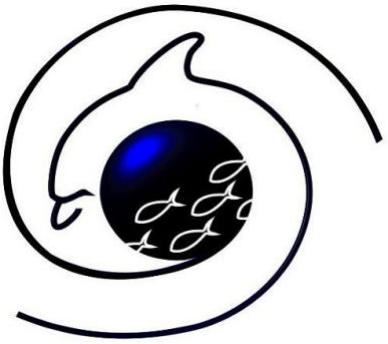

19th ANNUAL CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY

AND

ASSOCIATED WORKSHOPS

April 2-7, 2005

LA ROCHELLE, FRANCE

CONFERENCE CENTRE: *L'ESPACE ENCAN*

ORGANISED BY:
Laboratoire de Biologie et Environnement Marins, CNRS/Université de La Rochelle
Centre de Recherche sur les Mammifères Marins, Université de La Rochelle
Centre d'Etudes Biologiques de Chizé, CNRS

Marine mammals and food: from organisms to ecosystems

ORGANISING COMMITTEE:

Vincent Ridoux, Cristina Beans, Florence Caurant, Armelle Combaud, Willy Dabin, Virginie Lahaye, Roland Lick, Jean-Roch Meslin, Michel Pouyllau, Claire Pusineri, Jérôme Spitz, Olivier Van Canneyt, Cécile Vincent.

SCIENTIFIC COMMITTEE:

Vincent Ridoux, Florence Caurant, Greg Donovan, Peter Evans, Mike Fedak, Christophe Guinet, Thierry Jauniaux, Graham Pierce.

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Michel André, Cristina Beans, Willy Dabin, Peter Evans, Amandine Eynaudi, Simon Ingram, Paul Jepson, Tierry Jauniaux, Denis Ody, Eric Pauwels, Elena Ranguelova, Vincent Ridoux, Laila Sadler, Adri Steenbeek, Peter Tyack, Dylan Walker

ABSTRACT REVIEWERS:

Michel André, Lance Barret-Lennard, Giovanni Bearzi, Per Berggren, Bernie McConnell, Simon Berrow, Arne Bjørge, David Borchers, Mark Bravington, Ana Cañadas, Florence Caurant, Chris Clark, Boris Culik, Krishna Das, Eric Delory, Geneviève Desportes, Greg Donovan, Padraig Duignan, Peter Evans, Jaume Forcada, Alexandre Gannier, Manuel Garcia-Hartmann, Evgeny Gol'din, Jonathan Gordon, Christophe Guinet, Ailsa Hall, Phil Hammond, Sami Hassani, Denise Herzing, Rus Hoelzel, Aleta Hohn, Erich Hoyt, Simon Ingram, Thierry Jauniaux, Paul Jepson, Seamus Kennedy, Carl Kinze, Thijs Kuiken, Iwona Kuklik, Véronique Lesage, Damian Lidgard, Céline Liret, Christina Lockyer, Colin MacLeod, Kelly MacLeod, Patrick Miller, Ada Natoli, Simon Northridge, Graham Pierce, Toni Raga, Randall Reeves, Peter Reijnders, Vincent Ridoux, Emer Rogan, Patricia Rosel, Begoña Santos, Ursula Siebert, Tiu Similä, Paul Thompson, Dominic Tollit, Nick Tregenza, Andrew Trites, Peter Tyack, Cécile Vincent, Ben Wilson

PARTNERS AND SPONSORS OF THE CONFERENCE

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CLS Argos
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Com'Science
Conseil Général de la Charente-Maritime
Conseil Régional de Poitou-Charentes
E.C.O.L.E. de la mer
European Commission, programme *Life nature* LINDA
Institut Français pour la Recherche et l'Exploitation des Océans, Ifremer
La Rochelle Réception
La Trinitaine
Ministère de l'Ecologie et du Développement Durable, MEDD
Siemens Mobile
Université de La Rochelle, ULR
Ville de La Rochelle
World Wildlife Fund – France, WWF-France

VOLUNTEER STUDENTS AND HELPERS

Magda Chudzinska, Meritxell Clavel, Michael Dähne, Alexandre Dal-Pan, Carole Di Poi, Olivier Drouguet, Michael Dumay, Anneli Englund, Ruth Esteban, Daphna Feingold, Victoria Fernandez Heredia, Thomas Gaillard, Maureen Gerondeau, Becci Jewell, Delphine Lamoise, Sophie Linot, Véronique Magnin, Guillaume Marcais, Maria Morell, Niels Petersen, Nicola Quick, Cécile Roche, Bastien Rochowski, Kristina Salzer, Flore Samaran, Olga Sokolova, Yanis Souami, Hélène Tabouret, Leita Tschanz, Katja Vinding Petersen, Amelia Viricel, Ksenia Vulikh, Danuta Wisniewska.

CONFERENCE LOGO DESIGNER
Tiana Guenant

CONFERENCE GUIDE (see locations on maps)

Venue: the plenary session of the 19th annual conference will take place at the conference centre *L'Espace Encan*. Workshops will be either at the *E.C.O.L.E. de la mer* (in the building of the Aquarium), at the conference centre or at the *Laboratoire Départemental d'Analyses* (details given in the workshop section of the programme).

Registration: the ECS registration desk will be open at *Espace Encan* from Sunday 3rd afternoon to Wednesday 6th, at Atalante Hall (*Espace Encan*) on Sunday and in the poster exhibit the other days. Participants are invited to check-in and get their conference material on Sunday from 16:00-19:00 or on Monday from 8:00-12:00. Only cash money can be accepted for on-site payment.

Ice-breaker: all participants are warmly invited to a welcoming reception to be given at the Aquarium Cafeteria on Sunday 3rd from 20:00-23:00.

Verbal presentations: 12 minute talk + 3 minutes for discussion with the audience; please be careful to keep to your schedule. Chair persons will be instructed to keep tightly on schedule and can interrupt

lengthy presentations. A speaker-ready room will allow speakers to make final amendments to their presentation. The presentation must be given to the session chair person on CD or memory stick at the beginning of the preceding half day.

Poster presentations: the posters of 80x120cm, vertically oriented, must be on display from Monday morning to Wednesday afternoon. Clips or hooks are available. Two specific poster sessions will be arranged, during which presenting authors are requested to stay by their poster in order to facilitate exchanges and discussion with the participants.

Coffee breaks: 30 minutes-long coffee breaks will be arranged every morning and every afternoon from Monday to Wednesday. Hot drinks, refreshment and pastries will be offered. Out of these breaks, a bar will be open close to the poster exhibit during the whole conference.

Lunch breaks: sandwiches, salads and pastries will be available in the cafeteria area of the poster exhibit. Alternatively, arrangements have been made with the Aquarium cafeteria and the Moroccan restaurant "Le Chenal" where ECS attendees will be proposed a menu at a discount price. Another option in the vicinity of the conference centre is the sea-food restaurant "La Marée".

Public lecture and exhibition (in French): Three conferences on marine mammals will be given in French by Véronique Lesage (Institut Maurice Lamontagne, Québec), Denis Ody (WWF France) and Florence Caurant (Université de La Rochelle, France). They will be given at the lecture room of the *E.C.O.L.E. de la Mer*, within the building of the Aquarium, and will start at 18:00 on Tuesday 5th. They are free and open to the public.

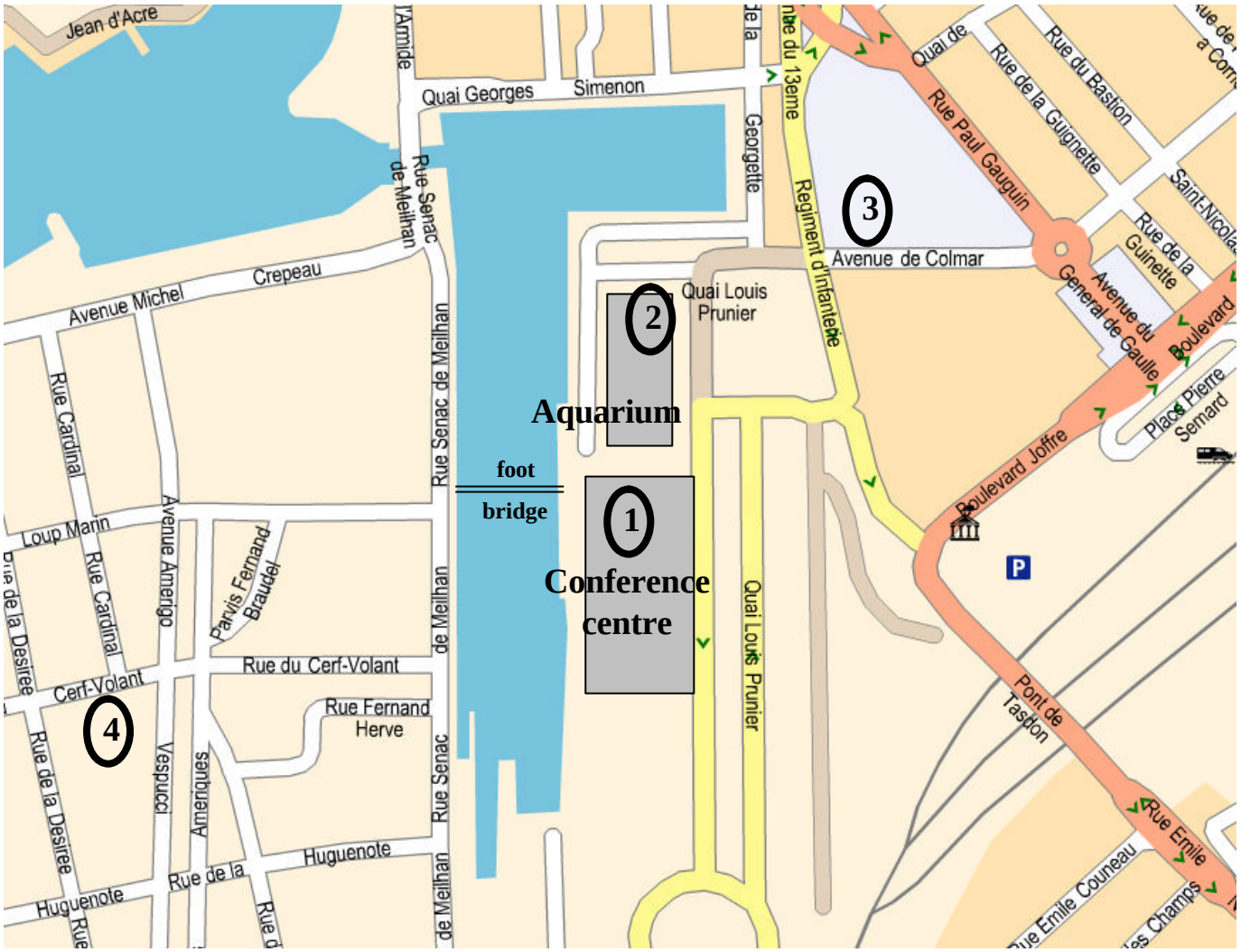
Video night: The traditional video session will be arranged at the Conference Centre on Tuesday evening, April 5th, starting at 21:00. It is free and open to the public.

Banquet and dancing: The banquet will take place at the Casino, situated on the sea front in La Rochelle, on Wednesday 6th. The banquet will start at 21:00 and the dancing at 23:00. Connections by bus will be available for free, starting from the exhibition centre at 20:00 for the banquet and at 22:30 for the dancing. They will also stop at the *Eglise Saint-Sauveur* and in front of the cathedral on the *Place de Verdun*, both in the city centre, on their way to the Casino (see maps). Buses will also be available for the way back from 01:00 to 02:30 (Casino-city centre-exhibition centre). All banquet tickets are sold out, but attendees can still book their dancing ticket at the ECS desk.

ECS2005, La Rochel **Map 1: General map of La Rochelle**

1. Conference centre: *Espace ENCAN* (registration, plenary conference, poster exhibit, "Pinger", "Tursiops", and "Ethics" workshops)
2. Aquarium – location of the *E.C.O.L.E. de la Mer* (ice-breaker, "stranding network", "Europhlukes", "Bay of Biscay", and "beaked whales" workshops)
3. *Laboratoire Départemental d'Analyses* ("necropsy" student workshop)
4. Casino (banquet and dancing, bus connections organised from and to city centre and conference center)
5. Railway station
6. Place de Verdun (city centre: bus station, arrival for buses from airports).
Buses from the conference centre to the Casino for the <u>banquet and dancing</u> will stop on this place <u>in front of the cathedral</u>.
7. *Eglise Saint-Sauveur* - Buses for the <u>banquet and dancing</u> will also stop <u>in front of this church</u> situated close to a number of hotels.
8. Tourism Office
9. Historical harbour (beer sessions)
10. Leisure harbour
11. Beaches (sun bathing)

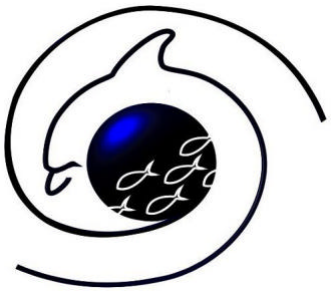
Map 2: Places recommended for lunch



1. Open bar in the coffee break hall of the conference centre: fast food and drinks (sandwiches, salads …)
2. Restaurant of the Aquarium: Local food
3. Restaurant “La Marée”: Sea food
4. Moroccan restaurant “Le Chenal”: Moroccan food (proposes a menu at special price for ECS attendees)

PROGRAMME OF THE ECS ANNUAL CONFERENCE AND ASSOCIATED WORKSHOPS

2-7 April 2005, La Rochelle, France
Conference Centre, *Espace Encan*



WORKSHOPS

Saturday 2nd April 2005, 9:30 am - 5:00 pm
Stranding Networks Workshop
Aquarium workshop room
Convenors: Paul Jepson, Thierry Jauniaux, Vincent Ridoux

Saturday 2nd April 2005, 2:00-6:00 pm
Europhlukes Photo-Identification Workshop
Aquarium lecture hall
Convenors: Eric Pauwels, Elena Ranguelova, Adri Steenbeek, Peter Evans

Sunday 3rd April 2005, 9:00 am - 5:00 pm
Bay of Biscay Workshop
Aquarium workshop room
Convenors: Dylan Walker, Vincent Ridoux

Sunday 3rd April 2005, 8:30 am - 6:00 pm
Ziphiids and Active Sonar - Research priorities to reduce risk to beaked whales from military sonar
Aquarium lecture hall
Convenors: Peter Tyack, Peter Evans
Sponsored by Woods Hole Oceanographic Institute

Sunday 3rd April 2005, 9:00 am - 6:00 pm
Marine Mammal Research and Ethics: A *European Cetacean Society* Strategy to Establish an Ethical Advisory Committee (EAC)
Conference Centre *Espace Encan*
Convenors: Michel André, Laila Sadler
Sponsored by RSPCA

Thursday 7th April 2005, 9:00 am - 6:00 pm
How can Science best inform Managers: the role of field studies in the conservation management of European bottlenose dolphin populations
Conference Centre *Espace Encan*
Convenors: Peter Evans, Simon Ingram
Sponsored by ASCOBANS

Thursday 7th April 2005, 9:00 am - 6:00 pm
Acoustic deterrent: state of the art and development perspectives
Conference Centre *Espace Encan*
Convenors: Denis Ody, Amandine Eynaudi
Sponsored by WWF-France

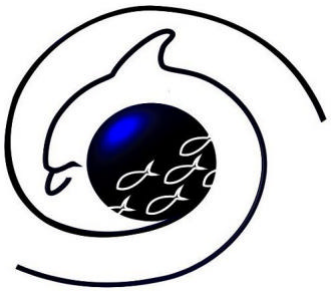
Thursday 7th April 2005, 10:00 am - 1:00 pm
Student workshop on marine mammal necropsy
Laboratoire Départemental d'Analyses
Convenors: Cristina Beans, Thierry Jauniaux, Willy Dabin

ECS ANNUAL CONFERENCE

Sunday 3rd April, 14:00-15:00
Volunteer student meeting at Conference Centre *Espace Encan*

Sunday 3rd April, 16:00-19:00
Registration at Conference Centre *Espace Encan*

Sunday 3rd April, 20:00-22:00
Ice-breaker at the Aquarium Cafeteria



Monday 4th April

8:45-9:00
Introductory words and practical information

Foraging strategies

Chair: Vincent Ridoux

9:00-9:30
Invited speaker
Biuw, M., Fedak, M.A.
COPING WITH ENERGETIC CONSTRAINTS IN A DYNAMIC AND UNPREDICTABLE ENVIRONMENT: ONTOGENY AND INDIVIDUAL VARIATION IN FORAGING STRATEGIES

9:30-9:45
Tollit, D., Wilson, L., Trites A.W.
ESTIMATING DIET COMPOSITION IN MARINE MAMMALS: WHAT TECHNIQUE TO CHOOSE?

9:45-10:00
Grellier, K., Hammond, P.S.
ROBUST SPECIES-SPECIFIC ESTIMATES OF DIGESTION COEFFICIENTS AND RECOVERY RATES FROM CAPTIVE FEEDING EXPERIMENTS WITH GREY SEALS

10:00-10:30
Coffee break

Foraging strategies (continued)

Chair: Padraig Duignan

10:30-10:45
Wilson, B., Lea, M.-A., Trites A.W., Sigler, M., Gelatt, T.
BLENDING CETACEAN, PINNIPED AND FISHERIES METHODOLOGIES TO INVESTIGATE STELLER SEA LION FINE-SCALE FORAGING BEHAVIOUR

10:45-11:00
Presentation of poster slides on related topics

11:00-11:15
Aguilar de Soto, N., Johnson, M., Díaz, F., Domínguez, I., Aparicio, C., Guerra, M., Hernández, A., Padrón, A., Tyack, P., Brito, A.
DEEP FORAGING OF PILOT AND BEAKED WHALES: DTag RESULTS

11:15-11:30
Sharples, R.J., Hammond, P.S.
FACTORS AFFECTING THE FORAGING CHARACTERISTICS OF HARBOUR SEALS

11:30-12:30
Official opening

Conference Committees
La Rochelle Mayor and MP
Conseil Général de la Charente Maritime
Conseil Régional de Poitou-Charentes
Ministère de l'Ecologie et du Développement Durable
Ifremer
Université de La Rochelle

12:30-14:00
Lunch break

Foraging strategies (continued)

Chair: Christophe Guinet

14:00-14-15
Madsen, P.T., Aguilar de Soto, N., Johnson, M., Tyack, P.
FIELD METABOLIC RATE ESTIMATES IN DEEP DIVING TOOTHED WHALES WITH IMPLICATIONS FOR BIOMASS TURNOVER

14:15-14:30
MacLeod, C.D., Santos, M.B., Pierce, G.J.
DOES SIZE MATTER? PREY SELECTION IN DEEP-DIVING ODONTOCETE CETACEANS

14:30-14:45
Similä, T., Turunen, S., Ericsson, Y.
INTERACTIONS BETWEEN KILLER WHALES AND HERRING IN NORWAY

14:45-15:00
Simon, M., Wahlberg, M., Ugarte, F., McGregor, P. K., Miller, L.
SOUNDS OF KILLER WHALES HUNTING HERRING

15:00-15:15
Presentation of poster slides on related topics

Conservation and management

Chair: Giuseppe Notarbartolo di Sciara

15:15-15:30

Gucu, A.C., Ok, M., Sakinan, S., Rappé, K.

MEDITERRANEAN MONK SEAL IN THE LEVANT SEA - RESPONSES TO MITIGATION MEASURES APPLIED

15:30-15:45

Rojas-Bracho , L., Jaramillo-Legorreta, A., Urban, J.

STEPS FOR A RECOVERY PLAN FOR THE VAQUITA: THE JOINT EFFORTS OF THE INTERNATIONAL COMMITTEE FOR THE RECOVERY OF VAQUITA (CIRVA-INE) AND THE COALITION FOR THE UPPER GULF

15:45-16:00

Duignan, P.J., Geschke, K., Stone, G., Teilmann, J., Hutt A., Suisted, R., Russell, K., Jones, G.W., Cockrem, J., Yoshinaga, A.

SATELLITE TELEMETRY, HEALTH, AND GENETIC ASSESSMENT OF FREE RANGING HECTOR'S DOLPHINS (*CEPHALORHYNCHUS HECTORI HECTORI*) OFF BANKS PENINSULA, NEW ZEALAND

16:00-16:30

Coffee break

Conservation and management (continued)

Chair: Nick Tregenza

16:30-16:45

Brownell, R. L., Jr., Mead, J. G., van Helden, A. L., Yamada, T. K., Frantzis, A.

WORLDWIDE MASS STRANDINGS OF BEAKED WHALES: RETROSPECTIVE REVIEW AND CAUSES

16:45-17:00

Tyack, P.L., Johnson, M.P., Madsen, P.T.

EXTREME DIVING BEHAVIOUR OF BEAKED WHALE SPECIES KNOWN TO STRAND IN CONJUNCTION WITH USE OF MILITARY SONARS

17:00-17:15

Presentation of poster slides on related topics

17:15-17:30

Ugarte, F., Felce, T., Stone, E., Perez, S., Hartley, S., Evans, P.G.H.

ABUNDANCE OF MARINE MAMMALS IN THE CARDIGAN BAY cSAC ESTIMATED WITH DISTANCE SAMPLING AND PHOTO IDENTIFICATION SURVEYS FROM A SMALL BOAT

17:30-19:30

Poster session 1

Tuesday 5th April

Population and ecosystem processes

Chair: Peter Evans

8:30-9:00

Invited speaker

Trites, A.W., Rosen, D.A.S.

MARINE MAMMALS AS INDICATORS OF ECOSYSTEM CHANGE

9:00-9:15

Forcada, J., Trathan, P. N., Reid, K., Murphy, E.J.

CLIMATE PERTURBATIONS, ENVIRONMENTAL FORCING AND DEMOGRAPHIC RESPONSES IN ANTARCTIC FUR SEALS

9:15-9:30

Gannier, A., Bosc, E., Laran, S.

RELATING DELPHINID RELATIVE ABUNDANCE TO PRIMARY PRODUCTION: A SHORT-CUT THROUGH THE UNKNOWN COMPLEXITY OF THE FOOD WEB

9:30-9:45

Cadet, C., Lemel, J.-Y., Thompson, P. M.

FORAGING STRATEGIES AND MOBILITY OF BOTTLENOSE DOLPHINS IN A SPATIO-TEMPORALLY VARIABLE ECOSYSTEM: A MODELLING APPROACH

9:45-10:00

Presentation of poster slides on related topics

10:00-10:30

Coffee break

Population and ecosystem processes (continued)

Chair: Simone Panigada

10:30-10:45

Invited speaker

Lindstrøm, U, Haug,T.

ON THE ROLE OF MINKE WHALES IN THE BARENTS SEA ECOSYSTEM

10:45-11:00

Michaud, J., Taggart, C.T.

VARIATION IN PREY-FIELD ENERGY AVAILABLE TO NORTH ATLANTIC RIGHT WHALES IN A PRIMARY FEEDING HABITAT

11:00-11:15

Lesage, V., Michaud, R., Giard, J., Harvey, M., Runge, J.A.

FIN WHALES TUNE THEIR DISTRIBUTION AND GROUPING PATTERNS ON KRILL STANDING STOCK BIOMASSES: A TEST OF THE HYPOTHESIS USING STABLE CARBON (d13C) AND NITROGEN (d15N) ISOTOPE RATIOS

11:15-11:30

Santos, M. B., Pierce, G. J., López, A., Martínez, J.A., Fernández, M.T., Ieno, E., Mente, E., Porteiro, C., Meixide, M.

VARIABILITY IN THE DIET OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) IN GALICIAN WATERS 1991-2003 AND RELATIONSHIP WITH PREY ABUNDANCE

11:30-11:45

Brophy, J., Murphy, S., Rogan, E.

FEEDING ECOLOGY OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) IN THE NORTH EAST ATLANTIC

11:45-12:00
Presentation of poster slides on related topics

12:00-12:15
Wade, P., Zerbini, A., Waite, J., Durban, J., Dahlheim, M., Herman, D., Burrows, D., LeDuc, R., Matkin, C., Krahn, M.
KILLER WHALES AS PREDATORS OF MARINE MAMMALS IN THE ALEUTIAN ISLANDS AND WESTERN GULF OF ALASKA

12:15-12:30
Born, E.W., Acquarone, M.
AN ESTIMATION OF WALRUS (*ODOBENUS ROSMARUS*) PREDATION ON BIVALVES IN THE YOUNG SOUND AREA (N.E. GREENLAND)

12:30-14:00
Lunch break
and
Annual student meeting in the auditorium from 12:30-13:00

Stock identity, survey, distribution

Chair: Phil Hammond

14:00-14:15
Mandleberg, L., MacLeod, C.D., Schweder, C., Bannon, S.M., Pierce, G.J.
A COMPARISON OF THE PREDICTIVE ABILITIES OF FOUR APPROACHES FOR MODELLING THE DISTRIBUTION OF CETACEANS

14:15-14:30
Guinet, C., Mate, B., Bentaleb, I., André, J.-M., Mayzaud, P., Stephanis de, R.
WHERE ARE THE MEDITERRANEAN FIN WHALES WHEN THE SUMMER IS OVER?

14:30-14:45
Certain-Hubert, G., Ridoux, V., Van Canneyt, O., Bretagnolle, V.
CETACEAN AERIAL SURVEY IN THE BAY OF BISCAY: DISTRIBUTION MAPS AND MINIMAL ABUNDANCE ESTIMATES ON THE SHELF AREA

14:45-15:00
Presentation of poster slides on related topics

15:00-15:15
Quérouil, S., Silva, M.A., Magalhães, S., Prieto, R., Matos, J.A., Mendonça, D., Santos, R.S.
BOTTLENOSE DOLPHINS OF THE AZOREAN ARCHIPELAGO WOULD BELONG TO A SINGLE POPULATION OF THE "OFFSHORE" TYPE

15:15-15:30
Fontaine, M.C., Tolley, K.A., Ridoux, V., Jauniaux, T., Sequeira, M., Addink, M., Smeenk, C., Siebert, U., Birkun, A., López, A., Bouquegneau, J.M., Michaux, J.R.
PHYLOGEOGRAPHY OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE SOUTHEASTERN NORTH ATLANTIC AND IN THE BLACK SEA EXPLORED BY THE ANALYSES OF NUCLEAR AND MITOCHONDRIAL DNA

15:30-16:00
Coffee break

Behaviour

Chair: Ben Wilson

16:00-16:15
Herzing, D.L., Rogers, C.A.
DIRECTIONALITY OF SEXUAL AGGRESSION IN MIXED-SPECIES ENCOUNTERS BETWEEN ATLANTIC SPOTTED DOLPHIN AND BOTTLENOSE DOLPHIN IN THE BAHAMAS

16:15-16:30
Rogers, C.A., Herzing, D.L.
LONG-TERM ASSOCIATION PATTERNS BETWEEN SPOTTED DOLPHINS AND BOTTLENOSE DOLPHINS IN THE BAHAMAS

16:30-16:45
Presentation of poster slides on related topics

Critical habitat

Chair: Lorenzo Rojas-Bracho

16:45-17:00
Mate, B., Urban, J.
THE MIGRATION OF HUMPBACK WHALES BREEDING OFF SOCORRO ISLAND, MEXICO TO SUMMER FEEDING HABITAT

17:00-17:15
Compton, R.C., Dalebout, M.L., Wimmer, T., Øien, N., Goodwin, L., Whitehead, H.
PREDICTING KEY HABITAT AND POTENTIAL DISTRIBUTION OF NORTHERN BOTTLENOSE WHALES (*HYPEROODON AMPULLATUS*) IN THE NORTHWEST ATLANTIC OCEAN

17:15-17:30
Presentation of poster slides on related topics

17:30-19:30
Poster session 2

18:00-20:00
Public lecture
Aquarium lecture hall (*E.C.O.L.E. de la Mer*)

21:00-23:00
Video night
Conference Centre *Espace Encan*

Wednesday 6th April

Trophic links as vectors of contaminants and pathogens

Chair:FlorenceCaurant

8:30-9:00

Invited speaker

Pierce, **G.J.,** Santos, M.B., Learmonth, J.A., Zuur, A.F., Boon, J.P., Zegers, B., Caurant, F., Ridoux, V., Bustamante, P., Lahaye, V., Law, R.J., Rogan, E., Murphy, S., Moffat, C.F., Addink, M., López, A., Alonso, J.M., González, A.F., García Hartmann, M., Jauniaux, T., Lockyer, C., Reid, R.J., Dabin, W.

TROPHIC LINKS AS VECTORS OF PATHOGENS AND CONTAMINANTS

9:00-9:15

Lahaye, V., Bustamante, P., Dabin, W., Spitz, J., Van Canneyt, O., Das, K., Holsbeek, L., Learmonth, J., Santos, B., Pierce, G., Rogan, E., Guerra, A., Gonzalez, A., Caurant, F.

NEW INSIGHTS FROM METALLIC TRACERS ON THE FEEDING ECOLOGY OF COMMON DOLPHINS

9:15-9:30

Hall, A.J., Law, R.J., Allchin, C.R., Deaville, R., Jepson, P.D.

THE RISK OF INFECTION FROM POLYCHLORINATED BIPHENYL EXPOSURE IN HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) – A CASE-CONTROL APPROACH

9:30-9:45

Kakuschke, A., Valentine-Thon, E., Griesel, S., Siebert, U., Prange, A.

METAL INTAKE WITH FOOD – METAL SENSITIVITY AS INDICATOR OF IMMUNMODULATION IN SEALS

9:45-10:00

Presentation of poster slides on related topics

10:00-10:30

Coffee break

Genetics and social structure

Chair: Emer Rogan

10:30-10:45

Rendell, L., Dalebout, M., Burtenshaw, J., Mesnick, S.L., Whitehead, H.

MITOCHONDRIAL DNA VARIATION AMONG VOCAL CLANS IN SPERM WHALES

10:45-11:00

Viricel, A., Caurant, F., Dabin, W., Garcia-Meunier, P., Lahaye, V., Spitz, J., Pierce, G.J., Learmonth, J., Boon, J., Zegers, B., Rogan, E., Ridoux, V.

GENETICS AND SOCIAL ECOLOGY OF PELAGIC DELPHINIDS: THE STRUCTURE AND DYNAMICS OF A GROUP OF SHORT-BEAKED COMMON DOLPHINS IN THE NORTHEAST ATLANTIC

Medicine and disease

Chair: Ursula Siebert

11:00-11:15

Jepson, P.D., Houser, D.S., Crum, L.A., Tyack, P.L., Fernández, A.

BEAKED WHALES, SONAR AND THE "BUBBLE HYPOTHESIS"

11:15-11:30
D'Amelio, S., Barros, N., Busi, M., Paggi, L.
MOLECULAR GENOTYPING AND PHYLOGENY OF ANISAKID NEMATODES FROM CETACEANS OF FLORIDA WATERS

11:30-11:45
Macé, M., Crouau-Roy, B.
MHC CARACTERIZATION IN THREE CETACEAN SPECIES AND THE CONNEXIONS BETWEEN PATHOLOGY AND POPULATION GENETICS

11:45-12:00
Presentation of poster slides on related topics

12:00-12:15
Stephenson, C.M., Matthiopoulos, J., Everard, K., Harwood, J.
THE USE OF AN INDIVIDUAL-BASED MODEL OF SEAL MOVEMENT TO INVESTIGATE THE SPREAD OF PHOCINE DISTEMPER VIRUS WITHIN LOCAL POPULATIONS

12:15-12:30
Müller, G., Wohlsein, P., Kaim, U., Haas, L., Greiser-Wilke, I., Stede M., Siebert, U., Harder, T.C., Baumgärtner, W.
MOLECULAR CHARACTERIZATION OF PHOCINE DISTEMPER VIRUS ISOLATED IN 2002

12:30-14:00
Lunch break

Ecology

Chair: Bob Brownell

14:00-14:15
Baines, M.E., Reichelt, M., Evans, P.G.H.
INVESTIGATION OF HARBOUR PORPOISE AND BOTTLENOSE DOLPHIN ECOLOGY IN CARDIGAN BAY, U.K., USING MODEL BASED SPATIAL ANALYSES

14:15-14:30
Bailleul, F., Charrassin, J.-B., Ezraty, R., Guinet, C.
FORAGING IN ANTARCTIC SEA ICE BY SOUTHERN ELEPHANT SEALS: A COMPROMISE BETWEEN FOOD AND BREEDING CONSTRAINT

14:30-14:45
Beauplet, G., Barbraud, C., Dabin, W., Chambellant, M., Guinet, C.
AGE-SPECIFIC SURVIVAL IN SUBANTARCTIC FUR SEALS BORN IN AMSTERDAM ISLAND: THE FILTERS GENERATING WITHIN-COHORT SELECTION PROCESSES

New techniques

Chair: Michel André

14:45-15:00
McConnell, B., Bryant, E., Bach, H., Beaton, R., Lovell, P., Monks, F.
FASTLOC / GSM – A HYBRID GPS POSITION-FIXING SYSTEM FOR MARINE MAMMAL TRACKING

15:00-15:15
Johnson, M.P., Madsen, T., Aguilar de Soto, N., Tyack, P.L.
ECHOLOCATION AND MOVEMENT OF A FORAGING BLAINVILLE'S BEAKED WHALE (*MESOPLODON DENSIROSTRIS*)

15:15-15:30

Evans, P.G.H., Beekman, B., Cañadas, A., Davis, P., Gordon, J.C.D., Huele, R., Panigada, S., Pauwels, E., Ranguelova, E., Steenbeek, A., Steiner, L., Thijsse, P.
THE EUROPHLUKES PROJECT – A EUROPEAN-WIDE PHOTO-ID CATALOGUE

15:30-15:45
Culik B.M., Koschinski S., Trippel E.A.
WARNING SOUNDS: A NEW APPROACH TO INCREASE THE AWARENESS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) TO GILLNETTS USING PURE 2.5 kHz TONES

15:45-16:15
Coffee break

Acoustics

Chair: Peter Tyack

16:15-16:30
André, M., Johansson, T., Delory, E., van der Schaar, M., Morell, M.
FORAGING ON SQUIDS: THE SPERM WHALE MID-RANGE SONAR

16:30-16:45
Zimmer, W.M.X., Johnson, M.P., Madsen, P.T., Tyack, P.L.
ECHOLOCATION CLICKS OF FREE-RANGING CUVIER'S BEAKED WHALES (*ZIPHIUS CAVIROSTRIS*)

16:45-17:00
Rasmussen, M., Miller, L.
TESTING HEARING ABILITIES OF FREE-RANGING WHITE-BEAKED DOLPHINS

17:00-17:15
Beedholm, K., Miller, L.A.
STIMULUS-RESPONSE CHARACTERISTICS OF AUDITORY BRAIN STEM RECORDINGS (ABR) IN A HARBOR PORPOISE (*PHOCOENA PHOCOENA*) DURING ACTIVE ECHOLOCATION AND PASSIVE HEARING

17:45-19:30

AGM

20:30-23:00
Banquet at the Casino

23:00-4:00
Dancing at the Casino

Abstracts of oral presentations

Monday 4th April

Foraging strategies

Monday 9:00-9:30

COPING WITH ENERGETIC CONSTRAINTS IN A DYNAMIC AND UNPREDICTABLE ENVIRONMENT: ONTOGENY AND INDIVIDUAL VARIATION IN FORAGING STRATEGIES

BIUW, M. (1), FEDAK, M.A. (2)

(1,2) SMRU, Gatty Marine Lab., University of St Andrews, St Andrews, Fife, KY16 8LB, UK

Many marine organisms undertake extensive migrations between foraging areas and sites for other critical life activities, such as reproduction. Such annual, seasonal or more frequent migrations may be energetically costly, and individuals must weigh travelling costs against expected returns. For instance, should they travel to more distant areas in hope of higher prey densities or return to a breeding site in a given season? Data loggers and transmitters provide behavioural records whose increasing level of detail allow us to make inferences about the behavioural decisions made by individuals facing these conflicting demands. To exemplify some novel ideas based on telemetry data, we explore individual strategies used by phocid seals. In particular, grey and elephant seals are good examples of "central-place foragers", and our data from these two species alone have driven much of our current thinking about individual foraging strategies. We specifically focus on three key aspects: 1) Ontogeny of foraging and migratory patterns from naïve pups to adults; 2) Habitat preference and foraging site fidelity of adults; and 3) Individual differences in habitat preference and their dependency on environmental characteristics. We show how the diving behaviour of individuals can depend on the physical characteristics of the water masses in which they forage, and discuss such variations in terms of their immediate consequences on energetics as well as the more long-term implications on their ability to transfer energy to the central place and, in the case of breeding females, into their offspring.

Monday 9:30-9:45

ESTIMATING DIET COMPOSITION IN MARINE MAMMALS: WHAT TECHNIQUE TO CHOOSE?

TOLLIT, D. (1), WILSON, L. (2), TRITES, A.W. (3)

(1-3) Marine Mammal Research Unit, Fisheries Centre, University of British Columbia, Hut B-3, 6248 Biological Sciences Rd., Vancouver, BC, V6T 1Z4, Canada

Accurate estimates of diets are vital to monitor marine mammal populations, their relationship with their ecosystem and with fisheries. The traditional approach has been to examine stomach contents. More recently, attempts include using prey remnants in scats, fatty acid signatures in blubber, prey DNA from scats, stable isotope ratios in predator tissues and direct observation using cameras or field observations. Each methodology has particular advantages and limitations, many of which can be assessed and improved through controlled captive feeding trials and computer simulations. We review current methods to determine diet in marine mammals, with a focus on experiments conducted with seven Steller sea lions at the Vancouver Aquarium which aimed to 1) compare the accuracy of different diet reconstruction indices when using hard prey remnants 2) compare multiple structures versus otoliths in estimating numbers and size of fish consumed 3) validate the use of blubber fatty acid signatures in quantifying diet 4) validate the use of DNA/PCR techniques to quantify diet using prey soft remains in scats. Use of multiple bones (versus otoliths) increased the probability of certain species being identified, but caused difficulties in estimating prey numbers and significant differences across prey species remained. Experimentally derived digestion correction factors were shown applicable to any studies involving marine piscivores. Isolating prey DNA using PCR techniques may provide an expensive but useful alternative to using prey remnant analysis. Detection rates were consistent across four species despite widely varying proportions in the diet (6-47%). Given further development quantification may be possible. Fatty acid signatures in blubber reflect a far longer dietary history, as can stable isotope ratios in various tissue samples. In contrast, animal-borne cameras provide a unique insight into particular feeding events. Overall, it is clear that a suite of techniques is required to fully assess diet in marine mammals.

Monday 9:45-10:00

ROBUST SPECIES-SPECIFIC ESTIMATES OF DIGESTION COEFFICIENTS AND RECOVERY RATES FROM CAPTIVE FEEDING EXPERIMENTS WITH GREY SEALS

GRELLIER, K. (1), HAMMOND, P.S. (2)

(1,2) SMRU, Gatty Marine Lab., University of St Andrews, St Andrews, Fife, KY16 8LB, UK

There is much debate about the state of North Sea fish stocks, of which the grey seal is a major predator. Grey seal diet was last studied comprehensively in 1985, when commercial fish stocks were much larger than today. There is therefore great interest in obtaining current estimates of grey seal diet to assess their impact. We are using >50,000 fish otoliths and cephalopod beaks recovered from >2,000 grey seal scat samples collected from around the North Sea in 2002 to estimate grey seal diet composition and consumption of commercially important fish species. To account for digestion of otoliths/beaks we carried out experiments with seven adult female grey seals to derive species-specific estimates of digestion coefficients (to account for partial digestion) and recovery rates (to account for complete digestion). Nineteen prey species were fed as whole prey. Each prey species was offered to multiple individuals; some species were offered to the same individual multiple times. The recovery rate of the system was tested. Two measurements were taken from each otolith/beak that was recovered. To account for inter- and intra-individual variability, inverse variance weighted mean digestion coefficients and recovery rates were calculated for each prey species. Digestion coefficients were greatest for sandeels (1.47) and then gadids (1.17-1.44), cottids (1.41), callionymids (1.4), flatfish (1.17-1.33), clupeids (1.32) and scombrids (1.19). Recovery rates were greatest for gadids (0.95-0.99) and then flatfish (0.70-0.97), scombrids (0.72), sandeels (0.3), cottids (0.29) and callionymids (0.23). The large differences in estimated digestion coefficients and recovery rates among species reinforce the importance of obtaining robust estimates of these quantities when assessing diet from scats. The results are the most systematically obtained and most comprehensive for any species of pinniped, and will allow accurate and precise estimation of grey seal diet from wild scat samples.

Monday 10:30-10:45

BLENDING CETACEAN, PINNIPED AND FISHERIES METHODOLOGIES TO INVESTIGATE STELLER SEA LION FINE-SCALE FORAGING BEHAVIOUR

WILSON, B. (1), LEA, M.-A. (2), TRITES, A.W. (3), SIGLER, M. (4), GELATT, T. (5)

(1) Scottish Association for Marine Science, Ardtoe Marine Lab, Acharacle, Argyll, Scotland; (1,2,3) Behaviour@Sea Project, Marine Mammal Research Unit, UBC, Vancouver, Canada; (4) NMFS Auke Bay Lab, 11305 Glacier Highway, Auke Bay, Alaska, USA; (5) NOAA, National Marine Mammal Lab, 7600 Sand Point Way N.E., Seattle, WA, 98115, USA

The decline of Steller sea lion populations in the North Pacific have prompted considerable research efforts but the foraging behaviour of juveniles still remains little understood. In this study we combined traditionally discrete research approaches to quantify the at-sea behaviour of juveniles and relate their activities to the biological and hydrographic contexts in which they occurred. In the winter of 2003/04 we fitted 21 juvenile sea lions in SE Alaska with telemetry transmitters (satellite, acoustic & VHF). The satellite tags provided broad-scale perspectives of the animals' distributions as well as detailed information on their diving behaviour. We used these fixes to focus searches and subsequent fine-scale tracking using the VHF and acoustic tags. Animals were followed with an 18m boat and the abundance and distribution of prey quantified using wide ranging and targeted hydroacoustic surveys. We also deployed an autonomous ultra-quiet boat fitted with an echosounder to examine the underwater behaviour of the sea lions in relation to their prey. During 10 weeks at sea we followed 15 animals on 37 occasions for sessions lasting from 12mins to 58hrs. Trips away from the haul-out occurred at two scales - local (<5km) and distant (10-35km). Younger animals tended to make the short local trips while older animals varied in their behaviour. One repeatedly travelled to areas of high herring abundance and dived to depths that mirrored the fishes' diel migrations (deep-day, shallow-night), while another focused on areas of high pollock abundance and dived on the opposite temporal regime (shallow-day, deep-night). Overall, the sea lions spent the majority of their time within a few hundred meters of the shore with forays into open water being rare and crossings between shore-lines taking the shortest straight line route. Transient killer whales were frequently observed and may account for this previously unexpected habitat preference.

Monday 11:00-11:15

DEEP FORAGING OF PILOT AND BEAKED WHALES: DTag RESULTS

AGUILAR DE SOTO, N. (1), JOHNSON, M.P. (2), MADSEN, P.T. (3)

(1) Dept. Animal Biology, Faculty of Biology, La Laguna University, Tenerife, Spain; (2,3) Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA

The Canary Islands archipelago holds year-round populations of short finned pilot whale (*Globicephala macrorhynchus*) and Blainville´s beaked whale (*Mesoplodon densirostris*). In 2003, a total of 23 *G. macrorhynchus* and 2 *M. densirostris* were instrumented with onboard digital tags (DTag). DTags record sound continuously at up to 96 kHz, and include sensors for depth, water temperature and orientation sampled at 50 Hz. The tags were attached to the whales with 4 suction cups, and include a radio beacon to facilitate tracking and recovery. A total of 60 deep dives (>500m) were recorded on *G. macrorhynchus* and 7 on *M. densirostris*, and occurred during day and night. The vocalizations of the whales during these dives included broadband clicks and buzzes consistent with biosonar-mediated foraging, with buzzes indicating the terminal phase of a foraging sequence. Click echoes from the sea bottom in the tag recordings made it possible to calculate the distance from tagged whales to the seabed (up to 450 m). Results show that the two species have very different strategies for feeding at depth: pilot whales performed fast, energetic deep dives with a mean duration of 15 minutes (max 20 min). They concentrated on mid-water prey at two depth ranges, centred at 270 m and 670 m (max 1018 m). In contrast, *M. densirostris* deep dives lasted four times longer and, although they fed at similar depths (mean 690 m, range 227 to 874 m), they often approached the seabed, exploiting meso- and bentho-pelagic niches. While *M. densirostris* buzzed up to 44 times/dive, the deepest dives of pilot whales usually contained only one buzz. These data suggest differences in the nutritive value of prey taken and in the balance adopted between aerobic and anaerobic metabolism in the two species.

Monday 11:15-11:30

FACTORS AFFECTING THE FORAGING CHARACTERISTICS OF HARBOUR SEALS

SHARPLES, R.J. (1), HAMMOND, P.S. (2)

(1,2) SMRU, Gatty Marine Laboratory, University of St Andrews, UK

Fundamental to understanding the ecology of a species is to understand how it gains enough energy to survive, the characteristics of foraging. Harbour seal foraging behaviour has been observed to vary considerably both within and between regions. In this study, endogenous factors such as body size and sex were investigated to attempt to explain some of the variation observed in the characteristics of foraging trips and the activity budgets of animals within a region. Information on activity budgets and foraging characteristics were obtained from satellite relay data loggers (SRDLs). Data were collected from 25 seals between October 2001 and July 2003 in St Andrews Bay, Scotland. Individual tracks of seals were classified into foraging trips; the duration and average distance travelled to forage could then be calculated as well as the proportion of time spent in each activity. Males travelled significantly further to forage than females (males: mean distance = 50.25 km, SE = 1.13km, n = 12; females: mean distance = 31.56 km, SE = 1.26 km, n = 12; $p<0.01$). Both the proportion of time spent at sea and the duration of trips (Spearman's rank correlation = 0.47, $p = 0.019$) were significantly related to body length. Therefore, endogenous characteristics explained some of the variation exhibited within a region. These findings were compared with those of a previous study conducted in the Moray Firth. The differences between regions in distance travelled and the proportion of time spent at sea, as well as differences in the animals body condition index suggests that animals in St Andrews Bay are operating under much tighter energetic constraints than their counterparts just ~150 km to the north. The results raise questions about possible differences in the population dynamics of these two populations of harbour seals on the east coast of Scotland.

Monday 14:00-14-15

FIELD METABOLIC RATE ESTIMATES IN DEEP DIVING TOOTHED WHALES WITH IMPLICATIONS FOR BIOMASS TURNOVER

MADSEN, P.T. (1), AGUILAR DE SOTO, N. (2), JOHNSON, M.P. (3), TYACK, P.L. (4)

(1,3,4) Woods Hole Oceanographic Institution, MA, 02543, USA; (2) La Laguna University, Canaries, Spain

Cetaceans forage in a range of habitats from shallow freshwater to mesopelagic depths, and their impact on these ecosystems is likely significant. The cost of existence of a free ranging whale is given by the field metabolic rate incorporating the energy needed for respiration, growth and reproduction. Large, deep diving toothed whales do not easily lend themselves to physiological measurements. Estimates of field metabolic rates for this group of marine mammals have been limited to scaling from smaller animals, heat flux models, or stomach size extrapolation. These rough estimates have provided a range of field metabolic rate values, sparking a heated debate of whether the field metabolic rates of cetaceans are elevated or not compared to land mammals. This study tests the hypothesis of elevated field metabolic rates by using a novel approach of estimating the field metabolic rate of the deep diving toothed whales, *Physeter*, *Mesoplodon*, *Ziphius*, and *Globicephala* with multisensor Dtags. The sensors and acoustic recordings of the tags provide information about every lung ventilation of the animals over extended periods of time along with estimates of the air volumes carried by the whale after inhalation. Combining these measures with scaled relative tidal volumes and oxygen extraction in captive cetaceans allow us to estimate the oxygen consumption in the four species studied. Sperm whales appear to have field metabolic rates of less 2 ml O2/kg/min, the lowest reported for any mammal so far. The smaller beaked whales have field metabolic rates around 3 ml O2/kg/min, and the

Globicephala seems to have the highest metabolic rates of around 4 ml O2/kg/min. It is concluded that large, deep diving toothed whales do not have elevated field metabolic rates compared to land mammals scaled to the same size, and that previous estimates of biomass turnover by these predators are overestimated.

Monday 14:15-14:30

DOES SIZE MATTER? PREY SELECTION IN DEEP-DIVING ODONTOCETE CETACEANS

MACLEOD, C.D. (1), SANTOS, M.B. (2), PIERCE, G.J. (3)

(1-3) School of Biological Sciences (Zoology), University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 3EX, UK

Traditionally, dietary studies have concentrated on the taxonomic composition of stomach contents, with odontocete cetaceans being implicitly assumed to primarily select prey based on species. However, it is possible that odontocetes primarily select prey based on size relative to the individual cetacean, with different prey taxa being treated by the cetacean as being interchangeable. To test this hypothesis we investigated the diet of deep-diving cetaceans in the north-east Atlantic using stomach contents and stable isotope analysis. Both mean prey size and trophic level were found to be positively related to cetacean body size across this guild. However, when the relative prey size was calculated, all deep-diving cetacean species were found to preferentially consume prey of 1-3% of their own body size. This supports the hypothesis that prey selection in deep-diving cetaceans is primarily driven by relative prey size. We suggest that prey selection is size-based as a result of two conflicting pressures. The morphology of the upper aero-digestive tract means that proportionately larger prey are more difficult to swallow, pushing cetaceans to preferentially select relatively smaller prey. In contrast, hydrodynamic limitations on manoeuvrability mean that relatively smaller prey are harder to catch, pushing animals towards preferentially taking larger prey. A trade-off between these two factors will lead to animals selecting prey of intermediate relative size, as observed, to optimise foraging efficiency. Such size-based optimal foraging will lead to a conflict between species with similar body sizes. Therefore, sympatric odontocete species occurring in the same habitat are predicted to differ sufficiently in body size to reduce potential competition to an acceptable level, while similar-sized cetacean species within the same guild are predicted to be allopatric. Such size-based niche partitioning between sympatric species is observed in deep-diving cetacean in the north-east Atlantic and similar-sized species are, indeed, allopatric.

Monday 14:30-14:45

INTERACTIONS BETWEEN KILLER WHALES AND HERRING IN NORWAY

SIMILÄ, T. (1), TURUNEN, S. (2), ERICSSON, Y. (3)

(1) Project NORCA, P.O.Box 181, 8465 Straumsjøen, Norway; (2) Department of Hydrobiology, University of Helsinki, Finland; (3) Evolutionary Biology Centre, Uppsala University, S-75236 Sweden

The main prey of killer whales (*Orcinus orca*) occurring in the coastal waters of northern Norway is Norwegian spring-spawning herring (*Clupea harengus*). A long term study (1990-2004) has been conducted on the wintering grounds of herring to study interactions between killer whales and their prey. Killer whales have been studied using behavioural observations, underwater video, high-frequency sonar and satellite-tracking. The aims of the work have been to study 1) the techniques that killer whales use in capturing their prey; 2) how the diurnal migration pattern and behaviour of herring affects killer whale behaviour and habitat use; 3) possible interactions between the herring fishery and killer whales. In the wintering grounds, herring is present in deep waters (usually 150-250 m depth) during daytime. Results show that the whales can chase schools from this deep layer towards surface, but prefer to search out small patches of herring, which occur in shallow waters in early morning. 85 % of the killer whale feeding behaviour occurs in an area covering less than 10% of the study area. Feeding occurs mainly in shallow waters and in areas with underwater seamounts, which aid the whales in herding their prey. Killer whales are not capable of catching herring unless they have stunned them first with tail slaps. As the herring catch quotas have increased from 70 000 tn in 1990 to 470 000 in 2004, the whales have learned to follow the fishing fleet, feeding on herring that fall from the nets. The herring fishery has thus become a major factor influencing the movement pattern, habitat use and behaviour of killer whales. This raises important questions concerning the reliance of killer whales on the herring fleet and how killer whale distribution and foraging may be affected by changes in the behaviour of the fleet.

Monday 14:45-15:00

SOUNDS OF KILLER WHALES HUNTING HERRING

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(1,5) Institute of Biology, University of southern Denmark, Odense, Denmark; (2) Zoo-physiological Institute, University of Århus, Denmark; (1,3) Sea Watch Cymru, New Quay, Ceredigion, Wales-UK; (4) Centre for Applied Zoology, Cornwall

College, Newquay, Cornwall, UK

Killer whale (*Orcinus orca*) acoustic behaviour varies with the hearing ability of their prey. Here we report the sounds produced by killer whales while feeding on herring (*Clupea harengus*). Broadband recordings (100Hz – 150kHz) of Norwegian killer whales engaged in different activities were made with a hydrophone array, allowing frequency analysis and source level estimates. We recorded Icelandic and Norwegian killer whales using a single hydrophone and a DAT-recorder (bandwidth: 20Hz - 20kHz). Foraging killer whales produced significantly more clicks, calls and underwater tails-slaps (used to debilitate herring), than whales engaged in other activities. The intensity of echolocation clicks from herring-eating killer whales (189 ± 7.1dB (pp) re.1µPa @ 1m) was lower than that reported from salmon-eating killer whales (200 - 225dB (pp) re.1µPa @ 1m). Calculations of the active space suggest that killer whales adjust the intensity of their echolocation clicks to avoid herring detecting their approach. The source level of the underwater tail-slaps (186 ± 5.4dB (pp) re.1µPa @ 1m) is not intense enough to debilitate the fish acoustically. However, acoustic characteristics indicate that the tail-slaps may produce cavitation, and other factors such as pressure changes, turbulence and particle movements may debilitate fish in the near field of the tail-slap. Sounds of underwater tail-slaps recorded from Icelandic killer whales indicate that their hunting techniques are similar to those of Norwegian killer whales. In addition the Icelandic killer whales produce a low frequency call (peak frequency: 683Hz) of high intensity (179 ± 8.5dB (pp) re.1µPa @ 1m) prior to underwater tail-slaps. This call would be suitable for herding herring into tight schools, which in turn may increase the debilitating effect of tail-slaps. Killer whales may eavesdrop on sounds of other feeding killer whales to find accessible food patches. Eavesdropping whales can hear foraging sounds of neighbours at distances of up to three kilometres.

Conservation and management

Monday 15:15-15:30

MEDITERRANEAN MONK SEAL IN THE LEVANT SEA - RESPONSES TO MITIGATION MEASURES APPLIED

GUCU, A.C. (1), OK, M. (2), SAKINAN, S. (3), RAPPÉ, K. (4)

(1-3) Middle East Technical University, Institute of Marine Sciences, P.O.Box 28, Erdemli 33731, Mersin, Turkey; (4) Krommedijk 66, 8300 Knokke-Heist, Belgium

Levant Sea has been proven important for the survival of critically endangered Mediterranean monk seal. With the 11 pups joined into the colony between 1994 and 2000, the number of seals inhabiting the area had been estimated as 25 individuals. Although reproductive capability had been uninterruptedly maintained, the annual reproductive rate was very low when the demographic structure of the colony is taken into account. Lack of food and destruction/disturbance on the breeding habitats were listed as the key threats. In order to protect the species, the area has been banned to large scale fishery in 1999. The breeding habitats were also set aside against human disturbance. This study evaluates the consequences of the mitigation measures launched on the colony's reproductive capacity and expansive behaviour. Recovery in the fish stocks has been monitored through control catches. Considering the similarity between landing composition of the artisanal fishery and the diet of the monk seal, daily catch statistics of fishermen were used as an indicator to the food availability to the seals. Finally, habitat partitioning and whelping success have been monitored through field surveys carried out on the habitat of the seals during their breeding season. The results indicated a slow but consistent recovery in the fish stocks as a response to protection. The CPUE has increased from 8 kg/hour to 24 kg/hour. The landings in the local fishermen and hence food availability to the seals showed an increasing trend very similar to CPUE. The evaluation of seal survey results reveals that the anual birth rate in the colony on the west coast of Mersin is increasing, and the colony is also following an expanding trend. Caves which have not been used in the last 10 years are now frequented by the seals, which may indicate that the measures are effective.

Monday 15:30-15-45

STEPS FOR A RECOVERY PLAN FOR THE VAQUITA: THE JOINT EFFORTS OF THE INTERNATIONAL COMMITTEE FOR THE RECOVERY OF VAQUITA (CIRVA-INE) AND THE COALITION FOR THE UPPER GULF

ROJAS-BRACHO, L. (1), JARAMILLO-LEGORRETA, A. (2), URBAN, J. (3)

(1,2) Programa de Mamíferos Marinos, Instituto Nacional de Ecología/ CICESE. Km 107 Carretera Ensenada-Tijuana. Ensenada, BC 22860, México; (3) Departamento de Biología Marina, Universidad Autónoma de Baja California Sur, Ap. Post. 19B, La Paz, BCS 23081, México

The mandate of the International Committee for the Recovery of Vaquita (CIRVA) is to develop a recovery plan for *Phocoena sinus* based on the best available scientific information and which contemplates and considers the socioeconomic impacts of any necessary regulations. During the first meeting of CIRVA, in 1997, we reviewed the biology and analyzed the risk factors

for this species. The Committee agreed that the immediate risk factor for the survivals of vaquita are gillnets. The second meeting of CIRVA, in 1999 reviewed and analyzed work carried out in response to the recommendations of the first meeting, most importantly the new abundance survey in summer 1997 (567 vaquitas CV = 0.51, 95% CI 177 – 1073) and the potential mitigation measures. CIRVA concluded that only about 600 vaquita are left and that the species is critically endangered. To prevent extinction, bycatch of vaquitas must be reduced to zero as soon as possible. Since 2000 WWF, CIRVA Conservation International (CI) and IFAW have convened a series of meetings of parties interested in the recovery of the vaquita. The main outcome was the establishment of a Working Group whose mandate is to develop a general strategy for the recovery of the vaquita based on recommendations from CIRVA which consists of four main elements: Conservation, Socioeconomic aspects, Communication issues and Legal framework. In January 2004 the third CIRVA meeting took place and aspects of abundance, trends in abundance, bycatch, status assessment, alternative fishing gear design, and the socioeconomic alternatives were discussed. Here we will report on the advancements achieved so far and describe and assess current obstacles to conservation progress.

Monday 15:45-16:00

SATELLITE TELEMETRY, HEALTH, AND GENETIC ASSESSMENT OF FREE RANGING HECTOR'S DOLPHINS (*CEPHALORHYNCHUS HECTORI HECTORI*) OFF BANKS PENINSULA, NEW ZEALAND

DUIGNAN, P.J. (1), GESCHKE, K. (2), STONE, G. (3), TEILMANN, J. (4), HUTT, A. (5), SUISTED, R. (6), RUSSELL, K. (7), JONES, G.W. (8), COCKREM, J. (9), YOSHINAGA, A. (10)

(1,8,9) New Zealand Wildlife Health Centre, IVABS, Massey University, Palmerston North, New Zealand; (2) Wellington Zoo, New Zealand; (3,10) The New England Aquarium, Boston, USA; (4) National Environmental Research Institute, Department for Arctic Environment, Denmark; (5,6) Dept. of Conservation, New Zealand; (7) Auckland University, New Zealand

Three Hector's dolphins (*Cephalorhynchus hectori hectori*) were caught in the waters surrounding Banks Peninsula, New Zealand, in March 2004, and released following attachment of lightweight SPOT 3 satellite transmitters. The trial was intended to evaluate the efficacy and safety of satellite tagging for potential application to the critically endangered Maui's dolphin (*Cephalorhynchus hectori maui*). A complete health and physiological assessment was conducted on each captured dolphin prior to tagging and release, providing the first baseline health data for this species. Blood samples collected from the dolphins allowed extraction of RNA to characterize functional diversity of genes involved in the immune system defense. All three satellite tags transmitted for more than three months, providing detailed information on the home range of each dolphin. There was no evidence that the dolphins experienced deleterious health impacts from the tagging, nor did they exhibit disruption to normal behaviours. New evidence was obtained on exposure to potentially significant pathogens such as *Brucella sp*., a known cause of reproductive failure in dolphins. The results exceeded contract expectations, and have provided unprecedented insights into the movements, health and genetic diversity of the Hector's dolphin that will assist in management of critical habitat for the species.

Monday 16:30-16:45

WORLDWIDE MASS STRANDINGS OF BEAKED WHALES: RETROSPECTIVE REVIEW AND CAUSES

BROWNELL, R. L., Jr. (1), MEAD, J. G. (2), VAN HELDEN, A. L. (3), YAMADA, T. K. (4), FRANTZIS, A. (5)

(1) Southwest Fisheries Science Center, Pacific Grove, California 93950, USA; (2) National Museum of Natural History, Washington, D.C. 20560; (3) Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand; (4) National Science Museum, Tokyo 169-0073, Japan; (5) Pelagos Cetacean Research Institute, 16671 Vouliagmeni, Greece

Mass strandings of beaked whales (three or more) were rare prior to 1960. However, in the early 1960s, the frequency of such strandings markedly increased. We examine worldwide mass strandings of beaked whales and propose reasons for their increase after 1960. We documented 98 beaked whale mass strandings. Eight occurred before 1960 and 90 between 1961 and 2004. In the
first eight strandings only three of the 21 currently recognized species of beaked whales were involved. After 1961, another nine species of beaked whales mass stranded. Thirty-nine of the 98 (40%) mass strandings involved Cuvier's beaked whales, *Ziphius cavirostris*. Thirty-two cases involved Gray's beaked whale, *Mesoplodon grayi*. No atypical beaked whale mass strandings or multi-species beaked whale mass stranding were reported before 1961. All mass strandings of Cuvier's beaked whales were either strongly correlated with naval activities off the Bahamas, Canary Islands, Greece or areas where the U.S. naval vessels were deployed off Japan, Puerto Rico, and Italy. There are no known mass strandings of this species in other parts of the world. The start of these mass strandings coincided with the start of wide-scale use of tactical mid-frequency sonar by the US Navy in the early 1960s. The mass strandings of Gray's beaked whales are not associated with mid-frequency sonar but their cause is currently unknown. The US navy is exploring mitigation measures but additional studies on population size are urgently needed. Studies are critical in areas where local resident populations are subject to repeated naval operations in the same areas, as shown by repeated mass strandings, as well as other impacts such as past direct hunting and bycatch. The

impacts of deaths likely due to military operations are compounded by the very low reproductive rates in beaked whales and possible disruption of social behavior that could also reduce survival.

Monday 16:45-17:00

EXTREME DIVING BEHAVIOUR OF BEAKED WHALE SPECIES KNOWN TO STRAND IN CONJUNCTION WITH USE OF MILITARY SONARS

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Multisensor tags were used to study deep diving beaked whales of two species, *Ziphius cavirostris* and *Mesoplodon densirostris*, reported to mass strand after exposure to naval sonars. It is shown that beaked whales forage on a food source so deep that the average dive depth (*Ziphius* 1077 m, *Mesoplodon* 788 m) and duration (*Ziphius* 58 min, *Mesoplodon* 50 min) is extreme compared to other air-breathing animals. The deepest dive to 1950 meters is 20% deeper than the deepest reliable measures for any marine mammal, and the longest dive (85 min) is near the maximum reported for air breathing animals. When diving so deep to find food, the whales exceed their aerobic dive limit, and must repay the oxygen debt by prolonged periods of surface time and recovery dives in between foraging dives. Recent evidence of a decompression syndrome in stranded beaked whales has led to the hypothesis that their deep diving behaviour may pose a risk factor for these strandings. We use current models of breath-hold diving to demonstrate that their natural diving behaviour is inconsistent with problems of nitrogen super-saturation and decompression sickness. If the assumptions of these models are correct for beaked whales, then an abnormal behavioural response is a more likely risk factor for strandings in response to sonar.

Monday 17:15-17:30

ABUNDANCE OF MARINE MAMMALS IN THE CARDIGAN BAY cSAC ESTIMATED WITH DISTANCE SAMPLING AND PHOTO IDENTIFICATION SURVEYS FROM A SMALL BOAT

UGARTE, F. (1), FELCE, T. (2), STONE, E. (3), PEREZ, S. (4), HARTLEY, S. (5), EVANS, P.G.H. (6)

(1,4,6) Sea Watch Foundation Cymru, New Quay, Wales; (2-5) Cardigan Bay Marine Wildlife Centre, New Quay, Wales

In 1996, the UK submitted an area of 976 km² in Cardigan Bay, Wales, to the EC as a candidate Special Area for Conservation for its bottlenose dolphins. Our goal was to estimate the densities of marine mammals in this area. Our budget allowed for 16 distance-sampling/photo-identification surveys per year, from a 10m vessel (observation height, 3m). In 2003, a pilot study indicated that an increase in effort was needed to improve confidence intervals in abundance estimations based on the distance-sampling methodology. In order to increase the survey effort during 2004, we incorporated this methodology into dolphin-watching trips. Using Distance software, we estimated densities of 0.2 grey seals/km² (%CV 23.32) and 0.5 harbour porpoises/km² (%CV 23.08). These estimates were consistent with the ones obtained during the pilot study and confirm the importance of the area for the conservation of these species. The density estimated for bottlenose dolphins was unrealistically low (0.12 dolphins/km², %CV 39.72), probably due to a small sample size combined with the detection function being skewed by atypical sightings. In addition to distance-sampling estimations, estimates of the numbers of dolphins were carried out using identification photographs. The flattening of a discovery curve showed that a large proportion of well-marked animals had been identified. Based on the size of our catalogue, the minimum number of dolphins utilizing the area is 119. Based on the proportion of well-marked animals present in encountered groups (72%, SD=0.41, N=75 group counts), it was estimated that approximately 138 dolphins inhabit the study area. This number is consistent with the high dolphin density estimated during the pilot distance-sampling study (0.3 dolphins/km², %CV 36.58). This study highlights both potential and limitation of monitoring marine mammals by combining distance-sampling/photo ID surveys, funded by a variety of sources, including the government, an NGO, the dolphin-watching industry and volunteers.

Tuesday 5th April

Role in the ecosystem

Tuesday 8:30-9:00

MARINE MAMMALS AS INDICATORS OF ECOSYSTEM CHANGE

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The 115 species of marine mammals that live in the world's oceans span most trophic levels (2.0 – 5.1) and feed on organisms ranging from plankton to large whales. They have few predators other than sharks, polar bears, killer whales and people—and respond to changes in the quantity and quality of the prey they consume. Prey abundance directly affects individual behaviors (*e.g.*, foraging times) and physiologies (*e.g.*, metabolism and stress hormones), and can stunt or enhance body growth. At a population level, food affects birth and death rates, which can cause overall numbers to increase or decrease. Such individual and population level variables are meaningful indicators that something has changed in the ecosystem—but they are not easily interpreted. A wide range of inter-related data need to be collected to effectively use marine mammals as indicators of ecosystem status, particularly to untangle the effects of changes in the quantity and quality of available prey (*e.g.*, population size, diet, body condition, body growth rates, stress hormone concentrations, abortions, birth rates, survival rates and foraging trip lengths). Using marine mammals as effective indicators of ecosystem change requires a commitment to long-term monitoring. The most valuable combination of parameters to measure appears to be population size, diet and individual body condition—particularly for *young* animals. As *K*-selected species, adult marine mammals tend to buffer the effects of decreases in quantity and quality of prey better than young animals, and are therefore less sensitive indicators of ecosystem change. Young animals however appear to be extremely sensitive barometers of changes in prey and are potentially a useful age group to monitor ecosystem change.

Tuesday 9:00-9:15

CLIMATE PERTURBATIONS, ENVIRONMENTAL FORCING AND DEMOGRAPHIC RESPONSES IN ANTARCTIC FUR SEALS

FORCADA, J. (1), TRATHAN, P. N. (2), REID, K. (3), MURPHY, E.J. (4)

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Temporal environmental autocorrelation and the persistence of climatic anomalies lead to transitory modifications of the biological environment in marine ecosystems. Such modifications cascade to apex predators, depressing their vital rates through bottom-up control, *i.e.* limited food supply. We investigated changes in Antarctic fur seal demography over 20 years at South Georgia in response to climatic anomalies and unusual environmental conditions. Anomalies in sea surface temperature (SST) ocurred from 1990 to 1999, during a decade of warm background (time-averaged) conditions. The succession of anomalies at South Georgia was preceded by and cross-correlated with frequent El Niño-La Niña events occurring from 1987 to 1998. We analysed capture-mark-recapture data of Antarctic fur seals collected at a study site in Bird Island, South Georgia, to understand the demographic consequences of these anomalies. The results suggested that fur seal females breeding in unusually warm summers increased investment in pup rearing and significant numbers did not survive because of increased post-breeding costs. Most of the survivors deferred or failed in the subsequent breeding season. The persistence of high SST levels during the Austral summers was probably associated with the development of physical-biological processes that altered the local environment. These processes were likely to restrict the main food supply of fur seals, largely Antarctic krill, over scales longer than the breeding cycle of females. The demographic fur seal response to extreme environmental events was highly non-linear and indicated bottom-up control of SST, a proxy of Antarctic fur seal food supply. Establishing the lagged relationships between environmental anomalies and female demographic responses is fundamental for assessing the consequences of ecosystem changes driven by trends in global climate perturbations for Antarctic fur seals.

Tuesday 9:15-9:30

RELATING DELPHINID RELATIVE ABUNDANCE TO PRIMARY PRODUCTION: A SHORT-CUT THROUGH THE UNKNOWN COMPLEXITY OF THE FOOD WEB

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About 35 delphinid species can be found from 60°N to 60°S, although with variable abundance. Most species rely on an opportunistic diet, hence as a predator community, delphinids can feed upon an immense variety of prey items, with sizes ranging from one to 200 cm (and over). Primary production can be accessed worldwide by processing remote-sensed data with recently developed models. We used a set of comparable survey data from the Mediterranean Sea and French Polynesia to compute sighting rates for individuals (SRI). These relative abundance indices were compared to annual primary production (APP) computed from SeaWiFS and Pathfinder satellite sensors, for the years 1998 to 2001. In seven regions of the Mediterranean Sea, SRI's ranged from 1.11 delphinid.km^{-1} in the Alboran Sea to 0.76 in the northwestern basin and 0.33 delphinid.km^{-1} in the Ionian Sea. APP amounted from 109 gC.m^{-2}.year^{-1} in the Levantine basin to 183 in the NW basin and 236 gC.m^{-2}.year^{-1} in the Alboran Sea. When SRI and APP were plotted together (seven data), a quasi linear correlation appeared. On another hand, APP's of 68 and 175 gC.m^{-2}.year^{-1} were obtained in the Society and Marquesas archipelagos, respectively. Delphinid SRI's were of 0,07 and 0,66 delphinid.km^{-1}, although with a marked spatial segregation in the Societies (almost all dolphins were observed within 5 milles from shore). SRI-APP couples obtained in Polynesia fitted reasonably well within the range obtained in the Mediterranean, in spite of a difference in detecting efficiency in both areas. This study suggests that primary production provides a useful clue for predicting delphinid relative abundance in temperate to tropical seas. Further survey results may be used to discuss this simplified approach linking dolphin presence to oceanic productivity.

Tuesday 9:30-9:45

FORAGING STRATEGIES AND MOBILITY OF BOTTLENOSE DOLPHINS IN A SPATIO-TEMPORALLY VARIABLE ECOSYSTEM: A MODELLING APPROACH

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Marine ecosystems are generally characterised by an important heterogeneity in space and time. Such fluctuations may have fundamental consequences for marine mammal top predators, as Cetaceans, in terms of spatio-temporal distribution, mobility and foraging strategies. In the population of bottlenose dolphins, *Tursiops truncatus*, living in NE Scotland, both spatio-temporal distribution and grouping patterns have varied over the last decade. However, the extent to which this is due to variation in prey resources remains uncertain. In particular, we little know how far the population rely on salmon, a particularly predictable prey, compared to other more fluctuating prey like herring, sandeels and mackerel. Here, we use a modelling approach to investigate how the spatial and temporal distribution of prey may affect the foraging strategies of bottlenose dolphins and their distribution. We develop a food web model that incorporates explicitly population dynamics and where both the diversity and abundance of prey species may vary in space and time. Using the adaptive dynamics framework, we determine which foraging strategies and related mobility patterns predators should adopt for various scenarios of prey variability. Our results show in particular that competitive interactions and temporal variability in prey abundance may favour the coexistence of several foraging strategies within the predator population, leading to different patterns of mobility. We determine the conditions that favour such scenarios in terms of various life-history traits and bioenergenetic parameters. Our results suggest a mechanism for the spatial and temporal stratification of dolphins observed in NE Scotland.

Tuesday 10:30-10:45

ON THE ROLE OF MINKE WHALES IN THE BARENTS SEA ECOSYSTEM

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The present review aims to summarize Norwegian ecological minke whale (*Balaenoptera acutorostrata*) studies performed during the past decade, and demonstrate how scientific whaling under special permit and subsequent establishment of a routine sampling scheme during commercial whaling operations have yielded a time series (1992-2004) which have permitted assessment of spatial and temporal variations in diets, prey selectivity and annual consumption of prey. The diet of northeast Atlantic minke whales diet varies considerably both in space and time, presumably due to geographic differences in the

distribution and availability of potential prey. Capelin and krill dominate the whale diets in the northernmost Arctic areas while herring is the major prey in the southernmost coastal areas. Small and medium scales prey preference studies suggests that capelin is the most preferred prey species during early summer, followed by krill and herring. Apparently, minke whales switch to other prey in years of low densities of preferable prey such as herring and capelin resulting in a broader diet and decreased body condition. Although, minke whale consumption of prey has been assessed in the northeast Atlantic, practical use of this knowledge for the management of the resources in this ecosystem was made only recently. Minke whales predation on herring was implemented in the assessment model of herring. The result suggest that minke whales predation of herring affect the assessment of herring; the estimated stock size of juvenile and adult herring decrease 20% and 35%, respectively, compared with the baseline assessment. The predation mortality constituted almost half the total natural mortality of adult herring but only 10% of the total juvenile mortality. In the latter study the functional response was estimated from data, and the results suggest that minke whales exhibit a type III functional response.

Tuesday 10:45-11:00

VARIATION IN PREY-FIELD ENERGY AVAILABLE TO NORTH ATLANTIC RIGHT WHALES IN A PRIMARY FEEDING HABITAT

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The North Atlantic right whale is critically endangered and facing extinction. Annually, 30% or more of the whale population, primarily females and their calves, occupy the Grand Manan Basin, Bay of Fundy, during the summer and autumn period. Recent hypotheses suggest that variations in the summer distribution and reproductive capacity of the whales are related to variations in food production, abundance, and energy content. The justification of such hypotheses rests on the fact that the whales primarily feed on the lipid-rich copepods (*Calanus finmarchicus* C5 resting-stage) that accumulate at depth in the Basin during summer. However, until now, the essential data necessary to test such feeding-related hypotheses were both indirect and insufficient. In this presentation we address the working hypothesis that the energy available to the whales in this feeding habitat is equal to, or greater than, the energy demand. Specifically, we estimate the spatial (1 to 1x104 m scales, vertical and horizontal) and temporal (diurnal, tidal) variations in the abundance, lipid-content and energy-content distribution of the copepods during the primary whale-feeding period in the Basin. Our results that focus on the *C. finmarchicus* C5 indicate that the energy available (kJ m-3) to the whales, a function of copepod concentration and lipid-content, varies 25-fold with depth and 5-fold with time (at depth) over a tidal cycle. The expansion of these time- and space-varying energy estimates throughout the entire feeding domain, as derived from optical plankton counter and direct net-estimates of zooplankton size and abundance distribution data, further demonstrate that the energy available is strongly depth- and tidally-dependent. This dependence, in effect, circumscribes the time and space domain where the foraging right whales would be able to meet their energy demands. Further, we demonstrate that the above small-scale variation in energy availability is commensurate with seasonal variations.

Tuesday 11:00-11:15

FIN WHALES TUNE THEIR DISTRIBUTION AND GROUPING PATTERNS ON KRILL STANDING STOCK BIOMASSES: A TEST OF THE HYPOTHESIS USING STABLE CARBON (d13C) AND NITROGEN (d15N) ISOTOPE RATIOS

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Fin whales are euryphagous feeders, which are suspected to vary their diet according to prey availability. Between 1994 and 1999, a highly significant negative relationship was documented between krill biomasses and the spatial distribution (r^2=0.728) and density of fin whales around whale-watching vessels (r^2=0.983) in the St Lawrence Estuary, Canada. This relationship was thought to reflect fin whales response to the changing abundance of krill: whales dispersed to feed on krill during krill-rich years, but aggregated over schooling fish, probably capelin, in krill-poor years. To verify this hypothesis, δ13C and δ15N values of skin biopsies from 71 fin whales that were collected in 1998–2004 were compared to values of potential prey. Krill biomasses in the Estuary were maximal in 1994 (37.6 tons.km^{-2}) and declined to a plateau in 1996–2004 (10.1 tons.km^{-2}). Therefore, the biopsy program covered the krill-poor period only. δ15N values of whale skin showed no significant between-year variations during that period. However, values varied by 1.4–5.1‰ between whales biopsied during the same year, suggesting non-uniform diets among individuals. Assuming an onset of feeding at our latitude in May, and using only biopsies collected =3 mo after May to allow for skin turnover, a trophic enrichment factor ?t=1.7‰ for δ15N, and extremes of δ15N values known for capelin, sandlance or herring (10.2–13.7‰) and euphausiids (7.9–11.3‰) in the Northwest Atlantic, the 2-

dietary source, 1-element (N) linear mixing model suggests that prey other than capelin constituted >32% of the diet in the 47 whales, leading to the rejection of the initial hypothesis of a switch of diet towards capelin during krill-poor years. These results are consistent with the absence of fin whale feeding aggregation in the Estuary beyond 2000 (Max. N of whales per systematic survey = 1.1 in 2001–2004 *vs* 6.2 in 1996–2000).

Tuesday 11:15-11:30

VARIABILITY IN THE DIET OF COMMON DOLPHINS (*DELPHINUS DELPHIS*) IN GALICIAN WATERS 1991-2003 AND RELATIONSHIP WITH PREY ABUNDANCE

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Analyses of marine mammal diets in Galician (NW Spain) waters have been carried out over the last 13 years as part of four consecutive European funded projects. The species that is best represented in samples from stranded animals is the common dolphin, *Delphinus delphis*, for which 414 non-empty stomachs were analysed during 1991-2003. We quantified interannual and seasonal variation in the diet, as well as differences between the diets of male/female and juvenile, sub-adult and adult dolphins. Although sampling is based on stranded dolphins, the majority showed evidence of having died as a consequence of interactions with fisheries (by-catch). The influence of cause of death on stomach contents was examined. The most important prey species were (small) blue whiting (*Micromesistius poutassou*), sardine (*Sardina pilchardus*) and scad (*Trachurus sp.*), all of high commercial importance in Galician waters, and (in the first quarter of the year), sand smelt *Atherina sp*. Redundancy analysis (RDA) and generalised additive models (GAMs) were used to analyse variation in diet composition and prey length. Preliminary estimates are also made for the amount of fish removed by the common dolphin population in Galician waters. Results of both the multivariate and the univariate analyses highlighted seasonal and interannual differences in diet. Both types of analyses also indicated effects on diet composition of location, dolphin length and spawning stock biomass of the two main prey (blue whiting and sardine) although these were not significant in all models. GAMs indicate than interannual trends in the importance of sardine in the diet of common dolphins appear to track trends in sardine spawning stock biomass and blue whiting recruitment. There were also significant seasonal, interannual, dolphin size and sex effects on length of the main prey eaten, once individual variation between dolphins had been taken into account.

Tuesday 11:30-11:45

FEEDING ECOLOGY OF COMMON DOLPHINS (DELPHINUS DELPHIS) IN THE NORTH EAST ATLANTIC

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Using stomach contents from 133 individuals we examined seasonal and regional variation in the diet of common dolphins in the North East Atlantic. Samples came from dolphins stranded along the Irish coast (n=76), representing nearshore foraging, and individuals bycaught in the albacore tuna fishery (n=56) representing offshore foraging. Forty nine prey species were recorded, 35 fish species, 13 cephalopods and 1 crustacean. A total of 15,427 prey items were recovered from the offshore dolphins. Fish were numerically the most important prey group (94.6% prey numbers), with cephalopods and crustaceans comprising 5.4% and 0.1% respectively. Fish representing at least five families and 16 species were identified. Myctophids dominated the fish component accounting for 13,155 (90.2%) of the fish recovered. *Diaphus sp*., *Myctophum punctatum* and *Notoscopelus kroeyerii* were the three most important species representing 89% of fish prey. Fish also formed the dominant portion of the stomach contents of stranded individuals (96.7%), with cephalopods making up 3.3%. Gadidae comprised 59.4% of the fish component. The most commonly occurring fish were *Trisopterus spp*. (45.2%). In both groups, the foraging strategy appears to involve targeting relatively small-sized schooling fish. Offshore dolphins feed nocturnally when the migrating deep-scattering layer approaches the surface. In inshore areas, aggregations of small pelagic fish are preyed upon. A positive relationship (Spearman Rank Correlation, $P<0.01$) was found between dolphin body length and total prey numbers, but not between body length and fish species number, or proportion of cephalopods in the diet. No significant difference for these variables was found between different sex or maturity groups. Eight individuals had milk in their stomachs (aged 0 – 3 months), while three (aged 3 – 6 months) had both milk and solid food suggesting that weaning occurs between 3 and 6 months.

Tuesday 12:00-12:15

KILLER WHALES AS PREDATORS OF MARINE MAMMALS IN THE ALEUTIAN ISLANDS AND WESTERN GULF OF ALASKA

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The declines of Steller sea lions, harbor seals, northern fur seals and sea otters in the Aleutian Islands (AI) and western Gulf of Alaska (GOA) have generated a range of hypotheses regarding possible causes of these declines, including predation by killer whales. A new research program has documented that all three killer whale ecotypes known from the eastern North Pacific are also found in this region, and occur at a density that is among the highest measured in the world. Killer whale abundance from line-transect surveys was estimated at 251 (95%CI 97-644) for mammal-eating 'transients' and 991 (95%CI 379-2585) for fish-eating 'residents', indicating less than 21% of the killer whales are transients. Observed prey of 'transients' in Alaskan waters includes gray and minke whales, small cetaceans, pinnipeds and sea otters, but the percent composition is unknown. A positive correlation was found between transient density and Steller sea lion trends; the highest 'transient' density was found in the eastern AI where Steller sea lions have declined the least. Prey preferences were investigated with fatty acids (FA), stable isotopes (SI) and organochlorine contaminants (OC), using biopsy samples. Individuals from all three ecotypes can be unambiguously classified using FA, SI, and OC analyses, and levels in the AI/GOA were consistent with values expected for these predators if they have the same dietary specializations found in the eastern North Pacific. SI results suggest that AI/GOA 'transients' could not have a diet dominated by Steller sea lions or harbor seals, and must include substantial prey that feed at a lower trophic-level (such as Dall's porpoise). Interestingly, the chemical analyses suggest that 'offshore'-type killer whales feed at a higher trophic-level than expected from a fish-only diet, and may prey on fur seals (or a predator of fur seals), though this has not been observed.

Tuesday 12:15-12:30

AN ESTIMATION OF WALRUS (*ODOBENUS ROSMARUS*) PREDATION ON BIVALVES IN THE YOUNG SOUND AREA (N.E. GREENLAND)

BORN, E.W. (1), ACQUARONE, M. (2)

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The total consumption of bivalve prey by walruses (*Odobenus rosmarus*) in the important inshore summer feeding area Young Sound (about 74° N) in Northeast Greenland was estimated. To determine relative area use, the movement and activity of three adult male walruses with satellite transmitters were studied during the open water season in 1999 and 2001. Because one of the animals was tracked during both years the study covered a total of four "walrus seasons". Overall, the animals used ca. 30% of the time in the water in the inshore study area in Young Sound. The remainder of time was used along the coast north and south of Young Sound and offshore in the Greenland Sea. Information on the total number of walruses using the area (n=60), occupancy in the study area, and estimates obtained from satellite telemetry on the number of daily feeding dives (118-181/24 h at sea), was used to calculate the amount of bivalve food consumed by the walruses during a total of 1620 "walrus feeding days" inshore in Young Sound. Depending on the applied estimator of number of feeding dives, the estimated consumption by walruses of shell-free (SF) bivalve wet weight (WW) during the open water period range between 111 and 171 tons. Based on estimates of mean total body mass (TBM: 1000 kg) of walruses using the area and daily per capita gross food intake, the corresponding estimate of consumption by walruses is 97 tons SF WW. Daily feeding rates in walruses (6-7% of TBM) indicate that an estimate of total predation of around 100 tons SF WW per year is plausible.

Stock identity, survey, distribution

Tuesday 14:00-14:15

A COMPARISON OF THE PREDICTIVE ABILITIES OF FOUR APPROACHES FOR MODELLING THE DISTRIBUTION OF CETACEANS

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Accurate absence data for cetaceans are not always available, for logistical (high cost of dedicated surveys at sea) and ecological reasons (cetaceans spend most of their time underwater remaining undetectable to visual observers on the surface). This can limit the application of presence-absence modelling techniques, such as generalised linear modelling (GLM), to cetacean datasets. Recently developed techniques for analysing presence-only data avoid these limitations and permit the analysis of data from a wider range of sources (e.g. non-effort corrected surveys, public sightings databases etc). This study compared the ability of GLM with three presence-only techniques (PCA, ENFA and GARP) to predict the occurrence of harbour porpoises on the west coast of Scotland. Data were collected during dedicated surveys using passenger ferries as survey platforms. Two-thirds of the dataset was used to construct models of harbour porpoise occurrence in the study area using each technique. The remaining third was used to test and compare the model predictions using Receiver Operating Characteristic (ROC) plots where the area-under-curve (AUC) indicated predictive ability. The AUC values indicated that all four techniques produced models with significantly greater predictive abilities than random models, and the presence-only models had similar predictive abilities to the presence-absence model. In addition, all models predicted very similar spatial distributions of presence and absence. However, there were some differences. For example, the GLM predicted absence in some locations where harbour porpoises are known to occur in the study area. Interestingly, combining the predictions of all four techniques provided the most representative picture of harbour porpoise occurrence within the study area. Such a combined modelling approach may provide the best understanding of actual species distribution since the limitations of any individual technique can be compensated for by the strengths of another.

Tuesday 14:15-14:30

WHERE ARE THE MEDITERRANEAN FIN WHALES WHEN THE SUMMER IS OVER?

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Fin whale (*Balaenoptera physalus*) is the largest marine predator currently observed in the Mediterranean Sea. The population was found to be genetically distinct from the fin whales found in the north Atlantic. Each summer, an estimated 1000 to 2000 individuals concentrate in the Northern part of the occidental basin (Ligurian sea and Gulf of Lion) where they mainly feed on the zooplankter (*Meganyctiphanes norvegica*). However no clear picture has emerged so far about their year round distribution and the question of possible migration between the Mediterranean Sea and the Atlantic remains unanswered. Information about the level of isolation of that population is highly needed to determine its status and to insure its conservation. In order to describe the yearly distribution of this fin whale population we combined several indirect means of investigation. Firstly stable isotopes ratios of carbon (13C/12C) and nitrogen (15N/14N) were measured along 13 baleen plates collected on stranded animals on the French-Spanish Mediterranean (n=11) and Atlantic coasts (n=2). Analyses of 15N/14N indicate that these whales were mainly feeding on the secondary trophics levels. The comparison of 13C/12C isotopic patterns of baleen plates and the whale's krill prey sampled in the Mediterranean sea and Atlantic suggests that whales sampled in the Mediterranean sea exhibited two different migratory behavior 8 fin whales appeared to be resident to the Mediterranean while 3 individuals exhibiting large variation of their 13C/12C ratio consistent with regular migrations to the Atlantic. Secondly, inward and outward fin whale movements through the strait of Gibraltar were observed throughout the year. Finally, in August 2003, 11 fin whales were tagged in the Ligurian sea with Argos satellite-monitored radio tags to provide direct information on their distribution and movement thorough the year.

Tuesday 14:30-14:45

CETACEAN AERIAL SURVEY IN THE BAY OF BISCAY: DISTRIBUTION MAPS AND MINIMAL ABUNDANCE ESTIMATES ON THE SHELF AREA

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Top predators impact small pelagic fish stocks and compete with fisheries in all exploited ecosystems. This impact cannot be correctly inferred until predators' abundance and distribution are known. Such data are also needed to determine potential interaction with fisheries. In the Bay of Biscay, data concerning cetacean populations are sparse and come from beached animals or platforms of opportunity. In this work, we aimed to assess distribution, preferred habitats and abundance of small cetaceans in the Bay of Biscay. Then we compared it to the spatial extent of fisheries. Fourteen aerial surveys were conducted, from March 2001 onwards. Data were analysed under a geostatistical framework to produce distribution maps, and under a distance-based approach, providing abundance estimates for this area. *Tursiops truncatus*, *Stenella coerulaeoalba* and *Delphinus delphis* observations were pooled together as "small delphinids" in order to obtain sufficient data for modelling the detection function and semivariograms. Their pooled abundance was estimated at 35214 individuals (95% CI: 22399 – 55362). This must be viewed as a minimal abundance since we did not estimate g(0). Abundances were higher at the upper slope, with two principal areas located off Brittany (35.3% of the total population) and the Basque coast (47.6%). In contrast, the continental shelf (water depth < 120 m) contained only 17 % of the total population although it represented as much as 60% of the total surveyed area. Fisheries are mainly located in the shallow part of the continental shelf, and acute interaction areas are distributed south and north of the Bay, and on a coastal band included in the area less frequented by cetaceans. These results will help environmental managers to take conservation measures, and will serve as guidelines for the design of stratified sampling schemes, accounting for heterogeneity of cetacean spatial distribution.

Tuesday 15:00-15:15

BOTTLENOSE DOLPHINS OF THE AZOREAN ARCHIPELAGO WOULD BELONG TO A SINGLE POPULATION OF THE "OFFSHORE" TYPE

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Whilst assessment of cetacean stocks by direct observation is difficult and time-consuming, genetic analyses can readily provide information on population structure and dynamics, as well as patterns of genetic relatedness between individuals. In the bottlenose dolphin (*Tursiops truncatus*), mitochondrial and nuclear DNA analyses revealed the existence of genetic differentiation between nearshore and offshore ecotypes in the North-West Atlantic. Genetic differentiation can also be observed on a limited geographical scale, as in the British waters. Here, we provide information from the Azorean archipelago, the most isolated islands in the North Atlantic. We analysed 77 skin samples from all three groups of islands of the Azorean archipelago and 11 samples from animals stranded along the coast of mainland Portugal. Genetic analyses consisted in molecular sexing, sequencing of 627 bp of the mitochondrial hyper-variable region and screening of ten microsatellite loci. Both DNA sequences and microsatellites indicated a lack of population structure within the Azores, while the Azorean population appeared to be differentiated from that of mainland Portugal. A regression of relatedness coefficients against distance between sampling locations did not reveal any geographical pattern within the Azores, suggesting that bottlenose dolphins might belong to a single community. Consistently, photo-identification techniques showed that some individuals moved between groups of islands. Comparison with DNA sequences available in GenBank revealed that the Azorean population was discrete, but was only slightly differentiated from the offshore population of the North West Atlantic. Haplotypes divided into three main groups, but showed no concomitant differentiation with microsatellite variation. Contrary to what was found in the North West Atlantic, behavioural and genetic data did not indicate any differentiation between nearshore and offshore ecotypes in the Azores. Azorean bottlenose dolphins would be of the offshore type, despite the fact that they were mostly spotted within five miles from the coast.

Tuesday 15:15-15:30

PHYLOGEOGRAPHY OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE SOUTHEASTERN NORTH ATLANTIC AND IN THE BLACK SEA EXPLORED BY THE ANALYSES OF NUCLEAR AND MITOCHONDRIAL DNA

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In recent years, a decline in harbour porpoise (*Phocoena phocoena*) populations in the North Atlantic has been reported and this has raised concern over population sustainability. Although mitochondrial genetic marker has reported population structure in some parts of the North Atlantic, mitochondrial DNA (mtDNA) is a single, maternally inherited locus and therefore insufficient to fully characterize population structure and history. It is thus of utmost importance to complement mtDNA with autosomal nuclear markers. Polymorphism at 11 microsatellite loci in 248 harbour porpoises collected from the Southeastern North Atlantic waters (the south bay of the North Sea, France, Spain, Portugal) and in 61 from the Black Sea (Ukraine, Bulgaria and Georgia) were examined. Multilocus tests for allele frequency differences and population structure estimates indicate strong genetic differentiation between Atlantic and Black Sea porpoises. Microsatellite data also revealed significant partitioning of the genetic variation at smaller scale in Atlantic: porpoises of the south bay of the North Sea, those of France and those of the Iberian peninsula (Spain, Portugal), appeared genetically differentiated from each other. A similar pattern based on the mtDNA control region was reported previously (Tolley and Rosel, 2003), but nuclear loci report weaker differentiation between groups. This suggests a sex-biased dispersal with male-mediated gene flow that may maintain some homogeneity among nuclear loci. No fine population structure was observed within the Black Sea, but in contrast this population displays a lower genetic diversity compared to those of Atlantic. These results could be seen in the light of the demographic history of this population and the strong founder effect and bottleneck it may have undergone in its past evolution.

Behaviour

Tuesday 16:00-16:15

DIRECTIONALITY OF SEXUAL AGGRESSION IN MIXED-SPECIES ENCOUNTERS BETWEEN ATLANTIC SPOTTED DOLPHIN AND BOTTLENOSE DOLPHIN IN THE BAHAMAS.

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In the Bahamas, interspecific groups of Atlantic spotted dolphin, *Stenella frontalis*, and bottlenose dolphin, *Tursiops truncatus*, have been observed underwater since 1985. Mixed-species groups engage in affiliative and aggressive behaviours including foraging, babysitting, travelling, and socializing. Between 1993-2003, 177 Mixed-Species Encounters (MSE) were categorized by the minimum age of male spotted dolphins present: adult males 68% (n=120), juveniles 14% (n=24), calves 7% (n=13) or no males present 11% (n=20). Encounters were scored as Associative (travelling, babysitting) or Interactive (chases, mounting, head to heads). Associative behaviours were observed more than Interactive behaviours in groups where no male spotted dolphin, only male calves, or only male juvenile spotted dolphins were present. Interactive behaviours were observed more frequently (2:1) than Associative behaviours in adult male spotted dolphin groups. In 91 MSE with adult male spotted dolphin, directionality of sexual/aggressive behaviours included bottlenose males chasing/mounting spotted males (n=31), bottlenose males chasing/mounting female spotted (n=6), spotted males chasing/mounting female bottlenose (n=9), spotted males chasing male bottlenose (n=14), and mutual head to heads (n=31). Male spotted dolphins were never observed attempting to mount male bottlenose dolphin. In 137 encounters the ratio of spotted to bottlenose dolphins was greater than 1:1, ranging as high as 38:1 when adult male spotted dolphin were present. In 40 encounters ratios were < 1:1. Encounters when no male spotted dolphins were present favored lower ratios. Mixed-species interaction with juvenile male spotted dolphins was reciprocal/playful. Despite the larger ratio of male spotted dolphins to bottlenose dolphins during MSE, directionality of aggression was primarily one-way with male bottlenose mounting male spotted dolphins. Opportunities for cross-species mating clearly occurred. Copulation by male bottlenose dolphins mating to female spotted dolphins and the male spotted dolphins copulating with female bottlenose dolphins was observed.

Tuesday 16:15-16:30

LONG-TERM INTERSPECIES ASSOCIATION PATTERNS BETWEEN ATLANTIC SPOTTED DOLPHINS AND BOTTLENOSE DOLPHINS IN THE BAHAMAS

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There have been many descriptions of interspecies interactions, however none have quantified these in association values. This study reports on associations between Atlantic spotted dolphins (*Stenella frontalis*) and bottlenose dolphins (*Tursiops truncatus*), in the Bahamas, from 1993-2003. The half-weight index was used to determine coefficients of association (COA) during mixed species encounters (MSE, n=179) for individuals with 7 or more MSE sightings. There were 109 individuals: 94 spotted (49 male, 45 female), and 15 bottlenose (7 male, 8 female). Total group size ranged from 3 to 78, with spotted dolphins having significantly higher group sizes (x=12.9) than bottlenose (x=4.7). Spotted dolphin individuals had a significantly higher number of MSE sightings (7-46, x=17.1) than bottlenose (7-18, x=10.2). Spotted dolphin males had significantly higher numbers of MSE sightings than females. Of the total possible associations, 77% were observed (COA > 0). Of these associations 72.85% were low (< .39), 4.1% were moderate (.4-.79), and .05% were high (> .80). Within species COA were significantly higher than between species COA for both males and females. For both bottlenose and spotted, same-sex pair COA were significantly higher than mixed-sex pair COA. Male-male pairs for both species had higher COA means than female-female pairs. Sixty-five percent of all moderate COA were between spotted dolphin male-male pairs. Two of 3 high COA were also spotted male-male pairs. The majority of the males with moderate-high COA are members of known alliances. Only two known male bottlenose alliances were present in MSE sightings, with COA of .32 and .37. There appear to be no long-term associations between species during MSE. However, male spotted dolphins retain long-term associations within species during MSE, and bottlenose do not. This suggests that the function of within species male alliances is more important for spotteds in MSE than for bottlenose.

Critical habitat

Tuesday 16:45-17:00

THE MIGRATION OF HUMPBACK WHALES BREEDING OFF SOCORRO ISLAND, MEXICO TO SUMMER FEEDING HABITAT

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During February 2003, 11 humpback whales (*Megaptera novaeangliae*) were tagged off Socorro Island, 400km SSW of Baja California, Mexico. Little is known of where members of this breeding and calving population migrate for summer feeding. Tagged whales travelled >42,343km (average 3,849km and 59.3d) at 0.8-3.8km/h. The longest track was 10,480km in 149d, averaging 2.9km/hr. Migrations at 4.1-6.4km/h were 40-1,000km offshore, not unified, and reasonably direct to summer destinations >42km offshore, explaining why few photo matches have occurred. Habits of whales feeding in open-ocean habitats are largely unknown due the difficulties and expense in studying these populations. Pelagic feeding for 56d following migration provided the first insights into humpback whales feeding exclusively in offshore areas and suggests small home ranges.

Tuesday 17:00-17:15

PREDICTING KEY HABITAT AND POTENTIAL DISTRIBUTION OF NORTHERN BOTTLENOSE WHALES (*HYPEROODON AMPULLATUS*) IN THE NORTHWEST ATLANTIC OCEAN

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The distribution, status and specific habitat requirements of northern bottlenose whales (*Hyperoodon ampullatus*) in the Northwest Atlantic are unknown beyond the well-studied small population that use the Scotian Shelf. The population in the Labrador Sea is believed to be relatively large and distinct from that of the Scotian Shelf, with the potential for interchange

between the populations unclear. We apply Ecological Niche Factor Analysis (ENFA), a predictive modelling approach to identify areas of key habitat for northern bottlenose whales within the Northwest Atlantic, and establish whether a habitat corridor links the Labrador and Scotian Shelf populations. ENFA models species distribution in relation to ecogeographical variables (EGVs) using presence-only data. Using a combination of modern survey data, fisheries observer reports and historic whaling catch data; a database of 2103 records was compiled. This was combined with four EGVs: depth, slope, aspect and sea surface temperature (SST) and then modelled using ENFA. Habitat suitability (HS) can then be expressed as a value between 0 (low suitability) and 100 (maximum suitability) for each 2.75km x 2.75km cell within the study area. The HS map demonstrated northern bottlenose whale habitat to be concentrated in the steep, shelf-edge waters of the Northwest Atlantic, with habitat of at least marginal suitability (HS values 34-66) providing a continuous link between the Scotian Shelf and the Labrador Sea. Mean area-adjusted frequency during jack-knife cross-validation showed the model to be a good fit to the data: Fi>1 for high habitat suitability values (Fi=11.95 ± 1.884). The model supported the possibility for movements of individuals between the Scotian Shelf and Labrador Sea, and highlighted the specialisation of this species in terms of their habitat requirements. The potential habitat of this species was shown to be limited, with 'core' habitat predicted by the model representing only 2.5% of the study area

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Trophic links as vectors of contaminants and pathogens

Wednesday 8:30-9:00

TROPHIC LINKS AS VECTORS OF PATHOGENS AND CONTAMINANTS

PIERCE. G.J. (1), SANTOS, M.B. (2), LEARMONTH, J.A. (3), ZUUR, A.F. (4), BOON, J. (5), ZEGERS, B. (6), CAURANT, F. (7), RIDOUX, V. (8), BUSTAMANTE, P. (9), LAHAYE, V. (10), LAW, R.J. (11), ROGAN, E. (12), MURPHY, V. (13), MOFFAT, C.F. (14), ADDINK, M. (15), LÓPEZ, A. (16), ALONSO, J.M. (17), GONZÁLEZ, A.F. (18), GARCÍA-HARTMANN, M. (19), JAUNIAUX, T. (20), LOCKYER, C. (21), REID, R.J. (22), DABIN, W. (23)

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In marine mammals, feeding represents the main route of entry for persistent organic pollutants and toxic elements, as well as most internal parasites and many pathogenic micro-organisms. This talk will briefly review current knowledge on the trophic transfer of pathogens and contaminants into marine mammals and then present some of the results from the recent European project *BIOaccumulation of persistent organic pollutants in small CETaceans in European waters: transport pathways and impact on reproduction* (BIOCET). The overall aims of the project were to identify vulnerable populations or sub-groups of small cetaceans and to establish the factors which contributed to observed patterns of contaminant distribution. By accessing samples from national strandings networks, levels of POPs and toxic elements were measured in female common dolphins and harbour porpoises from various areas within the NE Atlantic: Scotland (UK), Ireland, Netherlands, France and Galicia (NW Spain). The project also measured putative explanatory variables such as length, age, reproductive status and history, and diet, as well as measuring contaminant levels in selected prey species. Blubber fatty acid profiles provided a long-term picture of diet at the individual level while stomach contents represent a snapshot. Results indicate that concentrations of PCBs were highest in harbour porpoises from the southern North Sea, and common dolphins from the western Channel and Bay of Biscay, whereas levels of brominated flame retardants were highest in waters to the west and east of the UK. The estimated reproductive rate of harbour porpoises from Dutch waters was lower than in other areas. In female common dolphins, it was shown that diet was the most important determinant of the overall pattern of POP levels in blubber, although there were also significant effects of country, reproductive status, size and season. Contaminant measurements on putative prey species confirm that POP levels are highest in fatty fish such as mackerel. Mercury concentrations were highest in large prey from more southern latitudes, while cadmium concentrations were also higher in larger prey and generally higher in cephalopods than in fish. Using quantitative FA analysis it is possible to refine this interpretation to tentatively identify the prey species that are most strongly linked to accumulation of specific contaminants. On the other hand, toxic element burden in female common dolphins was most strongly related to age and reproductive status although a significant effect of diet was also apparent. Comparative data on porpoises are presented.

Wednesday 9:00-9:15

NEW INSIGHTS FROM METALLIC TRACERS ON THE FEEDING ECOLOGY OF COMMON DOLPHINS IN EUROPEAN WATERS

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The common dolphin, *Delphinus delphis*, is the most abundant small cetacean inhabiting the temperate waters of the north-eastern Atlantic. Although its distribution can be correlated to oceanographic features, it is likely that prey abundance is the major factor in determining its occurrence and movement. Traditional dietary approaches dealt with a short time-scale compared to the life span of cetaceans, which make heavy metals like cadmium (Cd) and mercury (Hg) potential complementary tools to investigate long-term dietary preferences. Accumulation trends of Cd and Hg with age were compared between dolphins collected from Northern Spain (Galicia) to West Ireland. Metal analyses were assayed in whole prey in order to reflect exposure via food, as well as in liver and kidney of dolphins. As expected, cephalopods constituted the main source of Cd while Hg was present in its bioavailable form (Methyl-Hg) at equivalent proportion in both prey. The important variability of Hg concentrations in dolphins did not permit to discriminate any areas. However, renal Cd accumulation enabled the identification of different groups ($p < 0.0001$). The highest concentrations were observed in dolphins from the offshore waters of the Bay of Biscay (16.3 ± 14 µg.g-1 w.wt), which were 10 times higher than those stranded along Galician and French Atlantic coasts. Such elevated levels in offshore dolphins were linked to the consumption of oceanic cephalopods, which exhibited the highest Cd level among cephalopods. The important concentrations encountered in Irish dolphins (11.2 ± 8.9 µg.g-1 w.wt) could also be the consequence of either a Cd enrichment with latitude or movements of dolphins to offshore waters. Lastly, the elevated concentrations displayed in some individuals from the Bay of Biscay and a stranding mass along the northern Brittany coast suggested movements and mixing of common dolphins between the considered areas, which were not identified with traditional methods.

Wednesday 9:15-9:30

THE RISK OF INFECTION FROM POLYCHLORINATED BIPHENYL EXPOSURE IN HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) – A CASE-CONTROL APPROACH

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Organochlorine contaminants, particularly polychlorinated biphenyls (PCBs) have immunosuppressive effects on a wide range of species, including cetaceans. Recent studies of harbour porpoise stranded around the UK coast have demonstrated a significant relationship between death from infectious disease and high levels of blubber PCBs (sum of 25 CB congeners, S25CBs), after controlling for confounding factors such as nutritional state. Here we show that data from long-term strandings schemes can be used to estimate the relative risk of infectious disease death using a classical case-control epidemiological study design. Cases were defined as animals that died of an infectious disease (parasitic, bacterial, viral or mycotic, n=82) and controls as those that died due to acute physical trauma, by-catch or dystocia (n=175). Logistic regression was used to estimate the exposure odds ratio (or relative risk) and its 95% confidence interval, comparing the S25CBs in the blubber of the cases and controls and controlling for the effect of nutritional status, sex, age, region and season. The odds ratio (OR) was 1.035 with 95% confidence limits of 1.01 – 1.06, indicating a higher risk of infectious disease death in harbour porpoise for a 1mg/kg increase in blubber S25CBs, i.e. the odds that an animal will die of infectious disease is 3.5% higher for each unit increase in blubber S25CBs over that of the controls. For a difference of 10 mg/kg the OR increases to ~1.5 (95% CI 1.3 – 1.7) which indicates a 50% increase in the risk of infectious disease death. Such an approach is useful for conservation managers to understand the likely impact of exposure to PCBs at different levels and may provide a further tool for risk assessment decisions. In addition it may provide constructive dose-response data for population level effect studies.

Wednesday 9:30-9:45

METAL INTAKE WITH FOOD – METAL SENSITIVITY AS INDICATOR OF IMMUNMODULATION IN SEALS

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The influence of metals on marine mammal health is still in the focus of interest and not totally investigated. For the clarification of this point the purpose of this study was to investigate metal-specific hypersensitivity and metal content in blood. Immunotoxic pollutants may lead to two main types of effects: immunosuppression, which may result in an increased susceptibility to infectious diseases or tumours, or dysregulation of the immune response leading to hypersensitivity and autoimmunity. We investigated the T-lymphocyte response to metals in terms of hypersensitivity using a lymphocyte transformation test (LTT) for detecting antigen-specific metal sensitivities according to the MELISA® (memory lymphocyte immuno-stimulation assay). Furthermore, blood trace element concentrations were measured with mass- or fluorescence-

spectrometry. In this study 13 free-ranging harbour seals from the North Sea were investigated. Surprisingly, we found metal hypersensitivities in 7 of 11 seals, 4 animals showed single and 3 multiple reactivity. The sensitising metals were Mo, Ti, Ni, Cr, Al, Pb, Sn. The whole study comprised 154 single tests including 13 tests with a hypersensitivity reaction. Elevated metal levels in whole blood correlated with hypersensitivity reactions in 7 of 13 tests. Particularly for Ni, Al and Cr highest concentration in whole blood are connected with sensibilisation. Summarizing, the combination of both investigations, the measurement of the actually metal body burden and the determination of metals hypersensitivities caused by recently or former metal contact probably through food intake is a good basis to determine marine metal pollution and the hazardous impact on marine mammals.

Genetics and social structure

Wednesday 10:30-10:45

MITOCHONDRIAL DNA VARIATION AMONG VOCAL CLANS IN SPERM WHALES

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It has been previously shown that sperm whales in the Eastern Tropical Pacific can be divided into vocal clans based on their production of codas (stereotyped patterns of broadband clicks). These results raise the obvious question of how this clan structure might relate to genetic population structure. During extended fieldwork off northern Chile, we collected sloughed skin samples from 79 individual whales, identified by photograph subsequent to sample collection; none were mature males. According to concurrent photo-identification effort, these individuals belonged to 15 different social groups, from 3 of the 4 clans identified in Chilean waters; 42 individuals from 7 'regular' clan groups, 30 individuals from 4 'short' clan groups and 7 individuals from 4 '4+' clan groups. We sequenced 399 base pairs from the hypervariable control region of the mitochondrial DNA and assigned all but one individual to previously known haplotypes; one individual had a previously unrecorded haplotype, increasing the known global haplotype list to 26. G-tests on the haplotype distribution showed significant differences in the haplotype frequencies among clans ($p<0.001$), although no clan was strictly matrilineal as every clan contained at least 2 haplotypes. This result suggests that vocal clans are linked to matrilineal population structure, and as such has important implications for the management of this species and our understanding of the evolution of vocal clans. However, more work is needed on nuclear DNA to assess the extent of male-mediated gene flow.

Wednesday 10:45-11:00

GENETICS AND SOCIAL ECOLOGY OF PELAGIC DELPHINIDS: THE STRUCTURE AND DYNAMICS OF A GROUP OF SHORT-BEAKED COMMON DOLPHINS IN THE NORTHEAST ATLANTIC

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Compared to long-term studies on coastal delphinid social structure, little is known of pelagic dolphins as they are generally less accessible to behavioural investigations. The present work was aimed at investigating group structure and dynamics of the pelagic common dolphin, *Delphinus delphis*. A mass stranding observed in 2002 provided material from 53 individuals that constituted a single social unit and 112 individual strandings collected over the period 1993-2004 provided animals randomly taken from different social units. We analysed genetic (mtDNA control region and cytochrome B) variability within a social unit as compared to between dolphins taken at random. We also assessed for how long the members of the social unit were likely to have shared a common existence by analysing within and between group variability in ecological parameters that are integrated in the organism over increasing periods of time: stomach contents (days), fatty acids (month), heavy metals (years to tens of years) and organic contaminants (tens of years). Analyses on coding and non-coding mitochondrial DNA fragments showed that intra-group variability was similar to inter-group variability and failed to detect genetic differentiation between the social unit and individuals taken at random. As to the different ecological marker of common existence, stomach contents within the group were much more similar than between individuals from different groups in the same area. Additionally, fatty acid composition showed that the individuals of the social unit were more similar than other common dolphins of the same region. By contrast, variability in organic contaminants and heavy metals within the social unit was comparable to variability

observed between different social units in the area. As a conclusion, this suggests that common dolphins constituting a social unit have not been genetically isolated and that the duration of their common existence is limited to a few months or years.

Medicine and disease

Wednesday 11:00-11:15

BEAKED WHALES, SONAR AND THE "BUBBLE HYPOTHESIS"

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Spatio-temporal links between some deployments of active mid-frequency sonar and beaked whale mass strandings are now widely accepted to be indicative of some cause (sonar) and effect (stranding); however, the underlying mechanism(s) remain a topic of intense scientific debate. Among potential mechanisms considered for these stranding events, theoretical mechanisms for acoustically mediated in vivo bubble formation in marine mammals exposed to high intensity anthropogenic sound sources (e.g. naval sonar) have been proposed. More recently, pathological findings consistent with in vivo bubble formation and tissue trauma observed following severe decompression sickness have been reported in three beaked whale species (comprising 10 necropsied individuals) that mass stranded in the Canary Islands in 2002 contemporaneously with naval sonar use. Bubble formation associated with acute and chronic tissue injury has also been demonstrated in some individually-stranded cetaceans in the UK, although the definitive cause of these bubbles has not been established. These pathological findings demonstrate that cetaceans can experience gas bubble development, possibly through induced off-gassing of nitrogen supersaturated tissue. Emerging data from beaked whale dive profiles suggest that these species exhibit a combination of slow ascent rates and short surface intervals. It has been hypothesized that behavioural disruption of normal beaked whale dive profiles (e.g. accelerated ascent combined with extended surface interval), could occur at received levels of noise significantly lower than those needed to directly damage tissues, and may precipitate a potentially fatal degree of nitrogen bubble formation in tissues. Alternatively, it may be necessary for an external stimulus, such as acoustic exposure, to induce destabilization of pre-existing bubble nuclei. The confirmation of whether in vivo nitrogen gas bubble formation occurs in diving cetaceans and whether it can serve as a mechanism in sonar-induced beaked whale mass strandings are future research priorities. Research topics should identify acoustic signal types and levels necessary to trigger an adverse behavioural response or cause the destabilization of existing bubble nuclei.

Wednesday 11:15-11:30

MOLECULAR GENOTYPING AND PHYLOGENY OF ANISAKID NEMATODES FROM CETACEANS OF FLORIDA WATERS

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Anisakid nematodes are common cosmopolitan parasites of marine mammals (pinnipeds and cetaceans) and fish-eating birds. Cetaceans are definitive hosts of many anisakid species of the genus *Anisakis* and of two species of the genus *Pseudoterranova* (*P.kogiae* and *P.ceticola*). Molecular approaches have improved our ability to identify anisakid species, thus contributing to our understanding of their systematics and biodiversity, allowing for the detection of new species and/or sibling species. In this study molecular genotyping was performed on the anisakids parasitic on cetaceans in Florida waters. Nematodes were collected from two groups of stranded animals: physeteroid whales (*Physeter macrocephalus, Kogia breviceps,* and *K.sima*) and delphinid dolphins (*Steno bredanensis, Lagenodelphis hosei, Stenella attenuata* and *S. longirostris*). Genotyping of anisakid specimens was achieved by PCR amplification of the region of the rDNA gene, spanning the ITS-1, 5.8S and ITS-2. Amplicons were then digested using diagnostic endonucleases. DNA sequencing was performed to confirm PCR-RFLP genotyping and for phylogenetic purposes. For physeteroid whales, *P.macrocephalus* nematodes showed to genetically correspond to *Anisakis physeteris*. RFLP patterns of specimens from *K.breviceps* allowed the detection of two distinct taxa, morphologically assigned to *Anisakis brevispiculata,* indicated as species I and II. These two cryptic species were also detected in *K.sima.* One individual identified as *A.physeteris* and few specimens corresponding to *Pseudoterranova ceticola* were also detected in *K.breviceps.* For delphinid dolphins, PCR-RFLP patterns from most of the nematodes from *S.bredanensis* corresponded to *Anisakis typica* and a few of them to *Anisakis simplex s.s.* Nematodes from *L.hosei, S.attenuata* and *S.longirostris* were all characterized as *A.typica*. Sequence analysis provided a phylogenetic tree describing two main clades,

one comprising *Anisakis* species recovered from physeteroid whales and the other including species found in delphinid dolphins, indicating a significant host-parasite relationship, advocating the use of parasitic nematodes as biological tags of stocks or closely-related species of cetaceans.

Wednesday 11:30-11:45

MHC CARACTERIZATION IN THREE CETACEAN SPECIES AND THE CONNEXIONS BETWEEN PATHOLOGY AND POPULATION GENETICS

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Little is known about Cetacean Major Histocompatibility Complex (MHC). The few studies that were carried out on Cetacean MHC diversity (Hayashi et al, 2003 ; Murray et al, 1995 ; Murray et al 1998) revealed a low degree of diversity and they attributed it to marine homogenous environment. In order to verify such hypothesis, we surveyed three species not previously studied on a new locus : *Stenella cœruleoalba*, *Tursiops truncatus* and *Balaenoptera physalus*. The MHC loci were identified by PCR followed by DGGE separation and direct sequencing. The obtained sequences were compared by ML, MP and genealogies simulated by MCMC Metropolis-Hastings methods. Heterozygoty was assessed by classical methods on Stenella cœruleoalba were the sampling was large enough. The results shows not only a much greater diversity than previously assessed for neighbouring loci but also ancestral polymorphism shared with other Cetartiodactyls and for some alleles Primates. The first result may be due to the more powerful method used and the second by a close contact to ancestral shared virus interactions such as *Morbillivirus*, strongly associated with our MHC locus (Ovsya et al, 2003) and a great balancing selection. The method should be used to assess impact of *Morbillivirus* on Cetacean populations by coupling it with RT-PCR detection of *Morbillivirus*. Another application of this method, as in human forensic studies, is to finescale assessment parentage between individuals.

Wednesday 12:00-12:15

THE USE OF AN INDIVIDUAL-BASED MODEL OF SEAL MOVEMENT TO INVESTIGATE THE SPREAD OF PHOCINE DISTEMPER VIRUS WITHIN LOCAL POPULATIONS

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Phocine distemper virus (PDV) was responsible for the death of around 23,000 common seals in 1988 and 30,000 in 2002 in European waters. The 2002 epidemic, in particular, provided an opportunity for relevant information to be collected for the estimation of epidemic parameters such as contact rate and case mortality. Despite this, there is still uncertainty surrounding a number of parameters and several different hypotheses have been proposed to explain observed differences in mortality between regions and epidemics. We used an individual-based model of seal movement in real space to test the influence of movement and epidemiological parameters on the spread of PDV and to compare the predictions of the hypotheses mentioned above. We used satellite telemetry data from the UK to estimate the probability that a seal will move between haulout sites within a region, and the effect that the distance between sites has on this probability. The best-fitting model involved an inverse distance function and a constant probability of return to the haulout that was last used. The resulting probabilities were used to parameterise the movement within the individual-based simulation model. This model has been used to investigate a number of parameters including % immunity in the pre-epizootic population, length of the infectious period and time of epidemic onset. All parameters had a significant effect on the probability that an epidemic would actually occur. However, each parameter had a different effect on overall mortality, the peak mortality date and the duration of an epidemic. These models have enhanced our understanding of the consequences of uncertainty in the epidemic parameters and of regional differences in seal movement on the spread of PDV.

Wednesday 12:15-12:30

MOLECULAR CHARACTERIZATION OF PHOCINE DISTEMPER VIRUS ISOLATED IN 2002

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In 2002, the outbreak of a devastating phocine distemper virus (PDV) epizootic killed several thousand seals from northwest European waters. The start of the disease at the Danish Isle Anholt, the clinical symptoms and the pathomorphological findings resembled those, observed during the first mass die-off in 1988. To date, a characterization of the morbillivirus isolated during the last epizootic is missing. Here we report the nucleotide and deduced amino acid composition of the haemagglutinin (H) protein of phocine distemper virus isolated in 2002. RNA from three seals deceased during the seal distemper epidemic was isolated and the cDNA was determined by RT-PCR using overlapping primer pairs. At the nucleic acid level, a 98-99% homology with known seal distemper isolates from 1988 was demonstrated. The deduced amino acid sequence showed a 98% homology with PDV-isolates from 1988, a homology of 74% with canine distemper virus and a 36% level of concordance with human measles virus and rinderpest morbillivirus, respectively. Changes in the nucleotide sequence did not lead to changes in the junction zone between the F and H genes. In addition, no changes were observed in the cysteine residues or the glycosylation sites of the H protein. Amino acid exchanges were distributed across the H protein. Indications of virulence-associated mutations in this gene section were not observed. The presented data indicate, that PDV is closely related to CDV and seems to be a highly-seal adapted virus with minor changes over the past 14 years.

Ecology

Wednesday 14:00-14:15

INVESTIGATION OF HARBOUR PORPOISE AND BOTTLENOSE DOLPHIN ECOLOGY IN CARDIGAN BAY, U.K., USING MODEL BASED SPATIAL ANALYSES

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Model based spatial analyses can improve our understanding of distribution and habitat use by allowing assessment of the significance of environmental variables as predictors of animal abundance. Data from a line transect survey carried out in Cardigan Bay in 2001, previously analysed using DISTANCE software, were re-analysed using generalised additive models. A grid of 2 minutes latitude and longitude resolution was overlaid on the study area and the following environmental variables associated with each grid cell: latitude, longitude, distance from the coast, distance from New Quay, distance from the Teifi estuary, depth, slope, substrate type, and substrate diversity. Transects were divided into short segments and associated with grid cells on the basis of the position of the mid point of each segment. The response variable modelled was the estimated number of groups of either bottlenose dolphins or harbour porpoises, derived from the Horvitz-Thompson estimator. Models were fitted using the mgcv package for R; objective criteria were used in decisions to drop terms and select the best fit. The best fitting models for both species were those that included latitude, longitude, distance from the coast, and depth. Substrate type and diversity improved the fit of the bottlenose dolphin model, but these variables did not improve the fit of the harbour porpoise model, for which distance from the Teifi estuary was more important. The models explained 81% of deviance in the case of bottlenose dolphins, and 60% in the case of harbour porpoises. The predicted distribution of abundance for the two species suggested harbour porpoises tend to avoid high density areas for bottlenose dolphin. A model of harbour porpoise abundance that included a term for bottlenose dolphin abundance further improved the fit (67% deviance explained), and suggested that dolphin abundance was a significant factor ($p=0.01$) affecting the spatial distribution of porpoise abundance.

Wednesday 14:15-14:30

FORAGING IN ANTARCTIC SEA ICE BY SOUTHERN ELEPHANT SEALS: A COMPROMISE BETWEEN FOOD AND BREEDING CONSTRAINT

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Southern elephant seals (*Mirounga leonina*) have a circumpolar distribution and they breed on subantarctic Islands lying close to the Antarctic Convergence. In 2002-2004, five breeding females and seven juvenile males were fitted with new ARGOS-CTD transmitters at Kerguelen Island, after they completed their moult. Their foraging success was evaluated by measuring changes of drift rate in drift dives through the foraging trip. All but two individuals tracked and regardless of their sexes reached in early fall the Antarctic continental shelf where they tended to forage successfully and benthicaly. The seasonal changes of sea-ice concentration were monitored daily using Advanced Macrowave Scanning Radiometer and were provided

by the university of Bremen. As the sea ice extended, from April to August, males and females adopted different foraging behaviour. Males remained on the continental shelf to forage in heavy pack ice reaching 80 to 100 %, while females moved northward to remain associated with the ice edge. Both sexes were able to travel across sea ice concentration ranging from 80% to 100%, with one male crossing up to 600 km of sea-ice in less than 8 days to reach the Antarctic plateau in winter. The marginal sea-ice zone is a highly productive area and breeding females were likely to target this area to maximise their energetic gain. Furthermore females may also favour this strategy to minimize the risk of ice entrapment, which would prevent them to reach their breeding colony in early spring to give birth in contrast to the juvenile males which have no breeding constraint. This study strongly indicates that the elephant seals from Kerguelen are Antarctic seals breeding on a subantarctic Island.

Wednesday 14:30-14:45

AGE-SPECIFIC SURVIVAL IN SUBANTARCTIC FUR SEALS BORN IN AMSTERDAM ISLAND: THE FILTERS GENERATING WITHIN-COHORT SELECTION PROCESSES

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Past developments of life-history strategies in long-lived species have permitted to show that in large mammal populations, offspring survival represents a significant contributor to variation in population dynamics, and a potential indicator of the population status. Hence a precise assessment of the factors affecting survival from offspring to adulthood is crucial for the understanding of population dynamics. Using a mark-recapture dataset of 7 consecutive years, this study investigated the factors affecting individual survival throughout the life of known-aged tagged subantarctic fur seals (*Arctocephalus tropicalis*) born on Amsterdam Island (southern Indian Ocean). Survival at weaning represented 69% of the pups born, and no factor seemed to influence this value. In contrast, postweaning survival represented 66% of the weaned pups, and was related to both sex, pup preweaning growth rate, and environmental conditions at weaning. Therefore, approximately half of the pups born reached the juvenile stage, where yearly survival was high and constant (0.964 ± 0.022), and unrelated to any tested environmental or individual characteristic. Adult female survival was similar to the juvenile value, but while non-breeders could be divided in two age-classes (older age class at 13 yrs plus), the breeding females exhibited a three age-class pattern with a maximum survival for the prime-age class (7-12 yrs). Non-breeders exhibited a lower survival than that of breeders, and female breeding performances showed consistency from one year to the next, providing evidence for female individual quality. Moreover, the lower survival in younger breeders also suggested the existence of reproductive costs. These results suggest that younger age-classes included a higher proportion of lower quality individuals, which are likely to face higher costs of maintenance and/or reproduction. This consequently led to consider the rearing process, the postweaning period, and the first breeding event as the 3 main within-cohort selection processes occurring within the population.

New techniques

Wednesday 14:45-15:00

FASTLOC / GSM – A HYBRID GPS POSITION-FIXING SYSTEM FOR MARINE MAMMAL TRACKING

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We present a novel, hybrid GPS location-fixing system, termed Fastloc, that is incorporated into a telemetry tag that relays data ashore by means of the GSM mobile phone system. Despite recent advances in filtering algorithms, both Argos and Geo-location techniques may provide the user with location fixes that are either of insufficient accuracy or temporal resolution. From a cold start, conventional GPS requires an uninterrupted surfacing period of up to two minutes to obtain the required satellite constellation ephemeris and almanac data. This is seldom achievable for many seal, and all cetacean, species. However, Fastloc only requires a 16 ms snapshot of GPS satellite signals. Satellite pseudo-range data are then decoded from this snapshot and stored (30 bytes) for subsequent transmission. The entire operation requires 10 joules of energy (a D cell contains c. 120,000 joules). Once ashore, the pseudo-range records are combined with archived GPS constellation data, available on the internet, to produce location fixes. 95% of such fixes are accurate to within 50 m. Fastloc has been interfaced to a GSM mobile phone unit to relay pseudo-range data ashore when the opportunity arises. Data rates of 300 bytes per second have been achieved over an international roaming route at energy cost of c. 20 joules per Kbyte. Routing pseudo-range data via Argos has also been achieved. Fastloc thus opens up the possibility of studying fine scale movement with far higher accuracy and temporal resolution.

Wednesday 15:00-15:15

ECHOLOCATION AND MOVEMENT OF A FORAGING BLAINVILLE'S BEAKED WHALE (*MESOPLODON DENSIROSTRIS*)

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Despite several well-documented stranding events coincident with naval maneuvers, little is known about the normal behaviour of Blainville's beaked whales. Recent deployments of acoustic and orientation recording tags (DTags) on this reclusive species have revealed the production of click and buzz sounds, analogous to those made by other echolocating odontocetes and bats, during deep dives. Also frequently recorded were closing sequences of echoes from objects in the water, the first recording of such echoes in a free-ranging cetacean. The coincidence of some echoes with buzz sounds and related rapid orientation changes offers a detailed view of the final stages of a feeding event. Data from a new high frequency and stereo version of the DTag, deployed on a Blainville's beaked whale in September 2004 in the Canary Islands, includes the bearing to each echoic target in addition to its range and closing speed enabling target motion analysis. The data show that the whale turned its head from side-to-side frequently during foraging effectively sweeping a narrow sonar beam across a broad field. Given the large number of echoes in the tag recording, such head-turning is likely a method for increasing the search volume for prey with a narrow insonifying beam in a highly cluttered acoustic scene. Combining the deduced head movement with the orientation changes and fluking of the whale, and the relative motion of the target, enables the first study of prey selection and acquisition of a free-swimming whale in a natural environment.

Wednesday 15:15-15:30

THE EUROPHLUKES PROJECT – A EUROPEAN-WIDE PHOTO-ID CATALOGUE

EVANS, P.G.H. (1), BEEKMAN, B. (2), CAÑADAS, A. (3), DAVIS, P. (4), GORDON, J. (5), HUELE, R. (6), PANIGADA, S. (7), PAUWELS, E. (8), RANGUELOVA, E. (9), STEENBEEK, A. (10), STEINER, L. (11), THIJSSE, P. (12)

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Between 2002 and 2004, the European Union funded a project entitled Europhlukes. Forty-seven research groups from 14 countries around Europe have contributed over 54,000 digitised images and associated data representing 20 cetacean species. These are held on a central database that can be accessed electronically, and a meta database structure has been developed that enables the linking of different types of data (such as photo-ID, line-transect survey, acoustic monitoring, biopsy sampling, and focal follows). The main features used to identify individual cetaceans are reviewed. These include nicks in dorsal fins and tail flukes, and pigmentation patterns on the head, back, flanks, fin and tail The ten species with the greatest number of images are bottlenose dolphin (30%), long-finned pilot whale (21%), short-beaked common dolphin (17%), Risso's dolphin (10%), sperm whale (8%), killer whale (5%), fin whale (4%), short-finned pilot whale (1%), minke whale (1%), and humpback whale (1%). Bottlenose dolphin images existed in the catalogues of 24 research groups, Risso's dolphins in the catalogues of 12 groups, and sperm whales in the catalogues of 10 groups. Three automated matching software programs – for tail fluke margins, dorsal fin margins, and fluke pigmentation patterns have been developed, and some preliminary tests conducted. Although still requiring further refinements, they show potential to greatly assist the matching process when dealing with large catalogues. Attention needs to be paid to ways to combine the use of features of different types present on the same individuals, as well as to changes over time in those features, and any automated matching process should maximise recognition of true matches whilst minimising false matches. Some scientific uses to which the Europhlukes system can be put are illustrated.

Wednesday 15:30-15:45

WARNING SOUNDS: A NEW APPROACH TO INCREASE THE AWARENESS OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) TO GILLNETTS USING PURE 2.5 kHz TONES

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Traditional acoustic alarms, also called "pingers" use aversive sounds to keep harbour porpoises away from threatening gillnets. Porpoises maintain a large distance and may be excluded from critical habitat. New gillnets made of acoustically enhanced material are supposed to increase the chance of detection by echolocating porpoises and reduce collision risks. However, our field tests show that the percentage of echolocating porpoise groups near gillnets is low, regardless of net type. Therefore, by-catch reduction using e.g. barium-sulphate nets may remain below expectations. In a fjord on Vancouver Island, Canada we tested a new approach by combining the best of both methods: a barium-sulphate net in conjunction with warning sounds. Low-intensity (115 dB re 1m, 1µPa) 2.5 kHz pure sounds without harmonics were supposed to alert, not chase away harbour porpoises. Whereas the original Lien-pinger (2,9 kHz with strong harmonics, 115 dB re 1m, 1µPa) keeps harbour porpoises at 170 m from the sound source (Koschinski and Culik 1997), pure 2.5 kHz tones used here only increase the median surfacing distance from 21.3 m (n = 23, no sound) to 37.9 m (n=43, sound). Below the surface, click-intervals (measured via POD), an indirect measure of target distance, were highest in the ensonified barium-sulphate net (64.7 ms, n=9) as opposed to the ensonified standard net (51.6 ms, n=23) and the barium-sulphate net without sound (42.8 ms, n=25; KS-Test, $p<0,05$). The number of clicks per minute recorded within 80 m of the net increased from 54 (barium-sulphate net without sound, n=10) to 64 (standard net with sound, n=8) to 86 (barium-sulphate net with sound, n=5). Although our data base is still small, we are confident, therefore, that using this new approach harbour porpoises could be trigered to increase their vigilance near acoustically-enhanced gillnets.

Acoustics

Wednesday 16:15-16:30

FORAGING ON SQUIDS: THE SPERM WHALE MID-RANGE SONAR

ANDRÉ, M. (1), JOHANSSON, T. (2), DELORY, E. (3), VAN DER SCHAAR, M. (4), MORELL, M. (5)

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It has been long speculated about the sperm whale sonar capabilities. While the usual clicks of this species are considered the support of mid-range echolocation, no physical characteristics of the signal have clearly confirmed this assumption nor have explained how sperm whales forage on squids. The recent data on sperm whale on-axis recordings have allowed us to simulate the propagation of a 15kHz pulse as well as its received echoes from different targets taking into account the reflections from the bottom and the sea surface. The analysis was performed in a controlled environment where the oceanographic parameters and the acoustic background could be modified. We also conducted experimental measurements of squid target strength (*Loligo vulgaris* and *Sepia officinalis*) to further investigate and confirm the TS predictions from the geometric scattering equations. Based on the results of the computer simulations and the TS experimental measurements (TS squid = - 36.3 ± 2.5dB), we were able to determine the sperm whale sonar minimum requirements, i.e. range and directional hearing, to locate a single 24.5cm long squid, considered to be from stomach contents the major size component of the sperm whale diet. Here, we present the development of the analysis which confirms that sperm whale usual clicks are appropriate to serve a mid-range sonar function allowing them to forage on individual low sound-reflective organisms.

Wednesday 16:30-16:45

ECHOLOCATION CLICKS OF FREE-RANGING CUVIER'S BEAKED WHALES (*ZIPHIUS CAVIROSTRIS*)

ZIMMER, W.M.X. (1), JOHNSON, M.P. (2), MADSEN, P.T. (3), TYACK, P.L. (4)

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Strandings of beaked whales of the genera *Ziphius* and *Mesoplodon*, of which comparatively little is known, have been reported to occur in conjunction with naval sonar use. Detection of the sounds from these whales could reduce the risk of exposure, but descriptions of their vocalizations are incomplete. This presentation reports the temporal, spectral and spatial characteristics of clicks from deep-diving Cuvier's beaked whales (*Ziphius cavirostris*) using a unique data set. Two whales in the Ligurian Sea were simultaneously tagged with sound and orientation recording tags, and the dive tracks were reconstructed allowing for derivation of the range and relative aspect between the clicking animals. At depth, the animals produced trains of regular echolocation clicks with mean inter-click intervals of 0.43 s (±0.09) and 0.40 s (±0.07). The clicks are frequency modulated pulses with durations of ~190 µs and center frequencies around 42 kHz, –10 dB bandwidths of 22 kHz, and Q_{3dB} of 4. The sound beam is narrow with an estimated directionality index of 28 dB, source levels of 214 dB_{pp} re 1µPa at 1m, and energy flux density of 164 dB re 1µPa^2s. As these properties are different to those of non-ziphiid odontocetes the potential for passive detection is enhanced.

Wednesday 16:45-17:00

TESTING HEARING ABILITIES OF FREE-RANGING WHITE-BEAKED DOLPHINS

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We report the first playback experiment to test the hearing abilities of free-ranging dolphins. The aim of the study was to test if white-beaked dolphins could hear frequencies up to 200 kHz. White-beaked dolphins use echolocation clicks with a secondary frequency peak at 200-250 kHz. It would be an advantage for them to hear these high frequencies when using echolocation to detect sand eels, a major prey item. The studies were made in Faxafloi Bay, Iceland, during the summer of 2004 using a small boat as a platform. We used primarily three 2 second, raised cosine, amplitude modulated (max. 61Hz), acoustic signals with pure frequencies of 100 kHz, 200 kHz, and 250 kHz. The maximum source level (at 1 m) was between 163dB and 168dB re 1µPa. A sound stimulus was played when a dolphin was in visible in our underwater video camera. A "No sound" signal was used as a control. The dolphins did not react to the "No sound" signal, but they reacted behaviorally or acoustically to all the sound stimuli for 100 kHz, 200 kHz, or 250 kHz. The dolphins reacted by circling around the hydrophone array, approaching the hydrophone array, with underwater tail slapping, by emitting bubbles, by showing their white undersides or by emitting burst pulses towards our hydrophone array and the video camera. However, we did not observe reactions to a stimulus of 300 kHz. The behavioral reactions were also sometimes of "avoidance character" like swimming away or changing swimming direction. The behavioral reactions were significantly different for three frequencies. The avoidance behavior was mostly elicited at 250 kHz, while the other behaviors were mostly found at 100 kHz and 200 kHz. Our tentative conclusion is that white-beaked dolphin hearing extends to 250 kHz, but this needs verification by other methods.

Wednesday 17:00-17:15

STIMULUS-RESPONSE CHARACTERISTICS OF AUDITORY BRAIN STEM RECORDINGS (ABR) IN A HARBOR PORPOISE (*PHOCOENA PHOCOENA*) DURING ACTIVE ECHOLOCATION AND PASSIVE HEARING

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For ethical reasons neurophysiological investigations into the hearing and sonar sensory systems of cetaceans are currently limited to recording weak electrical activity on the surface of the animal resulting from an auditory stimulus (ABR). In evaluating the stimulus-response characteristics of the auditory system of a harbor porpoise, we stimulated with narrowband pulses resembling the animal's own echolocation pulse (130kHz, 100µs), but shifted in frequency (80, 100, 125, 160kHz). Our animal was trained to accept two suction cup electrodes and to station at a small plastic square 1m below the water surface for up to 60s per trial. Pulses could be presented either as simulated echoes at a fixed delay (5ms) relative to the animal's echolocation clicks, or at a constant rate chosen by the experimenter. Stimulus levels were varied between 90 and 150dB re 1µPa and the ABR responses were averaged (>16 responses per average) at each level. The relationship between input level (in dB) and ABR amplitude was reasonably linear for simulated echo and constant rate experiments. Regression lines were calculated to determine the stimulus level at which the response crossed zero µV ABR amplitude, defining the ABR threshold. There was little difference in the ABR threshold (100 to 110dB re 1µPa) for the four frequencies used in the constant rate experiment. However, the ABR threshold was lower in the simulated echo experiments for the same stimulus frequency, which can be explained by experimental design. The rate of growth of the ABR response with increasing stimulus level was steepest at 125kHz, close to the frequency of the pulse this porpoise emits during echolocation. This could well reflect a relatively denser population of neurons tuned to this frequency area. (We acknowledge Fjord & Bælt, Kerteminde, Denmark, for training the animal and the Office of Naval Research for financial support.)

Abstracts of poster presentations

ACOUSTICS

A-01

DETECTION AND LOCALIZATION OF A SPERM WHALE OBSERVED BY PASSIVE ACOUSTICS IN THE TOULON CANYON, FRANCE

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Over the last 3 years, the LiiA-iSnS Laboratory has been working on the definition of a passive acoustic system for the detection and localization of sperm whales. Our objectives were to complete our database and to confirm the results obtained in Gibraltar in 2003. To this end, we organised a new scientific experiment in collaboration with the Association Breach. From August 1-8, 2004, 20 members, (scientists, research volunteers and skippers) on 3 sailboats observed the maritime zone off the coast of Toulon, France (42°58N 5°51E–42°39N 5°43E–42°39N 6°30E–42°58N 6°27E), aided by aircraft provided by the Association Ketos. Observations of striped dolphins, fin whales, and Risso's dolphins, were carried out on a daily basis. In addition, we took samples of fin whale excrement for analysis. We noted the pollution level on the sea surface of this zone, keeping a record of floating debris (garbage, plastic bags, etc). We recorded the one sperm whale present in this area (42°50N 6°04E) using 3 Thomson hydrophones at 100m depth. The data was coded on 16 bits, sampled at 44 kHz. Data analysis allowed us to reconstitute 3D dive trajectories, validating our automatic technique for sperm whale localization based on the use of a single hydrophone and taking into account the direct path and multi-echoes of the sound emitted by the animal. We were able to accurately deduce the 3D positions of the sperm whale throughout its dives to a depth of 450m; the average duration of its dives was 48mn. Because the recording conditions were extremely favorable (high SNR), we can very clearly distinguish many series of creaks (between 30 to 35 per dive). Our laboratory's focus is on the development of an acoustic signature recognition method and aims to repeat this scientific experiment this year.

A-02

SUMMER VOCAL BEHAVIOR OF THE WHITE SEA BELUGA WHALES (*DELPHINAPTERUS LEUCAS*) FORAGING IN THE OPEN SEA

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Belugas (*Delphinapterus leucas*) have a various vocal repertoire. Their acoustical behavior depends on context. Notable, that vocal behavior of belugas has been mostly studied in summer inshore aggregations, meanwhile much less is known about vocalizations in other contexts, particularly at open sea. Thus, the aim of this study was to describe beluga's vocalization in summer at open sea. Simultaneous sound recordings and behavioral observations of belugas were made on board sailing boat in July 2004, in Onega Bay, the White Sea. The yacht was equipped with towed hydrophones (system frequency response 20 Hz - 20 kHz). Presumably, behavior of encountered belugas was foraging ("milling"). Whales (singles and small groups) were widely dispersed. A total of 158 min of recordings of foraging belugas were made at the open sea. Recordings were analyzed using Cool Edit Pro software. All signals were counted (n=635). Signals were classified into four main categories: whistles (types based on contour shape), pulsed tones (creaks, screams and voice-like calls), noisy calls and click trains. Overall calling rate (0.7 calls/min/whale) and amplitude of recorded signals were extremely low. On this background, rare (6% of all signals) loud calls, flattened low-frequency (F0 ~ 2 kHz) whistles, were well distinguished. Generally, whistles (85%) predominated in acoustical production. Total proportion of FM whistles (56%) considerably exceeded proportion of flat whistles (29%). Among latter, the whistles with relatively high fundamental frequency (F0: 5-7 ???) were most frequently heard (23%). Many whistles had segmented structure. Creaks (9%) dominated among pulsed tones. Portions of screams (1%), voice-like calls (2%), and also noisy calls (1%) and click trains (2%) were very small. Thus, according with our results, belugas foraging at the open sea mostly emit whistles. Probably, whistles are the most suitable for long-range communication, which seems to be predominating in this context.

A-03

SOUNDS OF PANTROPICAL SPOTTED DOLPHINS (*STENELLA ATTENUATA*) OFF S. TOMÉ AND PRÍNCIPE ARCHIPELAGO, WEST AFRICA

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The S. Tomé and Príncipe archipelago is situated in the Gulf of Guinea in front of the Gabonese coast and is formed by two principal islands and by several small islands. Since 2002 an effort has been made in order to study the occurrence, distribution and behaviour of cetaceans in this equatorial region. Along the years and throughout several field seasons we have sighted groups of humpback whales, as well as groups of bottlenose and pantropical spotted dolphins, orcas and pilot whales. In this work we describe sounds emitted by pantropical spotted dolphins (*Stenella attenuata*) recorded in three different recording sessions, with single hydrophones and an upper frequency limit of 20 kHz. Between October and November of 2004, we conducted 22 boat-based surveys surrounding the island of S. Tomé in order to evaluate cetaceans' presence, distribution and habitat use. During the surveys we recorded GPS positions, group composition and size, behaviour and made acoustic samplings whenever the sea conditions allowed. We sighted, in four different days, groups of pantropical spotted dolphins, with a total of 252 minutes of direct observations, and 64 minutes of acoustic recording. Several sound types were identified, including whistles, click trains and pulsed sounds (such as buzzes, creaks, moans, screams and squeals), during episodes of behavioural excitement, including feeding (with birds above the sea surface) and interaction between conspecifics. Some of the pulsed sounds recorded are also very common in *Stenella longirostris* and *Stenella frontalis* during behavioural arousal. This study intends to be a first approach on the sounds of pantropical spotted dolphins in this region and will allow a comparison with the acoustics repertoires and behaviours of related dolphin populations.

A-04

TESTING THE WHISTLE REPERTOIRE OF THE STRIPED DOLPHIN IN THE WESTERN MEDITERRANEAN SEA

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The striped dolphin (*Stenella coeruleoalba*) is the most abundant dolphin in the Mediterranean Sea and can be easily detected with acoustics, depending on behavioural context. We wanted to test the reliability of the whistle repertoire as a tool to acoustically determine species identity. We used recordings made in the Western Mediterranean Sea from sailboat survey data during the 1990-1998 period. We used 200Hz-20 kHz hydrophones, either simple or towed array, and analogue recording devices. All good quality vocalizations were digitized at 32 to 44 kHz-16 bits in 90 seconds sequences. Every whistle provided one sample from which a FFT-spectrogram was produced and the following variables extracted: duration, beginning Fb and ending Fe frequencies, frequency range Fr, number and type of frequency modulations. A first set of 336 signals coming from 5 different sightings made in 1990-92 were first processed giving a medium duration of 400ms, a frequency domain of 10.5kHz and an average frequency range of 4.2kHz. This repertoire was sorted into 19 categories, by considering the distribution the above variables. A second data set based on 343 whistles recorded from 9 sightings in 1994 was compared to the preliminary repertoire and found to be statistically different based on duration, Fe, Fb and Fr distribution (Chi-2, $p<0.05$). At this stage, a reference repertoire built from the complete 1990-94 data set was prepared, including 22 categories, among which two classes of whistles were observed: those with simple frequency modulation, and those with complex modulation. As striped dolphin whistle repertoire included variability possibly based either on individuals, groups, regions or behavioural context, the variance on Fb, Fe, Fr and duration were high. Consequently, the tests with data coming from one striped dolphin sighting from eastern Mediterranean Sea and one common dolphin data set from western Mediterranean Sea were not significant.

A-05

THE ACOUSTIC BEHAVIOUR OF *L'OCEANOGRAFIC* BELUGA WHALES

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Despite the fact that beluga whales are known for their ability to produce a wide range of sounds, their acoustic behaviour is still largely unstudied. The few quantitative reports available in the literature show non-standardized subjective classification methods obtaining diverse vocalization repertoires of graded nature. Behavioural contexts have been included in very few of these studies and are scarce to achieve conclusive results. *L'Oceanogràfic*, a new marine park in Spain, has started a long-term study of the acoustic behaviour of 2 beluga whales. Acoustic and behaviour activity of an adult male and a juvenile female are being analysed since March 2003, before their transportation to new facilities. Acoustical observations proved to be an effective technique for the monitoring of the whale's adaptation to the new environment, as well as the adaptation to changes in their facilities. Adaptation periods were identified by a drastic decrease in their vocalization rate (ANOVA, $p<0.01$). Based in available literature, a standardized categorization scheme has been designed allowing the classification of 97 % of all acoustic activity recorded. More than 43000 vocalizations have been identified obtaining a vocal repertoire of 29 types distributed in 7 categories (pure tonal, mixed tonal, pulses, pulse trains, click trains, mixed and noisy). Behavioural contexts have been associated to the acoustic activity through focal sampling methods. To date, 7 context-specific vocalizations have been identified (Chi-square, $p<0.05$). Detailed knowledge of the acoustic behaviour of these 2 whales and the evolution over a 2-years period has been obtained in the first phase of this study and is presented in this report.

A-06

THE DEVELOPMENT OF *TURSIOPS TRUNCATUS* SONAR SYSTEM FROM ITS ENTRY INTO THE COMMUNITY (6 MONTHS OLD) TO 14 MONTHS OLD

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A female bottlenose dolphin, *Tursiops truncatus*, born on Oct. 2001 at Palablù Delphinarium (Peschiera del Garda, Italy), has resided separately from the other two dolphins of the community and lived only with its mother for six months (May 2002). Then the calf and its mother were reintegrated, first gradually (June 2002) then completely (since July 2002), into the community. The aims of this work are: 1) to present the changes in the sonar signals of the calf from 6 to 14 months of its life (May – Dec. 2002); 2) to compare, month by month, the sonar signals emitted by the calf with those from each dolphin and from the community as a whole. The sonar signals emitted by the dolphins were collected systematically, three sessions every month, by using a wide band hydrophone, positioned 2 m below the water surface, and an analogical wide band recorder and were monitored with a digital oscilloscope. All the dolphins were accustomed to the presence of the hydrophone and the experimenters. The comments of the experimenter were recorded onto the audio channel of the wide band recorder. All the data were processed in the laboratory using MATLAB software. Clicks structure was analysed extracting six parameters from the signals recorded from each dolphin in each session: asymmetry and kurtosis, first and second moments in time, first and second moments in frequency. Click structure was compared between the four dolphins by cluster analysis. The results show a progressive decrease of the acoustical distances, between the calf and the other members of the community, and mostly between the calf and its father. This decrease seems due not only to changes in the characteristics of the calf click structure, but also to acoustical changes of the community after the entry of the calf in it.

A-07

ACOUSTIC CHANGES OF A PREGNANT *TURSIOPS TRUNCATUS* AND OF ITS COMMUNITY

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The aims of this paper are: 1) to present the acoustic changes of a bottlenose female in the last six months of pregnancy (Apr-Sep 2003); 2) to compare, month by month, the signals emitted from the pregnant dolphin with those from the other members of the community; 3) to compare the acoustic behaviour of each dolphin during the pregnancy period with that in the pre-pregnancy (Jun. 2002) and in the post-pregnancy periods (Oct-Nov 2003; Feb 2004). The subject of the research was a bottlenose family formed by an adult female, that gave birth to a calf on Sept. 2003 in Rimini Delphinarium, an adult male and their two juvenile sons. The signals emitted by dolphins were collected systematically, one session every month, by using a wide band hydrophone, positioned 2m below the water surface, and an analogical broadband recorder. The comments of the experimenter were recorded, simultaneously with the sonar signals, onto the audio channel of the broadband recorder. The dolphins were accustomed to the presence of the hydrophone and the experimenters. Clicks emitted by each dolphin were counted and their structure was analysed, through MATLAB software, extracting six parameters from each set of signals emitted by each dolphin in each session. The results show a significant decrease of the acoustical activity of the female and its two juvenile sons in the pregnancy period, respect to both the pre-pregnancy and post-pregnancy periods, while the acoustic activity of the adult male increased significantly during the pregnancy period. All the dolphins used, in the last months before the birth and in the post-pregnancy period, frequencies much lower than in the pre-pregnancy period. Moreover, in the post-pregnancy period, the structure of many clicks emitted mostly from the mother appeared simple (mono-modal) as if it was influenced by the signal shape of the calf.

A-08

ACOUSTIC REPERTOIRE OF THE LONG-FINNED PILOT WHALE IN THE NORTHWESTERN MEDITERRANEAN SEA

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During this study, we determined the acoustic repertoire of long-finned pilot whales (*Globicephala melas*) in the NW Mediterranean Sea from a set of sailboat survey data obtained during 1990-1996 period. We used 200Hz-20 kHz hydrophones, either simple or towed array, and analogue (1990-1994) or DAT recording devices. All good quality vocalizations were digitized at 32 kHz-16 bits in 90 seconds sequences. Every tonal signal (whistle or call) provided one sample from which a FFT-spectrogram was produced and the following variables extracted: duration, beginning and ending frequencies, frequency modulations, number of harmonics. A total of 658 tonal signals coming from 5 different sightings were processed and sorted into 19 categories and 90 sub-categories based on their duration (64ms to 4529ms), frequency domain (730Hz to 16 kHz) and harmonic structure. Four categories amounted to 55% of the signals and were represented in four sightings. Recordings from three sightings displayed each more than 8 different sound types. This result indicated a wide variety of repertoire for Mediterranean pilot whales,

unique compared to other pelagic odontocetes in the Mediterranean Sea. As pilot whale is a highly social species, thought to rely on long-term stable associations, we wanted to determine if part of the repertoire might be group-specific: two categories of signal were common to 4 sightings and four categories were shared by 3 sightings, other signal types being emitted by only one or two groups of pilot whales. There was a preliminary indication that signals could be partly group specific, although further analysis are needed by taking account of group structure and behavioural context. A comparison with other pilot whale populations may eventually indicate if a population dialect exists, as was shown for *Orcinus orca* in the North-eastern Pacific.

A-09

A PORTABLE AUDITORY EVOKED POTENTIALS ACQUISITION SYSTEM FOR RAPID DIAGNOSIS OF DOLPHIN HEARING FUNCTIONALITY

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Whether in captivity or on stranding sites, the screening of dolphins auditory capabilities is a necessary complement to their clinical diagnosis. A screening tool is presented, which enables, together with the collection of species related acoustic characteristics, a rapid diagnosis of hearing impairment and biosonar functionality in dolphin facilities and on stranding sites. Its portability and the integration of the latest advances in objective auditory assessment through steady-state evoked potentials should shorten response times significantly, limit the stressful experience and provide nearly instantaneous complementary information on the animal viability.

A-10

SEASONAL AND DIURNAL VARIATION IN ECHOLOCATION ACTIVITY OF WILD HARBOUR PORPOISES

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The density of harbour porpoises calculated from results of monthly aerial surveys over four years shows a clear seasonal pattern over a 2.500 km² wide area within the inner German Bight. Maximum numbers were reached in May/June while only few animals were counted during winter. In order to study this strong seasonal pattern at a higher temporal resolution we used porpoise detectors (PODs) as a tool to log echolocation activity of harbour porpoises over a long time. We moored four PODs in water depths of 17 meters two meters above the sea bottom 35 km away from the coast. The PODs recorded data for a period of 2.5 years at two locations, which were separated by 10 km. The echolocation activity of porpoises at both locations also shows a clear seasonal pattern with significantly higher activity during May and June than in autumn and early spring. During May and June a strong diurnal activity pattern with significantly more click activity during day-time compared to night-time was also observed. A more detailed analysis of click train structure resulted in a small proportion of echolocation clicks with a minimum interclick interval below 10 ms, which indicated that porpoises mostly used their echolocation for orientation. Due to no change in train structure during a 24 hour cycle, it is suggested that there is no difference in porpoise behaviour when comparing day to night. The use of PODs gives us the option to study seasonal presence of porpoises during 24 hours a day all the year round. These data give us important information on seasonal abundance as well as new insights into the behaviour of harbour porpoises.

A-11

CONTRIBUTIONS TO PASSIVE ACOUSTIC OCEANIC TOMOGRAPHY – INVERSION ALGORITHMS BASED ON MARINE MAMMALS VOCALIZES

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Acoustic tomography is a way to produce a fast, accurate and cheap monitoring of water mass. This monitoring requires an inversion procedure. Large scales deep water and small scales shallow water configurations were successfully studied and associated with matched delay, matched field and matched impulse response inversion processing. Accurate estimates of acoustic properties demand the emission of powerful and recurrent signals in the adapted bandwidth and in agreement with the scale of the monitoring. But we would rather not send these hard active sounds through the water column if mammal species health is considered. A recent solution has emerged in the community to tackle this problem with the passive tomography processing. Passive tomography processing consists in estimating acoustic properties by using opportunity sources present in the channel at the time of interest such as marine mammals sounds. This paper aims at presenting algorithms to estimate delay, magnitude of acoustic paths when the channel is excited by an unknown transient signal such as marine mammals vocalizes. Under the assumption of a acoustic ray propagation, the received signal due to an emission is the sum of attenuated and delayed replicas of it. A Time Frequency scheme for time and magnitude of arrival measurements is briefly reviewed and its performances are analysed with its application to

real data from an experiment performed in the Laurentian Channel (Québec) during the summer 2003. We first use the intercepted signal emitted by a seismic sparker, and then marine mammals vocalizes, as opportunity sources. As a result, a need for temporal high resolution is enhanced. A processor based on local analysis is developed. This processor is applied with success on true marine mammal vocalises where multipath structure is estimated and compared with simulated impulse responses of underwater channel between marine mammal and receiver.

A-12

DAILY VOCALIZATION PATTERN OF STRIPED DOLPHIN (*STENELLA COERULEOALBA*) IN THE LIGURIAN SEA

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Seven days of wideband recordings collected by a sonobuoy that was placed at the bottom of the Ligurian Sea have been statistically analyzed (43° 58' North; 8° 27' East; depth 950 meters). Due to previous and contemporary visual surveys made in this area, the dolphin vocalizations recorded can be reasonably attributed to *Stenella coeruleoalba*. A value for duration and intensity was assigned to each category of biological or non-biological sound for each minute (time slot analysis). Using a statistical estimator which assessed the masking effect of naval noise, a daily pattern of dolphin clicks, whistles and "*nacchere*" was plotted. No diurnal in/off shore migration patterns were observed using this acoustic method: dolphin vocalizations were present all day long. Clicks and "*nacchere*" clearly showed different presence between light and dark hours with a significative peak around dawn. In particular, "*nacchere*" seems to be completely absent during the day and more present between 3AM and 8AM. This pattern may be related to foraging behaviours and to the usage of ultrasound vision in poor light conditions. Whistle contacts were audible all around the day and unpredictably decreased at dusk for all the duration of the study. No behavioural reasons or technical faults could be found for this peculiarity. The maximum of acoustical activity was recorded at 4:00 am and the minimum at 2:00 pm. These results clearly show that dolphin vocal activity varies during the day and this should be kept into account in estimating animal abundance from acoustical data coming from records made in different light conditions. Moreover night time is the best time to record dolphin vocalization repertory. More accurate and stable patterns will be developed as soon as more data is collected and processed.

A-13

ECHOLOCATION BEHAVIOUR OF FIVE SYMPATRIC DOLPHIN SPECIES OFF LA GOMERA, CANARY ISLANDS

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In a field study off La Gomera, Canary Islands, we recorded echolocation signals and behaviour of five sympatric pelagic delphinid species (*Steno bredanensis*, *Globicephala macroryhnchus*, *Stenella frontalis*, *Stenella coeruleoalba*, *Tursiops truncatus*) using single-hydrophone broadband recording equipment (+/- 3dB up to 200 kHz) to investigate intra- and inter-specific variation with respect to its possible adaptive value. To select on-axis signals we only included the two loudest clicks of each 10s-recording-sequence in our analysis of click structure and compared signals emitted at an estimated distance of 20m and 1.5m to the hydrophone. Echolocation use during travelling behaviour differed little among the smaller dolphin species, but was lower in slow-travelling pilot whales. A detailed behavioural analysis of click interval patterns has been carried out for the rough-toothed dolphin (*Steno bredanensis*). Median click-intervals differed significantly (Kruskal-Wallis, $p<0.001$) between different behavioural situations (foraging, exploring, travelling, socialising) and reflected the echolocation tasks the animals had to perform. A discriminant function analysis revealed 20-dB duration, peak and centre-frequency to be the most important factors for classifying species. Centre frequencies of clicks were lowest in pilot whales (68kHz) and highest in spotted dolphins (120kHz). The high-frequency peak in the bimodal energy spectrum (means from 72kHz to 137kHz) dominated in all species and centre-frequencies remained relatively high, even in signals emitted at 1.5 m distance, which might be an adaptation to the pronounced low-frequency ambient noise in subtropical, pelagic habitats (*Stenella frontalis*: 120kHz (20m) and 108kHz (1.5m)). A cluster analysis did not reflect the phylogenetic relationship between species. Instead a negative correlation between centre-frequency and body length ($r2=0.8$, $p<0.05$) was found. Although lower-frequency signals in pilot whales might be useful for long-range echolocation in deep water we conclude that click design is mainly constrained by physical mechanisms of sound production and less by specific adaptations to the foraging habitat.

A-14

SWAMP: A FLEXIBLE, LOW-COST, HIGH-PERFORMANCE APPROACH TO ACOUSTIC AND OCEANOGRAPHIC MONITORING

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The Durlston Marine Project has operated a fixed hydrophone off the south coast of the UK for ten years. This hydrophone has been used to monitor for the presence of cetaceans in the Marine Research Area associated with Durlston Country Park. The system has become increasingly unreliable over the last three years and so the decision was made to completely replace it with a new monitoring system based on current technology and incorporating a number of new facilities. This paper describes the first SWAMP unit which was recently deployed and will replace the older system. The SWAMP system has been designed as a modular system allowing a number of acoustic and oceanographic options to be chosen to suit a particular acoustic environment or experimental application. The electrical and mechanical design has been optimised to reduce costs while achieving excellent noise and strong signal performance. Results showing the performance achieved during pre-deployment characterisation and post-deployment evaluation are presented demonstrating a significant improvement in performance compared with the original hydrophone unit.

A-15

THE ACOUSTIC SIGNALS OF THE *TURSIOPS TRUNCATUS* IN THE PRESENCE OF A PERSON UNDER WATER

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The acoustic signals of a community of four Atlantic Bottlenose dolphins in captivity were studied in trials with and without a diver. We looked at differences in the signals between these and between three different hydrophone positions (head, abdomen and legs) and especially at the dolphin's acoustic reaction when the diver responded to their clicks with an artificial one. The parameters of the spectrum taken into consideration were: the peak frequency, the secondary peak frequencies, the barycentre and the bandwidth. The diver with wetsuit but without bottles was not in physical contact with the dolphins, which had several tanks available to them. A device capable of both making the acoustic signals partly audible to the diver and transmitting an artificial click, was carried by the diver. During six months three sessions were performed consisting in: a trial with a known target, three trials with a trainer and a trial with the diver without the artificial response followed by one with, both divided in three parts for the different hydrophone positions. There was an obvious acoustic reaction from the dolphins to the artificial click imitating it both in spectral form and frequency. Moreover corresponding to the artificial click's emission time there was a peak in the use of its frequency range by the dolphins. Also the number of clicks in this range was significantly higher than in the other trials. Between the trials with and without diver differences were found in the lowest and highest frequency classes. The position at the leg showed a lack of the high frequency classes. Dolphins differed in the use of secondary peaks, their frequency distribution and the highest and lowest peak frequency classes, although they all used the same frequency class (37.5 kHz) most, which was also the most represented in all trials.

A-16

WHALE WHISTLES MODELING AND ENHANCEMENT BASED ON A SINUSOIDAL MODEL

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Whale whistles have long duration and may contain multiple narrow band tones. The study of these sounds is important since they are used in whale underwater communication and it seems to be the dominant type of sound recorded during socialising. In this work we apply a sinusoidal model for modelling whale whistles. The signal is modelled as a sum of sinusoids (not necessarily as sum of harmonics) of time-varying amplitudes, frequencies and phases. Analysis is performed in frame by frame basis. Frequencies are determined by a peak picking algorithm followed by a frame-to-frame frequency matching technique based on a concept of 'birth' and 'death' of sinusoidal components. During synthesis the amplitudes of the matched sinusoidal components are linearly interpolated. Such a simple solution is not possible for the phase information since phase is computed modulo two pi. Therefore a phase unwrapping is important before any type of interpolation is applied. Moreover, phase unwrapping must be performed jointly with interpolation to ensure that the frequency trajectories are continuous across frame boundaries. A characteristic of whistle sounds is the fast change of frequencies over a time unit. In order to model such fast movements, phase unwrapping and interpolation is achieved by using a cubic polynomial for the phase information. The above system has been successfully applied for analysis and synthesis of complex signals like human speech. However, it is not clear how to evaluate its performance in biologic signals since the signal to noise ratio (SNR) is quite low in most of the recordings we have. Therefore it is meaningless to compare the time-series or the spectrum of the original recordings with those of the synthetic data. However, we state that perceptually the synthetic audio, sounds very similar to the original whistles without the background noise.

A-17

BEHAVIOURAL REACTIONS OF FREE-RANGING HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) TO STANDARD NYLON AND BARIUM SULPHATE MESH GILLNETS

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Field tests suggest that high-density nets can reduce harbour porpoise by-catch in fisheries. However, it is not clear whether acoustic reflectivity or stiffness is responsible for this. In a fjord on Vancouver Island, Canada we investigated porpoise surfacing and echolocation behaviour with respect to two surface gillnets (45 x 9 m, 165 mm mesh size) made of 1) high-density barium sulphate and 2) standard nylon. Distribution of click interval duration was shifted to longer durations when the barium sulphate net was used (median = 51 ms vs. 45.2 ms for standard net; $p < 0.001$, Kolmogorov-Smirnov-Test), suggesting a greater detection distance. However, an unexpected low percentage of echolocating porpoise groups near nets (barium sulphate 19.3 %, standard 30.6 %; $Chi^2 = 5.44$; $p < 0.02$) puts the concept of enhancing acoustic reflectivity in question. A second experiment showed that playing "enticing" low-intensity 2.5 kHz tones can increase biosonar use by a factor of four compared to controls (16.7 % in controls vs. 71.4 % of groups during ensonification; $Chi^2 = 211.5$; $p < 0.001$). We therefore suggest the combination of "enticing" sound with reflective nets.

A-18

THE ECHOLOCATION OF THE BELUGA (*DELPHINAPTERUS LEUCAS*) IN DIFFERENT BEHAVIOURAL SITUATIONS

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The purpose of our work was to compare the echolocation trains of the free-range beluga (*Delphinapterus leucas*) on the different behaviour situations. Our records were made from June to July 2004 in a White sea. We recorded sound with the help of PC (from 006 to 25 kHz.). We marked out three types of beluga behaviours: "searching", "resting" and "hunting". For all trains, we measured the length, the number of clicks in a train and the interclicks intervals (ms); we also used a regularity criterion and checked the number of two-clicks trains. As a result, we can describe the echolocation trains in these three situations. During "searching" behaviour, animals locate only in 30% from all records; we can suppose that they get the information with the help of hearing and eyesight. The repetition rate is 17.7 ±1.8 cps and the interclick interval is 110.9 ±5.6 ms; thus it could be possible that in this case whales use echolocation to classify objects that were detected earlier and the trains are used in such conditions and in such distances where other senses are useless. It is typical that many trains are regular (36.7%) or consists of two clicks (30%). It probably could help belugas to stay unnoticed when they search for fish. During "hunting", belugas are supposed to use mainly eyesight and echolocation, which is constituted of short trains (0.28 ±0,03 s) with a high repetition rate (67 ±5 cps), the inteclick interval is 28.1 ±7,8 ms. There are 31.7% of regular trains and 4,6% are two-click trains. During "resting" belugas produce long trains 0.94 ±0.15 s with a big number of clicks 44.4 ±8.7, interclick interval – 40.3 ±4.2ms, repetition rate 45.2 ±4.6cps, 25% of trains are regular; two-click trains are absent. Probably here the echolocation is being used for communication or for orientation.

A-19

ACOUSTIC RESPONSE OF A COMMUNITY OF *TURSIOPS TRUNCATUS* TO BIOLOGICAL WHISTLES, EMITTED BY DOLPHINS UNKNOWN TO THEM, AND TO AN ARTIFICIAL WHISTLE

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The experiment aimed: 1) to investigate on the acoustic answers (whistles, clicks, mimicry) of four bottlenose dolphins in captivity to biological whistles emitted by unknown dolphins; 2) to look at the differences in the answers when a synthetic whistle was presented to them. The acoustic system consisted of a play back subsystem (DAT, for playing the recorded sounds, a wide band preamplifier and a projector) and a recording subsystem (a hydrophone, a pre-amplifier and a wideband recorder), synchronised with the comments of the experimenter. Four sound stimuli were used in the experiment: two whistles of adult females, one whistle of a calf and one whistle produced by a waveform generator. The subjects of the experiment were two adult dolphins (a female and a male), their calf and a juvenile. The projector and the hydrophone were precluded physically but not acoustically to the dolphins, which had several tanks available for them. During four months four sessions were performed. In each session 10 sounds were presented in randomized schedule that included about 3 min of blank tape after each stimulus to control its effect on each dolphin. Recordings were analysed with a PC using "MATLAB" software. The results show that dolphins answered to each stimulus with both whistles and clicks. The number of whistles was generally greater than that of clicks, but it depended significantly on the type of stimulus (high *vs*. biological whistles; low *vs.* artificial whistles), and on the dolphin. Whistles and clicks structure was studied by spectral and statistical analysis. The results show a high degree of similarity between clicks emitted by the youngest dolphins in answer to artificial whistle, while the adults emitted similar clicks in answer to biological whistles. The correlation between emitted whistles and artificial whistle was very significant for the calf, significant for the juvenile.

A-20

ROBUST JOINT TIME-FREQUENCY REPRESENTATION FOR CETACEAN ACOUSTIC SIGNALS ANALYSES

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The joint time-frequency (TF) analysis of acoustic signals emitted by cetaceans is of great importance for biologists. An acquaintance with their sounds allows one to detect their presence and localise them. It is even possible to recognise individuals within the species via acoustic signature. The motivation for this work issues from the need for effective (optimal resolution) and robust (resistant for the continuously present noise) TF representation for whale call analyses. In fact, we can distinguish two general types of whale calls: whistles and clicks. The nonparametric TF representation, such as the Fourier spectrogram has some limitations and does not take any a priori information about the analysed signal. One of our research areas focuses on time-frequency analysis based on parametric models such as autoregressive models (AR). We propose a technique based on the generalised Schur algorithm which allows, firstly, effective detection and description of non stationary broadband signals emitted by marine mammals (clicks); secondly, precise analysis of chirps emitted by marine mammals (whistles). A TF representation of the Schur algorithm characterises a better resolution in the TF plane than a representation arising from non parametric methods such as spectrogram, due to the fact that the evolutive spectrum is updated at each time step. The generalised Schur algorithm is an optimal orthogonal filter which is characterised by excellent convergence and very good tracking capabilities. At each time step the Schur filter calculates a set of reflection coefficients which could serve as a acoustic signature of the whale call. Every variation in signal, with respect to second order statistics, is mapped to the changes in the Schur model parameters, and thus the TF signal representation. Accurate investigation of different types of whale calls with different values of SNR, which we had collected, demonstrated the performance of the Schur approach for TF analysis.

A-21

ABR RESPONSES IN TWO SPECIES OF MARINE MAMMALS

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Plans exist to build numerous offshore windfarms in the North and Baltic Sea, comprising several thousand windmills. The sound emitted during the construction (225+dB re 1µPa) as well as the operation of the windmills is considered to have potentially negative impact on marine mammals. Therefore an audiometric study on harbour porpoises and harbour seals has been initiated within the framework of the research projects MINOS. This study comprises measurements of the absolute hearing threshold of both species in captivity as well as of harbour seals in the wild. These data are prerequisite as a baseline for a subsequent resilience test (TTS test) of the animal's auditory system. The measurement of auditory brainstem response (ABR) is being used in this study. This method is a common tool to investigate the auditory abilities of vertebrates including humans. So far measurements have been conducted on a wild and a captive harbour seal with wideband signals at 4kHz, a male harbour seal with narrow band tone bursts of 0.125 to 16kHz, a male harbour porpoise with tone bursts of 0.3 to 2kHz and amplitude-modulated sounds of 2kHz to 22.4kHz. Thresholds were determined using a correlation technique as well as regression analysis. The resulting audiograms are in accordance with the shape of behavioural audiograms, although thresholds are shifted to higher values. Further animals are currently measured for their absolute hearing threshold and TTS measurements are in preparation. In addition, the response of seals to broad-band click stimuli was measured comparatively on the captive and on wild animals. ABR waveforms and hearing thresholds were similar to those of the captive individual. It can be concluded that ABR measurements can become a tool for an ecological survey programme with wild-caught animals if more experience is gathered regarding the precise assessment of auditory thresholds under suboptimal conditions.

A-22

INTERPRETING THE ECHOLOCATION BEHAVIOUR OF WILD HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) AROUND THE ISLAND OF FEHMARN, GERMANY

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The project investigates the echolocation behaviour of harbour porpoises at two measuring stations, located in the Fehmarnbelt and West of Fehmarn island, Germany. Porpoise detectors (T-PODs), registering porpoise echolocation click trains, were moored 7 m below water surface at 28 m (Fehmarnbelt) and 8 m (West of Fehmarn island) water depth. Both areas were monitored for one year (04/2002 to 05/2003). Most click trains could be categorised into three types of click pattern: successive trains with: - 1) long, linear decreasing click intervals (= time in-between two successive clicks), decreasing in average from 266 ms to 52 ms at the deep, from 194 ms to 42 ms at the shallow station (n=15 for each station); - 2) long click intervals without regression: averaging 70 ms at

the deep and 41 ms at the shallow measuring station (n=11 for each station); - 3) Very short click intervals below 10 ms (n=10 for each station). Those click pattern were interpreted as different behaviours: - 1) landmark-focused navigation (Verfuss *et al*., submitted), porpoises use a far away landmark to navigate towards it. The two-way-transit-time (time between sending out a click and receiving its echo from the landmark) gets shorter with the approach. The time the porpoise lags to send out a click after having received the echo of the preceding click (lag time) stays constant. The click interval decreases linear with decreasing two-way-transit-time; - 2) Seabed-focused orientation: lag times are similar for both stations (~30 ms) when using their water depth to calculate the two-way-transit-time, leading to the assumption that the seabed is used as landmark for orientation; - 3) Fish catch or communication: short click intervals are associated with fish catch (Verfuss et al., 1999; in prep.) or communication (Amundin 1991). No differences could be determined for this pattern between the measuring stations.

A-23

EVALUATION OF THE AUDITORY FILTER BANDWIDTH AND INTEGRATION TIME OF A HARBOR PORPOISE (*PHOCOENA PHOCOENA*) USING THE AUDITORY BRAINSTEM RESPONSE (ABR)

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For ethical reasons neurophysiological investigations into the hearing and sonar sensory systems of cetaceans are currently limited to recording weak electrical activity on the surface of the animal resulting from an auditory stimulus (ABR). We used the ABR technique to characterize the integration time and auditory filter bandwidth of a harbor porpoise. The integration time and bandwidth taken together determine the effective signal-to-noise ratio relevant for the receiver (at least in linear systems). Our animal was trained to accept two suction cup electrodes and to station at a small plastic square 1m below the water surface for up to 60s per trial. To measure the integration time we stimulated with trains of pulses, where each pulse resembled the animal's own sonar signal (130kHz, 100µs). We varied the number of pulses within a single pulse train keeping the energy of each pulse train constant. The amplitude of the ABR decreases when the duration of the pulse train exceeds the integration time window. Results indicate an integration time between 250 and 500µs. To determine the frequency window, or critical band, we used two closely spaced, short (125µs), narrow-band pulses with different centre frequencies as stimuli. The resulting ABR was compared to that obtained when the frequency of the two pulses was the same. We then registered to what extent the two pulses acted as independent stimuli as a function of the frequency separation between the pulses. Independence was assumed when the elicited ABR had twice the amplitude compared to that obtained when the pulses had the same frequency (with the amplitudes reduced by 3 dB), indicating that the pulses are analyzed in separate filters. (We acknowledge Fjord & Bælt, Kerteminde, Denmark, for training the animal and the Office of Naval Research for financial support.)

A-24

COMPARISON OF ODONTOCETE EARS THROUGH COMPUTERISED TOMOGRAPHY

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While there is an increasing concern about the impact of noise on cetaceans very little is known on the species related hearing capabilities and the use of sounds in their environment. Although some data are available for some species (*e.g.* audiograms and full bandwidth signals), no basic morphological comparison of the tympanic-periotic bullae has been conducted to establish a standardised anatomical database. Here, we present a method of analysis based on the comparison of nine odontocete species hearing systems through computerised tomography which shows that standard size and volume measurements may help to ascertain the relationship between specific morphological parameters (air spaces and intra-cochlear volume) and the species known sound characteristics, *i.e.* the frequency bandwidth.

A-25

DO METHODS MATTER? A COMPARISON OF DIFFERENT APPROACHES MEASURING ACOUSTIC PROPERTIES OF WHISTLES

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Quite a large number of different approaches have been used to measure and compare the contours of tonal vocalisations such as cetacean whistles. Some of these approaches measure the contours directly, others investigate them applying techniques based on cross-correlation between whistle contours; some of the methods consider whistle duration, others do not. However, to our knowledge, the degree to which using different of these methods might lead to different results has hardly ever been assessed. We thus applied different methods of measuring and comparing whistle contours and compared their results. We used calls of a bird as an acoustic model and, as an exemplary analysis, tested whether they differ between subjects. In detail, we applied two methods based on cross-correlation (one of which involved normalising whistle duration), two methods measuring the frequency of the whistle contour at a certain number of equally spaced points (one of which including whistle duration at an additional parameter), one method measuring various

acoustic properties of contours, and one method that describes contours using the coefficients of polynomial expressions fitted to the contours. We then applied Discriminant Function Analyses (DFA) to test whether subjects can be discriminated by the properties of their whistle contours and compared the results obtained using the different methods of measuring contours. We found that results based on different methods were more or less comparable and hence conclude that applying one method in favour of the others would not largely influence the overall result with regard to the individuality of contours in the species we investigated.

A-26

ACOUSTIC AND BEHAVIOUR OF SPERM WHALES' NURSERY GROUPS IN THE WATERS OF ISCHIA, ITALY

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Sperm whale (*Physeter macrocephalus*) nursery groups are poorly know in the Mediterranean Sea. Since 2002, 8 sightings of sperm whale social groups were listed in the deep waters of the canyon of Cuma (Island of Ischia, Italy). Animals were detected by the means of towed hydrophones and 820 minutes of recordings were collected. Maximum group size was of 12, including two juveniles and one calf. Whales were observed from August to October between 320 and 750 bathymetric lines. The principal behaviours seen were slow travel (2.5/3 knots) and rest at the surface. In the 2004, both acoustical and behavioural activities were recorded, since whales stayed in the above mentioned area for 20 days. Adults spent most of their time diving while juvenile individuals remained at the surface (or just below it) for at least one hour or more. Although adult whales appeared to dive scattered in a wide area (1370 km²), they immediately joined juveniles when the research vessel tried to approach them, showing a clear protective behaviour. Principal surface activities included: spy hop, tail slap, side fluke, fluke out, fluke float and breach. Recordings of acoustic vocalizations showed long sequences of regular clicks and social sounds as codas, chirrups and squeals. Due to the high probability of error in naked eyes estimation, IPI was calculated in order to better define the length of the clicking whales. Results (9.13-11.36) confirm the absence of large bulls in the groups, probably composed only by females with juveniles and calves. The existence of sperm whale nursery groups in the study area over periods of years is an important finding, since it may represent the evidence that reproductive and breeding activities occur within the Tyrrhenian Sea. Where and when they mate, as well as they produce offspring is still unknown.

A-27

THE POSSIBLE ROLE OF TEETH IN SPERM WHALE (*PHYSETER MACROCEPHALUS*) ECHOLOCATION

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Echolocation is common among the odontocete cetaceans and is thought to be used in orientation and hunting. It is generally accepted that certain sperm whale clicks are used in echolocation. There is much debate as to the peak frequency of these clicks. The "classical view" suggests that sperm whale echolocation clicks have peak frequencies of 2 – 8 kHz. The "large aperture" view suggests that the clicks are centred on frequencies in excess of 10 kHz. The performance of a sonar system is influenced by the nature of the acoustic receiving mechanism. It is widely accepted that the lower jaw of the bottlenose dolphin is involved in the reception of echolocation signals. It has been suggested that the teeth of the lower jaw may act as an acoustic receiver array. At present, the possibility that this system is used by the sperm whale (*Physeter macrocephalus*) has not been explored. Sperm whales are homodont and only have functional teeth in the lower jaw. These teeth do not appear to be used in prey consumption. Sound velocities of 13 sperm whale teeth, along with a cross section of the lower jaw, were measured. The results suggested that it is plausible that the lower jaw is used in sound reception. Dental geometry of five sperm whales lower jaws were modelled. In all of these jaws there was an offset between the teeth in either side. This is thought to be an important feature of an acoustic receiving dental array. The resonant frequencies of the13 sperm whale teeth were measured. These frequencies appeared to be closely matched to the peak frequency of sperm whale echolocation clicks. The results of this study suggest that it is highly plausible that sperm whales posses an echo receiving dental array.

A-28

CODA REPERTOIRE AND GROUP-SPECIFIC CODA VARIATIONS OF SPERM WHALES (*PHYSETER MACROCEPHALUS*) IN THE BALEARIC SEA

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A combined total of 22.9 days was spent on effort searching for sperm whales around the Balearic Islands in 2003 and 2004. Forty-six recordings of whale vocalisations lasting 3hrs 58min were analysed using two separate methods of classification were; an observer classification and a k-means cluster analysis. Diverse coda repertoire was established for the sperm whales in the Balearic Islands with a total of 25 coda types with 3 to 10

clicks each. This is far more varied than previously recorded in the Mediterranean (Frantzis *et al*. 1999; Pavan *et al*. 2000; Drouot 2003). The 4-click coda was the most common coda comprising 76% of the repertoire and of the three most frequent coda types two were of the 3+1 general category (32%), consistent with previous findings, although the most common single coda type was actually the longer 3++1 type. The 2+1 type, which was also recorded from sperm whales in the Greek waters (Frantzis *et al*. 1999), comprised 8% of the codas. The overall duration of the codas ranged from 240ms to 2180ms with a mean duration of 682ms (SE =8.6, SD = 200, 95% CI = 0.0169). Codas with more clicks had generally longer durations and shorter absolute inter-click intervals indicating possible preferred coda duration across n-click types. Coda repertoires from three different groups were compared to find out whether the pattern of vocal clans present in other oceans (Weilgart and Whitehead 1997; Rendell and Whitehead 2003) was also present in the Mediterranean. No such division of coda dialects was found, and all the groups belonged to the short, plus-one clan. However, definite variations in repertoires were observed, and the groups had partially distinct repertoires with some unshared types and different dominant coda types in each.

A-29

TOWARDS A BOTTLENOSE DOLPHIN ACOUSTIC ETHOGRAM FROM THE SHANNON ESTUARY, IRELAND

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A number of recent studies of bottlenose dolphins have attempted to record context-specific whistles from animals in the wild. We have started to record vocalisations from bottlenose dolphins in the Shannon estuary via a fixed hydrophone array with sound signals transmitted to the research station through the Vodafone mobile phone network (Sound waves). Before we can start to attempt to relate vocalisations to behaviour we need to build up a catalogue (an ethogram) of the different types of vocalisations produced in the field. Here we present results from fieldwork carried out during 2004 in Shannon estuary. We present the different whistle types recorded and determine their relative frequency. To date over 200 different whistles have been recorded and allocated into five major categories. Most whistles (60%) fell into two categories (Rise and Fall). We hope to be able to compare this ethogram with similar studies of bottlenose dolphins for comparative studies with dolphins living in different environments and with different behaviours.

A-30

WHISTLE PRODUCTION AND ASSOCIATIONS AMONG THE BOTTLENOSE DOLPHINS OF THE SADO ESTUARY, PORTUGAL

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The aim of this work was to study the associations among the bottlenose dolphins (*Tursiops truncatus*) living in the Sado estuary and the contours of the whistles emitted by the groups that contained them. A boat was used in surveys totalling a 133-hour sampling effort, which enabled us to gather acoustic, photographic and video recordings of dolphin's behaviour, as well as other environmental data. The association index (HWI) among the animals was calculated, and also between the animals identified and the contours of the whistles that were recorded near the groups, in an attempt to relate them. Eighteen animals of the population were identified in these surveys, which represent a part of the resident population. A sample of 439 whistles was obtained. Among these, 214 showed stereotyped modulation frequency contours, and were grouped into 15 categories, 13 of which were common to recordings that had already been obtained in previous years. The maximum association coefficient among the individuals was 0.67 and only 5.23% of the values were equal to or higher than 0.5, which is consistent with fusion-fission social patterns. The HWI values equal to or greater than 0.5 between individual's present and stereotyped whistles were limited to 1.11% of the sample, which does not indicate any strong association between individuals and specific whistle contours.

A-31

STRUCTURAL AND TEMPORAL EMISSION PATTERNS OF VARIABLE PULSED CALLS IN RESIDENT KILLER WHALES (*ORCINUS ORCA*) OFF VANCOUVER ISLAND, BRITISH COLUMBIA

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Resident killer whales off Vancouver Island, British Columbia, produce whistles and burst pulsed calls in underwater communication. Calls can be divided into discrete and variable ones with the latter being most commonly used during close-range interactions such as socializing or social-travelling. Earlier studies showed that variable calls are graded and can be arranged into a scale from low-frequency calls to high-frequency ones. These graded calls are often emitted in sequences, were call-types of similar frequency follow one another more often than different types. However, a detailed analysis of sequences was lacking to date. Therefore our understanding of the function that variable calls play during interactions among killer whales is rather limited. Simultaneous recordings of underwater vocalizations and behavioural observations from resident killer whales were collected off Vancouver Island, British Columbia during 1996-2001. Socializing activities were divided into four categories: male-female, male-male, female-juvenile and juvenile-juvenile ones. Variable call sequences were analyzed with RTS and SIGNAL acoustic-software. We found no positive

correlation between group-size and number of used calls or the duration of sequences, indicating that only one or a few animals were involved in the production of each sequence. Furthermore, sequences were present in all four behaviour categories and the composition of the group had no influence on the duration of calls and used call-types. One particular call-type (V4) could be further separated into structurally distinct sub-types. These subtypes often formed rather stereotyped sequences. The results of our study indicate that sequences of variable calls emit broad motivational information that is not age or sex-related. Sequences of distinct subtypes might encode more subtle information on emotional states during socializing. Therefore, variable calls might posses different functions, depending on the nature of the interaction. Thus, variable calls might be of great importance for close-range communication in wild killer whales.

A-32

GEOGRAPHICAL VARIATION IN THE VOCAL REPERTOIRE OF BEARDED SEALS (*ERIGNATHUS BARBATUS*)

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Comparative studies of vocal repertoires over the geographic range of a species provide valuable opportunities for unravelling factors that shape the evolution and divergence of animal communication systems. This study describes bearded seal vocalisations from four different sites throughout the Arctic region, Alaska (N = 2319), Svalbard (N = 833), the Western (WCA, N = 139) and High Canadian Arctic (HCA, N = 530). Recordings were analysed as spectrograms and sixteen vocal parameters were measured for each vocalisation. Variability in vocalisations was examined using classification tree analysis. Bearded seal vocalisations separated into six main categories; ascents, trills with ascent/plume, long trills, short trills, sweeps and moans. Not all categories were present at all sites, with the ascent occurring only in Alaska and WCA, the sweep occurring only in Svalbard and HCA and the trill with ascent/plume occurring at all sites except for Svalbard. Variability within the six categories was explored for each site. Geographic differences between sites were apparent in repertoire size with Alaska exhibiting 9 call variants, the Western Canadian Arctic 7 variants, the High Canadian Arctic 11 variants and Svalbard 4 variants. One likely explanation for the observed vocal differences between sites is the genetic separation of populations by physical distance. For example, Svalbard (the most distant of the sites) showed the least variability in call repertoire and only four of the six main categories were present. Other factors such as varying ecological influences, *e.g.* habitat adaptation or sexual selection, may also help to shape local call variability.

A-33

REFLECTION ABOUT THE USE OF ACOUSTIC DEVICES IN THE CONTEXT OF FISHERY

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The interaction between dolphins and fish nets is an important problem and a solution must be found urgently to protect the cetaceans in accordance with the European laws and to reduce opportunistic foraging behaviour by dolphins around small-scale gillnet and trammel net fisheries. In the past, shots and explosive charges were used by fishermen to frighten dolphins. These methods are now forbidden and since 2001 new systems called deterrent devices or "pingers" have been proposed by several societies. They are low-intensity transponders emitting sounds in water. The European systems produce waveforms which are wideband, frequency modulated, with a low power. These emissions are supposed to disturb the sonar system of the dolphins. Several independent experimentations have been carried out in order to test their efficiency. Their results are contrasted and depend on the situation of used of the pingers. Especially, it appears that the accidental by-catch and the opportunistic foraging are two problematic completely different which need each one specific solutions. Moreover, it seems evident that deterrent systems cannot be efficient for several cetacean species simultaneously. So, scientists need to search on which principle of action deterrent systems must be developed and for what dolphin specie, that will impose a kind of signals and its power. Directly linked to the last point, they have to study what will be the consequences on cetaceans and others species of a massive use of these acoustic devices.

A-34

A STANDARD METHOD FOR SPERM WHALE CODA CLASSIFICATION

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Sperm whales (*Physeter macrocephalus*) produce a limited variety of broadband acoustic signals whose combinations include usual, rapid and slow clicks, creaks and codas. The use and importance of these signals are still poorly understood, but codas are believed to play an important role in the communication process of socializing sperm whales. They consist of a short series of clicks repeated

several times and are mostly heard when the whales are gathering at the surface. It has also been hypothesised that codas could be specific to a group and geographical location. To confirm these assumptions and compare codas from different data sets it is necessary to agree on and use a common standard for the classification process. An objective method for the classification of normalized sperm whale codas is proposed. The k-means algorithm is used for analysing the data; its clusters are accepted when they resemble a normal distribution in the direction of their principal components. Probabilistic outcome of the k-means algorithm is avoided by initialisation of the cluster centres. In addition a naming standard is suggested which accurately describes the rhythm of a coda.

A-35

MANAGEMENT OF ACOUSTIC THREATS TO MARINE MAMMALS: A MULTI-STAKEHOLDER APPROACH TO CONSERVATION POLICY

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Over the last two decades, marine mammal scientists have increasingly turned their attention to potential impacts of human-made sounds in oceans (*e.g.*, shipping noise, military sonar, and seismic exploration) that may affect marine mammals. Recent events such as strandings of beaked whales in the Bahamas and Canary Islands coincident with military activities and development and testing of low-frequency active sonar, as well as lawsuits challenging sonar tests and certain types of marine mammal acoustic research, have increased international attention on this issue. In 2003, the U.S. Congress responded to resulting controversies by directing the Marine Mammal Commission to "fund an international conference or series of conferences to share findings, survey acoustic 'threats' to marine mammals, and develop means of reducing those threats while maintaining the oceans as a global highway of international commerce." The Commission established the Federal Advisory Committee on Acoustic Impacts on Marine Mammals, which consists of 28 members representing the academic community (including marine mammal scientists and geophysicists), the shipping and oil and gas industries, the U.S. Navy, various environmental nongovernmental organizations, and relevant management agencies within the U.S. government. The Committee's task is to 1) review and evaluate available information on the impacts of human-generated sound on marine mammals, marine mammal populations, and other components of the marine environment; 2) identify areas of general scientific agreement and areas of uncertainty or disagreement related to such impacts; 3) identify research needs and make recommendations concerning priorities for research in critical areas to resolve uncertainties or disagreements; and 4) recommend management actions and strategies to help avoid and mitigate possible adverse effects of anthropogenic sounds. This multi-stakeholder approach has created new opportunities for communication and collaboration as the members survey available scientific information and negotiate agreements on appropriate management and mitigation of acoustic threats.

A-36

AN ASSESSMENT OF THE PERFORMANCE ACHIEVED BY TWO T-POD UNITS

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The use of passive acoustic methods, and specifically automated detection systems, in monitoring the marine environment is now increasingly commonplace. The most widely used automated system to monitor marine mammals being the T-POD unit. This system has evolved significantly since its inception and a number of different versions of the unit are currently in use by cetacean researchers around the globe. However, few attempts have been made to accurately calibrate the performance of these units in order to fully understand the detection performance achieved. Units representing two different versions of T-POD have been tested in an underwater acoustic calibration facility in order to verify their acoustic sensitivity and beam plots using simulated harbour porpoise pulses. The performance achieved is discussed, together with the impact on their use for detecting harbour porpoise echolocation pulses. Finally, the performance is compared with the performance of the SPUD algorithm, a new algorithm to classify harbour porpoise echolocation pulses.

A-37

ANALYSIS OF *HYPEROODON AMPULLATUS* (NORTHERN BOTTLE-NOSED WHALE) VOCALISATIONS

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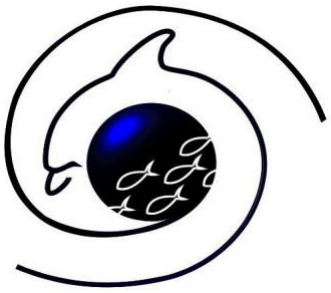
This paper discusses the analysis of the vocalisations of bottle-nosed whales. These recordings were made of the animal when it was near the sea surface and when it was dived. The recordings, each of around 10 minutes duration, were made using two Bethos AQ4 hydrophones arranged with a 295 cm spacing and were acquired on to a DAT recorder. The recordings were made over a bandwidth of 200 Hz-15 kHz. Along with a variety of other vocalisations, these recordings contain various click trains that are analysed to reveal the distributions of the inter-click intervals under the two conditions. It is shown that

during dives, the animal's mean (and median) click rate appears to be reduced relative to the rate observed near the surface. Detailed analysis of the distribution of click intervals, under both conditions, shows that at various times one can observe pairs of clicks separated by a reasonable fixed interval, with the time between each pair being more variable. It is argued that the presence of this regular inter-pulse interval, with similar characteristics, both near the surface and dived rules out the possibility of the second pulse being an echo. A fact further backed up by the observation that the estimated path difference corresponding to the delay is 70-80 m. This structure in the pulses gives the recorded data a distinctive character and may be used a key recognition feature.



BEHAVIOUR

B-01

BEHAVIOURAL RESPONSES TO FERRIES BY FOUR SMALL ODONTOCETES

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The Bay of Biscay and the English Channel are areas of high cetacean abundance and diversity, containing at least twenty species. At the same time these waters are exposed to a high volume of vessel traffic, which is likely to have a disturbance effect on the wildlife. Different odontocete species may react differently to vessel exposure. This study aims to compare the different behavioural reactions to approaching ferries of four species of small odontocetes: common dolphins (*Delphinus delphis*), harbour porpoises (*Phocoena phocoena*), striped dolphins (*Stenella coeruleoalba*), and bottlenose dolphins (*Tursiops truncatus*). Surveys have been conducted by the Organisation Cetacea (ORCA) along two different ferry routes from 1997 to 2003. The survey platforms were the Brittany Ferry from Plymouth, UK to Santander, Spain, and the P&O Ferry from Portsmouth, UK to Bilbao, Spain. Over 3,000 cetacean sightings were recorded, including 539 of common dolphins, 219 of harbour porpoises, 357 of striped dolphins, and 323 of bottlenose dolphins. Common and striped dolphins were found to approach the vessels during 67.3 and 69.1 % of the sightings respectively. Bottlenose dolphins showed indifference to the vessels for 77.5 % of the sightings. Harbour porpoises were either indifferent to (51.4 %) or evaded (45.9 %) the ferries. This implies that ferries have a greater impact on harbour porpoises than on other cetacean species. The population of harbour porpoises in this area has been decreasing over the last few decades. Increasing vessel traffic may be a factor in limiting the recovery of their population status. Vessel traffic appears to have a lesser impact on the three dolphin species. Future studies on the long-term effects of boat disturbance on cetaceans and harbour porpoises in particular would be required for effective management strategies in this area of high cetacean diversity.

B-02

DIURNAL PATTERNS OF HABITAT USE AND BEHAVIOUR OF INSHORE BOTTLENOSE DOLPHINS (*TURSIOPS ADUNCUS*), IN PLETTENBURG BAY, SOUTH AFRICA

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Plettenburg Bay is situated on the Southern coast of Africa at the western limits of the Indian Ocean. The utilisation of Plettenburg Bay's coastal environment is on the increase and thus raising the need for efficient and effective management of its marine flora and fauna. A habitat use survey was conducted on the inshore bottlenose dolphin population (*Tursiops aduncus*). Shore based observations were carried out during day light hours over a period of three months. Observations were recorded to determine any diurnal patterns in behaviour and define areas within the bay utilised by the dolphins. Focal group follows were conducted for a total of 250 hours and their behaviours categorised after 5 minute observation periods using predominant group activity. GPS was used to record 750 dolphin positions before transferring the data to ArcView GIS. The survey highlighted preferred areas of habitat usage and diurnal patterns of behavioural changes, displaying primary locations for foraging on rocky substrate in the morning. Offshore feeding activity only occurred in the afternoon when the individuals aggregated into large feeding associations. The estimated minimum number of dolphins recorded ranged from approximately 50-400 individuals within these feeding groups. The data also showed a preferred position for dolphin groups offshore relative to the shoreline, with a preference to reside behind the surf line, 0-50 metres on the seaward side of the breaking surf. The predominant behaviours were feeding and travelling, although surfing was also a common behaviour which is believed to be used as an energy saving mode of transport along the surf line. The results presented here will facilitate future conservation and management plans for Plettenburg Bays' marine and

coastal habitats. This will also aid the update of regulations for the bay's increasing local cetacean ecotourism industry.

B-03

GROUPS OF SUBADULT BELUGAS (*DELPHINOPTERUS LEUCAS*) OF SOLOVETSKIY STOCK IN REPRODUCTIVE GATHERINGS: FORMATION DYNAMICS AND COMPOSITION.

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Little is known about social relationships between immature individuals of belugas. Observations were conducted in the area of Bolshoi Solovetsky island, in the area of reproductive aggregation of beluga whales of Cape Beluzhy. Our study addressed the most frequent groups of immature individuals and there composition. The approximate age of beluga whales is normally determined by their coloration. It is assumed that the gray individuals are immature animals, whereas blacks are young of the year. Immature individuals may swim in "subadult" groups. Data on the size of subadult groups and on the age of their members are presented for the first time. Altogether, during the observation period, 296 groups were recorded, which fell into four classes as follows .The time of observations covered several periods of life of the reproductive aggregation. During three first periods of the existence of the reproductive aggregation immature beluga whales frequently form groups of two individuals (48.4%). Also, for all those periods the groups of fore individuals are the least characteristic. Groups of two individuals mainly (46 -50%) are formed by grey and light-grey animals. The ratio of groups of three and five animals is significantly different in the preparatory period and in the first mating period. Formation of "subadult" groups in reproductive aggregations, whose activities are play, imitation and social, is a unique feature of reproductive aggregations.

B-04

KILLER WHALE PREDATION ON SEA LIONS AT PUNTA NORTE, ARGENTINA: SEA LION ANTI-PREDATORY BEHAVIOUR AND EVOLUTION OF PREDATORY INTERACTIONS

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Killer whales on the east coast of Argentina have been observed to take prey by intentional stranding. This study aims to provide the evolution of predator prey interactions and sea lion response according to predatory stress. We hypothesised: 1) intentional stranding at Punta Norte to meet predators' energetic needs; 2) predator to increase hunting investment according to prey type capture rate; 3) sea lions gather under predatory stress. We found that: 1) intentional stranding at Punta Norte does not provide the minimum daily food requirements, suggesting foraging habits developed at other sites between 1988 and 2004; 2) predator adapts capture attempts according to prey type capture rate; 3) sea lions have two ways of grouping: increasing in group size and decreasing time span between groups. The first is predatory related, the latter is not. Increasing in group size is a learned anti-predatory behaviour that sea lions at Punta Norte apply selectively according to other individuals' capture rate.

B-05

HOME RANGES AND MOVEMENT PATTERNS OF BOTTLENOSE DOLPHINS IN THE SADO ESTUARY, PORTUGAL

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The Sado estuary, Portugal, is home to a small and apparently declining bottlenose dolphin population. Although it has been studied since the 1980's, systematic information concerning home ranges and distribution is still lacking. In this study we performed an individual analysis of behaviours related to movement and use of space by the bottlenose dolphins in the Sado estuary and adjacent coastal waters. Home range and movements were calculated using Animal Movement 2.0 beta extension for ArcView 3.1. Based on the home range versus sequential locations curve, we estimated 105 as the minimum sample size needed to reliably estimate home ranges for this population. The mean home range area calculated by the Minimum Convex Polygon method is 32.0 km² and by the Kernel (95% Utilization Distribution - UD) method is 41.9 km². Mean core area is 6.9 km² (Kernel 50% UD). The largest home ranges refer to two adults, a female (MCP 37.1 km², Kernel 47.8 km²) and a male (MCP 44.1 km², Kernel 50.8 km²). Core areas (Kernel 50% UD) seem to overlap with areas previously known to be of importance as a result of higher food availability and presumably lower level of contaminants. Daylight movements ranged from 12.4 km to 20.8 km. Sado estuary bottlenose dolphins have fairly wide movements as they some days travel a minimum distance close to the maximum width of their home range. The maximum instantaneous travel speed was calculated as being 32.4 km/h, but the mean individual speeds rarely go beyond 3.6 km/h.

B-06

OCCURRENCE, GROUP TYPES AND BEHAVIOURS OF HUMPBACK WHALES IN THE S. TOMÉ AND PRÍNCIPE ARCHIPELAGO

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The humpback whale (*Megaptera novaeangliae*) migrates during the austral winter to different breeding/calving grounds in the South Atlantic Ocean. The S. Tomé and Principe archipelago has been reported as a possible breeding ground in the Gulf of Guinea region since the whaling period. The objective of this study was to investigate the occurrence, group types and behaviours of humpback whales in this region. Data were collected in austral winter (between August and November) in 2002 and 2003, a total of 125 boat-based surveys were conducted in the south of S. Tomé Island. When the animals were sighted, photo-identification of individuals was made when the weather conditions allowed, and recording of GPS positions, group size, group composition and behaviour were made. A total of 18 individuals were successfully photo-identified but none of them were resighted in different years. Of a total of 46 groups observed, mother-calf pairs made up a large proportion (52%), followed by solitary individuals (32%). Mother-calf pairs have been seen in the region as late as November, showing extended periods in the region with resightings over a three week period. Very few behaviours associated with mating activity (competitive groups and singing) have been observed in this area. Given the high percentage of mother-calf pairs, sometimes with very young calves, and the low frequency of mating activity, the waters of this region seem to serve mainly as a wintering habitat for calving. Conservation needs and measures are now being considered to be applied in a near future.

B-07

PATTERNS OF ASSOCIATION OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) FEMALES DURING GESTATION AND POSTNATAL PERIOD

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Social mammals living in fission-fusion society are dominated by short-term associations between individuals. However, most bottlenose dolphin (*Tursiops truncatus*) females can associate other females in stable bands and have strong relationship with their infants for long time. The aim of this study was to estimate - through systematic observations - two aspects of female bottlenose dolphins at Rimini's Delphinarium (Italy): 1) the amount of time spent by two females with other adults in the pool during the last 4 months of pregnancy and 2) the proportion of time spent with their respective calves during the first 6 months of life. Both aspects were investigated considering the mothers' experiences and the sex of each calf. Animals were focally observed in weekly 8-hours sessions, applying Half-Weight-Index (HWI) as a measure of association, and Proximity Quotient (PQ) to test responsibility for proximity maintenance from mother to calf and vice versa. Data analyses indicate that both females preferred swimming with another female during gestation. After birth, mother and calf were within close proximity over 90% of the time, with a significant decrease from 1st to 6th month. As expected, results demonstrated an increase in calf independence shown by behaviours preformed in the proximity of individuals other than mother or increased time spent alone. HWI shows a similar trend for both pairs and no behavioural differences between primiparous and multiparous mother were founded. There was a shift in responsibility for proximity from mothers to their calves: PQ decreases over the time becoming negative till 5th month. At first, mothers were responsible for maintenance contact with their infants, with significant differences in the number of approaches to the females as to males. After, calves initiated more leaves/approaches then their mothers, swimming and socializing independently. These results suggested the existence differences in the mothers' newborn handling depending on the calves' sex.

B-08

EVOLUTION OF PROLONGED POST REPRODUCTIVE FEMALE LIFE SPANS IN KILLER WHALES, *ORCINUS ORCA*

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Prolonged post-reproductive female lifespan have so far only been described in three species; humans, short-finned pilot whales and killer whales. Prolonged post-reproductive life spans may have been selected due to the increased risk of giving birth later in life and allowing females to assist their existing descendants or increasing the reproductive fitness of daughters from the assistance of a menopausal mother as has been found in humans. Alternatively prolonged post reproductive female life spans may be non-adaptive and artefacts of a recent dramatic increase in longevity. Using demographic data from three decades of photo-identification on two populations of killer whales from the North-eastern Pacific we found mortality rates of post-parturition females increased above 40 years of age, but not above the level expected for this age bracket. The inter-calf interval and age of first parturition were lower for females whose own mother was still alive. The death of the mother had no effect on the survival rate of calves aged three years and above, adult males or adult females. These results suggest that prolonged post-reproductive lifespan in killer whales did not evolve as a result of increased risk of parturition with age, or prolonged care for the last born offspring, but possibly to increase the daughter's reproductive fitness.

B-09

A METHOD TO STUDY "DOLPHIN BEHAVIOUR AT THE MIRROR"

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Dolphins are big-brained, socially sophisticated mammals, socially and cognitively comparable to monkeys and apes in memory capacity, language comprehension and other cognitive abilities (Herman, 1980). This suggest that dolphins, may come to recognize themselves in mirrors (*e.g.*, Anderson, 1984; Gallup, 1970, 1982; Lethmate and Ducker, 1973; Suarez and Gallup, 1981; Marten and Psarakos, 1994). We chose to investigate the behaviour of three Bottlenose dolphins (*Tursiops truncatus*) in front of a screen. The animals, were different in age, sex, social position and probably also in cognitive abilities (one adult female, one young female, a juvenile male). We modified the "mirror test" (Marten and Psarakos, 1994) using screen presentation as a manipulate mirror with the dolphins and added to its experimental conditions some news. The "traditional" conditions were: mirror mode in real time self-view, mirror mode in play back self-view. Our news were: proposal of movies about familiar dolphin, proposal of movies about unfamiliar dolphin, proposal of "nothing image" (only the light of the projector like a control condition). Finally we were able to use the behaviours of dolphins relatively to the different conditions, to create an ethogram that in future steps of the research, we hope to be useful to attempt to answer to the question of whether the dolphins mirror-directed behaviour is social o self examination.

B-10

OBSERVATION AND BEHAVIOUR OF SEALS FROM BALTIC SEA COAST OF MECKLENBURG-VORPOMMERN, GERMANY

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The German Oceanographic Museum has been collecting information on marine mammals from the waters of Mecklenburg-Vorpommern for many decades. It is therefore possible to judge the occurrence and situation of marine mammals for that area of the Baltic Sea. As part of the Environmental Monitoring Program we observed pinnipeds and studied her behaviour. Since 1951 - 2004 we also observed 131 grey seals on the coast of Mecklenburg-Vorpommern. Two of them are living permanently since 1968 in the Darß-Zingster-Boddenkette. They had at least one young pup (found dead in 1978). Between January 2001 and October 2004 three tagged grey seals moved respectively from Denmark, Sweden or Poland to our coast and stayed here for three to five days (western from Rostock- male"Villi" tagged by Swedish Museum of Natural History and Darßer Ort- male freeze brand "Nr.2" tagged by National Environmental Research Institute (NERI) Denmark and three month in Strelasund/Stralsund female "Dulka" tagged by Hel Marine Station/Poland. Since 1991 common seals also occur more frequently. Altogether 4 new born common seals were found: 2 on the island Greifswalder Oie in 1999 and 2001 and 2 in the Wismar-Bay in 1992 and 2004. Tagged common seals from Rødsand/Denmark moved into German waters, mostly into the Mecklenburger-Bay. From 1979 to 2004 we observed 58 common seals (including the two newborne seals) near the coast of Wismar-Bay (30.9.1993: Four seals altogether on sand bank Lieps). The administration of Mecklenburg-Vorpommern is now working on a management plan for the FloraFaunaHabitat (FFH)-area Wismar-Bay to protect haul-out sites of seals. The investigations on the biology and health status like presented at the ECS in 2004 remains an important tool together with information for the management of the seal populations in the Baltic Sea. We are grateful for the contributions by Anna Roos, Swedish Museum of Natural History/Sweden; Iwona Kuklik, Hel Marine Station/Poland and Jonas Teilmann, National Environmental Research Institute (NERI), Denmark.

B-11

DEFINITION OF BEHAVIOURAL CATEGORIES IN STRIPED DOLPHINS (*STENELLA COERULEOALBA*) IN THE LIGURIAN SEA SANCTUARY IN THE PRESENCE OF BOATS

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Striped dolphins are the most frequent cetaceans in the central Mediterranean, an area with intense maritime traffic. Striped dolphins often approach boats and bow-ride. Whether a high frequency of encounters with boats may substantially disrupt the dolphins' natural behaviour has yet to be clarified. This study is aimed at defining behavioural categories that can provide a basis for the evaluation of potential disturbance by boats. A dataset of 364 3-min samples was collected in 2000-2001 between June-October. Eight main variables (BEHA-set) were scored (group size, age classes, group formation, surfacing mode, swimming direction, swimming speed, time underwater, distance from boat). Concurrently, 41 different behavioural events (EVENT-set) were sampled (one-zero method). BEHA- and EVENT-sets were analysed independently by means of hierarchical Cluster Analysis (Ward method agglomeration criterion). For the main variables, Chi-square was used as similarity metric whereas the Quadratic Euclidean Distance metric was used for the binary-event variables. Cluster Analyses came up with 5 groups for the BEHA-set and 7 for the EVENT-set. The BEHA and EVENT clusters were overlayed and different events were found associated to the BEHA clusters. Each category obtained by Cluster Analysis was interpreted by looking at: 1) response to boat (N of bow-riding individuals/ duration of bow-riding) and 2) general activity emerging from the BEHA variables. Categories were: Attraction/ Rest, Attraction /Feeding-Searching, Attraction /Travel, Avoidance/ Nursing, Indifference/Mill. The presence of calves, found inversely associated to bow-riding, was the strongest element determining the attitude

towards the boat. Furthermore the time profiles of bow-riding events, which were separately analysed, declined after the first 30 min of sampling, both in terms of duration and number of animals involved. This definition of behavioural categories can be used for further quantifying anthropogenic impact on striped dolphins and figuring out appropriate codes of conduct for whale-watching boats.

B-12

THE USE OF VISUAL AND ACOUSTIC SURVEYS TO INVESTIGATE THE EFFECTS OF BOAT TRAFFIC AND ENVIRONMENTAL VARIABLES IN THE PRESENCE OF BOTTLENOSE DOLPHINS IN NEW QUAY BAY, WALES

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The use of New Quay Bay, within the Cardigan Bay candidate Special Area of Conservation, by the resident bottlenose dolphins (*Tursiops truncatus*) was investigated by visual and acoustic means. A land-based visual survey conducted from May 1st to August 7th 2004 and a T-POD acoustical survey conducted from June 14th to August 7th 2004 were used to investigate which natural factors affect the presence of the dolphins and also the possible impact of boat traffic in this area. A total of 497 hours of visual data and 1077 hours of acoustic data were collected. Comparisons of the two data sets were made to determine any potential differences between the two techniques. Both bottlenose dolphin presence and boat traffic were found to peak in August. Dolphin presence throughout the day varied inversely with boat traffic. Peak use of the bay by dolphins was at midnight, whereas greatest boat traffic was observed at 1pm. The tidal cycle was significantly correlated with bottlenose dolphin presence, indicating greater presence during the ebb phase of the tide as compared to the flood phase. The reaction of dolphins during boat interactions varied significantly. Most encounters resulted in the dolphin either changing its behaviour or disappearing from view. Fast moving boats such as motorboats and speedboats appeared to cause greatest disturbance to the animals. Visual and acoustic methods revealed broadly similar patterns in most instances. The combined use of both techniques compensated to an extent for the drawbacks inherent to each survey. Precautionary measures such as codes of conduct for marine vessels may help to reduce disturbance experienced by bottlenose dolphins and other marine wildlife, due to increased boat activity in the area. Further study is necessary to determine any long-term impacts of disturbance caused by boat traffic.

B-13

SPERM WHALES CLICK FOCUSSING: TOWARDS AN UNDERSTANDING OF SINGLE SPERM WHALE FORAGING STRATEGIES

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Sperm whales make 30-90 minute dives in order to feed on middle-sea, deep-sea squid and fish. When diving, sperm whales make an almost continuous train of short echolocation sounds (clicks), with slow rate variations (~2clicks/s), fast accelerations (creaks), and silences (5s). Creaks and silences have been described as clues suggesting short range attacks and feeding. But how do sperm whales move and echolocate to so as to locate and track prey? There is so far no study (1) decrypting the sperm whale clicking rate variations, (2) proposing a reliable model estimating the sperm whale target range from the click rate variations, (3) describing how, if at all, sperm whales analyze the prey layer when (vertically) initiating a dive, (4) describing the sperm whale movements and echolocation strategy (when at the prey depth) to find and catch prey. The authors attempt to address these issues, by pointing out correlations between sperm whale click power/bearing/rate, making an estimation of sperm whale physical and acoustical activity. The authors demonstrate that (1) sperm whales, when making a click, would aim for a specific range (and direction) only, when searching as well as tracking prey, (2) the target range could indeed be directly estimated from the click rate, but only if considering a click processing delay, (3) sperm whales would not echolocate at the sea bottom when initiating a dive, but at the prey layer only, would analyze the horizontal distribution of prey by a vertical movement, and the vertical distribution of prey by click power modulations, (4) sperm whales would not randomly search for prey, but repeat 30-180s long 2-phase sequences, by methodically scanning a water cone, before entering the cone and attacking. Data would suggest a horizontal, 400m long cone, a downwards scan, and an upwards attack.

B-14

SOCIAL STRUCTURE OF BOTTLENOSE DOLPHINS IN CARDIGAN BAY

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Sizeable populations of bottlenose dolphins (*Tursiops truncatus*) in British and Irish waters are found in the Moray Firth, Scotland, the Shannon Estuary, Ireland and Cardigan Bay, Wales. We sought to investigate, for the first time, the social associations of bottlenose dolphins in Cardigan Bay. A total of 72 photo-identification surveys were made during 2003, resulting in 134 dolphin encounters. Fifty-two identified dolphins were selected based on their number of sightings. Individuals accompanied by calves were categorised as females and extensively scarred animals as males. Associations were

studied using half-weight indices and cluster analysis. In addition, temporal analyses of associations were made plotting changes in the standardised re-association rate over time. The social organisation was characterised by relatively fluid association patterns, with little stability over periods longer than a few days. Some longer-term companions were evident. Permutation tests revealed the presence of preferred and/or avoided companions. Both males and females interacted with a large number of other individuals. In contrast to studies from the Moray Firth and the Shannon Estuary, we found significantly stronger associations between certain male pairs. As in the Shannon Estuary and in the Moray Firth, we found no evidence of stable female bands. The low risk of predation in these three areas may reduce the need for stable female cohorts, such as those observed in more tropical waters, while the shallow waters of Cardigan Bay may favour the male alliance strategy in coercing reproductive females. Six loosely defined clusters of dolphins, including animals of both sexes, were identified. These clusters could reflect the existence of preferred geographical ranges that influence the dolphins' social networks. A similar situation has been hypothesised in the Shannon Estuary. This degree of site fidelity highlights the fact that monitoring based on photo-identification needs a good geographical spread.

B-15

COMMON BOTTLENOSE DOLPHIN'S FEEDING STRATEGIES AND CONSERVATION PROBLEMS IN NORTH EASTERN SARDINIA (ITALY)

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Bottlenose dolphins (*Tursiops truncatus*) have been regularly monitored in the Maddalena Archipelago National Park since 1999. Between January 2003 and November 2004, 202 days were spent surveying, resulting in 729 hours of sea surveys, 140 sightings and 743 observations, with an overall sighting frequency of 0.192. Sighting frequencies have shown marked seasonal variations. Research was carried out through boat surveys, with the use of photo-identification techniques and with detailed recordings of behavioural data. Feeding strategies were divided into 4 categories: (FeeC) feeding in coastal areas (0-0.5 nautical miles from the coast); (FeeP) feeding in pelagic areas (over 0.5 nautical miles from the coast); (Ffb) feeding following fishing boats; (Fnet) feeding on fixed fish nets. During the study period, feeding activities were observed in an overall 54 sightings (38.6% of the total). FeeC was the most frequently recorded strategy (52%) followed by FeeP (26%), Ffb (15%) and Fnet (7,4%). Ffb could be poorly represented because of the limited amount of fishing activity in the area with only 5 fishing boats on mid-water trawling, whereas Fnet could be underestimated because dolphins possibly visit the fish nets also during the night. Mean group size according to the type of feeding behaviour was the following: FeeC mean 3.83 - SD 2.30, FeeP mean 4.64 - SD 4.70, Ffb mean 4.37 - SD 2.77 and Fnet mean 3.75 - SD 3.10, with a significant difference in mean group size between FeeC and FeeP. Juveniles and calves were present in 82% of the cases in FeeC, 71% in FeeP, 62.5% in Ffb and 75% in Fnet. This study confirms the importance of coastal waters as feeding grounds for females and youngs, and further stresses the presence of fishing nets, the primary mortality factor for Bottlenose dolphin in this area.

B-16

TACTILE INTERACTIONS IN TWO FEMALES BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) DURING PRE- AND POST-PARTUM PERIODS

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An aquatic lifestyle has resulted in the evolution of unique adaptations for signal exchange among dolphins. Physical contacts are used as signals in tactile communication. Two females bottlenose dolphin (*Tursiops truncatus*) were observed at the Rimini's Delphinarium (Italy) during the last four months of pregnancy and six months after birth in order to investigate tactile communication by contact interactions throughout these specific phases of reproduction. In particular, focal sessions were conducted to monitor the mothers' behaviour versus the other members of the group, as well as versus their respective calves. A total number of 276h of observation during pre-partum period and 574h during postpartum period were collected. Affiliative contacts (62.22 %) and rubbing exchanges (22.72 %), both given and received, were the more frequent interactions seen, but bonding, push, clasp, hold down, beak genital propulsion, attempted nursing and nursing were also recorded. Given physical contacts by head, pectoral and dorsal fins were mostly observed, while received interactions on pectoral fins, sides and back were principally documented. Two ways ANOVA revealed significant differences between the mothers - both in trends and body regions involved in the interactions - according to: 1) gestation vs postpartum period, 2) primiparous *vs* multiparous condition, 3) females' hierarchical level, 4) calf gender. These last three aspects seem to also influence behavioural sequences during tactile sessions, as appeared in the analysis of transition matrices. Where and how anatomically dolphins touch each other, as well as frequency and the level of intensity with which they contact each other over the time, suggest a differential use of this communication channel, depending on the significance and context of exchanged signals.

B-17

AGGRESSIVENESS, DOMINANCE AND RECONCILIATION IN BOTTLENOSE DOLPHIN

(*TURSIOPS TRUNCATUS*) FEMALES DURING PREGNANCY AND AFTER BIRTH

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Bottlenose dolphins (*Tursiops truncatus*) are social animals, particularly they share a plenty of social behaviours, either affiliative or aggressive. The existence of dominance hierarchies and post-conflict reunions has been demonstrated, but no specific research has been conducted on females until the present time. The main purpose of this study was to analyse aggressiveness levels, dominance relations and post-conflict behaviour which occur in female bottlenose dolphins during the last three months of pregnancy and six months after birth. Focal observations has been conducted on two females, a resulting dominant one (Alfa) and a submissive one (Beta) hosted at Rimini's Delphinarium (Italy). Comparative data on three births – one female and one male from Alfa and one female from Beta – has shown that the dominant female presents lower level of aggressiveness and is more inclined to threat rather than to aggress. The submissive female revealed a higher conciliatory tendency than the dominant one, according to the theory of the "valuable relationship" Clue has shown that analysing aggressiveness towards calves, the multiparous female Alfa presents higher levels of aggressiveness towards her calves in comparison with the primiparous one Beta, but both females rather prefer to threat their own calves weakly. Gender of calf seems to definitively influence the agonistic behaviour towards mother. In fact, only the male calf shows an increasing of aggressiveness towards the mother over the time. This preliminary data opens a new scenario on the study of females' aggressiveness in mammals and suggests new research topics on the development of agonistic behaviour in growing up bottlenose dolphin calves.

B-18

SOCIAL STRUCTURE AND SUCCESS IN SEALS

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Intraspecific associations are commonly described in cetaceans but we present evidence of non-random associations amongst breeding female grey seals and identify possible fitness benefits that accrue. Grey seals show consistent, fine-scale preferences for breeding sites and this may favour the emergence of intrasexual associations and hence sociality. Associations can occur when mothers are found together irrespective of location, or because of joint preferences for locations. We found that, using strict spatial and temporal association criteria, 160/176 of known mothers had intraseasonal associations with at least one other mother, with 14/126 (11.1%) of associations repeated in two years. We modelled the likelihood of female association in two years as a result of site fidelity, parturition date variation and pupping site quality. Interannual association between mothers that moved little (<40m) was indistinguishable from our model's predictions. However, the number of mothers that showed interannual association after displacements of >40m from their previous year's pupping sites was almost 5 times greater than the model predicted. Therefore, active association between breeding female grey seals is not determined solely by pupping habitat preference. The benefit of staying with familiar neighbours is likely to be reduced aggression. The level of organisation observed probably represents nascent sociality.

B-19

BREEDING BEHAVIOUR OF BALTIC GREY SEALS (*HALICHOERUS GRYPUS*) IN FORSMARK BREEDING STATION, SWEDEN

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The breeding behaviour of Baltic grey seals (*Halichoerus grypus*) has not been studied before. The Baltic grey seals have a different breeding strategy than the Atlantic, giving birth in late winter, often on ice. It is important to know more in detail about suckling time, feeding behaviour, breeding behaviour. This study was performed in a half-natural environment and was studied from 4th February to 5th March 2004. The breeding colony consisted of three adult seals (two females and male). One female pup was born during the study period. The behaviour of the pup and three adults was studied in detail 24 hours a day, via observers and on web cameras. The pup sucked for 16 days. The number of suckling sessions decreased over time, but their average length increased. Moulting started when pup was 6 days old and lasted 8 days. She defended herself successfully from a hungry fox from newborn age, with help from her mother. She went into the water for the first time when one day old, probably because of a fox attack. Aggression between mother and father increased during the study period, with clapping, rolling and growing behaviour, until they mated, 15 days after the birth of the pup. Mating occurred both on land and in water. The male attacked the pup a few times, but not seriously. He was more curious, wanted to look and smell it, as well as to protect it from intruders. The pup could defend itself successfully from the male by hissing and growling. No aggression was seen from the other female towards the pup, nor towards each other. The pup was released to the wild at 5 weeks of age, to the southern Baltic. She was deployed with a satellite transmitter before release, so her movements could be studied.

B-20

BOTTLENOSE DOLPHINS AROUND THE ABERDEEN HARBOUR, N.E. SCOTLAND: A STUDY OF HABITAT UTILIZATION AND THE POTENTIAL EFFECTS OF BOAT TRAFFIC.

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The aim of this study was to investigate the factors that affect the pattern of habitat utilization of bottlenose dolphins (*Tursiops truncatus*) around Aberdeen Harbour (N.E. Scotland, UK) in summer. Land-based surveys were conducted over a period of 9 weeks, between early May and late July (2002). During this time 83 sightings of bottlenose dolphins were recorded. They occurred most frequently around midday and early afternoon, while abundance was greater around high tide and late afternoon. Foraging was the most commonly observed activity at all times and tidal states, suggesting that this area serves as an important foraging habitat. This may be related to the up-estuary movements of salmon. Dolphins were usually concentrated around the entrance of the Aberdeen Harbour, which is characterized by regular boat traffic. Dolphins' responses to boats varied considerably according to boat size, activity and speed. However, negative reactions were seen mainly in response to the proximity of small boats that were moving fast and in variable directions, suggesting habituation to boat traffic.

B-21

DEEP DIVING AND FORAGING BEHAVIOR OF SPERM WHALES (*PHYSETER MACROCEPHALUS*)

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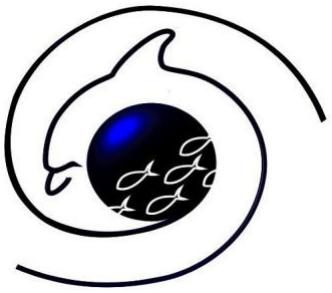
Digital archival tags (Dtags) were used to describe diving and vocal behaviour during 210 dives made by 36 foraging sperm whales in the northwestern Atlantic Ocean, Gulf of Mexico, and Ligurian sea. Whales dove to average maximum depths of over 960 m, 650 m, and 800 m in the three habitats, respectively. These foraging dives lasted an average of 46 minutes, and whales spent about nine minutes at the surface between dives, with no significant differences among regions. Whales exhibited similar foraging strategies in all three areas, spending over 80% of their time in foraging dive cycles. Whales produced regular clicks for on average 80% of all but one dive to over 300 m and for 60% of the descent phase. The occurrence of buzzes (originally coined "creaks") during deep dives was used as an indicator of the active foraging phase of a dive. Sperm whales descended a mean of more than 330m depth from the start of regular clicking to the first feeding buzz, which supports the hypothesis that regular clicks function as a long-range biosonar. Regardless of dive depth, there were no significant differences in foraging phase duration (29 minutes) or percent of the dive duration in the foraging phase (62%) between the three regions, with an overall diving efficiency (percent of dive cycle spent in the active foraging phase) of greater than 0.5. Whales maximized their time in the foraging phase by minimizing transit time to and from the foraging depth. Similarity in foraging behaviour in the three regions and high foraging efficiencies demonstrate that sperm whales are ecologically successful mesopelagic predators due to the combination of long-range echolocation of deep ocean prey patches, efficient locomotion, and a large aerobic capacity during diving.



CRITICAL HABITAT

CH-01

RESIDENT AND REPRODUCTIVE POPULATIONS OF BEAKED WHALES IN EL HIERRO, CANARY ISLANDS

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This paper presents results from an on-going study on the populations of Blainville´s (Md) and Cuvier´s (Zc) beaked whales located near the coast of El Hierro (Canary Islands). We summarise here data collected in 24 sea days in 2003 (March and October) and 43 sea days during 8 monthly

cruises from March to October 2004. In order to optimise the sighting rate we used research platforms on land (100 m altitude) and a boat, communicating by radio. Once a Ziphiidae group was located, behavioural, social composition and time-location data were recorded during each surfacing interval, plus identification. In addition, three Md were instrumented with acoustic and orientation recording tags (DTag). DTag data showed that Md performed deep foraging dives in the study area and visual observations of Zc suggest that they also dive for extended periods. Both species were sighted in all months. Groups of Zc comprised only adults and subadults, while those of Md often contained also juveniles and calves. Calves with foetal folds were sighted in autumn in both years, suggesting that El Hierro is a calving ground for Md, with a reproductive peak at the end of summer. A maximum of 18 Md and 20 Zc were photo-identified (minimum 12 for both species), while some 30% of the total photographed individuals had no distinctive marks on fin or body. Six individual Md and six Zc were re-sighted up to 4 times in different months of the study, implying that at least part of the populations of Md and Zc have a pattern of residence in the coastal waters of the island. On this evidence, El Hierro is a calving and feeding ground for Md and so it may constitute a critical habitat for this protected specie where potential disturbances such as military sonar should be avoided.

CH-02

THE COASTAL HABITAT OF THE MEDITERRANEAN MONK SEAL ON THE MEDITERRANEAN COAST OF MOROCCO(6)

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New research on the status of the Mediterranean seal *Monachus monachus* on Morocco was carried out during October 2004 along the coastal sectors where this species is historically known: National Park of Al Hoceima, Chemlala coast, Cap des Trois Fourches and Cap de l'Eau. Such research allowed improving our knowledge on this species in the western Mediterranean, where its short-term survival chances are of great concern. The caves considered in this study as potential terrestrial habitat for the seal were those having an aquatic corridor leading to a cave beach or rocky platform poorly illuminated with a certain degree of protection from direct wave action (Cebrian 1998). The density of marine caves to be prospected in the region was higher in Cap des Trois Fourches, where the rock is of volcanic origin, than in the other sectors, where sandstone, schist and calcareous rocks occur. Ten caves matching the criteria selected were identified and their characteristics recorded. Four of them are optimal for reproduction: one within the National Park of Al Hoceima, and three ones along the shores of Cap des Trois Fourches, being two of the latter ones in a sector where the scarce historical data on whelping in the region did not reflect it. The recent official declaration of the National Park of Al Hoceima provides an important challenge to improve the species status, through actions to facilitate the recovery of the monk seal in North Morocco. The coastal sector of Chemlala has been recently strongly degraded letting few hope for its suitability for the species from now on. On the same context, Cap des Trois Fourches, still shows to embrace optimal habitat for the Monk seal, fact that should stimulate the prompt legal protection of this area.

CH-03

THE INFLUENCE OF ABIOTIC ENVIRONMENTAL VARIABLES ON THE DISTRIBUTION OF HUMPBACK WHALE MOTHER-CALF PAIRS IN A TROPICAL LAGOON

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The Mozambique Channel Islands are a proposed migratory destination for humpback whales. Mayotte is the southeastern-most island in the Comoros Archipelago and the only island in the Mozambique Channel to have a complex double barrier reef system. The resulting lagoon (~1500 sq. km) is characterized by warm, shallow waters, averaging 20 m in depth, and punctuated by numerous smaller islands and coral islets. These environmental conditions have been broadly described as the preferred environment for calving female humpback whales. Collection of positional data has become standard practice during surveys for marine mammals to mark the location of where an animal or group of animals was encountered. Single geographic positions, however, are not representative of the variety of environmental variables encountered by animals throughout an observation period and can be misinterpreted if used for analyses of distribution in the absence of detailed spatial descriptions of effort. In response to these concerns, we developed a novel approach for spatially representing effort applied during surveys for marine mammals through the continuous acquisition of positional data. Combined with focal-follow methodologies, we undertook a multi-scale examination of the distribution of humpback whale mother-calf pairs in the waters surrounding Mayotte. Our survey results suggest that mother-calf pairs broadly exhibit a non-uniform distribution within the lagoon and surrounding waters. Finer scale analyses of group sightings from the southern lagoon, revealed further levels of differential distribution and some degree of individual preference. Positional data collected at four second intervals throughout focal-follow events, however, revealed a broad range of abiotic variables were utilized within a short period of time. Cumulatively, these data further our understanding of environmental preference and

utilization and contributing to sound conservation and management decisions by highlighting areas where critical human-animal interactions may occur.

CH-04

RELATIVE ABUNDANCE AND DISTRIBUTION OF THE HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) ALONG THE WEST COAST OF THE UK

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The harbour porpoise is the most frequently sighted cetacean in the UK. Two resident groups appear to exist within Cardigan Bay, Wales and Western Scotland. Smaller groups also exist elsewhere around the British Isles. Whilst volunteer observer schemes collate as much information as possible no dedicated effort-related survey has ever been conducted for the west coast of the UK and large gaps exist in the knowledge base for this area. During May-August, 2002 and May–September, 2003 a boat based visual survey of the harbour porpoise was conducted. Effort-related line transect methodology was employed, utilising two observers and one data recorder. The vessels location and heading were recorded every 30 minutes, along with a range of environmental data, including: sea state, water depth and water temperature. When harbour porpoises were encountered an estimate of group size and radial distance was made. Whilst on transect the following assumptions were made a) that all porpoises on the track line were detected, b) that porpoises were detected before they responded to the research vessel and c) that sightings are independent of one another. Relative abundance estimates demonstrated a statistically significant increase with distance north. Group size did not however elicit the same relationship, indicating that group size did not increase, but number of groups and hence individual porpoises did. There was no statistically significant relationship between group size and sea state, water depth or water temperature. This study clearly highlights the presence, although few, of harbour porpoises off the south coast of the UK and the importance of Western Scotland as habitat for the species. It is hoped that this baseline data and further studies will provide a comprehensive assessment of the harbour porpoise in UK waters, on which future conservation initiates may be based.

CH-05

HABITAT PARTITIONING IN SHORT-BEAKED COMMON DOLPHIN (*DELPHINUS DELPHIS*) AND STRIPED DOLPHIN (*STENELLA COERULEOALBA*) IN THE WESTERN ENGLISH CHANNEL AND BAY OF BISCAY

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This study describes the spatio-temporal distribution of two species of oceanic delphinids, short-beaked common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*) in the western English Channel and Bay of Biscay. Over 63,000 km of survey effort was recorded during 72 monthly surveys between August 1995 and July 2002. Year-round data collected from a commercial passenger ferry enabled comparisons between species with respect to season and five regions, defined by latitude and physiography. Environmental variables (EVs): depth, slope, distance to front, sea surface temperature (SST) and near-surface chlorophyll (CHL-a), were used to define habitat preferences for each species using a Geographical Information System. Distribution and relative abundance for both species varied both spatially and temporally. A bimodal distribution pattern for common dolphin existed, with encounter rates highest in shelf areas during the autumn and winter (n/km = 0.012), and in shelf-break and abyssal plain regions during spring and summer (n/km = 0.079). Striped dolphins were largely absent during the autumn and winter (n/km = 0.002) and most abundant during spring and summer (n/km = 0.006) in similar areas to common dolphin. Dispersal of striped dolphin from the study area may be related to seasonal variations in SST in the most northerly part of its range in the northeast Atlantic. Both species were non-randomly distributed in relation to depth, slope, SST and CHL-a, but with no relationship established to frontal areas. There was little variation found for striped dolphin distribution in relation to EVs, which was not the case for the more cosmopolitan common dolphin. Partitioning between the two species appears to occur spatially in relation to depth and slope when they are both found in close proximity, with striped dolphin preferring areas of higher depth and slope. Resource partitioning could not be investigated fully but may occur given established dietary preferences.

CH-06

SPATIOTEMPORAL PREDICTION MODEL OF FIN WHALES DISTRIBUTION IN THE LIGURIAN

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Distribution models were developed for fin whale (*Balaenoptera physalus*) of the Ligurian Sea, using the multiple logistic regression. Sightings data (n=83) were recorded between June and September. An effort of 3,700km from dedicated surveys, carried out monthly between Antibes (French mainland) and Calvi (North

Corsica) from 2001 to 2003. Presence of fin whales was modelled with topographic variables (Depth, Contour Index) and oceanographic parameters from remote sensing (Sea Surface Temperature, Chlorophyll and Net primary production) of the same period. These last variables were computed with two temporal scales: 1 month and 8 days. Spatial resolution of the grid was 14 x 12km and presence was predicted for an area of 43,500km². A total of 115 cells were sampled with good sighting conditions and 43% denoted presence of whales. Higher primary production area, distance to the coast and cold water were selected by stepwise procedure ($p<0.015$) as influent on whale distribution. Temporal resolution of biological parameters seemed slightly better for 8 days rather than 1 month with a correct classification rate 4% higher. Cross validation of the predicted distribution was done with an external data set obtained from a two weeks survey (July 2001) in the Marine Protected Area. In this survey, whales were observed in 23% of 64 cells sampled with a sufficient effort (>12km). The selected model predicted correctly 73% of the presence and 79% of the absence of the external data set. A model for the entire year distribution is under construction. This project will contribute to understand fin whales distribution and links with environmental parameters. A possible application of this kind of work could be to prevent collision between ship and whales or as conservation tool in the Marine Protected Area.

CH-07

DO BOTTLENOSE DOLPHINS AND HARBOUR SEALS IN THE INNER MORAY FIRTH, SCOTLAND, EXHIBIT HABITAT SELECTION IN RELATION TO ECO-GEOGRAPHIC VARIABLES?

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Habitat selection by bottlenose dolphins (*Tursiops truncatus*) and harbour seals (*Phoca vitulina*) in the inner Moray Firth, Scotland, was investigated in relation to eco-geographic variables (EGVs). Data on the distribution of bottlenose dolphins was collected during boat-based surveys conducted during 2001 to 2003, while data for seals came from a re-analysis of data from previously published studies on radio-tagged individuals using new GIS-based analytical techniques. General linear modelling was used to determine if water depth, seabed gradient and seabed sediment had a significant effect on the distribution of bottlenose dolphins or harbour seals. Bottlenose dolphin habitat use was not affected by water depth, seabed gradient or seabed type, which is in contrast to finer scale studies within the Moray Firth. However, the majority of seals foraged in areas of shallow waters, in depths of 20m or less and over mainly sandy sediments, most likely linked to the presence of sand eels. Habitat differences varied between individual seals, which may be related to body size, sex, previous experience, or to reduce intra-specific competition. The co-habitation of these two species in the same area may be related to feeding on different prey types. These findings support the designation of the candidate Special Area of Conservation (cSAC) for sandbanks, which were found to be a key habitat for harbour seals.

CH-08

THE AZOREAN WATERS: CRITICAL FORAGING HABITAT FOR CETACEANS IN THE CENTRAL NORTH ATLANTIC OCEAN?

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The marine ecosystem of the Azores shows a very high cetacean diversity: over 20 species of resident and migrating cetaceans are yearly recorded. In this study, we examined the importance of the Azorean waters as foraging area for cetacean species in the Central North Atlantic, combining species' time-budget, numbers present and re-sightings of individuals. The research comprised both land-based and at-sea observations. Daily observations recorded cetacean species presence, numbers, geographical location and behaviour and included photo-identification of individuals at sea. Data on sightings, abundance and behaviour was processed in a newly developed analytical program (TNO, Nova Atlantis Foundation; data: April-October 2003). All species recorded in the research area show a high amount of time spent foraging. The results show a high frequency of foraging behaviour for the migrating baleen whale species (60-95%), indicating that they use the area as a 'snack bar' during their migration over the North Atlantic. Identified individuals of migratory pilot whales (*Globicephala macrorynchus*) and Atlantic bottlenose dolphins (*Tursiops truncatus*) were observed during all research seasons. The very high re-sighting rates of Risso's dolphins (*Grampus griseus*) in and between years illustrate the residency of this species in Azorean waters. In total, the high abundance and biodiversity of cetaceans and their intense foraging behaviour point at a high abundance of food in a broad dietary range. Also, the high intensity of foraging behaviour and yearly re-sightings of migrating cetaceans, show a clear functionality as foraging habitat for these species. This strongly indicates that the nutrient-rich Azorean waters may form a critical foraging area for cetaceans in the generally nutrient poor waters of the Central North Atlantic Ocean.

CH-09

MAPPING CETACEAN BIODIVERSITY IN THE

BAY OF BISCAY

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Biodiversity is one of the major global environmental issues for conservation organisations, with current extinction rates estimated at between 1,000 and 10,000 times greater than they would naturally be. Consequently, conservationists are prioritising regions with the highest diversity of species for protection. Tools for measuring biodiversity have rarely been applied to offshore areas, which have generally received little survey monitoring. In the Bay of Biscay and English Channel, vessel-based surveys have created an unusual opportunity to assess and map cetacean biodiversity. Between 1998 and 2003 Organisation Cetacea (ORCA) volunteers completed over 40,000 km of survey effort. During this period, a total of 20 species of cetaceans was recorded (approximately 23% of world cetacean biodiversity), involving over 3,000 sightings. The aim of this study was to gain a greater understanding of cetacean biodiversity within the Bay of Biscay using GIS analysis. For mapping purposes, the study area was divided into 79 ICES squares and categorised into three regions: shelf, shelf slope and deep ocean. A biodiversity index (BI) was developed using a scoring system based on the distribution of each species within the study area. The index was weighted so that the highest scores were attributed to those species that occurred in the least number of squares. Preliminary analysis revealed that mean biodiversity index scores per ICES square were lowest for shelf areas (BI 7.9, n=35). Deep ocean areas supported a much greater biodiversity (BI 12.3, n=18), with shelf slope habitats supporting the highest biodiversity (BI 13.9, n=26). Marine Protected Areas (MPAs) largely protect coastal ecosystems, with very few offshore nature conservation areas and none on the high seas. This study illustrates the importance of these areas for their high relative biodiversity of cetaceans, making them a priority for future research and effective protection from damaging anthropogenic impacts.

CH-10

DISTRIBUTION AND SEASONAL OCCURRENCE OF BRYDE'S WHALES AND OTHER UNIDENTIFIED BALAENOPTERA WHALES IN THE HAURAKI GULF, NEW ZEALAND

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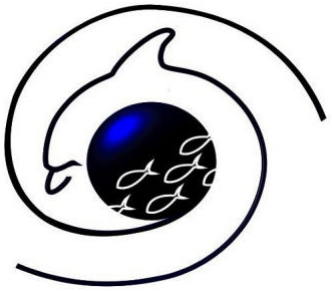
The Hauraki Gulf is a large, shallow bay (4000km² area, 60m maximum depth) on the north-eastern coastline of the North Island of New Zealand. There have been 21 species of marine mammals recorded in the Hauraki Gulf. The Bryde's whale (*Balaenoptera edeni* sp.) is the most frequently identified whale in the Hauraki Gulf. Their distribution has been previously related to sea surface temperature (SST), depth and prey distribution. Little is known about Bryde's whales' behaviour and seasonal occurrence in coastal waters. This study presents data on this and relates the seasonal distribution of Bryde's whales and other unidentified *Balaenoptera* whales in relation to SST and depth. The data were collected between September 2000 and December 2004 from opportunistic sighting surveys aboard the commercial whale and dolphin watch vessel 'Auckland's Whale and Dolphin Safari'. The results were compared by season, and the frequency of sightings of Bryde's and other unidentified *Balaenoptera* whales was higher in the Austral autumn and winter, and a shift between areas utilised was also identified. Bryde's and other unidentified *Balaenoptera* whales were seen in depths between 30 and 55 meters and temperatures between 12 and 25°C.



CONSERVATION / MANAGEMENT

CM-01

CAUSES OF CETACEAN MORTALITY ALONG THE NORTHEASTERN SARDINIAN COAST (2002-2004)

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The Northeastern Sardinian coast is part of an International Cetacean Sanctuary that comprises the entire Provencal-Ligurian Basin. The importance of the area as a hot spot for cetaceans has been additionally stressed by recent ACCOBAMS (2002) and WWF (2000) reports; nevertheless knowledge on cetacean species in this area is limited. The coastal nature of many small cetaceans makes them particularly vulnerable to human impacts: this account presents data on dolphin stranding along the north-

eastern coast of Sardinia between 2002 and 2004. Sixteen stranded dolphins have been reported and examined during the study period. Of these, 9 animals were identified as Bottlenose dolphin (*Tursiops truncatus*), 6 as Striped dolphin (*Stenella coerueloalba*) and 1 as Rough-toothed Dolphin (*Steno bredanensis*). According to post-mortem examinations, 2 of the Bottlenose dolphin were newborn, 3 were juveniles (2y), 3 were sub-adults and 1 was an adult specimen. The stranded Striped dolphins were 2 adults and 1 newborn. Five of the 9 Bottlenose dolphin strandings have been attributed to death in fishing nets, with 2 of the dolphins having suffered lethal amputations and/or mutilation. The remaining dolphin's death was linked to post natal lethal complications. The Striped dolphin's deaths all occurred within a short time range, the causes are uncertain but possibly attributed to fishery bycatch. This report evidences a high number of strandings within a marine protected area over a relatively short timeframe, most of which are possibly linked to interactions with fishing activities. It is therefore urgent to regulate fisheries and to promote the set up of mitigation measures to reduce negative interactions with dolphins, following the new IUCN guidelines as described in the Bottlenose dolphin action plan (2002-2010). A trans-boundary agreement with the neighbouring Bonifacio marine reserve would also help implementing the protocols of the Cetacean Sanctuary and of the Barcelona Convention.

CM-02

STRANDING OF A SHORT-FINNED PILOT WHALE *GLOBICEPHALA MACRORHYNCHUS* AND VILLAGE COMMUNITY-BASED RESPONSES LEADING TO ITS RESCUE

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A 1997 stranding episode concerning a juvenile Short-finned pilot whale *Globicephala macrorhynchus* in Zambales province in the Philippines provided a rare glimpse of a poorly documented aspect: grassroots actions by coastal village members leading to its ensuing rescue and release. Utilizing interviews with key witnesses to reconstruct the events, critical elements in the subsequent community-based actions were identified, comparing these with experiences from seven other strandings along the same Zambales-Pangasinan coastline recorded from October 1995 to December 1997. Unlike before when outright slaughter was essentially the only response and relay of information to legal authorities was flawed with delay, this instance remarkably involved collectively bargained decision making by the local community members: whether to slaughter or to rescue. The choice to opt for the latter departs from the norm existing throughout the islands. The results from the investigation pointed to a marine mammal conservation seminar done in 1995 that was locally devolved from a cascade of information campaigns in order to disseminate the rescue protocol, as a major underlying cause for this deviation. The concrete effects of such however had never before been described. Further notable observations were the active seeking of assistance from pertinent authorities, greatly reducing the delay in reporting and the mobilization and allocation of resources from within the community. This was a highly complex undertaking ranging from physical to social tasks in a coordinated fashion. This documented case realized in all expectations, the instrumental role envisioned that community volunteers may play in the management of stranding events. In a developing country with its marine mammal resources under constant population pressure, in particular, being regarded widely as food, this approach of tapping simple but innately knowledgeable fisher folks as monitoring and reporting components should be viewed as an indispensable in designing marine wildlife stranding response networks.

CM-03

BOTTLENOSE DOLPHIN AND ARTISANAL FISHERIES INTERACTIONS IN THE BALEARIC ISLANDS: A FINAL REPORT

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The interaction between *Tursiops truncatus* and the local fisheries is known since many years. Nevertheless, fisher's complaints received by fishing authorities became more frequent since 1990. But wich is the real magnitude of the conflict? The "EU" and the DGP supported a project to response this question between the years 2000-2003. In the evaluation of the interactions two points of view should be considered: the impact on the fishing activity and the impact on the dolphin's population. The fishermen have losses for: decrease of captures for direct predation and for ecologic competition and derived losses of the repair of the fishing gears damaged by the dolphins. For the dolphins the interactions suppose a loss of individuals for by-catch and direct aggressions and an ecologic competition for preys. To value the biggest number possible of the different types of losses it has been carried out the continue control of fishing boats, the analysis of the strandings and the interview to the fishermen. The independents observers on board collected information about location of net sets and catches and counted and marked each new hole and/or other damage on randomly selected 250 meters of net. In total 1040 fishing operation have been surveyed, 1123.85 Km of nets, a capture of 19354.03 Kg and 138 attacks of dolphins. With all these data it has been able to design an equation to calculate the economic losses of the fishermen (10-25% of the total of the fishing sales). 448 fishermen have been interviewed. Of the interview it have been concluded an annual mortality of 30 dolphins for interactions. This data is corroborated by the tracking of the strandings and the by-catch in the shipments. Globally, the interactions suppose a strong impact for dolphins and fishermen and it is urgent to take measures to minimize their effects.

CM-04

VERIFYING THE EFFECTIVENESS OF CODES OF CONDUCT FOR WHALEWATCHING: THE CASE OF TENERIFE, CANARY ISLANDS

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A substantial component of whale-watching management relies on the implementation of codes of conduct, although their effectiveness has rarely been assessed. The aim of this research was to assess the appropriateness, and verify the effectiveness, of codes of conduct for whale-watching activities using a multi-method, case study approach focusing on Tenerife, Canary Islands. The methodology comprised of three stages. Firstly, historical compliance data was analysed to determine vessel compliance with specific codes of conduct. Second, a questionnaire survey of whale-watching operators was conducted to explore their motivations, perceptions, and awareness of current codes of conduct. Third, marketing materials from all whale-watching businesses in Tenerife were analysed to determine their 'responsible' marketing content. Compliance by licensed whale-watching vessels was high, with significantly lower levels of compliance by unlicensed private vessels, implying a lack of awareness among private vessel users, which might be improved by the promotion of an international code of conduct. Responsible marketing content for Tenerife's whale-watching businesses was very low, and could compromise the economic sustainability of the industry, which might be improved by incorporating marketing guidelines into future codes of conduct. The most effective way of maximising vessel compliance was through a system of on-board monitoring, utilising NGO (Non-Governmental Organisation) volunteers. Results also indicate that it may be inappropriate and ineffective to strictly enforce all codes of conduct for whale-watching, with a need to incorporate flexibility and voluntary guidelines within compulsory frameworks. Ultimately, the development of codes of conduct is meaningless without continuing to develop methods to verify their effectiveness and determine levels of compliance in the field, in particular locations, to identify weaknesses and areas for improvement.

CM-05

COMMON BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) AND TRAWL FISHERIES AROUND LAMPEDUSA ISLAND (SICILY – ITALY); THE IMPORTANCE ON THIS FEEDING STRATEGY

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This work, begun in 2003, is part of a general project called LIFE Nature 2003 NAT/IT/000163 "DEL.TA protected dolphin and turtle", whose goal is to reduce the interactions of professional fishing and its effects on *Tursiops truncatus* and *Caretta caretta* in the Archipelago of Pelagie and along the southern coast of the Sicily. The population of Common Bottlenose dolphin has been regularly checked by the Nature Conservation Department of CTS since 1997, according to the technical document ECS N° 23 lines guides, through its own Dolphins Research Centre situated in Lampedusa Island. The research effort has been considered in the period between March 2004 and September 2004 inclusive, for a total of 70 sightings with 272 observations, shared in 37 positive days on 65. Data have been analyzed considering the number of the exemplary for every group, the presence of females with pups and comparing the observations with and without trawl fisheries. It has been also compared the spatial distribution before 9 August (intense professional fishing activity, previous the biological stop), with the one of the biological stop period, from 10 August to the end of September. The importance of the Common Bottlenose dolphin alimentary strategy in the Pelagie area, underlines the hard clash of interest between professional fishing and the studied species. In 2007, at the end of LIFE Project, a Conservation Action Plan for Common Bottlenose dolphin will be done and approved, aimed at extenuating the current clashes and guarantying this species survivorship.

CM-06

FIN WHALES AND MARITIME TRAFFIC IN THE NORTH-WESTERN MEDITERRANEAN SEA: HIGH RISK AREAS OF COLLISION AND MITIGATION SOLUTIONS

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Ship strikes have been identified as a major threat for fin whales within the Mediterranean Sea. This study aims at estimating spatially the collision's risk between fin whales and large vessels in the north-Western Mediterranean Sea, in summer. Data on fin whales distribution and relative abundance were gathered using 520 sightings collected over 300 000 km under effort and the intensity of ferry traffic (11000 passages, 57 connections) and of cargo vessels (5002 passages, 478 connections) was evaluated. We first identified the fin whale abundance within the north western Mediterranean Sea and secondly based on the shipping route and traffic intensity we evaluated the probabilities of collision using a G.I.S. Regarding the ferries, two areas of high risk were identified. One localised in the centre of the liguro-provençal basin, approximately 90 km off the coasts, and the other at the SW edge of the PELAGOS Sanctuary. Risks were negligible in the Gulf of Lion and its offshore waters. Concerning the cargo vessels, high risks were located in

the western part of the Ligurian Sea, in the offshore waters of the Gulf of Lion, and along the continental shelf. For both ship's categories, the highest risks zone were located within the Sanctuary. Several solutions are proposed to mitigate collision risks. Firstly specialized observers could be promoted. Secondly reduce ship travel speed within areas of high fin whales concentration, and re-routing of the ships in order to minimise the length of ship route and to avoid recurrent favourable fin whales foraging areas. This study also evaluates the evolution of the risk collision according to shipping development projections. In addition we plan to evaluate if the mitigation measure such as the new routes proposed will not increase the collision risks incurred by other species of cetaceans, in particular sperm whales.

CM-07

CETACEANS AND PELAGIC TRAWL FISHERIES IN THE WESTERN APPROACHES OF THE ENGLISH CHANNEL DURING WINTER

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The purpose of this study was to monitor winter pelagic trawl fisheries, the interactions between these fisheries and cetaceans and to study cetacean populations in the Western Approaches of the English Channel. The present study provided the first estimates on density and abundance of short-beaked common dolphin (*Delphinus delphis*) in the English Channel during winter, highlighting the problem of responsive movement for surveys of common dolphins. The group size of common dolphins was significantly higher during fisheries monitoring than other survey modes where trawlers were not present. During fisheries monitoring, more common dolphins were also found to display behaviour indicative of feeding. Interactions between fisheries and cetaceans were reported, involving common dolphin, harbour porpoise (*Phocoena phocoena*) and unidentified dolphin. Common dolphins were seen around trawlers during both hauling and towing procedures. The acoustic survey results indicated that the vocalisation activity of dolphins was not distributed evenly across the diurnal cycle, with peaks in the percentage of acoustic detection in the morning, just after sunrise, and in the evening, just after sunset. The area where bycatch is occurring is on the edge of the distribution of the common dolphin bounded by coast to the north and south and with very few observations further east in the Channel. If this area is only used by a subset of the total population which return each year then there is a risk of localised depletion within the Channel area even if the total stock does not become depleted. The relatively high encounter rate in this study (the highest when compared to other surveys) shows that the Channel is an important winter habitat for common dolphin.

CM-08

SNAPSHOT OF SHIP DISTRIBUTION IN GERMAN WATERS: IN CONFLICT WITH HARBOUR PORPOISE HABITAT?

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Assessing anthropogenic impacts on the distribution of marine mammals is difficult as the use of marine resources is not monitored at the same spatial and temporal scale. From May 2002 to November 2004 aerial surveys have been conducted regularly in German waters (North and Baltic Seas) to monitor harbour porpoise spatial distribution and to estimate their abundance. Additionally, the flights have delivered a snapshot of ship distribution as these objects were recorded as well by detection on the line transect. Ships were classified according to their type (e.g. fishing vessel, sailing boat, container ship) and their "behaviour" (*e.g.* trawling, travelling, sailing). In the study period 2002-2004, a total of 265 ships were detected in the North Sea and 967 ships were recorded in the Baltic Sea. Most ships were sighted in summer and autumn. Observed ship types did differ between the two seas: fishing vessels (34.3 %) and container ships (21.9 %) dominated in the North Sea, whereas recreational boats like sailing (49.4 %) and motor boats (17 %) set the picture in the Baltic Sea, first of all in summer. Set nets were sighted at 384 positions in the Baltic Sea. It was possible to reveal potential conflict areas. In the North Sea, where most container ships were detected in the south, a distinct north-south gradient in porpoise density was observed. The survey area in the Baltic Sea constituted only half the size of the North Sea area but nearly four times more ships were detected. The narrow and shallow channel "Kadetrinne" is one of the busiest shipping lanes in the world. This is well reflected in our results: In this area we seldom sighted porpoises. In future, more effort should be put into the quantification of anthropogenic impacts, *e.g.* in developing a geographical 'underwater noise map' of the North and Baltic Seas.

CM-09

A NEW LEGAL BASIS FOR MANAGEMENT OF CETACEANS IN SCOTTISH INSHORE WATERS

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The Protection of Wildlife provisions of the Nature Conservation (Scotland) Act 2004 came into force on the 1st October 2004. These set out important new responsibilities in relation to the management of cetaceans in Scottish inshore waters. Firstly, in addition to the existing offences of intentional and deliberate disturbance, new offences of reckless disturbance and harassment of cetaceans have been introduced. Secondly, Scottish Natural Heritage (SNH) has been given a new

responsibility to produce a Scottish Marine Wildlife Watching Code (SMWWC) which is intended to be an advisory code covering whale and dolphin watching and other similar activities. In particular it will provide information on the avoidance of disturbance to marine wildlife around Scotland. As a result of these legislative changes SNH's Species Licensing Programme has been reviewed and work on the development of the SMWWC by SNH is underway. Both of these proposals have implications for those who work with cetaceans in Scottish inshore waters, in particular the need to ensure that they have taken appropriate measures to avoid committing an offence under the new Nature Conservation (Scotland) Act. Depending on the activity, measures that may be required include applying for a licence to undertake certain types of cetacean-related work and being aware of and complying with the provisions of the SMWWC when it comes into effect. These legislative changes provide the basis for significant improvements to the management of cetaceans and cetacean-related activities within Scottish inshore waters.

CM-10

MARINE PROTECTED AREAS AND SANCTUARIES FOR WHALES, DOLPHINS AND PORPOISES: THE STATE OF CETACEAN CRITICAL HABITAT PROTECTION AND MPA MANAGEMENT WORLD-WIDE

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A project to assess the world-wide status of cetacean habitat protection in 102 coastal countries and overseas territories has identified 358 marine protected areas (MPAs) with cetacean habitat, 41 of which are proposed for expansion, plus 176 newly proposed MPAs with cetacean habitat. The world-wide total is 534 proposed or existing MPAs with cetaceans. In addition to these MPAs, the project identified 19 existing and four proposed national sanctuaries for cetaceans, most covering the entire exclusive economic zone (EEZ). On the high seas, used by 79 percent of all cetacean species (37 percent use the high seas exclusively), there are only five existing and nine proposed international sanctuaries. The national and international sanctuaries in general provide a much lower degree of protection than the smaller MPAs. Cetacean habitat protection has made great strides in the past decade, yet it remains at a preliminary stage. Few of the existing MPAs protect cetacean habitat adequately. Creating and managing effective MPAs for cetaceans depends upon: • the identification and strict protection of substantial areas of cetacean critical habitat, the places where whales and dolphins hunt, feed, court, play, mate and reproduce; • the implementation of an overall ecosystem-based management approach to ensure that ecosystems will remain healthy and support cetaceans into the future; • the institution of MPA networks to link the protected habitats of cetaceans throughout a population and a species' range; • a generous use of the precautionary approach when choosing and designing MPAs; • a good management plan with periodic review developed in conjunction with all stakeholders; • identification and effective control of all cetacean threats (pollution, marine traffic, fishing conflicts) with appropriate legislation and enforcement as needed; • a push to identify and protect high seas habitats for cetaceans through regional and international agreements.

CM-11

CETACEAN BYCATCH IN ISRAELI FISHERIES IN THE MEDITERRANEAN

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This work presents data on cetaceans bycaught during 1993-2004 in fishing gear of the Israeli Mediterranean fishery. Our objective is to detect sub-populations more vulnerable to bycatch and to correlate spatiotemporal variation in bycatch frequency to fishing effort. Unlike in other oceans, most dolphins were caught by bottom-trawlers. Bycatch data for all species are reported, though analyses were performed only on common bottlenose dolphins (*Tursiops truncatus*), the most frequently caught species (64.1%) and the only one caught in trawl-nets. Our data-set is incomplete, as not all bycaught animals are reported by fishermen. This is evident by beached animals with clear entanglement marks. Furthermore, we assume that not all bycaught individuals bear such markings. Comparing size distribution of bycaught dolphins to that of beached individuals revealed no significant difference in mean size (Mann-Whitney U-test, $p>0.9$). All age groups are affected with the noticeable exclusion of calves. Mean monthly rates of capture were compared to mean monthly trawler fishing effort. Dolphins were caught more often in summer (45% in July-September), although fishing effort is distributed uniformly throughout the year (one-way ANOVA, $p=0.056$). Sporadic stomach content data prevented comparison between seasonal catching rate and prey breeding season, but we strongly recommend such procedures when data will become available. In conclusion, vulnerability is wide-scoped through the age groups, with possible protection of calves. Additionally, the higher occurrence of bycatch during summer, if confirmed, could indicate that the dolphins are driven towards foraging around trawlers due to depletion of fish stocks during winter. In the fall, new recruits reach a certain size and become available prey for dolphins, which then return to foraging away from the trawlers. For better understanding of this phenomenon further data as well as a better reporting network are essential.

CM-12

INTEGRATION OF REMOTE SENSING DATA WITH *TURSIOPS* SIGHTINGS IN THE PELAGIE ISLANDS

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In the framework of the LIFE project NAT/IT/000163 a methodology integrating satellite remote sensing with conventional in-situ data has been developed to obtain the ecological information relevant to the preparation of the Common Bottlenose Dolphin (*Tursiops truncatus*) Action Plan in the Pelagie Islands area. The LIFE project activities include the realization of maps based on the measurements of Sea Surface Temperature (SST) and surface chlorophyll concentration by satellite and in-situ observations. Results for 2004 (period March-December) regarding the relationship between dolphin distribution and satellite data will be presented. In accordance with the local climatologic distribution of superficial currents, the area of Pelagie Islands is locally interested by different current regimes and characterized by water of different origin. Main differences occur between areas interested by jets from West to East across the Channel (in proximity of large bottom slopes) and areas subject to a coastal regime over flat and shallow bottom. Water characteristic depends on the regimes in these different areas. Intensification or attenuation of local phenomena (as pulses of coastal gyres and intensification of jets) have been daily monitored using MODIS satellite data to describe the main dynamics of the area of Pelagie Islands (Lampedusa and Linosa). Sea surveys for dolphin monitoring has been conducted from March to December 2004, enabling close approaches for photo-identification, for a total of 106 sightings with 386 observation, shared in 55 positive days on 82. Satellite data have been used to produce statistics of satellite based measurements of Sea Surface Temperature (SST) and surface chlorophyll concentration. Datasets have been integrated with sightings of dolphin to find correlations between sightings and physical and biological aspects of the marine environment in the Pelagie Islands area.

CM-13

SCANS-II: MEETING EUROPEAN CONSERVATION OBJECTIVES FOR SMALL CETACEANS THROUGH ABUNDANCE SURVEYS, MONITORING AND MODELLING.

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Bycatch in fishing gear is the greatest threat to small cetacean populations in European waters. This is recognised under several European agreements and the Habitats Directive requires Member States to "ensure that incidental capture or killing does not have a significant negative impact on the species concerned". The Small Cetaceans in the European Atlantic and North Sea (SCANS-II) project aims to develop a management framework to assess the impact of bycatch for small cetaceans and to set safe limits. To realise this, new and updated information is needed on small cetacean abundance. Shipboard and aerial surveys will be conducted over the European Atlantic continental shelf during July 2005. Line transect methods will be used to collect double platform visual survey data and novel analytical methods will be used to generate accurate and precise abundance estimates for the harbour porpoise and other small cetacean species. Passive acoustic data will be collected simultaneously on survey ships, primarily for harbour porpoises. The project will further develop methods for monitoring small cetaceans to allow temporal and spatial changes in relative abundance to be investigated. "Best practice" monitoring methods will be recommended to conservation managers. A population model will be developed to form a framework to assess population status and to develop and test algorithms for setting sustainable bycatch limits. Data on absolute and relative abundance and from existing independent bycatch monitoring schemes will be used within this framework to determine safe bycatch limits. The SCANS-II project will allow national governments to meet the requirements of the Habitats Directive and their obligations under other international agreements, such as ASCOBANS, in regard to cetacean bycatch and conservation.

CM-14

GIS AS A TOOL TO IDENTIFY PRIORITY AREAS FOR HUMPBACK WHALE CONSERVATION AT EASTERN BRAZILIAN COAST

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The humpback whale breeding stock "A" uses the Brazilian Coast as a calving and breeding ground during the austral winter. Aerial surveys, using line transect distance-sampling protocol, took place in the peak of humpback whale abundance (late August early September) in 2001, 2002 and 2003 seasons, covering the continental shelf of the states of Bahia and Espírito Santo (Eastern Brazilian Coast). As an essential tool, the Geographic Information System (GIS) offers support for environmental planning and management aiming for the conservation of natural resources. The aerial survey distribution data were analyzed using the GIS ArcView 8.3 and the extensions: Xtools and Spatial Analyst in which a mean density map was generated. This map was overlaid on the map of risk factors (and adjacent areas) relative to barge routes, navigation corridors, harbor and port areas, and proposed areas for oil and gas exploration. One of the humpback whale concentration areas located in the

southern portion of the Abrolhos Bank coincides with two proposed areas for hydrocarbon exploitation (blocks named BM-ES-6 and BM-ES-7). The same mean density map was overlaid with Marine Protected Areas (MPA's and their possible contiguous zone – 10, 20 and 50nm), and also with coastal community locations and proximities (15, 30 and 60nm). The last one allowed us to identify potential areas for whale-watching development. The combination of all the maps (risk factors, MPA's and potential whale-watching) allowed the identification of priority areas for whale conservation and will guide the planning process. The Eastern Brazilian Coast besides being used as a breeding ground for humpback whales encompasses important coral reef formations and numerous mangroves systems. The area is receiving investments for tourism development and it has been the focus of oil and gas industry. Careful management should be implemented in order to guarantee the conservation of this important Ecosystem.

CM-15

BYCATCH MITIGATION TRIALS IN THE UK BASS PAIR TRAWL FISHERY

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The UK bass pair trawl fishery has an acknowledged bycatch of common dolphins. Work with the fishermen involved with this fishery has been ongoing for four seasons. During the past three seasons we have tested several exclusion devices, designed to deter dolphins from the most dangerous part of the net and or to allow them to escape. This poster summarises the measures that we have tested and addresses their effectiveness. During the 2003/4 season, we tested three different exclusion devices. These devices were tested over a period of three months, and were compared with one another. Response variables that we measured included the number of tows resulting in one or more bycaught animals, the number of animals per event, and the approximate location of animals in the net. One of the devices was found to be significantly more effective than the others, and the possible reasons for this are discussed. Further trials of this device fitted near the back of the trawl where most animals get caught showed that animals were now also being caught further forward in the net, without approaching the barrier. Repositioning the system further forwards and implementing a video surveillance system has allowed us to see when and how dolphins are able to manoeuvre through the escape holes. Our objective remains to find the most effective means of minimising bycatch in the shortest possible time.

CM-16

BEHAVIOUR OF A NURSERY GROUP OF ENTANGLED SPERM WHALE (*PHYSETER MACROCEPHALUS*) OFF CAPO PALINURO (SOUTHERN TYRRENIAN SEA, ITALY)

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Historically, driftnetting is the most significant source of entanglements for cetaceans, with devastating consequences in the Mediterranean Sea. Of large cetaceans, the sperm whale (*Physeter macrocephalus*) is most affected by this fishery. On 9th August 2004 a group of five sperm whales – three adults, one subadult and one calf – was found entrapped in a driftnet 50 miles S-W off Capo Palinuro (Italy). Their tails were tied by the net and one animal was completely entangled. The group was succoured by the Coastguard diver nucleus, which had played a leading role in the two-days rescue operations. The first day they managed to free two adults, cutting the polyfilaments with scissors. The untied animals remained near the others, watching the divers' work until evening, touching the entangled tails and rubbing the calf's side with the melon. During the night, whales were constantly monitored from the Coastguard boat by a radar equipment. The group kept together. On 10th August early morning, the divers started to cut the net again, freeing another animal first and then the calf and the last one. The animals had a large number of lesions on their body and were clearly stressed. During these procedures, the whales' behaviour included: roll on side, open the mouth, shake the tail and the pectoral fins, and sound production. Acoustic vocalizations (45 minutes recorded) were slow clicks, codas and a very high rate of chirrups (1.5). Despite international and national regulation banning driftnets from the Mediterranean, driftnetting continues in sperm whale habitat, thereby continuing to threaten the species' survival in the region. While no one knows exactly how many sperm whales are resident in the Mediterranean Sea, most estimates number in the hundreds. With such a small number there are concerns over the impact of this illegal fishery on this isolated population.

CM-17

"BE WHALE WISE" - COMPLIANCE WITH WHALE WATCHING GUIDELINES AND REGULATIONS IN CANADIAN AND US WATERS 1999-2005

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The Marine Mammal Monitoring Program has been engaged in monitoring, stewardship, intervention and outreach activities for five years in Canadian and U.S. waters in the Pacific Northwest. The development of a "Be Whale Wise" program has been highly successful and precedent setting as it has been endorsed as the standard for responsible vessel-based whale watching by Canadian and U.S. government agencies responsible for marine mammals. The commercial whale watching industry has grown tremendously over the past ten years during which time the preferred marine mammals (southern resident orcas) have been listed as endangered in both countries.

Vessels, both private and commercial, have been cited as one of the reasons for the general decline of the southern resident orca population. With an annual economic benefit estimated at more than $75 million, the pressures of vessel-based whale watching are expected to increase. The issues regarding how to manage regulations, guidelines, compliance and limits to growth are currently being reviewed as part of a larger recovery strategy. This presentation is based on five years of observation, lessons learned and the way ahead.

CM-18

DOLPHIN INTERACTIONS WITH HAND LINE DEMERSAL FISHERIES IN THE AZORES

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The Azorean demersal fishery is a multispecific and multigear fishery with more than ten commercially important species caught by hand lines and bottom longline. Fishermen working in this fishery often complain about dolphins stealing fish from the gear but opinion regarding the severity of the problem varies between them. To test the magnitude of these interactions for vessels using hand lines, data was collected on the fishery itself, presence of cetaceans near the boat during fishing operations and frequency of interactions resulting in fish stolen from the lines. The experiment took place between May 2002 and August 2004 (39 months), totaling 156 fishing days and covering all seasons. Whilst dolphins were detected near the boat on 13.5 % (n=21) of the total fishing days, only on 1.9% (n=3) of the days dolphins were reported stealing fish from the line. When interaction took place, the species involved were common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*). Since there were so few interactions, we could not test prey and size preferences. The results suggest that dolphins indeed interact with this fishery in the Azores, but the level of interaction is low and does not pose an economic threat to most fishermen that use this particular fishing technique.

CM-19

A SUMMARY OF ANOMALOUSLY PIGMENTED COMMON DOLPHINS (*DELPHINUS SSP*) OFF NORTHERN NEW ZEALAND

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Although anomalous pigmentations have been recorded in many cetacean species, typically only one variation is reported from a population at a time, e.g. an albino. We report a spectrum of pigmentation from common dolphin (*Delphinus spp.*) off northern New Zealand. All-black, dark-morph, pale-morph and all-white individuals, as well as variation between these have been observed. Pale-coloured pectoral flippers are prevalent, and a number of individuals with white 'helmets' are recorded. We present some examples of these anomalies and discuss their significance.

CM-20

SEA TESTS OF A PORPOISE ALERTING DEVICE

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Pingers are now becoming widely used to reduce porpoise bycatch in set gill nets. Pingers are known to be aversive, with massive reductions in porpoise acoustic activity detectable at the pinger, although they have often been described as alerting porpoises to the presence of the net. The possibility of a truly alerting device was tested in this study. A signal closely resembling a very short porpoise click train was repeated every 4 seconds at source levels of 130dB ref 1uPa @1m. To provide a control alternate half hours were silent. 0.5 million porpoise clicks in trains were recorded over 60 days using T-POD autonomous click train loggers. Comparison of active and control period in deployments at several sites showed a strong and consistent alerting effect. The effect was still clearly evident when many high click rate trains were present suggesting active feeding, and did not show any habituation in this study. The power requirement of a truly alerting device would be very much less than present-day pingers, thus enabling much longer running times, lower running costs and much simpler monitoring via date-stamping of devices at manufacture. If porpoise bycatch can be reduced by alerting alone substantial benefits are possible.

CM-21

A MULTI-NATIONAL DOLPHIN RESEARCH AND CONSERVATION PROJECT IN THE DOMINICAN REPUBLIC

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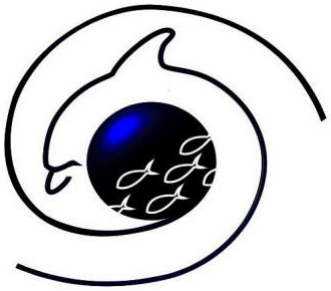
Europeans' first documented contact with cetaceans in the new world occurred when Christopher Columbus noted sightings in his ship's log, but have attracted little attention until recently. In the coastal waters of the *Parque National*

del Este, bottlenose dolphins have been regularly sighted. However, the size and health of this population have not been assessed. On 8th August 2002 at least 8 bottlenose dolphins were removed from this area to supply a captive dolphin facility, with no regard to the impact of the removal on the dolphin population and Dominican law. These captures have led to a multi-national research project, Dominican group Fundemar, in collaboration with UMBS Millport (University of London, UK) George Mason University (US), with funding and support from: H.S.I, WSPA, C.S.I and WDCS. This program seeks to: (i)assess the number of dolphins inhabiting the coastal waters through photo-identification and line transect surveys; (ii)investigate patterns of habitat use and identify areas of critical habitat; (iii)determine and quantify anthropogenic and natural causes of disturbance, injury and mortality; (iv)assess the sustainability of dolphin-watching activities. In 2004, baseline surveys were conducted over 153.5hrs covering approximately 2100km, resulting in 16.31hrs of encounters. During these surveys 68 bottlenose dolphins (and 43 Atlantic spotted dolphins, *Stenella frontalis*) were sighted. Bottlenose dolphins had encounter rates of 0.449 individuals per hour and 0.032 individuals per km. Atlantic spotted dolphins were recorded less at 0.280 individuals per hour and 0.020 individuals per km. Although it is too early to give an exact estimate of the number of dolphins, initial findings would suggest that it's relatively low. Evoking the 'precautionary principle', it is critical to introduce conservation measures as soon as possible, such as identifying and minimizing anthropogenic impacts to the population – including ensuring non-disturbing dolphin-watching practices and ensuring that there are no further live captures.



ECOLOGY

E-01

SPERM WHALE (*PHYSETER MACROCEPHALUS*) DISTRIBUTION IN THE WESTERN LIGURIAN SEA: DOES A CORRELATION EXIST WITH SEA SURFACE TEMPERATURE?

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Sperm whales are known to occur in the western Ligurian Sea and particularly along the continental slope of the shelf-edge area. However, very little is known about the environmental factors influencing their distribution. It is worldwide well known that sperm whales concentrate in areas with a specific bathymetry and occasionally along specific hydrographic features such as sea surface temperature patterns and fronts. Aim of this study was to investigate the relationship between sperm whale occurrence and hydrographic features in the Western Ligurian Sea. A total of 84 sighting data collected during opportunistic shipboard surveys conducted from 1991 to 2003 during the summer season were analysed. Surveys covered an area of about 20,000 km² in the western Ligurian Sea between the western Gulf of Genoa, the French Riviera and the Northern coast of Corsica. The study area was divided into 3,128 cells of 3x2 nautical miles and sperm whale presence was associated to remotely-sensed sea surface temperature data (SST-AVHRR). Mean and standard deviation were computed for SST in every cell. Sperm whale occurrence resulted significantly variable over the whole study period (Kruskal-Wallis: 32.37, df: 8, $P<0.01$), while it was rather stable in the 1996-2000 sub-period (Kruskal-Wallis: 4.009, df: 3, $P>0.20$). The relationship between sperm whale presence and SST was investigated by using 1996-2000 sighting data and the corresponding SST monthly images (June to September). Logistic Regression analysis was used to correlate sperm whale presence to SST features. Both SST mean and standard deviation were found significant predictors ($P>0.05$) for sperm whale presence; the resulting logistic models were able to predict 60-78% of presence (1) /absence (0) cells. The percentage of correct predictions was higher for presence (1) cells (up to 85%). These results suggest that thermal fronts and SST patterns play a role in explaining sperm whale occurrence and distribution in Ligurian Sea.

E-02

FRACTAL ANALYSIS OF BOTTLENOSE DOLPHIN MOVEMENTS RELATED TO FORAGING

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In a heterogeneous environment, predators are expected to spend most of their time in those areas where food is abundant. Predators may therefore adjust their behaviour to maximise intake rate by reducing travelling speed and increasing their turning rate. Consequently the tortuosity of an animal's movement path is expected to reflect the habitat quality and provides a means to quantify the importance of different areas. Sightings of a marine top predator, the bottlenose dolphin (*Tursiops truncatus*), were found to be significantly related to the number of salmon

(a known prey item) passing upstream. To test whether this was indeed an important foraging area, detailed tracks of bottlenose dolphins were recorded from land, and fractal dimensions calculated as an index of the tortuosity of the movement paths. Fractal dimensions were significantly higher (indicating higher tortuosity) close to a headland characterised by steep topographical relief and the presence of tidal fronts; both of which could act as mechanisms to aggregate prey or make prey easier to capture. Lower fractal dimensions occurred on the approach to this site indicating straighter, directed travelling behaviour that would minimise their energetic costs. This approach provides a quantitative method of identifying important sites, and could be further used to examine foraging behaviour at a range of spatial and temporal scales.

E-03

DIVERSITY AND RELATIVE ABUNDANCE OF CETACEANS IN THREE AREAS OFF THE WEST COAST OF SCOTLAND

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This study investigated the diversity and relative abundance of cetaceans in three areas off the west coast of Scotland. Regular surveys were conducted using passenger ferries as research platforms during the months of May to September from 2002 to 2004. The ferry routes used in this study transected three distinct bodies of water: The Minch, Little Minch and the Sea of Hebrides. During 15,170 km of survey effort, a total of 677 groups of cetaceans were sighted, consisting of 1,952 animals from seven species. The Minch had greatest diversity of species (seven), followed by the Sea of Hebrides (four) and the Little Minch (three). The most commonly sighted species in all three areas was the harbour porpoise (*Phocoena phocoena*). However, the sightings rates and relative abundance of harbour porpoises were significantly greater in the Minch and Little Minch than the Sea of Hebrides. A similar pattern in sightings rates and relative abundances was found for the third most commonly sighted species, the minke whale (*Balaenoptera acutorostrata*). However, a different pattern was observed in the second most commonly seen species, the common dolphin (*Delphinus delphis*). This species was sighted most frequently in the Sea of Hebrides and its greatest relative abundance was in the Little Minch. The sightings rate and relative abundances of all other species (white-beaked dolphin, bottlenose dolphin and Risso's dolphin) were much lower than the three most commonly seen species. The differing species diversity, sightings rates and relative abundances may reflect differences in hydrographical and topographical structures of the three areas. The Minch and Little Minch are sheltered by the Outer Hebrides and contain large areas of shallow, coastal waters, ideal habitat for harbour porpoises and minke whales. In contrast, much of the Sea of Hebrides consists of deeper, open waters where common dolphins were most commonly encountered.

E-04

CALIFORNIA SEA LIONS USE DOLPHINS TO LOCATE FOOD

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Aggregations by three species of dolphins (the common bottlenose dolphin, *Tursiops truncatus*, the short-beaked common dolphin, *Delphinus delphis*, and the long-beaked common dolphin, *Delphinus capensis*) and California sea lions (*Zalophus californianus*) were investigated in Santa Monica Bay, California. Over 200 surveys conducted during 1997-2001 documented that California sea lions were seen 18.6% of the sightings aggregated with common bottlenose dolphins (n bottlenose dolphin sightings = 150) and 45.9% of the sightings aggregated with the two species of common dolphins (n common dolphin sightings = 98). Aggregations of common bottlenose dolphins and sea lions were seen both in inshore and offshore waters, whereas common dolphins and sea lions were observed only in offshore waters. These aggregations were often recorded feeding near escarpments and submarine canyons, showing a striking preference for these bathymetric features versus flat areas, plateau and inshore waters of the continental shelf (< 500 m from shore). Observations for Santa Monica Bay show that: (1) sea lions initiate aggregation and departure from dolphin schools, (2) sea lions imitate dolphin behaviour, and (3) no aggressive behaviour between sea lions and dolphins was ever recorded. I argue that sea lions may take advantage of the superior food-locating abilities of dolphins. This study provides the first detailed description of mixed-species aggregations and habitat usage by three dolphin species and sea lions.

E-05

TRANSPORT CAFÉ OR FIVE-STAR RESTAURANT: WHAT IS ATTRACTING LARGE BALEEN WHALES TO THE SOUTH COAST OF IRELAND?

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There is a strong seasonal pattern to the occurrence of fin and humpback whales in inshore waters off the south coast of Ireland. Over the last four years, fin whales are observed from June, to February, peaking in November while humpback whales occur in smaller numbers from July to a peak in December. The south coast of Ireland is known to be the site of complex coastal fronts and upwellings of cold nutrient rich waters and this study aims

to determine whether there is a correlation between the presence of large whales and these productive planktonic waters. Fieldwork was been carried out during 2003 and 2004. We recorded basic physical parameters (temperature, salinity) to locate stratified water and areas of upwelling and sampled different trophic levels (from phytoplankton, zooplankton, fish, seabirds and cetaceans) to see what species associated with different types of water. Samples of phyto- and zooplankton were collected in the vicinity of whale sightings in an attempt to characterise water type associated with the appearance of whales. Phyto- and zooplankton were most abundant in July and September but declined in November, thus the peak in whale abundance is at a time when there is very little plankton available. When whales were observed in September and November, distinctive dense marks were noted on the sounder but we have yet to definitively identify the fish present. To date three of the six individually recognisable humpback whales and two of the 10 fin whales have been recorded from 2001 to 2004 suggesting these whales are returning annually and stay in the area for extended periods. We hope to establish long-term trends and fluctuations in the relative abundance of large baleen whales and relate this to changes in the oceanographic conditions and availability of food.

E-06

AN ASSESSMENT OF THE AMOUNT, DISTRIBUTION AND SOCIAL ORGANIZATIONS OF KILLER WHALES (*ORCINUS ORCA*) IN THE STRAIT OF GIBRALTAR

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Sightings of killer whales have been reported in the area of the Strait of Gibraltar for more than 500 years. This area is important location for bluefin tuna (*Thunnus thynnus*) fisheries and killer whales were always observed interacting with these fisheries. A study of photographically identifiable individual killer whales was undertaken in springs and summers from 2001 to 2004, and a total of 25 whales were photo-identified. No new individuals - except newborns – have been photo-identified since 2003. These 25 whales are divided into two groups. Nine of them were only sighted during the spring in interaction with the trap net of Barbate when tuna is entering the Mediterranean Sea to breed. The 16 other killer whales were only sighted during summer interacting with the drop line fishermen in the centre of the Strait. All these 25 whales seem to be, at least seasonally, specialized in the tuna hunting and adapt their foraging location according to the migratory behaviour of this prey. The social interaction of the 16 summer-killer whales was investigated using an association index analysis. Social structure is proved to be complex because all the individuals are bonded with each others. However this study reveals three stable matrilines composed of an adult female and two of her juvenile and/or adult offspring. Two of these matrilines were always seen together and we can assume that both adult females are closely related. In addition, new-born appeared strongly associated with their mother during their first year and young juveniles exhibited a strong affinity between each others spending more time together than with their own mother. The other bonds tend to be more dynamic and ephemeral.

E-07

ECOLOGY OF THE SHORT-BEAKED COMMON DOLPHIN (*DELPHINUS DELPHIS*) OFF SOUTHERN SPAIN

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The short-beaked common dolphin is believed to have suffered a steep decline in the Mediterranean in recent years. ACCOBAMS is therefore developing a Conservation Plan for this species. Effective conservation will depend largely on our ability to understand and predict the relationship between the population and its habitats. The Alboran Sea is currently the most important remaining habitat for this species in the basin and constitutes, therefore, a critical source of information on their ecology, essential for development of conservation measures. Spatial analysis has been shown to be a valuable tool for describing the distribution and habitat preference of species and for estimating their abundance. Spatial modelling using GAMs was therefore applied to the data on common dolphins in the area to provide information on abundance and distribution. In total, 27,074 km of non-systematic line transects conducted from 1992 to 2004, with 601 sightings, were analyzed (research area = 11,949 km²). Distribution and abundance were examined for different sub-areas, years, seasons and behavioural categories. No overall trend in abundance was observed for the whole period, with an average density of 0.7 animals/km². Seasonal differences were detected, with lower density in 'winter' (October-May: 0.2 animals/km²) than in 'summer' (June-September: 0.9 animals/km²). Geographical differences were also found, with higher density in the west (1.0 animals/km²) than in the east (0.7 animals/km²) during summer months. In general, a bimodal distribution was predicted by the models, with higher densities both around the continental slope (100-400m) and in deeper waters (800-1200m). This could be partially explained by the difference in predicted habitat use depending on behaviour (*e.g.* preference for shallower waters for feeding and deeper waters for socialising).

E-08

WHAT THE PAST LARGE WHALE DISTRIBUTION IS TELLING US ABOUT THE ANTARCTIC MARINE ENVIRONMENT

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Whaling industry removed 99% of blue and 95% of fin whales from Antarctic waters in just 3 decades, providing a synoptic view of the past circumpolar distribution and abundance of these whales. The vast majority of blue-fin whale catches were encompassed within the Seasonal Ice Zone (SIZ) and were essentially located in the Atlantic - West Indian sector. This large scale database shows that whales circumpolar abundance was both associated to the SIZ extent and Summer Oceanic Chlorophyll a Concentration (SOCC). During summer, whale distribution and abundance appear to be driven by the synergetic influence of sea ice and oceanic primary production at the global Southern Ocean scale. Because whale is the largest Antarctic krill predator, consuming thousand times more than the actual krill fishery, these results provide a new insight on the oceanographic features driving krill density. Furthermore, whales are generally associated with ice edge where high krill abundance inhabits. However, the accuracy of past ice edge location by whaling method was disputed and prediction of ice retreat is subject to debate at the circumpolar scale. We estimated bias and whale catches provide an unequalled dataset to evaluated historical inter-annual trends in sea ice extent at the circum-Antarctic scale. This method, associated to ship-satellite data since 1968 reveals a striking ice retreat (7.6°) occurring between 40°W and 30°E in the 1960s. This study also raises the question of the whale population recovery in the actual context of global warming, changes of sea ice conditions, and Antarctic krill stocks decrease.

E-09

COMPARATIVE RELATIONSHIP BETWEEN THE DISTRIBUTION OF TWO SPECIES OF CETACEANS (FIN WHALES AND STRIPED DOLPHIN) AND OCEANIC FEATURES IN THE NORTHWESTERN MEDITERRANEAN SEA

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This study presents the distribution patterns of fin whales (*Balaenoptera physalus*) and striped dolphins (*Stenella coeruleoalba*) in the northwestern Mediterranean Sea, in relation to oceanographic features: sea surface temperature and frontal zones. During the 2001 Cap-Ligures survey (WWF-France), prospections were done aboard two motorised sailing ships from the 18th July to the 8th August in the International Mediterranean Sanctuary. The standardised line transect method was applied. The effort totalised 1220 nauticals miles and 100 observations were made (54 % of striped dolphins, 35 % of fin whales). Thermal properties of the sea surface are derived from high-resolution sensors (AVHRR from NOAA). To detect the frontal zones, we applied an edge-detection technique on resampled SST maps (ground resolution 2 km). The analyses are on a daily basis. The geostatistics and point-process analyses were used to evaluate the role of the environment in structuring the spatial pattern of cetaceans. The results show how both species present a different degree of relation to these sea surface parameters. This is explained according to their trophic level and their foraging strategy.

E-10

STABLE ISOTOPES AND MERCURY IN BLOOD OF HARBOUR SEALS (*PHOCA VITULINA*) CAUGHT ON A GERMAN SANDBANK

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More than 21 500 harbour seals were killed by Phocine Distempter Virus in the North Sea and adjacent waters in 2002. After the second seal die-off had ceased, seals were captured alive (and then released) on a sandbank (Schleswig-Holstein, Germany) for health and ecotoxicological investigations. Stable carbon and nitrogen ratios (d13C and d15N) were measured by mass spectrometry in clotted blood cells of 24 harbour seals captured between 2002 and 2003. Total mercury (Hg) concentrations were determined by spectrometric absorption in the whole blood of 8 harbour seals and compared to the Hg level measured in blood from 8 seals found stranded along the southern North Sea coast. The average isotopic composition measured in the blood cells was –15.6 ± 0.3 0/00 and 18.7 ± 0.6 0/00 for d13C and d15N respectively, similar to that obtained previously in muscle of stranded individuals, confirming the high position of the harbour seal in the trophic food chain. d13C and d15N values did not differ significantly between seals caught in November 2002, April 2003 and September 2003 suggesting similar diet throughout these 3 periods. The average concentration of mercury in whole blood of living and stranded harbour seals did not differ significantly (94 ± 41 vs 146 ± 71 µg.l-1 respectively). No biological parameters (weight, length, age status and stable isotopes ratios) seemed to influence these concentrations. Blood is known to reflect recent exposure to mercury through the diet. These preliminary results suggest that blood is an interesting substrate for both trophic studies and pollutant long-term monitoring of the harbour seal in the North Sea.

E-11

ECOLOGICAL AND PATHOLOGICAL FACTORS RELATED TO TRACE METAL CONCENTRATIONS IN HARBOUR SEAL, *PHOCA VITULINA*, IN THE NORTH SEA

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During the last decades, recurrent epizootics have affected harbour seal (*Phoca vitulina*) populations in the North Sea. Recent data on their trophic habits and pollutant levels are of primary importance for their conservation. As isotopic composition of an animal is related to that of its prey, d13C and d15N were measured by mass spectrometry in the muscles of 66 harbour seals beached along the coasts of France (n = 10), Belgium (n = 30) and Netherlands (n = 26) between 1994 and 2004. Trace metals concentrations (Zn, Cu, Fe, Cd, Hg and Se) were also determined in liver, kidney and muscles by Inducted Plasma Spectrometry. d13C and d15N values remained similar between harbour seals from France (-15.7 0/00; 18.7 0/00, respectively), Belgium (-15.7 0/00; 19.0 0/00, respectively) and Netherlands (-14.7 0/00; 18.7 0/00, respectively). These data are in good agreement with their coastal and piscivorous life-style. Isotopic values remained similar between males and females and between body conditions. Hg levels were significantly higher in seals from the southern North Sea when compared to previously published data from seals collected in Norway, probably due to geographical differential exposure. Hepatic Hg was positively correlated to hepatic Se, both increasing with the length of the seals. Such a relationship reflected an age accumulation process coupled to a detoxication mechanism involving antagonism between Hg and Se in the liver. No relationship between stable isotopes and Hg and Cd levels was observed. Increasing Zn and Hg hepatic levels were observed with degrading body condition of the harbour seals, which is reflected by decreasing blubber thickness and high hepatic to total body mass ratio. These observations tend to indicate a global redistribution of trace metals from muscle and blubber to liver, as a result of protein and lipid catabolism linked to disease and starvation.

E-12

LARGE WHALES AND THEIR KRILL PREY: CONTRIBUTION OF THE NUMERICAL MODELLING

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In ecology, a major paradigm states the importance of spatial structure and spatial interaction between an organism and its environment. A synoptic view of the marine environment is only possible through satellite telemetry. These measures inform the spatial distribution of the bathymetry, sea surface temperature, sea-level anomaly and chlorophyll concentration and provide information about the physical structuring of the marine environment. For higher trophic levels, on which top marine predators feed, no synoptic measures of prey distribution are available. To assess the spatial relationships between top marine predators and their preys, we developed a trophic transfer model constrained by the circulation to simulate the resources distribution (TTAD model: Trophic Transfer Advection Diffusion). The inputs are given by the primary production derived from SeaWIFF data and the current fields come from Topex-Poseidon measurements and/or the outputs of the OPA circulation model. We developed this approach in a two-case study : i) the distribution of the Mediterranean fin whales in relation to the TTAD model of their Mediterranean krill (*Meganyctiphanes norvegica*) prey and ii) the Antarctic blue and fin whales in relation to Antarctic krill (*Euphausia superba*). Both TTAD models were configured according to the biology of the considered krill species. We constructed climatology of krill distribution and compared it with (i) in situ data of Antarctic krill and (ii) the distribution of whales. Whale data were obtained through the IWC catch dataset for Antarctica and Argos track /observations data for the Mediterranean Sea. We investigate the spatial decorrelation between the observed primary production and the TTAD or whale distribution and the biological fit between the output of the TTAD-krill models and the whale distribution. It suggests that TTAD models might improve significantly our understanding of the spatial relationship between top predators and their marine environment.

E-13

DISTRIBUTION AND HABITAT USE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AND HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN IRISH WATERS, USING PASSIVE ACOUSTIC TECHNIQUES (TPOD'S) TO COMPARE LOCATIONS OVER A THREE YEAR PERIOD

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Habitat use by bottlenose dolphins and harbour porpoises on the Irish west coast is poorly understood with the exception of the resident population of bottlenose dolphins in the Shannon estuary cSAC. Survey effort in 2000 demonstrated habitat use by dolphins beyond the estuary and use of other sites. To further examine habitat use and seasonality we deployed T-PODs at seven sites along the west coast of Ireland, encompassing a range of habitat

types. Acoustic survey effort included three locations in the Shannon; Rehy (53,340 hrs), Kilstiffin (8,640 hrs) and Leck Point (39,316 hrs); four locations along the west coast; Broadhaven Bay, Co. Mayo (162,684 hrs) and Killary Harbour (153,519 hrs), Crump Island (144,296 hrs) and Ballynakill Harbour (95,148 hrs) in Co. Galway. Bottlenose dolphins were detected at all seven sites, whereas harbour porpoise were detected at five sites. The level of activity was measured by the use of 'detection positive minutes' (DPM) and compared between species and locations, accounting for differences in survey effort and time of year. Detection frequency for dolphins was similar between Broadhaven Bay (0.002), the three sites in Galway (0.005, 0.003 and 0.004) and two of the sites in the Shannon (both 0.007). These locations all had relatively low detection rates compared to the rate at Kilstiffin (0.029). Porpoise detections were also made in the Shannon at Kilstiffin (0.00047) but only in one month - October. In contrast, one of the Galway sites was used by porpoises regularly over all months, with a relatively long deployment time resulting in a detection frequency of 0.0014. Results indicate that both species occur along the west coast of Ireland. However, that there are differences in use of these areas, which in turn, provides important implications for conservation measures in the future.

E-14

GREY SEAL HAUL OUT AREAS IN THE 'ARCHIPEL DE MOLÈNE', WEST OF BRITTANY

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Although grey seals spend most of their time at sea, their presence in coastal environment is characterised by the use of rocks to haul out. Study of this land habitat indirectly contributes to manage and protect the species. In Brittany, grey seals are present the whole year round, particularly in the 'archipel de Molène' (west of Brittany). Haul out sites were studied in order to better understand the land repartition of grey seals. Between 1998 and 2004, the animals were counted at low tide along a boat transect carried out among the rocks, islets and islands (with houses) of the 'archipel de Molène'. During this 7-year study, the annual number of seals increased from 41 to 57. Monthly variations were pronounced with a maximum in winter (average of 60 individuals), corresponding to the moulting period. Over year, some areas appeared to be preferred. To determinate the parameters responsible of such a repartition, some land characteristics were tested by the analysis of variance (ANOVA). Grey seals seemed to mainly use areas included an islet with land vegetation and, conversely, to rarely use areas with an island. The sites with pebbles instead of rocks, indicating a more sheltered shoreline, corresponded to the commonly areas of haul out activity. Each year, less than 3 calves are observed in the 'archipel de Molène'. This situation could indicate that the land areas don't have the required characteristics for reproduction. These results indicated that only a few areas are of interest for grey seal haul out activity. The management and preservation of these small habitats are essential to maintain this species in the 'archipel de Molène'. This study is part of a wide investigation on the biodiversity conservation of this coastal area, included in the project of Marine National park of Iroise Sea.

E-15

PRELIMINARY STUDY ON WINTER PHYSICAL HABITAT OF FIN WHALES (*BALAENOPTERA PHYSALUS*) IN THE FEEDING GROUND OF LAMPEDUSA ISLAND

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We investigated the physical habitat of fin whales in the waters surrounding Lampedusa island (Central Mediterranean Sea), where a winter feeding ground for this species was recently documented. The data were collected during a winter oceanographic cruise carried out from the16th to 29th of February 2004. The area covered was approximately of 1800 Km². Seventeen CTD (Conductivity-Temperature- Depth recorder) stations, spaced approximately 10 nautical miles apart and along 15 transects, were sampled for hydrographic information. In 8 of these stations, along 6 transects, we collected also water samples for nutrients analysis. A Plankton Hamburg Net (PHN - mesh size 1 mm) was used to collect mesozooplankton samples in 11 stations. The study area was divided into 104 cells measuring 2.5 nautical miles. A G.I.S. was used to integrate sighting data with surface water characteristics (chlorophyll, temperature, oxygen, density, salinity and nutrients), depth and with euphausiids density. Habitat use, weighted by the effort, was analysed by means of a statistical software that allowed a graphical representation of the probability area of fin whales presence. Fin whales distribution appeared to be not homogeneous with a high probability of sightings South of Lampedusa, where sea depth is between 40 and 70 meters, in relation with an area rich of nutrients. In this zone there was also a high presence of euphausiids. Despite the small sample size and the short period of the study, the data collected throw light on winter habitat use of fin whales in the Mediterranean Sea.

E-16

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 (*e.g.* 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. Legislation obliges governments to monitor and conserve many cetacean species. For example, harbour porpoises *Phocoena phocoena* are listed in the EU Habitats Directive. In this project, temporal variation in abundance of harbour porpoises was compared at two locations in Anglesey (North Wales), at all possible combinations of tidal phase (spring, neap), tidal state (high, ebb, low, flood) and time of day (morning, noon, afternoon), using a factorial sampling programme. There was generally greater activity during neap than spring tides. In addition, variation in relation to tidal state was not consistent between locations. Further work was carried out to test the influence of 'tidal races' on porpoise abundance and behaviour at two sites. At each location, porpoise abundance was monitored visually and acoustically, using T-PODs, within two sub-areas; one containing a distinct tidal race and one without. At both sites, porpoises were more abundant within the tidal race than outside it. Vocalisation rates mirrored this pattern, with significantly greater numbers of click trains recorded within the tidal race sectors. Porpoises may be using the tidal race areas due to fast current speeds or bathymetry, which may accumulate prey species. Findings indicate that it will be necessary to consider tidal state and phase in designing monitoring programmes for harbour porpoises. This study also highlights the spatial and temporal associations between porpoises and tidal races. These findings may be useful in planning management strategies for marine mammals.

E-17

SOCIAL STRUCTURE OF A 'SMALL' COASTAL GROUP OF BOTTLENOSE DOLPHINS

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Cohesion of mammalian societies are based on many different social links. Social unit, corresponding to associated individuals in space and time, is a variable which leads to a wide range of social systems. In the Iroise sea (west of Brittany), a bottlenose dolphin group has been resident in a restricted range around '*Ile de Sein*' and studied since 1992. Between 1992 and 2004, the group size has increased from 12 to 22 individuals. Photo-ID data from schools with at least two dolphins were analysed using two association indices (half-weight and Cole) in order to describe association patterns. The observed associations can be divided into three types: 1/ The strongest association 'mother-calf' observed in many areas. The five females of '*Ile de Sein*' were highly associated with their calves during an average of three years, except for one female which broke the link after two years because of a new calf. 2/ The association between subadults. Several associations were observed and revealed a high variability over time characterised by age mixing. Brothers or sisters were temporarily associated and young individuals were generally accompanied by older subadults. 3/ The association of adults. Generally, these links were short (two years maximum), except for one 'duo' unsexed and one 'trio' supposed to be males. The associations between dolphins of '*Ile de Sein*' revealed a highly cohesive social unit. Today, these results need to be clarified by a genetic study in order to reply to the following questions : 1/ Is it really a closed group? No new adults have been observed but transient dolphins could take part for reproduction. 2/ What are the genders of all the individuals and what is their degree of relationship? 3/ It seemed that there was no dominant male. Do all the males have access to all the females?

E-18

FLUCTUATING ASYMMETRY IN KILLER WHALE COLOR PATTERN

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It has been shown that symmetrical individuals generally have better fitness, better survival, higher fecundity and faster growth than asymmetrical individuals. There are several genetical and environmental factors, which can break down the developmental stability. Environmental effects include lack of food, unusual temperatures, chemical pollutants and parasitism. Inbreeding, extreme homotsygosity and hybridization can break down the developmental system in normally bilaterally symmetrical individuals causing fluctuating asymmetry. The amount of fluctuating asymmetry in a population can be an indicator of the condition of the population. In this study, I have used killer whale (*Orcinus orca*) saddle patch pattern behind the dorsal fin as an indicator of fluctuating asymmetry. Six Pacific Ocean killer whale populations were used in this study: northern residents, southern residents, offshores, Californian transients, northern transients and Kamchatkan killer whales. Photographs of both sides of each individual were used in this comparison. Different killer whale populations in the Pacific Ocean had different proportions of asymmetric individuals. The southern resident killer whale population seems to be more asymmetric than the other studied populations. I suggest that in addition to the environmental factors, the genetical structure of the population, inbreeding and small size of the population could be the factors causing asymmetry in the southern resident population.

E-19

PHOTO-IDENTIFICATION OF ROUGH-TOOTHED DOLPHINS OFF LA GOMERA (CANARY ISLANDS) WITH NEW INSIGHTS INTO SOCIAL ORGANISATION

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Off La Gomera (Canary Islands), rough-toothed dolphins are present year round and distributed relatively close to shore. Photo-ID research was conducted from 2000 until

2003 on board of whale-watching vessels of a local operator. Rough-toothed dolphins showed several distinct features suitable for individual identification, such as notch patterns on the fin, global fin shape, pigmentation and distinct scratches. 63 individuals were identified. These were ranked according to the quality of obtained photographs and according to the recognisability of markings, thus measures of reliability for the re-identification of individuals were created. Changes of markings over time occurred, with colour/pigmentation patterns, global fin shape and notch patterns on the dorsal fin being the most reliable ID features. All identified individuals were included into the world-first electronic ID catalogue of rough-toothed dolphins. 65% of identified individuals were seen within more than one year, 37% within three or four years, strongly suggesting a resident population. This has several implications for management and conservation of this species in the Canary Islands. The formation of very tight subgroups is an outstanding behavioural peculiarity of rough-toothed dolphins. Subgroup composition was found to be dynamic, with subgroup sizes of 2-8 animals. The Half Weight Index (HWI) was used to asses non random associations between individuals. HWI values of up to 0.89 indicated the existence of a structured organisation of rough-toothed dolphin groups/populations. Association patterns also showed that this species has both strong social bonds between mother and calf/juvenile and between individuals of different age classes. With this first of its kind study the use of whale watching vessels for photo-ID studies was proven to be feasible with this species. Moreover, the study shed first light social life of a still not well understood species.

E-20

PRELIMINARY INSIGHTS IN THE FEEDING ECOLOGY OF MARINE MAMMALS FROM THE LIGURIAN SEA THROUGH STABLE ISOTOPE AND MERCURY MEASUREMENTS

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The Ligurian Sea, part of the Cetacean Sanctuary, is known to be a productive area hosting many marine mammal species of the Mediterranean Sea. Investigations on trophic relationship and pollutant monitoring are of primary importance for their conservation. As isotopic composition of an animal is related to that of its prey, d13C and d15N were measured by mass spectrometry in muscle of 12 striped dolphins (*Stenella coeruleoalba*), 1 bottlenose dolphin (*Tursiops truncatus*), 2 fin whales (*Balaenoptera physalus*), 3 Risso's dolphins (*Grampus griseus*), 1 Cuvier's beaked whale (*Ziphius cavirostris*) and 1 juvenile sperm whale (*Physeter macrocephalus*) stranded along the Ligurian coasts between 1991 and 2004. Hg concentration was also analysed in marine mammal liver by spectrometric absorption. Through d13C and d15N measurements, two marine mammal groups appeared: the first group characterised by high d13C and d15N values (mean values: -17.5‰ and 11.0‰ respectively) included the sperm whale, the bottlenose dolphin, the Risso's dolphin and the beaked whale. The second group including striped dolphin and fin whale displayed lower mean ð13C than the first group (-18,48‰), with the fin whale showing the lowest ð15N value (8,8‰ ± 0,7). Our isotopic data are in good agreement with previously described feeding habits: the first group obviously fed at a higher trophic level and in more coastal waters associated with the continental slope while the second fed offshore, with the fin whale occupying the lowest trophic position. Hg concentrations reflected a similar pattern, with the lowest value observed in the fin whale (mean value: 0.1 µg.g-1 dw) and the highest in both the bottlenose dolphin (3769 µg.g-1 dw) and the Risso's dolphin (1363 µg.g-1 dw). However, beside trophic position, numerous factors might be involved in Hg accumulation in marine mammals such as the age, body condition and specific metabolism.

E-21

BIOLOGICAL PROPERTIES OF MICROORGANISMS THAT PROVOKE PATHOLOGIES OF BLACK SEA BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*)

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Eighty percent of loss of captured Cetaceans, fall on the bacterial infections caused pathogenic *Coccus.* The most frequent agents of diseases are *Staphylococcus aureus*, *Staphylococcus delphini*, *Streptococcus pneumonia* and others. More often pathogenic microorganisms get to dolphins from the personnel of dolphinariums, with forage. Sickness rate in captivity can be bound up with reduction of immunoresponciveness. The purpose of our research was to study the microflora of 14 captured dolphins. Research objectives included**:** research of microflora of healthy and sick dolphins; studying of biological properties of the allocated microflora, with attention to pathogenic factors; studying a role of the allocated microorganisms in pathologies of dolphins. Our research was carried out in 2002-2005 at the Department of Microbiology of Moscow Academy of Veterinary Medicine and Biotechnology. The material was taken from 14 live dolphins. Bacterial researches were carried out by a standard procedure. Sowing was done in MPA, MPB, BMPA with 5 % erythrocyte of sheep and others. Virulence was studied by infection of white mice. Sensibility to antibiotics was studied by a method of standard disks. The sick dolphins had following clinical symptoms: abnormal haemotologicael index and change of behavior; from the sick dolphins have been isolated *Streptococcus*, *Staphylococcus*, *Escherichia*, *Pseudomonas.* Then hemolytic and toxicogenic properties were studied. These microorganisms have been isolated in monoculture, or prevailed in sowing. We conclude that: prevalence in microbe associations of an organism of sick dolphins and factors of pathogenicity of the allocated pathogens can

serve as the proof of their role in infectious pathologies of captured dolphins; at the dolphins with symptoms of infectious diseases are diagnosed: *Streptococcus* disease - 66, 7%, *Staphylococcus* disease -16, 7 %, *Escherichia* disease - 16, 7 %; it was researched the sensibility of these microorganisms to different antibacterial agents.

E-22

LASER ABLATION ICP-MS ANALYSIS OF SPERM WHALE TEETH: POTENTIAL FOR DETECTING VARIATIONS IN THE ONTOGENETIC EXPOSURE TO METALS

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Microprobe techniques have previously shown that incremental growth layers of hard structures such as teeth contain archival information about the chemical environment of an organism throughout its life. However, trace elements, including metals, are generally undetectable with these methods. A relatively new technique, laser ablation – inductively coupled plasma – mass spectrometry (LA-ICP-MS) promises multi-element capability with extremely low detection limits combined with very fine spatial resolution. The aims of this study were to investigate the feasibility of using LA-ICP-MS to detect potential patterns in the trace metal profiles of sperm whale teeth across incremental growth layers of dentine. These profiles would be expected to reflect the exposure to or accumulation of elements from the environment. The tooth of a male sperm whale stranded in Scotland was analysed. The dark and light bands of ten growth layer groups (corresponding to the last 10 years of the individual's life) were ablated with 100µm sample pits and 19 isotopes of 9 metals (Al, Ba, Ca, Cu, Mg, Na, Pb, Sr, Zn) measured in a semi-quantitative way (calcium was used as internal standard to cancel out matrix influence, and pre-ablation cleaned the surface from contamination) since no suitable reference materials were available. Profiles revealed variations of lead and aluminium across the growth layers with higher concentrations in the dark layers for both elements ($p < 0.05$). Lead isotope ratios also revealed variations across growth layers. Further work should concentrate on fine-tuning the methods and interpreting the observed profiles in light of ontogenetic movement patterns of sperm whales

E-23

BOTTLENOSE DOLPHIN STRANDING SURVEY ON THE WESTERN COAST OF THE NORTHERN ADRIATIC SEA

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From 1991 information on stranded *Tursiops truncatus* were collected along Emilia-Romagna and Marche coasts of the Adriatic Sea. Data are discussed relatively to distribution in time and space and the differences by sex and dimensional classes are shown in comparison with data from other Italian coastal areas. Ninety-four bottlenose dolphins came ashore in different ways and conditions along a coast of approximately 300 km. During 1991-2004 period the mean number of T. truncatus collected was 5.5 per year with high year variations and a maximum of 19 individuals in 2004. In the study area strandings occur all over the year, confirming the suggested presence of a stable population in this part of the Adriatic Sea. 53% of the occurrences were recorded from June to August. 38 females and 32 males determine a sex ratio of 1,19:1 and 24 were undetermined. "Newborns" (under 150 cm of total length) are concentrated in June-July (n=6) with 1 specimen in September and 1 in December, confirming the literature data about occurrence of birth in the late spring. 60% of the specimens were adults (more than 250 cm). The distribution of length classes in different months does not show any correlation. There is no statistical difference between male and female in total length. As well as total length is no statistically different between the Adriatic sample and the others Italian coasts strandings sample. Investigations on death causes were carried out and a high number of deaths have been ascribed to drowning, illness and boat collisions.

E-24

FIRST SUMMARY OF COASTAL SEA SURVEYS DONE OFF THE MEDITERRANEAN COAST OF ISRAEL BETWEEN THE YEARS 1999-2004

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Cetacean research carried out during the last decade In Israel and in the easternmost Mediterranean as a whole, has centered on species, gender and age determination, as well as on morphological, pathological, toxicological and genetic investigation of beached and by-caught carcasses. In 1999, a donation of a semi-inflatable Zodiac research boat allowed us to initiate dedicated open sea surveys with the aim of a local ecological characterization of coastal cetaceans in our study area. The present report summarizes the results of 122 half-day surveys, totaling 417 hours at sea, performed with the research boat as well as with a 13 m. yacht from that time till today. The surveys were carried out in seas under Beaufort 3 and up to 6 nautical miles off shore. During the surveys we collect navigational and observational data, according to a fixed protocol. The data is analyzed and presented using GIS software. The bottlenose dolphin (*Tursiops truncatus*) was the only species sighted. Even in low seas, encounter rate was only

42%. In 45% of the encounters the dolphins were interacting with bottom-trawl boats. The non-trawler encounters occurred mainly within the first 3 nautical miles off shore. The average pod size was 4.6 (2.6 SD), and seasonally dependent. 34 % of photo identified individuals have been determined to be skinny. The research so far suggests a small stable bottlenose dolphin population with annual migration events during early spring, at which time large pods are seen. The high percentage of skinny dolphins and the clear interaction with bottom trawl fishery suggest a nutritional stress. Research on free-ranging dolphins in Israel is still in its cradle, with much to be uncovered, yet it is a mandatory prerequisite for any conservation plan of action in this region.

E-25

POPULATION STATUS, SOCIAL ORGANISATION AND FEEDING STRATEGIES OF KILLER WHALES (*ORCINUS ORCA*) IN THE STRAIT OF GIBRALTAR

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The red tuna (*Thunnus thynnus*) migrates through the Strait of Gibraltar, entering the Mediterranean Sea in the spring to breed and leaving the Mediterranean Sea in the summer. Tuna are the main fish prey of killer whales in this area. Between 1999 and 2004, 9450 km were sailed around the Strait of Gibraltar, and 58 sightings of killer whales were realised. Killer whales were observed during both spring and summer preying on red tuna or interacting with the tuna fishery. On each encounter, observations were conducted (120 hours) and pictures taken (3500 pictures), including interactions with fishermen and tuna predation by the whales. In spring, two different groups of killer whales (2 and 8 individuals respectively) were observed. Hunting consisted in a long and high speed chase of tuna in shallow waters. The fish were followed for 30 and 45 minutes before being captured. Based on previous data on maximum anaerobic and maximum sustained swimming speeds of red tuna and other tuna species, a likely hypothesis is that killer whales may chase the tuna until they are exhausted. In the summer, killer whales were observed in the western central part of the strait where the red tuna drop line fishery is operating. Interviews to the fishermen revealed that during 2004, 18% of the catches realised by the fishermen were lost because of the killer whales. None of the killer whales seen in the spring were observed in the summer and a total of 16 different individuals were identified. The regular re-sightings of the same individuals suggest that the same groups of animals were interacting with fishermen during all these encounters. The interactions with fishery and depletion of red tuna stocks due to over-fishing are likely to have a negative impact on both killer whales and fishermen in this area.

E-26

A STUDY ON AN OPPORTUNISTIC FEEDING BEHAVIOR OF A POPULATION OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) IN THE GULF OF CATANIA, SICILY

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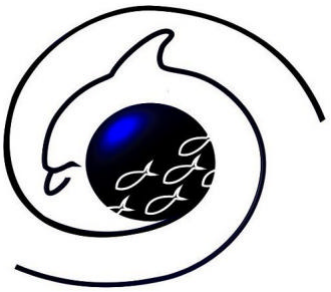
Suggested by the high frequency of gill-net damages reported by local fishermen, the study of the interaction of the community of *Tursiops truncatus* with local fishery in the Gulf of Catania, Sicily, is at the base of the project conducted by the Ketos association during the years 2002-2004. It is within this project that many graduation theses are being realized focalizing on different aspects of the same study. A total of 677 hours of observations were conduced both from land and from an inflatabe boat, starting from the beginning of 2002 up to the end of 2004. 231 hours of sightings were collected, counting for 173 individual sightings; in 95 (55%) of the sightings at least one interacting event with fishing gears was observed, with four different gears involved in the interactions. During all the sightings a photoidentification effort was made in order to be able to monitorize the individuals for possible further studies on associations during this complex opportunistic behavior. Moreover, the whole set of datas were processed in a GIS system, intentionally created for this study. Since this opportunistic phenomenon is putting in severe danger the survival of the local artisanal fishery, the main purpose of the work is to create valuable new guidelines for the local authorities to intervene.



FEEDING

F-01

DIET OVERLAP BETWEEN SHORT-BEAKED COMMON DOLPHINS AND LARGE TUNA IN EASTERN IONIAN SEA INSHORE WATERS: INSIGHT FROM SCALES OF FISH PREY SAMPLED DURING SURFACE FORAGING

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This work aims to investigate the prey preferences of short-beaked common dolphins (*Delphinus delphis*) and large tuna (*Thunnus thynnus* and *Thunnus alalunga*) in eastern Ionian Sea inshore waters, and explore a possible feeding competition between these species. Following predatory events performed at the surface by both common dolphins and tuna, drifting scales lost by fish prey were opportunistically collected by means of a snare and preserved in ethanol 80%. In the study period, May-October 1997-2002, a total of 537 fish scales related to predatory events of both predators were collected during 98 sampling events performed in different spots ("catches"). Scales from common dolphin prey were collected during 77 catches in 43 different days, each catch including 1-20 scales (median=3, IQR=6). A total of 21 catches from tuna prey were made in 16 different days, each including 1-50 scales (median=5, IQR=5). Scales were hydrated, cleaned and observed through a Nikon stereo microscope (x0.8-x4.0 lens). These unidentified scales were compared with a scale atlas of known fish species collected in the study area. Scales of European pilchard *Sardina pilchardus* and gilt sardine *Sardinella aurita* could not be reliably discriminated and were therefore pooled together in a "sardine" category. The analyses showed that epipelagic schooling fish were exclusive prey. European anchovies *Engraulis encrasicholus* represented 40.3% of common dolphin prey and 90.5% of tuna prey, while sardines constituted 59.7% of common dolphin prey and 9.5% of tuna prey. This study highlights that both common dolphins and large tuna target anchovies or sardines during surface feeding and suggests that remarkable diet overlap exists between these high-order predators in the study area.

F-02

DO MEDITERRANEAN CETACEANS EXPLOIT THE SAME RESSOURCES?

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Eight cetacean species occur regularly in the Mediterranean Sea. The diet of each species is determined on the basis of the analysis of stomach contents for odontocetes and faeces for mysticetes. This work, combining original data and literature data that covers both eastern and western basins, therefore summarises the actual knowledge on the diet of cetaceans in the Mediterranean Sea. Four separated groups of species can be distinguished. Three species are exclusively teuthophagous: Sperm whale (N=3 stomachs, n=2186 preys), Cuviers's beaked whales (N=15, n=891) and Risso's dolphin (N=22, n=688). Long-finned pilot whale (N=10, n=65) is preferential teuthophagous, occasionally feeding on fish. Bottlenose dolphin (N=47, n=1492), Striped dolphin (N=145, n=3307) and Common dolphin (N=29, n=617) have a mixed diet based on ingestion of cephalopods, fishes and crustaceans. Fin whale (N=29 faeces, n=4145), the only one mysticete, is totally planktonophagous in the summer and consumes exclusively one euphausiid species, *Meganyctiphanes norvegica*. Moreover, it seems that cetaceans in the Mediterranean Sea mainly eat fish over the continental shelf, fish and squid over the slope and mainly squid in oceanic waters. Bottlenose and Striped dolphins have the most diversified odontocetes diets with a specific richness of 63 and 60 different prey species respectively and a Shannon-Wiener Diversity Index of 4.94 and 4.17. The niche overlap between cetaceans studied was estimated using the Morisita's index. No evidence of interspecific diet overlaps was observed (CH <0.5). On the other hand, the Euclidean distance concludes that the nearest two diets in the Mediterranean are those of Risso's dolphin and long finned pilot whale, inducing a possible competition between these two species. Two species are distinctly apart: the Sperm whale, a very specific teuthophagous and the Fin whale, the only planktonophagous species.

F-03

DIET, ABUNDANCE AND INTERACTION WITH FISHERY OF CETACEANS IN THE ADRIATIC SEA (1988-1998)

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The aim of this work is to study the cetacean population of the Adriatic Sea considering its role in the food chain as consumer of small pelagic fish. Data concerning cetacean diet were obtained from the gut content of stranded individuals (bulletins of Cetacean Foundation, Riccione, Italy); these data show predominance (70%) of small pelagic fish in dolphin's diet. The abundance estimate of the cetacean population was based on visual census from ferry boats of the Italian Company travelling throughout the Adriatic Sea and on visual census effort, provided by qualified personnel of the same Company. The most abundant species resulted bottlenose dolphins (mean number of individuals per year: 900.9), striped dolphins (259.4) and common dolphins (87.6). On the base of the previous data mean annual consumption of small pelagic fish by the cetaceans of the Adriatic Sea was estimated. It was compared with the abundance of small pelagic fish, evaluated with echosurvey and with mean annual anchovy and sardine catches, derived from ISTAT bulletins. The conclusions can be summarized as follows: 1) feeding on

small pelagic fish by cetaceans is comparable with catches by fishery activity; 2) dolphins as fishermen seem to prefer some pelagic species over others, but the kind of preference is not exactly the same; 3) small pelagic fish biomass estimated acoustically resulted an order of magnitude greater than the quantity removed by both Fishery and dolphin's predation. Therefore man-dolphin competition for this kind of resource can be considered low in the Adriatic Sea.

F-04

DOES NUTRITIONAL STRESS IMPEDE GROWTH OF THE ENDANGERED NEW ZEALAND SEA LION (*PHOCARCTOS HOOKERI*) POPULATION?

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Classified as a threatened species, New Zealand sea lions breed only on the Auckland Islands (50.5°S, 166°E) in the NZ subantarctic. Despite full protection, the estimated population of 12,000 to 16,000 has not increased since the mid-twentieth century. Low reproductive success through low pup production and a high neonatal mortality may be impeding species recovery. An additional hypothesis is that the species is under nutritional stress due to a diet of low energy density. The aim of this study is to quantify for the first time the diet of the NZ sea lion. Stomachs of sea lions (n = 76) bycaught between 1997 and 2004 by the squid fishery around the Auckland Islands were analysed. Arrow squid (*Nototodarus sloanii*) formed the main prey by number (35%N) and by mass (37%M). Opalfish (*Hemerocoetes spp*), a bottom living fish, was an important prey by number (31%N), while *Octopus* and hoki (*Macruronus novaezelandiae*) contributed to a major part of the diet by mass (27%M and 15%M respectively) due to their large individual mass (>1kg). Minor species were oblique-banded rattail (*Coelorinchus aspercephalus*), jack mackerel (*Trachurus spp*) and red cod (*Pseudophycis bachus*). Even if the overestimation of the squid is obvious by the source of samples (bycatch), diet analysis from scats of the NZ fur seal (*Arctocephalus forsteri*) on the Snares Islands (48°S, 166.5°E) north of the Auckland Islands, also showed a predominance of squid. The low energetic value of squid is possibly limiting growth of the fur sea population. A dietary comparison was also made with NZ fur seals from the east coast of the South Island where the population is growing: their diet consists primarily of fish not squid. Further dietary analyses using other methods like fatty acid analysis and year round scat samples are crucial to validate the nutritional stress hypothesis.

F-05

NICHE SEPARATION OF FOUR ODONTOCETES IN THE WESTERN MEDITERRANEAN SEA

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Cetaceans play an important role as last consumers in the food chain. The diet of some cetaceans, especially of the most common species, is known in the Mediterranean Sea but their comparative feeding ecology has not been studied. This study focuses on the niche overlap between four odontocetes, *Tursiops truncatus*, *Stenella coeruleoalba*, *Grampus griseus*, and *Ziphius cavirostris*, whose diets are known in this specific area (40º25'N 00º32'W and 37º35'N 00º45'E). The unpublished fish contribution to the diet of the striped dolphin is now shown. Niche overlap has been considered according to both Pianka's symmetrical measure (Pianka, 1974) and size differences in the common prey. The overlap niche is very low, as can be expected from differences in the diet. The highest overlap niche (O = 0.155) is that of the two teuthophagous and less frequent dolphin species in the area: *G. griseus* and *Z. cavirostris*. Differences in the size of some cephalopods, *Todarodes sagittatus* and *Chiroteuthis veranii* (nested ANOVA, $F = 85.432$, $P < 0.001$ and $F = 62.858$, $P < 0.001$, respectively), which are common prey to these two dolphins cause the aforementioned index to decrease. In addition, some geographical or/and depth segregation may be expected based on the bathymetric distribution of the overall cephalopod prey. Any trophic competition by these top predators is rejected given the partition of available resources in the area.

F-06

NYCTIPHANES COUCHI (BELL, 1853) (CRUSTACEA, EUPHAUSIACEA) IS AN IMPORTANT PREY FOR MEDITERRANEAN FIN WHALES

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The principal prey for fin whale in the Mediterranean is considered to be the euphausiid *Meganyctiphnes norvegica*. In relation to the recently documented presence of a winter feeding ground for fin whales in the central part of the Mediterranean basin, we present information regarding a different prey species in this area. In close proximity of fin whales engaged in evident surface feeding behaviour, and in control areas where no whales were found, we collected plankton samples with a PHN (Plankton Hamburg Net, 1 mm net size, 4 square meters mouth) trawled in oblique from bottom to surface while the ship travelled at a speed of 3 knots for 1 hour. At the same time, a professional scuba diver with underwater camera collected short movie at close distance (3 to 10 meters) from feeding whales. During the 8 days of survey a total of eleven PHN tows were undertaken and analyzed, and three hours of U/W video footage was obtained in close (0.5-5m) proximity to ten different feeding groups. The plankton samples were sorted in four different components: euphausiids, other crustaceans, molluscs, fish larvae and gelatinous plankton.

Excluding the gelatinous plankton fraction, constituted of Thaliacea (Salpida and Doliolida), Siphonophora and Hydroidea, the principal component is constituted of euphausiids, dominated by *Nyctiphanes couchi*. Plancton samples collected in presence of whales have the higher density of *N. couchi*. U/W footage analysis confirmed that fin whales in this area feed on swarms of these small shrimps. Little is known about the fin whale's distribution away from the north-western part of Mediterranean basin, and no data are present regarding feeding in these areas. The existence of winter feeding areas based on presence and abundance of *N. couchi* can change current hypothesis about fin whale ecology and distribution in the Mediterranean Sea.

F-07

COOPERATIVE FEEDING IN MEDITERRANEAN FIN WHALES (*BALAENOPTEREA PHYSALUS*)

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The fin whale, *Balaenoptera physalus* (Linnaeus, 1758), is the only species of mysticete regularly present in the Mediterranean Sea. In the period February 16-29, 2004, our research team surveyed the waters surrounding Lampedusa, a small island in the Sicily Channel (Central Mediterranean Sea), and described the first winter feeding ground for this species in the Mediterranean Sea. During our study we encountered 18 whale groups (mean group size 2.2 animals/group; range 1-5), all of which where engaged in surface feeding behaviour. Although our sample is small, the mean group size we found is considerably greater than in almost all other studies (generally < 1.5) on Mediterranean fin whales. When encountered in groups the whales where feeding synchronously at the surface on swarms of *Nyctiphanes couchi*, and extremely close to one another (<1 m). Based on plankton samples collected both where whales were observed feeding, and in control areas, we can say that their prey in this area (*N. couchi*) may be considered to be sparse. Fin whale group size is supposed to reflect the distribution and patchiness of preys, with larger schools when food resources are sparse or homogeneously distributed and small groups when food is patchy. This behavior is supposed to reduce intraspecific competition. Therefore, based on the feeding behaviour of the whales and on the distribution of their prey, we can conclude that in the study area, large schools of whales engage in cooperative feeding on swarms of *N. couchi*.

F-08

DIET OF NORTHERN BOTTLENOSE WHALE OFF THE FAROE ISLANDS

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Knowledge of the ecology and behaviour of bottlenose whales remains poor. Diet data is often limited to the listing of prey species or, when more detailed, is based on a few isolated stranded whales. The Faroese collection contains stomach content samples from 23 bottlenose whales (10 males, 10 females and 3 unidentified, measuring between 380 and 811cm long), landed in groups of 1-6 individuals in August and September 1897 to 2002 and offer a nice opportunity to look at feeding behaviour. Samples consist almost entirely of cephalopod remains, and the diet composition (frequency, prey numbers and biomass) is based on the identification and standard measurements of the lower cephalopod beaks. More than 20.000 lower beaks were recovered and only a sub-sample was measured. A total of 20 prey taxa were identified, belonging to at least 12 families of mostly oceanic cephalopods. The boreoatlantic gonate squid *Gonatus* probably *G. fabricii* appeared in all stomachs, accounting for 53% of the beaks and 70% of the biomass. Cranchiids (incl. *Taonius*, *Teuthowenia*, and *Megalocranchia*) also appeared in all the stomachs and represented 30% of the biomass. Although some of the other taxa identified could appear in most of the stomachs (*e.g. Vampiroteuthis*, *Histioteuthis* A and B and *Octopoteuthis*), their contribution was negligible in numbers and biomass. The same prey taxa were usually found in the stomachs within a whale group, but the relative importance of the prey could vary significantly. At that period, the whales are assumed to migrate southward, from northern waters where *G. fabricii* should be dominant. The variety in the diet and the presence of species such as *Vampiroteuthis infernalis*, *Taonius pavo* and *Chiroteuthis could* indicate either that the whales have previously been through warmer waters or that the distribution of the prey is wider than thought.

F-09

GREY SEAL'S BEHAVIOURAL RESPONSES TO FOOD AVAILABILITY: AN EXPERIMENTAL APPROACH

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In this study, we set out to test experimentally the prediction of a recent model (Thompson and Fedak 2001) of foraging decisions by investigating the behavioural adjustments of grey seals, *Halichoerus grypus*, to food resource availability (prey encounter rate and surface-patch distance). According to this model, seals are predicted to end a shallow dive early if they encounter low prey density, while they should stay on the patch for deep dives of similar prey density. For a given depth, grey seals spent less time in the patch at low densities compared to high densities, as predicted by the model. However, they did not remain longer in the prey patch, at low density in deep dives compared to shallow dives, which is not consistent with the predictions. This relationship between

diving behaviour and prey accessibility, at the scale of the dive, in marine mammals such as grey seals demonstrates that marine mammals can be used as actual indicators of marine resources accessibility and abundance.

F-10

PRELIMINARY RESULTS OF C^{12} AND N^{15} STABLE ISOTOPES ANALYSIS IN BOTTLENOSE DOLPHINS, COMMON DOLPHINS AND HARBOUR PORPOISE IN SOUTH SPAIN

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In 2002 the Spanish Cetacean Society started an European LIFE-Program project regarding conservation of cetaceans and turtles in South Spain. This region has marine and coastal habitats of great importance for the three target species of the project, the bottlenose dolphin (*Tursiops truncatus*), the harbour porpoise (*Phocoena phocoena*) (considered extinct in the Meditteranean area) and the common dolphin (*Delphinus delphis*). One of the actions carried out by the project has as main objective the identification of diet of these three species. C^{12} and N^{15} stable isotopes analysis have been previously used to assess diet and trophic level of several marine mammal species in many locations all over the world. The results of these works have shown the utility of the technique to approach trophic issues when more traditionally used methods are not available. This technique have also provided good results when was used to approach population structure issues. In South Spain, little is known about the diet of marine mammals. Since the beginning of the project in July 2002 only 5 stomach contents were collected and available for analysis (2 common dolphins, 2 bottlenose dolphins and one harbour porpoise). In addition 27 skin and muscle samples from stranded common dolphins, 3 skin and muscle samples from stranded harbour porpoises and 30 skin and muscle samples of bottlenose dolphins (2 from stranded animals and 28 collected using the remote biopsies method) have been analyzed to measure carbon and nitrogen stable isotopes profiles. Also 50 samples of 20 different potential prey species have been analyzed. The results are the first reliable information concerning diet of these three species in the Alboran Sea, Strait of Gibraltar and adjacent Atlantic waters and will be used to assess competition for trophic resources with fisheries in the area.

F-11

TEUTOPHAGOUS CETACEANS OF THE LIGURIAN SEA: FEEDING STRATEGIES, NICHE BREADTH AND POSSIBLE COMPETITION WITH OTHER TOP PREDATORS

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Pelagic cephalopods represent a scarcely known group, although they play a basic role in the food chains regarding top predators, both fish and marine mammals. Aim of this study is to investigate which cephalopod species are exploited by marine mammals and other top predators, such as large pelagic fish and sharks, and possible interactions with fishing activities in the Cetacean Sanctuary of the Ligurian Sea. Direct sampling carried out by the means of more than 120 hauls effected with mesopelagic nets (IKMT, sampling range 0-800m) in the Ligurian Sea allowed to list 20 cephalopod species, included those inhabiting surface waters. Stomach contents analysis of strictly teutophagous cetacean species, such as *Grampus griseus*, *Globicephala melas*, *Ziphius cavirostris* and *Physeter macrocephalus*, permitted to focus the attention on a pool of only 7 species of cephalopods, which represents more than 80% of the ingested preys. The list of dominant prey items showed a common alimentary basis in Histioteuthidae, but different niches were established by feeding specializations concerning different families. For all the main food items, there was not any overlap with fishing activities. In order to investigate the trophic relationships between these four species of marine mammals and other top predators, all sharing the same pelagic habitat in offshore waters, the stomach contents of the swordfish (*Xiphias gladius*), the bluefin tuna (*Thunnus thynnus*), the Mediterranean spearfish (*Tetrapturus belone*) and the blue shark (*Prionace glauca*) were also examined. These all resulted to be partially teutophagous species; in their diet the most important cephalopod families were Ommastrephidae, Onychoteuthidae, Histioteuthidae, Cranchiidae and pelagic octopuses. Considering also literature data, niche breadth and niche overlap for all species were calculated. Teutophagous cetaceans showed generally narrow niche breadth but also a reduced dietary overlap with other predators, except blue shark, that preys on the same cephalopod species.

F-12

STOMACH CONTENTS OF THE AUSTRALIAN SEA LION (*NEOPHOCA CINEREA*) AND PREY OVERLAP WITH FISHERIES.

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The Australian sea lion (*Neophoca cinerea*) is an endemic species with a population of between 9,900-12,500, and distribution limited to the south-central to south-western coast of Australia. The diet of Australian sea lions is poorly-known, however, interactions with fisheries occur and diet information is needed to consider potential prey overlap. The aims of this study were to investigate the diet of Australian sea lions and to assess overlap with species

and size targeted by fishers. Eighty nine beach-washed Australian sea lion carcasses were opportunistically collected from the South Australian coast. Gastrointestinal tracts (GIT) contents were identified to lowest taxonomic level possible and prey size reconstructed. Comparisons were made with species and size of fish targeted by the fishing industry to indicate competition. Forty-eight GIT's had stomach contents including cephalopods, fish, crustaceans, milk, isopods, algae, netting and fabric. The most frequently occurring prey was cephalopods, with 1752 beaks representing 830 individuals of at least 5 species identified from 38 GITs. Octopus (48%) and cuttlefish (32%) were most numerous. The maximum number of cephalopods in a single GIT was 102 (4 spp.) Fish were identified from 18 GIT's representing 351 individuals, of 15 species with an additional 33 unidentified. The fish species that occurred in the most multiple GIT's were *Platycephalus basensis* (total of 11 indiviuals) and *Trachurus declivis* (5), both occurring in 4 GIT's. The maximum fish in a single GIT was 140 Sciaenidae, which were under the size that is targeted by fishers. All species identified from the Australian sea lion GIT's were also commercially and/or recreationally fished, however some prey species were smaller than those targeted by fisheries, indicating some partitioning.

F-13

GREY SEAL DIET IN WESTERN SCOTLAND: A COMPARISON BETWEEN 1985 AND 2002 IN RELATION TO CHANGES IN ABUNDANCE OF COMMERCIAL PREY

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Grey seal diet was last comprehensively studied in western Scotland in 1985. Since then, the grey seal population has more than doubled and the relative abundance of fish stocks in the area has changed markedly. Nothing has highlighted this more than the decline in cod stocks, presently at an historical low. The aim of this study was to provide current estimates of prey consumption that are required to address policy issues related to the impact of the still increasing grey seal population on commercial fish populations. We also relate these to changes in relative and absolute abundance of fish prey. During 2002, ten sampling trips totalling 56 days were completed around western Scotland, resulting in the collection of 1,589 grey seal scats. Fifty-two prey species were recorded in these samples revealing that grey seals on the west coast of Scotland remain highly catholic in their diet. Seasonal and regional variation in diet composition has been assessed, and the consumption of commercial fish species estimated. Proportions, by weight, of prey species indicate a strong preference for gadids, in particular ling. Sandeels were also an important component. Comparisons made between 1985 and 2002 reveal many similarities in diet composition. However, some species present in the diet in 1985 were absent in 2002 (*e.g.* Conger eel, an important prey during the last quarter) and some species were new to the diet in 2002 (*e.g.* Blue whiting). Changes in the size of fish stocks partially explain some of these changes. One interesting exception is cod, which, despite very low abundance in 2002, formed a significant part of grey seal diet in western Scotland. These results will be important to conservation and fisheries managers in Scotland.

F-14

STOMACH CONTENTS AND HISTO-PATHOLOGICAL EXAMINATION OF A YOUNG MALE SPERM WHALE (*PHYSETER MACROCEPHALUS*) STRANDED IN BRITTANY.

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The presence of numerous plastic debris in the oceans is well known and significant literature on the subject has been published. The ingestion of those debris by marine organisms is especially evident in turtles. In France for instance, the necropsy of stranded leatherback turtles revealed the presence of plastic bags in the stomachs of 50% of these animals. On the contrary, this type of ingestion in cetaceans seems to occur less frequently, even if the list of the various cases recorded throughout the world increases regularly. In France, since 1971, only 10 cases have been listed. Recently, in August 2004, in south Brittany, a young sperm whale male stranded alive and finally died. During the necropsy, we found in its stomach a trash bag and plastic debris, as well as "supermarket" plastic bags, a nylon rope, some accumulated cephalopods beaks, and a significant number of ascidians of the *Pyrosoma* genus. The nature of this content reveals food behaviour abnormally focused upon the capture of moderately mobile elements found in shallow waters. It may be interesting to compare these observations with another aspect revealed by the necropsy. Indeed, the animal displayed an anal constriction related to the presence of nodules at the origin of the dilatation of the distal colon. It seems evident that this pathological problem considerably weakened the animal and reduced its foraging abilities. The relatively moderate stoutness of the animal comforts this hypothesis. The histo-pathological examination showed that the nodules corresponded to a lymphoid hyperplasy. This observation confirms the existence of a lymphoid anal gland in sperm whales.

F-15

THE DIET OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) WITH SPECIAL REFERENCE TO SEASONAL VARIATION IN BODY CONDOTION AND AREA DIFFERENCES

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Recent discoveries of seasonal fluctuations in body-condition of harbour porpoise are the main background for this study of diet and energy intake of harbour porpoises in Danish waters. It is investigated if these seasonal fluctuations are caused by seasonal differences in diet and energy consumption. This is done by examining stomach contents of otoliths, which, despite problems, is the best indicator of diet of the harbour porpoise. The results showed that the diet and energy intake do not reflect the seasonal fluctuations in body condition. The main fish prey is gadoids in both gender and independent of state of maturity. It is suggested that the harbour porpoise may have changed its diet composition in response to changes in fish abundance. By looking at recent diet studies of harbour porpoises in the same geographical area, it is suggested that different populations have different diet preferences. This may lead to new management discussions.

F-16

A STUDY OF THE DIET OF CAPE FUR SEALS, *ARCTOCEPHALUS PUSILLUS PUSILLUS*, IN PLETTENBERG BAY, SOUTH AFRICA

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In response to public interest and claims of competition from local fishermen the diet of the Cape fur seal, *Arctocephalus pusillus pusillus*, in Plettenberg Bay was investigated between March 2003 and March 2004. The hypotheses tested were (1) the diet of Cape fur seals is varied- the species are opportunistic feeders, (2) the diet shows seasonal variation and (3) Cape fur seals in Plettenberg Bay compete with local fisheries, consuming fish of the same species and size class. Hard prey remains from faecal (scat) analysis and opportunistically collected gastrointestinal contents of beached animals were used for dietary analysis. A total of 485 otoliths was recovered representing ten teleost prey species. Seven cephalopod beaks were found, representing two species. The most important prey species in the diet (based on IRI, total mass consumed and percentage frequency of occurrence) was found to be *Sardinops occellatus*. Overall, 62.74% of the total mass of prey consumed was made up by small shoaling pelagic fish (*Sardinops ocellatus, Trachurus trachurus, Engraulis japonicus* and *Etrumeus whiteheadi*). Fisheries in the bay are line-fisheries targeting larger mesopelagic species such as *Merluccius capensis* and *Genypterus capensis*. The species consumed by Cape fur seals were compared to those targeted and caught by the fisheries. No evidence was found to suggest the occurrence of significant biological interactions between Cape fur seals and fishing vessels operating out of Plettenberg Bay, resulting in the rejection of hypothesis three. Variation in the diet composition of Cape fur seals in Plettenberg Bay over a temporal scale is presumably in response to seasonal variation in prey abundance and distribution, suggesting that the seals are opportunistic feeders and that hypotheses one and two are correct.

F-17

DIET OF THE COMMON DOLPHIN (*DELPHINUS DELPHIS*) STRANDED ON THE FRENCH CHANNEL COAST

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The diet of common dolphin, *Delphinus delphis*, was studied based on stomach contents' analysis of 26 animals (14 males, 10 females and 2 unidentified) stranded along the Normandy coasts (French Channel), between 1999 and 2003, during the winter (from January to march). Only 3 stomachs were empty. 7 different fish families were represented : Gadidae, Gobiidae, Scombridae, Carangidae, Clupeidae, Serranidae and Labridae. Gadids were the most important prey item (as well in percentage frequency as in percentage occurrence), mainly consisting of *Trisopterus sp.*. Gobiidae and Scombridae (*Scomber scombrus*) were also present in half of the stomach contents. 27 cephalopods, representing 3 families (Sepiolidae, Loliginidae and Octopodidae), were identified in 7 stomachs. They represent 13,5% of preys contained in the stomachs in which cephalopod beaks were found and only 4% of the total preys identified in all the stomachs. Otoliths of poutings found in stomach contents underline the small lengh of individuals of this species consumed by common dolphins in the Channel. It shows that these preys were captured in their first year, before their sexual maturity. At the same time, in Channel, the overexploitation of fishes' stocks by fishing industry seems to result in a rarefaction of large individuals.

F-18

ONTOGENETIC VARIATION OF d 13C AND d 15N IN A MALE SPERM WHALE TOOTH – A PILOT STUDY

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Incremental growth structures, such as teeth, that are metabolically inert once formed, provide a chronological biochemical archive of an individual's life history. In particular, stable isotope ratios of C and N in dentine collagen can be used to detect changes in foraging habitat and trophic level, respectively, with age. In this study we have attempted to elucidate ontogenetic movements and dietary history in male sperm whale by hypothesising that 1) the segregation of pubertal males to higher latitudes will be reflected in the d13C profile, 2) there will be an increase in d15N as the animal ages and grows, indicative of feeding at a higher trophic level, 3) birth and weaning, will be apparent in the stable isotope profiles. A pilot study was carried out with the tooth of a male stranded in Scotland. The tooth was cut in half and a slice taken off one of the halves. This was then decalcified and cut into consecutive samples, from the pulp cavity to the tooth apex, ensuring a continuous chronological profile. Collagen was extracted and d13C and d15N analysed using continuous-flow isotope ratio mass spectrometry. d13C decreased gradually beyond approximately 12 years of age consistent with an ontogenetic movement to higher latitudes where 13C is relatively depleted. d15N increased with age; concomitant with an animal feeding progressively at a higher trophic level. The marked differences between samples 3 and 4, with d15N increasing and d13C decreasing, are probably related to birth and the onset of suckling; the subsequent reduction in d15N is possibly coincident with weaning. This study confirms the potential of using d13C and d15N in teeth to investigate movements and dietary history of individual sperm whales, with prospects for extrapolating to the entire male fraction of the north Atlantic sperm whale population.

F-19

FOOD AND FEEDING ECOLOGY OF THE COMMON DOLPHIN, *DELPHINUS DELPHIS*, IN THE BAY OF BISCAY: INTRASPECIFIC DIETARY VARIATION AND FOOD TRANSFER MODELLING

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In the past fifteen years, much research has been done to address the subject of trophic interactions between marine mammals and fish stocks. Thus, trophic models have been developed by combining dietary information, energy budget and population models. Although the diet varies intraspecifically according to years and seasons, as well as sex and age, dietary variations are generally not taken into account in most models available in the literature. This work aims at investigating changes in dietary composition between seasons, years, sex and maturity stages of the common dolphin (*Delphinus delphis*) in the Bay of Biscay (France) and at assessing their impact on the outputs of trophic models. 76 stomach contents of common dolphins stranded along the French coast between 1999 and 2002 were analysed. Only four taxa contributed the bulk of the stomach contents in more than 50% of the individuals: anchovy (16.9 %N; 11.7 %M), sardine (6.7 %N; 35.6 %M), horse-mackerel (15.5 %N; 18.3 %M) and *Trisopterus spp* (10.4 %N; 3.7 %M). The diet composition displayed strong interannual and seasonal variation in prey importance and prey size. This temporal variation in diet composition could be an image of prey availability in the area. When dietary variations observed among years, seasons or demographic segments of the population are considered, the outputs of individual annual or life-time food intake models lead to conclusions that differed from that obtained by using the models with a generalised diet. The use of a constant dietary composition in this area does not reflect adequately the reality, and at least one factor among these temporal and demographic factors examined must be taken into account. For instance, in models of individual food consumption, season is of first importance whereas sex and maturity are essential to consider in models of contaminant intake.

F-20

FISHING TRAWLERS AND FEEDING DOLPHINS IN HONG KONG.

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Several species of delphinids have been recorded feeding behind fishing trawlers. It has been suggested that the dolphins are either exploiting a concentration of prey in an otherwise depauperate area or may simply have become accustomed to this perceived 'fast food' source. Also, some studies show that only certain individuals of a dolphin population actually follow trawlers. In Hong Kong, an 11 year photo-identification study of the local population of Indo-Pacific humpback dolphins (*Sousa chinensis*) indicates that the majority of the population feed behind certain types of fishing trawlers. This common behaviour, however, dramatically decreased when a closed fishing season was introduced. During the year following this initiative, dolphins were no longer commonly observed behind fishing trawlers, even outside the closed season, and, instead, feeding behaviour occurred mainly in nearshore, rocky reef habitat. This is believed to be the first reported incidence of a fisheries management strategy that has directly affected the feeding behaviour of a cetacean population. This observation also implies that, in Hong Kong, the dolphins were feeding behind trawlers as insufficient prey was available otherwise.

F-21

THE FORAGING NICHES OF TWO SPECIES OF SMALL DELPHINIDS IN THE OCEANIC TOP PREDATOR COMMUNITY OFF THE BAY OF

BISCAY

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The northeast Atlantic community of oceanic top predators is composed of species with contrasted status regarding fisheries: swordfish, *Xiphias gladius* and albacore, *Thunnus alalunga*, are target species; blue shark, *Prionace glauca*, is a secondary catch, and dolphins, *Delphinus delphis* and *Stenella coeruleoalba*, are protected species. The proper management of such a composite set of species requires the understanding of the structure of this community. Here, we compare the dolphin foraging niches to the other top predators' ones from stomach content analyses. The foraging niche breadth (Shannon indexes) in the "prey composition" and "prey length" dimensions were respectively of 3.3 and 5.6 for swordfish, 2.2 and 4.0 for albacores, 2.4 and 4.6 for sharks, 3.5 and 5.0 for common dolphins, and 3.9 and 4.9 for striped dolphins. From published data on prey biology and from prey digestion conditions in the stomach contents, the foraging niche breadth in the "depth" and "time of day" dimensions were found to be large for blue sharks and swordfish, which would forage at day in the mesopelagic layer and at night in the epipelagic layer; and restrained in dolphins and albacore, which would forage mainly in the epipelagic layer at night. Overlaps (Morisita indexes) in prey taxa between the two dolphins (ODD/SC=0.7) and overlaps in prey size classes between the two dolphins (ODD/SC=0.9) and between dolphins and albacores (ODD/TA=0.7; OSC/TA=0.6) were significant. Overlaps in foraging time and depth were significant between dolphins and albacores, and between swordfish and blue sharks. Hence, the two dolphins have large niche breadth in the "prey composition" and "prey length" dimensions, but small ones in the "depth" and "time" dimensions; they are fairly similar to one another in terms of foraging niches, but are well segregated from the other species, and can therefore be considered as a guild within the community.

F-22

FORAGING EFFICIENCY OF GREY SEALS IN RELATION TO VARIABLE PREY AVAILABILITY – AN EXPERIMENTAL APPROACH

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Theoretical models predict that in the face of varying prey availability seals should forage in such a way as to maximize their rate of energy utilization. Using a unique experimental set-up, we examined the balance of costs (energy expended) and benefits (food gained) during simulated foraging in relation to varying patch quality and patch distance from the surface. At the level of a foraging bout, 'giving up' when a low prey density patch is encountered on a dive improves the net rate of energy gain, compared to that achieved if seals stay at a patch until oxygen stores are depleted regardless of the prey density. This is accordance with Thompson and Fedak's 2001 model. However contrary to expectations we also found that despite increased travel time with increasing patch distance, foraging efficiency (in terms of energy gained/energy used) and rate of net gain (energy gained-energy used/time) remained constant regardless of whether seals were traveling to 40m, 80m or120m to feed. This is principally due to a reduction in metabolic rate while seals are diving further from the surface (a result of fewer, longer dives for the same energetic gain). We conclude that, in our captive setting at least, seals make behavioural and physiological adjustments in order to maximize the efficiency of their foraging.

F-23

CONSIDERATION OF SAMPLING SOURCES FOR CETACEAN DIET ANALYSIS: THE COMMON DOLPHIN, *DELPHINUS DELPHIS*, IN THE NORTHEAST ATLANTIC.

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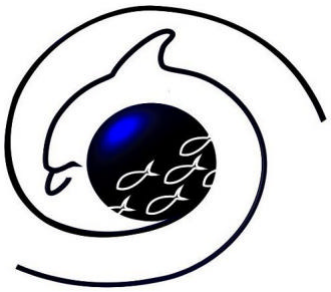
Dietary data are central to quantifying cetaceans-fisheries interactions, pollutants transfer or trophic relationships. Stomach contents analysis is widely use to determine the diet of marine predators. However, sampling is often opportunist in cetaceans, relying on stranded animals. Here we investigate how the diet of common dolphin differs according to the cause of death. We analysed the diet of common dolphin in relative mass (%M) from animals collected in contrasted stranding conditions: single stranding from 1996-2002 (n=71), a multiple stranding event of by-caught animals in 2002 (n=16) and a mass stranding in 2002 (n=49). Confidence intervals (CI) were calculated by bootstrap simulations. In chronic stranding, the diet of common dolphin is composed of small pelagic fish: scads (18%M, CI=18-57), anchovy (12%M, CI=6-16), sardine (36%M, CI=15-38). In by-caught animals, the diet was mostly scads (61%M, CI=24-89). In the mass stranding, the diet was composed of sardine (65%M, CI=56-74) and squid (29%M, CI=19-39). Factor analyses show that there is a strong variability amongst individuals from single stranding, whereas individuals from either multiple standings or from mass stranding show a very low intra-group variability. The composition of the diet of dolphins found during particular events such as by-catch related multiple stranding or mass stranding is mostly made of only one or two species only. This can be

interpreted as the expression of instantaneous distributions of both dolphin and prey. Observed prey composition depends on the circumstances of the death in each sample set. Thus, results obtained from a single source of individuals should be used with caution because of their temporal limitation and should not be integrated in modelling work because of their limited representativity. Stomach contents obtained from chronic stranding, because they encompass a much broader variety of causes of mortality, are likely to provide a better view of dolphin food composition.



GENETICS/EVOLUTION

GE-01

MULTIPLEXING OF MICROSATELLITES IN *STENELLA COERULEOALBA* FOR QUICK IDENTIFICATION AND CHARACTERIZATION OF INDIVIDUALS AND POPULATIONS

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The western Mediterranean and the north eastern Atlantic populations of *Stenella coeruleoalba* have been shown to be quite distinct regarding maternal lineages (restriction polymorphism of mitochondrial DNA), with a very limited gene flow across the Strait of Gibraltar. In order to investigate autosomal genetic patterns of diversity among those populations and their genetic differenciation, we tested and optimized the amplification of 6 microsatellite loci in *S. coeruleoalba*. These loci had been isolated in *Tursiops* for 2 dinucleotide repeats, and in *Megaptera* for the 3 tetranucleotide repeats and one dinucleotide repeat (divergence time > 30 My). The 3 dinucleotide loci had been already amplified in *Stenella*, but not yet the tetranucleotide loci. Cross-amplifications were successful for all except one! tetranucleotide repeat, denoting a conservation of the flanking sequence. In order to allow quick and efficient genotyping and assignment of individuals, we developped 2 multiplex sets of 3 and 2 markers each. We genotyped dolphins stranded along the Mediterranean (n=43) and Atlantic European coasts. Moreover, a geographically distant population, from Alaskan coasts (n=14), was added to allow a better investigation of gene flow. Population genetic studies revealed that these loci displayed high polymorphism with a high number of alleles. Moreover, one locus newly amplified in *Stenella* revealed a strong size difference of the PCR products (~100 bp) in comparison with Mysticetes. Combined with the study of other markers, this study may provide a wide genetic comparison between both basins.

GE-02

PATTERNS OF POPULATION STRUCTURE OF RISSO'S DOLPHIN (*GRAMPUS GRISEUS*)

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In this study we investigate the patterns of Risso's dolphin (*Grampus griseus*) population subdivision, the genetic variability and the kin structure in the Mediterranean Sea, and compare the assessed level of genetic differentiation between Mediterranean and Eastern North Atlantic. Analysis of the Risso's dolphin samples (n=50) collected in the Mediterranean and the ENA showed that the two populations were significantly differentiated (FST=0.0296). All loci were polymorphic (up to17 alleles), and mean Ho was 0.467 in the Mediterranean, 0.548 in the ENA. Analysis of 619 bp of sequence of the mtDNA control region revealed 28 variable sites defining 16 unique haplotypes among the two populations. The degree of differentiation was highly significant for both FST (0.260) and ϕST (0.542). The kin structure of the Risso's dolphins in the Ligurian population (Italy) showed that females had a considerably higher relatedness within groups than among groups. Data suggest a relatively fluid model of kin structure with a trend for female philopatry, and male dispersal.

GE-03

STENURUS MINOR: INTRASPECIFIC VARIATION IN NEMATODES FROM THE TYMPANIC BULLAE OF HARBOUR PORPOISES

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Porpoises from German waters show infections with different species of nematodes belonging to the

Pseudaliidae, one of them being *Stenurus minor*, parasitizing in the tympanic bullae and head sinus. To establish methods to characterise these nematode species, ribosomal DNA (rDNA) is a useful tool. The species-specific Internal Transcribed Spacer (ITS) regions are known to be variable regions and have been used to investigate the relationship among a variety of species including nematodes. Differences in the ITS-1 region of S. minor can provide information about intraspecific variation in this species and might also give insight on population genetics of these nematodes. Samples originated from porpoises collected along the North Sea and Baltic coasts of Schleswig-Holstein. Parasites were collected during necropsies, preserved in 70% Ethanol or frozen at –20°C and determined under the microscope. Genomic DNA from individual adult nematodes was isolated using a QIAamp Tissue Kit (Qiagen) according to the manufacturers protocol. Ribosomal ITS-1 was amplified by PCR using primers designed from the adjacent conserved 18S and 5.8S regions of *Caenorhabditis elegans*. Amplified PCR products were sequenced and compared using sequence-analyzing software (DNAstar). The ITS-1 region of S. minor is about 300 basepairs long and first results show several of the investigated nematodes coming from North Sea porpoises having a characteristic insert consisting of six nucleotides in their ITS-1. Individuals originating from one host showed the same characteristic. This indicates that porpoises from different regions host more distantly related parasite populations. Further investigations should determine if individual hosts usually harbour only one parasite population and how this relates to the life-cycle of the nematode.

GE-04

SOCIAL STRUCTURE AND RELATEDNESS IN THE ATLANTIC WHITE-SIDED DOLPHIN (*LAGENORHYNCHUS ACUTUS* GRAY, 1828)

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Atlantic white-sided dolphins form groups varying in size from few to hundreds of individuals. Although information from stranding records indicate that juveniles between three and six years of age are rarely found in groups of stranded adults, suggesting age and possibly sex segregation, very little is known about the social organisation or mating strategies in this species. In this study genetic markers (five microsatellite loci previously isolated from common dolphins, *Delphinus delphis*) were used to investigate the social structure of a group of 16 white-sided dolphins that live-stranded on the North-West coast of Ireland. The group consisted of adult males (n=7), adult females (n=5) and four juveniles (1-2 years old). Standard genetic analyses were carried out using Genepop 3.4. Parentage analysis of juveniles and relatedness estimates among all individuals were carried out using Cervus 2.0 and Relatedness 5.0 respectively. No serious deviations from Hardy-Weinberg expected proportions and linkage between loci were detected. Despite the relatively low number of loci tested, all adult males present in the mass stranding were excluded as parents of any of the four juveniles. In contrast, four adult females were identified as putative mothers of each of the juveniles, confirming that individuals between one and two years of age stay with their natal group. Average relatedness values appeared to be higher between adult males (r=0.107) than between adult females (r=0.036) in the group. In addition, some of the adult males and females showed a degree of relatedness. Genetic analysis of this mass stranding suggests that Atlantic white-sided dolphins tend to form strong cohesive groups of related individuals. Parentage analysis suggests two possible mating strategies: groups of adult males remain very briefly with the group in which they mate or adult males and females form stable groups but mate outside their group.

GE-05

POPULATION GENETICS AND SOCIAL ORGANIZATION OF THE SPERM WHALE IN THE AZOREAN ARCHIPELAGO

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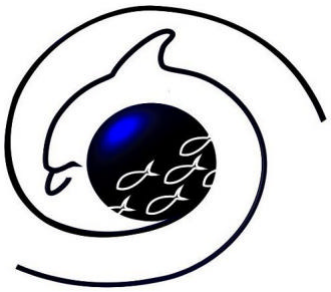
On a global scale, sperm whale (*Physeter macrocephalus*) populations show limited mitochondrial and no nuclear genetic differentiation between ocean basins. At the intra-oceanic scale, genetic variation seems to depend more on social organization than on geography. We investigated population structure and social organization of the sperm whale in the Azorean waters using microsatellite genotyping techniques. Analyses were based on 122 biopsy and sloughed skin samples that were collected in the Azorean waters in 2002 and 2003. Sloughed skin samples were easy to collect but could not be allocated to a given individual and were prone to replication. At the population level, microsatellite analyses failed to detect any population structure between the three groups of islands of the archipelago and also between animals sampled in different years. These results suggest that the individuals migrating through the archipelago belong to a single population. Photo-identification data confirm that some individuals come back to the Azores repeatedly throughout the years without demonstrating fine-scale site fidelity. At the individual level, only one significant parent-offspring pair was identified in the data set. A high degree of genetic relatedness was found within primary social units (individuals spotted in close proximity). Secondary associations of primary social units (individuals observed in the same area on the same day) were also made up of related animals. These results confirm that

female-offspring groups travelling together tend to be genetically related. They also emphasize the need for combining photo-identification surveys and genetic analyses to assess the impact of social organization on cetacean population structure.



LIFE HISTORY

LH-01

THE LIFE HISTORY OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) FROM SCOTTISH WATERS

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Biological and reproductive parameters were determined for harbour porpoises stranded around the Scottish coastline between 1992 and 2004. Female harbour porpoises had greater maximum total body length (173 cm) compared to males (170cm). Ages were determined for 132 females and 138 males and ranged from less than one year to 20 years for both sexes. Approximately one-third of the stranded harbour porpoises, with ages available, were less than two years old and only 4% were over 12 years old. Reproductive status was determined for 150 females and 112 males. Female harbour porpoises attained sexual maturity between two and five years of age while the majority of males reached sexual maturity between three and four years. Harbour porpoises in Scottish waters have a distinct synchronised reproductive season. The estimated peak conception period is between June and July. Active males were found between April and July, with peak testes weights in July. Gestation lasts 11 to 12 months with the majority of births occurring in June and July. Lactation appears to last 9 to 10 months with weaning taking place in March/April. The size at birth of harbour porpoise in Scottish waters is generally between 70-80 cm and 4.5-11.8 kg. The presence of two pregnant and lactating females suggests that female harbour porpoises in Scottish waters can give birth annually, however it is more likely that the majority of females give birth every two to three years. There was no evidence of senescence in female harbour porpoises from Scottish waters. The relatively large size of the male testes, up to 6.75% of the total body weight in active males, suggests that sperm competition plays a major role in the mating system of harbour porpoises.

LH-02

COMPARISON OF TWO DIFFERENT HISTOLOGICAL TECHNIQUES FOR AGE DETERMINATION IN THE TEETH OF ODONTOCETES

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The ability to estimate the age of individuals is an important tool in the study of life history and population biology. Different methods are currently used for determining the age in marine mammals. In most methods, age determination is based on counting the growth layer groups (GLGs; sensu Perrin & Myrick, 1980) present in hard tissues as recording structures throughout an animal's life, (Klevezal & Kleinenberg, 1967; Lockyer, 1995c; Hohn, 2002). Decalcified and stained longitudinal thin sections of teeth have been recognized as the most accepted preparation for ageing of small dolphins and porpoises (Lockyer, 2004). In our study two tooth-preparation histology techniques, commonly reported in the literature were used, the paraffin and cryostat technique. Teeth from 67 stranded animals, representing seven species in two geographical locations in the North Atlantic, were prepared using these two techniques and the resulting counts of growth layer groups (GLGs) were compared. Within the paraffin technique the teeth were sectioned at 8µm thick whereas within the cryostat technique three different thicknesses were used (8µm, 16µm, 24µm). In both techniques four different staining methods were tested. In longitudinal sections 8µm thick stained with Mayer's haematoxylin for which 80% of sections were good quality, there was a very high correlation between estimated age (GLGs) using the two techniques ($r=0.970$). Paired t-tests showed that there was no difference in the estimated age ($t=-0.51$, $p=0.610$). However, a Linear regression model analysis showed, some significant differences related to staining method and section thickness within techniques.

LH-03

USE OF MICROSATELLITE DNA MARKERS FOR THE STUDY OF THE REPRODUCTIVE SUCCESS

IN THE NEW ZEALAND FUR SEAL, *ARCTOCEPHALUS FORSTERI*

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Polygyny is the most common mating system employed by mammalian species (95%). However, our understanding of polygynous systems is still poor. In pinnipeds, social structures are essentially observed during breeding period where a large number of animals aggregates and interacts each other. Like nearly all the pinnipeds, the New Zealand fur seals mainly reproduce out of water (births and most copulations) and have an apparently polygynous mating system. Pinnipeds have traditionally been used as models to try to improve the understanding of such mating systems. The stability and increasing abundance of New Zealand fur seal populations gives us the opportunity to use it as an ideal pinniped model for mating system research. Several authors showed that observed mating success was correlated to the male reproductive success in some species (elephant-seals). However studies in other species, notably seals, have shown discrepancies between behavioural data and measurements of reproductive success in polygynous males. In these cases, the observed breeding success differed from the number of genetically assigned paternities. To investigate such discrepancies we focused on 1 main objective: use of genetic markers to confirm maternity, determine paternity and then examine the reproductive success of focal males for which behavioural data are available. The results of this main objective will help to better understand the complex mechanisms underlying the diversification and the maintenance of male reproductive strategies under a strong sexual pressure (competition).

LH-04

AN ABORTED FIN WHALE FOETUS FOUND IN THE LIGURIAN WATERS, ITALY

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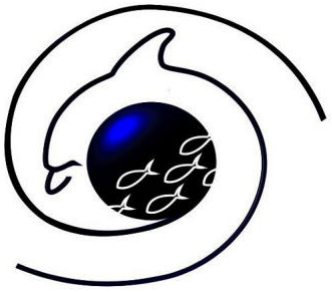
The authors report on a case of an aborted fin whale (*Balaenoptera physalus*) foetus found floating in the Ligurian Sea (western Mediterranean basin), 15 miles off Imperia, on July 21, 2004. In the same area, two days before, a female fin whale (about 15 metres long) has been found dead, with a clear prolapse of the uterus. The carcass was then resighted close to the shore on the same day of the foetus finding and it was hauled to the open sea. While towing offshore the adult specimen, the vessel encountered the floating foetus and transported it to the harbour of Imperia, where it was partially sampled and then frozen at the local *Istituto Zooprofilattico*. The aborted foetus, a female 2.7 metres long, had a weight of 120 kilograms and was found still wrapped up in the placenta. It was partially decomposed, while the placenta seemed to be better preserved. Measurements and necropsy were undertaken at the Natural History Museum of Milan. A detailed description of the recorded data is reported. The complete skeleton was preserved. By using the foetal growth formula based on the body weight as reported in literature, the foetus could be 6 months old. Some histological analyses were performed. Considering that *Neospora caninum* and *Toxoplasma gondii* are recognised causes of abortion in mammals, a PCR for their research was carried out. Both PCR were negative. Moreover a PCR was carried out to detect the presence of *Brucella spp*. A skin sample of the adult was also collected and parental relatedness between the adult female and the foetus is under investigation using 8 micro-satellite markers. This is the first fin whale foetus reported for the Italian waters. Italian strandings data on the species are analysed and comments on the reproduction in the area are also given.



MEDICINE / DISEASE

MD-01

PLASTIC GILLNET INGESTION IN A FEMALE BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) STRANDED ALONG THE ADRIATIC SEACOAST: A CASE REPORT

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On winter 2002, a female Bottlenose dolphin *(Tursiops truncatus)*, stranded along the Italian Adriatic Seacoast. It was pregnant and the fetus was in advanced state of development. The dolphin's condition was good; it had no wounds or particular damages over all flippers, except some abrasions on rostrum. During the carcass investigation some tissues were sampled and recovered for further analysis. All the stomach chambers were carefully emptied. Nothing particular was found, except in the main-stomach, where an ingested huge quantity in net and some cephalopod beaks were discovered. This gillnet mass was completely covered by a black liquid, maybe due to ink hold in cephalopod bodies. According to animal status, two are main hypothesis to explain death and following stranding: in the first case dolphin ate the net during its last feeding phase, in the second one it is possible that female remained entangled and started to ingest the net while trying to find a way out. According to the mass volume in the main stomach, it would be not possible dolphin would be able to have a longer lifetime; the mass, in fact, was really big, too much for normal defecation. According to literature and same stranding cases, plastic debris needs almost 1 or 2 years to dissolve.

MD-02

NOVEL "GAS EMBOLIC SYNDROME" IN BEAKED WHALES RESEMBLING DECOMPRESSION SICKNESS (DCS)

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Lesions consistent with in vivo bubble formation in beaked whales have been recently described in Nature by Fernández *et al*., and Jepson *et al.* A Decompression Like Syndrome has been postulated to happen in whales in response to sonar exposure and might result from behavioural changes to normal dive profiles, causing excessive nitrogen super-saturation in the tissues (as occurs in decompression sickness); alternatively, bubble formation might result from a physical effect of sonar on in vivo bubble presursors (gas nuclei) in nitrogen supersaturated tissues. As Gas Embolism "in vivo" is difficult to determine some time after death, fresh cases are certainly needed for this aim. One adult female and one old male Blainville´s beaked whales (*Mesoplodon densirostris*) stranded on the coasts of Gran Canaria and Tenerife in 2003 and 2004 respectively. Both animals were necropsied around 4 to 8 hours after died. A routine necropsy for whales was carried out by pathologist. A routine histological study was also performed in all the sampled organs, as well as a microbiological study. Possible relationship with sonar exposure is, up to date, not known. Both animals showed massive gas bubbles in the portomesenteric system, involving changes in the liver. Gas bubbles were seen macro and microscopically in the venous system, including portomesenteric system, liver, lung, kidney, heart and brain. Although test of nitrogen content of the gas is now underway, the pathological picture is consistent with a severe acute systemic gas embolism in DCS in humans. No bacterial pathogens were found. The present results restate the occurrence of "systemic gas embolism" in beaked whales, a new pathology entity to be described in cetaceans, with special attention to deep, long time diving species. Triggering causes of this "embolic syndrome" should be further investigated.

MD-03

NEONATAL MORTALITY IN NEW ZEALAND SEA LION PUPS BORN ON THE AUCKLAND ISLANDS, 1998-2004

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A six-year continuous survey of New Zealand sea lion (*Phocarctos hookeri*) pup mortality on Enderby Island has been conducted. Following an epidemic in 1998 that killed 50% of the pups born that year, a monitoring programme was established to determine causes of mortality from year to year in this threatened species. During the austral summers 1998 to 2004, over five hundred autopsies have been performed on pups found dead over the first two months post partum. In non-epidemic years, mean mortality at 6 weeks is 6.2%. The diagnoses have been broadly categorised as stillbirths (3%), trauma (35%), starvation/malnutrition (12%), bacterial infections (27%), and hookworm enteritis (15%). Two distinct and successive peaks of mortality due to trauma are identified. The first is associated with trampling by fighting bulls within the harem; the second peak mainly involves thoracic and abdominal trauma in older pups molested by sub-adult males. The survey revealed that during two summers, 2001/2002 and 2002/2003, the mortality doubled due to epidemics caused by the bacterium *Klebsiella pneumoniae*. The incidence of hookworm enteritis as a primary cause of death suggests that hookworms begin to kill pups about two weeks after the birth peak and persist as a cause of mortality for up to three weeks.

MD-04

CYTOKINE mRNA EXPRESSION IN WHOLE BLOOD OF HARBOUR PORPOISES: INDICATOR OF INFLAMMATORY DISEASES?

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Previous studies have described high levels of immunosuppressive pollutants associated with poor body condition of the harbour porpoise *Phocoena phocoena*. However, little is known about the specific immune functions of this species. Pro- and anti-inflammatory cytokines as mediators of the immune system play a key role in inflammation, acute phase response and disease progression of pathological processes. The expression of the house keeping gene glyceraldehyde-3-phosphate (GAPDH), pro-inflammatory cytokines, such as interleukin-(IL)1-ß, IL-2, IL-6 and anti-inflammatory cytokines, such as transforming growth factor (TGF)-ß and the chemokine IL-8 was investigated in whole blood samples of 31 harbour porpoises (2 captive, 10 by-catch, 5 stranded with evidence of net entanglements (by-catch), 1 life stranded, 13 stranded) from the North Sea and Icelandic coasts using reverse-transcription polymerase chain reaction (RT-PCR). Primers were selected from published cDNA sequences of other cetaceans and dogs. These blood samples contained RNA of a quality high enough to amplify GAPDH mRNA, independently of the mode of collect. Pro-inflammatory cytokines (IL-1, IL-2 and IL-6) were successfully detected in 20, 20 and 23 harbour porpoises respectively. The anti-inflammatory cytokine TGF-ß and IL-8 were detected in 10 and 20 individuals respectively. All individuals positive for IL-1 were also positive for IL-2. IL-1 and IL-2 were also expressed 93% of by-catch individuals but only in 43% of the stranded porpoises while other cytokine expression remained similar between these two groups. TGF-ß was more often expressed in emaciated porpoises (55%) compared to non-emaciated porpoises (20%). To conclude, this study revealed successful detection of cytokine mRNA even in the blood of stranded porpoises. The weaker expression of (IL)-1-ß and IL-2 mRNA in the blood of stranded porpoises could be either linked to a preferential autolysis or lack of expression in diseased animals. Further investigations are obviously needed on both a larger sampling and cellular models.

MD-05

INCRASING INCIDENCE OF STRANDED HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) KILLED BY BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN ENGLAND AND WALES – A BIO-INDICATOR OF HABITAT DEGRADATION?

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Between January 1991 and December 2004, 1230 cetaceans found stranded around the coastline of England and Wales were examined at post-mortem using standardised methodology as part of a project initiated by the UK government in 1990. Of these, 79 harbour porpoises (*Phocoena phocoena*) were diagnosed to have died as a result of violent interactions with bottlenose dolphins (*Tursiops truncatus*). The 79 cases (46 males and 33 females) were comprised of 25 adults, 54 juveniles and no neonates. Typical findings on post mortem included extensive bruising and haemorrhage in the subcutis and underlying muscles, multiple haemorrhagic tears (often cavitating) of the internal blubber layer, multiple rib fractures (usually bilateral) and other evidence of extreme physical trauma. A number of the porpoises (n=30) were also found to have rakemarks that were characteristic of bottlenose dolphins. Most of the animals were in good nutritional condition (n=65) and exhibited evidence of having recently fed (n=46). Nearly all the cases (n=74) were found within the Cardigan Bay area, although five were recently found stranded in the south west of England. From 1999 to 2004, the number of cases diagnosed increased annually, and is now the most common cause of death in Welsh stranded harbour porpoises (56% in 2004). This rise was paralleled by a decline in the number of Welsh stranded harbour porpoises diagnosed as being bycaught, from a peak of 55% in 1995 to a figure of 8% in 2004. The increasing incidence and the predominance of healthy, recently feeding, post-weaned porpoises killed by bottlenose dolphins in west Wales, suggests that these interactions could be the result of increasing resource competition between the two species.

MD-06

MICROFLORA OF THE UPPER RESPIRATORY TRACT OF WHITE WHALE (*DELPHINAPTERUS LEUCAS*)

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Our study is concerned with the species and quantitative composition of microbial associations of the upper respiratory tract of captive belugas and its dependence on the clinical condition of the animals. In the course of our study we investigated the biological properties of isolated microorganisms. Also we investigated their pathogen factors. Our study was performed at the Department of Microbiology of MSAVM&B named after K.I.Skryabin. We examined 12 animals of different age and sex at various stages of adaptation to captivity in August 2003.

From the upper airways of all the examined belugas, microorganisms belonging to various species were isolated. The species and quantitative composition of microbial association of the upper airways differed in different individuals of the group, depending on their clinical condition. From animals with hematological indices within the physiological norm, no more than 6 species of microorganisms were isolated. All of this microorganisms were non-virulent to mouse and having no hemolytic properties predominating. Bacteria isolated from the belugas with deviations from the physiological norm of hematological indices were highly diverse, hemolytic *E. coli*, *Streptococcus*, *Staphylococcus* predominating. Those bacteria were virulent to mice and had hemolytic properties.

MD-07

NEW BEAKED WHALE MASS STRANDING IN CANARY ISLANDS ASSOCIATED WITH NAVAL MILITARY EXERCISES (MAJESTIC EAGLE 2004)

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Four Cuvier´s beaked whales (*Ziphius cavirostris*) stranded on the Lanzarote and Fuerteventura islands. The first animal was found the 21th of July and the last one the 26th. The previous week (11th-16th July), an international naval exercise (including 10 countries) took place between the Canaries and Morocco waters. Up to now, no specific official information about naval acoustic activities has been obtained by our University. Necropsies were performed in 3 out of 4 stranded whales. The advanced autolytic conditions of the last animal did not allow us to take samples for histology. Tissue samples were processed for histology and for detecting fat embolism. The preliminary pathological results may conclude: 1) a new atypical beaked whale mass stranding temporally and spatially associated with an international naval exercise ("Majestic Eagle-2004"); 2) the three necropsied whales showed very similar macroscopical (including full stomachs with non-digested food) and histological findings to those observed in beaked whales stranded during or after the "Neotapon-2002" naval exercises; 3) gas embolism was not possible to demonstrate due to postmortem autolysis, but all three whales showed a systemic fat embolism as it was also detected in fresh and autolytic stranded beaked whales associated with "Neotapon-2002" naval exercises.

MD-08

NEW GAS AND FAT EMBOLIC PATHOLOGY IN BEAKED WHALES STRANDED IN THE CANARY ISLANDS

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Recently, evidence of acute and chronic gas bubble lesions in tissues of different stranded cetacean species. Acute gas and fat embolic lesions have also been described in a mass stranding of beaked whales exposed to anthropogenic sonar signals (Neotapón, 2002). These findings raise some important pathological questions: 1) What is the postmortem interval and necropsy technique necessary to diagnose acute gas emboli? 2) Are fat emboly common pathological findings in stranded cetaceans? (3) Do fat emboly develop at sea (*i.e.* prior to stranding) or during the stranding process? Recent strandings in the Canary Islands provide valuable data to help address these questions. Firstly, two fresh stranded Blainville's beaked whales (*M. densirostris*), one young adult female (stranded, 2003) and an old male (stranded, 2004) necropsied between 4 and 8 hours after death had massive, acute gas-bubbles within the porto-mesenteric system. Intravenous gas bubbles were found in other organs (*e.g.* in the epicardial veins and meninges). Secondly, 18 out of 115 stranded cetaceans of six different species showed diverse grades of lung fat embolism. Most of the cetaceans with fat emboli in lung tissue belonged to deep and long duration diving species. The majority died due to anthropogenic causes like severe trauma caused by ship collision, or were associated with naval exercises and sonar activities. In some cases the cause of death could not be determined. Finally, four beaked whales arrived around the Canary Islands coasts approximately one week after the Majestic Eagle naval exercises conducted more than 100 km north of the Canaries in July 2004. The probability that the animals died at the sea is extremely high. All three beaked whales showed fat embolism (the fourth was not able to be analyzed due to extreme autolysis). Although mid frequency sonar was certainly used during the naval exercises, the use of other possible acoustic sources (*e.g.* explosions, torpedos, etc…) is currently unknown.

MD-09

CYTOKINE EXPRESSION IN BLOOD SAMPLES OF HARBOUR PORPOISES: T-HELPER-(TH)-CELL CYTKOINES AS MARKERS OF THE HEALTH STATUS?

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Cytokines as mediators of the immune response have been described as indicators of infections. To study cytokine

expression and to detect changes during infection, blood samples of an adult female and male harbour porpoise living in the Fjord & Baelt center in Kerteminde (DK) were investigated. EDTA-blood samples taken in July, September, and December 2003 and in February, March, and May 2004 were investigated. Both animals developed health problems during this period and were occasionally treated with antibiotics. Expression of Interleukin-(IL)-1β, IL-2, -4, -6, -8, -10, tumour necrosis factor-(TNF)-α, transforming growth factor-(TGF)-β and of the acute phase proteins Haptoglobin and C-reactive Protein were analysed using real time RT-PCR. The female harbour porpoise showed highest cytokine and Haptoglobin mRNA levels in February and May, whereas the male showed highest values in March, which paralleled an increase in white blood cells. IL-6, an early marker of inflammation, increased in July blood samples of both animals and in the September and February samples of the male. Expressions of the pro-inflammatory cytokines IL-1β, IL-8, and TNFα, the Th1-cytokine IL-2 as well as of IL-10 were correlated to one another ($p<0.05$). Furthermore, expressions of these cytokines also correlated between subjects ($p<0.05$). Both animals showed an increase of the pro-inflammatory cytokines, the Th1-cytokine IL-2 as well as of IL-10 in December, March, and May. Furthermore, an obvious increase of Th2 and Th3 cytokines IL-4 and TGFβ in September and February was observed. These findings point at inflammatory incidences and appropriate immune responses in December, March, and May, respectively. In September and February a controlling of excessive immune response or impairment of immune system existed. These findings indicate that the proportions of Th1 to Th2 and Th3 cytokines seem to be helpful in analyzing the function of the immune response and thus the health status of marine mammals.

MD-10

INTRACYTOPLASMIC EOSINOPHILIC GLOBULES IN HEPATOCYTES OF STRANDED CETACEANS IN THE CANARY ISLANDS

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The presence in hepatocytes of intracytoplasmic inclusions has been described both in human and in veterinary medicine, being associated to different agents and pathogenic mechanisms. In cetaceans, the presence of this type of globules has been frequently described in animals stranded individual or massively. For the accomplishment of this work, samples of liver, corresponding to 108 cetaceans of 17 different species, stranded in the Canary Islands had been studied. In the cytoplasm of hepatocytes of 58 animals of 12 species, hyalines eosinophilic globules were observed, with a size between 4 and 20 µm. In 49 out of the 58 livers showing those inclusions, histochemical (Pas-diastase) and immunocytochemical (detection of alpha-1-antitrypsine) techniques were perfomed on formaline-fixed, paraffin-embedded sections. The results showed 26 positive livers to both techniques, 22 of which were associated with hepatic congestion, 10 were just PAS diastase positive, 6 only α-1-AT positive and 7 negative to both staining procedures. In the present study, the acute hepatic congestion was observed in 53% of the α-1-AT positive animals. The origin of these intracellular changes is probably related to hemodynamic phenomena suffered by the cetaceans stranded alive, in addition to hyperthermia and/or other factors wich may induce the production and storage of α-1-AT and as other acute phase proteins (under current study) in the hepatocytes.

MD-11

METAL INTAKE WITH FOOD – ELEMENT DISTRIBUTION IN BLOOD OF FREE RANGING SEALS

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Marine mammals are exposed to metals predominately through their position in the food web. The accumulation in tissues is already perceived. Toxicological studies of living animals are rarely causing by limited choice of sample types and quantity. Often sampling is restricted to blood. In our study whole blood levels of 20 elements reflect the actual metal body burden of living seals in the North Sea. Fresh whole blood samples from 26 harbour seals (*Phoca vitulina*) catched at the German and Danish Wadden Sea were analyzed. Samples were collected in special Lithium Heparin monovettes for metal analysis during 6 campaigns 2003 and 2004. Measurements were performed by 3 different analytical methods: 1) Be, Al, Cr, Mn, Co, Ni, Mo, Pd, Ag, Cd, Sn, Pt, and Pb by inductively coupled plasma-mass spectrometry (ICP-MS); 2) Fe, Cu, Zn, As, Se and Au by total-X-ray-fluorescence spectrometry (TXRF); 3) Ti by high resolution sector field ICP-MS. The median concentrations and range values of all elements will be shown. Appropriate amounts and ratio of essential and non-essential trace elements as well as geographical differences were discussed. In addition, the element distribution patterns provide information to the health status of these animals. In combination with the detection of metal-specific hypersensitivities it can be used for a monitoring of metal pollution and their hazardous impact on marine mammals.

MD-12

PARTIAL ALBINISM IN BLACK SEA CETACEANS

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There is no information on occurrence of total albinism in Black Sea cetaceans, and only four cases of partial albinism have been recorded in the mid 20th century in harbour porpoises (*Phocoena phocoena*) near the coasts of Crimea and Caucasus (Tsalkin, 1938; Kleinenberg, 1956). At the same time there was no dependable indication of partial albinism in other Black Sea cetacean species. Quite the contrary, during last eight years (1997-2004) at least nine bottlenose dolphins (*Tursiops truncatus*) and three common dolphins (*Delphinus delphis*), possessing clear signs of partial skin achromia, were registered in the northern Black Sea, whereas no resembling individuals were met among hundreds of sighted, stranded and bycaught harbour porpoises. The skin of albinotic animals were marked by polymorphous snow-white, melanin-free spots which had different size and number, unique shape and various (but always atypical) location including head and back areas, dorsal and pectoral fins, tail trunk and flukes. The maculation did not look like consequence of traumatic injury, inflammation or other skin disease resulted in focal depigmentation. Images of some cetaceans affected with this uncommon natural marking are presented in the preliminary identification catalogue of Black Sea bottlenose and common dolphins.

MD-13

RECRUITMENT AND HABITAT SELECTION OF *CORYNOSOMA STRUMOSUM* (ACANTHO-CEPHALA) IN HARBOUR SEALS, *PHOCA VITULINA*, AFFECTED BY THE 2002 PHOCINE DISTEMPER OUTBREAK IN NETHERLANDS

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We analysed recruitment, population structure and habitat selection of *Corynosoma strumosum* in 44 harbour seals (22 of each sex) stranded on the Dutch coast during the late summer of 2002, when a phocine distemper virus (PDV) outbreak occurred. Most seals were juveniles (males: range of length, 79-143 cm; mean ± SD: 113 ± 19; females: 90-141; 117 ± 15). The small intestine was divided into 6 equal sections; the large intestine was considered as the 7th section. All individuals of *C. strumosum* were sexed and classified as either juveniles or adults; the exact position of each worm was recorded. Apart from an unidentified digenean, only individuals of *C. strumosum* were found (no. infected hosts: 40; mean intensity ± SD: 19.8 ± 28.8; median: 12; range: 1-154; no sex differences in infection levels). Infection values are comparable to those found in seals killed by PDV during 1988 in the same area. The mean percentage of adult worms per host was 96.6 ± 7.0 %, suggesting a low recruitment rate. The number of worms, and the proportion of immature worms, increased weakly but significantly with host weight and, especially, with intestine weight. Similar patterns have also been observed in other species of *Corynosoma* and suggest that host metabolic rate directly influences parasite recruitment. Worms occurred through sections 2-6, although they tended to concentrate in sections 3-5. However, the percentage of adult (gravid) females did not differ significantly among sections. The position of the median of worm distribution did not significantly change with intensity, but niche breadth did. These patterns suggest a high tolerance to diverse intestinal conditions and wide habitat preferences; the expansion of distribution with intensity might simply be related to the number of recruits.

MD-14

FIRST REPORT OF *BRUCELLA SP.* FROM HECTOR'S DOLPHINS (*CEPHALORHYNCHUS HECTORI HECTORI*) IN NEW ZEALAND

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Hector's dolphin (*Cephalorhynchus hectori hectori*) is found only around the South Island of New Zealand and there are as few as 6000 to 7000 animals in three separate populations, off the east, west and south coasts. Maui's dolphin (*C. hectori maui*), is critically endangered with probably less than 100 individuals off the west cost of the North Island. In March 2004 a trial was conducted to evaluate satellite telemetry on Hector's dolphins in the waters surrounding the Banks Peninsula, South Island. This provided the opportunity to assess the health of three captured animals. One adult female was sero-positive for *Brucella abortus* in a cELISA test. This was the first evidence that *Brucella*, a potentially significant pathogen of dolphins, was present in New Zealand marine mammals. An investigation of all stranded Hector's and Maui's dolphins was initiated and since June 2004, post mortem examinations have been conducted on four specimens from the South Island. An adult female with a mascerated foetus, a pregnant female, and two subadult females. The following tissues were collected for culture on selective media for *Brucella sp.*: Mammary gland, spleen, lung, lymph nodes, liver, uterus, and foetus if present. The same tissues were also used for nested *Brucella* PCR for 442bp and 272bp sequences of OMP25. PCR product of the expected size was amplified from all tissues of one

subadult female dolphin. The genetic sequence of the amplified product is being compared to sequences for *Brucella sp*. from terrestrial and marine mammals. Further research is needed to determine the prevalence of this infection in Hector's and Maui's dolphins and to determine whether it is causing reproductive failure. This could have significant consequences for both subspecies but for the critically endangered Maui's dolphin in particular.

MD-15

LUNG FAT EMBOLISM IN CETACEANS STRANDED IN CANARY ISLANDS

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The objective of this study was to evaluate the presence of fat emboli in lung tissues obtained from cetaceans stranded in Canary Islands. Lung samples from 84 cetaceans of 15 different species were studied. The animals stranded in Canary Islands coast from 1995 to 2003. The tissues had been fixed in 10% neutral buffered formalin solution. Tissues samples were first fixed with osmium tetroxide. Lately routine laboratorial techniques for section and staining (hematoxilin-eosin) were made. 14 of 84 cetaceans of six different species, presented diverse lung fat embolism grades characterized by clear drops (H/E), black-stained with OsO4 in the lumen of small and medium size of pulmonary vessels: *Kogia breviceps* (4), *Kogia simus* (1), *Mesoplodon densirostris* (1), *Physeter macrocephalus* (3), *Tursiops truncatus* (1) and *Ziphius cavirostris* (4). All these animals belong to deep and long time diving species (13/14) excepting *Tursiops truncatus*. The cause of stranding and/or death of the 14 positive animals were related to: Antropogenic interactions (ship colision): 5/14; mass strandings: 4/14; unknown or natural causes: 5/14. According to these results, a clear association between lung fat emboly with violent trauma (ship colision) and with deep and long time diving species is observed.

MD-16

THE INVESTIGATION OF THE T/B LYMPHOCYTE SUBPOPULATIONS IN THE BLACK SEA BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) BY USING MONOCLONAL ANTIBODIES (ANALOGUES OF THE ANTI-HUMAN CD2, CD21, CD4) DURING THE ADAPTATION PERIOD TO CAPTIVITY CONDITIONS

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The present study was conducted at the meeting point of two sciences: ecology and immunology. It is well known that the immune system is the physiological mechanism which responds most quickly and finely to any change in the environment. This mechanism has been improving step by step in the process of evolution and most of the present-living organisms possess it. In this connection, the study of the dynamics of immune status indices in humans and animals is a promising approach to the evaluation of the degree of adaptation of an organism to a new habitat. The present study was fulfilled in 2004 at the Utrish Marine Station of the A.N. Severtsov IPEE RAS. Black Sea bottlenose dolphins (*Tursiops truncatus*) were examined. In the course of the study the dolphins were conditionally divided into four groups depending on the time of their stay in captivity. Two dolphins were investigated repeatedly at different stages of adaptation. The studies of T-, T- helpers and B-subpopulations of lymphocytes in the bottlenose dolphins were conducted using dolphin monoclonal antibodies: UCD-F21C (analogue of the human CD2), TR 1-204…33 (analogue of the human CD4), UCD ::F21F.3Sup (analogue of the human CD21) in the reaction of indirect immunofluorescence. We also investigated some haematological indices of peripheral blood for the estimation of the clinic health condition of the dolphins: the rate of the erythrocytes sedimentation (RES), the level of the haemoglobin content, the absolute quantity of erythrocytes (RBC), the absolute quantity of leucocytes (WBC), the absolute quantity of thrombocytes (Plt), and the blood leucocytic formula. Our results show that the B-cell component of immunity is suppressed in bottlenose dolphins at early stages of their adaptation to captivity. It may be indicative of the high level of stress or on the state of B-immunodeficiency in these animals in the beginning of adaptation period. These indices of immune status change to the norm gradually in the course of adaptation. Not less than a year is needed for the complete adaptation of bottlenose dolphins to captivity living.

MD-17

LABAROTORY DIAGNOSTICS OF INFECTIOUS DESEASES OF BLACK SEA BOTTLENOSE DOLPHIS (*TURSIOPS TRUNCATUS*) PROVOKED BY *PSEUDOMONAS AERUGINOSA*

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Captured Cetaceans are exposed to permanent attacks of different pathogens and conditionally pathogenic microbes. The surrounding water, air, foodstuff, personnel and visitors could be the sources of these microorganisms. Diseases provoked by pathogens show themselves thru pneumonia, affections of gastrointestinal tract, skin lesions, septicemia and should be treated depending on the kind of pathogen. Absence of timely, accurate diagnostics may result in the death of the animal. The goal of our investigation was to find out the role of *Pseudomonas aeruginosa* in infectious pathologies of dolphins. Stages of research include the study of microbe association of dolphins with clinical presentations of infectious desease, the study of biological properties of detected

microorganisms and the study of pathogenic factors and sensibility to different antibacterial agents. The research was carried out in 2002-2005 at the Department of Microbiology and Immunology of Moscow Academy of Veterinary Medicine and Biotechnology named after K.I.Skriabin. We investigated materials taken from 11 live animals with symptoms of infectious disease. Investigations were carried out following the standard procedure. Sowing was done in MPA, MPB, BMPA with 5% erythrocyte of sheep, Endo area, Pseudomonas area. Virulence was investigated by infection of white mice. Then hemolytic and toxicogenic properties were studied. Sensibility to different antibacterial agents was investigated by the method of standard disks. In 63,6% of cases *Pseudomonas aeruginosa* was detected. Microorganisms grew into mono-culture or prevailed. They had hemolytic and toxic properties and had virulence for white mice. The research of sensibility of *Pseudomonas aeruginosa* to antibacterial agents resulted in development of the most effective scheme of treatment of the dolphins. This research confirmed that *Pseudomonas aeruginosa* in most cases may be the cause of desease of dolphins. The detailed laboratory diagnostics of microflora of sick dolphins is necessary to work out the most effective treatment.

MD-18

ANALYSIS OF ANTIGENIC DIFFERENCES BETWEEN PHOCINE DISTEMPER VIRUS AND OTHER MORBILLIVIRUSES

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A mass mortality occurred predominantly among harbour seals (*Phoca vitulina*) in the German Blight and neighbouring countries 2002 and was caused by Phocine Distemper Virus (PDV02). Sequencing of the P-Protein of PDV02 displayed a great homology with the PDV strain causing the epidemic in 1988 (PDV88). The present study was carried out to analyse antigenic differences between both PDV strains, field and vaccine strains of canine distemper virus (CDV), and measles virus (MV). Cryostat sections of tissues from diseased seals, dogs and one marten as well as Vero cells on cover plates infected with CVD Onderstepoort, PDV88 and measles virus (Edmonston strain) were investigated using a panel of monoclonal and monospecific polyclonal antibodies raised against various proteins of CDV and PDV, respectively, and the avidin-biotin-peroxidase technique. Three patterns of antibody reactivity were found: a) Genus-specific pattern characterized by reactivity against all morbillivires investigated; b) Species-cross reactivity, which comprises antibodies recognizing epitopes only shared by morbilliviruses of carnivores; c) Reactivity exclusively with one species of morbillivirus was designated species-specific. A discrimination of different morbilliviruses using epitopic mapping is possible. However, PDV02 and PDV88 share common epitopes indicating a close antigenic realtionship and a certain evolutionary stability.

MD-19

PATHOLOGICAL AND EPIZOOTIOLOGICAL STUDIES OF VERMINOUS PNEUMONIA IN BELUGAS (*DELPHINAPTERUS LEUCAS*) FROM THE ST. LAWRENCE ESTUARY, QUEBEC, CANADA

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The objectives of this study are to assess the prevalence of pulmonary parasitic infection by nematodes of the genera *Stenurus sp*. and *Halocercus sp*. (Metastrongyloidae: Pseudaliidae) and to characterize the pathology and epizootiology of this condition in belugas found stranded on the shores of the St. Lawrence Estuary (SLE), Quebec, Canada. A total of 117 beluga carcasses examined between 1983 and 2003 were included in this study. During complete post-mortem examination, 18 sections of lung were systematically sampled and examined by microscopy for the presence of parasitic infection. The estimated intensity of infection was determined for each beluga (number of parasitic aggregates /cm² of pulmonary parenchyma examined). The nature of the inflammatory reaction associated with these parasites was also evaluated. Estimated prevalence of infection in examined beluga was 6.8% and 82.9% for *Stenurus sp*. and *Halocercus sp*., respectively. These parasites were rarely observed in calves (beluga < one year of age), and the estimated intensity of infection was greatest in juvenile animals (between 1 and 6 years of age). Adult *Halocercus sp.* were not often associated with inflammatory reactions; only 23% of the aggregates of *Halocercus sp*. being surrounded by a neutrophilic, pyogranulomatous or granulomatous infiltrate. Adult *Stenurus sp.* induced a neutrophilic or pyogranulomatous inflammatory reaction in approximately 50% of the aggregates. Most of the larvae observed were associated with a marked neutrophilic reaction. A significant negative association was detected between the severity of the parasitic infection (estimated intensity) and the ratio body weight / total length. This suggests that these parasites could potentially have an impact on body condition and therefore the health of infected stranded belugas.

NATURAL HISTORY

NH-01

SUMMARY OF CETACEAN STRANDINGS ALONG THE MEDITERRANEAN ISREALI COAST IN THE PAST DECADE (1993-2004)

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In the scantly surveyed easternmost Mediterranean, stranding information is still the main source for collating a list of inhabitant cetacean species. For abundant (mainly coastal) species, such information also provides biological parameters. Our aims are to update the species list and to shed more light on the poorly known coastal bottle nose dolphin population that inhabits these waters. Data presented herein, relates to cetacean carcasses, beached or floating close to shore, examined by IMMRAC personnel between 1993 and 2004. Obvious by-catch victims were excluded and are reported on separately. Standard measurements and teeth for age determination were taken. Among 94 strandings, 54 were common bottlenose dolphin (*Tursiops truncatus*), 11 striped dolphins (*Stenella coeruleoalba*), 5 rough-toothed dolphins (*Steno bredanensis*), 4 Cuvier's beaked whales (*Ziphius cavirostris*), 2 Risso's dolphins (*Grampus griseus*), 2 common dolphins (*Delphinus delphis*), 2 sperm whales (*Physeter macrocephalus*), 1 false killer whale (*Pseudorca crassidens*) and 1 fin whale (*Balaenoptera Physalus*). Strandings along the coastline do not present a geographic pattern. Among the common bottlenose dolphins, 15 were males, 15 females and 24 of unknown sex. Most beachings (26 animals) occurred during the summer season. A von Bertalanffy model fitted to age-length data places length at physical maturity at 252 cm. The mortality frequency in the 2-5 year age group is higher than expected from natural mortality. The results, taken together with sighting and by-catch data assert that this oligotrophic region supports a surprisingly high diversity of cetacean species, as all regularly occurring Mediterranean species, except the long-finned pilot whale (*Globicephala melas*) and the fin whale seem, at least seasonally, to frequent it. The length of the local mature bottle nose dolphin is lower than that of its conspecific from the Adriatic Sea. Its mortality age-distribution suggests a contribution from unreported by-catch, particularly affecting the 2-5 year age group.

NH-02

SEA MONSTERS AND CETACEANS SLOW EMERGENCE OF SCIENCE AND PERSISTENCE OF IMAGINATION

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In early history, cetaceans were generally represented under favourable lights, although dolphins were more frequently depicted than large whales. "Sea monsters" evolved either from ignorance or from fear in front of cetacean size or aspect. Curiously a shift towards a more negative perception of marine mammals emerged at the time of first oceanic journeys, perhaps when sailors met larger and more diverse cetacean species. Biblical myths and legends prevailed from Middle Age to XVIth century, when monsters and marvels were pictured on marine charts and log books. A science in its infancy, still inheritant of Aristotle (IVth century BC) and Pline the Elder (Ist century BC) gradually adopted a modern classification. If Belon (1551) employed the term "*cétacé*" in *Histoire naturelle des étranges poissons marins*, he still classified cetaceans alongside fishes, crocodile and hippopotamus, in spite of anatomic evidence. The specific status of cetaceans wa however recognized by Rondelet (1555) in *Les Poissons*. The XVIIIth century was another milestone with Buffon and Linné (1758) who proposed a modern classification of marine mammals in *Systema naturae*. Knowledge was progressively strengthened but the scientific imagery was still a problem for marine mammals: picture obtained from strandings were not in harmony with the appearance of living cetaceans at sea. This persisting gap stimulated novels like Moby Dick (Melville, 1851) or *Vingt mille lieues sous les mers* (Verne,1869). Even nowadays, scientific accounts on cetaceans still bear a dose of sentimentalism and anthropomorphism ("friendly" dolphins…) which opposes for example to the commercial whaling. Hence, representations of cetaceans are never exempt of imagination.

NH-03

FURTHER STUDY ON THE USE OF INFRARED-SENSITIVE VIDEO CAMERAS FOR THE CONTINUES MONITORING OF BREEDING CAVE USED BY MONK SEALS

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Monk seal presence in Turkish waters used to be widespread but has suffered a severe decline due to deliberate killing, loss of habitat and diminished prey availability. Although observation sessions and sightings indicated that number of few monk seals are present in the outer part of the Izmir Bay, except a one-month pilot study conducted in 1997, up to present study no continuous monitoring was carried out in the coastal breeding caves determined previously. Therefore, with the present study we aim to monitor the hidden life of the monk seals based on the most used seal breeding cave in which three pups were born between 1999 and 2001 annually. The study was conducted between October 2002 and January 2004, and depended on a TV surveillance system which consisted of 4 TV cameras, 4 infra-red illumination sources, 4 monitors that was placed in the observatory and a video recorder. To illuminate the interior of the selected breeding cave without any disturbance, infra-red illuminators that are invisible to seals' visual perception were selected. The TV images to be generated were observed by means of the monitors in the observatory which is approximately 200 m away from the cave. During the study, out of 5138 hours of recordings 98 hours monk seal images of at least of three individuals were made. However, no breeding was encountered. Though TV surveillance system was operated effectively during test recordings outside the cave, we believe that the severe humidity restrained the recording of sharp images inside the cave. The study was funded by The Scientific and Technical Council of Turkey, Prince Bernhard Fund for Nature, and Netherlands Commission for International Nature Protection.

NH-04

BEACHES, BONES AND BEASTS – SEARCHING FOR STRANDINGS IN NORTH-WEST AFRICA

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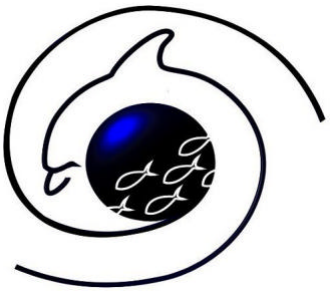
During an overland trip from Germany to the Gambia and back, long stretches of beach in southern Morocco, Mauritania and the Gambia were searched for strandings. Five beaches were sampled on the southbound trip in December 2003 to February 2004. On the northbound journey in February and March 2004 four new beaches were sampled as well as three that had been visited on the way south. Overall, approximately 345 km of beach were sampled by car and between one and five km for each beach investigated on foot. No whole carcasses of cetaceans were seen on the southbound trip, but five were found on the return journey. A harbour porpoise, an unidentified dolphin (*Stenella sp.* or *Delphinus sp*.) and a bottlenose dolphin were found on a 140 km long beach in Mauritania. All three carcasses were relatively fresh and probably washed ashore by strong winds prevailing in the region at that time. By-catch was suspected as a cause of death on the grounds of superficial injuries and proximity to fishing villages. Two harbour porpoises were found on beaches in southern Morocco, both in advanced stages of decomposition. Skeletal remains were found on all beaches sampled. Particularly large quantities were found on relatively short stretches of beach in southern Morocco. Overall, 115 finds of cetacean bones were made, from single bones to near complete skeletons and consisting mainly of vertebrae, ribs, jaws and skulls. Species identification was not possible in most cases, but sizes ranged from harbour porpoises to large baleen whales. A total of 25 entire skulls were found, comprising five harbour porpoises, one bottlenose dolphin, 14 unidentified dolphins and five unidentified large whales. In addition, 28 finds of turtle remains from at least three species were made, ranging from single bones to entire freshly stranded animals.



NEW TECHNIQUES

NT-01

INFRARED DETECTION OF MARINE MAMMALS

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In the framework of a marine mammal risk mitigation policy, there is still lack of methodologies for night-time visual watch. During the past, night vision visual amplifiers were tested, but were then abandoned because the results were unsatisfactory. Another solution potentially promising for night-time watch is the infrared technology. Infrared systems are in fact capable of detecting differences in apparent temperature due either to thermal energy irradiated by bodies or to reflected and scattered thermal energy. An infrared binocular, designed for on-the-field military applications, was tested for ten days during a NATO URC sea trial which took place in summer 2003 (the Mar-Ligure Joint Experiment – Sirena 2003). The effectiveness of this infrared system in detecting marine mammals resulted strongly affected by

weather conditions, spanning from excellent performance, to absolute ineffectiveness. Many examples of infrared images and short videos of dolphins and whales are presented in this work to show the potentials of this new technology for marine mammal detection.

NT-02

THE USE OF COMPUTER ASSISTED MATCHING SOFTWARE IN THE RE-EVALUATION OF AN ESTABLISHED BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) ARCHIVE

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Misidentification of individuals within a photo-identification database results in the accumulation of false positive and/or false negative errors. As a result, the size of a population may become either under or, more likely, over-estimated. Such errors may be highly significant in terms of recommendations for management and conservation policies for the protection of vulnerable populations. In order to assess the frequency of these errors in a typical photo-identification database, a two-stage computer-assisted photo-identification program was applied to an established bottlenose dolphin (*Tursiops truncatus*) archive collected from 1997 to 2004 along the southern coastline of the outer Moray Firth, NE Scotland. Using a strict grading system, only subjects of high photograph quality were included in the database. From a catalogue previously containing 96 marked bottlenoses, 2 false positive and 22 false negative errors were identified from 726 photographs, resulting in a re-evaluated total of 76 marked individuals. This method was time consuming; however, it was highly effective in the identification of false negative errors in particular. In conclusion, in addition to a strict photograph quality grading system, the use of this software should be considered to further aid the successful recapture of marked dolphins within an established photo-identification archive.

NT-03

RESULTS OF THE EUROPHLUKES PROJECT

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Photo-identification is one of the least intrusive ways to study stocks and populations of cetaceans. The European Commission funded a three year project from 2001 to 2004, to design and construct a database system of cetacean photos, to design a method for feature based retrieval and to set up a network of scientists involved in photo-id. The project was one of the initiatives to develop infrastructure for marine research as part of the Fifth Framework Programme. XX parties from YY countries participated in the project. More than 50 000 photos were collected and digitised and programmes were written for retrieval by trailing edge of fluke, dorsal fin or patches. The database and the tools are now available for the research community.

NT-04

MODELING AND MAPPING WORLDWIDE RESOURCE OVERLAP BETWEEN MARINE MAMMALS AND FISHERIES

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The impact of fisheries on marine mammals and other megafaunal components of marine ecosystems is a major concern. To assess the potential extent of food competition between marine mammals and fisheries in these ecosystems, we investigated the spatially-explicit overlap in food resource exploitation between both groups on a global scale using modelling and mapping tools. Within a GIS framework, we developed a generic model to predict the relative probability of occurrence of each of 115 marine mammal species in a global grid with 0.5 degree latitude by 0.5 degree longitude cell dimensions. For each species, estimates of mean annual food consumption (specified by food types) during the 1990s were generated based on published information about abundance estimates, mean body weights, diet compositions, and feeding rates. By linking predicted species' distributions and food intake, we then obtained estimates of marine mammal food consumption per km². Superimposing geographically disaggregated fisheries catches allowed the calculation of spatial and dietary overlap between catches and marine mammal food intake. We predicted that total marine mammal consumption was several times higher than total fisheries catches. However, spatial overlap and exploitation of the same food types was relatively low, suggesting that actual competition between fisheries and marine mammals may be quite low. We predicted the highest overlap in the temperate to sub-polar shelf regions of the northern hemisphere. Overall, < 1% of all estimated marine mammal food consumption stemmed from areas of high overlap. Nevertheless, overlap between marine mammals and fisheries may be an issue on smaller scales (especially for species with small feeding distributions) where more detailed local investigations are required. The mapping of geographical 'hotspots' of marine mammal-fisheries interactions can aid in focusing small-scale

research efforts and the development of management approaches on appropriate scales.

NT-05

DEVELOPMENT OF THE METHOD FOR PHOTO-IDENTIFICATION OF WHITE SEA BELUGAS (*DELPHINAPTERUS LEUCAS*)

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Observations of the breeding aggregation of belugas in the region of Cape Beluzhy (Bolshoi Solovetsky Island, White Sea) have been conducted since 1995. The problem of the recognition of belugas has been of interest from the very outset: observations were conducted and belugas with the most conspicuous marks as scars, blemishes on the back and the dorsal ridge caused in a natural way were made sketches of. But the drawings did not accurately convey beluga «image». In this connection in 2003, a new program concerned with beluga photo-identification was launched. The study was conducted from 12.06.03 to 03.08.03. There were a total of 35 days of actual photography. The equipment was photo-sniper (Zenit-EC) with lens 300 (Tair-3-FS) and Zenit-E with a lens 500 (?? -5?). The film - 35 mm Konica 200. The photography location was fixed: from a tower at a height of 3 m and 10 m from the water edge, and also from stones at the water edge (from a tripod). All adult belugas were photographed (about 90% of the entire aggregation) when they approached to a distance of not longer than 20 m from the water edge mostly in low water: end of ebb tide – beginning of high tide, which corresponds to the arrival and departure of belugas. The photos (836 frames) were (scanner Canon 2700F) and synchronized with the records of the log book. Using the program package MS Access 2000, a database was created. In the course of work, criteria were developed for selection of beluga photos similar to the selected archetype: skin color, side, natural marks (dimensions and their location), presence of ridge, its shape and dimensions according to the photo. Using the program package Photoshop v.7, in all the photos, the dorsal ridge was measured: (*L*) - length of dorsal ridge in a strait line between the points of beginning and end of the ridge (notable change in height); (*H*) - height of dorsal ridge (straight line between the highest point of the dorsal ridge and the length measurement line). The ratio of the length of ridge to its height ($K = L/H$) was relied upon as one of the criteria for individual identification. Analysis of all adequate photos (465 frames) revealed several shapes of dorsal ridges in belugas: Oblong-well-defined (40%), Oblong-loose (4,3%), Triangular-well-defined (4,7%), Triangular-loose (1,7%), Corn (13,7%), No dorsal ridge (35%). Analysis of the photos made it possible to identify 24 belugas. In the course of beluga recognition the shape of dorsal ridge is a key feature. The utilization of the coefficient of the ratio of dorsal ridge dimensions to identify the animals has certain limitations: 1) the coefficient in different belugas may be similar; 2) some error is admitted in the dimensions of the same beluga in different photos (one of the causes: change of the animal angle in relation to the photographer); 3) in the beluga the dorsal ridge grows during its entire life and its proportions change, which can be observed in belugas with oblong-well-defined shape of the ridge when the K of the gray, light-gray and, white and yellow belugas is compared.

NT-06

MAMASAT - MARINE MAMMALS MONITORING SATELLITE (SATELLITAR SYSTEM FOR MONITORING CETACEANS AND OTHER LARGE PELAGIC IN WILD)

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Satellite monitoring is a very useful method that is developing during this last decade and could be applied on several marine species, as large cetaceans species, marine turtles, or big pelagic fish as tuna and sword fish, could give a lot of information about their biology and ecology, especially concerning their home range, their daily and seasonal migrations, their feeding and reproductive areas, their range of depth, and so on. As known in bibliography, the satellite monitoring changed completely the previous way to study a population (through visual census, photo-identification, etc) adding to the previous knowledge much important information about the life and the movement of several marine species. In many case such discovery totally revolution the previous knowledge and the previous models. Only with satellite monitoring we have the possibility to follow “step by step” the animal that we study. Aviospace, in cooperation with Universities, Research Centres and Individuals, can set up an international program that will include a dedicated mini satellite (with a typical operating life of 2 to 3 years), a launcher and an on ground control system that will allow to collect a huge amount of data including i.e. migration routes, correlated with water temperatures or streams, human activities, geological phenomena, etc. Other application could be i.e. following tuna migration from Atlantic to Mediterranean and backwards, following Black Sea harbor porpoise and see if gets in the Mediterranean Sea, follow adult male of *Tursiops* that are suspect responsible of net damaging in Mediterranean small scale fishery, follow Atlantic humpback whale or gray whale in their feeding-breading migration, or following rare dolphins species of the southern hemisphere, belonging especially to the genus *Mesoplodon* that so much few is know about them, or correlate environmental/human interferences with cetacean routes, that could lead to death on beaches.

NT-07

NATURALLY BASED APPROACH FOR TAG DESIGN IN DOLPHINS TELEMETRY

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Telemetry as a method of data obtaining by means of sensors attached to the animal's body is widespread in study of different aspects of biology of marine mammals. Besides, dolphins and pinnipeds can be used as platform for oceanographic data collection. Tag design remains the main problem in dolphin's telemetry. Imperfect tag design cause difficulties for dolphin swimming and manoeuvres and, consequently, for breeding, catch the prey and escape predators. Imperfections of a tag can lead to unequal behaviour of dolphin and, consequently, it should affect on the reliability of data obtained. There is a technical contradiction between need of long-term power supply of the device and requirement of minimal additional drag caused by the tag. A new approach to the construction of telemetry tag for small cetaceans is proposed. According to this, tag design should be based on peculiarities of anatomy and hydrodynamics of selected species. The optimal tag should minimize its affect on the dolphin behaviour and be constructed well enough for long-term data acquisition. This compromise can be reached by the construction of ergonomic tag with advanced energy budget. Such low-drag device should correspond to the range of natural loads on the dolphin's body and its deformations during swimming and manoeuvres. The placement and characteristics of piezoelectric transducers on the surface of tag should correspond well to the magnitude and mode of disturbances in the boundary layer of tag. The flow-surface interface of the tag can be used as additional source of power, making contribution to the energy budget of the tag. Utilization of transducers enables increasing of tag longevity without additional battery, *i.e.* without additional weight and drag of the device. The preliminary computer simulation of dolphin hydrodynamics has been carried out in order to find the best place and method of tag attachment.

NT-08

MAGNETIC RESONANCE IMAGING: A NOVEL TECHNIQUE FOR REPRODUCTIVE STUDIES IN HARBOUR SEALS

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Examination of ovaries provides valuable information about the reproductive status of a marine mammal population. For the East Atlantic harbour seal (*Phoca vitulina*) population, knowledge of the reproductive status is particularly important because of the large fluctuations in population size resulting from viral epidemics. However, the traditional technique, based on macroscopical and microscopical examination of sectioned ovaries, is time-consuming and provides limited information, especially when ovaries are autolysed. Magnetic resonance imaging (MRI) is a novel technique with which ovarian structures can be visualized with unmatched anatomic resolution. However, so far its use has been limited to humans and a few species of domestic animals. The goal of our study was to determine the sensitivity and specificity of MRI compared to macroscopic examination for identifying *corpora lutea* (CL) in harbour seal ovaries. We examined 40 ovaries of 20 harbour seals found stranded along the Dutch coast during the 2002 phocine distemper epidemic. The seals varied in age category, month found, and state of autolysis. Macroscopic examination consisted of making cross-sections of the ovaries at 2 mm intervals and evaluating them by the naked eye. By this method, CL were detected in 26 of 40 ovaries. These results have yet to be confirmed by histological examination. MRI was performed using a clinical 3.0 Tesla imager with a 5 cm ID receiver coil. By MRI, CL were detected in the same 26 of 40 ovaries indicating a sensitivity and specificity of 100% compared to macroscopic examination. CL were characterized by their round shape, irregular edges and heterogeneous contents. Identification of CL in autolysed ovaries appeared to be easier by MRI than by macroscopic examination. This preliminary study shows the potential of MRI for identifying CL in seal ovaries; we will continue to use this technique to study reproductive status in seals.

NT-09

THE EFFECTS OF ACOUSTIC DETERRENT DEVICES ON HARBOUR PORPOISES IN THE VICINITY OF FISH FARMS IN THE ORKNEYS, SCOTLAND

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The growth of the aquaculture industry in coastal habitats in recent years, has led to concerns over possible impacts on the marine environment. Problems with predation have led to an increase in the use of acoustic deterrent devices (ADDs) at farm sites, but whilst these devices may provide a potentially useful role for the non-lethal control of predators, a number of studies have indicated that they cause significant habitat displacement for cetaceans, especially coastal species such as the harbour porpoise. A study into effects of ADDs on harbour porpoises was conducted in the southern Orkney Islands, Scotland. Visual and passive acoustic techniques were used to monitor the harbour porpoise distribution in an area with an active ADD deployed at a farm site. Continuous passive acoustic monitoring was achieved using five T-POD cetacean click detectors. Harbour porpoises were sighted in the study area on 64% of the days visual observations were conducted. Significantly fewer sightings were recorded in the area ensonified by the active ADD, p-value 0.001. T-PODs deployed in the impact area logged fewer porpoise positive days. A

significant increase in the number of positive days logged by the T-PODs was observed once the ADD was removed suggesting that the active ADD impacted the distribution of harbour porpoise in the study area. This suggestion was further supported by the continuity of porpoise positive days logged in the control area over the whole study period, both when the ADD was active and inactive. Seals were recorded at a haul-out site close to the farm site and it's active ADD 73% of the time, and one seal was recorded within 100m of the cages indicating that ADDs were not effective in deterring seals from the area around the farm sites.

NT-10

DISTRIBUTION AND HABITAT PREFERENCES OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AND SPERM WHALES (*PHYSETER MACROCEPHALUS*) WITH RESPECT TO PHYSIOGRAPHIC FACTORS IN THE WATERS AROUND THE AZORES ISLANDS (PORTUGAL)

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The Azores archipelago exhibits a particular physiography, with lack of continental shelf and presence of great heterogeneity of topographic features as submarine canyons and scattered seamounts. Patterns of distribution of bottlenose dolphins and sperm whales were evaluated with respect to two physiographic variables, water depth and sea-bottom slope. Boat-based surveys were conducted along pre-determined transects, from 1999 until 2003, covering a total of 24598 km. Cetaceans were encountered 1399 times, of which 151 and 496 sightings were of bottlenose dolphin and sperm whale groups, respectively. Data on survey effort and sighting positions were analyzed using a geographic information system, incorporating bathymetric datasets for the study area. Maps representing spatio-temporal distribution and habitat-use patterns were produced for each species. Both species were encountered throughout the archipelago all year round, but the distribution of sightings was not uniform within the study area. Chi-square analyses and multiple regressions demonstrated significant differences in distribution relatively to physiographic variables. Bottlenose dolphins showed preferential use of shallow areas (depths bellow 250 m, avoiding depths over 1000 m); whereas sperm whales were associated with deeper areas with steep slopes (preference for depths above 1250 m and slopes of 4-6º, avoidance of depths bellow 250 m and slopes lower than 2º). These results quantitatively support the hypothesis that the distinctive patterns of habitat selection shown by both species are related to local physiographic characteristics, and seem to match with each species' feeding habits. Bottlenose dolphins were found in close proximity to five areas designated as Special Areas for Conservation. The critical habitats identified for both species may contribute to the management policy of the whale-watching activity. Geostatistical analysis proved to be useful on elucidating habitat preference and ecology of both species, highlighting the importance of certain areas for conservation. Future work should focus on integration of oceanographic parameters.

NT-11

IMPLEMENTATION OF A MULTI-DISCIPLINE APPROACH TO INVESTIGATE MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*) DISTRIBUTION IN THE SOUTHERN OUTER MORAY FIRTH, N.E. SCOTLAND

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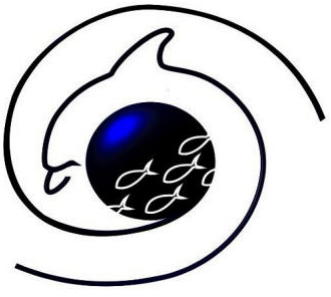
Reported sightings of minke whales (*Balaenoptera acutorostrata*) have been made in the Moray Firth, Scotland. However, no detailed research or studies have been published on the presence of these animals in this the largest embayment of its kind in eastern Scotland. In this study a multi-discipline approach was used to investigate the distribution of minke whales along the southern outer coastline of the embayment during the years 2000-2004. Methods used during the study included behavioural observations, geographical information systems (GIS) and remote sensing of sea surface temperature and chlorophyll-a concentration using AVHRR and SeaWiFS images respectively. Results of the study showed that the spatial distribution of minke whales encountered during the study had strong associations with fixed environmental variables such as bathymetry and sediment type. Also, a number of interesting observations were made between the species distribution and two oceanographic features which appear to dominate the Moray Firth system, a cold water current and a warm water plume. It was hypothesised that these environmental variables affected primary productivity within the embayment, associated with providing suitable habitat for the minke whales primary prey species in this region, the sandeel (*Ammodytes spp*). However, only through the integration of these methods were findings supporting the supposition that this area is important to the whales for foraging, made possible.



PHYSIOLOGY / ANATOMY

PA-01

GROWTH PATTERNS OF THE *DELPHINUS DELPHIS* SKULL

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Three large cranial areas of the *Delphinus delphis* experience certain changes within themselves during its animal growth. The main part of the skull constitutes a uniform set of two different patterns of growing: length and wide. The occipital bone makes up the second independent area, in which the two patterns before mentioned alternate from the foramen magnum to cause a gradient. The third area is the ethmoidal, which presents a similar behaviour. There is a fourth area independent from the previous mentioned which is made up by the tympanic bullas. These bullas experience almost no change during its postnatal life.

PA-02

DURATION LIMITS TO UNASSISTED SWIMMING BY SPOTTED DOLPHIN (*STENELLA ATTENUATA*) CALVES

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Size-related differences in power production and swim speed duration may contribute to the observed deficit of nursing calves relative to lactating females killed in sets by tuna purse-seiners in the eastern tropical Pacific Ocean (ETP). Power production and swim speed duration were estimated for northeastern spotted dolphins (*Stenella attenuata*, the species most often targeted by the fishery) ranging in size from neonate through adult. Power required by neonates to swim unassisted was 3.6 times that required of an adult to swim the same speed. Estimated unassisted burst speed for neonates is only about 3 m s^{-1} compared to about 6 m s^{-1} for adults. Estimated long-term sustainable speed is about 1 m s^{-1} for neonates compared to about 2.5 m s^{-1} for adults. Weight-specific power requirements decrease as dolphin calves increase in size, but power estimates for 2 year old spotted dolphin calves are still about 40% higher than power estimates for adults, to maintain the same speed. These estimated differences between calves and adults are conservative because the calculations do not include accommodation for reduced aerobic capacity in dolphin calves compared to adults. Discrepancies in power production are probably ameliorated under normal circumstances by calves drafting next to their mothers, and by employing burst-coast or leap-burst-coast swimming, but the relatively high speeds associated with evasion behaviours during and after tuna sets likely diminish use of these energy-saving strategies by calves.

PA-03

POSTNATAL GROWTH AND OSSIFICATION OF SKULL IN THE HARBOUR PORPOISE FROM THE SEA OF AZOV AND THE BLACK SEA

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Seventy-two skull measurements were taken from 182 harbour porpoises (*Phocoena phocoena relicta*) from the Sea of Azov and the Black Sea (149 of them were sampled in 1997-2003, 33 in 1936-88), at the age of 0-20 years. Ossification proceeds during the 1st year of life and stops with the forming of sutures. Suture fusion occurs only in the upper occipital zone. Growth of skull lasts during 3-4 years, which is comparable with the growth of total body length and flipper length. Growth of complex structures (*i.e.* rostrum) is totally determined by the growth of their constituents, growing sometimes in a "relay" manner. 8 main patterns of changes in bones allometry during the life were defined; at least, 2 key points in ontogenesis (the age of *c.*3 months and c.1 year), when growth pattern breaks, were determined. 6 major permanent clusters of correlation links between bone measurements, together with 5 independent components, exist during all the postnatal ontogenesis; they can be combined into 8-10 main principals in different age and sex groups. Sexual dimorphism is demonstrated in condylobasal length, rostrum length and width, zygomatic width. Distinctive geographical variation between the Black Sea and North Atlantic porpoises was found in relative size of rostrum and condylar width.

PA-04

MORPHOLOGICAL AND MULTINUCLEAR NMR CHARACTERIZATION OF THE LOWER JAW EXTERNAL TISSUE IN THE STRIPED DOLPHINS (*STENELLA COERULEOALBA*): PRELIMINARY STUDY

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It is widely accepted that, in the echolocating system, the lower jaw acts as a special receiver which conducts the returning echoes to the auditory bullae. The lower jaw contains an unusually thin bone, underneath that lays a large fat body that extends towards the throat and the bulla of the middle ear region. The molecular and histological structure of the lower jaw tissue of the striped dolphin (*Stenella coeruleoalba*) was investigated by means of

morphological and multinuclear NMR techniques. The analyses of samples belonging to adult and juvenile individuals were performed with the aim of seeking the presence of age-related differences that may reflect different sound reception properties. Samples of lower jaw external tissue of stranded dolphins were excised within 24 hours from the finding and divided in two lots: the former was formalin buffered-fixed, paraffin embedded and stained for morphological analysis; the latter was used for the NMR analysis. In our study, the level of isovalerate (iso5:0) in jaw tissue of calf individual is comparable with those of the adults counterparts, on the other hand longer isobranched fatty acids were detected in much lower quantities in the calf together with a higher degree of unsaturation. The morphologic analyses revealed that, in both adult and calf, this adipose tissue is similar to univacuolar adipose tissue. However, in the calf a clear muscular component was present, while only in adult subjects, enlarged and irregular shaped cavities may be seen within the adipose mass. These cavities, structurally organized as veins, may regulate the blood flow in response to changing water temperature and stabilize thermal gradient within the lipids of the jaw. All these findings suggest that no a single molecular component or histological organization, by itself, can be an index of maturity of the organ.

PA-05

AGING AND MORTALITY IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) AND RISSO'S DOLPHINS (*GRAMPUS GRISEUS*) FOUND BEACHED ASHORE ALONG THE ADRIATIC SEA COAST OF ITALY AND SLOVENIA

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Adriatic Sea is a peculiar ecological niche, characterized by an average depth of 50 m. Bottlenose dolphin (*Tursiops truncatus*) occupies this environment regularly and is widely spread over entire Adriatic Sea. In contrast, Risso's dolphin (*Grampus griseus*) is observed rarely. We collected teeth and tissues samples of several bottlenose and Risso's dolphins stranded along the Adriatic Sea coast of Italy and Slovenia during the past four years. In most cases, age determination was attempted and mortality causes were investigated. Necropsy and tissue sampling, as well as age determination were performed according to the established veterinary protocols. Cross and longitudinal teeth sections were used for age determination. Sections were stained with a rapid protocol to view the anatomy of growth rings. Age of stranded dolphins was correlated to mortality causes for the first time in the Adriatic Sea. In fact, information on causes of mortality and age is an important factor for improving conservation protocols of marine mammals living in this area.

PA-06

THERMAL WINDOWS, HEAT FLUXES AND RESTING METABOLIC RATES OF FLORIDA MANATEES (*TRICHECHUS MANATUS LATIROSTRIS*)

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The range of the Florida manatee appears to be governed by this species' inability to withstand cold water (less than approximately 18-19 degrees C). “Cold stress syndrome” affects and kills manatees during intense or prolonged cold weather, even in peninsular Florida. This inherent vulnerability is exacerbated by the endangered status of Florida manatees, the fact that existing natural and artificial warm-water refugia in Florida may disappear, and lack of knowledge regarding even some fundamental aspects of the thermal biology of manatees. Effective conservation and management will be hampered without better scientific data to inform potential mitigation decisions. This study determined the location of thermal windows in manatees, the extent of heat flux through such windows, and resting metabolic rates of two captive adult animals, housed at Mote Marine Laboratory. The manatees were trained to remain stationary (*i.e.*, resting) while a heat flux transducer measured heat flux rates across 41 different sites on the body. The heat fluxes ranged from -51 W/m^2 to 159 W/m^2, with the smaller, more active individual having somewhat higher mean heat fluxes than its tank-mate. The axilla and the lateral side of the pectoral flipper tip exhibited the highest heat fluxes and were, therefore, primary thermal windows. There were additional thermal windows located along the pectoral flipper, between the pectoral flippers on the ventral surface of the thorax, and in the dorsal center of the fluke. Mean metabolic rates were 129 W and 107 W for the two individuals, corresponding well with published data regarding the innately low metabolic rate of this species.

PA-07

REVISION OF THE VERTEBRAL REGIONS AND THEIR ROLE IN SPECIES DISCRIMINATION IN SOME TOOTHED WHALES

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The aim of this study was to compare the biometrical traits and describe an anatomical pattern of vertebral column in some toothed wale species. The studied material consisted of the skeletons of the vertebral columns from the following species: *Lagenorhynchus acutus*, *Globicephala melaena*, *Tursiops truncatus* (Family Delphinidae), and *Phocaena phocaena* (Family Phocaenidae). The measurements of the material resulted in 3612 values, grouped under eight variables, and processed through multivariate statistical methods. For each species, the vertebrae assembled in five groups according to the similarity among them. The variables that most differentiated among these groups were the total vertebral height and the width of the vertebral foramen. According to the discriminant analysis, this biometrical-based classification was 88.9% correct. Vertebral traits could also distinguish the studied species. In this sense, the most important variables were the vertebral thickness, disk height and width. The percent of correct classification of species was 87.1%. Biometrical-based vertebral regions did not totally coincide with the classical, topographic ones. Vertebral metric traits differentiated the studied species. This research could further extend to other marine mammals from different areas.

PA-08

STRESS AND OIL SPILLS IN *DELPHINUS DELPHIS*

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The increase of stress and mortality in cetaceans is directly related to the maritime human activities that are affecting to the mammals populations and the maritime environment in general. Oil spills caused by maritime transport of petroleum products are still an important source of ocean pollution, especially in main production areas and long major transports routes. The English Channel and waters around Galicia in Spain were the areas with most accidents in European Atlantic, maritime transport waters has been to continue increasing. Our study compares stress between *Delphinus delphis* (L.) populations from the northern coast of the United Kingdom, as well as from the English Channel and the Galician coast (NW of Spain). This is done by using fluctuate asymmetry calculated from the differences between right and left hemisphere measures of bilateral characters founded on the skull as an expression of the stress suffered during the growth. This stress can be mainly due to ecological disasters such as oil spills, acoustic pollution, etc...

PA-09

ADAPTATION TO UNDERWATER LIFE: HOW DOLPHIN DEVELOPED AUDITION

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Among the dolphin's sensory systems, audition is the most important and best adapted to marine environment. The goal of this work is to contribute to the Knowledge in odontocete auditory system, not yet completely investigated. Our attention focused on middle ear adaptation to marine environment. We worked on six striped dolphin (*Stenella coeruleoalba*) in good condition of preservation. A first anatomical observation was followed by histological analysis. Each auditory meatus and tympanic bulla was dissected and fixed. Common histological staining as Haematoxylin-eosin and Azan were adopted. The most important adaptation studied by us was the presence of a thick mesh of erectile tissue inside the middle ear cavity. This work, by comparing anatomical and histological data shows its following functions: 1) barotraumas preventing system; 2) muco-secernent erectile tissue; 3) volume and pressure regulating system. All this characterises are necessary for a correct function of dolphin auditory system in a marine environment.

PA-10

INTRAFIBER LIPID DROPLETS IN SWIMMING SKELETAL MUSCLE OF STRANDED CETACEANS IN CANARY ISLANDS

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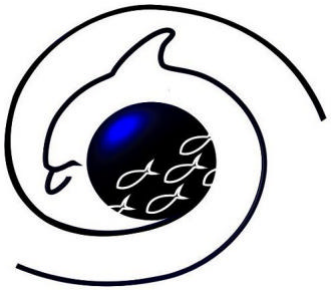
The present study is focused on the analysis of swimming skeletal muscle samples (*Longissimus dorsi*) from 15 different species of 86 stranded cetaceans in Canary Islands from 1996 to April 2004. The purpose of this study was to evaluate the presence of spherical intrafiber lipid droplets to explain the aerobic capacity of skeletal muscles under the hipoxic conditions of diving. The previously fixed tissue in 10% neutral buffered formalin solution was post fixed in 1% osmium tetroxide, dehydrated in graded ethanol series and embedded in paraffin. Sections (5 mm in thickness) were cut, treated with picric acid for 24 hours and stained with hematoxilyn-eosin. As result 19 of the 86 animals (22%) belonged to 7 of the 15 species of cetaceans presented different degree of intrafibrilar doplets with the osmium tetroxide method. The percentages exhibited for each specie were the following: *Globicephala macrorhynchus* (n=8) 38%; *Kogia breviceps* (n=5) 20%; *Kogia simus* (n=2) 50%; *Mesoplodon densirostris* (n=2) 100%; *Physeter macrocephalus* (n=7) 43%; *Stenella*

frontalis (n=12) 8% and *Ziphius cavirostris* (n=10) 70%. According to the results described above we may conclude that swimming skeletal muscle of deep, long-duration divers species showed a greater amount of lipid intrafiber droplets that swimming skeletal muscle of short-duration divers species.



SURVEY / ABUNDANCE

SA-01

ABUNDANCE ESTIMATE OF RISSO'S DOLPHINS (*GRAMPUS GRISEUS*) IN THE WESTERN LIGURIAN SEA THROUGH PHOTOGRAPHIC MARK-RECAPTURE

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Risso's dolphins are frequently found along the slope area of the western Ligurian Sea. A photo-identification study was carried out from 1990 to 2000, mostly during the summer months, in an area of about 24000 km². Approximately 69% of the photographed individuals had long-term natural marks suitable for individual photo-identification. A total of 178 Risso's dolphins were identified: 103 from both sides, 41 from the right side and 34 from the left side. Of these 159 individuals (89%) were resighted during the study period. Within-year recaptures (59%) occurred 1-7 times, while resightings in different seasons (41%) ranged between 1-6 times, with a maximum interval of 7 years. For the purposes of the mark-recapture analysis, the dataset with the most homogeneous sampling effort was chosen, *i.e.* 1998-2000. Single field seasons were considered as sampling units and only recaptures in different years were taken into account. Two photographic sets, the right (R; n=120) and the left (L; n=127) collections of dorsal fins were analysed separately. The software CAPTURE was used to perform a model selection and abundance estimate. The analysis provided an estimate of 242 individuals for the R dataset (SE= 37.4; 95% CI=188-339; CV=0.15) and 267 individuals for the L dataset (SE= 42.0; 95% CI=206-376; CV=0.16). The close agreement between the two estimates supports the reliability of these results. These are the first estimates of Risso's dolphin abundance in any Mediterranean area, and they represent an important baseline for Risso's dolphin conservation in the Cetacean Sanctuary.

SA-02

BALEEN WHALES OCCURRENCE IN MADEIRA ARCHIPELAGO INCLUDING RECORDS OF TWO NEW SPECIES FOR THE AREA

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Until 1995 the information of baleen whales in Madeira Archipelago (NE Atlantic) is scarce. Only few confirmed observations were known, namely, from the whaling period (1940-1981), published data from 1990 and one stranding in 1992. In order to gather data on cetaceans' occurrence in Madeira, an opportunistic sightings and stranding data base was created in 1995 by the Madeira Whale Museum. The analysis covering the period 1995-2004 showed the presence of 5 baleen whales: fin (*Balaenoptera physalus*), minke (*B.acutorostrata*), humpback (*Megaptera novaeangliae*), sei (*B.borealis*) and Bryde's (*B.edeni*). These two last species had their first confirmed sightings for these waters in August 2002 and September 2003, respectively. Between 1995 and 2001 there were a total of 11 records of baleen whales. In the following three years the number went up to 105 records. Humpback and minke whale sightings were rare (2 for each species), while the remaining 101 were from the other 3 species. The opportunistic nature of these data does not allow us to interpret with confidence the discrepancy in the number of sightings between 1995-2001 (9.5%) and 2002-2004 (90.5%). However, the frequency of which baleen whales have been seen in the last three years lets us believe that we might be witnessing an increase in the presence of these cetaceans in Madeiran waters. Also, data from sea surveys, with controlled effort, carried out around the islands of the Archipelago in 2001 (284 hours of sea effort / 1 sighting), 2002 (222hours / 12sightings) 2004 (49hours / 4sightings) reinforces this belief. Sei and Bryde's whale were sighted only during the summer and autumn, while fin whale was seen year-round. All 3 species have been seen feeding in these waters and calves of Bryde's and fin whale were observed, indicating that they may be using Madeiran waters as breeding/birthing area.

SA-03

PHOTO-IDENTIFICATION OF CUVIER'S BEAKED WHALES (*ZIPHIUS CAVIROSTRIS*) IN THE NORTHERN LIGURIAN SEA

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Stranding records indicate that Cuvier's beaked whales (*Ziphius cavirostris*) range widely from tropical to temperate waters of the world, but there are few documented sightings of this species at sea. We report on 147 sightings of Cuvier's beaked whales in the northern Ligurian Sea between July 1996 and November 2004, during which efforts were made to photo-identify the individuals observed. Pictures were taken opportunistically, during daily whale watching cruises operated by bluWest from spring to early autumn, and during 5 tagging cruises led by WHOI scientists between 2001 and 2004, in collaboration with bluWest. The objectives of our study are to determine if individuals of this species are resident to specific areas, and to document their social structure and individual life histories. Offshore searches for Cuvier's beaked whales were conducted in sea conditions of less than Beaufort 3. Whales encountered were photo-identified using 35mm cameras with 100-400 mm lenses and colour slide film. Photographs of the head and dorsal aspect were taken to confirm the species and sex (of adults) and to document fin shape and scar patterns. Group sizes of Cuvier's beaked whales ranged from 1 to 7 animals. Individually distinctive whales were successfully photographed during 86 encounters, and our catalogue now totals 54 animals. Thus far, five matches have been made. The most notables ones are: an adult female, first encountered in August 1998 and later in July 2004 accompanied by a calf; a sub-adult male, photographed in August 1998, October 2001 and June 2004; a large adult male, sighted 3 times between August and September 2003 and 3 more times between June and July 2004. Such resightings seem to indicate at least seasonal site fidelity of Cuvier's beaked whales in the northern Ligurian Sea.

SA-04

DISTRIBUTION OF WHITE-BEAKED DOLPHINS ALONG THE SOUTH GRAMPIAN COASTLINE

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White-beaked dolphins are regularly seen in the North Sea and are one of the most frequently observed cetaceans around Scotland. Usually associated with offshore waters, white-beaked dolphins have been regularly seen close to the coast of northeast Scotland during the summer months. Between May 2002 and November 2004, 76 boat surveys were carried along the east coast of Scotland. A total of 46 sightings of white-beaked dolphins was recorded during over 260 hours of survey time. The skipper of the survey vessel reported an additional 28 incidental sightings. Surveys were carried out during all months of the year, except December and January, but sightings of this species were recorded only between June and August, apart from a single sighting in October 2004. Group sizes ranged from 1 to 18, with an average of 4.6, similar to previous observations in the region (Weir & Stockin, 2001) Average group size did not vary with month, but increased to 5.9 when calves were present, though still lower than the 8.2 average previously reported. All sightings except one were in areas with water depths of 10 - 40m, mostly between 20 - 30 m. There was a significant association between sightings and tidal state (Chi square = 621, 3df. $p<0.001$). During daytime surveys, most sightings occurred at high tide, while during evening surveys it was at low and ebb tide. Whether this is primarily a tidal effect or a temporal effect is unclear. White-beaked dolphins were seen during 50% of the evening trips compared to 20% of the day surveys. There may also be a geographical effect, with individuals foraging in different areas at different times of the day or tide.

SA-05

USING BATHYMETRIC AND REMOTELY-SENSED OCEANOGRAPHIC DATA TO MAP THE SEASONAL DISTRIBUTION OF FIN WHALES IN THE BAY OF BISCAY

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The fin whale is the second largest cetacean on the planet, and probably the most abundant species of baleen whale in the North Atlantic. Despite this, relatively little is known about its distribution and relative abundance in relation to oceanographic parameters, particularly in European Atlantic waters. Previous studies have revealed that the Bay of Biscay is a particularly important area for the fin whale with large numbers appearing throughout the summer months to feed. Between the years of 1995 and 2003, Organisation Cetacea (ORCA) have surveyed a total of 17,872.5 nautical miles using ships of opportunity on a line transect survey across the Bay of Biscay. Of the 707 sightings of fin whales, 1,280 individuals were encountered between June and October with 55.6% (n = 712) sighted in the month of August. Environmental and habitat features were examined to investigate how oceanographic parameters correlate to the seasonal variability in fin whale locations. Bathymetry and remotely-sensed oceanographic data (i.e., sea surface temperature, water depth) were compared with location data via a geographic information system (GIS). The GIS provides the means to integrate remote satellite and bathymetric data over very broad temporal and spatial scales, providing a link between species and habitat. By contrast to the North West Atlantic where fin whales regularly feed in shallow waters of 100-200 m, the present study shows fin whales are restricted to water depths greater than 1000 m and often in 4000-4500 m off the continental shelf. The Bay of Biscay may be of high seasonal importance for fin whales and as such, future studies should focus on the effects of anthropogenic impacts on the fin whale population when present.

SA-06

DISTRIBUTION OF HARBOUR PORPOISES IN THE ARGYLL ISLANDS, SCOTLAND, FROM PASSIVE ACOUSTIC AND VISUAL SURVEYS

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Little is known about the distribution of harbour porpoises (*Phocoena phocoena*) in the Argyll Islands off the west coast of Scotland. This area is subject to anthropogenic noise from seal scarers and potentially from military sonar. It is important to monitor the distribution of cetaceans such as harbour porpoises in order to evaluate the impact of such pollution. Limited information on porpoises in this area is available only from surveys using visual survey methods, however sighting rates of porpoises are very low except in good conditions. Passive acoustics can improve detection in poorer conditions, and is used in this study along with visual survey methods to improve knowledge of the distribution of harbour porpoises throughout this area. Visual surveys of harbour porpoises were conducted from the Hebridean Whale and Dolphin Trust motor-sailor ketch, Silurian, during 10-day periods every month from April-October 2003, and February-August 2004. Since October 2003, passive acoustic monitoring was also conducted simultaneously by towing a two-element high frequency (50-150kHz) array 100m behind the boat. Automatic detection of porpoises was carried out using IFAW's porpoise detection hardware and software, and all data were automatically stored in the IFAW Logger database. Harbour porpoises were present in the Argyll Islands area during every month surveyed, both in coastal and deeper waters to the west of the islands. Seasonal changes in distribution of porpoises were found, with high-density areas switching between different coastal areas in different months. Due to the increased effectiveness of acoustic survey methods in poorer conditions, it has been possible to monitor porpoise distribution during periods for which visual surveys have been lacking. The winter survey (22 Feb-6 March 2004) indicated that porpoises remain in the Argyll Islands throughout the year but concentrate in more sheltered areas such as the Sound of Mull during the winter.

SA-07

TRENDS IN ABUNDANCE OF CETACEANS IN THE NORTHERN BLACK SEA AND THE SEA OF AZOV

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Although there are no exact abundance estimates for the Black Sea cetaceans, several hypotheses and speculations were recently suggested from indirect data by different authors. Among the observed trends, increase of bottlenose dolphin (BD) population and increase of total cetacean abundance were demonstrated by 2003. Possible decline of harbour porpoise (HP) population is under discussion. New data on these issues are highly necessary. This study is based on the poll in 2002-2004, in which 947 respondents were involved. 637 cetacean sightings and 257 strandings were reported for 1998-2004. Total number of sightings and strandings reached its maximum in 2003 and substantially declined in 2004. Year 2003 seems to be anomalous in cetacean occurrence: percentage of sightings and strandings observed during the year and reported in July-Dec. of the same year was almost twice more than in 2002 and 2004. Reporting about their last observations, respondents-2003 indicated much more cases for the current year than for the previous year, unlike respondents-2002 and -2004. Maximum HP occurence was reported for 2001-2003 (stranding outbreaks in 1998 and 2001 at the Black Sea coast), relative occurence since 2000 was stable or slightly declined. Maximum BD occurrence was reported for 2002-2003, relative occurrence rose in 2004. Thus, both species (and probably common dolphins) contributed to the occurrence outbreak in 2003. From this, we conclude that the observed fluctuation is not the evidence of population "increase" or "decline" but primarily the result of the pan-Black Sea migration processes. At the same time, HP population in the Sea of Azov dramatically declined after 2001-2002. This tendency needs further research.

SA-08

HOW REPRODUCTIVE ARE HARBOUR PORPOISES?

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Reliable estimates of calf ratios are crucial for developing population models and management targets of marine mammals. From 2001 to 2004 we conducted aerial surveys of marine mammals at monthly intervals in the German Bight flying at low altitudes of 250 feet. We found calf ratios in harbour porpoises of 17 to 27 % (average 20%). These values are much higher than the ones found in other studies in the same area and largely exceed the average ratio of 5% found in the framework of the SCANS surveys in the North Sea. Although a high calf ratio has been suggested to be typical for our study area, methodological differences may strongly bias the estimate of ratios. We therefore evaluate the significance of observation platform and flight altitude on the estimate of the ratios. Newborn calves of harbour porpoises can be easily identified from the plane by comparing the length of companion animals,

but the distance (the angle of the observation) may strongly influence the detection probability. We suggest that – due to favorable sighting angles - aerial surveys generally result in higher calf ratios than ship surveys and that altitude might be a very important variable in aerial surveys. We propose to run the distance analysis (DISTANCE 4.0) exclusively with calf sightings in order to quantify the effect of distance on the detection probability of calves. The difficulties in providing reliable estimates of calf ratios, which are essential for estimating and comparing productivity of harbour porpoise populations, demand critical review of methods and data.

SA-09

GEOGRAPHICAL DIFFERENCES AND SEASONAL CHANGES IN THE HABITAT USE OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE GERMAN BALTIC SEA

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We conducted a long-term acoustic monitoring of the presence of harbour porpoises (*Phocoena phocoena*) in the German Baltic Sea from Fehmarn Island to the Pomeranian Bay. Relative abundance and habitat use of porpoises were investigated over a 2.5 years period (08/2002-12/2004). Acoustic detectors (T-PODs), registering porpoise echolocation click trains and the corresponding times, were deployed on different measuring positions. For comparability of data, obtained from different T-PODs, all devices were calibrated before deployment. Field data were checked for quality. False alarms caused by e.g. boat sonars/engines were excluded from data analysis. The results show geographical differences and seasonal changes in the proportion of porpoise positive days (i.e. a day with at least one porpoise registration) within all monitoring days per month. During summer and autumn, porpoises were registered nearly every day in the Fehmarnbelt; in the Kadet channel, we had registrations on 2/3 of the monitored days. East of the Darss rigde, registrations became less frequent. In winter, days with porpoise registrations dropped to a minimum in the Fehmarnbelt as well as in the Kadet channel, and rose again in spring and summer, respectively. Our results substantiate the historical assumed seasonal migration of harbour porpoises in these areas for two consecutive years. T-PODs proved to be valuable devices for investigating the relative abundance of harbour porpoises and for assessing seasonal changes in habitat use. This study is financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the German Agency for Nature Conservation.

SA-10

THE DISTRIBUTION OF FIN WHALES (*BALAENOPTERA PHYSALUS*) AND MINKE WHALES (*BALAENOPTERA ACUTOROSTRATA*) IN THE LOWER BAY OF FUNDY, CANADA: USING A WHALE-WATCHING TOUR-BOAT AS A PLATFORM OF OPPORTUNITY

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The distribution of fin whales (*Balaenoptera physalus*) and minke whales (*Balaenoptera acutorostrata*) in the lower Bay of Fundy, Canada was examined using data collected from a commercial whale-watching vessel during the months July to September 2002. A single observer maintained a lookout for whales throughout each trip and recorded the position of each sighting, the number and species of whales encountered and their surface activity. The study area was divided into a grid of cells measuring 2' latitude by 2' longitude and in order to control for biased search effort we used the number of visits by the tour boat to each of these cells and together with sighting data calculated a sightings rate for fin and minke whales. Both species exhibited a non-uniform distribution and used different parts of the study area. Minke whale sighting rates were highest in relatively shallow waters and steep sloping areas; with sightings concentrated in areas subject to strong tidal eddies near the northern tips of Grand Manan and Campobello Island. Fin whales were also found off the northern tip of Grand Manan and sighting rates for this species were highest in areas with flat benthic topography adjacent to the relatively deep Owen Basin. Foraging behaviours were recorded during 87% of all whale encounters and our results indicate that whale distribution in this area is likely influenced by the interaction of strong tidal flows, coastlines and variable bottom topography that facilitates foraging. This study demonstrates that whale-watching vessels represent useful platforms of opportunity for collecting ecological data.

SA-11

CETACEANS ABONDANCE IN WATERS OF MARTINIQUE (FWI), LESSER ANTILLES: NEW RESULTS FROM A SMALL BOAT DEDICATED ACOUSTIC AND VISUAL SURVEY (FEBRUARY-MARCH 2004).

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For the second time, a dedicated survey was carried out in Martinique (Lesser Antilles,14°30'N and 61°W) with a small boat between 23 Febuary to 15 March 2004 to assess cetaceans biodiversity, acoustic relative abundance, distribution and behaviour. The survey was performed with three observers on duty for visual searching and passive acoustic sampling (every 2 nautical mile) by using

a towed hydrophone. A global effective effort of 1175 km was carried out between the coast line and 10-15 nautical miles offshore. The survey area was divided into four distinct regions to estimate an acoustic abondance index for Delphinids, Sperm whales and Humpback whales.104 Twenty days at sea permitted to detect at least 5 species (plus 3 probable) from thirty-five sightings (including one mixed species group) : *Tursiops truncatus* (n=5 groups detected), *Stenella attenuata* (n=8), *Globicephala macrorhynchus* (n=2), *Megaptera novaeangliae* (n=4), one specie of Beaked whale, *Mesoplodon ssp* (n=1) and *Physeter macrocephalus* (n=11). Nearly half a thousand (N=535) cetaceans were encountered during this ended winter survey, and only acoustic abondance index was estimated for the survey period: the relative abondance (48.5 %; SD=7) was shown to indicate that the survey area was middlely adundant if comparing with Spring 2003. On another hand, acoustic research revealed a distinctive pattern of distribution for species like *M. novaeanglie* (present in 14.9 % of the acoustic samples), resident Delphinids (14.5 %: *S. attenuata*, *T. truncatus* and *G. macrorhynchus*) and the sperm whale (29.9 %: often detected off the leeward side of Martinique). Futhermore, new species, *O.orca*, *P.electra* and probably *B.acurostrata* were encountered.

SA-12

CLUSTER ANALYSIS IN THE MODELLING OF BLACK SEA CETACEANS ABUNDANCE

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Until now there was no any mathematical model describing temporal and spatial dynamics of Black Sea cetacean populations in view of variable factors of the marine environment. For the purpose of such model be designed, we propose a concept of evaluation method based on the cluster analysis. According to initial hypothesis, different maritime areas characterized by similar biotic, abiotic and anthropogenic parameters should be similarly abundant in small cetaceans. The designing of the model includes a series of gradual steps: (a) the Black Sea is divided into the multitude of equal-sized strata (cells); (b) vectors of various environmental parameters are estimated in every stratum; (c) the strata are ranged since the proximity between their sets of vectors is evaluated by means of the weighed normalized metrics; (d) the strata are clustered by hierarchical method with aggregation of cognate areas into the classes; (e) the clustering process is terminated with fulfilment of classification criterion; and (f) empirical data on cetacean abundance in previously surveyed areas (separately for each species) are extended to appropriate classes of strata in the Black Sea in whole. As a result, numbers of harbour porpoises (*Phocoena phocoena*), common bottlenose dolphins (*Tursiops truncatus*) and short-beaked common dolphins (*Delphinus delphis*) may be estimated in all areas possessing the same sets of environmental conditions. The proposed approach makes it possible to take into account territorial non-uniformity of already completed estimations based on line transect analysis as well as to acquire the estimated number of cetaceans for the entire waters of the Black Sea using empirical data obtained in relatively small its portions.

SA-13

SIGHTINGS MADE DURING SURVEYS OF THE MEDITERRANEAN SEA IN 2003 AND 2004 INCLUDING AND UNUSUAL ENCOUNTER WITH ROUGH-TOOTHED DOLPHINS (*STENO BREDANENSIS*) IN THE IONIAN SEA.

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At the invitation of ACCOBAMS, two boat-based acoustic surveys of the Ionian Sea and western Mediterranean Sea were carried out during summer 2003 and autumn 2004. Although the primary purpose of the cruises was to survey for sperm whales acoustically, visual observers also recorded sightings in sea state 3 or less. Surveys were carried out along randomly generated, predetermined tracklines. Sightings of cetaceans, turtles, sharks and sunfish were recorded and classified as on or off track. Eight cetacean species were recorded, including an hour-long encounter in the Ionian Sea with a group of rough-toothed dolphins, *Steno bredanensis*, accompanied by a calf. This is a species which is rarely sighted in Mediterranean waters. The other species recorded during the survey were striped dolphin, *Stenella coeruleoalba*, (spread throughout the region); common dolphin, *Delphinus delphis*, (mostly in the western Alboran Sea); bottlenose dolphin, *Tursiops truncatus*, (in the coastal waters of the western Mediterranean Sea); Risso's dolphin, *Grampus griseus*, (in the Alboran Sea); long-finned pilot whale, *Globicephala melas*, (in the Alboran Sea) and sperm whale, *Physeter marocephalus*, (widely spread in the region). An opportunistic sighting of Cuvier's beaked whale (*Ziphius cavirostris*) was made off Kefallonia, Greece. Previous survey effort in these areas has been limited, and these data are therefore valuable especially as there are concerns over the conservation status of several species in the Mediterranean Sea. Additional baseline data, such as these may assist in the design of future research and surveys to assess the distribution and abundance of these species.

SA-14

STABILITY OF DORSAL EDGE MARKS FACILITATES LONG-TERM PHOTO-IDENTIFICATION OF MINKE WHALES (*BALAENOPTERA ACUTOROSTRATA*)

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The feasibility of photo-identification studies depends on the ability to correctly identify a high percentage of individual animals. New natural markings may result in

false negatives when matching two photographs. Here we present the analysis of the stability of dorsal edge marks (DEMs) such as nicks and dents which are the main characteristics used to identify minke whales (*Balaenoptera acutorostrata*) in the St. Lawrence Estuary in Eastern Canada. For this study we used sighting data from 1999 to 2004 when approximately 80% of all minke whales identified in any given season returned the following year. Of the 117 individuals identified by DEMs in at least two different years during this period, only 7 individuals (5.98%) acquired a new dorsal edge mark. The identities of these 7 minke whales were confirmed by the original DEMs as well as secondary features such as scars and body pigmentation. Additionally, dorsal edge marks of most animals known for more than ten years also remained stable. We conclude that minke whales of the St. Lawrence have a relatively low rate of change in this primary feature. Thus we are confident that mis-identifications of individuals caused by acquisitions of new markings are highly unlikely.

SA-15

A RECOVERY OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*) IN THE SOUTHERN NORTH SEA? A CASE STUDY OFF EASTERN FRISIA, GERMANY

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The harbour porpoise is the most common cetacean species in the North Sea. However, current knowledge on the status of the population is lacking as well as fine-scale information on the temporal use of certain areas by the species. Therefore, to date, area-specific recovery plans are difficult to establish. One area of concern is the southern North Sea where abundance has declined in the 20th century. Recent studies using stranding data and observations from seabird-surveys indicate a comeback of the species along the Dutch and Belgian coast. However, data on other regions of the southern North Sea is sparse. Between 2002 and 2004, we undertook 12 aerial line-transect surveys (5000 km on effort; altitude = 600 ft) in a 2500 km² coastal area off Eastern-Frisia adjacent to Dutch coastal-waters. The data were g(0)-corrected using a double-platform approach and analysed with distance-sampling-software. A total of 293 harbour porpoises were sighted, including eight calves. Densities ranged between < 0.1 – 1.69 individuals / km² with peaks in February and July 2003 as well as February and Mai 2004. Additional data from shipboard surveys and from automated click-detectors confirmed the trend of a year-round use of the study area with peaks of occurrence in late winter and spring and occasional high appearances in summer. The results of our study show that harbour porpoises are present in the coastal part of the southern North Sea even during their reproductive period. However, they seem to appear in smaller numbers and much more irregular than in other areas, for example off Northern-Frisia. Whether our results indicate a slow-recovery of harbour porpoise within the southern North Sea should be investigated using a combination of surveys and satellite telemetry.

SA-16

IDENTIFYING A MAJORITY OF MINKE WHALES (*BALAENOPTERA ACUTOROSTRATA*) IN THE ST. LAWRENCE BASED ON THE PRESENCE OF DORSAL EDGE MARKS

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Natural features such as dorsal fin shapes and marks as well as lateral scars and body pigmentation patterns are used to identify minke whales (*Balaenoptera acutorostrata*) in the summer feeding grounds of the St. Lawrence Estuary in Eastern Canada. For this study we focused on analysing photographs of whales that either have dorsal edge marks (DEMs) such as nicks, dents and cut offs at the tip and those who do not. DEMs are features whose presence can be photographically documented irrespective of most environmental and lighting conditions that usually limit the photo-documentation of lateral features. During the seasons 1999 to 2004, of over 5000 day-sightings of minke whales photographed, a mean of 70% showed dorsal edge marks. In any given year, between 65 and 73% of individual minke whales could be identified on the basis of DEMs. These results suggest a high identification success rate for the study area based upon a single feature that can be well documented under a wide range of weather conditions, distances, relative angles, and behaviours even if only one side of the whale is photographed.

SA-17

BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN NORMANDY'S COASTAL WATERS (FRANCE): PRELIMINARY RESULTS AND INDICATIONS OF A RESIDENT POPULATION

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The analysis of cetacean sightings data collected since 1980 has shown the bottlenose dolphin (*Tursiops truncatus*) to be the most common cetacean species reported on the French channel coast, probably due to the presence of a colony living in this area off the western part of the Cotentin peninsula. Since 1997, the GECC (*Groupe d'Etude des Cétacés du Cotentin*), a non profit organization leads some field studies in this large wide area, using several methods during day trip and summer surveys: photo-identification, acoustic and behavioural

data collection. In support of one-off surveys performed each summer a sightings network, based on an official collaboration with "sea users" (National Marine, fishermen unions, yachtsmen and naturalist correspondents) was created in 1998 in order to facilitate spotting of dolphins in the large study area. Use of photo-identification techniques has allowed the identification of over 100 individuals in the region and the follow-up of certain individuals seen for several consecutive years. Moreover, since 2000, mothers with very young calves have been observed more frequently, indicating some degrees of residency of the population. Preliminary sightings data also suggests the existence of preferential places in the area. Seasonal movements from offshore and to coastal waters have been recorded every year and the results show that dolphins are observed throughout the year and the area of the study. The analysis of the spatial distribution of the observations from both the sightings network and our boat surveys highlights a heterogeneous repartition. This information on *Tursiops truncatus* in Normandy waters provides baseline data for an ongoing study which will permit a greater understanding of *Tursiops truncatus* behaviour and movement on an individual and group level on the French Channel Coasts and site fidelity probably in relation to food resources.

SA-18

PURSE SEINE FISHING OFF PORTUGAL: FISHING ACTIVITY AND INTERACTIONS WITH MARINE MAMMALS

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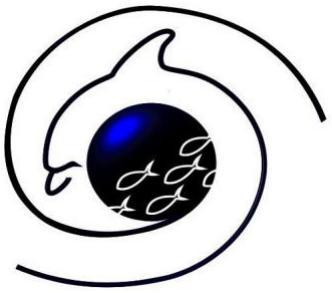
Marine mammal interactions with purse seine fisheries operating in four different ports (Figueira da Foz, Sesimbra, Setúbal, Sines) were studied over three months (July - October 2003). Observers accompanied commercial fishing vessels and monitored 48 fishing trips. An interview survey of skippers was also carried out. During the study, 48 sightings of cetaceans were recorded (31 by observers on board). These sightings corresponded to three species, the common dolphin (*Delphinus delphis*), the bottlenose dolphin (*Tursiops truncatus*) and the harbour porpoise (*Phocoena phocoena*). The majority of observations (53%) were of the common dolphin, while 42% of the occurrences, mainly from interviews, could only be identified to a family level (Delphinidae). Cetaceans were present at 13% of the observed fishing events (n = 137) and interacted with fishing operations at least in 8% of the cases. Small cetaceans were observed to sink, gather or disperse school fishes and damaged gear. Mean CPUE and fishing effort values were compared to ascertain if the presence of cetaceans affected the outcome of fishing trips. The values did not change significantly in the presence of dolphins ($H = 0$, $p = 1$; $H = 0.06$, $p = 0.8$). In Figueira da Foz, where the highest rate of interaction was observed, the largest sardine catches and shortest mean trip duration were also recorded, indicating that cetaceans are attracted to fishing grounds with a high abundance of their prey-species. No by-catch was recorded by observers but fishermen reported three events off Figueira da Foz. Compared to other fisheries, purse seine fishing does not seem to be among the most damaging practices. The study also provided an opportunity to describe purse seine fishing activity and showed that small regional differences are due in part to the characteristics of the vessels used and the abundance of different fish populations.



STOCK IDENTIFICATION / DISTRIBUTION

SD-01

ALLOMETRIC RELATIONSHIPS AND SIZE DISTRIBUTION FOR STRANDED AND BY-CAUGHT COMMON DOLPHINS IN THE NORTH EAST ATLANTIC

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The common dolphin is the most frequently found stranded species along the French coasts. The monitoring of the stranding has been carried out since 1970 by a national stranding network. The network includes different regional organisations and associations and the management is assumed by the CRMM of La Rochelle. The database includes, among other information, different length measurements. In order to establish allometric length relationships, different models were tested for males and females. The same approach was conduced using the database of the GERDAU programme (Ifremer, 1992-1993) on the impact of the tuna driftnets on the small cetacean in the North-East Atlantic. In this case the common dolphins were caught incidentally in the oceanic area. It is supposed

that there are two populations of common dolphins, one related to the continental edge and shelf, and the other related to the oceanic zone. Thus we can suppose, that the two environmental conditions (prey availability, prey composition, food competition and energetic requirements...), can have a different impact on the morphological aspects and body conditions of the common dolphins. The aim of this study is to verify this hypothesis by comparing the allometric relationships and size distribution in the two cases. The "by-catch" factor has been tested by extraction of evident by-catch from the stranded database. Subsequently this approach needs to be considered together with other biological parameters such as food habits, pollutant levels and genetic studies.

SD-02

HARBOUR SEAL STOCK IN MONT SAINT-MICHEL BAY: ULM CENSUS, SPATIOTEMPORAL DISTRIBUTION FROM 2002 TO 2004

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Harbour seals have been known to be present in Mont Saint-Michel bay, on the French coast of the Channel, since the 80s. This stock is quite symbolic since its habitat is located at the most southern limit of the species' distribution in Europe (48°N). It is a difficult stock to monitor, considering how large the estuary (25,000 hectares) and how great the tidal amplitude (up to 15 meters, the greatest tidal range in Europe) are. With this study we hope to assess the number of seals and its seasonal fluctuation. We should also be able to collect data on reproduction and the distribution of resting sand banks. Harbour seals' stock in the bay has been monitored since June 2002 through bimonthly ULM overflights. This method enables us to cover the whole intertidal zone and gather very accurate data on the use of space by each animal. GPS data is completed by photographs taken to identify outstanding animals. Harbour seals are monitored all year round. Their total number is slightly increasing and varies with seasons, peaking during summer with reproduction (40 animals counted in 2004). Sand banks are shaped by the various changing rivers flowing through the bay and it appears that the animals adapt their main resting places accordingly. After observing the seals for three years, we can say that an area is usually singled out to raise the young. Mothers with their calves do not use the same resting spots than the rest of the animals do throughout the year. Results show that Mont Saint-Michel bay is a site of special interest for the species. Since many different human activities (such as tourism, fishery, shellfish breeding, etc) take place in the bay, a protected area should be put into place in order to ensure seals' conservation.

SD-03

TOWARDS THE DEFINITION OF THE NORTHERN ADRIATIC BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) HOME RANGE

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The bottlenose dolphin (*Tursiops truncatus*) is the only regular species of cetaceans in the northern Adriatic Sea. A study on the population of bottlenose dolphins inhabiting Slovenian Sea and the surrounding waters has been started in 2002. The population or the population segment seems to be resident. The study area is rougly 600 km², including the Gulf of Trieste and the neighbouring waters. Surveys were conducted randomly all year round. A total of 31 sightings were recorded, from boat- and land-based surveys between August 2002 and October 2004. Dolphins were seen all year round and they are also breeding in the area. During the 14 sightings, in which it was possible to carry out photo-identification, 36 bottlenose dolphins were identified over two years. Several dolphins identified in 2003 were also sighted in 2004, showing a significant rate of site fidelity. In order to get an insight into the bottlenose dolphins' home range and movements in the northern Adriatic Sea, all identified dolphins were compared to those of the most updated catalogue of the Adriatic Dolphin Project, a long-term study carried out in Kvarneric by the Blue World Institute of Marine Research and Conservation (Croatia). This study represents the first step towards the definition of the population structure of north-eastern Adriatic bottlenose dolphins. Such information is a fundamental element that must be highlighted before any actions for effective conservation can be taken.

SD-04

INFLUENCE OF PHYSIOGRAPHIC VARIABLES ON THE SPATIAL DISTRIBUTION OF TOOTHED CETACEANS USING PLATFORM OF OPPORTUNITY DATA: A CASE STUDY IN THE BAY OF BISCAY AND ADJACENT WATERS

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Data on habitat utilization by oceanic marine mammals are generally difficult to collect. However, such information is beneficial to most conservation and management purposes. In order to collect these data with minimum resources, we conducted multi-species line transect surveys between

1998 and 2002 in the English Channel and Bay of Biscay onboard a passenger ferry. A total of 17,870 nautical miles were surveyed and 1,008 toothed cetacean encounters were recorded (represented by thirteen different species). We investigated the influence of physiographic variables (related with depth and slope), latitude and longitude on the distribution of toothed cetaceans in the study area. Generalized Linear Models (GLMs) were used to model counts of animals using a logarithmic link function and assuming a quasipoisson distribution with these variables. The results suggest a significant influence of these variables on the distribution of some species. Depth and slope ranges of the different recorded species were highly variable. The distribution of the common dolphin was significantly related to areas with pronounced slope, *i.e.* over the shelf edge. Striped dolphin was strongly associated with deep oceanic waters and flat areas. The distribution of bottlenose dolphin was not correlated with physiographic variables, which lends support to this species having considerable ecological plasticity. The long-finned pilot whale occurred only in the deeper oceanic waters, but none of the environmental variables included in the GLM analysis were significant. The distribution of the sperm whale was linked to deep oceanic waters of the southern Bay of Biscay. Finally, the presence of the Cuvier's beaked whale was highly correlated with areas of considerable slope gradients, *i.e.* the submarine canyons. This study provides the first knowledge on the critical habitat of toothed cetaceans in the Bay of Biscay and adjacent waters using a low-cost survey method.

SD-05

THE OCCURRENCE OF CETACEANS IN THE POLISH WATERS OF THE BALTIC SEA BETWEEN 1945 AND 2004

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Harbour porpoise is the only residential species of cetaceans in Polish waters of the Baltic Sea. Others 13 species have visited this region since XIII century. After 1945 *Lagenorhynchus albirostris* was the most frequent species. Two individuals were bycaught in the drift nets near Kolobrzeg in 1989; one was found stranded near Rozewie, one observed swimming north of Hel Peninsula and got entangled in trawl net in 1995 and one regularly seen in the vicinity of oil platform "Beta-Petrobaltic" since May 1997, bycaught in trawl net in September 1998.Two individuals of *Delphinapterus leucas* were observed - one in May 1979 in the Puck Bay and another one near the tip of Hel Peninsula in December 1986. In February 1978 a humbak whale got entangled in fishing net in the mouth of Vistula river and was released afterwards. A spectacular visit was observed in winter 1998. In December one individual of *Stenella coeruleoalba* was taken in set nets in December in coastal waters near the Vistula Spit. In April 1999, probably a representative of the same species was found stranded in the same region. Additional findings confirm the occurrence of other whales. Sculls of *Hyperoodon ampulleatus* and *Delphinus delphis* were drugged by fishermen from the Gulf of Gdansk in 1960 and in 1994 respectively. Large fragment of the body of *Physeter macrocephalus*, stranded previously on the Russian coast of Vistula Spit in August 2004, was found on Polish site in September 2004. A vertebra of unknown whale species was found on Rozewie beach. Since 1945 there have been collected 133 reports on harbour porpoises, including bycatch, strandings and sightings. In comparison with the data collected between 1920 – 1940 (over 700 animals bycaught in fishing net) the number is significantly lower and indicates a severe depletion of the Baltic population.

SD-06

SPATIAL AND TEMPORAL PATTERNS OF SPERM WHALES GROUPS (*PHYSETER MACROCEPHALUS*) IN THE AZORES ARCHIPELAGO

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Sperm whale social structure is based on matrilineal groups of related females and immatures, which often form temporary associations with other female groups at lower latitudes, whereas mature males disperse to higher latitudes, visiting females in breeding areas. Although male and female sperm whales can be found in the Azores, there is no information on how they use the archipelago year round. Photoidentification surveys were carried out between 1999 and 2004 in all groups of islands year round, except in January. We used photoidentification to analyse sperm whale aggregations structure, and the nature and extent of their movements within the archipelago. Our results showed that sperm whale individuals visit the region during several years, though the temporal pattern of their visits is still unclear. Some of these individuals travelled in groups showing some degree of association and, thus, a level of social cohesion. Until now, there are no evidences that groups stay in the region all year round. Although some whales were detected in all months and seasons, no resightings between winter months and other seasons were made. Our results suggest that while in the Azores, sperm whale individuals or groups stay for periods of few days up to 2 months (12 days average), and then leave the area. Concerning spatial pattern and extent of movements, they travel throughout the whole archipelago. Movements between groups of islands were detected within the same year, with the maximum displacement detected of 101km. When analysing all years together, movements as far as 459km were observed, corresponding to resightings amongst the most distant group of islands. These findings suggest the absence of fine-scale

geographic preferences within the archipelago but some degree of seasonal preference. The results of this work have implications for the management of the local whale watching industry.

SD-07

CETACEAN POPULATION IN COAST OF THE BASQUE COUNTRY: DIVERSITY AND DISTRIBUTION SPRING-SUMMER 2003-2004

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A study has been done to determine the diversity and distribution of cetaceans in spring and summer in the adjacent waters of the Basque Country in the Bay of Biscay. Shipboard visual surveys were conducted, in a 15 meters long boat according to the Spanish Cetacean Society methodological protocols. Samplings were made during spring and summer 2003 and 2004, sailing a total of 2.398.73 miles with correct observation effort, covering 7.532.32 Km². The data, both of sighting and observation effort, were analysed with a Geographic Information System (Arc view 3.2), and a Statistic program (SPSS 11.0). Thirteen different species were encountered in a total of 81 sightings. The most frequent species of cetacean observed during the season was the common dolphin (*Delphinus delphis*) with 22 sightings (27 %), bottlenose dolphin (*Tursiops truncatus*) with 17 (21 %), long-finned pilot whale (*Globicephala melas*) 12 sightings (15 %), striped dolphin (*Stenella coeruleoalba*) with 10 (12 %), Cuvier´s beaked whale (*Ziphius cavirostris*) 9 (11%), sperm whale (*Physeter macrocephalus*) 2 (2%), (*Hyperoodon ampullatus*) 2 (2%), (*Mesoplodon gen.*) 2 (2%), harbour porpoise (*Phocoena phocoena*) 1 (1%), orca (*Orcinus orca*) 1 (1%), short-finned pilot whale (*Globicephala macrorynchus*), 1 (1%), Risso´s dolphin (*Grampus griseus*), 1 (1%), and minke whale (*Balaenoptera acutorostrata*), with one sighting (1%). From the data collected, the distribution of all the species with respect to the depth was examined. Significant differences were observed, between the rates of encounter in relation to the effort made and according to the depth, showing a non uniform distribution in the area. A greater presence in depths from 1200-2000 m is found located mainly in the zone of the canyon of Cap Breton (41% rate of encounter), the continental slope (35%) and 5 % in the continental platform, where the bottlenose dolphin was the species most frequently encountered.

SD-08

PRELIMINARY PHOTO ID ANALYSIS OF THE COMMON BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*), ALONG THE MEDITERRANEAN CONTINENTAL SHELF OF ISRAEL, 1999-2004

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The study's aim was the characterization of the local common bottlenose dolphin (*Tursiops truncatus*) population as regards to site fidelity, and individual mobility. Throughout 5 years of research, we preformed 112 dedicated single-day dolphin surveys using either a 6 m semi- inflatable boat or 12 m yachts. Most (105) surveys were conducted in the main study area, along 50 Km of coastline in central Israel, 3 were done in the northern part of Israel, near the Lebanese boarder and the remainder in the southern part. Surveys were limited to sea states up to 3 on the Beaufort scale. Individual identification was performed using the Photo-ID method, with new photos compared to existing ones in an ever growing catalogue, aided by the "Layer" tool of Adobe Photoshop 7. Dolphins were sighted on 41 surveys, but only 30 surveys produced photos that could be used for identification. A total of 74 different individuals were identified, of which 50 were only identified once, 14 were photographed twice, 4 on 3 occasions, 3 on 4 occasions and 3 on 5 surveys. Of the one-time IDs, 18 were sighted during the spring in groups of >20. Two individuals were identified both in the main research area and in northern Israel, at points 130 Km apart. Accumulation rate of new individuals to the catalogue is still 3-4 per survey, implying that we are not yet nearing complete identification. The results indicate that there is a geographically stable population of bottlenose dolphins in the surveyed region. A few Individuals show a rather extensive habitat range, although the limited research effort and geographical scope precludes determination of its actual size. It also seems that the area is an aggregation point for dolphins during spring time. The origin of the unusually large pods is still unknown.

SD-09

CONSERVATION GENETICS OF THE SHORT-BEAKED COMMON DOLPHIN (*DELPHINUS DELPHIS*) IN THE MEDITERRANEAN SEA AND IN THE EASTERN NORTH ATLANTIC OCEAN

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The common dolphin Mediterranean population has recently been listed as 'endangered' in the IUCN Red list. This is due to the population's drastic decline since the middle of the twentieth century, especially in the central region of the basin. However, little is know about the structure and identity of this population. We analysed 118 samples from the Black Sea, Mediterranean Sea and eastern North Atlantic using nuclear and mtDNA markers. We found population differentiation across the basin between the eastern and the western Mediterranean, and could not exclude further population structure in the central area of the basin. Such structure matched the different distribution pattern and the different habitat use exhibited in the eastern and the western part of the Mediterranean Sea. These regions are defined by different oceanographic characteristics. Moreover, nuclear and mtDNA data suggested similar dispersal for males and females. However, evidence for directional migration of females was observed from the easternmost marginal populations towards the Atlantic populations. These data suggest that adaptation to different habitat may have shaped the population structure observed.

SD-10

LONG-TERM SITE FIDELITY OF BOTTLENOSE DOLPHINS IN CARDIGAN BAY, WALES

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Cardigan Bay, Wales, is one of the three places in the UK and Ireland where bottlenose dolphins can be seen regularly. Boat-based photo-identification surveys have been carried out in this area since the late 1980's. Photo identification effort has focused on an area of approximately 1,000 km² that was designated as the Cardigan Bay candidate Special Area of Conservation (cSAC) in 1996. In this study, we compare identification catalogues of bottlenose dolphins that were obtained by different research teams. The data sets include catalogues from two available reports and three sets of unpublished identification pictures. The study periods were 1990-1993, 2001 and 2003-2004. Sighting patterns were separated into 3 categories: 1) animals seen in all three periods (N= 12), 2) animals seen in 2001 and 2003-2004 (N= 29) and 3) animals only seen 2003-2004 (N=88). Re-sightings of dolphins range from 4 to 42 times. When possible, tentative sex, birth dates and reproductive histories were allocated to identified dolphins. Plots of locations where dolphins were identified more than 20 times indicated that certain individuals exhibited a preference for specific areas within Cardigan Bay. The present study demonstrated for the first time that there is a population of bottlenose dolphins in Cardigan Bay whose long-term seasonal residency extends over more than 15 years. In addition, we provided information, such as cross-referenced identification catalogues, sightings histories and demographic data, which are useful for future management and monitoring programmes.

SD-11

INFLUENCE OF ENVIRONNEMENTAL FACTORS ON SPERM WHALE DISTRIBUTION IN NORTH-WESTERN MEDITERRANEAN SEA

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The distribution of sperm whale (*Physeter macrocephalus*), in the Mediterranean North-Western basin, is not homogenous. The 802 sperm whale acoustic observations obtained between 1998 and 2003 can be divided into four groups. The two first groups are situated near the Balearic Islands (Balearic zone) and the Provence – Côte d'Azur (Provence zone) coasts. The two others are located in the Gulf of Lyons (Gulf of Lyons zone) and in the middle of our study area (Central zone). In order to know how environmental factors influence the different groups of observations, we used sea surface temperature, chlorophyll concentration and topography maps, and compiled them in a Geographic Information System (GIS). We calculated the distances between all acoustic observation localisations and three factors: the shelf break (2000 m isobath), high primary production zones chlorophyll concentrations>0.9 $mg.m^{-3}$) and frontal zones (difference of temperature>1.2°C). We then compared the distance between factors and the positive acoustic observations of sperm whale (d1) on one hand and others acoustic observations (d0) on the other. For all the main influential factors, $\overline{d}_1$ is inferior to $\overline{d}_0$, with a significant Mann-Whitney p-value ($p<0.001$). In the Provence and the Balearic zones, the most important factor is the shelf break, while in the Gulf of Lyons zone the most influential factor seems to be the difference between sea surface temperatures, representative of frontal zones. In the Central zone, the presence of frontal zones, in particular the North Balearic front, appears to be the main influence on sperm whale distribution. So the frontal zones could be the principal feeding sources for sperm whales in area distant from shelf break, such as near the North Balearic front. These results reflect the plasticity of sperm whale behaviour, in which hunting is adapted to the local environment.

SD-12

SUMMER DISTRIBUTIONS AND THE OCCURRENCE OF COASTAL CETACEAN SPECIES IN THE OUTER SOUTHERN MORAY

FIRTH, NE SCOTLAND

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Our current knowledge of the distribution and occurrence of coastal cetacean species in the outer Moray Firth remains fairly rudimentary to date, the most substantial research in this area having been conducted almost exclusively on bottlenose dolphins within the estuarine waters of the now protected "inner" Moray Firth, with few detailed studies of this or other costal species having been carried out elsewhere in the region. The coastal cetacean species frequenting the currently unprotected waters of the outer southern Moray Firth, however, may be of considerable conservation priority, and a better knowledge of the behaviour and biology of these animals and their role in the marine ecosystem may also be of significant scientific interest. In this study, the distribution and occurrence of cetacean species using an 800 square kilometre area of this coastline was examined between May and October 2001 to 2004 inclusive. Approximately 550 encounters were recorded across this period of 7 different cetacean species, the results showing that these animals used the study area intensively throughout the summer months. The species recorded in descending order of sightings frequency were: the harbour porpoise (*Phocoena phocoena*) (n=378), the minke whale (*Balaenoptera acutorostrata*) (n=109), the bottlenose dolphin (*Tursiops truncatus*) (n=62), the killer whale (*Orcinus orca*) (n=6), the long-finned pilot whale (*Globicephala melas*) (n=3), the humpback whale (*Megaptera novaengliae*) (n=3) and the Risso's dolphin (*Grampus griseus*) (n=1). The significance of these findings are reviewed and discussed in relation to the importance of the area and the influence of the biological factors and physical characteristics of the immediate environment.

SD-13

CETACEAN POPULATIONS STUDY IN THE GULF OF BISCAY AND SOUTH OF GREAT SOLE FROM FISHING BOATS

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During summer, the fishing boats of the Basque country sailed around the Gulf of Biscay and the area of Gran Sol aleatoricly looking for fisheries of red tuna (*Thunus thynus*). During those transects they usually make sightings of cetacean species. In this scope, a research program started in 2003 to evaluate the possibility to use these platforms to identify hot spots for cetaceans during summer in these waters. Six boats of between 30 and 35 meters long and 10 meters high were used as sighting platforms. In 5 of those boats, the fishermen were formed to collect information on cetacean sightings. To calculate the effort, a group of biologist sailed onboard one of the boats following the observation protocols of the Spanish Cetacean Society and made transects in 2003 and 2004. In this boat, 3010 nautical miles were sailed with adequate sighting effort, covering an area of 44.240,227 square nautical miles. The data, both of sighting and observation effort, was analyzed with a Geographic Information System (Arc view 3.2), and a Statistic program SPSS 11. A total of 490 sightings were made, 221 with correct effort, on the boat with scientist, and 268 were opportunistic sightings (nº of sighting with effort/nº of opportunistic sighting) identifying 12 species. Fin whale (*Balaenoptera physalus*) 64/54, (*Balaenoptera sp*.) 11/52, striped dolphin (*Stenella coeruleoalba*) 33/38, common dolphin (*Delphinus delphis*) 32/34, long-finned pilot whale (*Globicephala melas*) 14/30, bottlenose dolphin (*Tursiops truncatus*) 12/111 (1%), orca (*Orcinus orca*) 2/18, minke whale (*Balaenoptera acutorostrata*) 6/6. Fishing platforms are useful to study the relative distribution, diversity and abundance of cetaceans. The implication of the fishing sector in research programs is an ideal way for sea's sustainable management.

SD-14

POPULATION STRUCTURE OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE AZORES USING PHOTOIDENTIFICATION

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Bottlenose dolphins are known to exhibit a wide range of ecological and social systems, which are found to be seasonally and geographically dependent. Distinctive coastal and offshore ecotypes have been reported in many regions. Dolphins inhabiting coastal areas appear to form a continuum in distribution but within this range separate population units may exist. In some areas these populations were found to be discrete, whereas in others they produced a mosaic of overlapping home ranges, with some genetic mixing. Most of these studies, however, have focused on coastal populations and little is known about the behaviour of the species in pelagic habitats. In this study we examined site fidelity, association and ranging patterns of known individuals to describe the structure of the bottlenose dolphin population inhabiting the Azores, an isolated archipelago located in the North Atlantic. Photoidentification data was collected during 420 boat surveys conducted between 1999 and 2004. Of the 907 individuals identified, 592 were encountered in the main study area, and an additional 315 were photographed during surveys conducted in other groups of islands. Sighting frequencies suggested that only a small number of dolphins use the main study area on a regular basis, being

encountered in all seasons and years. For these individuals distance between consecutive sightings was small (11.7±10.4 km). However, we also detected long-distance movements (ranging over 300 km) between groups of islands and these were made by the individuals less frequently encountered in the main study area. The ranging pattern seemed to be independent of the sex or age class of the individuals. The association index calculated between pairs of adult individuals failed to demonstrate a clear geographic pattern. In summary, these results suggest that bottlenose dolphins inhabiting different groups of islands are not isolated from each other, and some interaction is taking place.

SD-15

PATTERNS OF FIN CHANGES IN AN INSHORE BOTTLENOSE DOLPHIN POPULATION IN ADELAIDE, AUSTRALIA: IMPLICATIONS FOR PHOTO-IDENTIFICATION

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Photo-identification of individual animals is a widely used method in cetology. This paper examines dorsal fin characteristics of bottlenose dolphins in the Port River Estuary area (Adelaide, Australia). Over 3000 photographs (1988-2003) of 160 individual dolphins with identifiable dorsal fins were analyzed. Most changes to fin configuration were on the trailing edge and upper parts of the dorsal fin. There was no difference in the number of notches between males and females but males had a greater extent of their fin notched and the pattern of notches changed more frequently. Older animals had more notches and had a greater extent of their fin affected. Individuals living at least partly outside the estuary displayed bigger notches. Skin marks were also examined. The analysis indicated that notches on bottlenose dolphin dorsal fins in this environment change with time and in accordance with gender, age and home range. Changes occur on average every four years. Skin marks should be used to improve identification, and to detect notches changes, but have an average lifespan of only 7 months. Implications for the conduct of photo-identification studies are: 1) particular care has to be observed with the upper part of the fin, with individuals living in an open environment, and with juveniles and males; 2) photo-identifications survey has to be made at least every 7 months here, ideally more often in order to sample every individuals during this interval.

SD-16

ENCOUNTER RATES OF SMALL CETACEANS, PILOT WHALES AND ZIPHIIDAE IN COASTAL WATERS OF THE BASQUE COUNTRY (SOUTHERN BAY OF BISCAY)

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In order to contribute to the favourable conservation status of cetaceans it is necessary to get accurate information on distribution and abundance, and their relationship with their habitats. As first step in this direction, in this study encounter rates were used as index of relative abundance. During 2004 seven dedicated surveys were carried out by AMBAR (Society for the study and conservation of the marine fauna) in the Basque Country waters (up to 25 nmi offshore) following the distance sampling methodology with non-systematic line transects. During the 28 days of the study period, a total of 1234 nmi were sailed and 90 sightings of 11 different species were recorded in the area. In this work, encounter rates (number of sightings/ nautical miles sailed on effort) for the three most frequent species of small cetaceans (*Delphinus delphis*, *Stenella coeruleoalba*, and *Tursiops truncatus*), pilot whales (*Globicephala melas*) and Ziphiidae were calculated and plotted in maps with grid cells of 2 minutes latitude by 2 minutes longitude. The spatial distribution of the encounter rate shows differences between species. While bottlenose and common dolphins are distributed in the whole survey area, striped dolphins and pilot whales show differences associated to depth, with higher encounter rates in the continental slope. Finally, the encounter rate for the Ziphiidae family is strongly associated with the submarine canyon of Cap Breton.

SD-17

TESTING THE USE OF BLUBBER BIOPSIES TO DETERMINE ECOLOGICAL DIFFERENCES OF MARINE MAMMALS

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Iverson (2004) described a method for determining dietary prey components from analysis of blubber fatty acid profiles (FAP). The method requires a prey database; a set of factors to correct for differences between prey and predator FAPs; and preferably samples of whole-core or inner-layer blubber. These are difficult requirements to attain for cetaceans. However many studies now collect biopsy samples (consisting of skin plus a portion of outer-layer blubber) from live cetaceans for genetic studies, so can use be made of the blubber? Although unlikely to be useful in determining diet, it has been suggested they can, through multivariate analysis techniques be used for stock determination and examining individual, spatial and temporal variations. Such studies (using full-core biopsies) have proved useful in studies of UK seal colonies. The present study examines if the technique is also useful with

samples collected by biopsy dart. Sperm Whales and Bottlenose Dolphins from the Azores were biopsied [project CETAMARSH] and the blubber lipids extracted. Triglycerides from dolphins and triglycerides and wax esters (both fatty acids and fatty alcohols) from whales were analysed. FAPs were compared using principal component, discriminant and classification tree analyses. Outside of the breeding season mature male Sperm whales travel to higher latitudes than females, and one might expect dietary changes to be reflected in the blubber. The results showed a tendency for male and female FAPs to differ, but with some overlap which may be because it was difficult to distinguish mature from immature whales. There was some differentiation between dolphins sampled from the central islands and those from the eastern islands, but overall there was no strong evidence for the existence of separate stocks. This agrees with the findings from genetic and sightings studies. Overall FAP analysis of blubber biopsies can be useful, providing there is appropriate sampling.

SD-19

PHOTO-IDENTIFICATION OF HUMPBACK AND FIN WHALES OFF THE SOUTH COAST OF IRELAND

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The Irish Whale and Dolphin Group have been monitoring large baleen whales along the south coast of Ireland since 1999. As part of this monitoring, photo-identification of individual whales has been conducted between June and December 2004. Images of the tail-flukes or dorsal fin area of the whale are taken in an attempt to recognize individuals. To date seven individual humpback whales and ten fin whales have been identified. One fin whale was recorded in both 2003 and 2004 off Galley Head, County Cork, while several have been observed between June through to December 2004 in the same waters off West Cork. Of the seven humpback whales, five have been re-sighted, one humpback whale #HBIRL3 has been photo-identified in each of the last fours, between 2001 and 2004 in the same area of West Cork. This humpback whale has been recorded from Mine Head, County Waterford to Galley Head, County Cork and between July and November. Two other humpback whales have been re-sighted after a gap of 3 years. In addition, 10 images of humpback whales were collected in 2003 from the Cape Verde Islands off West Africa, a possible breeding ground for Irish humpback whales. No matches were made. Images have been submitted to the North Atlantic Humpback Whale catalogue but there have been no matches with images collected elsewhere in the Atlantic, which means we do not know where these whales are coming nor from their breeding grounds.

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