.

A continuous scanning methodology (Altmann, 1974) was utilised throughout each survey, both using binoculars and the naked eye. A minimum of two trained observed participated in each survey. Throughout each survey GPS locations and environmental data where recorded. Upon an encounter, additional sightings data were recorded. Focal group follows were conducted (Mann, 1999) and data relating to group size, group composition and behaviour were recorded.

Photo-identification was additionally used where possible to identify animals within the study area (Neumann *et al*., 2002).

RESULTS A total of 141 separate encounters occurred in the hauraki gulf during the nine month field season, involving six separate species of cetacean (table 1). The common dolphin was the most frequently observed species, accounting for 80.9 % (n=114) of the total number of encounters. Other species encountered included the bryde's whale (*balaenoptera edeni*), the bottlenose dolphin (*tursiops truncatus*) and the killer whale (*orcinus orca*). A single encounter of a solitary humpback whale (*megaptera novaeangliae*) was also recorded in the gulf during the presented fieldwork.

Common dolphins were observed during each month of the study (Fig. 1) in water depths ranging from 15.6 to 51.m. However, common dolphins were primarily encountered in water depths of 36-45m (n=63). The Sea Surface Temperature (SST) for common dolphin encounters ranged between 10.5^{o}C in July to 25.6^{o}C in March. The mean SST for common dolphin encounters was 18.6^{o}C.

Group size ranged from between 2 to 200+ animals, with the highest proportion of groups encountered (44.6%) containing between just 20 and 30 animals (Fig. 2). Majority of common dolphin groups encountered (80.2%) contained less than 50 animals.

Without exception, calves were present during each month of the fieldwork (Fig. 3). Groups containing calves and/or juveniles accounted for over 60% of the total number of common groups encountered between September and November.

Common dolphins were frequently encountered in association with the Australasian gannet (*Morus serrator*). Such encounters (n=72) predominantly involved feeding/foraging animals. On occasion (n=7) common dolphins were also encountered whilst in association with other cetacean species, primarily the Bryde's whale (n=7). Again, such encounters predominantly involved animals that were engaged in either feeding or foraging behaviours.

CONCLUSIONS Short-beaked common dolphins in the hauraki gulf were predominantly encountered in water depths of 36-45m. This appears to be a relatively shallow water depth for this species, which is usually described as offshore and pelagic in distribution (perrin, 2002). Moreover, oceanic dolphins such as the common dolphin are not typically sighted in near-shore, enclosed bodies of water such as the hauraki gulf.

Early results of this study reflect a year round presence of common dolphins in the Hauraki Gulf. Furthermore, preliminary photo-identification undertaken in this region suggests some degree of residency exists for at least a proportion of the Hauraki Gulf common dolphin population.

Calves were notably present throughout the entire fieldwork period, suggesting that the Hauraki Gulf may be an important breeding and/or nursery area for this species. This may be an important conservational issue given the numerous potential sources of disturbance within this region, especially heavy commercial shipping and recreational vessel traffic.

ACKNOWLEDGEMENTS The author wishes to acknowledge the generous support of all sponsors who have made this research possible. Particular thanks are owed to mercury marine engines, gulfland marine, gulf harbour marina, hanimex nz ltd., viko nz and the one world challenge (america's cup 2003).

The author would also like to thank the commercial operator, *Dolphin Explorer* for their kind assistance with fieldwork logistics and acknowledge the continued support of Massey University, in particular Dr. Mark Orams and Dr. Padraig Duignan. Finally, the author wishes to acknowledge all volunteer research assistants who contributed to this study, in particular Julie Black, Angus Bloomfield, Peter Collins, Jacqueline Jirgala, Kate Lomas, Sara Mann, Fiona McNie, Cullen Meade, Laura Milman, Jenny Mitcham, Sofia Salvador and Nicky Wiseman.

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Table 1. Frequency of species encountered in the Hauraki Gulf (February – November 2002)

SPECIES	Number of Encounters
Delphinus delphis	114
Tursiops truncatus	10
Balaenoptera edeni	17
Orcinus orca	3
Megaptera novaeangliae	1
Unidentified Species.	2
Total	147

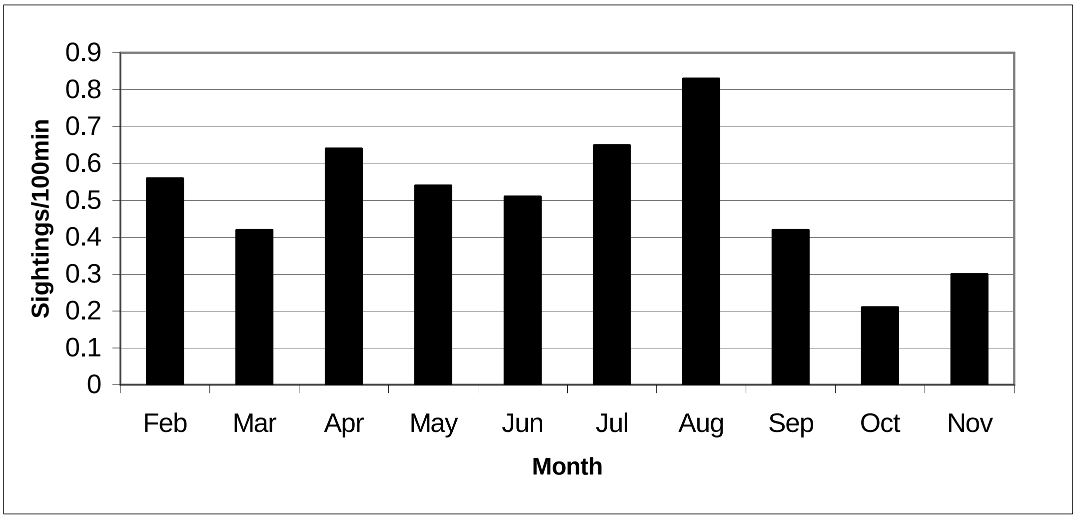

Fig. 1. Monthly distribution of common dolphin sightings per 100 min unit effort

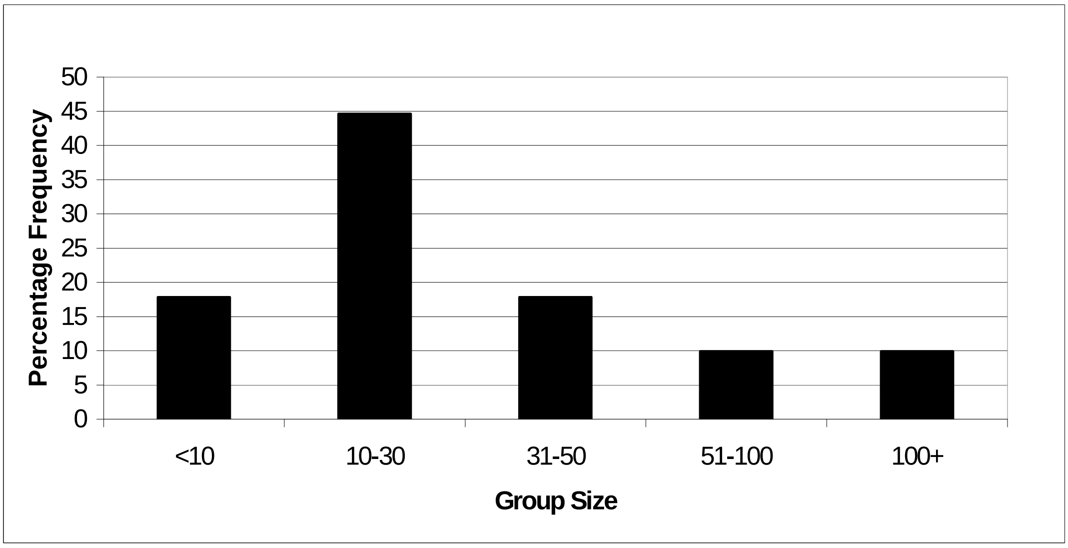

Fig. 2. Percentage frequency of common dolphin group size

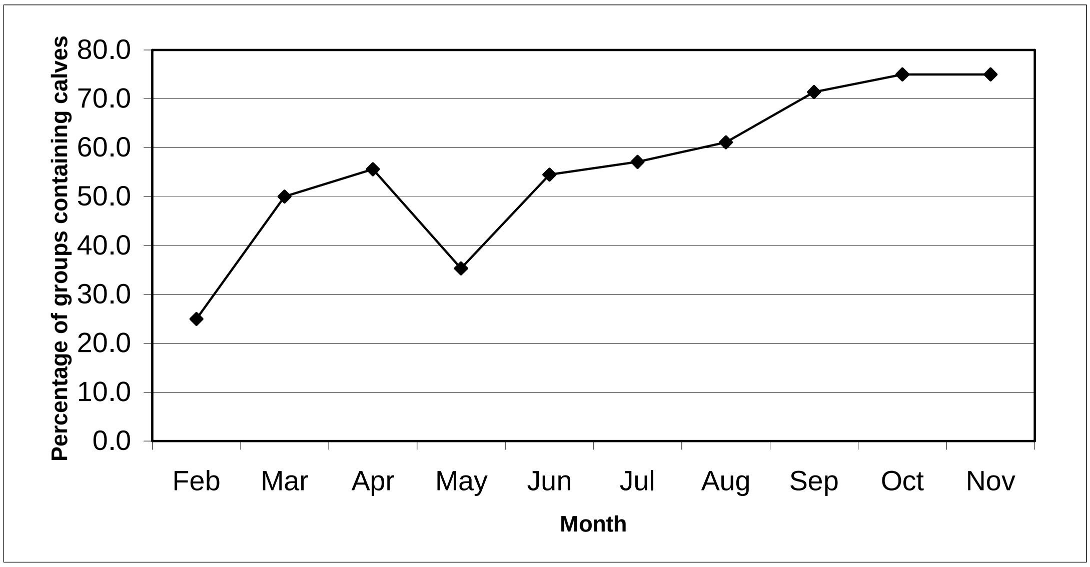

Fig. 3. Monthly percentage of common dolphin groups containing calves

DISTRIBUTUION AND FREQUENCY OF CETACEANS AROUND GRAN CANARIA ISLAND

V. M. Martin and G. A. Servidio

Sociedad para el Estudio de los cetáceos en el Archipiélago Canario (SECAC), Apartado de Correos, 404 de Arrecife de Lanzarote, Islas Canarias, Spain

The present study was focused on the structure of the cetacean communities around the island of Gran Canaria, especially of the bottlenose dolphin. A total effort of 178 days, 1.205 hours and 3358.9 nautical miles was realized in two periods: from January 1999 to June 2000, and from March to September of 2002. During this time, a total of 322 sightings were recorded 15 identified species, and 12 unidentified cetaceans: *B. physalus* (n=2; 0.6%), *B. borealis* (n=1; 0.3%), *B. edeni* (n=44; 13.7 %), *P. macrocephalus* (n=9, 2.8%), *Z. cavirostris* (n=1; 0.3%), *M. europaeus* (n=1; 0.3%), *M. densirostris* (n=2; 0.6%), *S. bredanensis* (n=21; 6.5 %), *T. truncatus* (n=66; 20.5%), *D. delphis* (n=32; 9.9%), *S. coeruleoalba* (n=29; 9.0%), *S. frontalis* (n=57; 17.7%), *G. griseus* (n=20; 6.2%), *G. macrorhynchus* (n=24; 7.5%), *P. crassidens* (n=1; 0.3%), unidentified beaked whale (n=7; 2.2%), unidentified small cetaceans (n=1; 0.3%) and unidentified big cetaceans (n=4; 1.2%). From this study, a series of conclusions can be stressed . The Bottlenose dolphin showed a year around presence, with a great range and fidelity to the area on the W-SW coast of the islands. Risso´s dolphin displays a regular presence in the North area of Gran Canaria. In contrasts, the common, striped and spotted dolphins showed a wider distribution and consistent seasonality. The data showed an inter-annual variation in the frequency of occurrence of the Bryde´s whale, Atlantic Spotted dolphin and sperm whale. All the Rough-toothed dolphins were met more inshore, frequently next to the SW coast of the island. This study revealed a high diversity of the cetacean fauna, especially in the SW area of Gran Canaria. The combination of calm waters and the local increase in the productivity, due to oceanographic events related with the “mass islands effect”, might be the factor behind this diversity.

“BOTTLENOSE DOLPHIN PROJECT”: A REVIEW OF EIGHT YEARS OF ACTIVITY

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Since 1995, in collaboration with national and international researchers, the Nature Conservation Department of CTS has been running a programme called “Bottlenose Dolphin Project” (BDP). The project aims at increasing the knowledge on Bottlenose Dolphin (*Tursiops truncatus*), one of the most common dolphin species found along the Italian coasts but yet not much studied in the wild. Acquiring a better knowledge on this species is essential to undertake efficient conservation measures for its protection. As part of this project, awareness programmes on this species and the wider marine environment are run, with special attention given to people living within or nearby protected areas. The specific aims of the project are to: 1) map the bottlenose dolphin distribution in the Italian seas; 2) verify the health status of its population; 3) study the impact of Bottlenose dolphin on the fishing activities; 4) define the most adequate conservation strategies for this species; 5) promote the institution of marine sanctuaries and marine reserves; 6) run extensive information campaigns and awareness programmes for the general public. Up today the BDP has studied the species mainly oriental coast of Sardinia and the Archipelago of Pelagian Islands (Sicily), by several research station and two research centre. In Sardinia the research area extends through some Marine Protected Areas and National Parks with marine extension like Archipelago of La Maddalena, where CTS locate the first National Dolphins Research Centre on Caprera’s island, MPA of Tavolara Punta Coda Cavallo, Oroseis’ Gulf National Park and the MPA of Capo Carbonara. The research area include also the MPA of Pelagian Islands (Sicily) and the MPA of Pontine Archipelagos (Lazio).

SIXTEENTH ANNUAL REPORT OF EUROPEAN CETACEAN SOCIETY: 2002

Paid-up members of the European Cetacean Society for the year 2002 numbered 368 with 31 countries represented. The highest representation came from United Kingdom (55), France (49), Italy (47), Germany (40), Spain (28), Belgium (22), Denmark (19), The Netherlands (16), USA (15), Switzerland (14), Greece (13), and Portugal (13).

Countries with ten members or less include Algeria, Argentina, Australia, Austria, Canada, Colombia, Croatia, Finland, Ireland, Israel, Japan, Luxemburg, Malta, Monaco, Norway, Poland, Slovenia, Sweden, 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 April 2002 was held at the University of Liège, Belgium, and was attended by 300 people. The theme was 'Marine Mammal Health: from individuals to populations'.

The conference was organised by Thierry Jauniaux and Krishna Das. Abstracts were reviewed by a team of reviewers organised by Thierry Jauniaux and Greg Donovan. Awards were judged by a team led by Jaume Forcada.

A total of 41 talks and 148 posters were presented at the conference; there was also a student meeting and three workshops:

- Seals working group meeting on research on seal rehabilitation
- Pathology working group meeting on morbilliviruses
- Europhlukes Photo-ID

Discussions were initiated with the Council of the European Association of Aquatic Mammals over a possible collaboration for publishing conference papers from ECS in its journal “Aquatic Mammals”. A Special Newsletter Issue from the Workshop on “Collisions between Cetaceans and Vessels: Can we find solutions?” edited by Giovanna Pesante, Simone Panigada, and Margherita Zanardelli, was published.

A week long Student Seminar on Marine Mammals involving several ECS members was held for European students at UIMP, Valencia, Spain in September. A textbook entitled “Marine Mammals: Biology and Conservation” edited by Peter Evans and Antonio Raga and arising from the course was published by Plenum Press / Kluwer Academic at the start of the year.

The Society web page continued to be managed by Jan-Willem Broekema with help from Ursula Verfuß.

In accordance with the AGM decision, an expression of concern for the serious conservation status of the vaquita was sent to the government of Mexico.

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 MARCH 2003

	Irish account IEP	German account DM	British account GBP
Balance as of 1 April 2002	22,029.79	37,925.16	6,104.09
INCOME			
ECS account savings from 2002	22,029.79	37,925.16	6,104.09
Membership fee during the year 2002/2003		11,680.68	12.50
Profit, Conference Liège		21,497.05	
Other payments (Sale of Proceedings, T-Shirts, etc)		681.45	
Interest on Savings account, 2002	247.87	801.77	3.43
Total Income	**22,277.66**	**72,586.11**	**6,120..02**

EXPENSES	**Irish account IEP**	**German account DM**	**British account GBP**
Travel expenses board meeting 2002		4,586.17	234.90
ASCOBANS Meeting			515.61
ECS Newsletters (printing)		2,779.82	
Editorial Expenses			124.21
Postage (Newsletters, Proceedings, E-mail subscription, etc)		1,562.50	150.00
Bank account and credit card expenses		2,713.33	
Total Expenses	**0.00**	**11,641.82**	**1,024.72**
Balance as of 1 March 2003	**22,277.66**	**60,944.29**	**5,095.30**
	Overall balance	**EURO**	**91,374.43**

Roland Lick
Treasurer

EUROPEAN CETACEAN SOCIETY – 2003

The **European Cetacean Society** was formed in January 1987 at a meeting of eighty marine mammal scientists 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. Although named a cetacean society, the ECS extends its interests to all marine mammals.

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; by-catches 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 and another on research in the Bay of Biscay) have been established. The names and addresses of contact persons for existing working groups are given below.

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*. They 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, Rome (Italy) in 2001, and Liège (Belgium) in 2002.

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 for Cetaceans, held in Valencia (Spain), 1999; no. 40 – a workshop on Collisions between Cetaceans and Vessels, held in Rome (Italy), 2001; and no. 41 – a workshop on the Use of Controlled Exposure Experiments to investigate the Effects of Noise on Marine Mammals, held in Rome (Italy), 2001.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **39 Euros** for full members; **77 Euros** for institutional members and **23 Euros** for student members. For members outside of Europe, an additional **15 Euros** 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. 789-584-205, 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.

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Stewart, B.S. and Leatherwood, S. 1985. Minke whale *Balaenoptera acutorostrata* Lacépède, 1804. Pp. 91-136. In *Handbook of marine mammals,* vol. 3. (Eds. S.H. Ridgway and R.J. Harrison). Academic Press, London. 430pp.

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