The 5th International Bio-logging Science Symposium

22-27 September 2014
Strasbourg, France

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Preface

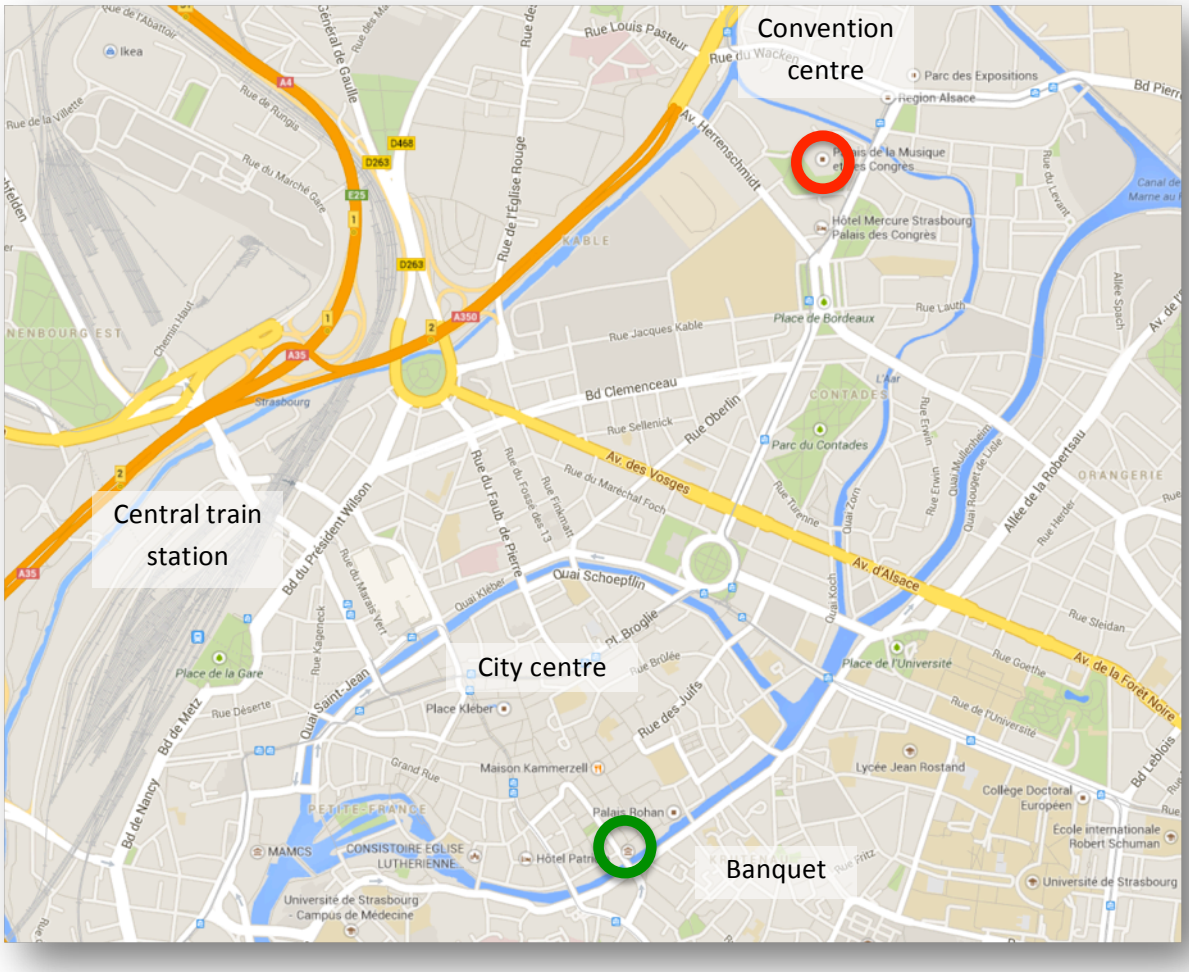
Welcome to the 5th Bio-logging Science Symposium, to France, and to Strasbourg, European capital and historical city of the Alsace region. Already eleven years have passed since the 1st International Bio-logging symposium; eleven years and four symposia that have lured an increasing number of people from various fields to join the bio-logging family. To reflect the diversity of Bio-logging approaches that can be found in the literature, we are continually expanding the scope of these symposia. Accordingly, the themes of this year's symposium are so broad as to encompass studies investigating aquatic, terrestrial and aerial species and their respective habitats. We have also widened the scope of the symposium to include cutting-edge telemetry applications, as well as innovative systems using passive tags, when used in conjunction with Bio-logging.

The organizers would like to thank all of the sponsors, who have been extremely supportive despite continuing global financial difficulties. Indeed, this event would not have been possible without the help of the Institut Pluridisciplinaire Hubert Curien (UMR7178) and its two supervisory bodies, the Université de Strasbourg et l'Initiative d'excellence «Par-delà les frontières, l'Université de Strasbourg », and the Institut National pour l'Ecologie et l'Environnement from the Centre National de la Recherche Scientifique, as well as sponsorships from the Région Alsace and the Communauté Urbaine de Strasbourg, the Office of Naval Research (USA, Award Number: N000141410405), Little Leonardo (Japan), Wildlife Computers (USA), the Collecte Localisation Satellites (France), Biologging Solutions (Japan) and Maritime BioLoggers (Canada). BLS5 also welcomes 14 vendors who will be displaying their products during the week. Finally, a huge thanks is due to Peter Klimley, Ran Nathan and Luca Giuggioli who, under a special arrangement with BioMed Central, have offered to waive the open access publication fees for those manuscripts that will be accepted for publication in the supplemental issues of Animal Biotelemetry and Movement Ecology. Finally, we would like to thank all the young volunteers who will help you throughout the symposium and share their enthusiasm with you.

We hope this week will be stimulating and that you will enjoy your stay in beautiful Strasbourg. Make sure you visit Strasbourg's Petite France, the cathedral and – if you have time – the surrounding region with its beautiful Vosges mountains, wine roads and picturesque villages. And remember, Strasbourg is *the* place to enjoy Choucroute, Flammeküeche, Riesling and Picon Bière, so don't miss out!

The organizing committee of BLS5.

Maps and venues

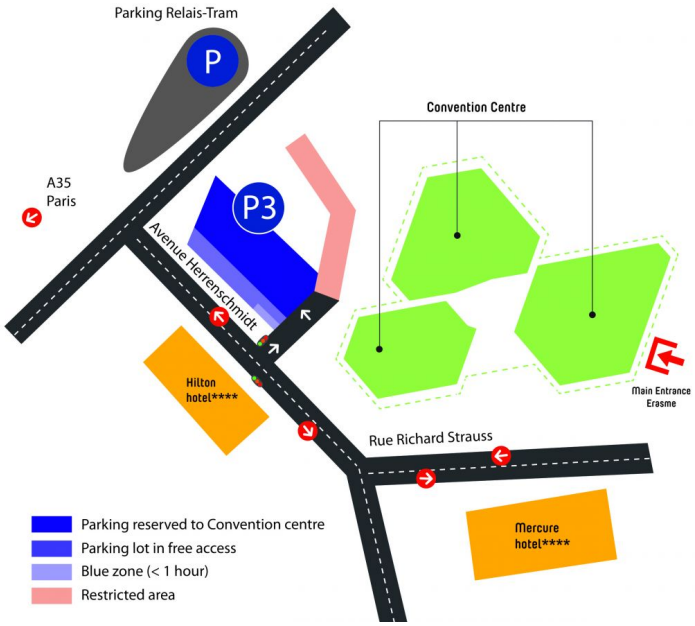


22-26 September

The symposium will be housed in the Strasbourg Convention + Exhibition Centre (also known as Palais de la Musique et des Congrès, **red circle** on the general map) in the northestern part of Strasbourg.

Palais des congrès Pierre-Pflimlin
Place de Bordeaux
FR-67082 Strasbourg cedex

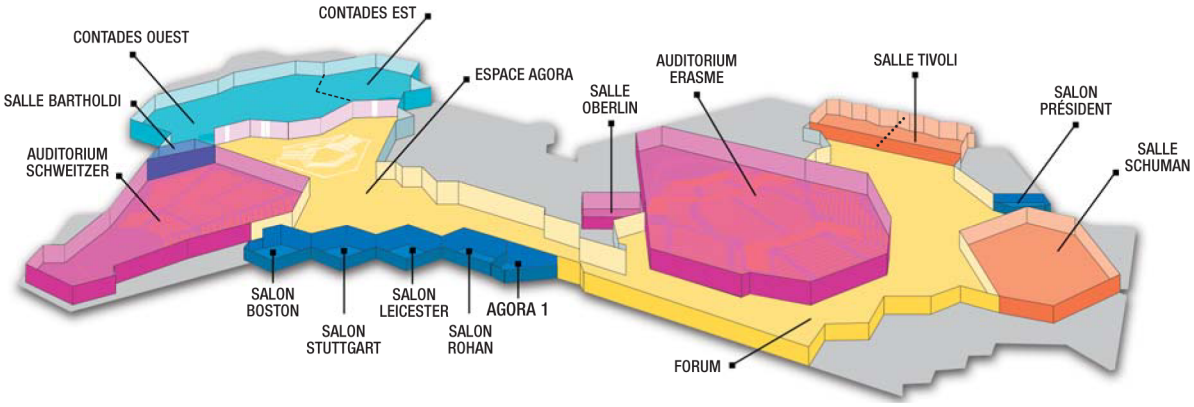
The Convention + Exhibition Centre is accessible by tramway, lines B or E, until the “Wacken” stop. You will be provided with tram-bus passes that will allow you to circulate free of charge in the city for the week.



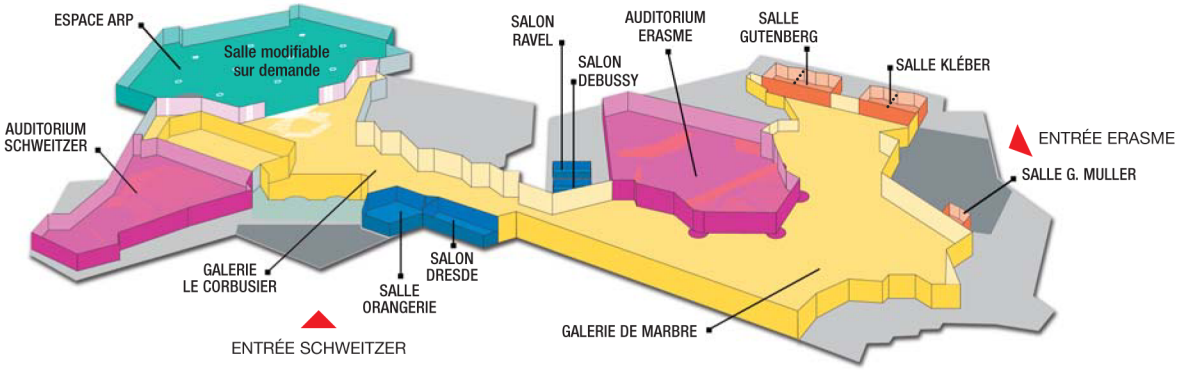
Strasbourg city also offers a Vélhop self-service cycle hire scheme. Bicycle rental points can be found at the railway station and in the city centre. A cycle path brings you directly to the Convention Centre.

The main conference will be held in the «Salle Schuman» on the first floor of the Center. Posters will be on display the whole week in the «Forum». Exhibitors' stands will be in the «Forum» nearby «Salle Schuman». The Icebreaker will take place in the «Galerie de Marbre» in the ground floor of the building on the evening of Monday 22. Wednesday workshops will be held in «Salle Schuman», «Salon Rohan», «Salon Leicester» and «Salle Oberlin», all located on the 1st floor of the building. The rooms will be available from 9h to 13h on Wednesday. PC and video projector will be available.

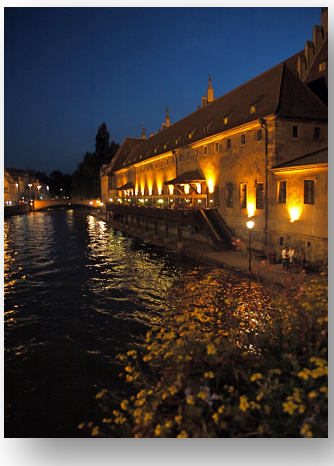
1st Floor map



Ground floor



24 September – BANQUET



The banquet of Bio-logging 5 will be held at the Restaurant «L'Ancienne Douane» located in the center of the city (http://www.anciennedouane.fr/) (see the **green circle** on the general map).

L'Ancienne Douane
6, rue de la Douane
67000 Strasbourg
Tél +33 (0)3 88 15 78 78

27 September – Workshops

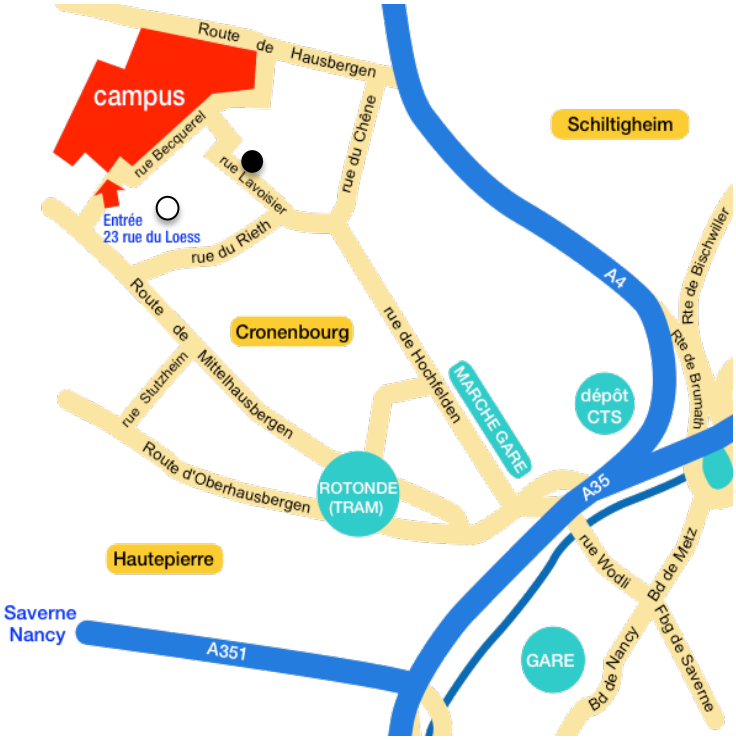
Saturday's workshops will be housed on the Cronenbourg campus of the CNRS. The address of the campus is:

Institut Pluridisciplinaire Hubert Curien

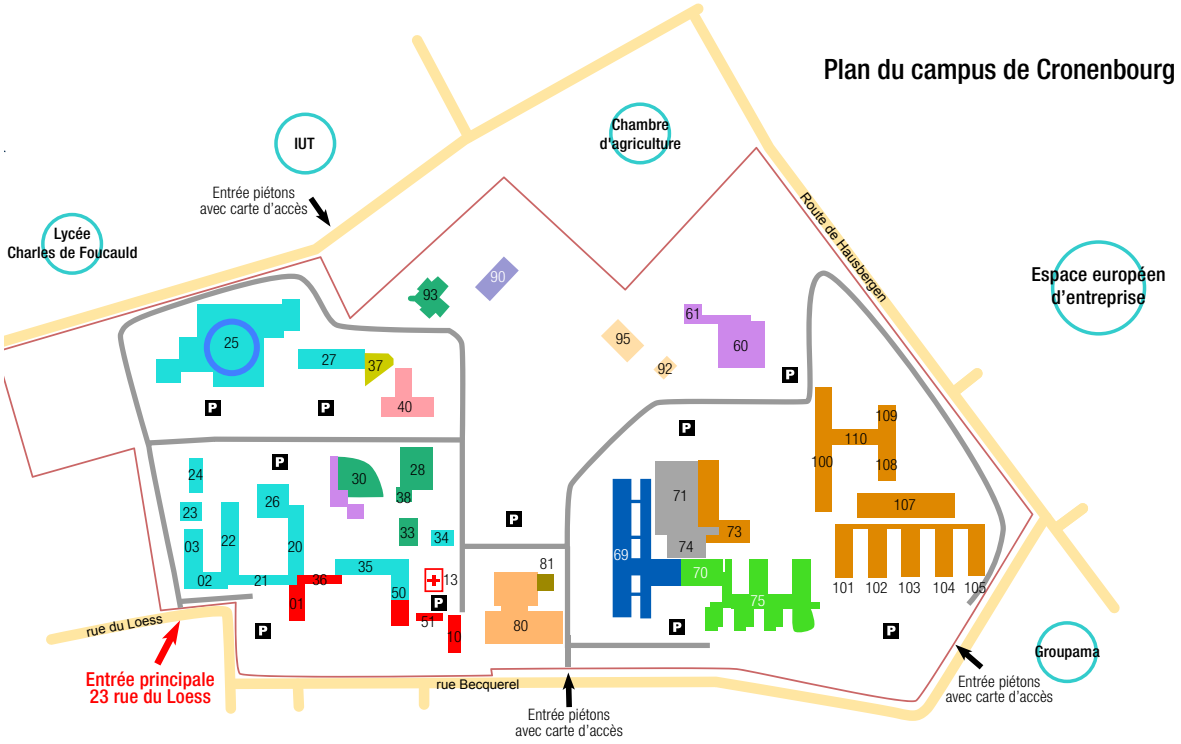
23 rue du Loess

67200 Strasbourg

At the Strasbourg central train station (GARE) you can either take the tram-bus G until ARAGO station (black dot) or the tram A or D until ROTONDE station and then the bus 19 until HALDENBOURG stop (white dot). There are several entry points to the CNRS but please use only the entry point situated « rue du Loess » (red arrow). The workshops will all be held in the building 25 (top left, bluish building on the campus map below). Volunteers will be at the main entry gate, rue du Loess, in the morning to assist you with directions.



The rooms will be available from 9h to 17h. PC and video projector will be available. Please note that there is no Wifi in the premises of the workshops. Coffee and refreshment will be provided. Participants to Saturday workshops will need to register for workshops on the first day of the symposium at the registration counters so that lunch boxes can be ordered for Saturday.



Sponsors


IPHC
Institut Pluridisciplinaire
Hubert CURIEN
STRASBOURG


cnrs
dépasser les frontières


UNIVERSITÉ DE STRASBOURG


Strasbourg.eu
& COMMUNAUTÉ URBAINE


Région
Alsace


Office of Naval Research
USN
ONR
Science & Technology


Little Leonardo
TOKYO JAPAN


WILDLIFE
COMPUTERS


CLS
COLLECTE LOCALISATION SATELLITES


BIOLOGGING SOLUTIONS INC.


MARITIME
bioLOGGERS

Exhibitors

Little Leonardo

Wildlife Computers
http://wildlifecomputers.com/

Desert Star Systems LLC
http://www.desertstar.com/

Humu Labs
http://www.humu.io/

Biologging Solutions Inc.
http://www.biologging-solutions.com/

Collecte Localisation Satellites (CLS)
http://www.cls.fr/

CATS - Customized Animal Tracking Solutions
http://cats.is/

Star-Oddi
http://www.star-oddi.com/

Cefas Technology Limited
http://www.cefastechnology.co.uk/

SMRU Instrumentation
http://www.smru.st-and.ac.uk/Instrumentatin/

Technosmart Europe srl
http://www.technosmart.eu/

BIOTRACK
http://www.biotrack.co.uk/

ATESYS-MONTOUX
http://www.atesys-montoux.com/fr/

ECOTONE
http://www.ecotone.pl/

Proceedings

The Proceedings of BLS5 will be published in two open-access *BioMed Central* (BMC) journals: *Animal Biotelemetry* and *Movement Ecology*. If you are interested in submitting to one of these journals a manuscript based on your presentation at BLS5, please follow the online procedure at:

http://www.animalbiotelemetry.com/ for Animal Biotelemetry

http://www.movementecologyjournal.com/ for Movement Ecology.

Animal Biotelemetry

Submissions for *Animal Biotelemetry* should focus on the use of biotelemetry to determine the mechanisms physiological, behavioral, and ecological processes.

MOVEMENT ECOLOGY

Submissions for *Movement Ecology* should focus on the patterns, mechanisms, causes and/or consequences of the movement, of any kind, of the whole organism.

You can submit your manuscript from the start of the conference (22nd of September 2014) till the end of December 2014. The manuscript will be evaluated following BMC's standard peer-review process. The open access publication fees of manuscripts submitted during the abovementioned period will be free of charge in both journals.

Plenary speakers

A. ECOLOGY AND ENVIRONMENT

A1. **Prof. Martin Wikelski** (Max-Planck Institute for Ornithology / University of Konstanz, Germany)

The Department of Migration and Immuno-ecology at Radolfzell Ornithological Station aims to understand why animals migrate, how they move from one place to another, and how they survive. To analyse global animal migrations, we equip individuals with state-of-the-art radio transmitters. Data from these transmitters are collected and stored in an online database accessible to researchers and the public across the globe. Between 2014 and 2020, the ICARUS-Initiative plans to establish a novel system capable of tracking even very small animals. This research will provide new insights into how organisms cope with the effects of climate change, disease, and man-made alterations to their environment.

A2. **Prof. Mark Hindell** (University of Tasmania, Australia)

Mark is Program leader of the Marine and Antarctic Ecosystems Program in the Institute for Marine and Antarctic Studies at the University of Tasmania. Prof. Hindell has been working with Antarctic mammals and birds for more than 25 years, during which time has made 17 research trips to the Antarctic or sub-Antarctic. Drawing on a range of biological disciplines (including bio-telemetry, physiology, genetics and demography), his studies are united by the common theme of understanding how predator populations respond to environmental variability, and how this knowledge can then be used to investigate the implications of human activities (in the form of commercial fisheries or climate change) for Southern Ocean birds and mammals.

B. BEHAVIOUR AND BEHAVIOURAL ECOLOGY

B1. **Prof. John Fryxell** (University of Guelph, Canada)

The general questions being addressed by my research group are (1) how do ecological constraints shape animal behavior and (2) what are the consequent effects of behavioral decisions on population processes? Much of our work at the moment focuses on movement behavior. Working on animals ranging in size from freshwater rotifers to wildebeest, we are interested in developing robust models of individual movement based on complex random walks, then scaling up individually-based movement processes to consider patterns of population spread and rates of ecological interaction amongst species. Systems currently under study include large herbivores and carnivores in Serengeti National Park, woodland caribou, wolves, and moose in northern Ontario, and zooplankton and phytoplankton species in large mesocosms. One of our most exciting areas of research in recent years relates to the use of on-board video and accelerometer packages linked to GPS radio-collars to estimate fitness costs and benefits, as a means of developing robust models of state-dependent movement. The resulting movement models can then be used to evaluate the impact of habitat changes on long-term population viability.

B2. **Prof. Rory P Wilson** (Swansea University, UK)

Rory works within the Swansea Laboratory for Animal Movement (SLAM), which comprises a group of people who study and attempt to understand animal movement in all its manifestations and for all its reasons. A major goal is the development of an energetic-based framework with which to examine any movement. Paramount in this is the acknowledgement that the capacity to describe animal movement is limited by technology. Thus, SLAM interacts with other departments within Swansea University, using the good-feeling, co-operative Welsh vibes, to develop animal-attached systems (such as the 'daily diary' – complete with accelerometers, magnetometers, speedometers and depth/height transducers) and research analytical techniques (such as 'ODBA', a proxy for movement-based energy expenditure - or 'crystal ball', a program that visualises multidimensional data) to enhance SLAM's capacity to quantify movement and understand the reasons for it. The team works with animals as small as weevils and as large as whale sharks, incorporating such enigmatic creatures as beavers, condors, mouflon, penguins and sloths, happily collaborating with a suite of important and amicable people around the world in regions ranging from Antarctica to Norway.

C. PHYSIOLOGY AND MEDICINE

C1. **Prof. Dan Costa** (University of California Santa Cruz, USA)

Daniel Costa is a Distinguished Professor of Ecology and Evolutionary Biology at the University of California at Santa Cruz and holds the Ida Benson endowed Chair in Ocean Health. His research focuses on the ecology and physiology of marine mammals and seabirds and he has worked in almost every habitat from the Galapagos to the Antarctic. He has worked with a broad range of animals including penguins, albatross, seals, sea lions, whales and dolphins. He has been a pioneer in using animals to provide oceanographic data as well as data on their own behavior. His recent work has focused on understanding the relationship between climate-driven oceanographic processes and marine mammal and seabird foraging behavior and success. These studies are critical to provide an understanding of how climate change affects marine vertebrate populations. Specifically we know that marine vertebrates rely on physical oceanographic processes to concentrate or aggregate their prey. However, we do not understand the linkages between specific oceanographic features and the foraging behavior and success of individual marine vertebrates. Along with Barbara Block he founded the Tagging of Pacific Predators program. A multidisciplinary effort to study the movement patterns of 23 species of marine vertebrate predators in the North Pacific Ocean. He has served on a number of international science steering committees including the Integrated Climate and Ecosystem Dynamics program (ICED), The Census of Marine Life, CLIOTOP and the Southern Ocean Observing System (SOOS).

C2. **Prof. Chantal Simon** (Université de Lyon, France)

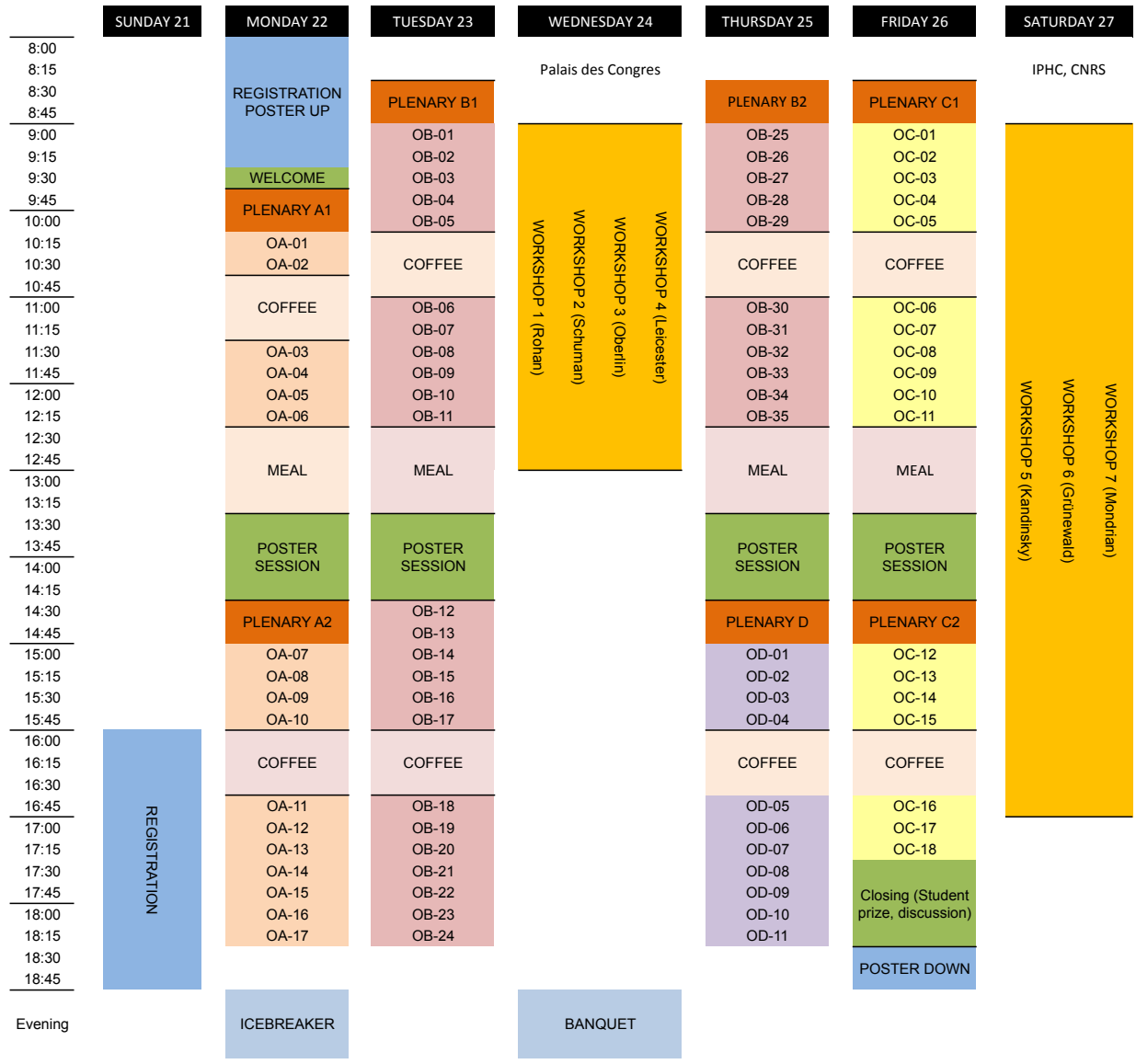
Chantal is Professor of Nutrition and Senior Fellow in the Department of Diabetology of the University Hospital of Lyon. She is co-leader of a research team in the INSERM Laboratory CARMeN U1060 (CARdiovascular, Metabolism and Nutrition) and Member of CENS (Center for European Nutrition and Health). Her primary research interests are in the physiology of physical inactivity and sedentary behaviors; in their implication in the physiopathology of excessive weight gain and insulin resistance and in the contextual and socio-environmental determinants of health (particularly diet, physical activity and psychological wellbeing). A remarkable aspect of her research is to allocate great efforts in developing interventional studies using state of the art of bio-logging and stable isotopes techniques, and conducted in free living conditions to account for the major socio-ecological constraints that regulate human behaviors. Among other studies she conducted ICAPS, an interventional randomized study aiming at reducing sedentary behaviors in adolescents by acting on their environments and which is probably one of the most effective study in the field. ICAPS is now a reference brought forward at the national and international levels and its transferability in the general French population is currently evaluated. She is Member of the Scientific Advisory Boards of the French National Nutritional Health Plan and of the European Joint Program Initiative «A healthy diet for a healthy life". She is author or co-author of more than 150 scientific international papers.

D. AROUND BIO-LOGGING

D. **Dr. Clive McMahon** (Sydney Institute of Marine Science, Australia)

Bio-logging is a powerful and insightful field of study that allows us to study the cryptic lives and habitat structure of animals in detail with ever increasing precision, accuracy and duration. But, equipping animals with recording and tracking devices can influence their behaviour and vital rates, and quantifying how these devices affect animals is important. It is important because animal habitats are being eroded locally by human activities e.g. city encroachment and more globally by anthropogenic changes to climate and the need for vital life-history information to inform management and conservation is at a premium. However, researchers can and often come across vehement opposition to studying animals using state-of-the-art tracking devices, mainly due to welfare concerns for individual animals carrying recording instrumentation. Recognising the important and urgent need to collect vital life-history information from animals my collaborators and I have embarked on assessing and developing methods for assessing the effects devices may have on individuals to provide a platform for balancing the need for bio-physical information with the welfare of individual animals. My collaborators and I work mainly with seals in Antarctica and are interested in measuring, using sophisticated tracking and recording devices, how in situ habitat structure influences behaviour and how this affects reproductive performance, survival and population growth.

Timetable


SUNDAY 21
MONDAY 22
TUESDAY 23
WEDNESDAY 24
THURSDAY 25
FRIDAY 26
SATURDAY 27
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18:45
Evening
REGISTRATION
REGISTRATION POSTER UP
WELCOME
PLENARY A1
OA-01
OA-02
COFFEE
OA-03
OA-04
OA-05
OA-06
MEAL
POSTER SESSION
PLENARY A2
OA-07
OA-08
OA-09
OA-10
COFFEE
OA-11
OA-12
OA-13
OA-14
OA-15
OA-16
OA-17
ICEBREAKER
PLENARY B1
OB-01
OB-02
OB-03
OB-04
OB-05
COFFEE
OB-06
OB-07
OB-08
OB-09
OB-10
OB-11
MEAL
POSTER SESSION
OB-12
OB-13
OB-14
OB-15
OB-16
OB-17
COFFEE
OB-18
OB-19
OB-20
OB-21
OB-22
OB-23
OB-24
Palais des Congres
WORKSHOP 1 (Rohan)
WORKSHOP 2 (Schuman)
WORKSHOP 3 (Oberlin)
WORKSHOP 4 (Leicester)
BANQUET
PLENARY B2
OB-25
OB-26
OB-27
OB-28
OB-29
COFFEE
OB-30
OB-31
OB-32
OB-33
OB-34
OB-35
MEAL
POSTER SESSION
PLENARY D
OD-01
OD-02
OD-03
OD-04
COFFEE
OD-05
OD-06
OD-07
OD-08
OD-09
OD-10
OD-11
PLENARY C1
OC-01
OC-02
OC-03
OC-04
OC-05
COFFEE
OC-06
OC-07
OC-08
OC-09
OC-10
OC-11
MEAL
POSTER SESSION
PLENARY C2
OC-12
OC-13
OC-14
OC-15
COFFEE
OC-16
OC-17
OC-18
Closing (Student prize, discussion)
POSTER DOWN
IPHC, CNRS
WORKSHOP 5 (Kandinsky)
WORKSHOP 6 (Grünewald)
WORKSHOP 7 (Mondrian)

Program

22 September, Monday

09:30 Opening remarks
Oral session A1 (Chairperson: Ratcliffe Norman)
09:45 Plenary A1: Wikelski Martin – Open questions and technological advances in terrestrial animal tracking.
10:15 OA-01: Righton David – Spatial segregation of ocean migrating Atlantic salmon.
10:30 OA-02: Meekan Mark – Why do whale sharks get so big? Ecological drivers of the evolution of body size in the world's largest fish.
Coffee break
11:30 OA-03: Mansfield Kate – First satellite tracks of yearling sea turtles provide new insight on the "lost years" oceanic niche.
11:45 OA-04: Conners Melinda – Shadowed by scale: Important behavioral states of foraging Hawaiian albatross revealed with fine-scale GPS data-loggers.
12:00 OA-05: Tarroux Arnaud – Disentangling effects of oceanography and individual states on foraging patterns of a long-lived seabird.
12:15 OA-06: Weimerskirch Henri – Impact of environmental variability and extreme events on foraging of tropical seabirds.
Lunch
13:30 Poster session
Oral session A2 (Chairperson: Roquet Fabien)
14:30 Plenary A2: Hindell Mark – In praise of big bio-logging data sets.
15:00 OA-07: D'ovidio Francesco – Integrating high resolution tracking data with the meso- and submesoscale dynamics of the open ocean.
15:15 OA-08: Goetz Kimberly – Seasonal habitat preference and foraging behavior of a top Antarctic predator, the Weddell seal.
15:30 OA-09: Baylis Alastair – Multiple foraging strategies of adult female southern sea lions (*Otaria flavescens*) breeding at the Falkland Islands.
15:45 OA-10: Guinet Christophe – Finding food at the best price: the cost of foraging in relation to habitat in southern elephant seals.
Coffee break
Oral session A3 (Chairperson: Lea Mary-Anne)
16:45 OA-11: Fedak Mike – A strategic approach to the study of oceanic heat flow to the Pine Island Glacier: the role of ocean data collected by seals in in relation to that of other modalities used in the iStar Ocean2ice Project.
17:00 OA-12: Scheffer Annette – Foraging areas of macaroni penguins (*Eudyptes chrysolophus*) in the south Atlantic and south Indian Ocean.
17:15 OA-13: Sugishita Junichi – Is it advantageous for albatrosses to forage near fishing vessels? An integrated approach using chick weight gain as a proxy for benefit.
17:30 OA-14: McInnes Alistair – Foraging strategies of breeding African penguins *Spheniscus demersus* in relation to fine-scale distribution and abundance of pelagic fish species.
17:45 OA-15: Fort Jérôme – Spatial ecotoxicology: combining biotelemetry to pollutant analyses to investigate the origin of Arctic seabird contamination.
18:00 OA-16: Russell Debbie – Visualisation of the use of anthropogenic structures by marine mammals.
18:15 OA-17: Schneider Manuel – Analysing behaviour of grazers in heterogeneous terrain using high-frequency GPS tracking.
19:00 *Icebreaker*

Oral session B1 (Chairperson: Takahashi Akinori)

08:30 Plenary B1: Fryxell John – Remote sensing of behavior, energetic constraints, and movement ecology of woodland.

09:00 OB-01: De Grissac Sophie – The Early life at sea of juveniles albatrosses and petrels: a comparative study.

09:15 OB-02: Adachi Taiki – Searching prey in 3D environment: hierarchical foraging behaviour of northern elephant seals.

09:30 OB-03: Aguilar De Soto Natacha – Sharing the wealth, a cost-benefit analysis of niche segregation in deep-diving pilot and beaked whales.

09:45 OB-04: Orben Rachael – Bigger is not always better: Body size predicts individual winter foraging strategies of thick-billed murres (*Uria lomvia*) in the Bering Sea.

10:00 OB-05: Horning Markus – In cold blood: evidence of sleeper shark predation on Steller sea lions from Life History Transmitter implants.

Coffee break

Oral session B2 (Chairperson: Stimpert Alison)

11:00 OB-06: Rutz Christian – Using proximity loggers to map social-network dynamics in wild, free-ranging birds.

11:15 OB-07: Vazquez Diosdado Jorge Alberto – Detection of welfare problems in dairy cows using a real time local positioning system.

11:30 OB-08: Wisniewska Danuta – Targeting fast prey in shallow waters: Predator-prey interactions revealed by echolocation.

11:45 OB-09: Vacquié Garcia Jade – Foraging in the deep dark of the Southern Ocean for luminous prey.

12:00 OB-10: Papastamatiou Yannis – Behavioural routines and central place refuging in a marine predator that never stops swimming.

12:15 OB-11: Hooker Sascha – Images as proximity sensors: recording conspecific Antarctic fur seals at sea.

Lunch

13:30 *Poster session*

Oral session B3 (Chairperson: Heide-Jørgensen Mads Peter)

14:30 OB-12: Fuiman Lee – Foraging tactics of Weddell seals in McMurdo Sound, Antarctica, and their changes with seasonal variations in ambient light.

14:45 OB-13: Christiansen Fredrik – High-resolution Fastloc GPS telemetry reveals fine-scale diel movement patterns and habitat use in grazing sea turtles: links to predation threat and optimisation of resource acquisition.

15:00 OB-14: McHuron Elizabeth – Foraging strategies of California sea lions at the individual and rookery level.

15:15 OB-15: Swift Rene – Prey type and density predict the foraging behaviour and kinematics of two sympatric baleen whale species, fin and humpback whales.

15:30 OB-16: Bodey Thomas – Net gains: Seabird movement reveals the ecological footprint of fishing vessels.

15:45 OB-17: Friedlaender Ari – Feeding rates and under-ice foraging strategies of the smallest bulk-filter feeder, the Antarctic minke whale (*Balaenoptera bonaerensis*).

Coffee break

Oral session B4 (Chairperson: Shepard Emily)

16:45 OB-18: Yovel Yossi – On-board GPS monitoring reveals that wild bats aggregate to improve foraging, but are impaired when conspecific density becomes too high.

17:00 OB-19: Goetsch Chandra – Specific foraging behaviors are associated with different diets in northern elephant seals (*Mirounga angustirostris*).

17:15 OB-20: Jeanniard-Du-Dot Tiphaine – Can acceleration data help to accurately estimate foraging behaviours and efficiencies of free-ranging fur seals?

17:30 OB-21: Williams Hannah – What can accelerometry tell us about soaring flight?

17:45 OB-22: Jorgensen Salvador – Locomotory patterns and energetics of the northeastern Pacific white shark, a long-distance oceanic migrator.

18:00 OB-23: Bestley Sophie – Taking animal tracking to new depths: synthesising vertical and horizontal movement relationships across multiple marine predators.
18:15 OB-24: Tremblay Yann – Going further in seabird tracking: from observing patterns to understanding processes.

24 September, Wednesday

09:00 *Workshops*
WS-1: Body temperature measurement in free ranging animals (*Salon Rohan*)
WS-2: How can bio-logging advance our understanding of flight? (*Salle Schuman*)
WS-3: A picture is worth a thousand words: bio-logging as a tool for collecting video footage and still images of animal behaviour (*Salle Oberlin*)
WS-4: Wildlife Satellite Telemetry (*Sallon Leicester*)
19:00 *Banquet (L'Ancienne Douane)*

25 September, Thursday

Oral session B5 (Chairperson: Gleiss Adrian)
08:30 Plenary B2: Wilson Rory – In search of a new movement framework based on energetics.
09:00 OB-25: Miyata Naoyuki – Japanese sea bass repeated short excursion to freshwater around salinoedge: Foraging behavior under constraint of salinity adaptation.
09:15 OB-26: Malkemper E. Pascal – Novel techniques to assess spontaneous magnetic behavior in predatory foxes and other free roaming animals.
09:30 OB-27: Watanabe Yuuki – Ecological significance of endothermy in fishes: do they swim faster?
09:45 OB-28: Norman Bradley – From a whale shark's (*Rhincodon typus*) perspective: the effect of tourism on the behaviour of the world's biggest fish.
10:00 OB-29: Fossette Sabrina – Swim or strand: accelerometry and particle tracking model reveal the importance of rheotaxis to jellyfish dispersal and survival.
Coffee break
Oral session B6 (Chairperson: Shamoun-Baranes Judy)
11:00 OB-30: Sims David – Scale-free behaviour patterns detected in diverse marine predators: what do they mean and why should we get excited?
11:15 OB-31: Sousa Lara – Satellite tracking the world's heaviest bony fish: Movements and behaviour of the ocean sunfish (*Mola mola*) in the northeast Atlantic.
11:30 OB-32: Kölzsch Andrea – Goose family behaviour explored with accelerometers and high-frequency GPS.
11:45 OB-33: Gilbert Nathalie – Are white storks addicted to "Junk Food"? Habitat selection and identification of behaviour by the white stork (*Ciconia ciconia*) from newly developed GPS/GSM data loggers and tri-axial accelerometer data.
12:00 OB-34: Thygesen Uffe – Vertical migrations of bigeye tuna: Predictions from a dynamic optimal foraging model.
12:15 OB-35: Macintosh Andrew – Logging complexity: Ecological challenges and the emergence of behavioural organization.
Lunch
13:30 *Poster session*
Oral session D1 (Chairperson: Weise Michael)
14:30 Plenary D: McMahon Clive – Biologging acrobatics: balancing the need for research and animal welfare in a vibrant research environment.
15:00 OD-01: Metcalfe Julian – Hooked on acceleration.
15:15 OD-02: Pichegru Lorien – Experimental fishing exclusions for penguins in South Africa - A success story.

15:30 OD-03: Andrews Russel – Improving attachments of remotely-deployed dorsal fin-mounted tags: tissue structure, hydrodynamics, in situ performance, and tagged-animal follow-up.
15:45 OD-04: Block Barbara – Monitoring ecosystems with biologging: The challenges and frontiers.
Coffee break
Oral session D2 (Chairperson: Evans Karen)
16:45 OD-05: Jones T. Todd – Electronic tagging studies of pelagic fish: Implications of drag on tag retention and data applicability.
17:00 OD-06: Mulero Margarita – Use of Unmanned Aerial Systems for gathering data from animals marked with GPS collars in Doñana National Park (southwest of Spain).
17:15 OD-07: Bidder Owen – A Movement Ecology Toolkit: Novel biotelemetry methodologies for elucidating animal behaviour and location.
17:30 OD-08: Murphy Christin – An animal-borne datalogger records vibrations from seal whiskers during hydrodynamic trail following.
17:45 OD-09: Mooney Aran – Concurrent measures of fine-scale behaviors and basic oceanographic parameters in the veined squid, *Loligo forbesi.*
18:00 OD-10: Humphries Nicolas E. – Unravelling GPS tag data: A simple, objective method for the identification of steps and turns in movement paths.
18:15 OD-11: Tyack Peter – A biologging approach to studying acoustic communication.

26 September, Friday

Oral session C1 (Chairperson: Hawkes Lucy)
08:30 Plenary C1: Costa Daniel – Advances in field physiology.
09:00 OC-01: Miller Patrick – Body density and diving lung volume of northern bottlenose whales (*Hyperoodon ampullatus*) derived from analysis of hydrodynamic performance during glides.
09:15 OC-02: Whitney Nick – Hook, line, and sinker? Accelerometers to assess post-release mortality and recovery periods in coastal sharks.
09:30 OC-03: Williams Cassondra – Blood oxygen depletion patterns and heart rate in a cold-blooded diver, the loggerhead turtle.
09:45 OC-04: Bishop Charles – Locomotion dynamics and heart rate of migrating bar-headed geese (*Anser indicus*).
10:00 OC-05: Portugal Steven – Bright nights, costly mornings: increases in night-time body temperature correspond with brightness of the moon and cloudless nights in wintering barnacle geese (*Branta leucopsis*).
Coffee break
Oral session C2 (Chairperson: Mellish Jo-Ann)
11:00 OC-06: Ponganis Paul – How to dive deep: Heart rate and blood oxygen profiles in California sea lions.
11:15 OC-07: Tift Michael – Gliding down and stroking up: Blood oxygen depletion and exercise intensity in California sea lions.
11:30 OC-08: Hindle Allyson – Endothermy at the poles: understanding air/water thermoregulation in free-ranging Weddell seals by skin surface heat flux.
11:45 OC-09: Furukawa Seishiro – Switching of gill-ventilation modes in freely-swimming sailfish revealed by video/speed/depth/acceleration data-loggers.
12:00 OC-10: Madsen Peter T. – Playing tag with the biggest nose on record: Biomechanics of air-driven sound production in deep-diving sperm whales.
12:15 OC-11: Johnson Mark – Where's the air? Sound recording tags on deep diving whales reveal nasal air movements.
Lunch
13:30 *Poster session*

Oral session C3 (Chairperson: Handrich Yves)

14:30 Plenary C2: Simon Chantal – Stakes and challenges of physical activity evaluation in relation to health in humans.

15:00 OC-12: Evans Alina – Drivers of den entry and exit behavior in the brown bear.

15:15 OC-13: McDonald Birgitte – Big hearts, small bodies, and cold water: Diving heart rate in harbor porpoises.

15:30 OC-14: Roos Marjoleine – The significance of respiration frequency and timing in the energetics of killer whales (*Orcinus orca*).

15:45 OC-15: Van Der Hoop Julie – Acoustic parameters as indicators of metabolic rate in *Tursiops truncatus*.

Coffee break

16:45 OC-16: Graf Patricia – Diving behaviour and energetics of a semi-aquatic, shallow-diving species: The Eurasian beaver (*Castor fiber*).

17:00 OC-17: Willener Astrid – Reassessment of the cardio-respiratory stress response: accounting for stress-associated movement.

17:15 OC-18 Grémillet David – Energetic fitness: linking metabolic effort derived from accelerometry data with Darwinian fitness.

17:30 *Closing remarks*

27 September, Saturday

09:00 *Workshops at IPHC, CNRS*

WS-5: Variability in the movement patterns of marine predator populations: physiological, behavioural and environmental drivers. A CLIOTOP WG2 workshop (*Salle Kandinsky*)

WS-6: Linking marine predator behavior to prey fields (*Amphithéâtre Grünwald*)

WS-7: Making tags work (*Salle Mondrian*)

Abstract

Plenary and Oral

Plenary-A1

Open questions and technological advances in terrestrial animal tracking

Wikelski Martin [1]

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The study of animal movement is entering a golden age because we now have the technology, the big data possibilities and the theoretical underpinnings to make rapid advances on a global level. The human society at large shows large interest in understanding the interconnectivity of life on the planet because of the global ecological and societal consequences that our field can uniquely address.

I will highlight what I generally see as the biggest deficiencies of the animal movement field. We generally have very little information about:
1) Selection: Where, when and why an animal dies. Knowing this will answer the ultimate question about selection pressures, and help us advance conservation.
2) Ontogeny: How an individual develops its movements during it's lifetime. Knowing this will give us insights into decision mechanisms and the reaction norms of animal decisions.
Although in the biological sciences we generally know more about mechanisms compared to the previous topics, we still have a large knowledge gap about:
3) Mechanisms in the wild: How an individual decides in the wild, based on it's internal physiology and
4) Environmental constraints: What are the external surroundings upon which an individual decides. One of the largest unknowns here are the
5) Social constraints: How does an individual decide based on the decisions of other animals around it and interacting with it.

We can and should involve the public in interacting and communicating with animals. Where this is done, often in native cultures, animals are already used as indicators and sentinels for biological and earth processes. Modern observational tools now allow us to interact with animals in unforseen ways and change our perception about the connectivity of life on the planet.

OA-01

Spatial segregation of ocean migrating Atlantic salmon

Righton David [1], Rikardsen Auden [2], Hedger Richard [3], Chittenden Cedar [2], Davidsen Jan [3], Okland Finn[4], Naesje Tor [4], Gargan Patrick [5], Thorstad Eva [4], Halttunen Elina [2], Aarestrup Kim [6], McKinley R. Scott [7]

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7: The University of British Columbia, Canada

Catches and survival of Atlantic salmon in the North Atlantic have declined by ~70% since the 1970s. The cause of the decline has been attributed to overfishing and reduced marine survival that, in the latter case, links to ocean climate. However, the links between ocean processes, habitat occupation and marine survival of salmon are only poorly understood. We used pop-up satellite archival tags (PSATs) to observe the behaviour and oceanic migration of more than 150 kelt salmon from eight different Atlantic salmon populations within the North Atlantic. We show that the primary migration routes of different populations aligned with surface ocean currents, with the result that kelts moved rapidly northward and/or westward after release to productive frontal areas off Greenland. Populations were spatially segregated during the feeding season, with more northerly populations exploiting latitudes higher than 70N during the Arctic summer, while more southerly populations exploited feeding grounds further south. Individuals in each population showed increased diving activity when resident in frontal regions. Predicted changes in the location and strength of the polar front due to a more variable and changing climate are likely to impact the feeding migrations of kelt salmon, with consequent effects on their population dynamics.

OA-02

Why do whale sharks get so big? Ecological drivers of the evolution of body size in the world's largest fish.

Meekan Mark [1], Fuiman Lee [2], Davis Randall [3], Berger Yuval [1], Thums Michele [1]

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2: The University of Texas, Marine Science Institute, USA
3: Department of Marine Biology, Texas A&M University, USA

Whale sharks (*Rhincodon typus*) eat very small prey, implying strong selection for cost-effective foraging. Using biologging and satellite tagging approaches, we show that they improve foraging efficiency by fixed, low power swimming at constant speeds, gliding descents and asymmetrical diving. This results in an average 27% increase in foraging efficiency relative to horizontal swimming. However, during the daytime in the open ocean, these sharks must access food resources at depths of 250-500 m, where long, slow gliding descents, continuous ram ventilation of the gills and filter-feeding are likely to rapidly cool the blood and body. Whale sharks overcome this problem through their large size and a specialized body plan that isolates red muscle on the dorsal surface, allowing heat to be retained near the centre of the body within a massive core of white muscle. This plan differs from that of endothermic tunas and lamnid sharks, which conserve metabolically-derived heat through the use of heat exchangers and balaenid whales, which have an insulating layer of blubber. The energetic circumstances of whale sharks have led to a body plan that allows these warm-adapted fishes to maintain enhanced function of organs and sensory systems while exploiting food resources in deep, cool water.

OA-03

First satellite tracks of yearling sea turtles provide new insight on the "lost years" oceanic niche

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2: Florida Atlantic University, USA
3: University of Wisconsin, USA
4: Rosenstiel School of Marine and Atmospheric Science, University of Miami, USA

Using small, solar-powered satellite tags and novel tag attachment methods, we satellite tracked 17 neonate loggerhead sea turtles from their natal beaches in the western Atlantic. Young loggerheads are known to associate with epipelagic *Sargassum* for food and shelter; however, the thermal benefits of associating with surface habitats have not been considered. The first satellite tracks of neonate loggerheads in the Atlantic revealed a thermal disconnect between predicted (satellite- and model-derived) sea surface temperatures and ambient temperatures recorded by the satellite transmitters. Tag charge rates and Argos location accuracy codes both suggest that these neonate turtles spent most of their time at the sea surface. We measured the solar reflectivity of satellite tags, turtle shells, *Sargassum* spp. specimens, and seawater to determine whether the observed difference between ambient and predicted temperatures could be explained by differences in solar reflectivity among these different materials. Our results show that the average 6°C difference is likely due to surface-based habitat use and solar absorption. This surface-based habitat selection provides oceanic stage turtles with a thermal refuge that promotes growth and temperature-dependent processes such as feeding, suggesting an evolutionary mechanism that supports the survival of young, heterothermic reptiles in the open ocean.

OA-04

Shadowed by scale: Important behavioral states of foraging Hawaiian albatross revealed with fine-scale GPS data-loggers

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2: San Jose State University, USA

As synchronous, colonial breeders, Hawaiian albatrosses face heightened constraints during the chick brood phase: 1) a spatial restriction to poorer-quality subtropical habitat and as a result 2) a putative increase in resource competition (both intra- and inter-specific). We combined residence times, landing rates, and drift sinuosities to characterize the fine-scale foraging behavior of brooding black-footed (*Phoebastria nigripes*, n = 20) and Laysan (*P. immutabilis*, n = 16) albatrosses to understand how albatrosses mitigate these increased constraints. Albatrosses foraged both in direct flight and in area-restricted search, but direct flight foraging was most prevalent, supporting the idea that spatial analyses dependent upon turn angles and speeds can miss important foraging states. Highly tortuous drifts (unrelated to wave height) were also common, suggesting that both species employed a «sit-and-wait» tactic, a result reinforced by a concomitant analysis of diet. Both species had similar time-activity budgets, but subtle differences emerged when examined under diurnal and lunar influences. There was substantial overlap in foraging hotspots, and both actively foraged in the Papahanaumokuakea National Marine Monument, previously considered inconsequential «transiting grounds» for albatrosses. These results highlight the importance of matching behavioral, ecological, and management questions with appropriate tracking technology and sampling regimes.

OA-05

Disentangling effects of oceanography and individual states on foraging patterns of a long-lived seabird

Tarroux Arnaud [1], Cherel Yves [2], Kato Akiko [3], Love Oliver [4], Ropert-Coudert Yan [3], Varpe Øystein [5], Descamps Sébastien [1]

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5: Norwegian Institute for Water Research, Norway

Sea ice dynamics coupled to other oceanographic features are known to influence the underlying marine primary productivity, which can ultimately drive resource abundance and distribution for marine top predators. Some species, such as the Antarctic petrel (*Thalassoica antarctica*), breed in mountain ranges situated several hundreds of km inland. In such cases, energetic constraints (bird's physiological condition) are thus expected to be critical for breeding individuals that must undertake long and energetically costly foraging trips at sea. Superimposed on individual costs are those dictated by their highly dynamic foraging environment. Here, our goal is to tease apart the relative effects of individual vs. environmental factors on the foraging behaviour on a long-lived Antarctic seabird, and try to determine how they could affect its breeding success and population dynamics. We investigated 132 GPS tracks (for a total of 123 Antarctic petrels, pooled over 3 field seasons) depicting foraging movements during the incubation or chick rearing period. Using a combination of measurements of individual characteristics (morphometric and physiological indicators of condition, stable isotopes of carbon and nitrogen) and satellite-derived environmental data on sea-ice dynamics and ocean productivity, we suggest likely mechanisms linking these factors to the observed foraging patterns.

OA-06

Impact of environmental variability and extreme events on foraging of tropical seabirds

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In addition to an increase in temperatures, decrease in productivity, and change in wind regimes, future climate changes are expected to be associated to an increase in extreme climatic events. How will climate change and extreme climatic events such as storms affect the foraging abilities of marine vertebrates is still poorly known. During a long-term study on the effects of climate variability on foraging abilities of tropical seabirds, several cyclones have affected the foraging zones of red-footed boobies and great frigatebirds. We show that the two species were affected extensively in their foraging abilities by annual variation in the average environmental conditions. When cyclones affect the breeding grounds, on the colony juveniles and adult birds reacted differently in their foraging decisions in relation to the potential specific fitness consequences. When encountering storms at sea adult birds try to avoid the center of low-pressure systems, and can be transported far from colonies. We discuss potential consequences of climate change and of increase in stormy conditions on seabird populations.

Plenary-A2

In praise of big bio-logging data sets

Hindell Mark [1]

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The early years of bio-logging studies focused on establishing the techniques that have now become established as routine methodologies. At that time, the emphasis was on the equipment and collecting new data from a relatively small sample of animals. Now, more than two decades later, we are seeing a shift from bio-logging studies of samples of individuals, to studies that are attempting to address questions that are concerned with population, species or even community level questions. This is a sign of the maturation of the discipline, and results in an increased capacity to use these techniques to contribute to some of the big ecological questions in science today, such as what factors determine habitat utilisation and how this might change under various regimes of human activity. These big questions require big data sets, in terms of number of (i) the number of species studied, (ii) the number of individuals studied and (iii) the duration of the time-series of data. In this presentation, I will present examples of each of these types of big data sets that illustrate how bio-logging is making a contribution to large-scale ecological studies. The first is the Tagging of Pacific Pelagics (TOPP) program which saw the deployment of tags on 23 species in the North Pacific over 9 years. The resulting big data set was used to demonstrate the importance of the California Current large marine ecosystem to the predator community. The Marine Mammals Exploring the Oceans Pole to Pole (MEOP) is a good example of a big data set collected on a single species in order to understand fundamental questions about habitat utilisation and the potential effects of a changing marine environment. In particular, data from over 300 southern elephant seals that were instrumented at all their major Southern Ocean Breeding sites, were used to identify the importance of the Antarctic Continental shelf to this species, and how this varied among the populations. Of specific importance was the interaction between habitat use of female seal and how the annual advance of the winter sea-ice reduced access to the high quality shelf habitat. The final example is work of the Australian Integrated Marine Observing System (IMOS) and the French CNRS-CEBC study of ocean properties in the Kerguelen Plateau and Prydz Bay region of Antarctica. This study has been using conductivity, depth and temperature satellite relayed data loggers (CTD-SLDRs) deployed on Southern elephant seals since 2004 to monitor not only habitat use by the seals but also the fundamental oceanography of the region and how it varies over time. The resulting 10-year time series (and still on-going) is providing valuable data on inter-annual variability in the marine environment and how the seals respond to it. These three examples demonstrate how bio-logging is emerging as a mainstream ecological tool and more importantly how the generation of these types of big data sets is an important part of the future of bio-logging.

OA-07

Integrating high resolution tracking data with the meso- and submesoscale dynamics of the open ocean

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In the past, low-resolution (~100km) tracking of marine predators has shown that animals' distribution in the open ocean is far from being random but responds to large-scale physical gradients. More recently, the technological advancements in telemetry is challenging us for matching much finer scale trackings (~km and even smaller) to physical structures of comparable size. What are the environmental structures which animals respond to below the 100km scale? This question is particularly interesting because this finer scale is the one that can resolve behavioral switches in animal trajectories as well as the spatial scale of interest for conservation or fisheries' managing plans. Here I will review some recent results on the meso- and submeso-scale ocean dynamics, with special emphasis on high-resolution satellite data. When analyzed with nonlinear tools, remote sensed physical observations like sea surface altimetry can identify in the seemingly uniformity of the open ocean dynamical regions of potential ecological interest like highly retentive eddy cores, transport barriers, or fronts between water masses of different origin. When compared to high-resolution trajectories of whales, frigatebirds, elephant seals, these structures appear as a promising approach for describing the contrasted pelagic landscape in which trophic interactions occur.

OA-08

Seasonal habitat preference and foraging behavior of a top Antarctic predator, the Weddell Seal

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Despite many years of focused research on Weddell seals (*Leptonychotes weddellii*), surprisingly little is known about their seasonal movements and foraging ecology. From 2010 to 2012, we deployed satellite tags on 63 animals (11M, 52F) around Ross Island and up the Victoria Land coast, collecting behavioral information on over 335,000 dives. We used generalized linear mixed models to identify the importance of environmental variables in structuring habitat use and important foraging areas. Sea ice concentration, modified circumpolar deep water, mixed layer depth, bathymetry, distance to coast, and distance to the shelf break were significant in predicting Weddell seal presence but the importance of these variables seasonally dependent. In addition, ice concentration, bathymetry, distance to shelf break, distance to open water and distance to coast, along with several dive parameters (bottom duration, dive duration, and decent rate) were significant in predicting foraging areas. However the importance of these variables changed with season as well as time of day (dawn, day, dusk, night). Understanding Weddell Seal habitat preference and the subset of habitat where high intensity foraging occurs is especially important in light of increased presence of Antarctic fisheries in these areas.

OA-09

Multiple foraging strategies of adult female southern sea lions (*Otaria flavescens*) breeding at the Falkland Islands

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3: British Antarctic Survey, United Kingdom

Southern sea lions breeding at the Falkland Islands have declined by 97%, from the largest component of the global population in the 1930's (pup production of ca. 80,000) to now the smallest (< 3,000 pups per annum). Despite this dramatic decline and failure to recover, the population has remained virtually unstudied. In particular, knowledge of their at-sea movements (required to elucidate impediments to population recovery) is limited to one adult female equipped with a satellite tag in 1992. Between 2011 and 2014, we deployed GPS tags and dive loggers on 37 adult females during the austral summer and autumn at the largest Falkland Islands breeding colony (ca. 330 pups). Results revealed that adult females foraged in two discrete habitats. These are broadly defined as inshore (coastal) habitats (max. foraging trip distance < 40 km, dive depth 20 m) and offshore (Patagonian Shelf slope) habitats (max. foraging trip distance 150 km, dive depth 140 m). Results are compared to the foraging trip characteristics of adult females breeding at other South American colonies and discussed in the context of dietary and oceanographic differences between these breeding sites.

OA-10

Finding food at the best price: the cost of foraging in relation to habitat in southern elephant seals

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Optimal Foraging Theory predicts individuals should maximise the rate of net energy gain by balancing energy expenditure to cover maintenance/locomotion costs and the energy gain from prey consumption. Assessing net energy gain remains difficult in free ranging marine predators but critical to understanding how changes in prey abundance, quality and/or accessibility impacts the energy balance and, ultimately, the reproductive performances of individuals. Eleven post- breeding southern elephant seals (*Mirounga leonina*) females were equipped with a combination of GPS, time-depth, accelerometer, temperature and light data recorders to investigate their foraging behavior and performance in relation to the foraging habitat visited, ranging from subtropical to Antarctic waters. Variations in prey catch attempts (PCA), seal body condition (i.e. buoyancy) and swimming effort were inferred from accelerometer data along the individuals' foraging routes. PCAs were negatively related to water temperature at 200 m depth and to local chlorophyll-a concentration and to the dominant phytoplankton types (assessed using PHYSAT algorithm) with individuals being more successful in the presence of diatoms. Variation in seal buoyancy was positively related to the number of PCAs but negatively to swimming effort with 7-day lag. A significant effect of foraging habitat was also found on the number of PCA performed.

OA-11

A strategic approach to the study of oceanic heat flow to the Pine Island Glacier: the role of ocean data collected by seals in relation to that of other modalities used in the NERC iStar Ocean2ice Project

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3: British Antarctic Survey, United Kingdom
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The Pine Island glacier (PIG) drains an area ⅔ that of the entire UK and may contribute 3.5-10mm to global sea level rise in the next 20 years. But year-to-year variability in melting of the glacier is sensitive to the amount of warm ocean water reaching the ice shelf's underside. Over a period of 6 weeks, Ocean2ice utilized an icebreaker to deploy CTDs, micro-velocity profilers, gliders, moorings and SMRU-CTDs (on Weddell and Southern elephant seals) in the area around the PIG, from the shelf break to the ice front and within the deep troughs that funnel warmer circumpolar deep water to below the floating ice shelf. Autosub was deployed to explore the topography of the seabed and underside of the ice and provide CTD and micro-velocity profiles below the ice. The sea was rapidly freezing over as the ship departed. We present an overview of how the combination of observation technologies enhances our ability to examine and model the impact of ocean water on the PIG. Only the moorings and the seals provide *in-situ* observations during the winter. The combination of approaches is essential to model the oceans effect and seals provide crucial geographical coverage of the winter-time water-column structure.

OA-12

Foraging areas of macaroni penguins (*Eudyptes chrysolophus*) in the south Atlantic and south Indian Ocean

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Macaroni penguins are the most important avian consumer of marine resources on the planet, but their population has declined substantially and consequently is regarded as Globally Endangered by BirdLife International and the IUCN. A better understanding of this decline and the implementation of effective protection are dependent on the identification of the bird's key foraging areas and the oceanographic features characterizing these areas. We analysed GPS, Argos and GLS tracking data of macaroni penguins breeding at South Georgia, Crozet and Kerguelen, where approximatively 80% of their entire world population breed. We identified key foraging areas at sea, and recognized most important marine habitat features during different stages of the breeding cycle using Generalized Additive Models. The Antarctic Polar Front and Sea Surface Height appeared to play an important role for foraging macaroni penguins during incubation and pre-moult, whereas birds during the broodguard and crèche stage explored smaller-scale oceanographic features often related to bathymetry and regional circulation in proximity of the colony. Our maps of marine habitat use of these breeding sites will be used to delimit the boundaries of most important at-sea areas of macaroni penguins and list these as marine Important Bird Areas (mIBAs) according to BirdLife International criteria.

OA-13

Is it advantageous for albatrosses to forage near fishing vessels? An integrated approach using chick weight gain as a proxy for benefit

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Incidental fisheries bycatch is recognised as a major threat to albatross populations worldwide. Yet, fishery waste produced in considerable quantities may benefit some scavenging seabirds. We examined whether feeding in association with vessels is advantageous for chick provisioning, in northern royal albatross (*Diomedea sanfordi*) at Taiaroa Head/Pukekura, New Zealand. Fine- scale interactions between albatrosses and vessels were analysed using GPS tracking and Vessel Monitoring Systems. Meal size fed to chicks was measured using automatic nest balances, and radio transmitters attached to adults allowed us to allocate each feeding event to the appropriate parent. The combination of these techniques enabled comparison of meal sizes relative to parental foraging with or without association with fishing vessels. A total of 46 foraging trips and subsequent chick feeding events were monitored during the chick-rearing period. The effects of fishery interaction on the meal size was analysed using a linear mixed-effect model, adjusted for foraging trip duration. Our results suggest there is no advantage for chick provisioning in foraging with vessels, with low rates of bird/fishery interaction recorded. This study used an integrated approach to studying the ecology of interactions between seabirds and fisheries, and could be applied to any species that are susceptible to bycatch.

OA-14

Foraging strategies of breeding African penguins *Spheniscus demersus* in relation to fine-scale distribution and abundance of pelagic fish species

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To optimize energy gain, animals need to adapt their foraging strategies to the scale of variability of the environment in which they feed. Determining these strategies for inshore marine species is complicated by scale-related discrepancies in interpreting the variation in their food supply. For instance, African penguins forage within ca. 50 km of their colonies during the breeding season. To examine the foraging strategies adopted by this species, we deployed 172 chick-rearing individuals with GPS loggers between 2012 and 2013, while simultaneously surveying pelagic fish schools within their foraging ranges around St Croix and Bird islands. Machine-learning algorithms were used to predict the behavioural state of penguins using dive descriptors from 229 birds equipped with both GPS and depth loggers between 2007 and 2013 to classify foraging and commuting modes. During periods of lower prey abundance, birds frequented distinctive areas of predictable prey availability. When pelagic fish were abundant, penguins foraged over a wider range of directions, likely limiting intra-specific competition, while remaining close to their colony. Foraging path metrics were inversely related to overall fish abundance. Differences in foraging strategies between sites are discussed with reference to the influences of ocean physical processes and purse-seine fishing activities.

OA-15

Spatial ecotoxicology: combining biotelemetry to pollutant analyses to investigate the origin of Arctic seabird contamination

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The Arctic wildlife is exposed to increasing levels of pollutants in their environment, among which mercury (Hg) has raised important environmental concerns. Hence, defining concentrations, trends and ecotoxicological effects of Hg on Arctic organisms is essential for the conservation of vulnerable species and sensitive ecosystems, and has been the objective of various studies. However, many top-predators such as seabirds are highly mobile, can travel over large distances and spent a large part of their cycle far from the Arctic, in areas where their exposure to contaminants remains largely unknown. By combining biotelemetry to pollutant analyses, we investigated the seasonal contamination of little auks (*Alle alle*) in relation to their distribution, and showed how long-lived top-predators such as seabirds, tracked with electronic devices, can be used to monitor pollution of marine ecosystems at large spatial scale. More specifically, we used geolocators to investigate the non-breeding distribution of three Arctic little auk populations from Greenland and Spitsbergen. We showed that birds from all sites were more contaminated when not breeding, with important inter-colony contamination differences. Furthermore, we found that a non-breeding area located in the northwest Atlantic was associated with a higher Hg contamination and merits further attention.

OA-16

Visualisation of the use of anthropogenic structures by marine mammals

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In the marine environment, ocean infrastructure has led to artificial reefs, resulting in localized increases in fish and crustacean densities. A general lack of accurate fine-scale animal movement data has hampered the investigation of whether marine apex predators can exhibit behavioural adaptations to utilise these resources. Such data are now available with the advent of GPS/GSM tags which provide both behavioural and GPS quality location data at a high temporal resolution. We deployed these tags on harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) in the North Sea. The North Sea has a high density of structures including oil/gas infrastructure, and there are proposed dramatic increases in marine renewable development, particularly of wind farms. Using bespoke telemetry visualisation software, MAMVIS, we demonstrate that anthropogenic infrastructure shape the movements of individuals of both species. We then, using state-space models, infer that these individuals are using the structures to forage. As we are entering a period of unprecedented development of the marine renewables industry and decommissioning of oil and gas infrastructure, we note that the ecological consequences of these highly individualistic behaviours are likely to be complex.

OA-17

Analysing behaviour of grazers in heterogeneous terrain using high-frequency GPS tracking

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A substantial portion of Earth's surface is shaped by the activities of grazing livestock and wildlife. Understanding their behaviour is crucial for ecosystem conservation and management. On six contrasting sites in the Swiss Alps, we investigated the relationship of livestock management and ecosystem services by continuously tracking positions of grazing cows at a frequency of 20 seconds. A random forest classifier was trained with independent field observations and allowed to group positions into the behavioural stages of grazing, walking and resting with an accuracy of about 80%. Hence, high-frequency GPS data alone has great potential for many investigations related to rangeland management. The resulting spatio-temporal activity patterns were analysed in dependence of environmental drivers (topography, vegetation) and management factors (stocking rate, water sources) using Integrated Nested Laplace Approximation (INLA) and related to ecosystem services provided by the pastures (forage production, biodiversity conservation, openness of the landscape, carbon sequestration). We find that environmental variables (terrain slope, distance from the shed and vegetation) are the primary drivers of livestock activities and that intensive rotational grazing is necessary to influence small-scale grazing impact. This provides new insights into the future management of rangelands and guidance to herdsmen and policy makers.

Remote sensing of behavior, energetic constraints, and movement ecology of woodland caribou

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Energetic balance is thought to be a key determinant of demographic rates, yet estimating energetic costs and benefits in free-ranging animals presents significant logistic challenges. Animal-borne activity monitors (using accelerometer technology) combined with behavioral assessment (using on-board video cameras) present a promising method for meeting this challenge. For the past 3 years we have used accelerometry and behavioral observations from animal-borne video cameras to evaluate the demography and movement ecology of 34 free-ranging caribou (*Rangifer tarandus caribou*) in inaccessible locations in northern Ontario. Video cameras linked to satellite GPS collars provided thousands of random behavioral samples across seasons for each individual, which were used to evaluate sources of variation within and among individuals. Video-based behavioral assessment was used to estimate patterns of diet selectivity, energy gain, habitat choice, breeding success, and social interactions. Video data also provided key information on breeding success of animals in inaccessible locations, vital for demographic analyses of such endangered species. Accelerometry was capable of predicting with reasonably high precision coarse categories of behavior (lying down, feeding, standing, running) that differ in energetic costs. Both captive and free-ranging studies revealed positive relationships between activity level based on accelerometry and energy expenditure. Activity patterns based on accelerometry scores were then measured over thirteen months for 131 free-ranging woodland caribou spanning 450,000 km^2 in northern Ontario. Individual displacement was strongly related to integrated accelerometer scores. After accounting for displacement, activity was significantly influenced by vegetation abundance (presumably due to foraging), snow depth (presumably associated with digging for winter forage), and temperature (suggestive of behavioural thermoregulation by caribou). These energetic parameters were used to estimate parameters for mechanistic movement models and local habitat selection by caribou living in remote parts of the Canadian north, demonstrating the utility of multi-faceted satellite radio-telemetry platforms for remote sensing of key variables influencing the long-term sustainability of wildlife populations in inaccessible environments..

OB-01

The Early life at sea of juvenile albatrosses and petrels: a comparative study

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In long-lived species, juveniles and immatures, represent up to 50% of the total population. Therefore, in order to understand the dynamics of those populations, it is essential to better understand their foraging ecology that remains, until recently, poorly known. We tracked the juveniles of ten species of Procellariiformes in the Southern Ocean during their first month at sea in order to examine how their foraging strategy differ from that of adults, and how they differ between species whose adults show contrasted foraging habits. (1) We use multifactorial analyses of trajectory parameters in order to characterize and compare the different foraging strategies. Within species, birth colony and sex can affect individual strategy and foraging zones. (2) We find that species differ extensively from dispersive to true migratory behavior. Most juveniles of each species follow, the migration or dispersion patterns of non-breeding adults, showing an innate ability for navigation toward preferred foraging places. However, for two species we observe a clear contrast between foraging strategies of adult and juveniles. Important sex specific differences also occur for some species. We discuss the implication of these results in terms of the evolution of the foraging behavior of naïve individuals.

OB-02

Searching prey in 3D environment: hierarchical foraging behaviour of northern elephant seals

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Predators are expected to adjust their movement path according to the spatial distribution pattern of prey. In the marine environment, diving predators exploit three-dimensional (3D) environment where small-scale prey patches are often nested within large-scale patches (hierarchical distribution). However, few studies examined the fine-scale foraging behaviour of deep divers in three dimensions. Here we applied spherical first-passage time (SFPT) analysis on 3D diving path of four female northern elephant seals during their foraging migrations. We also examined prey encounter events along the 3D diving path using mandible accelerometers. SFPT analysis showed that area-restricted search (ARS) behaviour occurred at the small spatial scale of 8-10 m (i.e. radius of sphere), which was nested within the larger ARS scale of 17-19 m. Small- and large-scale ARS behaviour occurred 4.7 and 5.9 times in a single dive on average, respectively, and covered only the small proportion (9 and 22%, respectively) of the total distance traveled during the bottom phase of dives. However, a large proportion of prey encounter events (71 and 84%) occurred during the small- and large-scale ARS behaviour, respectively. These results suggest that elephant seals effectively use nested ARS behaviour to enhance foraging success in the hierarchically structured 3D marine environment.

OB-03

Sharing the wealth, a cost-benefit analysis of niche segregation in deep-diving pilot and beaked whales

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Different foraging behaviours and physiology enable predators to exploit various niches in the same geographical area. In the Canary Islands short-finned pilot whales and the similar-sized Blainville's beaked whale forage at comparable depths. Data from sound and movement recording DTAGs show that the average foraging dives of these species differ in duration (15 versus 50 min), number of prey-capture attempts (1.3 versus 25) and swimming speeds (up to 9 m/s versus 3 m/s). Here, movement indicators of the cost of dives: the cumulative jerk (acceleration rate), ODBA/VeDBA (overall/vectorial dynamic body acceleration) and drag-related swimming cost, are compared in their effectiveness to predict oxygen consumption after each dive, providing an estimation of the relative cost of the dive. Considering this cost and the number of prey-capture attempts per dive, prey targeted by pilot whales in sprinting dives can be 20 times more caloric than prey targeted by the same species at low speed or by Blainville's beaked whales. The foraging behaviour of pilot whales is generalist, with strong circadian and depth differences in the caloric value of prey. In contrast, Blainville's have specialized in less caloric but more abundant and stable resources, exemplifying top-predator niche segregation in the deep-ocean.

OB-04

Bigger is not always better: Body size predicts individual winter foraging strategies of thick-billed murres (*Uria lomvia*) in the Bering Sea

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Individual or population-specific foraging strategies can reduce competition between colonies in a manner that influences migration patterns and niche specialization. For birds that fly and dive, small/light body size can be advantageous for flight but a disadvantage for diving performance. Thick-billed murres are deep divers with high-cost flight so we expect to observe differences in winter foraging patterns related to body size differences between sexes and colonies. We tested this using geolocation time-depth recorders (Lotek LAT2500) to examine wintering strategies of murres (n=54) from three colonies in the Bering Sea (2008-2010). A hierarchical cluster analysis identified three strategies based on distributions, diving, and stable isotopes. Most birds, from all three colonies, wintered south of the Aleutians, dove shallower, and at night foraging at a low trophic level. A third of the larger birds from St. Paul composed one cluster where they remained in the Bering Sea, dove deeper, and feed at a higher trophic level. A third strategy occurred during a La Niña cycle when murres increased diving effort by 2.2-fold, suggesting limited prey resources. For the larger birds from St. Paul, higher flight-costs appear to spatially constrain wintering strategies, likely contributing to population decline at that colony.

OB-05

In cold blood: evidence of sleeper shark predation on Steller sea lions from Life History Transmitter implants

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Temperature data transmitted post-mortem from 15 of 36 juvenile Steller sea lions with implanted Life History Transmitters (LHX tags, Wildlife Computers) suggest all 15 animals died by predation. In three cases at least one of two LHX tags was ingested by a poikilotherm predator and tags recorded temperatures corresponding to deep-water values after death. These tags were ejected 5 – 11 days later and transmitted after sensing light and air while floating at the surface, reporting temperatures corresponding to regional sea surface estimates. A fourth case is ambiguous, and eleven cases recorded immediate tag liberation that did not allow inferences of predator species. Among reported predators of Stellers, only sleeper sharks are known to have body core temperatures near ambient. Our data suggests that Pacific sleeper sharks need to be considered as a possible source of juvenile Steller sea lion mortality in the Gulf of Alaska region. In contrast, published studies of sleeper shark stomach contents near rookeries provided no evidence of sea lion tissue. However, estimates revealed a less than 5% likelihood of sampling such tissue amongst 200 sharks, while the probability of detecting sleeper shark attacks from LHX tags implanted into 36 sea lions is near 100%.

OB-06

Using proximity loggers to map social-network dynamics in wild, free-ranging birds

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Growing interest in the structure and dynamics of social networks has stimulated efforts to develop biologging technologies that can accurately map social encounters in free-ranging animals. A particularly promising approach is the use of wireless-sensor-networks, in which animal-attached transceiver tags communicate with each other, to record the proximity and duration of encounters, as well as with fixed receiver stations, to enable spatial tracking and remote data transfer. Here, we describe the successful deployment of such a 'proximity-logging' system («Encounternet») to study social-network dynamics in tool-using New Caledonian crows. Apart from reporting on aspects of system calibration, field deployment and performance, we will present key biological results. Our project – which is the first to use proximity loggers on birds, and the first to deploy a large-scale Encounternet system on any species – will serve as a case study to illustrate some of the opportunities, and challenges, of the emerging field of 'reality mining'. While proximity-logging systems require considerable resources for set-up and operation, they enable fully automated, near-realtime collection of association data for entire animal populations, at unprecedented spatio-temporal resolutions. At least in terrestrial applications, proximity logging is quickly becoming the method of choice for studying fine-scale intra- and inter-specific association patterns.

OB-07

Detection of welfare problems in dairy cows using a real time local positioning system

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Advances in sensor technology, together with the application of new statistical methods, have recently provided scientists with unprecedented amounts of movement and behavioural data across large networks of animals. However, the information obtained from this data is typically used in a descriptive rather than predictive manner. In our «cow tracking project» we use novel local positioning wireless sensors to record high resolution data on the movement, space use and social interactions in herds of dairy cows over an extended period of time. Using novel statistical techniques we are then able to use observed changes in individual and social behaviour to predict changes in welfare or disease status of individual cows. At the individual level, a Hidden Markov Model is used to infer typical patterns of behaviour for each cow within the herd. The model enables us to determine the likelihood of particular observed behavioural patterns, and from this we can predict if individual cows may be suffering reduced welfare or disease. In addition, we can use social network analysis to obtain simple metrics (proximity encounters, approach and avoidance) to describe the social structure of the herd and to relate changes in the social structure to welfare status of individual cows.

OB-08

Targeting fast prey in shallow waters: Predator-prey interactions revealed by echolocation

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Studies on foraging strategies of toothed whales have focused on medium- to large-sized, deep-diving species. Despite a considerable tagging effort on harbour porpoises, little is known about the foraging ecology of this small, shallow-water predator, and most of our knowledge is based on stomach contents of by-caught individuals. We used Dtag3 tags to investigate the biosonar system of six porpoises foraging in Danish waters. The tags provided continuous recordings (≤24 hours) of stereo sound (500 kHz), as well as pressure, triaxial acceleration and magnetometer data (625 Hz). Sound recordings contained echolocation signals of the tagged whale and other nearby individuals, together with echoes from the sea floor, sea surface, and organisms in the water column. Porpoises switched between several foraging strategies. When tracking benthic prey, they produced up to 40-second-long foraging buzzes accompanied by multiple capture attempts, as evidenced by rapid changes in acceleration and echoes from escaping prey. Dives for pelagic prey extended down to 5-15 m above the sea floor and involved 1-4 sprints (at 3-4 m/s) concluded with short buzzes. Moreover, one of the animals engaged in near-surface foraging behaviour, potentially cooperative with ≥ 3 other individuals. Thus, porpoises have adapted to target highly motile prey in diverse foraging niches.

OB-09

Foraging in the deep dark of the Southern Ocean for luminous prey

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Bioluminescence is very common but difficult to study in ocean. It is produced by a broad range of organisms at ends of defense, predation or communication. We aimed at assessing that bioluminescence could be used by deep diving predator to locate their prey. Southern elephant seals (SES) have a vision adapted to low intensity light with a peak of sensitivity of 479 nm, matching the wavelength of bioluminescence of most myctophid species known to represent SES's main prey. To address that question, three satellite-tracked females were equipped with high sampling rate Time-Depth-Light 3D-accelerometers and magnetometers recorders (MK10-X and DDT). First, we tested experimentally that the MK10-X light sensor was sensitive enough in detecting natural bioluminescence. Second, we linked the number of Prey Catch Attempts (PCA), assessed from the processing of accelerometer data, with the number of detected bioluminescence events. Third, using 3D dive path reconstructed from dead-reckoning, we assessed if SES modified trajectory and then performed PCA in relation to bioluminescence events. Although PCA could take place in absence of bioluminescence events, we found that PCA was positively related to bioluminescence events which provide strong support that bioluminescence represents a key element in predator-prey interactions in this deep-dark marine environments.

OB-10

Behavioural routines and central place refuging in a marine predator that never stops swimming

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Animals are likely to select behavioural routines that optimize foraging success, while minimizing energy expenditure and threats from predators. These often lead to diel changes in activity with periods of resting and active foraging peaking during certain periods of the day. For many fishes, behavioural routines are further constrained by tidal cycles and separating the effects of both cycles can be difficult. Many species of shark must swim continuously, making it difficult to identify periods of resting. We used a combination of bio-loggers and acoustic telemetry to quantify the behavioural strategies of blacktip reef sharks at an unfished Pacific atoll. Sharks demonstrated central place refuging, repeatedly occupying the same daytime habitats and making forays to and from these core areas. Sharks were most active at dusk, particularly during the falling tide. Lowest levels of activity occurred during the day when they inhabited deeper water. Dusk was also the period when body temperatures and digestive activity (based on gastric motility) were highest. These sharks may therefore utilize a 'hunt warm, rest cold' strategy, but maintain high levels of activity while body temperatures start to decrease.

OB-11

Images as proximity sensors: recording conspecific Antarctic fur seals at sea

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Despite recent advances in development of animal-borne 'proximity' tags to remotely record the interactions of multiple individuals, their efficacy depends on the instrumentation of sufficient animals, which subsequently have spatial interactions. Among densely colonial mammals such as fur seals this remains logistically prohibitive, and interactions between animals during foraging have not previously been recorded. Here we examine conspecific data collected by still image and video cameras deployed on 23 Antarctic fur seals. These cameras provide an insight into the presence of multiple diving animals at prey swarms. Conspecifics were detected in 74% of deployments, with a maximum of 5 seals detected in a single image (n = 122 images, 28 videos). No predators other than conspecifics were detected. Detection was primarily limited by light conditions, since conspecifics were usually further from each other than the 1m range illuminated by camera flash. Orientations and distances of conspecifics differed dependent on phase of dive. Implications of these results in terms of social foraging versus random aggregations are considered. These results have consequences for models linking predator behaviour to prey field densities since this relationship may be affected by the presence of multiple predators at the same patch.

OB-12

Foraging tactics of Weddell seals in McMurdo Sound, Antarctica, and their changes with seasonal variations in ambient light

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Our goal was to understand the role of light and vision in the hunting behavior of Weddell seals by examining changes in foraging tactics as day length and surface light intensity vary seasonally. We attached video/data recorders to Weddell seals and reconstructed 3-dimensional movements within foraging dives that occurred during late Winter (September-October) when there was a light (photophase) and dark (scotophase) period each day and during Spring (November) when there was no daily scotophase. Results indicate that foraging activity and foraging success (prey per day and prey per dive) were lower during late winter than during spring. In dives where prey were present, seals encountered more prey during late winter photophase than during Spring photophase. Since the principal prey, Antarctic silverfish, exhibit diurnal vertical migration, foraging depth was expected to vary inversely with ambient light. Foraging dives were shallower in late winter compared with spring and shallower during late winter photophase than during the same time of day in spring. However, foraging dives in late winter photophase were shallower than during scotophase. We cannot yet reject the possibility that seals alter diving tactics in response to seasonal changes in prey distribution, rather than responding directly to light.

OB-13

High-resolution Fastloc GPS telemetry reveals fine-scale diel movement patterns and habitat use in grazing sea turtles: links to predation threat and optimisation of resource acquisition

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Recent developments with Fastloc GPS telemetry offers the opportunity to investigate fine-scale spatial and temporal behavioural pattern in air-breathing marine animals. We equipped green turtles with Fastloc GPS-Argos transmitters at the Chagos Islands, within the World's largest Marine Protected Area, and tracked their movements for up to 2 year. The aim was to investigate if green turtles show diel behaviours on their feeding grounds and if their foraging behaviours can be likened to that of terrestrial grazers. After being tagged, some turtles migrated nearly 4000 km to their feeding grounds while others remained within the MPA. On their feeding grounds the turtles exhibited distinct diel movement and habitat use patterns. Most individuals showed preference for a single or a few distinct resting areas at night. At sunrise, the turtles moved to specific feeding sites where they stayed for most of the daylight hours. In addition, some individuals alternated between different feeding sites, similar to terrestrial grazers. These patterns seem to reflect the trade-off between grazing and risk of predation. This study demonstrate some of the great potential that Fastloc GPS telemetry can offer in terms of studying fine-scale behavioural patterns in free-living animals to address fundamental questions in ecology.

OB-14

Foraging strategies of California sea lions at the individual and rookery level

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Intraspecific competition may drive the diversification of foraging behavior in resource-limited environments, which has broad implications for population and community ecology. We used satellite tags and time-depth recorders to examine individual differences in foraging behavior of adult female California sea lions (n = 45) from San Nicolas (SNI) and San Miguel Islands (SMI), the two largest rookeries. Females from both rookeries were classified into one of three strategies (shallow-, intermediate-, or deep-divers) based on 9 dive variables, with the deep-diving strategy almost exclusive to SNI. Females from SNI were 2.8 times more variable in their dive behavior than females from SMI, which may reflect geographic differences in prey availability. Although females at different rookeries were grouped within the same strategy, shallow- and intermediate-diving females from SNI travelled farther and spent a greater percentage of time away from the rookery than their SMI counterparts. There were also differences between strategies, with intermediate-diving females travelling farther and spending a greater percentage of time away from the rookery than deep-diving females. These results indicate that the energetic costs associated with foraging are likely strategy- and rookery-specific, which could result in differential population responses to changes in prey availability.

OB-15

Prey type and density predict the foraging behaviour and kinematics of two sympatric baleen whale species, fin and humpback whales.

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Selective forces lead to ever more extreme adaptations in behaviour and morphology to reduce predation risk and maximise foraging success. Foraging in two sympatric species of baleen whale, fin (Bp) and humpback (Mn) whales, on their summer feeding grounds in the Gulf of St. Lawrence (Canada) was compared and linked to morphology, prey type and density. Whales were tagged with Little Leonardo 3MPD3GT (Japan) high-resolution data loggers between 2011 and 2014. Foraging dives were identified by the presence of lunges. Prey type and density were assessed using an echosounder, and confirmed by visual inspection of faeces. Three fin and ten humpback whales were tagged during daylight hours. Fin whale maximum dive depth corresponded to the depth of the 50 kHz deep scattering layer, humpbacks were observed to engage in benthic feeding. Lunge rate and maximum lunge speed varied with prey type for fin whales but not for humpbacks (BpFish ≈ 5.5-6.0 ms^{-1} BpKrill ≈ 3.0 ms^{-1}; MnFish/Krill ≈ 3.0 ms^{-1}). Based upon morphology we are investigating whether other parameters vary with prey type and density; e.g. turn rate, jaw gape and instantaneous acceleration. The high lunge speeds observed for fin whales match reported escape response speeds for mackerel and capelin.

OB-16

Net gains: Seabird movement reveals the ecological footprint of fishing vessels

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Anthropogenic impacts on the marine environment are diverse and operate at scales ranging from the local to oceanic basins. Discard production by commercial fisheries is one such multi- scale phenomenon, producing positive and negative impacts on scavengers at the population and community levels. These effects are driven by individual foraging behaviour, but we currently have a limited understanding of the scale(s) at which animals initiate such behaviours. This is problematic for assessing current effects, and predicting future impacts, of management. Here we use high-resolution GPS tracks of Northern gannets *Morus bassanus* to determine behavioural states, and link this with Vessel Monitoring System data to investigate the scale at which fishing influences seabird foraging decisions in near real-time. We use Markov models to document the large footprint of fishing vessels (up to 11 km), and reveal a potential behavioural mechanism as birds respond differently to vessels depending on gear type and activity. These results suggest that gannets can differentiate between vessels with respect to foraging opportunities, so that even limited fishing activity could have substantial effects on the distribution and behavior of these wide-ranging predators. Such influences have important implications for management, including discard bans and the implementation of marine protected areas.

OB-17

Feeding rates and under-ice foraging strategies of the smallest bulk-filter feeder, the Antarctic minke whale (*Balaenoptera bonaerensis*)

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Minke whales occur throughout the world's oceans, but their foraging behavior remains largely unknown. As the smallest baleen whale, they provide a unique opportunity to explore the physical and energetic limits of bulk-filter feeding characteristic of this marine predator guild. We describe the diving behavior of Antarctic minke whales (*Balaenoptera bonaerensis*) and compare their feeding rates with other species to better understand their foraging strategies and determine how they exploit the sea ice environment. We used multi-sensor suction cup tags to record 2,831 minke whale feeding events along the Western Antarctic Peninsula during summer. These whales exhibited the highest feeding rates for any lunge-feeding whale: up to 24 lunges/dive and 102 lunges/hour. Hydro-mechanical models of engulfment suggest that minke whales execute such high numbers of lunges per dive because the energetic cost of each lunge is low. Their relatively diminutive size allows minke whales to maximize access to krill patches in pack-ice environments that are not readily accessible to other baleen whales. Their ability to lunge-feed in bulk also provides an advantage over other predators such as penguins and seals, which feed on individual krill. Our data provide new insights into the limits of baleen whale feeding behavior and ecology.

OB-18

On-board GPS monitoring reveals that wild bats aggregate to improve foraging, but are impaired when conspecific density becomes too high

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How animals forage in the presence of conspecifics is one of the most fundamental questions in social behavior. Bats account for more than a fifth of mammalian species, but are very hard to monitor in the wild because of their small size and their agile nocturnal behavior. We present a new system which allows full night monitoring of a bat's movement and foraging activity. We mount bats with a GPS and a microphone. We take advantage of the bat's emission of sound to analyze its behavior allowing us to study bat foraging with conspecific competition. We tracked bats along hundreds of kilometers in the wild while following their foraging. Data shows that bats group and are attracted to conspecifics but that their foraging success decreases when they are too close to each other. We show that the decrease in foraging does not result from sensory jamming by other bats, as has been previously suggested, but from the need to localize other bats to avoid collision. We therefore found strong evidence for the existence of a classical group foraging dilemma between the need to forage together to improve success and the need to keep a distance apart to avoid interference.

OB-19

Specific foraging behaviors are associated with different diets in northern elephant seals, (*Mirounga angustirostris*)

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Foraging behavior of marine predators is a function of the diverse behaviors and life histories of their prey. Consequently, successful capture of different prey may require different pursuit and capture techniques. We examined whether the diet composition of adult female northern elephant seals influenced foraging behavior. To measure foraging behavior we deployed satellite tags and time-depth recorders (2005-2006, 2009-2012) on free-ranging seals (n=123). Diet was assessed by comparing the fatty acid profiles of each seal with those from mesopelagic prey using quantitative fatty acid signature analysis. Three diet types were evident: fish specialists, squid specialists, and mixed diet seals. Fish specialists had a significantly higher percentage of active-bottom foraging dives and dived deeper during these dives than squid specialists. They also dived deeper on V-shaped forage dives than the other two diet types. In contrast, squid specialists dived deeper and had longer dive durations on benthic dives than fish specialists. Mixed diet seals consistently had intermediate values compared to the specialists. These behavioral differences between the three diet types likely have implications for energy budgets and may influence the response of these groups to changing environmental conditions.

OB-20

Can acceleration data help to accurately estimate foraging behaviours and efficiencies of free-ranging fur seals?

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Accurate estimates of foraging efficiency (i.e. the capacity to extract a net gain of energy from the environment) are crucial to many biological studies because energy is the fundamental currency underlying individual fitness. In this study, we determined the costs of foraging (DLW, ODBA, flipper strokes count) and the energy gained from foraging (quantity and type of prey ingested) for 40 adult female northern and Antarctic fur seals using tri-axial acceleration signals from their heads and backs in addition to GPS, TDR, metabolic, isotope and diet-related measurements. We found that the cost of foraging measured using the doubly labeled water method did not correlate with ODBA or flipper strokes count (as measured from back acceleration). Second, we found that prey capture attempts (measured from acceleration on the heads of animals) combined with diet information from scats and C and N stable isotopes provided a measure of energy gained during foraging. Our results show that female fur seals employed different foraging strategies that had different foraging efficiencies ranging from negative to positive balance. Foraging strategies with low cost-to-gain ratios can impact the energy that lactating females can allocate to feeding their pups, and can consequently affect the survival of their offspring.

OB-21

What can accelerometry tell us about soaring flight?

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Accelerometry has been used to identify behavioural patterns through the quantification of body posture and motion for a range of species moving in different habitat types. The use of acceleration data to quantify different flight modes, e.g. soaring versus gliding, is however more problematic, as changes in acceleration may also arise if a bird is «pulling g». This study uses Daily Diary tags, with tri-axial accelerometers, to collect high-resolution data on the flight performance of the Andean condor (*Vultur gryphus*), a soaring species that relies on slope lift and thermals to gain height to search of resources. Unlike many of the accelerometer devices used in the study of animal movement, these tags are also equipped with tri-axial magnetometers and pressure sensors, allowing flight to be categorized into gliding and soaring, and the nature of the lift (i.e. thermal or wind-driven) to be identified. We examine patterns in bird posture and vectorial dynamic body acceleration specific to different phases of flight and so devise a classification tree to allow others to identify these using accelerometry alone. We investigate to what extent information can be extracted from accelerometry regarding soaring performance, including parameters such as bank angle and glide speed.

OB-22

Locomotory patterns and energetics of the northeastern Pacific white shark, a long-distance oceanic migrator

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We used a combination of accelerometer loggers and Pop-up Archival Transmitting tags to study feeding and kinematics of white sharks (*Carcharodon carcharias*) in the wild, and validated results using video analysis and controlled feeding in an aquarium setting. Tags were fed to eight free-swimming specimens with deployments ranging from 2 to 14 days. While inside the stomach, the orientation of the logger was arbitrary and resulted in slow shifting over time, a challenge for normal analysis routines. We used a novel calibration technique to transform the accelerometer data and produced accurate measurements of pitch and roll after post-processing. From accelerometer and depth data, periods of climb and glide swimming were elucidated. Changes in gliding descent rate over time correlated with changes in body condition in an aquarium specimen, and similar changes in the wild suggested white sharks store energy at foraging sites and tap those reserves during migration. Stomach-deployed tags provide an effective option for simultaneously logging locomotion, movement, and foraging.

OB-23

Taking animal tracking to new depths: synthesising vertical and horizontal movement relationships across multiple marine predators

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A key question for aquatic species is how changes in movement behavior are related in the horizontal and vertical dimensions when individuals forage. Alternative theoretical models and inconsistent empirical findings mean that this question remains unresolved. Here we test expectations by incorporating the vertical dimension (dive information) when predicting switching between movement states ('resident' or 'directed') within a state-space model. We integrated tracking and diving data for four seal species (Southern elephant, Weddell, Antarctic fur and crabeater) in East Antarctica. Where possible, we included dive variables derived from the relationships between (1) dive duration and depth (as a measure of effort), and (2) dive duration and the post-dive surface interval (as a physiological measure of cost). Our results varied within and across species, but there was a general tendency for the probability of switching into 'resident' state to be positively associated with shorter dive durations (for a given depth) and longer post-dive surface intervals (for a given dive duration). Our results suggest simplistic interpretations of optimal foraging theory, based only on horizontal movements, do not directly translate into the vertical dimension in dynamic marine environments. Analyses that incorporate at least two dimensions can test more sophisticated models of foraging behavior.

OB-24

Going further in seabird tracking: from observing patterns to understanding processes

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Many foraging strategies in seabirds imply more than one individual. Group foraging, network foraging, facilitation, competition, local-enhancement, producers, scroungers, all of these concepts imply several individuals. We know it happens, we do not know how. Despite tremendous improvements in animal tracking, it has remained impossible to directly observe and quantify processes of prey searching involving many different individuals. Using animal-borne video camera, we show how patterns in a GPS track can be understood in a compelling way. This technique allows us to understand the foraging context and the behavioral decisions of an individual in relation to its neighbors. Using radar technology, we show how it is possible to track an entire community of foraging seabirds. Patterns of collective behavior emerge at scales undescribe previously. We also show how seabird coordinate their actions, and at which scales. We show how these two techniques (radar and video cameras) complete each other, and we then discuss about the evolutionary importance of group foraging in seabirds.

Plenary-B2

In search of a new movement framework based on energetics

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Animal movement appears complex, as increasingly finely resolved trajectories attest, making the task of determining the rules driving movement patterns problematic. Mathematical models of animal movement, such as Brownian motion or Lévy walk, are interesting descriptors but are unlikely to help determine the elicitors of movement, nor of what causes trajectory variation. This work advocates an approach based on energy optimality whereby animals should attempt to minimize movement costs and maximize movement gain. In this framework, any point in a movement trajectory which has increased power use is defensible if the potential benefits accrued are high enough. Factors affecting power directly are speed, acceleration, angular velocity and angular acceleration, and these are modulated by the characteristics of the environment (energy landscape). Animal-attached tags now routinely measure parameters such as magnetic field intensity and acceleration, that allow us to allude to the energetic costs of movement and this, coupled with dead-reckoning approaches which allow movement to be resolved with high (sub- second) resolution, means that power use can be examined in wild animals in relation to habitat. The expectation is that points of inflection in power use will occur at points where animals have made a decision to change their movement trajectory and that specific examination of the positioning and context of these points should help determine what features elicit such change and thus enhance our understanding of what accounts for the overall movement patterns that we observe in animals.

OB-25

Japanese sea bass repeated short excursion to freshwater around salinoedge: Foraging behavior under constraint of salinity adaptation

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Japanese sea bass is an euryhaline marine fish and some population have amphydromous charactaristics, however, previous study reported that sudden changes in salinity cause fatal stress on osmoregulatory functions. Around salinoedge, where salinity changes dramatically, how do they accomplish foraging under problem of osmoreguration? We examined this question by two steps. At first their behavior was revealed by Bio-logging method under natural habitat. New devices, W190-DTC or ORI400-DTC, were attached to fish to measure salinity, ambient water temperature and depth. ORI380-D3GT was also attached to measure swimming behavior. Fish were caught, tagged and released at freshwater area (n=5), middle area (n=1) and seawater area (n=2) in Ohno river, Oita Prefecture, Japan. All fish experienced wide-range salinity from freshwater to seawater, however, average salinities were between 11.5 and 27.5, which were almost same or larger than the body-fluid osmolality of this specie. Relatively strong tail beat was recorded when fish experienced freshwater. Secondly, gill ionocytes was detected immunohistochemically with antibody specific for Na+/K+-ATPase. Their distributions of ionocytes showed that all fish were not completely adapted to freshwater. It is suggested that Japanese sea bass entered into freshwater for short period to forage under physiological constraint.

OB-26

Novel techniques to assess spontaneous magnetic behavior in predatory foxes and other free roaming animals

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A wealth of recent field studies has revealed spontaneous magnetic behaviors (SMB) in a variety of mammalian taxa. However, these studies are mainly observational and lack the experimental power needed to understand the adaptive significance and underlying sensory mechanisms mediating SMB. Here we take advantage of SMB in 'mousing' foxes shown to be ~4X more successful when facing ~north or south during predatory attacks in dense foliage. Harnesses secured to semi-domesticated foxes and equipped with GPS and miniaturized triaxial accelerometer/magnetometer units are used to develop novel 'magnetic ethograms' by comparing direct observations with time-stamped accelerometer/magnetometer data. In addition, radio- frequency collars integrated into the harness system emit weak oscillating magnetic fields shown to specifically disrupt radical-pair based magnetoreception mechanisms (RPM). Radio-frequency effects on the alignment or success of predatory attacks would provide strong evidence for involvement of a RPM in prey targeting behavior. The unique harness systems will be deployed to assess SMB in free roaming wild foxes and determine if a RPM underlies SMB during predatory attacks. These techniques provide powerful tools to investigate SMB across a range of domestic and wild animals and, for the first time, provide a direct test of the sensory basis underlying SMB in mammals.

OB-27

Ecological significance of endothermy in fishes: do they swim faster?

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Among >30,000 fish species, only tunas and some lamnid sharks have evolved the ability to maintain body temperatures higher than ambient water temperature. To explain this remarkable convergent evolution, two ecological hypotheses (which are not mutually exclusive) were proposed: thermal niche expansion and enhanced swimming performance. The thermal niche hypothesis is widely supported, as many endothermic fishes experience wide temperature ranges by migrating latitudinally and vertically. However, the enhanced swimming performance hypothesis, and its ecological advantages, has not been fully examined. Here, we compiled the routine swim speeds and the annual migration distances, recorded with various bio-logging tools, for a range of ectothermic fishes, endothermic fishes, and other swimming endotherms (penguins, seals, and whales). Using phylogenetically informed allometry, we show that the swim speed and migration distance of endothermic fishes are much greater than ectothermic fishes, and comparable to other endotherms. The cost of transport for endothermic fishes was high, indicating that fast cruising speed is not an energetically efficient strategy. Thus, an ecological advantage of endothermic fishes is the ability to cruise at fast speeds, which relaxes time constraint and allows them to utilize seasonally available resources over wide geographical ranges, much like penguins, seals, and whales do.

OB-28

From a whale shark's (*Rhincodon typus*) perspective: the effect of tourism on the behaviour of the world's biggest fish

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The whale shark (*Rhincodon typus*) is listed as 'vulnerable to extinction' under the IUCN Red List with hunting at various locations throughout its range resulting in a decline in numbers worldwide. Non-consumptive ecotourism revolving around this species has expanded dramatically in many global locations in recent years but with limited review of the impacts that this industry on the behaviour of the world's largest shark. To address this, we deployed 'Daily Diary' data-loggers on 10 whale sharks over three whale shark 'seasons' at one location (Ningaloo Reef, Western Australia) where whale shark ecotourism is well established. It was possible to establish a set of behaviours for *R. typus* and record the frequency of behavioural change under 'natural' (non-tourism) versus experimental (tourism) conditions. On-animal video cameras were also deployed to ground-truth the data collected by the data-loggers. Results from this study will be provided to relevant authorities to assist with refining management guidelines aimed at minimising future impacts to *R. typus* and the long-term sustainability of whale shark ecotourism industries worldwide.

OB-29

Swim or strand: accelerometry and particle tracking model reveal the importance of rheotaxis to jellyfish dispersal and survival

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Quantitative analyses on how marine animals respond to ocean currents are lacking. Marine turtles seem unable to detect and respond to current drift, in contrast, some fish and zooplankton species are able to sense and swim against currents. The adaptive benefits of the different strategies remain unclear. Here, we explored the response to current drift of a large zooplanktonic species: the jellyfish *Rhizostoma octopus*. In August-September 2012, *in-situ* observations of jellyfish in the Pertuis Breton, Bay of Biscay, France showed that individuals may use rheotaxis, i.e. active counter-current swimming behaviour, in response to current drift in a similar way as fish and crustaceans. To better understand this behaviour, we deployed miniature tri-axial acceleration data-loggers on 18 jellyfish and investigated their activity-budget and swimming effort. Finally, we used these empirical data to inform a particle-tracking model which simulated the distribution of virtual jellyfish in the Pertuis Breton. This model revealed that rheotaxis may help jellyfish remain aggregated and dramatically reduces their probability of stranding. We recently gathered similar results on sea nettle jellyfish *Chrysaora fuscescens* in Monterey Bay, California. This demonstrates for the first time that developing an active response to current drift might have critical life-history benefits for planktonic organisms.

OB-30

Scale-free behaviour patterns detected in diverse marine predators: what do they mean and why should we get excited?

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Animals that actively search for resources, e.g. food, mates or shelter, must often make behavioural decisions based on incomplete information about their environment, leading to degrees of randomness in actions. This random search problem is particularly acute in the open ocean, where resources can be very sparsely distributed in space and time. Given this, how do marine predators like sharks and tunas structure movements to find sufficient prey? Are there commonalities in movement pattern between taxa that point to general organising principles in behaviour? In this paper we describe how recent advances in tracking technology and movement analysis has been used to explore how marine predators move; from basking sharks and great white sharks, to jellyfish, tunas and albatrosses. We show that a 'bursty' pattern of actions consistent with scale-invariance appears common across taxa, and we explore the idea that such patterns are an intrinsic behavioural 'rule of thumb'. The new findings challenge the decades old model of Brownian motion for ecological movement and dispersal.

OB-31

Satellite tracking the World's heaviest bony fish: Movements and behaviour of the ocean sunfish (*Mola mola*) in the Northeast Atlantic

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Advanced technology now allows the characterisation of habitat-use patterns of numerous marine species, across different spatial and temporal scales, and where direct observation is impossible. However, the ocean sunfish (*Mola mola*) remains largely overlooked, despite being subject to significant fisheries bycatch worldwide. Here we present results from tracking the movements of sunfish in the Northeast Atlantic, using a combination of different tagging and analysis techniques. Since 2007, 18 sunfish have been tracked for up to 6 months using three different tracking systems (PSAT, ARGOS and Fastloc^{TM} GPS). Results show a seasonal latitudinal distribution in the region (north in summer and south in the winter), with sunfish showing an increased ability to cross major geostrophic currents, apparently, related to growth. At finer scales, sunfish exhibit intense usage of discrete areas along migratory paths that may be linked to patch foraging. With recorded dives approaching 700 m depth, sunfish show normal and reverse diel vertical movements indicating flexible behaviour to prey distributions. A more detailed understanding of migratory behaviour and space use of this charismatic species may inform potential management strategies to limit bycatch in the region.

OB-32

Goose family behaviour explored with accelerometers and high-frequency GPS

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Migratory geese fly between their breeding and wintering grounds in family groups; some families even stay together all winter and during the first spring migration. It has been hypothesised that juveniles learn about correct timing and suitable foraging sites from their parents. In order to obtain more detailed insights in how long and how close parents and chicks stay together, we have tagged 20 adult and 12 juvenile greater white-fronted geese (*Anser a. albifrons*) in family groups in their Russian breeding grounds and Dutch wintering sites. High-resolution GPS positions and 3D accelerometer measurements that were downloaded during the winter provide insights in the foraging and social behaviour of those geese. At the breeding grounds we could observe that the young geese moved around more, but stayed within 30-150 m of their parents. In the wintering grounds some chicks undertook more distant excursions (2-10 km), a few returned to the parents after 1-3 days, others remained independent for good. Accelerometer data will provide further insights about who decides to move or stay in a goose family and how this changes with time. Such knowledge will improve our understanding of learning and its influence on the future fitness of juvenile geese.

OB-33

Are white storks addicted to 'junk food'? Habitat selection and identification of behaviour by the white stork (*Ciconia ciconia*) from newly developed GPS/GSM data loggers and tri-axial accelerometer data

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The white stork (*Ciconia ciconia*) was a wholly migratory species in Europe. Since the 1980s, guaranteed, year-round food at landfill sites has enabled resident populations to establish in Iberia. Increasing numbers of storks nest near landfills, where productivity is higher. However, due to EU directives, open-air landfills are being replaced by facilities inaccessible to birds, likely causing important consequences for stork winter and breeding foraging and migratory strategies. This study fitted newly developed GPS/GSM data loggers to 15 white storks to transmit 5 high- precision (±2m) GPS locations daily including speed and tri-axial accelerometer data. Habitat selection was evaluated and 4 behaviours identified: standing/sitting, preening, foraging, flying; verified by field observations. Percentage-time spent on landfill and other habitats was quantified, as was percentage-time spent on different activities. To our knowledge, this is the most high- resolution, comprehensive study of white stork habitat selection. The percent time spent on landfills decreased by 11.8-100% from wintering to breeding. On landfill storks forage more intensively than in non-landfill habitat, particularly during breeding. Landfill users spend less total time foraging and on average 20% more time attending chicks, which likely contributes to increased productivity. The accelerometer data also highlighted a characteristic foraging style almost exclusive to landfills.

OB-34

Vertical migrations of bigeye tuna: Predictions from a dynamic optimal foraging model

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Bigeye tuna is known for remarkable vertical migrations between cold deep layers with abundant food and warm surface layers with less food available. Here, we report results from a modeling study which attempts to explain these dive patterns by dynamic optimal foraging theory, where the individual maximizes its average energy gain rate. We solve this dynamic optimization problem numerically using dynamic programming. Unknown parameters are estimated statistically based on time series of depth, ambient water temperature, and body temperature, measured at the individual with an archival tag. The final model, being conceptually simple while technically sophisticated, is able to explain the main patterns in the data, although not all features, which we discuss. The model predicts that the optimal strategies bifurcate from constant-depth strategies to vertical migrations, when the tuna is sufficiently large or the food is at sufficiently cold water layers, predict temperature thresholds which in turn determine duration of the dive cycle. The study demonstrates the feasibility of combining dynamic optimization models with time series analysis, all in a consistent state-space framework. The analysis supports the hypothesis that the tuna behaves such as to maximize its net energy gains, and allows predicting foraging behavior in unobserved environments.

OB-35

Logging complexity: Ecological challenges and the emergence of behavioural organization

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Interdisciplinary studies of complex phenomena can provide insight into ecological processes. We illustrate this by investigating an emergent property of behavioural organization: fractal time. After introducing the concept, we show how fractal analysis – which quantifies the degree to which a structure or process fills space or time – has been applied to measure complexity in normal versus pathological systems. Studies have shown that stress and disease cause complexity loss in various biological systems, including animal behaviour. We exemplify this with two models, first using directly-observed sequential behaviour in a wild primate (*Macaca fuscata yakui*) and second using bio-logged data from two penguin species (*Eudyptula minor* and *Pygoscelis adeliae*). These studies show that animal behaviour occurs in fractal time, supporting the hypotheses that complexity is biologically adaptive and that complexity loss, i.e. the greater periodicity or stereotypy displayed by stressed individuals, may reflect reduced behavioural fitness. We also use these studies to highlight the advantages of using high-resolution and continuous data collected via animal-attached devices within this analytical framework. We hope to encourage future research into the interplay between complexity, behavioural organization and ecological challenges, particularly focusing on disruption of natural processes in organisms traditionally used as environmental sentinels.

Biologging acrobatics: balancing the need for research and animal welfare in a vibrant research environment

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The advent of increasingly smaller and ever more powerful bio-logging instruments has revolutionised our ability to study animal behaviour in the wild. This ability to study wild animals is especially important given the current conservation crisis, with species being lost at rates unprecedented in the last millennia. The information gathered by bio-logging instruments is vital to developing evidence-based policy and biologically appropriate management strategies for the conservation of animal populations. In parallel with these technological advances there has been increased awareness of and concern for, the welfare of individual animals, both wild and domesticated. In some instances, sound research has been compromised, or in extreme cases high-jacked, because of concerns about the effects that research, including use of bio-logging devices, may have on animals. This raises serious concerns because without basic information on life history and vital rates it is virtually impossible to develop informed evidence-based conservation policy. In an environment that is hostile to invasive research, researchers are confronted with real obstacles in collecting management relevant information from animals. Solutions are not always readily apparent. This is because in a debate about (animal) welfare, opinion often wins out over evidence as a result of the emotionally charged environment in which such debates often occur. How then do we breach the chasm between the need to study animals and the very real concerns around the welfare of the target animals. The answer is not simple. Researchers may regard presenting evidence showing that instruments do not adversely affect animals as sufficient justification for proceeding. However, we find that this often does not allay concerns from welfare advocates. Here we review the evidence of how bio-logging research affects animals and suggest ways in which this evidence can best be used to address welfare concerns. This is not a new debate, with very similar conflicts in biomedical research which have been addressed by the use of the three-dimensional Bateson Cube decision tool. The Bateson cube quantifies (i) the benefit of the research, (ii) the welfare of the subject animals and (iii) the quality of the research in a three-dimensional risk assessment framework. We propose that applying the concept of such a multi-dimensional decision tool to conservation research, bio- logging in this instance, may be an effective way of ensuring that welfare is explicitly included in conservation research decision making and at the same time alleviate the conflict between researchers and welfare advocates.

OD-01

Hooked on acceleration

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Fish caught in trawls are usually dead when landed, but fish caught on long-lines are often still alive and vigorous when landed so discards from long-line fisheries could have a high chance of post-release survival. While live discarding could have potential conservation value, there needs to be clear, defensible, scientific evidence that a high proportion of live discarded fish will survive to support any case for exemption from the EU landing obligation. Critical to the survival of discards is the time fish spend hooked before hauling and the extent to which they struggle during this time. Fish hooked for several hours will be exhausted when landed, compromising subsequent survival. Understanding how fish behave when hooked, whether this differs between species and how it is affected seasonally (warm vs cold) is critical for predicting likely post-release survival and developing fishing practices that may enhance it. We are using long-lines instrumented with accelerometer loggers to record behaviour when fish are hooked and how this might affect post-release survival. Hooking experience will be linked to estimates of mortality predicted using reflex impairment methods and to post-release behaviour and survival as revealed by subsequent release of hooked fish that are tagged with depth/ temperature loggers.

OD-02

Experimental fishing exclusions for penguins in South Africa – A success story

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No-take zones may enhance sustainable use of marine resources and restore the integrity of marine ecosystems, but it is not clear whether they benefit top predators that rely on mobile pelagic fish. Following a >70% decrease of African penguin *Spheniscus demersus* numbers since 2004 in South Africa, 20 km radius experimental exclusions of purse-seine fishing were initiated in 2008 around some of their colonies. Using state-of-the-art technology, we studied penguin foraging behaviour and breeding output in relation to fishing catches and small-pelagic fish distribution. For the world's largest African penguin colony, chick growth and breeding success were negatively affected by fishing catches in the vicinity, and foraging effort decreased by 30% during the closure. Re-opening to fishing had dramatic consequences on that population, thereby demonstrating the benefits of relatively small no-take zones for a marine top predator relying on pelagic prey. As a result, a permanent purse-seine fishing exclusion zone was declared in 2014 around the largest African penguin colony. Spatial management of small pelagic fisheries is also currently being considered to reduce catches elsewhere where penguin prey is scarce. The use of highly advanced technology allowed the development of conservation strategies benefiting local endangered marine predators.

OD-03

Improving attachments of remotely-deployed dorsal fin- mounted tags: tissue structure, hydrodynamics, in situ performance, and tagged-animal follow-up

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The Low Impact Minimally-Percutaneous External-electronics Transmitter (LIMPET) satellite tag has been applied to 21 cetacean species including species previously difficult to track. We aimed to achieve longer, less variable attachment durations and ensure this method provides critical data without an adverse effect on tagged animals. We examined effects of tag shape, orientation relative to flow, and location on the dorsal fin. Our hypothesis that lift was just as important as drag in tag detachment was supported through both computational fluid dynamics simulations and water tunnel experimentation. We examined dorsal fin tissue from five species to assess structural layer geometry and collagen composition along with fiber strength. Variation within a fin was nearly as great as variation between species. FLIR thermal imaging of tagged whales confirmed that LIMPET tagging did not compromise the ability of the fin vasculature to radiate heat. Follow-up studies of survival and reproduction of tagged whales focused on two Hawaiian odontocetes. Survival of tagged and untagged individuals was not significantly different, but our power to detect an effect was very low. While results are improving LIMPET tag and attachment design, we feel it is appropriate to recommend the current system for medium- sized cetaceans, even those that are endangered.

OD-04

Monitoring ecosystems with biologging: the challenges and frontiers

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The challenges confronting our oceans, such as climate change and overfishing, require that we consider how to monitor and protect ecosystems for the health of our planet. Any such program must enable us to make biological, physical and chemical measurements simultaneously. The rise of a Global Ocean Observing System offers promise for unifying biologging across the planet; however, differences in national priorities, limitations on funding and the large scale of activities required are all challenges our community would have to overcome. Given it is vital for us to develop these integrated systems, the key question is, what knowledge is required to manage biological systems and predict their state in the future? Using two basin-scale programs - TAG and TOPP - we will explore and discuss the challenges for large-scale biologging science, such as how to provide results to international fisheries commissions (e.g. ICCAT). How can results of electronic tagging in management models be advanced more rapidly? What limits biologging's progress- tags, algorithms, data organization, or funding? The answers to these questions are critical to advance biologging beyond its role as a tool for ocean research, to an enabling technology in marine resource management and conservation.

OD-05

Electronic tagging studies of pelagic fish: Implications of drag on tag retention and data applicability

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Increasing importance has been placed on understanding the movements and habitat preferences of large apex fishes such as tuna and to incorporate this data into stock assessments. Pop-up satellite archival tags (PSATs) are increasingly used because they are fishery independent and do not need to be physically recovered. Despite the widespread adoption of PSATs in marine studies, concerns remain about reporting rates, with the vast majority of PSATs shedding before their programmed pop-up date with median retention times of 9 days in bigeye tuna. For PSATs to be an effective tool they need to stay attached to the animal in order to monitor long-term trends and to maximise experimental design. To address the issue of short retention time of PSATs we characterized their movement and drag force at various speeds and accelerations in a tow-tank. The data suggest that the burst speed and quick acceleration of pelagic fish may be cause up to 36 kg of pull force on the anchor tag-head leading to the early ejection of PSAT tags. PSATs oscillated regularly with a frequency of approximately 9 Hz; and the frequency of oscillation was independent of speed and acceleration.

OD-06

Use of Unmanned Aerial Systems for gathering data from animals marked with GPS collars in Doñana National Park (Southwest of Spain)

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Biologging consists in the remote data collection from free-ranging animals using attached electronic devices. This is an increasingly popular option because it provides valuable information on the animals' spatio-temporal movements. Biologging presents some challenges, as recovering the data from the tagged individuals, that requires to recapture them, get close to them with receivers, the installation of antennas with receptors in the areas frequented by the animals or animals' presence in areas with mobile phone coverage so the researcher can gather the data by this way. Unfortunately, there are many natural areas where recovering data is complicated (i.e. remote areas, with difficult access, flooded, dangerous). The use of Unmanned Aerial Systems (UAS) is conservation biology research is growing fast on the last years, although mainly for observational studies based on the aerial images that UAS obtain in flight. In this study, we describe the use of UAS for recovering data from a group of 34 free-ranging horses marked with GPS collars in Doñana National Park (Southwest of Spain). We present the results of the flights that were conducted in the park for data gathering and discuss the capacities and limitations of the procedure (optimal flight altitude, data transmission speed and others).

OD-07

A Movement Ecology Toolkit: Novel biotelemetry methodologies for elucidating animal behaviour and location

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Accelerometers are proving effective for the study of animal behaviour and have been used on terrestrial, aquatic and volant species with success. In the past, behavioural modes were detected in accelerometer data through manual inspection, but with developments in technology, modern accelerometers now record at frequencies that make this impractical. This has led to the development of many automated systems that make use of machine learning techniques. In this talk, we will review some of the methods available to researchers in this field and detail the application of the K Nearest Neighbour (KNN) algorithm for the study of animal behaviour. KNN is conceptually simple, effective and easy to implement with the freeware program 'R', and so offers an opportunity for established researchers to optimise their procedure, as well as opening up accelerometry to researchers established in the field of animal behaviour, but are less familiar with these bio-logging techniques. We will also discuss how behaviour can be linked to position in fine scale through the use of 'dead-reckoning', and illustrate this method using examples from the terrestrial environment for the first time. Dead-reckoning monitors location on a fine scale, offering an opportunity to revisit stochastic models for animal movement.

OD-08

An animal-borne datalogger records vibrations from seal whiskers during hydrodynamic trail following

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Seals use their whiskers (vibrissae) to extract complex information from hydrodynamic flow fields generated by swimming prey. How this is accomplished is not known and the physical cues available to the sensory system are not well understood. In order to investigate the signals received by seals during hydrodynamic tracking, we developed an animal-borne instrument, the wLogger, which uses a miniature digital accelerometer to directly measure the vibrations of individual whiskers. Laboratory testing using excised whiskers in a water flume confirmed that this tag faithfully records vibrational signals without hampering the natural movement of the whisker. In addition, tag recordings revealed that typical vortex shedding from the whiskers is altered by the presence of a hydrodynamic disturbance. In both excised whiskers and those of a live seal performing a trail-following task while fitted with the wLogger, interaction with a hydrodynamic disturbance increased the frequency bandwidth of whisker vibration. From these results, we suggest that seals rely on disruption of the whisker's natural vortex shedding to detect hydrodynamic trails. This is the first study to describe the vibrissal signals received by a live seal, opening the opportunity for field measurements on free-ranging individuals.

OD-09

Concurrent measures of fine-scale behaviors and basic oceanographic parameters in the veined squid, *Loligo forbesi*

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Squid are an ecologically key marine taxon, providing a crucial trophic link between top ocean predators and smaller pelagic and mesopelagic prey. Their behavior and physiology are highly dependent upon environmental conditions such as temperature, light, oxygen and salinity. Yet the basic biology and ecology of these taxa are often poorly understood. Here we apply a new eco-sensor devised for soft-bodied marine invertebrates in both the lab and the field. Squid movement (acceleration), orientation, light, temperature and pressure are all logged on the tag at high sampling rates (50-200Hz) to allow quantification of fine-scale behaviors relative to the local environment. Respiration rates, fin movements (basic swimming) and larger accelerations (e.g., escape jetting) were consistently observed and quantified. Tagging durations were up to 30 hrs, after which the archival tags released for collection at the surface. The attachment methods and tag provide a novel means to address the behavior, physiology and physical environmental measures for these ecologically vital marine invertebrates which have historically been difficult to observe.

OD-10

Unravelling GPS tag data: A simple, objective method for the identification of steps and turns in movement paths

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Modern, lightweight GPS tags are providing ever more high-resolution movement data for a burgeoning range of species. To go beyond the spatial aspects of the data, and elucidate behaviour, these datasets are often deconstructed into a series of steps and turns, where significant turns are considered to represent behavioural decisions. The identification of steps and turns has, until recently, been hampered by methods that require ad hoc parameter choices. Somewhat subjective methods such as these demand comprehensive sensitivity testing and are often open to interpretation, as different parameter choices can significantly affect the results. Here I present a new, objective, method for the identification of significant turns, and consequently step-lengths, which requires no parameters, is simple to apply to any high resolution data set and which is robust to common recording errors. The veracity of the method will be shown using simulated data and its application to empirical studies will be demonstrated using movement data from a range of species from fish to albatrosses. Finally, the nature of some example dive time series data sets will be reappraised with reference to the new method to reveal the 3 dimensional origins of the movement data.

OD-11

A biologging approach to studying acoustic communication

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Communication research often requires continuous unbiased sampling of which animal within a group produces a signal, and which individuals within range to detect the signal respond. There has been growing appreciation that studying communication requires monitoring signaling and responses of an entire network of participants. Here we describe a novel approach to this problem which involves tagging selected signalers and receivers with tags that can record signals and behavioral responses of several individuals that may be interacting socially. The application presented here involves marine mammals, which rely heavily on acoustic communication, as they frequently swim beyond the range of other modes of underwater communication. The tag records acoustic signals along with depth, temperature, and three-axis acceleration and magnetometry. These last two sensors detect orientation and movement of the animal. The combination of sensors on these tags are excellent for detecting vocal or other behavioral responses to signals. However, determining whether a vocalization recorded on the tag has been produced by the tagged individual turns out to be a difficult problem. Here we focus on methods to identify focal calls from tagged animals, along with ancillary information on their movements and context.

Plenary-C1

Advances in field physiology

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Some of the earliest biologgers were developed to examine the diving behavior of marine vertebrates. These early devices were quite simple and only measured time at depth. These simple devices have been deployed widely and when coupled with measurements of the animal's oxygen stores and metabolic rates that can be used to estimate the animals aerobic dive limit. These studies show that there is a range of responses that correlate with the foraging ecology and phylogeny of diving mammals, where some foraging patterns require animals to more routinely push their physiological capability. These differences have conservation implications in those animals that push their physiological capability are likely to have a reduced ability to withstand environmental perturbations such as climate change. Finally, advances in sensors are enabling us to better understand the management of O_2 stores during individual dives in freely diving animals, as we can now measure heart rate, blood PO_2 levels and even lactic acid levels in freely diving animals.

OC-01

Body density and diving lung volume of northern bottlenose whales (*Hyperoodon ampullatus*) derived from analysis of hydrodynamic performance during glides

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Lipid-store body condition and diving lung volume are both important physiological parameters of marine divers, but there is no standard technique to measure these values for animals which cannot be captured. In this study, we demonstrate how estimates of body density and diving lung volume can be systematically obtained for an elusive deep-diving beaked whale species. Biologging data from seven animals were collected using tri-axis accelerometers equipped with depth (Dtag, N=3) and speed sensors (3MPD3GT, N=4). Gliding periods during ascent and descent phase were automatically identified by analysis of accelerometer oscillations, and hydrodynamic performance was quantified by measuring pitch, depth, speed, and acceleration from 2476 glides. Acceleration during glides was modelled in a Bayesian framework as a function of drag and buoyancy forces, which accounted for pressure effects on gas and tissue volumes. Diving lung volume of 17.8±6.3 ml/kg showed little influence with dive depth or duration. Body density ranged from 1031.0-1034.2 kg/m^3 and correlated with percentage of time gliding during descent and ascent phases. The high precision of these estimates (±0.25-1.5 kg/m^3) indicate that body density calculation may be a practical means to quantify how lipid-store body condition of free-ranging cetaceans varies due to natural and anthropogenic factors.

OC-02

Hook, line, and sinker? Accelerometers to assess post- release mortality and recovery periods in coastal sharks

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Despite its importance for resource management, determining the post-release mortality rate of coastal sharks caught on hook and line has long been a challenge using conventional telemetry techniques. We collected blood samples from, and applied acceleration data loggers to various shark species caught and released by recreational (N=31) and commercial (N=47) fishermen in Florida, USA. Mortalities (N=10) all took place within 2 h after release and were apparent from static depth data and the cessation of tailbeat activity, whereas surviving sharks were monitored for 7 to 55 h (27 ± 18 h, mean ± SD). From acceleration and depth data, we evaluated 58 metrics of fine-scale swimming behavior for their potential to indicate a recovery period. We used nonlinear mixed modeling to fit a four-parameter logistic function to these metrics. 18 metrics displayed a significant logistic relationship with time after release, with mean recovery periods of 9.9 ± 1.9 h (mean ± SD). These results were compared with blood stress indicators (e.g., pH, lactate, pCO_2, glucose, electrolytes, etc.) which showed little correlation with animal outcome. Our results show the utility of accelerometers to provide definitive information on animal outcomes and suggest caution in using blood parameters alone to predict mortality.

OC-03

Blood oxygen depletion patterns and heart rate in a cold- blooded diver, the loggerhead turtle

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Heart rate is considered an essential determinant of blood oxygen depletion rates in diving endotherms. To evaluate the relationship of heart rate to blood oxygen depletion in a diving marine ectotherm, we deployed electrocardiogram- blood PO_2 recorders and depth/acceleration recorders on four loggerhead turtles (*Caretta caretta*) to construct heart rate and venous PO_2 profiles during dives. During spontaneous, submerged rest periods of 20 to 40 mins, initial heart rates (6-10 bpm) decreased throughout the dive to as low as 2-4 beats min^{-1} during the longest dives. Heart rate during voluntary submergences was much lower than previously reported in loggerhead turtles. At the surface, venous PO_2 values were between 50 to 70 mmHg (6.7 to 9.3 kPa) and then declined monotonically to less than 20 mmHg (2.7 kPa) during very long dives. The observed changes in PO_2 corresponded to venous hemoglobin desaturation rates of 1 to 1.9% min^{-1} during these voluntary submergences. We conclude that, just as in diving homeotherms, bradycardia is associated with low blood O_2 depletion rates and conservation of the blood O_2 store in the diving loggerhead turtle.

OC-04

Locomotion dynamics and heart rate of migrating bar-headed geese (*Anser indicus*)

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We report on the locomotion dynamics and energetics of wild bar-headed geese (*Anser indicus*) as they negotiate the high mountain passes of the Qinghai-Tibetan Plateau and Himalayan mountains. Using implantable data loggers, we tested the hypothesis that heart rate (fH) and wing-beat frequency (fw) would be closely correlated during flight. Metabolic flight power (Pm) was estimated from fH and heart mass (Mh). Biomechanical flight body power (Pb) was estimated from fw and root-mean-square dorsoventrally-aligned acceleration (ZRMS). We show that estimated Pm and Pb are very highly correlated (mean correlation coefficients r^2 >0.85, 77 flights, 7 individuals). Wing-beat frequency (mean fw = 4.13 ± 0.28 Hz, 334 hours flying, ~ 5 million wing-beats) was very tightly regulated and exquisitely sensitive to estimates of flight power. The geese flapped almost continuously, even on descent. Heart rates were generally low, even at high altitudes. We show that, on rare occasions, the geese were 'aided' by significant orographic lift generated in the mountains, and may also have benefited more frequently from smaller updrafts. Overall, much could be discerned about the flight performance and energetics of migrating bar-headed geese without direct knowledge of either flapping flight aerodynamics or complex measures of 3D wing kinematics.

OC-05

Bright nights, costly mornings: increases in night-time body temperature correspond with brightness of the moon and cloudless nights in wintering barnacle geese (*Branta leucopsis*)

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It is established that animals respond to fluctuations in light-levels, with distinct circadian rhythms apparent in physiological variables such as heart rate (*f*H) and body temperature (Tab). We deployed implantable data-loggers that continuously record *f*H and Tab, in 6 wild barnacle geese (*Branta leucopsis*) wintering in south-west Scotland. The geese had a distinct circadian rhythm in *f*H and Tab, with night-time values being, on average, 25 beats per-min and 2.5°C lower for *f*H (resting) and Tab respectively when compared to day-time values. Furthermore, we have identified rhythmic night-time peaks in Tab, with increases of 1.5°C above normal night-time values occurring in the middle of the night at regular intervals throughout the winter period. These night-time peaks in Tab coincided with specific phases of the moon, when at its brightness and when there was little or no cloud cover. Upon dawn, resting *f*H was significantly higher during the mornings following the incidences of night-time peaks in Tab than those mornings where no night-time peak in Tab had occurred. This suggests a 'carryover effect' of night-time peaks in Tab, which could have consequences for daily energy-budgets.

OC-06

How to dive deep: Heart rate and blood oxygen profiles in California sea lions

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Aerobic dive capacity underlies the limits of dive behavior and foraging ecology. Heart rate and blood oxygen depletion patterns in deep dives (> 300 m) of California sea lions (*Zalophus californianus*), determined with backpack electrocardiogram and partial pressure of oxygen (PO_2) recorders, revealed a) severe bradycardia (< 10 beats min^{-1}) during descent and a gradual increase in heart rate during ascent, b) arterial PO_2 profiles consistent with lung collapse and impairment of gas exchange near 200-m depth, c) maintenance of arterial hemoglobin (Hb) saturations > 85%, d) near-complete venous Hb desaturation mid-dive, and e) increasing venous Hb saturation during ascent. These profiles suggest a) minimal, if any, muscle blood flow, b) extreme blood O_2 extraction in hypo-perfused tissues mid-dive, c) limitation of gas exchange at depth, and d) resumption of gas exchange and O_2 delivery during ascent. In addition, maintenance of arterial Hb saturation and lack of complete blood O_2 depletion in even the longest, deepest dives confirm the significance of the respiratory O_2 store in sea lions, and also suggest that their aerobic limit (onset of post-dive blood lactate accumulation) is secondary to depletion of the muscle O_2 store and subsequent glycolysis. (Supported by ONR N000141010514, N000141210633).

OC-07

Gliding down and stroking up: Blood oxygen depletion and exercise intensity in California sea lions

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A critical question regarding oxygen management in diving mammals is the coupling of heart rate and muscle blood flow with the level of exercise intensity. Using blood oxygen recorders and tri-axial accelerometers, we examined flipper stroke rate and posterior vena caval hemoglobin saturation of oxygen (SvO_2) profiles from 4 freely-diving California sea lions. We hypothesized that the decline in venous oxygen content during dives should correlate with swimming strokes if heart rate and muscle blood flow were related to muscle workload. The relationships between change in SvO_2 and flipper stroke rate were variable and weak during the descent, bottom and ascent phases of all dives. During descents of deeper dives (>300m, n=106), stroke rate and number of strokes (10.8 ± 0.5 strokes min^{-1} and 26.1 ± 1.5 strokes) were lowest while the change in SvO_2 (-18.3 ± 0.9%) was greatest. Conversely, during ascent from these dives, SvO_2 increased (+8.2 ± 1.7%) despite a significantly higher stroke-rate (25.2 ± 0.3 strokes min^{-1}) and number of strokes (90.2 ± 2.0 strokes). The coupling of blood oxygen delivery and muscle workload is not supported by the weak relationship between the posterior vena caval oxygen content and stroke rate in deep-diving sea lions.

OC-08

Endothermy at the poles: understanding air/water thermoregulation in free-ranging Weddell seals by skin surface heat flux

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A weakness in predicting habitat change impacts in polar regions is that little is known about thermoregulatory energetics in high-latitude seals. We present a method for estimating total body heat dissipation and modeling thermoregulation from skin surface heat flux sensors deployed on 42 Weddell seals over 2-7d. As body size/condition affect heat loss and may manifest as altered thresholds for thermal homeostasis, we compared 4 life history categories—pups, juveniles, non-reproductive adult females (skip breeders) and post-weaning females. Blubber insulation was advantageous over size, as all-sized lean animals lost more heat (W/m^2) than even small seals. Despite warmer air temperatures and maximum solar irradiance of austral summer, post-weaning females lost significantly (p=0.005) more heat overall than did good condition skip breeder females. This was especially apparent under non-steady state conditions such as the transition from haul-out to water (+40% W/m^2 heat loss), indicating additional metabolic costs for these females. Juveniles, with limited blubber and high surface area: mass ratios lose 60% more heat than pups on initial water entry. Continued efforts to quantify and model thermoregulatory thresholds will provide important insights into the ability of polar pinnipeds to respond to changing ice conditions. Funded by NSF Polar Programs.

OC-09

Switching of gill-ventilation modes in freely-swimming sailfish revealed by video/speed/depth/acceleration data-loggers

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Two ventilation modes are known for fish, which typically relate to swimming velocity. Fast-swimming fishes such as tuna usually use ram ventilation forcing water flow over the gills by forward swimming, while sluggish fishes rely upon gill pump activated by rhythmic movement of skeletomuscular system of the head. Thus, it is expected that the sailfish *Istiophorus platypterus*, nominally the fastest swimmer in water, would use ram ventilation for respiration. We conducted video/speed/depth/acceleration data logging for the sailfish (fork length: 207–251cm, N=4) to obtain detailed information on the swimming behavior and the ventilation mode employed in the natural environment off the east coast of Taiwan. The sailfish mainly swam at the surface or just floated, but sometimes exhibited a vertical movement where it dived from the surface to a maximum depth of 90m. Mean swimming speed ranged from 0.25 to 0.58m/s (0.11–0.25FL/s) with the maximum swimming speed of 1.0–2.6m/s (0.47–0.97FL/s). Image analysis demonstrated that the fish used the gill pump when floating at the surface or swam slowly (< approx. 0.18–0.48m/s), or ram ventilation when swimming at a higher speed, confirming that the fish switched between the two ventilation modes depending upon swimming speed.

OC-10

Playing tag with the biggest nose on record: Biomechanics of air-driven sound production in deep-diving sperm whales

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The sperm whale nose produces sonar clicks for long range echolocation of prey during deep dives, but very little is known about how these sounds are made. To alleviate that, we placed non-invasive Dtags on different, photo-documented parts of the nasal complexes of 6 male and female sperm whales. From synchronized measurements of tissue acceleration and sound propagation in the soft structures of the sperm whale nose, we demonstrate that sperm whale clicks are generated when the monkey lips are accelerated apart by pneumatic action. The reverberation patterns recorded by tags placed between the reflective air sacs of the nose show that the multi-pulsed clicks are generated by reflections of a single sound pulse made by the phonic lips. Recycled air is used to drive the sound generator at less than 0.1 liter of air per click, limiting the length of click trains, but not the output or properties of individual clicks with increasing hydrostatic pressure. These experimental data from free-ranging sperm whales confirm the bent horn model, and show that the sperm whale nasal complex is a giant sound generator producing clicks by air driven acceleration of a finely controlled pair of phonic lips.

OC-11

Where's the air? Sound recording tags on deep diving whales reveal nasal air movements

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Deep-diving echolocating whales produce sound pneumatically using a limited supply of compressed air. Air is presumably recycled between nasal sacs to produce the thousands of clicks in a long dive but the amount of air required per click or when recycling occurs are unknown. On-animal recordings of vocalizations are affected by the passage of sound through anatomic structures including air spaces making them markedly different from remote recordings. Although this is usually undesirable, we show here that artefacts in sounds recorded by DTAGs on short- finned pilot whales contain information about the disposition and movement of air in the head. We use this to deduce when recycling occurs and to estimate the air volume required to produce different sounds. Applying the analysis to three other deep-diving echolocators (sperm whale, Blainville's beaked whale, and Cuvier's beaked whale) reveals differences in the way that air is managed throughout dives. Reflection and resonance of sound in cranial air-spaces influence how the whale's vocalizations propagate to its own ears and therefore their potential to mask echoes from nearby prey. Both cranial morphology and click-by-click air management may play a role in controlling this source of interference.

Stakes and challenges of physical activity evaluation in relation to health in humans

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With food behavior, physical activity (PA) is recognized as a key element in the prevention and the treatment of several chronic diseases in humans, including cardiovascular diseases, type 2 diabetes and some cancers. While until the recent years, research, prevention and therapeutics have focused on energy expenditure due to exercise, mainly based on self-reported physical activity, recently the specific impacts on health of everyday physical activities, active transport, sedentary behaviours and of their temporal patterns throughout the day have been underlined. On the other side, it is nowadays recognized that, as for health prevention in general, physical activity promotion needs a comprehensive understanding of its multidimensional determinants including the physical, built and social environment in which the individuals evolve.

Deepening our understanding of the impact of physical activity and sedentary behaviours on health requires precise and objective methods that can be used in free-living conditions. The availability of biologging technologies (accelerometry, magnetometry, geolocation, stable isotopes), associated with geographic information systems (GIS) tools and innovative methodological approaches to automatically recognize postures and activities, offers us a new insight into the complex relationships of the movement behavior with health and into its network of ecological determinants. We however still have to face several technological and conceptual challenges, such as the dynamic interplay between perceived and objective dimensions of the environment. This all highlight the need for high-level transdisciplinary research.

OC-12

Drivers of den entry and exit behavior in the brown bear

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The brown bear (*Ursus arctos*) undergoes drastic physiological changes during hibernation. It was unknown whether this drives the bear to seek a den, or if these changes begin after the bear has begun denning as a reaction to potential triggers in the environment. Bears (N=25) decreased movement and activity over a period of 5-10 days before entering a den. Heart rate decline began 27±5 days (mean±SD) before and stabilized 21±15 days after den entry. At den entry, heart rate was 40±13 beats per minute (bpm) and body temperature was 36.5±0.5°C and in the spring, body temperatures increased gradually over 66±32 days, and the bears exited when their body temperature was 36.6±0.5°C, while the heart rates were still half of normal (28±8 bpm). During the den entry period, ambient temperature appeared to drive changes in body temperature but not heart rate. Our study illustrates that the temperature and heart rate changes are still occurring during the transition period from the hibernating to the active state, and may trigger the bear to exit the den. This is the first study in free-ranging brown bears to document both the physiological and ecological sequence of events associated with den entry and den exit.

OC-13

Big hearts, small bodies, and cold water: Diving heart rate in harbor porpoises

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Heart rate (fH) and peripheral blood flow distribution are the primary determinants of oxygen store utilization and hence ultimately breath-hold duration. Despite this, relatively little is known about the cardiovascular response in diving cetaceans. We predict that harbor porpoises will exhibit a decrease in fH in all dives, but the degree of bradycardia will be influenced by activity, i.e., the dive fH response should be exercise modulated. We investigated dive fH in three captive porpoises (*Phocoena phocoena*) using a Dtag3 data logger that records dive behaviour, fH, and ventilations. Captive porpoises performed stationary dives to a target at a depth of 1m as well as active prey capture dives. In all dives, fH decreased compared to surface rates, however dive fH was 10 bpm higher in active dives due to a slower decrease in fH and more variable fH during pursuit of prey. Our data suggest that porpoises may exhibit a more severe bradycardia than previously documented even in routine, short duration dives (often < 30 bpm, occasionally < 20 bpm). However, dive fH was variable even in short duration dives, suggesting the conscious ability to regulate fH in relation to dive type, duration, and activity.

OC-14

The significance of respiration frequency and timing in the energetics of killer whales (*Orcinus orca*)

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Breathing rate has been used as indicator of cetacean metabolic rates to evaluate their role in food webs, though it does not account for breath-by-breath variation in gas exchange. Our aim was to investigate the potential influence of including respiratory timing (in addition to rate) and oxygen uptake dynamics on in-situ cetacean energetic studies. Kinematic data from 19 wild North-Atlantic diverse sized herring-feeding killer whales (*Orcinus orca*) were recorded with high-resolution tags (DTAGs) to reveal individual breathing events. Three-axis accelerometer and flow noise data were used to derive stroking rate and speed as metrics of underwater activity level. An oxygen exchange model, including an oxygen uptake curve as key feature, was established to estimate oxygen extraction dynamically per individual breath, based upon modelled oxygen store at the time of each breath. Correlations between predicted oxygen uptake and stroking activity over 15 min periods were relatively weak when using constant uptake per breath ($R^2 < 0.5$ for 15 individuals). Including fluctuating oxygen uptake per breath significantly improved the correlation between modelled oxygen uptake and activity level ($R^2 > 0.9$ for 17 individuals). Hence, taking into account respiration timing, in addition to rate, is crucial in making accurate cetacean energetic estimations.

OC-15

Acoustic parameters as indicators of metabolic rate in *Tursiops truncatus*

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Respiratory sounds in humans offer a significant amount of information on lung pathology and physiology. Recording parameters from biologging devices can serve as proxies for variables that cannot be directly measured during deployments on free-ranging animals. Here we propose to use acoustic parameters of animal exhalations (peak-to-peak sound pressure level [dB re 1μPa], 95% energy duration [s], and energy flux density [Pa2 s]) as indicators of breath-by-breath respiratory measures (expiratory flow rate [L s^{-1}], tidal volume [L], and volume of expired O_2 [L]). To investigate these relationships we analyzed simultaneous respiratory and acoustic measurements from trained bottlenose dolphins before and after 10-minute swimming exercises. Breath-by-breath measurements of expired O_2 and CO_2 and respiratory flow rates were made via a pneumotachometer, and the sound of the exhalation was recorded by an acoustic tag (DTAG3) placed near the animal's blowhole with suction cups. Preliminary results from multiple linear regressions suggest energy flux density may be a reliable indicator of tidal volume ($R^2 = 0.81$). However, additional analyses are required to further establish this relationship. For example, sound deformation in the respirometry device and potential masking from flow or wave noise must be understood to enable metabolic rate estimates from free-ranging marine mammals.

OC-16

Diving behaviour and energetics of a semi-aquatic, shallow-diving species: The Eurasian beaver (*Castor fiber*)

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Semi-aquatic endotherms face increased energetic costs especially in the case of diving: While quadru- or bipedal propulsion is far less efficient than lift-based propulsion, it is above all the air in the respiratory system and in the pelage that increases buoyancy and energetic costs, respectively. In this study, we used an accelerometer combined with a depth sensor to investigate the diving behaviour of Eurasian beavers (*Castor fiber*) in Norway. Overall dynamic body acceleration (ODBA) was used to assess energy expenditure during dives. Beavers featured a diving pattern similar to full aquatic endotherms with clear descent, bottom and ascent phases. However, dives were generally shallow (x = 1.0 m) and short (x = 23.6 sec), while beavers reached a maximum depth of 4.2 meters and stayed for up to 4.9 minutes underwater. ODBA was highest during the descent phase of the dives and decreased with increasing dive depth, implying that the animals carried a substantial amount of air with them. While ODBA also decreased during the bottom phases of dives, the mean dive duration of that phase increased. This alludes to a benefit from decreased buoyancy effects due to an increasing impact of hydrostatic pressure at deeper depths.

OC-17

Reassessment of the cardio-respiratory stress response: accounting for stress-associated movement

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The typical cardio-respiratory stress response involves a large increase in heart rate and a small increase in rate of oxygen consumption ($V'O_2$). Thus the key cardio-respiratory stress response is widely considered to be increased heart rate. However, there is reason to question what the direct physiological effects of a stressor are. Small movements cause relatively large increases in heart rate and no relevant studies to date have accounted for possible changes in movement levels. We undertook stress-inducing experiments on incubating king penguins, measuring their heart rate and $V'O_2$. These animals have a drive to maintain their position ever under duress. Furthermore, we equipped the birds with accelerometers to measure fine-scale changes in body movement. Comparison of the control v. experimental condition without consideration of the accelerometry data indicated the typical response of increased $V'O_2$ and heart rate. However, movement levels were also found to increase, albeit subtly, during exposure to the stressor and once this was controlled for only $V'O_2$ increased in response to the stressor. Thus the cardio- respiratory stress response per se, at least for king penguins, does not involve a change in heart rate. Our study calls into question our fundamental understanding of the cardio-respiratory stress response.

OC-18

Energetic fitness: linking metabolic effort derived from accelerometry data with Darwinian fitness

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Linkages between energy expenditure and Darwinian fitness are suggested in the scientific literature across the last century (Lotka PNAS 1922, Brown et al. Ecology 2004). However, testing this premise in the natural world is constrained by difficulties in measuring energy expenditure of wild animals while monitoring conventional fitness metrics such as survival and reproductive output. We addressed this issue conceptually and empirically by (1) refining the definition of metabolic effort for routine measurements in free-ranging animals (2) exploring the functional links between metabolic effort, body condition and reproductive performance in a wild population. To this aim we deployed 3-axis accelerometry data loggers on 75 Adélie penguins (*Pygoscelis adeliae*) across three breeding seasons at their breeding site on Ross Island, Antarctica. This population has been the subject of demographic monitoring for the past 18 years, and accelerometry data were collected for birds of known age and breeding history. We determined Overall Dynamic Body Acceleration as a proxy for energy expenditure, and derived metabolic effort from ODBA levels. We then explored the links between metabolic effort, body condition and multi-year reproductive performance. This allows us to propose using metabolic effort as a Darwinian fitness component, complementary to more conventional fitness metrics.

Posters

PA-01

Transferable species distribution models of a pelagic seabird link ecology, oceanography and conservation

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High predictive performance of species distribution models (SDMs) has been documented when validated by data from within the model calibration area (interpolation). Yet, few studies have tested the ability of SDMs to correctly predict habitat to novel areas (extrapolation), particularly across large spatial scales or pelagic ecosystems. Here, we use GLS tracking data from grey petrels from two remote breeding sites in the Pacific and Indian oceans separated by > 8000 km. Using Boosted Regression Trees, three SDMs of their non-breeding habitat were generated: two individual population SDMs, and one combined SDM. Tracking data revealed use of pelagic areas by both populations that was previously undocumented as seabird habitat. The interpolated predictive capacities of the two individual population SDMs were high, yet when extrapolated the models performed poorly. However, the combined model had increased generality of large- scale grey petrel habitat use patterns allowing high predictive capacity for both populations, equivalent to that of the interpolated individual models. We conclude that SDMs trained by data from multiple populations have increased transferability over single population models, which risk overfitting to local patterns and limited transferability to novel areas. Our study highlights the importance of generality in predictive SDMs applied across broad scales.

PA-02

New advanced devices tell us meaningful information on habitat use of Japanese sea bass and application to Integrated Coastal Management

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To make Integrated Coastal Management (ICM), it is important to collect accurate information on habitat use and environmental condition of aquatic animals, which adapted to wide-range salinity zone. New device W380-DTC (length: 90mm, diameter: 20mm, weight: 45g) developed by Little Leonardo Co., Japan, measures salinity (range: 0~40‰), accuracy: ±0.5‰), temperature (-10~50°C, ±0.1°C), and depth (0~300m, ±0.2m). Acceleration data obtained by ORI400-D3GT was combined with above data. We analyzed 60-hour data obtained from three Japanese sea basses (TL: 523~575 mm) collected in Tokyo Bay. Three types of movements of the species, which was released into Obitsu river after 5~6 hours keeping in river cage, were observed as follows; 1. movement to the upper part of the river, 2. movement from the river to sea, 3. movement between the river and sea. Interestingly, these basses showed burst records during their movement in both river and sea, and tried to catch false-food of recreational fishermen in the river. Fish-mounted video recorded other fish and fisherman. In conclusion, these devices are useful tools for understanding habitat use and environmental condition of aquatic animals adapting to wide-range salinity, for detecting characteristic foraging behavior, and for providing efficient direction to establishment of ICM.

PA-03

Location, location, location: variability in grey reef shark movements

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Grey reef sharks are one of the predominant shark species on coral reefs within the western Pacific Ocean. Despite their common occurrence little is known about their long-term movement patterns although there are several assumptions including: long-term residency at a single reef, limited or no movement to adjacent reefs, and that patterns are similar or the same regardless of location. We examined the movement patterns of grey reef sharks from three sections of the Great Barrier Reef. Individuals were tracked for periods of six months to 2.5 years at three sites. Data from the three sites indicate movement patterns vary between regions and suggest habitat utilisation by this species may be more influenced by environmental characteristics than innate drivers. These results indicate that it will be difficult to generalise about grey reef shark spatial patterns. This unpredictability creates uncertainty in the efficacy of marine protected area benefits for this and similar species and should be taken into consideration when developing management and conservation policy for coral reef sharks.

PA-04

Foraging ecology of crested penguins during the pre-moult stage at Marion Island

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After the breeding season penguin parents must replenish body condition and reach a state of hyperphagia before the annual moult. Failure to do so may lead to starvation and impact survival. Understanding how crested penguins find adequate resources in a limited period during the most energy intensive stage of their annual cycle is a vital aspect of their ecology. Here, GPS and TDR were used to record movements and diving behaviour of macaroni *Eudyptes chrysolophus* and southern rockhopper penguins *Eudyptes chrysocome* from Marion Island during pre-moult foraging trips in 2012, 2013 and 2014. Mean trip duration and maximum foraging range of macaroni and southern rockhopper penguins were 32 and 26 days, and 887 and 626 km, respectively. Trip duration and foraging range of macaroni penguins differed between sexes and years. Penguins travelled deterministically in a southerly direction to waters 10 m) increased. Foraging effort was concentrated around the Antarctic Polar Front (APF) which is known for increased concentrations of the lipid-rich Antarctic krill *Euphausia superba*. Continued monitoring is essential to determine how penguins adapt to the predicted southward shift of the APF.

PA-05

Neighbouring little penguin colonies in Western Australia exhibit different responses to climate change

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Little penguin colonies on islands less than 10 km apart in Perth, Western Australia, have surprisingly dissimilar rates of annual breeding success. Biologging has revealed that the proximity of the important habitat is also markedly different for these colonies located on Penguin and Garden islands. As the spatial and temporal abundance of fish prey are related to breeding success, it is thus presumed that fish stocks are more consistent in one of these habitats. However, anomalously high sea surface temperatures have been recorded in these habitats since 2011, and climate change modelling suggests a continued warming of the Indian Ocean in the south west of Western Australia. I therefore use biologging techniques to determine 1) if the foraging habitats have changed in response to these high SST and 2) gain an insight into the resilience of both the penguins and the coastal marine ecosystem to impacts associated with climate change. This is important for the management of these colonies, which are of high conservation value and located at the limit of their distribution.

PA-06

Breeding and overwinter movements of Leach's storm-petrels, *Oceanodroma leucorhoa*

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Knowledge of foraging movements during the breeding season is key to understanding energetic stresses faced by seabirds. Using archival light loggers (geolocators) and stable isotope analysis, we compared foraging movements of Leach's storm-petrels (*Oceanodroma leucorhoa*) during their incubation periods in the 2012 and 2013 breeding seasons. Data were collected from two colonies, Bon Portage and Country Island, which are 380 km apart along the coast of Nova Scotia, Canada. Based on allometry for procellariiform mass, predicted foraging ranges for Leach's storm-petrels are 200 km; however, observed maximum distances from the colony were 3 to 5 times that: 613 ± 167 km for storm-petrels from Bon Portage Island, and 1,015 ± 238 km for storm-petrels from Country Island. Stable isotope analyses indicated that, during the breeding season, prey items from Country Island were from higher trophic levels than those from Bon Portage Island, perhaps explaining the more distant foraging trips for Country Island birds. Despite increasing interest in migration, the wintering areas of some pelagic seabirds are still unknown. Here, we also present the first study tracking migration movements of Leach's storm-petrels during the non-breeding season.

PA-07

Elephant seals: biologgers of contaminants in the mesopelagic North Pacific

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Northern elephant seals (*Mirounga angustirostris*), mesopelagic (200-1000 m) marine predators that forage in the coastal and open-ocean North Pacific, integrate contaminants into their tissues while foraging. We used satellite-tracked adult females (with time-depth recorders) as biologgers of mercury and persistent organic pollutants (POPs) to examine links between foraging ecology and contaminant accumulation, as well as to determine how contaminant distribution may vary geographically. At the end of a foraging trip, we sampled 78 seals for total mercury (blood and muscle) and a subset of these (N=23) for POPs (blood and blubber). Total mercury in blood and muscle fell among the highest concentrations reported for marine predators. Moreover, foraging ecology influenced mercury exposure, with the highest concentrations observed in offshore, deep-diving females. We observed differences in mercury and POP concentrations across the foraging range of elephant seals, suggesting varying geographic distributions and bioaccumulation of specific compounds. Our results indicate that mesopelagic predators may be at greater risk for contaminant accumulation than previously assumed and provide insight into the potential for contaminants in elusive and vulnerable mesopelagic species. We also demonstrate how quantifying animal behavior using biologging technology can be used in conjunction with animals as biological integrators of their environment.

PA-08

Living on the edge: harbour seals in the high Arctic

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Harbour seals are generally regarded as a temperate species, but one population inhabits the arctic waters of Svalbard year-round. Climate warming (air/water temperature increases, sea ice decreases) is expected to cause shifts in species' distributions and abundances at all trophic levels particularly in arctic marine communities. In this study we document at-sea movements and diving behaviour of 30 adult harbour seals instrumented with CTD-SRDLs in two successive years (2009-2010) and compare their behaviour patterns to sea-ice concentrations and oceanographic features. The seals showed strong preference for the west side of the archipelago, staying mainly in coastal areas over the continental shelf. These areas are strongly influenced by the West Spitsbergen Current and experience little sea-ice cover during the winter. However, significant amounts of drift ice can occur and the seals actively avoided high ice concentrations. Diving behaviour shifted towards deeper, longer, less numerous dives as influxes of warmer less saline Atlantic Water (AW) were observed on the shelf during winter. The seals seemed to target AW or the mixed layer just above it, which likely concentrates prey. Heat and volume of AW are predicted to increase in the future, possibly rendering conditions in Svalbard more favourable to harbour seals.

PA-09

Seals are valuable auxiliaries to observing the Southern Ocean

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Over the last decade, several hundred seals have been equipped with conductivity-temperature-depth sensors in the Southern Ocean for both biological and physical oceanographic studies. A calibrated collection of seal-derived hydrographic data is now available, currently consisting of more than 250,000 profiles. The value of these hydrographic data within the existing Southern Ocean observing system has recently been demonstrated. Using seal-derived data to constrain a model simulation of the ocean circulation substantially modified the estimated surface mixed-layer properties and circulation patterns in the Southern Ocean, improving the agreement of the model simulation with independent satellite observations of sea-ice concentration. Simultaneously, several recent regional studies of ocean circulation around Antarctica are strongly benefiting from the availability of seal data. Instrumented animals efficiently reduce a critical observational gap, and their contribution to monitoring polar climate variability is expected to grow as data accuracy and spatial coverage increase.

PA-10

Ringed seals in a changing world: effects of declining sea ice extent on behaviour and movement patterns

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Declining sea ice extent (and volume) in the Arctic is expected to have large consequences for many arctic species. The ringed seal (*Pusa hispida*) is an abundant arctic endemic pinniped that relies on sea ice for most aspects of its life cycle including giving birth, moulting, resting and some ice-associated feeding. In this study sixty ringed seals were tagged with Satellite-Relay Data Loggers during a ten year period in Svalbard, Norway; 22 in 2002-2003 and 38 in 2010-2012. These two time periods experienced dramatically different sea ice conditions in terms of summer sea ice extent and the amount of land-fast ice formation in the winter. During the early period the southern extent of the summer ice edge was over the continental shelf, while during the latter period this edge was situated much further north over the deep Arctic Ocean Basin. This data set was used to investigate changes in ringed seal behaviour and movement patterns in relation to the declining sea ice conditions in Svalbard, Norway. These results quantify the impacts current sea ice declines have had on ringed seals and will facilitate a better understanding of how this species will respond to further reductions in sea ice extent.

PA-11

Large scale tracking and home range of an apex predator

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Satellite telemetry is a useful tool for investigating the movement patterns of sharks, however, short surface intervals, physical damage to the tag, biofouling and premature shedding of the tag often result in short and sparse datasets. Consequently, current information on movement of tiger sharks is usually over short time scales and thus may not capture wide ranging movements. We used the Brownian Bridge Kernel method to calculate the home range of eight tiger sharks from Ningaloo Reef, WA. This method applies a conditional random walk to the expected path between locations, taking into account the distance between points, the direction, speed of the animal and time interval, as well as the imprecision of the location estimates. One shark moved over 4000 km during 517 days of monitoring, one of the largest ranges of movement ever documented for the species. In contrast, most of the remaining sharks had short monitoring times, most likely due to tag failure, resulting in more restricted movements. The wide-ranging shark had three distinct home range cores ranging from temperate regions to tropical. Brownian Bridges showed a more dynamic and realistic approach to define habitat use, particularly for animals with wider movements and larger home ranges.

PA-12

The Barents Sea – Polar bear habitat in a changing climate?

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Sea-ice-depended animals such as the polar bear (*Ursus maritimus*) will be particularly affected by a warming Arctic. This apex predator uses the Arctic sea ice as primary habitat and hunting ground for its main prey species; ringed seals (*Pusa hispida*) and bearded seals (*Erignathus barbatus*). Polar bears exhibit annual migrations within individual home ranges and demonstrate denning and spring feeding site fidelity. In order to assess polar bear habitat and how they respond to a changing environment in the Barents Sea, we developed seasonal resource selection functions using 281 satellite-collared adult females and environmental data (e.g. sea ice, bathymetry, and distance to coastlines). The bears typically selected sea ice over the continental shelf, close to the sea ice edge or land, but with seasonal variations.

PA-13

Detecting buoyancy changes from compressed dive profiles using a step-wise filtering method

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One way of assessing an animal's well-being over a migratory period is through looking at changes in body composition that indicate successful foraging. Changes in body composition in pinnipeds are often reflected by changes in buoyancy, affecting their dive behaviour. By looking at passive drift movements within dives, i.e. drift fragments, a drift rate can be determined which reflects a seal's buoyancy. A new method was developed to extract vertical speeds of drift fragments from compressed, broken-stick abstracted time-depth dive profiles. Individual dive fragments are identified as passive drifting if they feature set characteristics of drift dives. The changes in drift rate over time highlight certain phases of a migration during which a seal's body composition changes. If these changes occur due to successful food assimilation, it can also be inferred where seals forage successfully. Being independent of visual dive classification this method attempts making drift dive analysis from compressed data a more standardised process which is easily reproducible, automated and fast. Whilst the method was based on drift diving characteristics of elephant seals, it can be adapted to suit behavioural characteristics of other drift diving species such as fur seals or hooded seals.

PA-14

Time-in-area represents foraging activity in a wide- ranging pelagic forager

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The ability to identify at sea foraging hotspots for mobile predators is crucial in marine spatial planning. Frequently, time spent in a given area is calculated from positional data collected by animal-borne data loggers. This is used as a representation of the foraging area, under the assumption that an individual will spend longer in an area when foraging than when transiting. Here, we compare positional data with behaviour data, extracted from tri-axial accelerometers, and test this assumption by examining the relationship between time-in-area and foraging rate. Data from nine northern gannets (*Morus bassanus*) caught from Les Etacs, Alderney and fitted with both GPS and acceleration data loggers were used in the analysis. Each bird recorded between two and four trips and only complete return trips were included. We assigned behaviours (flying, floating, diving) based on unsupervised cluster analysis of acceleration signals, using ethographer in software IGOR Pro. This was then refined using logical arguments in R. Our findings suggest that there is moderate-strong correlation between time-in-area and seabird foraging rate. These findings support the idea that when more fine scale data on seabird behaviour are not available then time-in-area is a reliable mechanism with which to gauge foraging hotspots.

PA-15

Interpreting the movement behaviour of an endangered marine apex predator

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The flapper skate (*Dipturus intermedia*) used to be widely distributed in the North East Atlantic. Due to fishing pressure the population suffered a 90% decline in the last 30 years. Data Storage Tags (DSTs) were applied on 18 individuals in the Sound of Jura (Scotland). Four tagged individuals were recovered after time spans ranging from two weeks to twelve months. DSTs collected data on depth and water temperatures. Activity levels (meters/hour) and daily average depths were related to environmental covariates as daylight duration and lunar cycles (a proxy for the tidal cycle) in order to highlight possible drivers of individual behaviour. Daily vertical migration was detected in all individuals showing higher activity and shallower depths at night. To quantify individual behaviour a Markov switching autoregressive model was applied. The dynamic evolution of the depth profiles is best explained by a model accounting for two states and an autoregressive order of two. So far the effect of covariates on the transition between states has been tested only on one individual and it is the succession of the four lunar phases which has the strongest effect. Information on the vertical behaviour of *D. intermedia* will help define conservation measures for this endangered species.

PA-16

On the front line: composite front mapping for investigating oceanographic drivers of habitat use by marine predators

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Identifying critical at-sea habitats of wide-ranging marine predators is complex, yet necessary for effective conservation. Remotely-sensed oceanographic data can be used to provide context for movements of tracked animals, improving understanding of habitat use. Sea surface temperature (SST) and chlorophyll-a (chl-a) are frequently included as environmental covariates in predictive models, yet have limitations for identifying the processes that underly foraging habitat use and preference. A diverse range of marine vertebrates is thought to associate with mesoscale (10s -100s kms) oceanographic fronts at the transitions between water masses. Front mapping via remote sensing is, therefore, a useful tool for identifying potentially important pelagic habitats. We present results of investigations using composite front mapping (Miller, 2009) together with tracking data (GLS, Argos-PTT, GPS) to elucidate the cross-taxa ecological significance of thermal and chl-a fronts. Using both 7-day and seasonal indices of frontal activity, we examine responses to mesoscale fronts as foraging cues, and the influence of persistent frontal zones on broader-scale habitat selection, in several different species inhabiting contrasting oceanographic regions; northern gannets (*Morus bassanus*; Celtic Sea), basking sharks (*Cetorhinus maximus*; UK waters), loggerhead turtles (*Caretta caretta*; Mauritanian Upwelling), and grey-headed albatrosses (*Thalassarche chrysostoma*; Southern Ocean).

PA-17

Argos tracking to understand the ecology and behaviour of agami herons

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The agami heron is ranked 13th among the world's conservation priority heron species, and 2nd for the Americas. To date, nothing is known about the feeding grounds of this species during the breeding season, or about areas used during the nonbreeding season. In French Guiana, which holds the world's largest agami heron colony (representing over 95% of the known population), the location and characterization of these habitats as well as the identification of the geographic location and routes travelled by breeding and non-breeding individuals is crucial in order to evaluate the threats on the species and develop an effective conservation action plan both in French Guiana and throughout its distribution in South and Central America. To achieve this objective, GEPOG (Group for the Study and Protection of Birds in French Guiana) is tracking agami herons since 2012 via the European LIFE+ Cap DOM program. Data from 4 individuals show that this species can migrate in different directions along the coast (Brazil, Suriname and Venezuela) and is able to cover up to1300 km within two months, including several stop-overs. Sizes and habitats of the breeding season home ranges are determined.

PA-18

GPS and accelerometry data reveal inter-annual variation in the foraging effort of Australasian gannets

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South-eastern Australia is a region where the oceanographic impacts of climate change will be felt the strongest. Such changes have the potential to alter prey type and distribution which may impact on the foraging success, reproductive success and, ultimately, the population dynamics of marine life in the region. Assessing such changes is limited due to the difficulties of direct observation and the stochasticity of the marine environment. Central place foragers, such as seabirds, provide the opportunity to deploy high-resolution loggers with a high rate of recovery. As a top-order predator, the changes in effort and behaviour of seabirds can be related to changes in prey distribution and primary productivity. Such changes may indicate important foraging areas for species of limited number or enigmatic behaviour. Using GPS tracking and accelerometer data loggers, this study investigated the foraging ecology of the Australasian gannet (*Morus serrator*) at two colonies in south-eastern Australia which experience different marine productivities: nutrient-poor northern Bass Strait and the seasonally productive western Bass Strait. Indices of foraging effort (i.e. trip duration, distance travelled, speed, and diving activity) were compared across three breeding seasons (152 individuals) with different reproductive success to assess how individuals respond behaviourally to environmental variability.

PA-19

Multi-decadal variability in the spatial dynamics of southern bluefin tuna

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Juvenile (1-4 yr) southern bluefin tuna (SBT) undertake extensive migrations between winter foraging ground s in the Indian and Pacific Oceans and summer foraging grounds in the Great Australian Bight (GAB). Valuable commercial and recreational fisheries target SBT throughout their range and commercial catches are internationally managed by the Commission for the Conservation of Southern Bluefin Tuna. The GAB is currently the focus of exploration activities associated with large-scale oil and gas development. This has generated concern for potential impacts on the migration and behaviour of SBT with associated consequences for annual abundance indices collected as part of management strategies associated with the recovery and future sustainable harvest of the species. As part of a large ecosystem study of the GAB, historical archival tag data collected during 1990-2010 in combination with new deployments of tags, will characterize multi-decadal variability in the horizontal and vertical movements and foraging behaviour of SBT. Novel statistical approaches to geolocation used in combination movement and behavioural models will characterise foraging behaviour from horizontal and vertical movement behaviour. Results from this project will provide baseline information from which future assessments of the impacts of exploration and extraction activities in the GAB can be undertaken.

PA-20

Northern lapwings *Vanellus vanellus* tracked year(s)-round by light-level geolocation

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Northern Lapwings are known for displaying a complex pattern of diffuse migratory connectivity. One question arising from this phenomenon is, for example, if the spatial variation in non-breeding sites translates into temporal variation of events at the breeding site, which may further influence reproductive performance. Also, different wintering strategies may bring about different chances for survival. Those outcomes have direct consequences on population dynamics and should also be considered in species conservation management. Lapwing populations throughout Western Europe have shown serious declines over the past decades. We tracked eight lapwings by light- level geolocation year-round, some of them for multiple years, and monitored their breeding performance in their Dutch breeding colony. We show that birds from the same local breeding colony may choose widely separated winter grounds, stretching from Ireland and the UK via France to Portugal. One individual did not leave the Wadden Sea area and overwintered close to the breeding site. Despite such large variation in migratory routines among individuals breeding next to each other, within-individual consistency of a given routine was high from year to year. This presentation compares details of these different migratory strategies and relates them further to events in the breeding area.

PA-21

Linking northern fur seal behavior with prey distributions: the impact of temporal mismatch between predator and prey surveys

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An essential part of foraging ecology is identifying how the distribution and abundance of prey impact predator behavior. However, in marine systems, temporal or spatial mismatches often exist between prey surveys and predator tracking periods, especially for species with large foraging ranges. Using northern fur seals as a model, we investigated how conclusions about predator-prey relationships change with increasing temporal disparity between predator tracking periods and prey surveys. To measure foraging behavior, northern fur seals (N=13) from St. Paul Island (Alaska, USA) were equipped with satellite tracking transmitters and time-depth recorders. Variation in dive behavior was examined using metrics such as dive rate, total dive time, bottom time, and ascent and descent rates. An annual trawl survey of the eastern Bering Sea shelf provided data on prey abundance and distribution. The relationship between dive behavior and prey abundance was examined in survey grids at 3 time scales: within 2 weeks of the survey, within 1 month, and over the entire northern fur seal reproductive season (> 4 months). Understanding predator-prey relationships, including the impact of varying temporal scales, is particularly valuable for developing management and conversation strategies for northern fur seals as the population continues to decline.

PA-22

WhaleWatch: Integrating blue whale satellite telemetry and oceanographic data to develop habitat models for conservation and management

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Management of highly migratory species requires spatially and temporally explicit information on their distribution and abundance. Satellite telemetry provides time-series information on individual movements, but these “presence-only” data have generally been less useful for management than density estimates derived from survey observations. We applied a state-space model to 104 blue whale satellite tracks, deployed in the northeast Pacific from 1994 to 2008, to estimate daily positions and account for location errors. We created “absence” points using a correlated random walk to sample the environment where whales could have gone at the same temporal and spatial scales as the tag data. Daily positions from the “presence” and “absence” were integrated with remotely-sensed environmental data as a proxy for habitat preference and prey availability. A generalized additive mixed model was applied to determine and predict in near-real-time the probability of occurrence of blue whales in the California Current, with the goal of reducing ship strikes. We found sea surface temperature, surface chlorophyll, bathymetry and sea surface height RMS were important predictors of blue whale habitat. Our approach could be applied to other protected populations and species for which telemetry data is available, and further inform policies to reduce human impacts.

PA-23

Thermal biology and habitat selection in box turtles (*Terrepene carolina*)

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The goal of the study is to further understanding of the interactions of free-living Eastern box turtles (*Terrapene carolina carolina*) with their thermal habitat. Box turtles are a long-lived terrestrial turtle species that range from Maine to Georgia along the east coast of North America and westward to the Mississippi river, occupying a variety of habitats. We measure selected temperatures in a laboratory gradient as well as ambient and internal body temperatures measured by animal borne temperature loggers. Fine scale tracking of animal movements is overlain on GIS maps of vegetation type and with measurements of habitat thermal quality generated using operant models (equivalent to non-thermoregulating turtles). These thermal maps permitted assessment of the ability of models to reliably represent the actual thermal microclimates occupied by free-living turtles and assessment of the importance of temperature in turtle movements. Simultaneous logging of heart rate through heating and cooling as well as maintenance of active body temperature indicates the importance of the cardiovascular system in regulation of thermal physiology. Box turtles are listed as a species of special concern or endangered in parts of their range, thus data on their cardiovascular and thermal response provides critical information for conservation across their range.

PA-24

Use of wildlife underpasses by small mammals through a road interchange

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To mitigate roads' negative impacts on wildlife movements and survival, the construction of wildlife undercrossing structures is recommended. In the aim to determine the use of these passages, we monitored with triggered cameras 12 different sized wildlife undercrossing structures located in road interchange. We also used some variables, like openness and weather to explain the variation of wildlife frequentation. We found that all structures are used by a variety of species including common hamster (*Cricetus cricetus*) and a high number of wood mice (*Apodemus* sp.) and voles (*Microtus* sp.). The frequency of successful crosses was variable along the year, with a maximum in October and minimal in February. Our results show that half the animals seen at the entrance of standard sized culverts refused to cross them, suggesting bad designed structures or a non-motivation to go on the other side. Openness interfered significantly with species presence and therefore suggests that varying openness of wildlife undercrossing structures would satisfy as many species as possible. However, the individual utilization of these structures is not known, biasing statistics. We therefore decided to equip local populations with transponders and to monitor hamsteroducs with automatic RF/ID readers.

PA-25

Moving and foraging in a flowing environment: how do marine predators respond to turbulence?

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Marine top predators play a fundamental role in maintaining and assessing the health of open ocean ecosystems. During the last two decades bio-logging has been used to improve the understanding of their behaviour and habitat use, to gather information about remote regions and to investigate their response to environmental change. However, what determines marine predators' horizontal exploration of the ocean is still largely not known, especially at the fine scale (1-100 km, days-months). We combine the use of bio-logging (GPS tracking and accelerometry), altimetry and a Lagrangian approach to investigate the effect of the horizontal sub and meso-scale dynamics on a marine predator, the southern elephant seal. We find that, in spite of what is often assumed, we can identify 'passive', quasi-planktonic behaviour sections along elephant seals' foraging trips. When foraging more intensively, the horizontal velocity of elephant seals is close to geostrophic currents as much as the one of drifting buoys. In these cases trajectories appear to be strongly affected by advection and influenced by the attractive dynamics of transport fronts. Our results suggest that the effect of currents even on fast-swimming animals is not negligible and that 'passive' transport can provide useful information about their foraging behaviour.

PA-26

Behavioural and environmental correlates with foraging success of southern elephant seals from Marion Island

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Southern elephant seals (*Mirounga leonina*) from Marion Island are known to consistently perform some of the longest and deepest dives recorded for elephant seals. Here we assessed the relative foraging success of seals from this population by assessing changes in buoyancy (resulting from the loss or addition of adipose tissue) of tracked individuals as displayed in so-called 'drift' dives. Based on time-depth profiles, drift dives were identified from 84 migrations undertaken by seals instrumented with satellite-relay data loggers (SMRU, University of St Andrews) and vertical displacement rates calculated for the identified drift phases within dives. We found no obvious pattern in the spatial distribution of areas where seals improved or lost condition, supporting the previous work that suggested much variability in targeted foraging areas. However, mixed model outputs suggested that increases in buoyancy were associated with colder sea surface temperature and areas with deeper water masses. Furthermore, seals tended to perform shallower, yet longer dives in areas where they improved condition. Our results confirm the spatial heterogeneity of foraging patches of southern elephant seals and further suggest that elephant seals likely profit maximally from areas characterised by colder water masses, particularly where prey species are concentrated in shallower water layers.

PA-27

From individual prey capture to reproductive success: exploring the link between foraging behavior and reproduction in Adélie penguins

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Understanding the mechanistic link among prey availability, foraging behaviour and reproductive output of predators is essential to monitoring and predicting their responses to environmental changes. Prey capture and foraging movement of predators would be important parameters to examine this link; however, few studies quantified the prey capture variability of free-ranging marine predators. We examined the prey capture rate and fine-scale movement of Adélie penguins breeding in a fast sea ice area in Antarctica, using GPS, acceleration and animal-borne video loggers. Reproductive success was highly variable among years (0.2-1.5 fledglings per nest), and was linearly and negatively related to average annual foraging trip duration. Maximum foraging distances explained 20-42 % of the variability in the foraging trip durations, but there were significant year effect on the foraging distance-trip duration relationships. Prey capture rate was examined from video footages as well as head- and body-acceleration records, and partly explained the between-year variation in trip duration accounted for distances. We discuss how changing prey patchiness and distribution affect foraging and reproductive success of Adélie penguins.

PA-28

Predicting population-level foraging habitat use in the endangered Galapagos sea lion using Generalised Functional Responses

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Identifying spatial zones that are critical for the biology of a species is essential for the delineation of protected areas and for the conservation of threatened species. Habitat preference analyses based on biotelemetry data often form the backbone of spatial management recommendations. In practice, such data is often sampled in only a subset of possible habitat availabilities of a species' distributional range, due to logistical and financial limitations. To date, the predictive power of such analyses outside the sampled conditions is poor, due to non-linear responses of individuals to changes in habitat availability, reducing the general applicability of such studies for spatial conservation management. Here, we apply the novel Generalised Functional Response (GFR) analysis framework to at-sea GPS telemetry data of female Galapagos sea lions from two colonies characterised by starkly contrasting marine environmental conditions. We test the ability of the framework to predict foraging distributions from limited data enveloping un-sampled, intermediate conditions by comparing the predictions of our model to published foraging ranges of female sea lions from two different colonies. Understanding population-level habitat use of the endangered Galapagos sea lion is particularly vital on the background of rapidly increasing anthropogenic usage and traffic within the Galapagos Marine Reserve.

PA-29

Extrinsic and intrinsic factors influence the winter migrations of black-legged kittiwakes (*Rissa tridactyla*) in the North Pacific

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Migratory movements can be influenced by factors that are either intrinsic (e.g. sex, colony, adult quality, past experience) or extrinsic (e.g. prey availability, weather, oceanography). To better understand their interaction, we analyzed geolocation data from black-legged kittiwakes breeding at St. Paul and St. George in the Pribilof Islands, Alaska. Between 2008 and 2011, we tracked 124 winter migrations of kittiwakes that traveled south to pelagic, sub-arctic waters. Although there was a high degree of similarity in the habitats used in successive winters, birds from St. Paul and St George made greater use, respectively, of the Bering Sea and western sub-arctic. Distributions were further north in 2009/10, during a moderate El Niño, and more dispersed in the subsequent La Niña conditions of winter 2010/11. In all years, females tended to disperse more widely than males. Birds tracked during two consecutive years (n=18) showed higher fidelity to wintering areas than expected by chance. Birds that traveled farther each day and occupied larger areas failed to initiate breeding the following season (n=12). It appears that a balance between intrinsic and extrinsic factors mediate migrations, that then may have carry-over effects on breeding initiation in black-legged kittiwakes.

PA-30

Prediction of krill swarm characteristics driving a marine predator "hotspot" region in East Antarctica

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Understanding open-ocean predator-prey interactions is hampered by a persistent lack of information on prey fields at scales relevant to the distribution and behaviour of predators such as seals, whales, penguins, and seabirds. Hence there is considerable interest in identifying the biological and physical factors that influence the distribution and abundance of prey species, and potentially predator decision-making, which may be of broad predictive use. We focus on Antarctic krill swarms as an example prey, utilising acoustics observations from a large research survey (BROKE-West, 2006) of East Antarctic waters. Employing a comparative approach we develop and test two sets of models predicting individual swarm characteristics (density, biomass and depth distribution) and spatial distribution. We use two sets of data for the explanatory variables: (i) underway research vessel data, and (ii) the satellite remotely-sensed analogues of these. While research survey data is in situ and contemporaneous, remotely-sensed data is all that will be available for prediction and inference about prey distribution in most predator tracking studies. We evaluate the utility of model-based prey-field predictions from both approaches, and demonstrate an application using predator tracks drawn from independent studies.

PA-31

Population-level foraging variability in a mesopelagic predator, male northern elephant seals (*Mirounga angustirostris*)

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Northern elephant seals experienced a severe bottleneck in the late 1800s where the species was reduced to ~10 individuals; since then, the population has grown rapidly and is currently estimated to be ~200,000 individuals. This recent expansion provides an opportunity to compare life history differences between historic and new populations. We examined foraging variability in male seals (n=42) from one of the original populations in Islas San Benito, Mexico with those from a northern, recently colonized population at Año Nuevo, California, USA using satellite tags and time-depth recorders. Both populations foraged in similar habitats: continental shelf ecosystems. Most San Benito seals (60%) foraged along the Mexican and southern California coasts, exploiting locally available prey. The remaining San Benito seals foraged at the boundary of the California Current and Alaska Gyre. The northernmost range of the San Benito seals overlapped with the southernmost range of the Año Nuevo seals. However, the majority of Año Nuevo seals (61%) traveled double the maximum distance of San Benito seals (3,210 vs. 1,518 km) to foraging habitats in the Gulf of Alaska and Aleutian Islands. Despite similar foraging habitat preferences, plasticity in foraging behaviors may reduce intraspecific competition in this rapidly expanding population.

PA-32

Commute or migrate? Differing winter foraging strategies of Antarctic fur seals revealed through multi-dimensional tracking

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During the winter, Antarctic marine predators face an extreme and variable environment. Winter foraging behaviours can differ markedly from the constrained summer patterns that are well documented for many species. The Antarctic fur seal is a key Southern Ocean predator which undertakes long-distance winter movements. Geolocation devices tracked the movements of females from Marion Island, revealing several individual strategies forming two major groups: commuters and migrators. Commuters performed short repeat trips, while migrators undertook a single, wide-ranging trip. From 2012-13, 17 animals carried time-depth recorders, providing the first observations of multi-dimensional winter habitat use for this species. Switching behavioural state-space models inferred searching behaviour along tracks, while models of dive metrics predicted foraging effort across various temporal scales. Results indicate marked differences in dive behavior with latitude, represented here as foraging south or north of the Polar Front (PF), analogous to commuters and migrators. Dives south of the PF were shallower and shorter than those to the north. Foraging effort reduced for individuals transiting south of the PF. Changes in dive behavior over the winter were observed. Results are discussed in context of target prey and individual foraging strategies. The use of complimentary methodologies for inferring foraging is also discussed.

PA-33

Estimation of mortality and movement in elasmobranchs using multi-state models and telemetry data

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Worldwide, there is growing concern over the status of elasmobranchs with over one quarter classified as threatened according to the IUCN Red List criteria. Determining population status and monitoring population trends in non-commercial, conservation-dependent elasmobranch species is often limited by a lack of data from which to determine fundamental population parameters such as annual mortality. Recent improvements in the battery longevity of acoustic tags now offers considerable potential to monitor individuals for many years – particularly where species show annual fidelity to specific aggregation areas or where life history stages (e.g. juveniles) occur in geographically discrete habitats or regions over multiple year-classes. However, for these data to be useful, models are needed which can objectively disentangle movement and behavioral processes from mortality events. This can involve integration of multiple telemetry data types (e.g. acoustic and satellite tracking), accounting for individual or age-specific variability in movement, location specific environmental influences on these movements as well as detection probabilities. We consider estimation of juvenile survival in spatial and non-spatial contexts and present case study examples of this work from Australian elasmobranch species.

PA-34

A mobile predator? Variable space and depth use patterns of an exploited coral reef fish

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Movement influences the distribution and abundance of populations. Knowledge of movement patterns is particularly useful for parameterising assessments and designing management strategies for exploited fish populations. Despite importance to fisheries, limited empirical evidence have portrayed adult tropical lethrinids as sedentary with small home ranges and as mobile predators that potentially migrate long distances. To distinguish the typical movement patterns of redthroat emperor (*Lethrinus miniatus*), horizontal and vertical activity space use and depth utilisation were investigated. Sixty individuals were monitored for up to 12 months using an acoustic telemetry network comprising three reefs in the Great Barrier Reef, Australia. Evidence supporting a mobile lifestyle includes broad-scale movement (~160km) of one individual, periods of non-detection and potential movement away from the reef edge at night. Yet most individuals displayed high site fidelity and moderate-sized horizontal activity spaces (~4km^2) over a period of up to 12 months. Individuals inhabited a variety of depths with an absence of consistent trends based on time or size of individuals. Variation in movement among adult redthroat emperor indicates that while some individuals migrate over long distances, spatial closures that cover individual reefs (>4km^2) could provide protection from fishing for the more resident proportion of the population.

PA-35

Environmental drivers of depth use by an exploited reef fish

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Redthroat emperor (*Lethrinus miniatus*) is an important species to fisheries of Australia, Japan, New Caledonia and Tonga, yet little is known about its movement patterns. Recent research has revealed variability in movement patterns among individuals, with no consistent patterns observed in presence or depth use related to individual size or time of day. Knowledge of how environmental conditions influence movement patterns of redthroat emperor is vital to better understanding response of this species to changes in climate. Utilising an acoustic telemetry network at three reefs combined with in-situ real-time monitoring of environmental conditions, this research investigates the vertical space use of redthroat emperor in relation to water temperature, tides, rainfall, air pressure and wind speed. Sixty adult individuals were fitted with Vemco V13P transmitters over three deployments, and monitored within a network of passive acoustic receivers in the southern Great Barrier Reef, Australia (April 2011-September 2013). Models compared environmental data with weekly and monthly vertical activity spaces and identified the environmental parameters that drive patterns in depth use. This study offers new insights into the ecology of this important species, and will allow managers to better predict the effect of environmental conditions on the movement patterns of this species.

PA-36

Dive behavior and spatial variability of bearded, ribbon and spotted seals in the Bering and Chukchi Seas

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Satellite tags (n=68) were deployed on bearded (*Erignathus barbatus*; n=7), ribbon (*Histriophoca fasciata*; n=39) and spotted seals (*Phoca largha*; n=22) in the Bering and Chukchi seas between 2007 and 2012. The tags provide Argos location estimates and summarized dive behavior data. Seal use was predicted using a continuous-time correlated random walk and documented different seasonal patterns of spatial across species. Additionally, we expanded the analysis to include dive behavior data to illustrate further differences. Predicted locations were temporally matched with dive records and a quasi-weighted kernel density analysis was employed to estimate a density surface reflective of both space use and dive behavior. A novel jack knife approach was used to optimize kernel bandwidth to better reflect population level use patterns. Ribbon seal dive behavior (200-600+ m) was more intense along the Bering Sea shelf break and deeper waters while spotted and bearded seals limited their dive behavior (<200 m) to the shallower, on-shelf habitat. The spatial variability in dive behavior across these species is an important component of understanding and predicting responses of ice-associated seals to changes in sea-ice and other elements of their marine ecosystems as a result of future climate change.

PA-37

ARGOS or GSM? Also loggerhead turtles can call us to communicate their location

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Tracking animals through the ARGOS system in the Mediterranean has been shown to be problematic, especially in the South Tyrrhenian Sea, due to a broadband noise that covers the ARGOS frequency range. Recent tracking of loggerhead turtles, *Caretta caretta*, through ARGOS in SW Italian waters yielded only ten locations per day, of which, however, some 40% were discarded through filtering. Moreover, the high proportion (72 – 97%) of locations for which ARGOS provides no accuracy, precludes from any detailed spatial analysis of loggerhead turtle habitat use and home ranges. We have thus equipped 3 turtles with a GPS tag containing both ARGOS and GSM antennas to test the possibility of relaying data through the mobile phone network and to compare the performance of both transmission pathways. As expected, the number (<1 d^{-1}) and quality of ARGOS locations was poor, but there were sufficient connections to the GSM network sending up to 26 high accuracy GPS locations per day. This demonstrates the utility of GSM to monitor sea turtle movements and produced the first detailed map of area use by loggerhead turtles in Italian foraging grounds useful to mitigate human impact through fisheries regulation in that area.

PA-38

Foraging behavior, habitat use, and provisioning success of rhinoceros auklets at five colonies in British Columbia

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GPS dataloggers, remotely sensed oceanographic data, and chick diet sampling were used to study the foraging behavior, habitat use, and provisioning success of rhinoceros auklets breeding at five colonies throughout British Columbia, Canada, during the summer of 2014. These colonies span the transition zone between the California and Alaska Current systems and thus differ in habitat characteristics, environmental conditions, and breeding success. In addition, three colonies are located in nearshore waters while two are offshore, resulting in unique foraging requirements. Habitat utilization has not been studied for this species and links between foraging location, environmental conditions, and provisioning success at the individual level remain unexplored. This study will address these knowledge gaps, improving our understanding of habitat requirements during the chick-rearing period and the potential effects of increasing environmental variability throughout this region. We hypothesize that there will be differences in prey type between northern and southern colonies, and differences in foraging behavior between nearshore and offshore sites. Sex-specific differences in foraging behavior have been documented in both size-dimorphic and monomorphic seabird species and will also be examined and discussed with respect to their relative contributions to chick growth.

PA-39

Quantifying the variation in scale and magnitude of grey and harbour seal responses to their environment

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Habitat preference can be modelled as a function of space use, accessibility, and competition, combined with environmental covariates to describe why animals use geographic space in a certain way. However, animals response to their environment changes throughout space (i.e. the relationship is non-linear), and this is not usually taken into account. Dependant on the spatial scale (i.e. rate of change), model predictions can be affected unless they capture diverse environmental conditions. 20 years of telemetry deployments with Satellite Relay Data Loggers and GPS tags on grey and harbour seals around the UK have built a rich dataset of hundreds of individual animals tracked on average for 4 months at a time. We used this data to identify determinants of core seal habitat, delineated geographically around the UK. Models were built using data-rich regions to provide robust predictions to data-sparse and unobserved areas, providing continuous habitat preference maps. Modelling was carried out by fitting regression models implemented using resource selection functions to obtain generalised functional responses to account for environmental change. To use this method on our broad-scale, complex data we trialled models of increasing complexity, beginning with mixed effects generalised linear models in R-library lme4.

PA-40

Where to do what? Spatial distribution and foraging behaviour of harbour seals (*Phoca vitulina*) in the Wadden Sea

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Information on movement and habitat use is fundamental for good management and conservation of wide ranging species. Little is known about movement and habitat use for the Danish Wadden Sea harbour seal population. To remedy this, 17 harbour seals were tagged on the island Rømø with Argos tracking devices that transmitted for a median of 92 days. State-Space models were used to integrate treatment of tracking system limitations and probabilistic assignment of a behavioural mode to each geolocation by means of movement metrics. The behavioural assignment was then used to infer distribution and habitat use in terms of individual variations and site fidelity. Results showed that animals travelled up to 300 km from the tagging site in order to reach foraging spots, with pups and young animals travelling longer distances, possibly due to competition with older animals for the best foraging locations. Additionally, individuals tended to show haul-out and foraging site fidelity, clearly sharing haul-out sites but potentially not foraging spots. Each seal may forage in a small area but the population as a whole is widely distributed. This information will allow for better identification of critical habitats and allow for assessment of effects of anthropogenic activities.

PA-41

Predicting population-level differences in the distribution of non-breeding albatrosses

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Advances in tracking methods have greatly improved our knowledge of marine predator movements, yet we still know relatively little about the drivers of movements of individuals from different populations, particularly outside of the breeding period. We tracked 66 grey-headed albatrosses *Thalassarche chrysostoma* with archival geolocator tags for a mean of 426 days from two major breeding colonies in different ocean basins; in the south-west Atlantic Ocean (Bird Island, South Georgia, n=41) and in the south-west Indian Ocean (Marion Island, Prince Edward Islands, n=25). The non-breeding distributions of birds from the two populations showed limited overlap; South Georgia birds foraged around colony or the Falkland Islands, and to a lesser extent around Marion Island, whereas individuals from Marion Island foraged around their colony or to the east of the Kerguelen Plateau. Grey-headed albatrosses are biennial breeders and spatial segregation was much more pronounced during the non-breeding summer than the first or second winter away from the colonies, suggesting that non-breeding birds avoid waters near other grey-headed albatross colonies due to potential competition with breeding birds. I present results from models that determine quantitatively whether the differences in distribution between the two populations are the result of environmental, geographical and/or density-dependent processes.

PA-42

From phytoplankton to foraging: Linking swimming speeds of post-breeding female southern elephant seals to fluorescence in the water column

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Area restricted search and optimal foraging theories predict that marine predators will measurably decrease their swimming speeds as they encounter higher densities of prey species. To test if this applies to free-ranging southern elephant seals, eleven post-breeding adult females from Kerguelen and Marion Island were tagged with instruments that relayed their at-sea positions while concurrently measuring salinity, temperature and fluorescence. Three-dimensional fluorescence yield was used as a measure of phytoplankton abundance, and this was employed as a proxy for presence of marine prey. Cumulative sums analysis of seal swim speed showed three distinct phases within tracks. Namely: departure (high speed, outward transit from Island), potential feeding (slow speeds at the distal end of the journey) and return (high speed, homeward- bound transit). Removing the return leg of the journey from the analysis improved goodness of fit between speed and fluorescence, supporting the hypothesis that seal behaviour measurably shifts from “search and feed” to “travel” towards the end of this intensive feeding migration. Despite variation between years and populations, with the return phase filtered from the data, speed was significantly related to fluorescence yield. No relationships were found between speed and other environmental variables including: temperature, salinity and density-derived mixed layer depth.

PA-43

Biologging across space and time: studying a terrestrial species at its distribution range scale

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GPS tracking is probably becoming the most common biologging approach to study species in Terrestrial Ecology. Reasons of success include a) the high relevance given to spatial position to relate terrestrial animals to the environment; b) the possibility to exploit the parallel fast development of remote sensing techniques in providing high coverage maps; and c) the need to track the effect of human-induced changes at a multi-scale level, e.g. from local microclimates to large continental effects, for conservation and management purposes. Animals show proximate responses to changes in seasonality and habitat loss through movement and use of space. Emergence of movement behaviour can be scaled up from individual space use tactics, to populations and meta-populations. With a purely bottom-up approach, the EURODEER group has shared a multi-population dataset of a small deer characterised by high ecological plasticity (the European roe deer, *Capreolus capreolus*), and has contributed to a multi-use platform for biologged data (www.eurodeer.org). We have investigated the complexity of the ecology of this adaptable species in dependence of environmental and climate-dependent factors, in a robust manner (i.e., testing the effects across a latitudinal and habitat continuum). We present a range of study cases, and some peculiarities of this initiative.

PA-44

Encouraging discoveries, rapid progress and a problem wrapped in deeper darkness: the trials and tribulations of following eels to the Sargasso Sea

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The population of the European eel (*Anguilla anguilla*) is in decline and a continent wide eel management plan has been implemented to recover the stock in the coming decades. Research is still needed to provide greater understanding of the factors that influence eel population dynamics. The eeliad project was a four year study aimed at unravelling some of the mysteries of the marine life of European eels, in particular the spawning migration to the Sargasso Sea. We developed and used a range of active and passive tracking techniques to track eels from river to ocean, and to measure their behaviour once at sea. More than 150 datasets were retrieved from ocean migrating eels, which enabled us to reconstruct the first 4000km of the migration from Europe to the mid-Atlantic. The field programme was coupled with modelling and analytical studies to assess recruitment dynamics, and the impacts of freshwater pollution and parasite load on eel quality. In consequence, our research has provided significant insights into the swimming capabilities and migratory behaviour of eels, the threats that migrating eels face during their migration, and how these link to the growth phase of their lives in freshwater catchments.

PA-45

Do krill fisheries compete with macaroni penguins? Spatial overlap in prey consumption and catches during winter

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Industrial fishing may compete with predators for food, but this can be reduced by setting catch limits and restricting the timing or locations of fishing. Such management needs information on the distribution of food consumption by predators. Macaroni penguins are important consumers and those in South Georgia feed primarily on Antarctic krill, which also forms the target of an industrial fishery. We examined their overlap during winter: the only period when direct competition can occur. We mapped penguin distribution using global location sensors and calculated food consumption using data from heart-rate loggers. We combined these to produce a surface of the biomass of krill consumed which could be compared directly with the distribution of that caught by the fishery. Adult macaroni penguins consumed 126,571 tonnes of krill during the winter which is similar to the 98,431 tonnes caught by fisheries. Spatial overlap was low because macaroni penguins dispersed widely across the Scotia Sea whereas the fishery was restricted to three small areas on shelf edges. The proportion of the estimated krill standing stock taken by both macaroni penguins and the fishery was small. We conclude that competition between macaroni penguins and the krill fishery is low under current management.

PA-46

Fin whale movements within and beyond the Pelagos Sanctuary: Should we reconsider its boundaries?

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By tracking animals' ranging patterns and fine-scale space use, telemetry provides us with means to assess the effectiveness of existing spatial management measures. Fin whales aggregate in the Ligurian Sea to feed in summer months. The Pelagos Sanctuary was established to protect this and other species of marine mammals using the area. However, it is unclear whether its boundaries offer sufficient coverage of the animals' critical habitats, especially outside the summer season. Location-only satellite transmitters (intradermal and LIMPET SPOT5, Wildlife Computers) were attached to eight individual fin whales in the Pelagos Sanctuary. Deployments occurred in late summer, to maximise information outside known feeding grounds. Tagged whales remained in the Sanctuary longer than expected. Two individuals left the Sanctuary and moved towards the Balearic Islands, ranging in a confined area (100x100 km) for approximately 20 days before heading towards the Gulf of Lions. We used a Bayesian hierarchical state-space model to discriminate between transiting and area-restricted search (ARS) behaviour. The animals were found to predominantly engage in ARS behaviour, while showing only short-term transiting. Albeit based on a small sample size, our results suggest that a wider and more dynamic management scheme is required to effectively protect fin whales' critical habitat.

PA-47

Where to forage? The secret to surviving an Antarctic winter revealed by Weddell seals from two different colonies in East Antarctica

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Winter is a critical period in the Weddell seal life cycle, during which time seals must optimize their resource acquisition and storage to maximise their breeding success in spring. How Weddell seals interact with their environment in winter remains poorly documented. To address this, we attached Argos-CTD tags to Weddell seals at Davis Station (n=21) and at Dumont d'Urville (n=12) between 2006 and 2011. These tags provided unprecedented information on seal movements (75 ± 140 km), diving behaviour (> 70000 dives) and physical characteristics of the water column (>12000 CTD and 8000 T° profiles). A novel index quantifying within-dive foraging effort was included in a First Passage Time (FHT) analysis. We identified the optimal scale of an individual's intensive search effort with FPT analysis integrating the horizontal, vertical and temporal dimensions simultaneously. Environmental variables were extracted for each location taken from 100 simulated tracks to account for Argos positioning errors. Abiotic feature including sea-floor topography, light, sea-ice and hydrography influenced seal foraging effort. We found that Weddell seals optimize their foraging strategies in winter by: (i) using habitat features likely to induce prey aggregates; and (ii) concentrating their search effort around a given access-hole in the ice until resources have depleted.

PA-48

Making the link: higher trophic biomass gives new insight into fine-scale foraging behaviour of southern elephant seals from Kerguelen Island

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Understanding the nature of trophic links in marine ecosystems remains a challenging issue. For example, female southern elephant seals (*Mirounga leonina*) foraging in the vicinity of the Kerguelen Plateau encounter phytoplankton bloom events during their two-month post-breeding foraging trip (Nov - Jan), but because elephant seals feed on mid-trophic species (e.g. myctophid fish) their foraging behaviour is poorly predicted by chlorophyll-a distribution. We therefore expect quantifying higher trophic biomass (HTB) to have greater explanatory power. Time-depth recorders, accelerometers and fast-loc GPS were deployed on 43 post-breeding southern elephant seals from Kerguelen between 2008 and 2012. Their movements, foraging behaviour, ambient light and temperature were recorded simultaneously. Light levels were used to estimate in situ biomass, taking into account bio-optical variability of phytoplankton group type (PHYSAT datasets). Our objectives included: (1) Relate in situ biomass with satellite-derived chlorophyll-a and use model residuals to extricate HTB from phytoplankton (2) Investigate the relationship between HTB distribution and seal foraging behavior (3) Consider HTB-seal interactions in relation to temperature gradients. We revealed how elephant seals responded to HTB distribution and corresponding temperature-depth profiles. This work improves our current understanding of links between lower trophic levels and apex marine predators in the Southern Ocean.

PA-49

Tracking ocean wanderers: BirdLife International's seabird tracking database as a conservation tool

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The development of tracking technologies have allowed an exponential growth in the number of studies focusing the at-sea movements of several seabird species, especially large and medium- sized ones belonging to the Procellariiform order (albatrosses, petrels and shearwaters). BirdLife International, with data inputs and collaboration from over 100 researchers around the world, have established an online database to centralize tracking information collected from more than 100 species of seabird (http://www.seabirdtracking.org). These data have proved an invaluable tool for conservation in the marine environment. Since 2004 overlap analyses of seabird distribution and fishing effort have proved instrumental in identifying areas where seabird bycatch is likely to be highest, and crucially has convinced fisheries managers to bring in new bycatch mitigation regulation. In 2012 novel analysis of data collected for 45 species, contributed by over 70 researchers defined boundaries for over 3000 marine Important Bird Areas (http://maps.birdlife.org/marineIBAs/default.html). These marine IBAs have provided a fundamental input in a range of marine decision making processes looking to identify candidate MPAs, in particular the EU Bird's Directive and the CBD EBSA process.

PA-50

What are southern elephant seals looking for? Long trip from Kerguelen to the Antarctic zone: The length and breadth of the mystery

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Understanding responses of higher trophic levels to variability of the environment is crucial for predicting how animals may respond to climate-driven change. Among elephant seals from Kerguelen, different foraging strategies have been unrevealed, yet little is known about why some undertake such long costly migrations. Utilization of an environment constrained by sea ice during winter time requires benefits to make this strategy profitable and maintainable over years, unique environmental features may hold the answer to the causes underpinning seal movements. For this, we developed a new approach consisting of using indexes of foraging derived from high resolution dive and accelerometry data (prey encounter events) to predict foraging behavior from an extensive, low resolution dataset (CTD-SRDLs). A total of 40 seals were studied during post-moult movements from Kerguelen to the Antarctic shelf from 2004 to 2013. Dive parameters (depth, bottom-time, speed ascent) explained 40% of the foraging index variance. Combining our prediction on foraging behavior with environmental features, we revealed that continental shelf, sea-ice features and areas where the bathymetric profile allow intrusion of nutrient rich water masses on the shelf are involved in the acquisition of food resources along the Antarctic. Significant differences were observed between males and females strategies.

PA-51

Sites during non-breeding seasons are stable for individual Arctic skuas but variable within the breeding population

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Arctic skuas (*Stercorarius parasiticus*) are long-lived seabirds and they are mainly kleptoparasitic. In Finland a pair occupies one small island and they return to breed there every summer. It has been assumed that Arctic skuas spend their non-breeding time in Southern Atlantic. The exact migration routes and wintering areas of arctic skuas were not known before. Our project is the first one to solve that with the help of small light-detecting geolocators. Since summer 2010 we have captured 16 adult birds and provided them with a geolocator and a reading ring in addition to a normal steel ring if they did not have that yet. We also recorded their breeding success. During the years we have managed to recapture ten of the birds to read their data. There was a lot variation between the individuals in their wintering areas and migration routes but half of the birds spent most of their non-breeding time in southern part of South America and half on the western coast of Africa. From some individuals we have data from two or more years and those show that an individual migrates to the same wintering area every year.

PA-52

Studying common crane (*Grus grus*) flight characteristics by high-resolution GPS telemetry

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Knowledge of fine scale bird flight characteristics is a prerequisite if we aim to comprehend potential impacts of man-made structures such as offshore wind farms on migrating birds. Soaring landbirds as cranes and raptors rely on meteorological conditions producing uplift, i.e. thermals, during their long-distance migrations. However, as thermals are normally not produced over water, these birds fly at lower altitudes (depending on other meteorological conditions) when crossing large water bodies, which make them more prone to collision risk with wind turbines. To study the fine scale flight characteristics of common cranes (*Grus grus*) we used GPS telemetry to track their migration from the breeding areas in Sweden to wintering areas in southern Europe. The transmitters were programmed using a «geofenced» area, delineating the Baltic Sea, where GPS locations were collected at very high resolution, every 30 seconds. The collected data was further used for fitting models, relating flight altitudes to topographic and meteorological variables. The developed models improve our understanding about crane flight altitude and directions in different weather conditions and serve as a practical tool when assessing potential impacts of offshore wind farms.

PA-53

Importance of marine circulation on the flexible foraging ecology of top predators

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During the two last decades, the progress in satellite telemetry has allowed to considerably increase our knowledge on at-sea ecology of top predators. Simultaneously the advance in satellite technology for measuring physical oceanographic parameters has been essential to understand the marine dynamics and circulation at global scale. These measurements were also the basis of studies conducted at mesoscale (about 100 kms) and submesoscale (1 km to 10 km), often defined by eddies and fronts/filaments. Our aim is thus to understand how marine top predators face to the dynamic and complex marine environment. We were especially interested in examining the influence of eddies and submesoscale fronts on the distribution and foraging behaviour of predators through an interdisciplinary approach. We focused our studies on elephant seals prospecting the circumpolar current in the Southern Ocean during their two long periods of time spent at sea. Mesoscale and submesoscale features, detected using Lagrangian diagnostics, influenced thoroughly the distribution and the foraging activity of seals. However, this effect is modulated by the seasonally-contrasted biological environment. This approach contributes to elucidate the foraging strategies of top predator in such dynamic environment and it brings new insights on physical-biological interactions occuring in the open ocean.

PA-54

Acoustic tags on wild harbour porpoises reveal context-specific reactions

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There is a growing concern that anthropogenic noise may disrupt the behavior, impair the hearing or compromise the general health of cetaceans. Little is known about the noise free-ranging animals are exposed to and how individuals react to specific noise sources. We deployed archival multi-sensor DTag3 tags on six wild harbour porpoises to study noise exposure and behaviour in the highly trafficked Danish Straits. The suction-cup attached tags provided continuous recordings for up to 24 hours, while logging stereo sound (500 kHz), triaxial magnetometry, acceleration and depth (625 Hz). The porpoises were exposed to low-to-moderate vessel noise for the majority of recordings, with occasional high levels extending for >1 hour. The highest received levels reached 138 dB re 1µPa m-weighted rms sound pressure level. At 125 kHz, received third-octave rms levels reached 121 dB re 1µPa, which suggests potential for masking porpoise echolocation and communication. The animals showed context-dependent reactions to noise including cessation of foraging and echolocation, logging at the surface, or sustained energetic fluking. The avoidance responses to the ship noise exposure, suggests strong implications for foraging efficiency, energy expenditure and stress impacts. Finally, it may increase susceptibility to bycatch by distraction, masking and reduced detection of fishermen's nets.

PA-55

Wintering habitat preferences of humpback whales (*Megaptera novaeangliae*) tagged in Madagascar using habitat modelling

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The Madagascar coastal waters represent an important mating and calving ground for humpback whales of the Southwestern Indian Ocean but very little is known about their movements and habitat preferences in this region during the breeding season. Argos satellite tags were attached to 23 individuals during the 2012 and 2013 breeding seasons at two distinct regions of Madagascar: in the Sainte Marie channel (Northeast) dominated by a wide continental shelf and weak ocean currents and off Anakao (Southwest) characterized by a narrow shelf and a strong southward current. The observed whale tracks indicated that the Central East, South and Southeast coasts were important areas in terms of time spent by the whales and that movement patterns differed between males and females. We combined State Space Model and regression technics to study the relationships between habitat use and environmental parameters according to sex and breeding status. For this, the individual distribution positions were correlated to physiographic (bathymetry, slope, distance from shore) and oceanographic (sea surface temperature, surface current) variables by extracting the relevant data relative to the whale tracks. Our results on two distinct regions improved our understanding on habitat suitability of humpback whale around Madagascar.

PA-56

Long-term tracking reveals winter site fidelity of bearded seals in the Bering Sea

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Seven bearded seals (*Erignathus barbatus*) were tagged with small Argos-satellite location transmitters attached to their hind-flippers in Kotzebue Sound, Alaska, during late June and early July of 2009-2012. These novel tags, to our knowledge, provided the longest recorded durations for Argos deployments on pinnipeds (346-1,379 days). After spending August - November in the Chukchi or Beaufort seas, all seven seals migrated south to the Bering Sea where they stayed during January - April. The areas used during winter were much smaller than those used in summer and autumn. Four of the seals were male and they returned in successive winters to the same small areas of the Bering Sea. Two sub-adult males were tracked for 3+ years; thus, Bering Sea bearded seal males apparently establish wintering (i.e., breeding) sites even as sub-adults. We were unable to determine whether females returned to previous wintering locations, though at least one made a return trip to the Chukchi Sea after wintering in the Bering Sea. The results from the males are the first direct confirmation of site fidelity in bearded seals. Strong fidelity to wintering sites may limit bearded seals' capacity to adapt to shifting ice distributions in a warming Arctic climate.

PA-57

Assessments of reduced environmental variation through the use of regional climatologies in the modeling of high- resolution telemetry data

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Marine animal-borne telemetry has allowed real-time, long-term observation of animal movement and wildlife behavior and become central tools in understanding a species' ecology. However, the sophistication of telemetry technology including improved locational accuracy and increased temporal frequency of geographic fixes exacerbate spatiotemporal scale mismatches and data gaps in traditional sources of environmental covariates (e.g., remote sensing). In species distribution modeling, regional environmental climatologies have developed as an alternate source of environmental covariates that circumvent issues with data gaps from cloud obstructions, characterize spatiotemporally ephemeral oceanographic features like fronts and eddies, and incorporate a broader set of variables including important subsurface and benthic processes. The use of climatologies in modeling requires significant assumptions regarding the temporal mismatch between the covariate and the animal's direct interaction with environment. Using GPS data from gray seals in the US Northeast, we assess the application of environmental climatologies in the species habitat modeling, comparing these models to traditional models created with instantaneous (e.g., from tag sensors) and contemporaneos (e.g., multi-day composites from satellite imagery) covariates. Model comparisons evaluate the utility of using climatologies in spite of temporal mismatches and inform decisions about their use in supplementing other contemporaneous sources of environmental data.

PA-58

How does temperature impact the performance of ectotherms? Lessons from accelerometers deployed on largetooth sawfish (*Pristis pristis*)

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Temperature affects most physiological processes which in turn impact animal behaviour and ecology. In ectotherms, both short- and long-term variations in temperature impact physiological (i.e. locomotor and metabolic capacity) and ecological (i.e. body condition and growth) performance and thus affect survival. Here, we investigated the impact of seasonally changing temperature on the ecological and physiological performance of juvenile sawfish (*Pristis pristis*). Animal-attached accelerometers, revealed that despite a 10°C increase in temperature, sawfish were active and displayed substantial burst-swimming capacity. Physiological performance, as ascertained by locomotory capacity, increased in the warmer late dry season conditions, whereas timing and duration of activity did not. Contrary to physiological performance, late season sawfish were poorer condition that those in the early season. This suggests that even though locomotory performance of juvenile sawfish increased at greater temperature, foraging activity and thus energy intake was not sufficient to maintain body condition, resulting in declining growth. For individuals that are intake limited, greater temperatures and associated metabolic rates are disadvantageous and can result in lower growth rates and potentially starvation. Physiological and ecological performances may thus respond differently to warming temperatures, emphasizing that optimal temperatures may be highly context dependent.

PA-59

Internal state versus external environment: combining eco-physiology and movement ecology of a large herbivore

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How will animals respond to changing climate is a fundamental question in ecology and evolution. Large animals in northern latitudes are especially vulnerable as they are heat sensitive and may require a adaptations to cope with the warming north. Such studies require novel methods of monitoring animals. We tracked 20 moose (*Alces alces*) equipped with GPS collars and abdominal temperature loggers to understand their movement patterns and simultaneous changes in body temperatures as well as external environment. The mean daily body temperature of individuals ranged from 37.09°C to 39.92°C. The lowest body temperatures were recorded in March and April and highest during July, when ambient temperatures were also highest. There were no significant differences in body temperatures between migratory and resident moose, however across areas; the body temperature was on an average slightly higher in the area at a higher elevation. In this first study measuring the internal state of a northern herbivore, we discuss our results in context of movement and habitat use of a large mammal at multiple scales and relate them to changes in ambient temperature, snow regimes, habitat composition and individual fitness.

PA-60

Tracking red-throated divers: from wintering to breeding and back

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Red-throated diver (*Gavia stellata*) is a protected bird species, spending winter - a critical period in its life-cycle, in intensely used marine waters of Europe, where it faces many potential threats, such as oil pollution, fisheries, wind power development. Understanding spatial dynamics, habitat use as well as migration routes and breeding areas is essential for effective conservation of this species. Six red-throated divers, fitted with implantable satellite transmitters on their wintering grounds in the Baltic Sea in 2012 and 2013, were successfully tracked throughout the wintering season, spring migrations and on their breeding grounds. On the wintering grounds, birds were rather mobile, each exploiting several discrete wintering areas along the eastern - south-eastern coast of the Baltic Sea, while one bird moved even into the North Sea, going as far south as France. Distinctive stopover sites were also used by birds during the spring migration to their breeding grounds in northern Russia. Breeding areas of five tracked birds were precisely pinpointed in the high Arctic of Russia, providing insight into their breeding and post-breeding ecology. The study was supported by EU LIFE+ programme as part of the DENOFLIT project, aimed at identifying and designating important marine areas for biodiversity conservation.

PA-61

High-resolution monitoring of Eleonora's falcon *Falco eleonorae* from Cyprus to Madagascar

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This study investigates the foraging areas of Eleonora's falcons, *Falco eleonorae* in Cyprus, the easternmost breeding limit of the species, as well as the migration routes and wintering areas. GPS/GSM/Radio transmitters are used, which provide data of a very high spatial accuracy, and had never been used before with this species. This ongoing study indicates that breeding individuals in Cyprus are flying mostly inland during the pre-breeding season feeding on several insect species, while after the hatching of nestlings they also fly towards the sea feeding on migrant bird species, but still feeding on insects inland as well. Migration routes towards Madagascar are almost straight over Egypt, Sudan, Ethiopia, Kenya, Tanzania and Mozambique. Wintering grounds are restricted to the eastern humid and sub-humid part of the island. We compare the relative merits of GPS/GSM/Radio transmitters and ARGOS satellite transmitters for studying migration and foraging patterns of *Falco eleonorae*.

PA-62

Differences in patterns of habitat utilization of Weddell and crabeater seals along their circumpolar distributions: responding to local conditions

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Addressing the potential changes in species distribution in response to global change requires evaluating current species-wide patterns of habitat utilization and how these are determined by the local environment. These efforts, however, can be limited by a lack of data on distribution of the species, which are particularly difficult to collect in the case of air-breathing marine predators in high latitude systems. We present here a retrospective analysis on the distributional patterns of both Weddell (*Leptonychotes weddellii*) and crabeater seals (*Lobodon carcinophaga*) throughout their circumpolar ranges, using satellite telemetry data obtained over a time span of three decades (1990 to 2010s). Raw Argos tracks (nWeddell = 132; ncrabeater = 115), were filtered using a Switching State Space Model, and the tracking-derived behaviors (transit, foraging) were used to construct localized habitat models based on sea ice and bathymetry derived variables using binary Generalized Additive Mixed Models. We found differences in the effects and significance that environmental covariates had on the distribution at the local scale. The development of local habitat models for the entire range of these species will allow us to understand the ability of each species to cope with the anticipated environmental changes in their habitat.

PA-63

Year in, year out in dire straits: Foraging movements and habitat utilisation by Abbott's boobies in oligotrophic tropical waters during breeding, migration and non-breeding

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Tropical seabirds have evolved distinct foraging strategies and reproductive life-history traits to reproduce successfully facing generally low prey availability. Little is known about how their foraging behaviour changes over the course of the breeding cycle during which they experience different constraints and varying marine conditions that might require different foraging strategies. Abbott's boobies, endemic to Christmas Island, Indian Ocean (CI), has one of the longest breeding periods in seabirds (up to 18 months) and is subjected to different oceanographic conditions during different periods of the breeding cycle. We tracked adult birds during incubation, chick- rearing, post-fledging care and non-breeding to investigate foraging movements and habitat utilisation. During breeding, the birds foraged close to CI in waters of low productivity but foraging behaviour differed between breeding stages in parameters like range, trip bearing, and foraging area. After breeding, adults migrated over 2,500 km to the Banda Sea. The differences in foraging behaviour during the different periods of the breeding cycle will be discussed with regard to the birds' changing constraints, the species' reproductive traits, and the varying oceanographic conditions in the utilised habitats to elucidate the variability in the foraging behaviour of a tropical seabird over the course of its breeding cycle.

PA-64

Adapted to change: Low energy requirements for Galapagos sea lions in an environment with low and unpredictable productivity

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Otariids are known for their expensive lifestyle which requires them to live in highly productive ecosystems. The endangered Galapagos sea lion (GSL) lives in the relatively low and unpredictably productive equatorial region, having to cope with large environment fluctuations in order to satisfy its high metabolic rates (MR) and energetically expensive life style. We studied the foraging behavior and determined the field MR in GSL lactating females (the most energetically demanding period) that were rearing pups (N=5) and yearlings (N=5) in the Galapagos Archipelago. Foraging effort (dive duration, depth, trip duration, dive rate, % time diving and max. distance traveled) was not significantly different between groups. Females with yearlings foraged in different areas than females with pups, suggesting different prey types and/ or abundance between foraging areas. As well, energy expenditure did not differ between groups (0.62 ±0.1 ml CO_2/g/h). However, body condition decreased with lactation progression (R^2=0.66). Food intake was significantly greater in females with yearlings than with pups. Field MR (4.06 W/kg, N=10) was lower than for other otariid species. GSL low energy requirements may be an adaptation to lower resource availability in warm, low and unpredictable productivity areas.

PA-65

The establishment of captive and wild-born juvenile grey seals released in the Baltic Sea

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The population of the Baltic grey seal (*Halichoerus grypus macrorhynchus*) has been decimated in the 20th century from 100 000 to approximately 3,000 as a result of hunting and intoxication with, inter alia, DDTs and PCBs. Despite the conservation efforts and presence of potentially suitable haul out sites, seals have not re-established colonies on the Polish coast. In 1996, Hel Marine Station started the "Restoration and Protection of Grey Seals in Poland" program as advised by HELCOM and the Polish Ministry of Environment. Between 2003 and 2013, 49 captive-bred and wild-born juvenile grey seals were equipped with satellite transmitters and released into the Baltic Sea. Most animals joined colonies along the southern coast of Sweden. In preceding years, some seals occupied the Vistula estuary on the Polish coast, where recently, an increasing number of grey seals have been observed including some of the tagged individuals. The appearance of seals in the southern Baltic is potentially related to population growth. The establishment of young seals in this case, is probably influenced by the presence of other seals. Further investigation of movement and habitat selection of juvenile seals might be vital to identifying important areas for this species.

PA-66

Multi-year spatial consistency in foraging grounds: the case of the Cory's shearwater (*Calonectris borealis*) in the Canary Current upwelling

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Upwelling systems usually show some regularity in their spatial productivity at meso-scale level, which generally results in a spatio-temporal predictability of the areas exploited by top-predators. The Canary Current is a highly productive sub-tropical upwelling system off northwest African coast. Although it holds large populations of seabird, the use of specific foraging areas is poorly understood but highly relevant for marine spatial planning. From 2011 to 2013 we analyzed annual variation in foraging grounds of Cory's shearwaters breeding in Canary Islands by simultaneously tracking birds with GPS and GLS devices. Within-individual spatial consistency of the foraging grounds tended to be low, suggesting low resource predictability at fine scale, but at population level we found a high spatial match between foraging grounds and primary productivity over the three years. On one hand, birds consistently exploited the highest productivity area at southern end of the upwelling, the Banc d'Arguin, 800 km south of the breeding colony. On the other hand, annual variations in primary productivity in northern areas matched with fluctuations in their usage by shearwaters. Our results highlight the value of multi-year tracking studies to define the spatial consistency of foraging hot-spots in top-predators and their potential responses to environmental changes.

PB-01

Estimating time-budget in freshwater turtles using animal-borne simple sensors

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Basking, through which animals warm up at sun heat, plays a key role in ectotherms' physiological, behavioural and ecological strategies. In the context of an emerging project of reintroducing the European pond turtle *Emys orbicularis* in Alsace, NE of France, we tested prototypes of temperature and light miniaturised autonomous dataloggers deployed on subadult held in semi- natural captivity at Réserve Naturelle de la Petite Camargue Alsacienne, St Louis, Alsace, France. We show that a recursive partitioning analysis (RPA) of these simple parameters permits to detect 85% of basking events observed during focal sessions. The duration of basking events detected by RPA was on average 10% longer than observed, resulting in a global difference of 1% in terms of basking duration between these two methods. This original approach represents a promising alternative method to time-consuming behavioural observations but also to currently available conductivity sensors (salt water switch) whose sensibility is not adapted to low conductivity of groundwater in Alsace. It thus represents a cost-effective method that can be applied in natura in any freshwater turtle species that may provide a better understanding of the ecology of these species.

PB-02

Do random flight analyses highlight animal performances? Influence of individual characteristics on Lévy flight patterns in a wild seabird

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Animals adapt their movement patterns to their environment to maximize their fitness. However, few studies have assessed whether individual characteristics, such as body mass, age or sex, could influence movement patterns. In our study, we used the maximum likelihood method to analyse the distribution of step lengths in 43 thick-billed murres (*Uria lomvia*). Of these birds, 40 displayed Lévy flights. Whilst mass, age or breeding status influenced tortuosity and/or patterns resulting from Weibull distribution, those same factors did not seem to influence power law movement patterns. Lévy flight is apparently not a good indicator of foraging efficiency because individuals using this movement pattern did not gain more energy and a heavier body mass than individuals using a Weibull distribution. Such evidence that life history traits influence decision-making behaviour casts doubt on the validity of random walk analyses and whether individuals are indeed optimum or at least trying to be.

PB-03

Stomach temperature of narwhals (*Monodon monoceros*) during feeding events

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One attractive and feasible means of obtaining a proxy for feeding events in homeostatic predators is to measure stomach temperature, which drops during prey ingestion. In this study stomach temperature pills (STPs) were deployed in eight narwhals (*Monodon monoceros*). Two STPs provided data for 7.9 and 17.3 days and six STPs were rejected within 48 hrs. All whales had their first ingestion event between 20 min and 14 hrs after handling and release. The mean duration of the STP deployments was 93 hrs (SD=164) and the duration was positively correlated with the time between the deployment and the first ingestion event, but duration did not seem to be affected by the ingestion rate. During ingestion events the temperature on average dropped to 31.6°C but it occasionally dropped to below 20°C. Ingestion events in 2013 took place at depths of 13 to 850 m with a mean depth of 286 m (n=126, SD=195). There was no apparent preference for specific depths. The minimum number of ingestion events was on average 9.9 (SD=4.2, n=8) per 24 hrs. The average duration of the ingestion events (from drop in temperature to return to normal temperature) was 9.6 min (SD=4.1).

PB-04

Integration of an active acoustic playback system with an animal-borne sensor suite for behavioral response studies

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A pilot study was conducted to evaluate the potential of animal-borne active and passive acoustic tags for conducting minimally-invasive behavioral response studies on pinnipeds. A prototype tag was developed and tested on juvenile northern elephant seals (*Mirounga angustirostris*) using translocation experiments at Año Nuevo State Park, CA, USA in spring 2012. The principal scientific questions of this pilot study were (1) do low-intensity sounds emitted by an animal- borne tag elicit behavioral responses, and (2) are potential animal responses related to signal content (e.g., threatening vs. non-threatening)? Preliminary results indicate that (1) low-intensity sounds emitted by animal-borne tags do elicit identifiable behavioral responses, (2) these responses appear related to signal content, and (3) the responses may differ based on depth, bathymetry, and location. The results of the study show the promise of this approach as a minimally-invasive and cost-effective method to investigate animal responses to underwater sounds, as well as a method to investigate physiological effects of extended dive behaviors. We are currently in the process of improving the tag design for future field efforts with the goal to increase the sample size, range of acoustic stimuli, and age/sex classes of tagged seals. [Funding from NOAA/NMFS Ocean Acoustics Program]

PB-05

Understanding and predicting baboon space use in a human altered landscape

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With an ever-growing human population, wild animals are being increasingly exposed to human- altered landscapes. These modified landscapes bring new high energy food sources which species learn to take advantage of, resulting in «raiding» behaviour. In South Africa's Cape Peninsula, 11/12 of the chacma baboon (*Papio ursinus*) troops raid in search of high-energy human foods expressing a different level of human wildlife conflict. In this talk, I will present my research, aiming to develop an understanding of the causes and consequences of raiding behaviour. Ten adult males from four troops were fitted with GPS, accelerometers and gyroscopes, and have undergone behavioural tests in the field. First, I will present data on movement and behaviour quantified thanks to accelerometry and estimate energy expenditure. Second, I will explore why some troops/individuals raid more than others; and discuss whether these differences are explained only by opportunity, or if route planning or personality can mediate these differences? Finally, since raiding baboons consume more high energetic food, I will explore the consequences for their energy and ultimately their physiology. I will end discussing of how these data can be used to generate predictive models concerning the mechanisms underlying raiding, and consequently develop more proactive mitigation tools.

PB-06

What flight heights tell us about foraging and potential conflicts with wind farms: a case study in lesser black-backed gulls

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Avian flight heights are currently a focus of interest in terms of assessing impacts of offshore and inland wind farms on birds. We therefore analyzed the flight-height distribution in a tracking study of foraging *Larus fuscus* on the southern North Sea coast during incubation period. We distinguished between marine and terrestrial, nocturnal and diurnal, straight and tortuous, and outbound and inbound flights. Individuals were equipped with specifically-programmed GPS data loggers to ensure accurate flight-height measurements. A total of 89% of recorded fixes were below 20 m above sea level, indicating an overlap between foraging flights and the rotor area of most operating wind turbines. The gulls flew lower over sea than over land, and lower at night than during the day. Straight commuting flights were higher than tortuous flights, when the gulls were supposed to be foraging. Outbound and inbound flights occurred at similar heights, flight height was unaffected by wind. This study provides insights into the individual flight- height distribution in a common seabird species throughout a range of foraging behaviors. These results might prove important for developing a comprehensive understanding of bird movements within and around wind farms, and the potential impacts of such wind farms on foraging patterns.

PB-07

Individual strategies in group coordination: the role of spatial organisation and vocal signaling

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Recently group coordination has received considerable interest, as it reflects how different individuals in a group overcome potential conflicts of interest to reach a consensus decision. However to fully understand how cooperation evolved and is maintained, we need to identify individual strategies used to influence the behaviour of others, by the use of signals or the occupation of specific locations within a group. In this study we investigate group coordination in meerkats (*Suricata suricatta*) in their natural habitat. Meerkats live in stable social groups and forage as a cohesive unit, using vocal signals to maintain cohesion. In order to identify individual strategies and to understand how the relative spatial location of each adult individual in a group is related to its behaviour and its vocalisations, we collect behavioural data and continuously record the location and the vocalisations emitted by every individual in a group. Furthermore, we will estimate costs and benefits of specific locations, behaviours and vocalisations, by manipulating external and internal factors and explore how different individuals contribute to group coordination. This will allow us to understand why some individuals emerge as leaders while others follow, as well as how vocalisations are used to manipulate group members.

PB-08

Anti-predator responses of cetaceans to killer whale sound playbacks

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This study is part of the 3S project (Sea-mammals Sonar Safety) and aims to assess how reactions to naval sonar relate to reactions to natural disturbance sounds such as predator sounds. Killer whales are potential predators of other cetacean species and so the detection of their vocalizations by cetaceans may indicate increased predation risk. To test this hypothesis, we conducted field experiments off Norway and used a non-invasive multi-sensor tag (D-TAG) to quantify the behavioral responses of free-ranging sperm whales (*Physeter macrocephalus*), long-finned pilot whales (*Globicephala melas*) and humpback whales (*Megaptera novaeangliae*) exposed to killer whale sound playbacks. Our results showed that 1) sperm whales interrupted the descent phase of foraging dives, grouped and altered their vocalizations, 2) pilot whales were strongly attracted towards the speaker and increased their group size, 3) humpback whales avoided the speaker and reduced their feeding activity. These results suggest that cetaceans stop fitness-enhancing activities such as feeding when encountering killer whales, and exhibit species-specific behavioral reactions in a context of potential predation. These clear and consistent reactions to killer whale sound playbacks contrast with the variability of reactions to sonar exposures. The concordance between anti-predator responses and reactions to sonar vary across species.

PB-10

Fin whale calling behavior assessed using high-resolution accelerometry

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Acoustic communication is a critical part of reproductive and foraging strategies for many species, especially in the marine environment, where sound propagates farther than light. Archival acoustic tags offer the possibility to correlate sound production with individual animal behavior, but variation in call production levels, properties of low frequency sound, and tight association in social groups can complicate identification of the calling individual in baleen whale acoustic tag data. A call recorded on a tag could be the tagged animal or an associate, and even calls from distant whales will register on the tag. Here we demonstrate a method for using fast accelerometry to assign call production to the tagged animal in fin whale datasets from the Southern California Bight, USA. 1298 calls from two tagged fin whales are used to test the method. Accelerometer signals share frequency and duration characteristics with associated acoustic signals, but magnitudes are higher than predicted by particle acceleration models, indicating that body vibration may be contributing to the signal. Selected calls are then used to characterize depth, body orientation, and speed associated with calling bouts in a larger dataset of fin whales, in order to assess potential calling efficiency and possible function.

PB-12

Movement patterns of brown skuas during the non-breeding period: internal vs. environmental drivers

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Pelagic seabirds spend most of their life, often except the breeding period, on the open ocean far off the continental coasts. Therefore it has long been difficult to investigate the ecology of their entire life history. For our study we analyse 49 brown skua (*Stercorarius antarcticus lonnbergi*) migration cycles from 29 individuals breeding on King George Island, Maritime Antarctic. Migration data were recorded between 2007 and 2010 using light-level geolocators. So far, we found that all tracked individuals spent most of the time in the area of the Argentine Basin. However, the aim of this on-going analysis is to investigate the spatial and temporal distribution of individuals in detail. We want to test the hypothesis that movement patterns were mainly driven by environmental factors, like food availability and not affected by internal factors like gender or individually conserved migration routes. To test this hypothesis we will use remote sensed data indicating food availability (chlorophyll a, sea surface temperature, sea currents) and correlate their dynamics with the individual tracking data and the overall population distribution.

PB-13

No back seat driving in pigeon flocks: Navigational scrounging or alternative homing strategies?

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Flocks of homing pigeons (*Columba livia*) home faster than solitary birds, suggesting birds fly in groups partly to gain navigational advantages via the experience of others. Pigeon flocks will also form highly idiosyncratic memorised paths back to their home loft. The degree, however, to which each individual within a flock of naive birds is contributing to the new route construction, is not well understood. Furthermore, whether all individuals are subsequently memorising the journey for future route capitulation is not known. Using GPS data loggers, we show that pigeons that had extensive training of a homing route as a group, but were typically in the back portion of the flock, had not seemingly learnt the group-stereotyped return route to the home loft. Upon solo release these back-birds took, on average, 8 hours longer to return home compared to the front-birds. We suggest this lack of route-learning is either a result of a visual impediment due to the back position within the cluster flock, or back-birds are navigationally scrounging off the birds in front. This scrounging may be a strategy to reduce cognitive load, through minimising the number of landmark images that must be remembered for successful homing.

PB-14

Habitat use and movement patterns of southern elephant seals during their moult

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Southern elephant seals (*Mirounga leonina*) alternate foraging periods at sea, where they replenish their body fuels, and periods on land where they fast to complete their breeding cycle and moult. Unlike most phocid species, Southern elephant seals experience a catastrophic moult where they not only replace their hair but also their epidermis when ashore for approximately 1 month. Southern elephant seals are known to move about and aggregate while moulting on land but have not previously been tracked in detail. In this study we examined how elephant seals behave during the moulting period by observing their movement patterns and habitat use. In addition to transect surveys on various habitats, 15 female individuals equipped with GPS tags were tracked in 2012 on the Kerguelen Archipelago to study movements during the moulting phase. Although moult duration was similar between individuals, movement patterns were different and initial results show a link between moult stage and habitat type. This study can help us to understand to what extent marine mammals are able to adapt behavioural strategies to critical periods in their lifecycle.

PB-15

Foraging behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in the Pacific Northwest and potential impacts of coastal hypoxia on foraging efficiency

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Upwelling-driven coastal hypoxia (low dissolved oxygen levels) in the California Current Large Marine Ecosystem has increased locally in spatial extent, duration, and severity over the past decade. Coastal hypoxia has the capacity to affect spatial distribution of fish and invertebrates, yet upper trophic level impacts of coastal hypoxia are little studied. The potential upper trophic level impacts of hypoxia were examined via an energetic individual-based model of adult Pacific harbor seal (*Phoca vitulina richardii*) spatial foraging behavior in response to hypoxia-related habitat compression for three predominant prey species: English sole, Pacific sandlance, and Pacific herring. Hypoxia strongly drove seal energetic balance, travel cost to foraging and time spent foraging at depth. For three masses of adult seal (60kg, 80kg, 100kg), the net benefit of each prey type changed with a gradient of simulated hypoxic conditions. For all masses of seals, transport costs roughly halved for each prey species. Time spent foraging at depth for Pacific sandlance increased by 2.54-3.59 times, and increased by 1.70-2.47 times for Pacific herring. The results suggest that altered spatial foraging behaviors driven by hypoxia should be apparent through telemetry that combines fine scale tracking with direct on-animal measurements of environmental variables, particularly dissolved oxygen.

PB-16

Exploring movement and behavior of southern bluefin tuna caught and released in coastal regions around southeast Australia

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Southern bluefin tuna are an iconic large pelagic species. They are distributed widely in the southern hemisphere but at certain times of the year schools of fish migrate along the southern coastline of Australia within range of recreational fishing boats. This presentation explores the movement and vertical behavior of 45 southern bluefin tuna that were tagged with pSATs as part of a project investigating post-release survival from recreational fishing. Tagged fish ranged in size from 10 – 100 kg and were caught in coastal waters around southeast Australia. Southern bluefin tuna spend only a limited amount of time in these nearshore areas with clear seasonal trends in the timing of their availability to recreational fishers. Tagged fish showed a high degree of migratory behavior with tags detaching over a range of 2,500 nm from Western Australia to the east coast of New Zealand with the direction and magnitude of the distance travelled dependent on the month and location of when and where the fish were tagged.

PB-17

How hydrodynamic handicaps modify complex diving behavioural organization of two deep diving predators

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Externally-attached devices can potentially affect the behaviour of swimming predators (e.g. increasing the drag in penguins), inducing a potential bias in the way data are interpreted. The recent application of fractal analyses to bio-logged data opens up new and promising perspectives on the effect of carrying bio-loggers, a potentially stressful event, on the complex behavioural organization of diving sequences. In this context, we re-visited diving datasets collected on two penguin species, little (*Eudyptula minor*) and Adélie penguins (*Pygoscelis adeliae*). Given that loss in dive sequence complexity can indicate a sub-optimal state (e.g. bio-loggers modify hydrodynamic properties of penguin through an increase in the drag), we predict an inverse relationship between logger size and complexity in behavioural organization, as well as negative effects on complexity of loggers placed high versus low on the backs of penguins.

PB-18

Year-round movement behaviour of Brünnich's guillemots

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Aquatic environments in the temperate, boreal and arctic climate zones are highly seasonal in terms of biological productivity. Many poikilothermic aquatic organisms survive the winter, when food availability is low, by reducing their activity levels and/or performing vertical migrations to deep cold waters where energy consumption is low. This causes potential problems for homoeothermic predators, which require constant access to nutritious prey to survive. Diving birds are particularly vulnerable to periods of low prey availability, as they are relatively small and unable to store significant amount of fat (due to buoyancy problems). Among diving birds, many species resolve this by migrating to warmer waters, where prey items are more active and thus more accessible. Detailed data on exactly how birds manage to obtain sufficient energy during winter have until recently been lacking due to technological limitations. In this study we used time-depth recorders (recording pressure, temperature, wet/dry and light every 10^{th} second for 365 days) to investigate year-round individual movement behaviour of Brünnich's guillemots breeding in the high Arctic. Specifically, we looked into how individual patterns of activity exhibited by Brünnich's guillemots breeding in Greenland differed with respect to stage of the breeding/migration cycle.

PB-19

When hawks attack: video studies of goshawk pursuit strategies

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This study reports on video studies of northern goshawks pursuing live, wild prey in natural settings, capturing artificial moving lures and landing on perches. We analyzed both videos of pursuits recorded from videocameras on the ground and recorded by a miniature videocamera mounted on the goshawk's head while it foraged and pursued prey. Animal-borne videos of chases were analyzed to determine apparent prey positions on the goshawk's visual fields during pursuits as well as the motion of the prey relative to the optical flow of fixed background objects. Video recorded from the ground was analyzed to determine the predator and prey trajectories in space. These data then were interpreted using computer simulations of pursuit steering laws previously used to interpret pursuits by falcons, insects and mammals. We found goshawks use different strategies for approaching perches and stationary targets vs. chasing moving live prey or lures. Goshawks appear to use hybrid combinations of simple pursuit models to pursue prey in the scenarios studied here.

PB-20

iSeals: Integrating multiple technologies to understand the foraging behavior of monk seals in the main Hawaiian Islands

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The Hawaiian monk seal has been studied extensively since the 1980s, but we still know little about their at-sea behavior. To develop an accurate picture of the foraging behavior of these endangered seals we deployed 3-axis accelerometers, National Geographic Crittercams, and GPS tags on seals in the Main Hawaiian Islands. We tagged 14 seals between 2010-2014 on Molokai, Kauai, and Oahu. Each instrument package was deployed for 3-6 days, resulting in an average of 6.14 hours of video. On average, foraging trips lasted 1.18±2.08 days and seals traveled up to 25.69±81.35 km per trip. Seals began benthic dives shortly after entering the water, with most foraging occurring between 20-40m. Integrating data from accelerometers with video and GPS allowed us to ground-truth 3D models of dive behavior, identify foraging habitat, and provided insight into the energetic cost of foraging trips in the region. We hope that this new information will help us understand the ecological role of monk seals in Hawaii, help to understand why they are recovering in this area and to dispel myths surrounding their foraging behavior.

PB-21

Effects of body size, school size and diel period on the degree of association with drifting seaweeds in juvenile *Seriola* spp., determined by video-logger and GPS satellite telemetry.

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Drifting seaweeds are considered to be an important habitat for juvenile Seriola spp.; however, the adaptive significance of the association with such seaweed remains to be revealed. In order to provide insight into the adaptive significance of this association, we developed a new monitoring system that consisted of brown algae, a raft, a satellite GPS buoy, interval video cameras, and various data loggers, which continuously monitored the objects (4 objects in April and May, 2013, respectively) for 5-8 days in the East China Sea. Juvenile Seriola spp. was the most frequently observed genus and their behaviors were categorized into two patterns: remaining within 0.5 m of the seaweed (intranatant) and swimming wider ranges (extranatant). Almost all fish were intranatant at night, while both patterns were observed during the day. When the body size or school size were smaller, intranatant behavior was more frequent. Dolphinfish, which had tactics to feed on animals inside the seaweed, were observed more frequently in May than in April, and *Seriola* spp. were more likely to be extranatant in May. These results suggest that juvenile Seriola spp. change their degree of association with drifting seaweed given various factors relating to predation risk.

PB-22

Krill density effects on the three-dimensional foraging strategies of blue whales

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Fine-scale foraging kinematics have been quantified in a wide range of animals using animal- borne tags, but how foraging strategies are modified in response to different prey conditions remains poorly understood. Here we used a combination of suction-cup multi-sensor tags and active hydroacoustic surveys to quantify the three-dimensional kinematics of foraging blue whales (*Balaenoptera musculus*) across varying krill (*Euphausia pacifica*, *Thysanoessa spinifera*) densities and distributions. As part of the Behavioral Response Study in southern California, we deployed 11 tags during the summer months of 2011 and 2012 in the southern California Bight, collecting over 30 hours of blue whale foraging data across a range in krill density that varied by an order of magnitude. Our analyses show the blue whales exibit more maneuvering when lunge feeding on low density, shallow and more patchily distributed krill patches. In contrast, when krill formed deep, high-density patches, blue whales exhibited high lunge frequencies (the number of lunges per dive) and less maneuvering. The complex relationship between krill density, depth, maneuvering, and lunge frequency demonstrates the flexibility of energetic niches exhibited blue whales despite being an obligate bulk-filter feeder that specializes on a single prey type.

PB-23

Blue whale (*Balaenoptera musculus*) optimal foraging as a function of fine-scale prey patches: conserving oxygen or maximizing energetic gain

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Blue whales (*Balaenoptera musculus*) are a mobile predator in the California current system that target a single prey resource, krill (*Euphausia pacifica*, *Thysanoessa spinifera*), and travel large distances to find and exploit these ephemeral patches. We used multi-sensor digital archival tags to define the dive parameters, to estimate the oxygen consumption and energetic gain, and to test how dive behavior varies as a function of acoustically measured krill patch characteristics. We deployed 20 tags in 2011 through 2013 off the southern California coast as a part of the SOCAL-BRS, collecting over 40 hours of concurrent prey and predator data. We tested whether blue whale foraging behavior was dictated by oxygen conservation or energy gain maximization using competing theoretical models of optimal foraging. Ultimately, our research showed that blue whale dives conserve oxygen at low prey densities (200 krill/m^3). By using oxygen as a common currency, we were able to demonstrate that individual whales will modulate their foraging behavior as a function of prey patch quality for the first time.

PB-24

Ontogenic changes in the foraging behaviour of naive southern elephant seal pups using a new generation of onboard data processing and satellite data relayed tag

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Large datasets are collected at high frequency by multi-sensors loggers to investigate the foraging ecology of marine predators. However they need to be recovered to process the data too voluminous to be successfully transmitted. Therefore our understanding of the foraging behaviour is strongly biased toward land based species, breeding individuals and those surviving. As part of the Early Life program, the ontogeny of the foraging behaviour of 4 naïve southern elephant seal pups was investigated using new logging and onboard data processing tags DSA (dive segment analysis) measuring pressure, light, temperature and 3D acceleration. Dives were split in five time/depth segments using a broken stick algorithm. Swimming effort, number of prey catch attempts (PCA), the descent and ascent angles were calculated from accelerometry data and a summary transmitted through Argos. From 1 to 8 weeks, dive depth and duration increased from 71±24m to 165±39m, and 372±74s to 464±82s respectively (30% of adult female performances on week8). Pups performed 3.2±1.4 PCA/min, with PCA varying mainly with foraging locations. Pups exhibited a nycthemeral foraging pattern, diving deeper and being least successful during the day. These tags open a new way to investigate the ecology of poorly known and accessible marine species.

PB-25

GPS tracking reveals fine scale colony-specific foraging behaviour and habitat use in the short-tailed shearwater

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As central place foragers, the habitat use of nesting seabirds is heavily influenced by the resources available within their foraging range. Using both GPS and GLS data-loggers, the at-sea movements and habitat use of short-tailed shearwaters (*Puffinus tenuirostris*) provisioning chicks were investigated over three breeding seasons (2011-13) at two colonies in southeastern Australia characterised by contrasting oceanographic conditions: Griffith Island at the western end of Bass Strait in the seasonally productive Bonney Upwelling region; and Gabo Island at the eastern extent of Bass Strait within the warm East Australia Current. While individuals from both colonies performed similar long foraging trips (duration and distance travelled) to the Southern Ocean, differences in their short trip strategies were observed. Birds breeding at Griffith Island had a longer trip duration and larger foraging range than those in eastern Bass Strait and showed inter- individual differences in foraging strategies with some individuals foraging over the continental shelf-edge while others foraged on the shelf close to the coast. This study highlights the importance of foraging plasticity as a fundamental aspect of life history in coastal/pelagic marine predators living in highly variable environments.

PB-26

Intense prospecting movements of failed breeders nesting among failed conspecifics

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Tracking prospecting movements of failed breeders is essential to understand dispersal mechanisms and predict individual and population responses to unfavourable environmental conditions. Yet, studies addressing this topic are scarce because of methodological and technological constraints. In 2013, we tracked with new GPS-UHF loggers the movements of failed black-legged kittiwake breeders nesting in a failed subcolony of Hornøya, Norway across chick-rearing. After one week of tracking, failed breeders abruptly deserted their nesting cliff and increased prospecting rates. Overall, 91 % of tracked failed birds performed intense prospecting visits to more successful cliffs within their nesting colony. Among them, 40% also visited neighbouring kittiwake colonies 40-50 km apart. Our results provides new elements on prospecting patterns at a fine spatial and temporal scale, and indicate that extensive and repetitive visits to alternative breeding areas could be the occasion for individuals to explore a new neighbourhood and potentially prepare dispersal to a new breeding site for the following year.

PB-27

Identification of shearwater's behaviour by mean of accelerometers and GPS loggers

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Shearwaters, like many petrels use different flight modes. Gliding flight is the most typical flight, allowing consuming a minimum amount of energy. However, birds do also flap when taking off, fishing or manoeuvring and this might add substantial cost to the energetic balance of a foraging trip. The GPS track alone is not sufficient to distinguish different flight modes, as filters on speed thresholds do not reflect the pattern of wing beat. We simultaneously deployed small accelerometers and GPS data loggers on Scopoli's shearwaters (*Calonectris diomedea*) to identify the daily activity budget particularly with regard to the flight pattern. We tracked birds breeding in Linosa Island during the chick rearing period at the time when they performed short (one day- long) foraging trips. Using combined data gathered with GPS and accelerometers we identified, within the flight portion of the GPS track, different flying modes used by the birds. Then, we compared the estimated energy consumption among flight modes with the Overall Dynamic Body Acceleration to produce time and energetic budgets of the foraging trips.

PB-28

A HMM-based model to geolocate pelagic fish from high-resolution individual temperature and depth histories: European sea bass as a case study

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Numerous methods have been developed to geolocate fish from data storage tag data. Whereas demersal species have been tracked using tide-driven geolocation models, pelagic species which undertake extensive migrations have been mainly tracked using light-based models. Here, we present a new HMM-based model that can infer pelagic fish positions from the sole use of high- resolution temperature and depth histories. A key contribution of our model lies in model parameter inference (diffusion coefficient and errors on the reference geophysical fields - satellite SST and MARS3D hydrodynamic model), which improves model robustness. As a case study, we consider long time-at-liberty tagging data of European sea bass. For the first time, reconstructed individual trajectories are provided. They evidence strong site fidelity on summer feeding grounds and suggest site fidelity on winter spawning grounds. This result on the fine- scale spatial structuring of the population is a key issue poorly addressed by current management frameworks. Beyond seabass behavioral ecology, our model opens new avenues for the reconstruction and analysis of migratory patterns of other pelagic species in relatively contrasted geophysical environments.

PB-29

Continuous, automatic, location recording in a wild house mouse population

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Since 2002 we have studied a free-living house mice population (*Mus domesticus*) in a barn near Zürich, Switzerland. Our research focuses on mechanisms that promote and stabilize social behaviour, and how interactions with conspecifics structure groups and populations. The barn is equipped with 40 nest boxes, used by the mice as their homes and where females rear litters. We follow individuals from cradle to grave, collect tissue samples for genetic analyses, and implant adult mice with RFID tags (transponders). In 2007 we installed a permanent transponder reading system to track the movements and social interactions of tagged mice (adult population size: 150-250). A second, more efficient prototype replaced the original in 2012. Mice access the nest boxes through acrylic tubes, each of which is equipped with two antennas (interspace 15cm). When a mouse passes an antenna its unique transponder number is transmitted and registered with the animal identification system «AniLoc», provided by FBI Science GmbH. This enables continuous monitoring of the in- and outbound passage of mice, providing information on box usage (proxy for an individual's home range), duration of associations with litters, and adult group composition within each nest.

PB-30

Classification of free-ranging Weddell seal dives during the late winter based on three-dimensional movements and video-recorded prey capture

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We classified the free-ranging dives of Weddell seals during the late winter (low solar elevation angle with extended periods of darkness) in McMurdo Sound, Antarctica. Video and data recorders were glued to the fur of eight seals (BM = 335 ± 48.0 kg) for two weeks. Classification based on 3-dimensional dive path and multivariate analysis revealed three dive types that clustered in a similar pattern to those previously identified from free-ranging seals in the same area during the spring (high solar elevation angle with continuous ambient light). Most prey captures occurred during Type 1 dives, and the primary (99%) prey was Antarctic silverfish (*Pleuragramma antarcticum*). Type 1 dives were the deepest (mean maximum depth 295 m), longest in duration (20.2 min), covered the greatest total distance (1,653 m) and were similar to Type 1 dives during the spring. Shorter duration dives that were associated with hole guarding (Type 2) or transiting between holes and exploring (Type 3) were also similar between late winter and spring. The diving behavior of Weddell seals does not change much between late winter and spring, and the sensory systems used to detect and capture prey do not appear to be affected by ambient light level.

PB-31

Identifying behavioural characteristics of habitat use in juvenile New Zealand sea lions using a state-space model

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New Zealand sea lions (*Phocarctos hookeri*) have suffered significant female-biased population loss from bycatch in sub-Antarctic squid fisheries (Chilvers 2009). Analyses on habitat use in juvenile sea lions have illustrated that females have increased spatial overlap with fisheries. Furthermore, the majority of dives by juvenile females coincide with the depth ranges of operating squid trawlers (Leung et al. 2012), signifying the implications of behaviour in bycatch risk. This study aims to expand the current knowledge of juvenile sea lion habitat use by examining their behavioural components using a state-space model. State-space models have been identified as a preeminent method for interpreting behavioural information from telemetry data (Jonsen et al. 2013). Furthermore, their use for predicting foraging behaviour in diving marine mammals has been illustrated by Dowd and Joy (2011). This model was thus selected to identify foraging and transitioning behaviours from time-depth (TDR) recordings on nineteen juvenile sea lions (12 females; 7 males). These data were then interpreted in three-dimensional space by interpolating Argos® satellite tag data to the known TDR data points. Finally, statistical analyses of the resulting data were undertaken to inform on the potential for female versus male interactions with fisheries as a function of behaviour.

PB-32

Novel leopard seal (*Hydrurga leptonyx*) foraging behavior revealed using integrated diving, surface position, and video instruments

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Leopard seals are apex predators that can alter the community structure of Antarctic coastal ecosystems. Previous behavioral studies were limited by restricted access and/or low resolution satellite-linked tags. Consequently, foraging tactics, habitat use and social behaviors are poorly understood. Here we present the first analysis of animal-borne HD video footage for foraging leopard seals. Each CRITTERCAM was deployed with fast-loc GPS and TDR instruments providing fine-scale habitat context for observed foraging behavior. We analyzed seven deployments obtained in January and February of 2013 and 2014 from adult leopard seals near mesopredator breeding colonies on Livingston Island, Antarctica. 5,130 dives were recorded for 18 foraging trips. Mean deployment length was 6.36 (s.d. 3.03) days. Three independent observers scored 50 hours and 18 minutes of video footage by time of day, habitat type, behavior, feeding event, foraging tactic, and inter and intraspecific social encounters. Novel foraging behaviors were identified including food caching/scavenging, kleptoparasitism, and hunting/processing of demersal fish. Diel movement patterns and prey choices were consistent across the sample; however, there was high individual variation of prey-specific foraging tactics. Our results suggest that position-integrated video data will be vital in quantifying the ecological impact of this abundant, versatile, apex predator.

PB-33

Weddell seal overwinter dive behavior in the Ross Sea: Are animals approaching physiological limits to support gestation?

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For Weddell seals (*Leptonychotes weddellii*), the overwinter foraging period (Feb-Sept) is likely critical for females to regain physiological condition prior to pupping the next year (Oct-Nov). We deployed 18 satellite tags on post-molt female Weddell seals in the Ross Sea, recovered tags at the start of the pupping season, and measured body condition and O2-stores at both times. Animals recaptured ~5 days post-parturition (N=11) and those that skipped reproduction (N=7) the following year, gained equivalent proportions of mass (+10-15%) and lipid stores (+3-5% body mass; P's <0.001) overwinter. These physiological parameters were highly correlated with dive duration at the onset of winter foraging. While mass-specific O2 stores did not change overwinter, dive duration, foraging efficiency, and the proportion of dives exceeding calculated aerobic capacities were highest just following the molt, in mid-winter (June-July), and again immediately prior to parturition. Pregnant females had consistently higher dive durations, %time diving, and foraging efficiencies across the winter than non-pregnant females, likely in order to support growth of the fetus. We identified five main dive types by cluster analysis, with slow-descent dives being more common during mid-winter, and square and U-shape dives just prior to pupping, supporting that these were times of increased foraging effort.

PB-34

Echolocating sperm whales and their prey: No big bangs, but buzzing and chasing

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Sperm whales (*Physeter macrocephalus*) possess a hypertrophied nasal complex that generates clicks with source sound pressure levels in excess of 235 dB re 1µ Pa (pp) for long-range echolocation of mesopelagic prey. Nevertheless, it remains a conundrum how this top predator, responsible for an annual biomass turnover about 100 million tons, catches its prey. Here we use multisensor Dtags in a fine-scale study of buzz sequences to relate the acoustic behaviour with prey-related changes in acceleration in the head region of the tagged whales. Sperm whales use low level buzzing at high repetition rates to provide high temporal and spatial resolution in prey tracking. Strong jerk signatures close to the end of buzzes are supportive of the notion that sperm whales employ suction feeding to engulf their prey and continue buzzing during post-acquisition prey handling in the mouth. Some prey items appear easy to subdue while other require substantial chasing. This observation shows along with exposure models that sperm whales do not debilitate their prey, but instead in some cases chase faster, more agile prey and perform stereotypical manoeuvre likely to facilitate capture. These results demonstrate that sperm whales use acoustic and capture techniques as shown in smaller toothed whales.

PB-35

Adjustment of diving behaviour with prey encounters and body condition in a deep diving predator: the southern elephant seal

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Optimal Diving Models (ODM) have been developed to investigate how air-breathing predators should adjust their diving behaviour to optimize their foraging efficiency. Using Time-Depth- Recorders and 3D accelerometers, we addressed that question on 6 free-ranging southern elephant seal (SES) females. 72.6% of prey catch attempts (PCA) detected by accelerometer occurred at the dive bottom. Results revealed that SESs adjust their dive duration according to a nonlinear relationship between bottom time, prey catch rate and diving depth in accordance to the ODM. For dives shallower than 200m, bottom time was shorter in non PCA-dives compared to PCA ones. Beyond that depth, SES had shorter bottom time in PCA-dives due to greater swimming effort, compared to non-PCA ones. When only considering PCA dives, the greater the PCA number and the closer the seal was to neutral buoyancy, the longer the bottom duration was. Buoyancy was found to be a critical factor in controlling the variation of dive duration through a direct effect on swimming effort over the whole foraging trip to access the preys at the bottom of the dive. Finally, post dive surface intervals were related to the duration and swimming effort of the previous dive.

PB-36

Acoustically tracking the lion's mane jellyfish: horizontal and vertical movements of *Cyanea capillata* (Scyphozoa) in a shallow coastal environment

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In Ireland and the UK, the highly venomous lion's mane jellyfish, *Cyanea capillata*, can pose a serious hazard to open-water swimmers (injured swimmers can suffer from Irukandji-like symptoms: nausea, back pain, even one case of cardiac failure). Understanding the factors driving the distribution of this species is therefore critical in order to develop strategies to limit its detrimental impacts. Using acoustic transmitters and drogue deployments, we investigated the horizontal and vertical movements of individual *C. capillata* in Dublin Bay, where the species is very abundant and open-water swimming a popular activity (>20 swimming competitions/year). In July 2010 and 2011, 9 individual jellyfish were tracked for up to 8h. Medusae horizontally travelled 1.6-5.9 km. These horizontal movements broadly followed the local currents, which were driven by the tidal cycle. However, at times, the velocity of tracked individuals differed from the velocity of surface drogues. Vertical movements were marked by periods of intense activity, but were diverse and changing. Mean individual vertical speeds ranged from 0.5 to 3.3 $m.min^{-1}$. The present study demonstrated the feasibility of deploying acoustic tags on *C. capillata* and confirmed that scyphomedusae are not quite the passive drifters they were once thought to be.

PB-37

How deep divers maximize energy gain with law foraging efficiency within limited foraging time: a case study of continuous deep diving behavior of northern elephant seal

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Foraging theory assumes that animals optimize their hunting behavior by balancing a net positive energy gain between energy intake and energy expended on hunting. How deep-diving marine mammals manage to successfully forage in the deep ocean remains unknown. As mesopelagic biomass decreases exponentially with depth and foraging time at the bottom of a dive declines exponentially with depth due to physiological constraint, it is unclear how deep divers are able to develop a successful foraging strategy. Given our inability to directly observe energy intake and energy cost in situ, we used forging efficiency index (FEI) derived from the number of jaw motion events, number of strokes and dive duration as proxy of net energy gain. FEI was measured using jaw motion recorders and stroke recorders which incorporated an on board processor for detection of jaw motion and stroke events respectively during extended foraging trip. We also used a miniaturized head-borne video system equipped with an onboard processor for effective recording of feeding events. We examined how FEI of deep diving northern elephant seals varied with depth and how seals manage dive frequency in relation to FEI during migration.

PB-38

New and improved ways to estimate propulsive body acceleration of marine mammals

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Tags incorporating accelerometers have provided powerful tools for understanding the behavioral kinematics of marine mammals. The accelerometer signal has been used to estimate energy expenditure, commonly with the ODBA metric (Overall Dynamic Body Acceleration). However, with such tags the linear accelerations of an animal cannot be clearly disambiguated from angular velocities owing to the dominance of the gravitational acceleration signal. Incorporating a gyroscope overcomes this constraint. We propose two new metrics with associated methods to take advantage of combined 3-axis gyroscope and accelerometer data: the Estimated Linear Body Acceleration metric (ELBA) which estimates overall dynamic accelerations, and Estimated Propulsive Body Acceleration (EPBA) which estimates body accelerations related to propulsion. We evaluated the new metrics using trained Steller sea lions (*Eumetopias jubatus*) equipped with Loggerhead Instrument's OpenTags. The sea lions swam alongside a boat at controlled speeds ranging from 4 to 10 kph. At each speed, we computed ELBA, EPBA, ODBA and VeODBA (a variant on ODBA). The results show that the new measures - ELBA, EPBA - are significantly better predictors of speed. In addition, EPBA more closely approximates accelerations expected due to drag.

PB-39

Foraging behaviour, energetics and migration currency of capital breeders during spring migration estimated from satellite telemetry

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Because migratory Arctic-nesting birds have to deal with a short Arctic summer to complete their breeding (and moulting) cycle, they are assumed to migrate as fast as possible. They are therefore hypothesized to maximize their refuelling rate at intermittent stopover sites. In order to test this, we estimated the net energy intake rate (NEI, the difference between metabolisable energy intake rates and energy expenditure) of pink-footed geese at a key spring stopover site, roughly midway on their migration to Svalbard. For this we used a novel technique based on a combination of satellite tracking data, food intake rates, and time-activity budgets to evaluate the birds' fuel accumulation rate. We validated the results using abdominal profile scores for neckbanded individuals. We found that NEI of pink-footed geese is not at their maximum rate. There are no indications that they are limited by either physiological factors or habitat availability. Most likely, their currency is reflecting a trade-off between energy maximization and predator/disturbance avoidance. At a stopover site further north, time constraints appear to be more important and fuelling is closer to their maximum rate.

PB-40

Inter and intra-individual directional foraging fidelity of lactating Subantarctic fur seals from Marion Island

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Marine central-place foragers exhibit foraging fidelity to areas with predictable high-quality foraging patches. Few studies have tested how this varies for lactating females between seasons when resource availability is less predictable. This study examined inter- and intra-individual foraging site fidelity of lactating Subantarctic fur seals (*Arctocephalus tropicalis*) from Marion Island (46°54'S, 37°45'E). Thirty-one females were tracked between 2009 and 2013 resulting in 111 foraging trips. During summer, trips extended east from Marion Island where females stayed within ~200 km of the island concentrating foraging over the Gallieni Rise. Compared to winter tracks, trips were more direct with females presumably swimming to patches of known prey quality. In the winter females foraged north-east and further afield, over the Del Caño Rise. Six individuals travelled west of the island but only four travelled west more than once. Westward trips are likely a short-term response to an inability to find sufficient prey, rather than a long- term foraging tactic. Winter trips were less direct, suggesting that females spent more time searching for foraging patches. Long-term stability in foraging areas indicates designated protected areas would be an efficient conservation measure; the preferred foraging locations could be used to expand Marion Island's current marine protected area.

PB-41

Effect of prey density on lunge feeding manner of humpback whales *Megaptera novaeangliae* in Iceland

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Lunge feeding is a feeding strategy of humpback whales which engulfs large amount of water and filters preys. It requires high energetic cost due to drag created when opening their mouth and its mechanism and energetics has been a subject of study. By attaching accelerometer and video logger to humpback whales in Iceland, their strategy of lunge feeding was investigated in relation to prey density level. Total of approximately 28 hours of acceleration and 3 hours of video data was obtained. 18 lunge events and krill were observed and their presence and absence were categorized as low or high density level using the video. Among the 18 lunges, 7 had low and 11 had high density level. Significant difference in maximum speed was observed and was faster when low and slower when high-density, yet no difference in their swimming effort. Lunges were separated into 3 lunge bouts which had a tendency to end when density level became from high to low. Therefore, whales might be rigorously observing the path and adjusting their magnitude in which they open their mouth depending on krill density and moves to the next patch when krill decreases to avoid loss of energy by insufficient lunges.

PB-42

Getting more from your tag - timing of data acquisition provides insights on blue shark surfacing behaviour

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The Argos satellite system has been used extensively for tracking migrations of marine animals. We present an alternative analysis of a satellite tracking dataset to investigate the behaviour of blue sharks (*Prionace glauca*) using 'timing of data acquisition'. We deployed three SPOT tags (Wildlife Computers) on blue sharks in Irish waters during 2012-2013. The sharks were tracked for 73-211 days and made southern migrations to warmer tropical waters. Due to the position of the tag (dorsal fin mount), data acquisitions (or 'messages') were only received by the Argos satellite system when the sharks' dorsal fins were knifing through the surface and when satellites were overhead. Despite the fact that sharks have no known physiological need to surface, a total of 1317 surfacing events were recorded. Mixed effect models (controlling for bias in satellite coverage), showed an increasing trend in surfacing events around dawn, peaking approximately 1 hour after sunrise (R^2=0.443, Chi24=38.435, p=<0.001). It is uncertain why the most abundant large oceanic predator surfaces more at this time, but is likely to be linked with foraging. The application of this method to larger datasets and other species is likely to increase our understanding of the ecology of wide-ranging marine predators.

PB-43

Coupling cameras with daily diary tags to study the kinematics and behavior of white shark (*Carcharodon carcharias*)

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The advent of animal-borne tagging in the marine realm has led to significant insight into many characteristics of animal movements and behaviors when they would normally be unavailable to observation. However, interpretations of behaviors and their underlying causes can be difficult to validate. Here we present data and findings from Daily Diaries tags (depth, temperature, 3- axis accelerometers, magnetometers and gyroscopes) equipped with cameras to describe the movements and behaviors of white sharks (*Carcharodon carcharias*). We targeted sharks during their seasonal aggregation in Gansbaai, South Africa to investigate the specific details of their predatory ecology. From this pairing of videos and with inertial sensing biologging tags we can validate our understanding of the physiology and kinematics of white shark movements and behavior gleaned from animal-borne tags.

PB-44

Influence of the diving behaviour of a southern elephant seal on the distance traveled at surface with respect to the oceanic currents and fishing success

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The foraging success of diving marine predators is generally inferred from the analysis of their surface trajectory. Yet, these animals forage in a dynamic three-dimensional environment. This study aims at describing how the changes in the surface behaviour relate to the changes of the three dimensional diving behaviour considering the influence of currents and fishing success. The data collected with a time-depth recorder, an accelerometer and a magnetometer deployed on an adult southern elephant seal allowed us to reconstruct the 3D animal path underwater through deadreckoning and to estimate prey catch rate. Seal diving behaviour such as bottom 3- D sinuosity, descent and ascent angles varied according to fishing success with a direct effect on the horizontal distance travelled. Although, several studies highlighted the effect of ocean currents on animal movements, their influence is generally neglected in seals due to their good swimming abilities, Hence, we quantified the contribution of currents to the horizontal distance measured at surface by comparing the observed surface locations to those expected according to there constructed path. We showed that the contribution of currents on seal movement increased with prey catch rate and could result in the incorrect seal foraging state when using state space models.

PB-45

Diving behavior and foraging strategies of southern elephant seals

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Satellite transmitters and video/data recorders were attached to 12 adult female southern elephant seals in Argentina from 2011-13 prior to their post-breeding migration. All seals traversed the continental shelf (300-400 km) in 3-9 days and spent the majority of the migration (mean 76 days; range 58-113) over the shelf slope or in the Argentine Basin (mean straight-line distance from the colony 1,146; range 775-1,774 km). Mean dive duration during the rapid transit over the shelf was 12.36 minutes with a mean interdive interval of 3.25 min. Beyond the shelf, mean dive duration increased to 20.41 min (mean interdive interval of 2.75 min). Seals exhibited a clear diel diving pattern. During the day, mean maximum dive depth was deeper and mean dive duration longer (588 m, 21.97 min) than at night (439 m, 18.38 min). Water temperature showed strong thermoclines in all areas traversed by seals with a mean vertical temperature gradient off the shelf of -0.0183°C/m. Video over the shelf slope showed that seals foraged primarily on lanternfish (Family Myctophidae) and herring smelt (Argentina sp.) at depths of 115-550 m. This is the first time that in situ video recordings have been made of southern elephant seals feeding at depth.

PB-46

First deployment of an acoustic tag on an East Greenland narwhal

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An Acousonde® acoustic tag was deployed for a duration of three days on an adult female narwhal in Scoresby Sound, East Greenland, in August 2013. The tag sampled acoustics on two hydrophone channels at sampling rates of 154 and 25 kHz, respectively. Auxiliary information, sampled at 10 Hz, included diving depth, pitch, roll, and yaw from a 3D accelerometer, and 3D geomagnetic orientation. Separately, the animal was also tagged with a satellite transmitter. The narwhal did not echolocate for the first 37 hours of the deployment, while traveling ~150 km to another fjord, where she started clicking and buzzing while diving to depths of up to ≈ 660 m. There was a significant correlation between the durations of dives and the surface intervals following those dives (n=260). About 600 high-frequency buzzes – possibly associated with feeding – were identified from both hydrophone channels. Buzzes mostly occurred at depths of 300-500 m. Over 40% of buzzes took place between 22:00 and 4:00 local time, i.e., in the darker part of the Arctic day cycle. Tags such as the Acousonde can provide a wealth of information on behavioral and ecological aspects of feeding and energetics in free-ranging odontocetes.

PB-47

Prey encounter rates and diving effort of female northern elephant seals during post-breeding and post-molt migration

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Elephant seals move great distances during their biannual foraging migrations. It has been suggested that the extra cost of long distance travel is offset by higher prey concentration at the distant foraging grounds. However, the relationship between prey encounter rate and foraging distance from the rookery has not been quantified. We examined the migratory movement and prey encounter rate (number of jaw motion events per bottom time) of female northern elephant seals, using satellite tracking together with mandible acceleration records. Daily prey encounter rates were highly variable during the course of outward travel, but increased significantly with distance from the rookery, during both short post-breeding and long post-molt migrations. Seals migrated farther and reached areas of higher prey encounter rates in post-molt than in post- breeding migrations. Seals accumulated a greater amount of time at the bottom of the dive each day during the post-breeding than post-molt migration. These results suggest that seals gain the benefit of high prey encounter rate by long distance travel, while they modify their diving effort to fit with the different time constraints of short and long migration.

PB-48

What do movements of Baltic ringed seals reveal us from seal-fishery interaction?

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Many aquatic predators, especially seals, induce losses to fisheries. In the northern Baltic Sea, the population of ringed seals (*Phoca hispida botnica*) has recovered after its collapse in the 20th century. Meanwhile, catch losses to coastal fisheries have increased and selective removal of seals from fishing gear has been proposed. Knowledge on the spatial ecology and existence of problem individuals regarding Baltic ringed seals is needed for assessing the effectiveness of selective removal. In 2011-2013, ringed seals (n=33) were captured from trap-nets used in commercial fisheries and released with plastic ID-tags. In addition, 10 of the seals were equipped with GPS Phone tags. Captured seals were mainly juveniles (mean weight ± SD = 36 ± 9 kg). None of the tagged seals was recaptured in the trap-nets during the study. In addition, the GPS data showed that the seals did not concentrate their movements to the capture area, but moved in large areas in the Gulf of Bothnia. Juvenile ringed seals showed low degree of foraging site fidelity, which indicate lack of spatial specialisation for feeding in trap-nets. Therefore, selective removal of individuals from fishing gear may not be effective in locally mitigating catch losses induced by ringed seals.

PB-49

Movement pattern and habitat use of giant trevally *Caranx ignobilis* in offshore reef habitats

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Passive acoustic monitoring was used to track the movements of 20 *Caranx ignobilis* at offshore reefs in the Great Barrier Reef from 2012 to 2014. Acoustic monitoring allows long-term monitoring of marine animal behaviour and movement via a network of moored listening stations recording the presence of tagged animals. Fifty-six listening stations were deployed on seventeen offshore reefs. Traditional spatial statistics (e.g. activity space) and network analysis (NA) determined temporal movement patterns and habitat use of this reef predator. NA is an alternative approach that treats listening stations as network nodes and analyses movement based on flows between nodes. NA provides new and useful interpretations of tracking data not provided by traditional approaches. Tagged individuals were present in the study region between 9 and 205 days (mean = 76). *Caranx ignobilis* were only detected at the reef they were caught and preferred the southwest side of that reef. Preliminary results showed tide, time of day and size of fish influenced size and location of activity spaces and individual pathways. By defining space use patterns of this important reef predator, results of this study may improve understanding of functional connectivity within offshore reef habitats and help provide guidance for their management.

PB-50

Positive buoyancy of deep-sea sharks assisted diurnal vertical migration

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Sharks use their large, oil-filled livers to provide buoyancy, yet most are recognized to be still negatively buoyant. Deep-sea sharks have especially large livers, and have been considered to archive nearly neutral buoyancy, however, it is never empirically tested in their natural habitat. In 2013 and 2014, we deployed accelerometers (W2000-3MPD3GT; Little Leonardo, Japan), which recorded depth, temperature, swimming speed, tri-axial acceleration and magnetism, on five bluntnose sixgill sharks (*Hexanchus griseus*) and a prickly shark (*Echinorhinus cookei*) caught by long-lines set off Kaneohe Bay, Oahu, Hawaii, USA, to quantify their swimming behavior in relation to buoyancy. Total 36-day length data was obtained, and all individuals showed diurnal vertical migrations: they swam at 200-300 m during night and deeper than 500 m during day. Ambient water temperature was around 15ºC at 200-300 m but below 7ºC at over 500 m. All individuals showed larger amplitude of acceleration caused by tailbeating during descent than ascent, and swimming speed at a given tailbeat frequency was faster during ascent than descent, both indicating positive buoyancy during vertical migration. The positive buoyancy might support their evening upward migration because their body temperatures were cooled by deep cold water and activities were low.

PB-51

Activity patterns of the black sea bream around oyster rafts in Hiroshima bay, Seto-Inland Sea, Japan

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The black sea bream *Acanthopagrus schlegelii* is main predators for oyster culture in Hiroshima bay, Seto-Inland Sea, Japan, however the behavior of breams around oyster rafts is poorly known. Herein we reported activity patterns of the fish in the oyster rafts by using bio-telemetry and bio- logging. We attached an acoustic transmitter with depth sensor or a depth-temperature data logger on 12 fish captured at oyster rafts in the Hiroshima bay. The twelve fish released and tracked from May 2011 to Dec. 2013 were referred to for analysis. The results showed that the fish frequently used the depth in which the oyster is present, and fish showed seasonal variation in their vertical depth distribution. Furthermore, the fish displayed a strong negative correlation between water temperature and ambient depth. Depth variation was investigated comparing with annual, circadian and tidal cycles. As a result, the fish displayed tidal, diel and seasonal vertical movement patterns. The depth variation typically increased during a daytime or outgoing tide. These findings show that activity pattern of bream is influenced by diel, tidal and annual cycle of water temperature.

PB-52

Experiences of prey-capture in the past 2-3 dives influenced the traveling of Antarctic fur seals

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Theoretical studies have predicted that the foraging behaviour of animals is decided based on the past prey-capture experiences. However, few empirical data exist for such decision-making in large predators including marine mammals. This study examined whether Antarctic fur seals *Arctocephalus gazella* made foraging decisions based on previous prey-capture experiences and over what time-scale these rates were important. We investigated three lactating female Antarctic fur seals on foraging trips from Bird Island, South Georgia, using acceleration and/or geomagnetic data loggers. We attached loggers to both the lower jaw, to detect mouth openings as index of prey-capture, and to the dorsal fur to reconstruct the dive paths of the seals. Within continuous dives, mouth-opening rates per dive showed large variation. The linear distance traveled after each dive was affected by the mean mouth-opening rate of the previous 2-3 dives rather than the mouth-opening rate in only the immediate preceding dive. Linear distance traveled tended to be short when the mean rate of mouth opening in the previous 2-3 dives was high i.e. seals tended to stay in areas of high prey captures. These results suggest that Antarctic fur seals make foraging decisions based on the prey-capture rate over a 2-3 dives time scale.

PB-53

Seasonal activity patterns of the endangered Saimaa ringed seal

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We examined seasonal and sex related variations in activity patterns of critically endangered Saimaa ringed seal (*Phoca hispida saimensis*). A total of 14 GPS phone tags (SMRU, Scotland) were attached to adult seals (females = 6, males = 8) in years 2007-2012. The activity pattern data, i.e. hauled-out vs. in water (diving, at the surface or in shallow water) were examined from 2-4 h summary bouts provided by the tags. The males spent over 85% of their time from July to January in water, while the females reached the same figures only during October and November. Overall the seals spent more than 50% of their time submerged (dives deeper than 1.5 m) during the open-water season from June to November. During the ice-cover season from December to March they were submerged for less than 40% of the time. The females spent more time hauling-out during the ice-covered season than the males. The average diving depth and duration peaked during July and August, whereas the number of dives per bout peaked in October-December. The knowledge on activity patterns is important for the identification of different ecological aspects of the Saimaa ringed seal in relation to protected areas and to seal-fishery interaction.

PB-54

Straight from the jackdaw's beak - biologging in bioacoustic research

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Biologging has helped us understand various aspects of animal physiology and behaviour. However, only a few studies have used such methods to study vocalisations, partly because of the high energy and storage demands of audio recorders. However, fixing microphones and recorders directly onto an animal would allow us to catch a glimpse of vocal behaviour previously unknown or extremely difficult to obtain, e.g. while they are covering large distances, moving in inaccessible terrain or when sounds interfere, as in noisy environments or in the presence of multiple signallers. This is especially interesting in group-living animals where individual recordings are difficult to obtain but remain crucial to the understanding of proximate and ultimate factors shaping specific vocalisations. Microphone transmitters have been used for this purpose but are prone to distortions and complete loss of acoustic information. To our knowledge, our study on a colony of jackdaws (*Corvus monedula*) is the first one to use miniaturised digital on-bird audio recorders in free-living passerines. At this symposium, I will present preliminary results from vocalisations recorded individually inside a group and some unexpected but exciting physiological parameters and will discuss some of the wider implications of this method for bioacoustics and behavioural science.

PB-55

Continental-wide tracking of swifts

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Swifts are spectacular flyers spending most of their life on the wings. Despite being a charismatic bird migrant, we still lack information on which migration routes the common swifts (*Apus apus*) follow and to where different populations migrate. Here I present data on a continental-wide geolocator study on the migration of common swifts between breeding locations in Europe and wintering sites in Africa. We have used miniature geolocators, so-called light loggers, to track the migration and wintering of common swifts from several different populations in Europe. The southern populations of common swifts initiate autumn migration prior to the northern populations, and they move to wintering areas further south to southeast in Africa compared to the northern populations. The initial work revealed that Swedish common swifts predominantly winter in the Congo basin. Central to most populations are that they pass West Africa on the migration north, where they make a short stopover in West Africa in the Liberian rainforest region, before they cross Sahara on a fast transportation flight to the breeding sites.

PB-56

Sperm economy in semelparous salmonid species, chum salmon

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We demonstrate the sperm economy of chum salmon and how to allocate their sperm released during spawning using an acceleration data-logger. First, we developed a method for collecting the amount of sperm released during spawning. The method was used to determine relationship between the amount of sperm ejaculated and length of time in vibration of trunk musculature at the moment of sperm release. Second, we examined relationship between volume of sperm released and a body size of paired female. In the absence of male-male competition, all spawning behavior of the fish was monitored in the spawning channel. The vibration length during sperm release was positively correlated with the amount of sperm ejaculated ($n=16$, $p < 0.05$), which indicated that the vibration length during sperm release can be an indicator of the amount of the sperm released. The vibration length during sperm release was positively correlated with a relative body size of paired female ($n=87$, $p < 0.05$) and was also negatively correlated with a body size of male ($n=87$, $p < 0.05$). These results indicate that chum salmon can allocate their sperm expenditure in accordance with paired female size and the larger male can economize sperm than smaller male.

PB-57

Harbour porpoises from West Greenland: Ocean-farers and deep divers

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Knowledge of harbour porpoise movements in Greenlandic waters has so far been non-existing. An adult and sub-adult female harbour porpoise was caught on the west coast of Greenland in July 2012 and instrumented with satellite-linked-dive-recorders (SPLASH, Wildlife Computers). The adult female made extensive movements throughout the central North Atlantic where it wintered (October – April). It returned to West Greenland the following summer and ended its transmission after 417 days. The sub-adult female spends considerable time in the deep water of the Davis Strait and ended its transmission after 475 days. Both porpoises returned to the tagging site in the following summer after travelling app. 17,500 km and 10,000 km and spending on average 83% of their time off the continental shelf where they dove to maximum depths of 382 and 410 m. Despite different movement patterns, both porpoises showed site fidelity to the summer breeding and feeding ground and demonstrated the capability of inhabiting oceanic waters for a large portion of the year. This is in contrast to the conventional knowledge concerning harbour porpoises and suggests that their occurrence in deep water areas play an important role in their ecology.

PB-58

The individual counts: Within sex differences in foraging strategies are as important as sex-specific differences in masked boobies

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Intrinsic factors, such as body mass differences between sexes or species influence animals' foraging behaviour, but studies investigating the effects of individual differences in body mass within the same sex are scarce. We investigated this in chick-rearing masked boobies *Sula dactylatra*, a species with reversed sexual dimorphism, through the simultaneous deployment of GPS and depth-acceleration loggers to obtain information on foraging movements and activity patterns. Heavier females performed shorter trips closer to the colony than lighter females. During these shorter trips, heavier females spent higher proportions of their flight time flapping and less time resting on the water than lighter females did during longer trips. In contrast, body mass did not affect trip duration of males, however heavier males spent less time flapping and more time resting on the water than lighter males. This may occur as a result of higher flight costs associated with body mass and allow conservation of energy during locomotion. Variation in trip length therefore seems to be triggered by body condition in females, but not in males. Our findings underline the importance of accounting for the effects of body mass differences within the same sex, if sex-specific foraging parameters in dimorphic species are being investigated.

PB-59

Preferred habitat of southern bluefin tuna around Australia

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Southern bluefin tuna are a highly migratory species with their range extending from the Indian Ocean in the west to the Pacific Ocean in the east. They are a valuable target species and are quota managed by the Commission for the Conservation of Southern Bluefin Tuna. In the Australian context, management wishes to limit unwanted interactions for non-quota holders and maximize economic efficiency for holders of quota. The applications of habitat preference models are presented that achieve these aims for management and industry in both a longline and purse- seine fishery. These methods have been developed using archival tag data and the application of satellite and light based geolocation methods to determine location. In addition, seasonal forecasts from dynamical ocean-atmosphere models of ocean conditions can be very useful tools for fishery management and allow dynamical habitat prediction and proactive management responses. The seasonal prediction system POAMA at the Australian Bureau of Meteorology currently produces operational real-time forecasts of sea surface temperatures around Australia, and these are used to provide useful habitat predictions for up to several months.

PB-60

Variation in activity patterns of non-native channel catfish observed in river and lake

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Channel catfish (*Ictalurus punctatus*) is widely spreading its distribution in several waters in Japan, including wide range of environment such as rivers, ponds and lakes. Many studies in its native countries have reported that channel catfish can live in both lentic and lotic conditions, have an omnivorous diet and be active in day and night, indicating that there have been a possibility of the increase in its population as an alien species, but direct measurement have not been performed and the information of their behavior in introduced areas is lacking. In 2012 and 2013 we performed field studies in Yahagi River and Lake Kasumigaura, Japan, and obtained activity data with accelerometers from 3 and 2 individuals, respectively. Integrating the previous studies on food habit and obtained activity data, channel catfish which occur in river mainly prey on terrestrial or aquatic insects flowing the water surface and their activity changes according to water level and turbidity, while those occur in lake prey on benthos, stay near the bottom of water and become active mainly in the night. The differences observed in their activity patterns imply that channel catfish change their behavior in response to the differences of their surroundings.

PB-61

Spatial and temporal variability in foraging behaviour of northern rockhopper penguins, *Eudyptes moseleyi*, a comparison between the Tristan da Cunha archipelago and Gough Island

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The endangered northern rockhopper penguin (*Eudyptes moseleyi*) is found in the South Atlantic and South Indian oceans with approximately 85% of this species' population breeding at Tristan da Cunha and Gough Island. The large-scale (>90%) reduction in penguins at Tristan da Cunha occurred prior to the 1950s and numbers have been relatively stable since the 1970s. In contrast, numbers at Gough Island, south of the Subtropical Front, have decreased by approximately 90% since the 1950s. We attempted to explain these contrasting regional trends in terms of differences in foraging behaviour and distribution at sea in relation to oceanographic features (as a proxy for prey assemblages and abundance) over the birds' annual cycle. Penguins were followed between 2012 and 2014 at Tristan da Cunha and Gough Island to monitor foraging habitat and diving behaviour using logger technology. The study included deployments during incubation, guard and crèche phase using GPS and TDR loggers and post-moult/over-wintering using GLS tags and satellite transmitters. A study of diet composition was carried out using the combined approach of stable isotope analysis and conventional dietary sampling to enhance the understanding of how foraging patterns, foraging areas and oceanographic parameters of northern rockhopper penguins can be linked.

PB-62

Migration and carry-over effects in tree swallows (*Tachycineta bicolor*)

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Aerial insectivores are declining in North America; therefore, to determine what factors are driving these declines it is important to have a holistic view of their annual cycle. There is also growing evidence of carry over effects in migratory birds. This study uses geolocators to map the annual movements of tree swallows breeding in Nova Scotia, Canada, and determine if events in the breeding season have carry over effects on migration. Geolocators revealed that tree swallows began migration in July and immediately had an extended stopover in the northeastern United States. They migrated down the eastern coast of the US and reached their wintering grounds in Florida or Cuba in late October - early November. They began spring migration in March or April, arriving at the breeding grounds in late April - early May. This study revealed that breeding events have carry over effects on the migration strategy of tree swallows. Swallows with late fledging dates began migration later than swallows with early fledging dates. However, late fledging birds did not arrive on the wintering grounds later, due to shorter stopovers. Tree swallows may be able to change their migration strategy to compensate for shifts in the timing of breeding.

PB-63

Use of 3D-accelerometers coupled with GPS-tags to investigate how often, when and where domestic cats (*Felis silvestris catus*) hunt

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In some cases, the predation exerted by domestic cats (*Felis silvestris catus*) is a threat for prey species conservation. Cat predation also contributes to the transmission of toxoplasmosis that infects almost 30 percent of human populations worldwide. Characterization of cat predation is thus of special concerns for wildlife biologists, epidemiologists and cat owners. Yet, very few data is available on accurate frequency, period and location of cat predation. In this context, we monitored 20 free-ranging house cats and 20 farm cats equipped with a tri-axial accelerometer data-logger and a GPS-unit during a continuous 9-day period. The study took place in a rural area in Ardennes (North-East of France). Accelerometry data were analysed in terms of body attitude, body acceleration and periodicity of movement based on additional direct observations. The CART method was used to classify behaviours and identify associated accelerometric variables. Location data were analysed by using the MBKE method to estimate the use of hunting patch into intensity and recursion. Individual and environmental factors affecting the predation exerted by cats were investigated using GLM. The simultaneous deployment of tags has provided insights to address precise and accurate fine-scale measures to characterize predation behaviour at a population level.

PB-64

Nightjar migration – New discoveries, and can we combine technology with people to learn more about small migratory birds?

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We use migratory movements of European nightjar (*Caprimulgus europaeus*), revealed by geolocators, to highlight remaining knowledge gaps in the migratory behaviour of Nightjars and other small birds in the African-Eurasian Flyway. The newly formed 'Migratory Landbirds Study Group' is introduced and we consider how biologging technology combined with research collaboration across Europe and Africa could help discover why so many of our migratory birds are in decline.

PB-65

Using high-frequency GPS: Foraging behavior of a colonial raptor

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Tracking technology has improved the possibilities to study free-ranging animal movement in last decades, and it continues progressing. Small-sized animals can now be tracked by using lighter devices and movements are registered at finer scales due to the high spatiotemporal accuracy provided. Those advances in technology are showing the individual plasticity in movements influenced by changing endogenous and exogenous factors. The lesser kestrel (*Falco naumanni*) is a small-sized falcon that suffered a strong population decline due to agricultural intensification. During the breeding seasons of two consecutive years, we tracked 23 individuals from a colony using GPS-dataloggers that collected positions at high-frequency, ranging from one fix per second to one fix per five minutes. That provided us with a detailed vision of individual daily-time budget, and foraging behavior. Our results show that individual spent 25% of day length at the colony early in the breeding season versus the 10% spent at the end, presumably due to nest defense from conspecifics early in the season and chick provisioning at the end. Females conducted a smaller number of foraging movements longer than those of males during the incubation period, concentrated in the first hours of the day after being incubating during the night.

PB-66

Oceanic habitat-use and activity patterns of large satellite-tracked blue sharks *Prionace glauca* in the North Atlantic: Linking behaviour with fisheries

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The blue shark *Prionace glauca* is a highly migratory, pelagic species found circumglobally in tropical and temperate coastal/pelagic regions. A central problem facing management of open- ocean shark populations is little understanding of where and when fish and fishing vessels do (and do not) interact, a knowledge gap not helped by poor monitoring and data reporting. This study aimed to determine the movement patterns and behaviour of satellite-tracked blue sharks to identify (i) preferred habitat from remotely sensed environmental fields and (ii) critical habitat from the extent of overlap with tracked longlining vessels. Tagged sharks exhibited different movement patterns across the North Atlantic spanning 14 to 51ºN and 6 to 70ºW; blue sharks also showed shifts in diving behaviour in relation to changing environmental landscapes (e.g. the Gulf Stream), cyclical activity patterns and frequent deep diving into cold water (deepest recorded dive of 1704 m; 4.8 ºC). Archival data from recovered tags also allowed the identification of individual dive profiles and finer scale patterns. Importantly, blue sharks had more than 80% of their tracked range overlapped by fishing vessels with observed interactions in space and time generally occurring in regions of high frontal frequency.

PB-67

Migrations and behavioural ecology of porbeagles in the north-east Atlantic

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The NE Atlantic stock of porbeagle (*Lamna nasus*) has been listed as Critically Endangered since 2008, leading to a ban on all catches in 2010. Despite this protection, porbeagles are still caught in fishing gear as unintentional bycatch. We used PSATs to track the migrations and behaviour of 30 porbeagles caught in the Celtic Sea and to the west of Ireland. During summer, porbeagles occupied warm stratified waters, diving between the surface and depths of up to 200m along the shelf-break. As the year progressed, the mean and maximum depths that porbeagles used increased as they migrated into waters over the continental slope. All porbeagles showed a strong diel pattern of depth occupation, occurring in deeper waters at day than during the night. This pattern was particularly evident during the winter, when porbeagles foraged at the deep scattering layer during the day. The majority of porbeagles moved south to the region of the Bay of Biscay during winter, although some undertook significant migrations to the west or north. Our results provide evidence of long-distance migration and deep water foraging, as well as strengthening evidence for a general north to south migration of porbeagles in the NE Atlantic.

PB-68

Head mounted accelerometers reveal the behavior of red deer (*Cervus elaphus*)

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Studies of animal behavior in the wild are important for understanding their ecology and conservation, but long-term studies of individuals are haunted by a lack of power to see. Here we used a head mounted accelerometer to study the foraging behavior of red deer. We demonstrate using a tame animal in captivity that eating, standing and walking behavior are detectable with accuracies of 70-90%. We also tagged four semi wild red deer with an Opentag (sampling at 50Hz) and a GPS collar. The data show that activity patterns peak at dusk and dawn and often correlates with increased head movements which may indicate eating sequences. Data also show that red deer keep to well established home ranges and that red deer are behaviorally affected by handling for at least 24 hours after release. Finally, behaviors such as rumination, running and browsing are most likely also detectable but further analysis is needed before this can be verified. We conclude that head mounted accelerometers provide a detailed quantification of the behavior of wild red deer to inform management and conservation efforts.

PB-69

Interactions between oceanography and the diving behaviour of a pelagic seabird, the northern gannet *Morus bassanus*, in the Celtic Sea

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Understanding how seabirds utilise their at-sea environment and interact with prey is essential for the effective protection and management of the marine environment. Rapid developments in biologging have contributed greatly towards our understanding of the at-sea behaviours of seabirds, and current research suggests a number of species use oceanographic features to locate and capture their prey. In particular, fronts, representing the interface between differing water masses, appear to represent important foraging habitats. However, research has concentrated predominantly on analysing the two-dimensional movements of individuals, and comparatively fewer studies have investigated how movements over three dimensions may be influenced by these and other oceanographic features. This study aims to determine if the diving behaviour of the northern gannet *Morus bassanus* alters in relation to oceanography with a specific emphasis on movements within frontal regions. Over three years, 60 chick-rearing gannets were equipped with GPS loggers and Time-Depth Recorders at Grassholm Island, Wales. This data was then coupled to front metrics, determined from remotely sensed SST data, as well as outputs from a hydrodynamic model, FVCOM. Dive locations and profiles are analysed and discussed in relation to this oceanographic data, allowing for new insights into how seabirds interact with their environment.

PB-70

Adjusting flight behaviour according to variable environmental conditions in a foraging marine gull

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Combining high resolution GPS tracking with weather models we infer how a seabird reacts and adjusts its flight behaviour depending on environmental conditions. We tracked the central-place foraging flights of lesser black-backed gulls (*Larus fuscus*) during pelagic marine foraging trips in the Baltic Sea. At low altitude (<150 m) it is important to take into account the effect of wind-shear, the tendency of wind speed to increase with altitude, to minimize energy expenditure. Adjusting flight altitude may allow birds to reduce the effects of wind drift and either increase tail-wind assistance, or reduce head-wind hindrance. Flight theory suggests that birds should fly at different airspeeds depending on whether they are optimising for net rate of energy transport or efficiency; further these optimal speeds are influenced by wind assistance/hindrance. We demonstrate that lesser black-backed gulls modulate their flight altitude according to predictions. It is questioned to what extent birds can detect wind drift over open water, where the stationary visual cues available on land are absent. By analysing goal-directed homeward flights we determine how gulls compensate for wind drift at sea. Tracking individual gulls over many foraging trips allows the comparison of flights performed under a wide variety of conditions.

PB-71

Identifying individual behavioural fidelity and migratory carryover effects in the Manx shearwater (*Puffinus puffinus*), from five colonies over five years, using a machine learning approach

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Gathering information about the breeding behaviour of seabird species requires long periods of field work and disturbance to the animals. The introduction of bio-logging technology has enabled major advances in our understanding of seabird behaviour at sea. The focus of these studies is often on behaviour away from the breeding colony, specifically long distance migration. Here we demonstrate that light and salt-water loggers (geolocators) can be used to identify different behaviours during migration and key life history events in the breeding season. Using a Gaussian mixture model we classify each day during the breeding season and migration into different behaviours. This allows us to identify laying and hatching dates, which are then compared to different migratory strategies to look for carry over effects. These techniques were applied to five Manx shearwater breeding colonies around the UK for a period of five years. We uncover distinct breeding strategies in birds from different colonies and individual fidelity in migration behaviour.

PB-72

Tracking into the deep: Multi-scale acoustic animal telemetry at island slopes and seamounts

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The progress of marine fish biotelemetry has been very much skewed towards inshore reef fishes and sharks and their habitats. In comparison, we know virtually nothing on the movements and fine-scale habitat use of species living in the depths of the ocean, for example around seamounts and on slopes of oceanic islands. In this paper we present the novel results of several years of acoustic telemetry experiments in the Azores archipelago, mid north Atlantic. We used both active and passive acoustic telemetry to track the movements and vertical displacement of various key species of deepwater habitats, including red seabream (*Pagellus bogaraveo*) and kitefin shark (*Dalathias licha*), at various spatial and temporal scales, from their fine-scale diel vertical migrations to their inter-annual residency at seamounts. These results highlight the complexity of displacements across the water column and between habitat types, and allowed testing some hypothesis concerning the importance of local resources for the ecology of these species. Importantly, they demonstrate the importance of novel approaches using multiple scale studies in understanding the behavioural ecology of deepwater species.

PB-73

Quantifying foraging behaviour of fish using tri-axial accelerometer biologgers

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Fine scale behaviour such as foraging is difficult to quantify in the wild, especially in fully aquatic species, yet has important basic and applied applications. We used tri-axial accelerometer biologgers to determine accelerometric predictors of foraging behaviours in a teleost fish, the bonefish (*Albula vulpes*), and an elasmobranch, the lemon shark (*Negaprion brevirostris*) in an enclosed, semi-natural wetland mesocosm in Eleuthera, The Bahamas. Based on ground-truthed visual observations, accelerometric predictors of foraging were identified using classification tree models. Bonefish forage on benthic invertebrates in the substrate, a behaviour that can be identified using characteristic changes in body movement and posture. Similarly, lemon sharks feeding on relatively large meals exhibit high-intensity dynamic movements that produce a unique acceleration signal from other routine behaviours. A further examination of bonefish behaviour over a 5-day period in the wetland revealed high among-individual variability in foraging behaviour, as well as potential environmental drivers. Collectively, this research highlights the utility of tri-axial accelerometer loggers for remote measurement of foraging behaviours in fishes that was not previously possible, and has important applications for understanding behavioural ecology, habitat requirements, population dynamics, and bioenergetics.

PB-74

Variation in body condition during the post-moult foraging trip of southern elephant seals and its consequences on diving behavior

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Female southern elephant seals may lose as much as 50% of their body mass, mostly in lipid stores, during the breeding season due to the combined effects of fasting and lactation. When departing to sea, they are denser than seawater (negatively buoyant). Changes in body condition during the foraging trip are generally assessed by monitoring change in density estimated from drift rates observed during passive recovery dives. However, seals performed few recovery dives resulting in low temporal resolution of body condition changes. Six post-breeding females were instrumented with time-depth recorders and accelerometers. Negatively buoyant elephant seals minimized swimming effort, gliding at slower speeds down to the bottom of the dive, and reduced their swimming effort to maintain a nearly constant swimming speed during the ascent as their buoyancy increased. Variations in descent gliding speed and ascent swimming effort were strongly correlated to the variation of seal density estimated from recovery dives, enabling the fine-scale monitoring of seal condition change over time. One percent of seal density variation over time was found to induce a 20% variation in swimming effort during dives with direct consequences on the change in dive duration: dive duration decreases with increasing seal density.

PB-75

Categorizing sperm whale dive types and possible foraging strategies using intermediate-duration Advanced Dive Behavior tags

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During July 2013, we tagged nine sperm whales with Advanced Dive Behavior tags (modified Wildlife Computers PATF-Mk-10 tags) in the northern Gulf of Mexico to collect GPS locations and high resolution (1 Hz) depth and body orientation data. Locations and dive summaries were sent via Argos during attachments averaging 19.5d for seven well-deployed tags. Five recovered tags recorded a daily average of 37 GPS locations and 29 dives >10 m deep and >10 min duration while showing that the number of rapid changes in body orientation (foraging attempts) during dives was highly variable. Cluster analysis revealed two general categories: 1) short (< 25 min)-shallow dives (< 300 m) with slower ascent and descent rates or 2) deep (> 350 m)-long dives (> 35 min) that were either very close to the bottom or mesopelagic (400 – 600 m depth). Few foraging attempts occurred during short duration dives, suggesting they were transiting and/or searching behavior in areas with poor prey density. Foraging attempts/dives were significantly more frequent during long-deep dives, indicative of benthic and mesopelagic foraging strategies. GPS locations allowed documentation of the spatial and temporal variability of sperm whale foraging behavior, likely reflecting the variable density of prey.

PB-76

Sound exposure during offshore windfarm construction: Integrating sound propagation models with telemetry data to predict auditory damage in harbour seals

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Anthropogenic sound has the potential to cause auditory damage in marine mammals. Predicting its likelihood is possible by integrating movement and dive data from telemetry and acoustic data to estimate cumulative sound exposure in individuals. Here, we describe behavioural study of harbour seals during pile driving at an offshore windfarm. We deployed 24 GPS/GSM tags which provided location and dive data (seal locations approximately every 15 minutes), allowing investigation of movements and a prediction of auditory injury in each seal. The closest distance of tagged seals to active piling locations varied from 4.7 to 40.5 km. Single pulse Sound Exposure Levels (SELs) at each seal were estimated using data on the timing and blow energy of each piling blow and Range dependent Acoustic Models (validated using field measurements). To assess the potential for auditory injury, cumulative sound exposure levels (cSELs) were calculated for each seal; predicted maximum cSELs for individual seals varied between 177.1 and 193.6 dB re 1µ Pa2-s. Our predictions suggest that 46% of seals received levels that exceeded published auditory injury criteria. This result greatly enhances our understanding of the environmental risks of offshore piling and demonstrates the value of telemetry data combined with acoustic propagation models.

PB-77

Does sonar ramp-up reduce the risk of exposure to high intensity sound? An experimental evaluation with humpback whales (*Megaptera novaeangliae*)

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There is a risk that naval active sonars cause detrimental physiological effects in nearby marine mammals. To reduce this risk, several navies have adopted a mitigation procedure known as 'ramp-up' whereby the source level is gradually increased to full power. To test the hypothesis that ramp-up reduces the acoustic received levels of a whale through the mechanism of inducing an avoidance response, we conducted 31 experimental vessel approaches with a towed sonar source (1.3-2.0 kHz; 214 dB re 1µPa/m). Thirteen solitary humpback whales and/or pairs in the waters north of Norway were instrumented with DTAGs (Woods Hole Oceanographic Institution) and Fastloc GPS loggers (Sirtrack Ltd). High-resolution tracks were obtained for most whales, but the rate of GPS fixes (range=0-71 per hour; mean=27.5) and their accuracy varied strongly with tag location on the whale's body, sensitivity of the salt-water switch, and number of GPS satellites in view. Bayesian state-space models were fitted to the data to reconstruct fine-scale movement tracks of the whales. Received level calculations were based on acoustic measurements and propagation modelling. Our results show that ramp-up can trigger avoidance behaviour that leads to reduced received levels in a proportion of the humpback whale population.

PB-78

Fission-fusion dynamics in wild non-breeding ravens (*Corvus corax*)

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Non-breeding ravens often form groups during foraging and roosting, however, the degree of fission-fusion dynamics is still unclear. At our study site in the northern Austrian Alps hundreds of non-breeders use a game park as permanent food source by scrounging from the captive animals. Around 20-40 individuals are constantly present, but the majority shows up irregularly. In order to get more information about the whole population, we tracked some vagrants with GPS loggers (n=10). Our data, spanning from four months to over one year, cover an area of approximately 30,000km² and daily distances travelled of up to 100km. In this area we identified >30 permanent food sources (game parks, garbage dumps...) and many night roost areas. These locations were used by at least one, up to all individuals, with variation in use frequency (daily-yearly) and visit duration (hours-months). Ravens often visited several locations in one day, and data often suggest directional movement between locations. We show that despite the huge area travelled, with numerous possibilities to forage and roost, these 10 ravens sometimes still converge at a single location. This provides intriguing insights into raven behaviour in light of their high social complexity - as previously shown in captive studies.

PB-79

To breed or not to breed? Implications of post-breeding foraging strategies on reproduction in Hawaiian albatrosses

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Life history theory states that long-lived species, such as albatrosses, should sacrifice reproductive effort to preserve adult condition and survival. An individual's decision to breed is dictated by an assessment of its internal energy stores and projected energetic needs (i.e. molting, breeding) as well food availability, all of which are influenced by the post-breeding season. To investigate the mechanisms driving individual variability in breeding parameters we deployed geolocator tags on 38 Laysan (*Phoebastria immutabilis*) and 43 black-footed (*P. nigripes*) albatrosses from Tern Island over four years (2008-2012). Upon the birds' return the following year, we recorded nest initiation, hatch date, chick survival and collected contour feathers for stable isotope analysis. We analyzed breeding parameters as a response to post-breeding foraging strategies, defined by: activity (time in flight, average water 'bout' duration, landing rates), habitat use (time in marine bio-geographical provinces, δ13C), and trophic position (δ15N). Since Hawaiian albatrosses are known to skip breeding when molting energetically expensive flight feathers, we paid particular attention to behavior that would suggest a «molting strategy» (i.e. low distance traveled, low landing rates). By linking individual variability in breeding behavior with at-sea foraging strategies we can begin to identify how population variability drives demographic responses.

PB-80

Individual activity strategies and circadian, circalunar and circannual activity in Boyd's shearwaters

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Many aspects of seabird behaviour at sea remain unknown, particularly from subtropical and tropical species. Nowadays, new-small tracking devices allow us to reveal at-sea activity patterns of highly pelagic species in more detail than ever before. Here we present for the first time the year-round activity patterns of a small oceanic seabird endemic to Cape Verde Islands, the Boyd's shearwater (*Puffinus boydi*), which migrates for the non-breeding period to oligotrophic waters in Central North Atlantic Ocean. GLS salt-water immersion data of 30 individuals, tracked from 2007 to 2012, revealed birds spent relatively high proportion of time on the sea surface year- round, but greater activity levels over the breeding than the non-breeding period, presumably related to parental duties. During their short migration, birds were particularly active at twilight, suggesting twilight migration. We found a negative association between time spent on water and moonlight, more remarkable during the non-breeding period, indicating birds take advantage of lunar light for foraging. Regarding circadian activity, number of landings and take-offs were greater during daylight than at night, both in breeding and non-breeding period. Finally, birds showed individual differences in their activity patterns, specially the time resting on the sea surface, suggesting individual specializations in foraging strategies.

PB-81

Activity patterns and thermoregulatory behavior of the invasive Burmese python, *Python molurus bivittatus*, in the Florida Everglades, USA

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A population of Burmese pythons has become established in the Everglades National Park (ENP), Florida, USA, and has been connected to a 90 % decline in the small mammal population inside the park, as well as threatening the native reptile and bird populations. Efforts to extirpate this invasive species are ongoing, but are hampered by a lack of information about the python's activity cycles, and thermal biology. Using a combination of field and captive trials we fit acceleration data loggers to pythons in ENP to measure body movement and temperature. Short captive trials (N=2, 28h total) indicated that different types of locomotion (concertina, rectilinear) could be identified from acceleration data. Field trials (N=4, TL=457.4 ± 63.1cm) lasted from 10 to 95 days, with two activity patterns emerging: one individual spent up to 30 percent of its time active during the day compared to < 10 percent time active at night. The remaining individuals (N=3) showed the opposite of this pattern, with significantly higher activity at night than during the day. Activity bouts were short (mean= 1.3 ± 4.8min), but reached a maximum of 9.7 hours. Body temperatures were found to fluctuate as much as 15°C within a day.

PB-82

Using simple biologging metrics to inform dynamic bioenergetics models: a case study with Weddell seals

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Dynamic bioenergetics models provide a theoretical construct for addressing specific physiological and ecological questions. These models can be combined with energy input values to develop a decision-based matrix of energy allocation strategies under different energetic stressors. However, many models lack data on quantitative relationships between foraging effort and mass gain, and thus cannot be used to estimate changes in energetic requirements due to climate change or fishing pressure. To define realistic prey density and capture probability values, we instrumented nine adult, female Weddell seals (*Leptonychotes wedellii*) with flipper tag time-depth recorders during the Nov/ Dec breeding season and recovered the tags during the Jan/Feb molting season. Seals were weighed during both procedures. Between-season mass changes (-1.3 to +1.7 kg/day) were converted to prey ingestion estimates using published distributions of mixed diet energetic density (2.9 to 10.3 MJ/kg) and digestive efficiency (87.8 to 90.3%). Using Monte Carlo simulations, we will combine dive parameters (e.g. dive duration, bottom time, dives per day) with caloric intake to back-calculate a range of potential prey densities and capture probabilities. After the prey density and capture probability values are incorporated into bioenergetics models, the increase in foraging effort resulting from reduced prey quantity/quality can be assessed.

PB-83

Understanding the consequences of recreational angling stress on the biology and movement of white sturgeon *Acipenser transmontanus* in the Lower Fraser River, British Columbia, Canada

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White sturgeons are the largest freshwater fish in North America and the target of a lucrative catch-and-release fishery, particularly in the Lower Fraser River, British Columbia. During the spring and summer of 2014 white sturgeon will be angled with conventional angling gear to determine the consequences of capture on individual sturgeon. Each sturgeon will have blood sampled to quantify physiological disturbance, will be assessed for reflex impairment and then equipped with acoustic transmitters with accelerometry sensors so that post-release locomotory impairment can be assessed. Additionally, Vemco Mobile Tranceivers (VMTs), with both transmitting and receiving capabilities, will be externally attached to large white sturgeon, providing extensive coverage of the river environment and allowing for long-term behaviour and sturgeon-sturgeon interactions to be identified. This technology is not often used on fishes due to the necessity to retrieve the device for data acquisition. White sturgeons are a model species for deployment of the VMTs, however, because recapture rates are high in the recreational fishery. During this talk we will address the usefulness of combining physiological parameters and telemetry to fully understand the white sturgeon stress response following a capture-and-release event. We will also discuss attachment methods developed for using white sturgeons as « bioprobes».

PB-84

Did you say 21 months of continuous tracking? The journey of a bowhead whale revealed

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Bowhead whales are a difficult species to study largely due to their remote and challenging arctic environment. However, baseline data on habitat use, ecology, and biology is critically needed for management of the Eastern Canada-West Greenland population because it supports indigenous hunts in both Canada and Greenland and appears to be impacted by climate change. A recent improvement in tagging technique has led to significant accrued tag longevity. An immature female bowhead whale fitted with a SPLASH10 data-archiving tag (Wildlife Computers) in July 2012, in northern Foxe Basin, has provided exceptional continuous transmission duration of over 21 months (still transmitting as of 30 March 2014). In early summer of both 2012 and 2013, this young female traveled from Foxe Basin through Fury and Hecla Strait to Gulf of Boothia and Prince Regent Inlet where it spent both 2012 and 2013 summers. Fall migration routes differed, with the whale travelling through Fury and Hecla Strait and Foxe Basin to Hudson Strait to spend winter in 2012, and using the northern route by almost circumnavigating Baffin Island to spend the winter in Frobisher Bay in 2014. We will also present dive-behaviour results for the 21 consecutive months and summarize findings.

PB-85

Habitat use of reef sharks in the Amirantes, Seychelles, and its management implications

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Starting in August 2012 an extensive acoustic receiver array, comprising 70 Vemco VR2w receivers has been deployed in and around D'Arros and St Joseph Atoll in the Amirantes, Seychelles. The aim is to characterise the movement behaviour and habitat use of sharks, such as blacktip reef, sicklefin lemon and grey reef, of which 86 have so far been tagged and tracked. Using a novel network analysis, significant differences in movement and habitat use have been identified between juvenile and adult sharks, and between species. While some individuals have shown marked site fidelity others have ranged more widely, some travelling considerable distances. There is in addition some evidence of nursery areas and possible sexual segregation. Overall it appears that around D'Arros and St Joseph juvenile sharks and smaller species remain close to the islands, particularly favouring lagoon habitat, while larger sharks travel more widely across the Amirantes plateau. Information gained from this project will be used to assist development of a Marine Protected Area in order to reduce the impacts of local fishing pressure.

PB-86

Effects of temperature on daily activity patterns of the little bustard

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Daily activity patterns in animals are influenced by exogenous factors such as photoperiod, temperature, predation risk, or level of disturbance. The main goal of this study was to examine seasonal changes in daily activity patterns in the little bustard (*Tetrax tetrax*), and explore the influence of time of day and temperature. Using data from 20 satellite-tracked birds captured in southern Portugal, we distinguished presence or absence of activity based on the distance between locations that were greater than the error given by the GPS. The frequency of activity patterns was assessed during a 24-hour period for each of three seasons (breeding, post-breeding and winter). In addition, we modelled the effect of time of day and temperature on activity using Generalized Additive Mixed models. During the breeding and post-breeding periods, daily activity showed a bimodal pattern with two peaks of activity, one in the morning and one in the evening. In the winter, there was no evidence of marked activity peaks during the day. Temperature had contrasting impacts across seasons: an increase in temperature was associated with lower activity levels during breeding and post-breeding, but had a positive (though very weak) effect on activity during the winter period.

PB-87

Multi-colony tracking reveals spatio-temporal variation in carry-over effects between breeding and non-breeding seasons in a pelagic seabird species, the black-legged kittiwake

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Quantifying seasonal interactions is key to understanding individual life histories and population dynamics in migratory species. Carry-over effects may persist throughout the annual cycle, such that breeding effort may drive timing of migration and winter destination which, in turn, may affect timing of colony return and breeding performance. In addition, these effects may vary across species' ranges due to local conditions or migration distances. Recent developments in tracking technologies make it possible to follow large numbers of individuals throughout the year, allowing us to address these questions. Using miniature geolocators, we investigated year- round carry-over effects in black-legged kittiwakes *Rissa tridactyla* at 10 breeding colonies in the East Atlantic. Both successful and failed breeders wintered in the North-west Atlantic between Newfoundland and the Mid-Atlantic Ridge. Variation in carry-over effects of breeding outcome on timing of autumn migration and winter destination were apparent among colonies. These differences, in turn, had variable impacts on the timing of spring migration and subsequent breeding success among colonies across the range. This study is the first to quantify the spatio- temporal dynamics of carry-over effects at a meta-population scale, and our results suggest that kittiwakes show flexible migration strategies linked to breeding outcome and local conditions.

PC-01

The moult in southern elephant seals: the cost of losing it all

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The moult in most phocid seals is a gradual process and takes around 3 to 4 months except for a few species. For example, Southern elephant seals experience a catastrophic moult where, as well as replacing their hair, they also shed their skin within approximately one month. This is an energetically costly phase of their lifecycle during which seals aggregate or huddle to varying densities depending on local climate. In this study, we tested the hypothesis that huddling allows individuals to minimise the time and energy required to complete the necessary replacement of hair and skin. Fieldwork was carried out during the 2011 and 2013 austral summers on Kerguelen Archipelago (49°50'S, 70°30'E). Using a novel thermal imaging technique, we determined the extent to which huddling behaviour was an energy-saving strategy for elephant seals. In addition, we equipped 40 individuals with a combination of Argos, VHF, GPS, accelerometers, stomach temperature pills and i-buttons to study their movements and behaviour on land. Seals were weighed at the beginning and end of their moult to provide body mass loss information. This is the first study to examine the energetics of huddling during moulting in Southern elephant seals.

PC-02

Heart rates of emperor penguins diving at sea: implications for oxygen store management

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In penguins, heart rate contributes to control of blood oxygen (O_2) depletion through regulation of the magnitude of pulmonary blood flow/gas exchange and through regulation of peripheral blood flow, especially to muscle. Therefore, we measured heart rates (fHs) during dives of emperor penguins (*Aptenodytes forsteri*) in four birds equipped with digital electrocardiogram (ECG) recorders and time depth recorders (TDRs) during foraging trips from the Cape Washington colony. In 398 dives as deep as 454 m and as long as 9.4 min, dive fH (total beats/duration) and minimum instantaneous fH decreased significantly with increasing dive depth. Heart rates as low as 10 beats min^{-1}, during the deepest segments of deep dives suggest that gas exchange and peripheral blood flow occur primarily at shallow depths with minimization of pulmonary/peripheral flow and subsequent reliance on myoglobin-bound O_2 for aerobic muscle metabolism at greater depths. In addition, fH does not appear to correlate with previously measured stroke rates (muscle workload), especially during deep dives, given that the lowest fH values in the deepest dives occur at a time when previously measured stroke rates are near maximal levels.

PC-03

Thermal profiling in Weddell seals: Implications for understanding thermoregulation of an Antarctic marine mammal

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We examined variability in surface heat patterns of Weddell seals (*Leptonychotes weddellii*) to better understand drivers and plasticity of thermoregulation of high-latitude seal species in a changing environment. Using indirect infrared imaging (IRT) we determined baseline profiles of dry, hauled-out seals (n = 43) of varied age and body condition during the Antarctic summer. The 5x range in body mass and a 3x range in blubber depth contributed to profile variability, however, smaller and leaner individuals maintained animal-air thermal gradients comparable to larger, better insulated individuals. Environmental variables of wind and relative humidity ranked higher than air temperature in a model describing skin surface temperatures across our experimental conditions. While IRT cannot be applied underwater, we assessed the development of thermal windows in n=7 seals upon hauling out as a proxy (e.g., also post-exercise). Windows appeared in all but one seal, although stability and size were minimal (total visible surface area 1.6 ± 2.4%). Heat stress may also be relevant under some conditions, as window temperature increased with body surface temperatures. The dual media lifestyle of marine mammals presents a highly dynamic thermoregulatory process that is only beginning to be understood in detail.

PC-04

Giving ODBA a shake: assessing the relationships between energy expenditure and accelerometer data in free-ranging animals

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Determining energy expenditure in free-ranging animals is central to understanding their ecology. With the advent of miniaturised data loggers, accelerometers are being increasingly used to measure activity patterns in animals. In particular, Overall Dynamic Body Acceleration (ODBA) has been proposed to estimate energy expenditure, with several captive studies showing strong correlations with oxygen consumption. To date, however, few studies have investigated such relationships in free-ranging species such that the general applicability of ODBA to estimate energy expenditure in ecological studies is not known. In the present study, accelerometer data was compared to energy expenditure determined using doubly-labelled water in five free-ranging species: two marine mammals (northern and Antarctic fur seals 31-38 kg); a diving seabird (little penguin ~1 kg); an arboreal marsupial (koala ~7 kg); and a scansorial marsupial (brushtail possum ~3 kg). Measurement intervals incorporated representative behaviour periods and ranged 1.5–7.1 d, depending on species. Correlations between ODBA and energy expenditure varied greatly (r^2 = 0.17-0.83). Potential causes for the low predictive power of some relationships, and how inclusion of other behavioural data can improve them, will be discussed. The results highlight the need for species-specific behaviours to be considered in indices of energy expenditure derived from accelerometers.

PC-05

On the wing physiology of bar-headed goose migration

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Bar-headed geese (*Anser indicus*) are renowned for high altitude flights across the Himalayan mountains between Indian wintering grounds and breeding grounds on the Qinghai-Tibetan plateau and Mongolia. GPS satellite telemetry and atmospheric pressure measurements of flight altitudes, at resolutions of 1 hour and 2 minutes, respectively, indicate that geese regularly change altitude on their long migratory flights but no evidence was found for a general paradigm of extreme high-altitude flight >8,000m. The two highest GPS records were 7,290m and 6,540m and the highest pressure altitude recording was 6,443m (90% of plateau flights <5,600m). Data from captive bar-heads demonstrate that geese could sustain maximum running speeds and heart rates of 466 beats per minute in an atmosphere of only 7% oxygen for 15 minutes. However, data from wild migratory flights, obtained using implantable data loggers, reveal that geese only spent 3.3% of their flight time with 455 beats·min^{-1}. Modeling their maximum physiological capabilities suggests that flying without environmental assistance above an altitude of 8,000m may not be a sustainable strategy. Abdominal body temperature was not sensitive to altitude but did rise when geese were flying strenuously. Indeed, geese would occasionally stop flying if was rising too rapidly.

PC-06

An over-cost of being a pelagic bird: A possible energetic conflict between thermoregulation and digestive processes

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In high latitude and for swimming birds, an expensive part of foraging activities consists to reach favourable areas but an additional cost is resting in cold water. In the king, the phenomenon is emphasized by their capacity to efficiently spare energy while undergoing deep dives. Thus, there is no difference in energy expenditure between nights of inactivity at sea and days of extensive diving. This paradox is probably linked with contrasting thermoregulation processes. During daylight, a general hypothermia occurs and is believed to reduce energy expenditure. At sunrise occurs a re-warming to normothermia, contributing to increase heat-loss during the night. We hypothesise an energetic conflict between thermoregulation and digestive processes. During daylight, the organism may be unable to assimilate the end product of prey digestion (free fatty acids FFA) inside the peripheral subcutaneous adipose tissues (SAT), because skin is no more blood perfused. During the night, re-warming and re-connecting to blood circulation peripheral tissues is inevitable to end the assimilation of FFA inside the SAT. To test this hypothesis, penguins equipped with loggers were placed in a seawater tank at different nutritional stages.

PC-07

Simultaneous measurements of breaths and energy expenditure reveal the dive tactics of sea turtles

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Air-breathing divers are assumed to have evolved to apportion their time between surface and underwater periods to maximise the benefit gained from diving activities. However, whether they change their time allocation depending on the aim of the dive is still unknown. This may be particularly crucial for 'surfacers' because they dive for various purposes in addition to foraging. In this study, we counted breath events at the surface and estimated oxygen consumption during resting, foraging, and other dives in 11 green turtles (*Chelonia mydas*) in the wild. Breath events were counted by a head-mounted acceleration logger or direct observation based on an animal-borne video logger, and oxygen consumption was estimated by measuring overall dynamic body acceleration. Our results indicate that green turtles maximised their submerged time, following this with 5-7 breaths to replenish oxygen for resting dives. However, they changed their dive tactic during foraging and other dives; they surfaced without depleting their oxygen content, followed by only a few breaths for effective foraging and locomotion. These dichotomous surfacing tactics would be the result of behavioural modifications by turtles depending on the aim of each dive.

PC-08

VeDBA: a possible 'count-free' proxy for estimating daily life physical activity energy expenditures from 3-axial accelerometry data in humans?

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Portable accelerometers are increasingly used to monitor physical activity (PA) and estimate the energy expenditure it generates (PAEE). Here we tested the ability of Vectorial Dynamic Body Acceleration (VeDBA, a metric which summarises 3-axial accelerometry data in a single value) to capture the intensity of various PA behaviours, and the possibility to develop a simple equation linking VeDBA to PAEE. 56 subjects equipped with 2 hips-worn 3-axial accelerometers (MotionLog and Actigraph GT3X+) performed 24 standardised activities in the laboratory with simultaneous indirect calorimetry measurements (Servopro4100, Servomex). The average VeDBA and Vector Magnitude (VM in counts, output of the ActiGraph) values were computed for each subject and activity. Data from 29 subjects were used to develop several linear mixed effect models (PAEE as response variable, VeDBA or VM as predictor, subject number as random effect, and with or without posture (standing, lying, or sitting) as an additional fixed effect). Model performances were tested with data from the other 27 subjects. The best model (lowest RMSEmixed, highest R^2mixed) used VeDBA as a predictor and integrated posture-specific coefficients. Further validation will be conducted against doubly labelled water in subjects carrying the devices for 2 weeks in total free-living conditions. Funding: ANR TecSan.

PC-09

Swim speed as a measurement to estimate cost of transport in diving otariids

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The cost of transport (COT) during foraging trips in otariid seals was estimated using diving datasets which included swim speed, pitch angle and dive depth. In our study, COT was based on estimated locomotory costs and maintenance metabolic costs. The locomotory costs were estimated from buoyancy and drag which is proportional to square of swim speed. The maintenance metabolic cost was estimated from resting metabolic rate in water. Lactating female New Zealand fur seals *Arctocephalus forsteri* (28.8-47.4 kg, N=5) and South American fur seals *Arctocephalus australis* (37.2-47.8 kg, N=2) were equipped with animals-borne devises in 2012 and 2013, respectively. A total of 12 trips were recorded, and the estimated COT during each trip (COT_Tr) ranged from 5.5-6.9 J/kg/sec, which was within the range of reported costs (5.0-8.1 J/kg/sec) measured by the doubly-labelled water method in similar-sized fur seals. COT_Tr showed strong linear relation with the percentage time at the surface between dives (R^2=0.98). COT during each dive was proportional to dive depth, which showed that the COT of otariids was comparable to that measured in Weddell seals using respirometery. Our results suggest that swim speed can be a useful tool to estimate COT in breath-hold divers.

PC-10

How does coastal flatfish migrate during the spawning season to control maturation, when experiencing naturally fluctuating temperature?

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Temperature modulates hormone activity of the reproductive system, affecting the different phases of fish reproduction, especially ovulation and spawning. Therefore, understanding how fish adapt to temperature during spawning migration will expand our knowledge regarding its role in controlling reproduction. We used temperature-depth data-loggers to measure the thermal experience of 112 adult barfin flounder *Verasper moseri* during their winter spawning migration. Over 7000 days of data demonstrate that fish showed consistent behavior during the maturation and spawning periods. During the late maturation period (December), fish left the Pacific coast of Hokkaido and migrated southward by January, where they experienced temperatures of 3 to 4°C at depths of 400 to 600 m, suggesting consistent exposure to cool temperatures may regulate the development of final maturation in females. During the spawning period (February to April), all spawners reached the upper continental slope (250 to 300 m) of southern Tohoku, where the experienced temperatures were 4 to 8°C; elevated temperature during this period may help to trigger final maturation. Our results showed that spawning fish on the shelf slope underwent fluctuating temperature regimes synchronized with the tidal cycle and provide a better understanding on how fish choose appropriate habitats and migratory routes.

PC-11

Accelerometry to quantify kinematic and energetic changes in flying pigeons after weight manipulations

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We manipulated the body mass of homing pigeons by the addition of lead weight around the crop, attached via a body harness. A miniature acceleration data logger was instrumented to the back of the bird, again via the harness, such that we could measure consequent changes in flight kinematics and energetic cost during flight. The loggers were custom-made at Bangor University. With a paired design we were able to uncover relatively subtle changes in energy costs within an inherently noisy environment (partly due to variable weather conditions from day to day). The loggers recorded data not only providing good evidence of the applicability of accelerometry as a measure of total energy costs during flight but also showing subtle but important energetic differences between experimental conditions; as expected energy expenditure during a flight was higher when the birds were more heavily weighted. An unanticipated finding was that wing beat frequencies are higher during take-off for conditions where flight energy expenditure is higher, however wing beat frequency is not higher during level flight. Currently, heart rate changes appear more sensitive to such experimental manipulations than do measures of body acceleration, however the method of acceleration data processing may be an important factor.

PC-12

Analysis of gliding pattern of humpback whales during the feeding season

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Many baleen whales undertake annual fasting and feeding cycles, which result in substantial changes in their lipid-store body condition, an important factor affecting fitness. As a measure of body condition, body density of some deep diving marine mammals has been estimated using a hydrodynamic gliding model. We examined swimming patterns of humpback whales (*Megaptera novaeangliae*) on a feeding ground, Gulf of St. Lawrence, Canada, to determine whether this approach can be applied to shallow diving baleen whales. Using tri-axis accelerometers equipped with speed sensors (3MPD3GT, Little Leonardo Co.), data were collected from 10 humpback whales during July and September in 2011 and 2012. Mean percent time gliding during descent and ascent phases varied greatly between individuals ranging from 6.0 to 36.5% (mean ± SD = 22.5 ± 9.8%) and 2.6 to 40.5% (20.3 ± 13.7%), respectively. One male was tagged twice at the beginning (July) and the end of the feeding season (September) in 2011. Percent time gliding during ascent phase increased in September. Additionally, body density estimated from the hydrodynamic gliding model decreased from 1035 in July to 1032 kg/m^3 in September. However, careful interpretation is required due to relatively large confidence intervals of the estimates.

PC-13

Are drugs for life, or just for Christmas? Accelerometers reveal long-term changes in Ecstasy (MDMA) users

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Ecstasy/MDMA is becoming an increasingly popular illicit drug so that understanding any long- term adverse effects on users is becoming more topical. Our study examined arm position and stability (tremor) in humans undertaking specific motion activities performed whilst wearing wrist-attached tri-axial accelerometers. Sixty subjects participated and were separated into three study groups: current drug users (CDU), former drug users (FDU) and non-drug users (NDU) [having not taken any drugs within at least the previous 18 months], based on their drug use history. There was a significant difference in both 'arm droop' (where participants were asked to hold their arms horizontally) and tremor (measured via vectorial dynamic acceleration) between NDU and the drug-using groups but no significant difference between CDU and FDU. These results point to long-term deficits in motor control or proprioceptive abilities in MDMA users indicative of long-term psychomotor deficits. Accelerometry appears to lend itself to examination of motion-related differences in drug users and we suggest further studies should be undertaken to examine the extent to which accelerometer-based tests can discriminate both the extent and nature of drug use.

PC-14

Accelerometery to determine the field metabolic rate of marine predators

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Accelerometers allow for formerly unattainable interpretation of fine-scale behaviors, addressing important questions regarding activity levels and energetic requirements. Ascertaining field metabolic rate (FMR) is essential for quantifying the impact of a species on its ecosystem and producing reliable bioenergetics models for fisheries management. Acceleration data has been collected for two free-living model species: *G. cirratum* (<90cm Total Length; n=4 dry season, n=3 wet season) and *N. brevirostris* (n=3 dry season, n=9 wet season). Preliminary analysis for *G. cirratum* data allowed us to characterize behaviours such as resting and steady swimming with fast-start swimming additionally identified for *N. brevirostris*. For *G. cirratum*, analysis showed that on average 87.70% ±1.52 (mean ±SE) and 86.73% ±3.02 of the time was spent resting during the dry and wet season respectively. *N. brevirostris* averaged 10.83% ± 1.97 and 15.74% ± 3.26 of their time resting during wet and dry seasons respectively; 89.04% ± 1.97 and 84.17% ± 3.26 steady swimming. This ongoing study is expected to demonstrate a revolutionary technique in determining FMR in marine predators. These field data will combine with results of ongoing respirometry experiments to correlate Overall Dynamic Body Acceleration and MO_2 to determine the FMR of these species.

PC-15

Measuring the energy cost of seasonal environmental challenges using heart rate transmitters in free-living songbirds

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Energy is the currency of life, where a surplus allows survival and reproduction and a long-standing debt leads to death, yet monitoring energy expenditures in free-living animals has been relatively limited by available technology. Radio transmitters that have been specially modified to detect heart rate, however, allow for real-time estimation of energy expense in free-living, behaving animals. Red crossbills (*Loxia curvirostra*) live at northern latitudes year-round and breed opportunistically throughout much of the year. They therefore offer a unique opportunity to examine the eco-physiology of different life cycle stages under drastically variable seasonal conditions. Here we present heart rate data and behavioral ecology of free-living, non-breeding red crossbills in the summer and winter. One striking result is a seasonal metabolic response to low pressure fronts in roosting birds that suggests a higher cost to storms in summer compared to winter. We discuss these data in the context of red crossbills' unique opportunistic and nomadic annual schedules and the highly seasonal conditions of our field site in Grand Teton National Park.

PD-01

Enabling animal acoustic telemetry data sharing and visualization

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The Integrated Ocean Observing System (IOOS) and the Ocean Tracking Network (OTN) both collect manage and use highly complex information assets, that is 'Big data' on a global scale. Here we describe efforts by these two communities to reconcile a community data standards data and demonstrate data services that could eventually enable animal acoustic telemetry detections to be routinely integrated with environmental data observations and models and data to be shared between projects. In this presentation we provide an overview of outcomes to date including: a proposed metadata convention for animal acoustic telemetry data exchange, sample data extracted from the OTN data warehouse using the proposed convention, example visualizations of the sample data using the NOAA - Environmental Research Division's Data Access Program (ERDDAP) and linking this data service to ocean models and applications.

PD-02

Why do satellite transmitters attached to emperor penguins stop transmitting?

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Investigation of early transmission failure of animal borne satellite transmitters will expose vital information about the reliability of the technology, and the risk of the application to the animal. We address the five most likely causes of satellite transmitter failure on 21 adult (10 male and 11 female) emperor penguins tagged near Cape Colbeck during late summer, 2013. They are: 1. Technical failure of the transmitter, 2. Instrument breakage, 3. Instrument loss because of attachment failure, 4. Predation, and 5. Icing of the salt water detection switch. The various clues to transmission blackout are discussed and we speculate about the most likely causes of transmitter loss. Understanding the likely reason behind blackout is important both scientifically and ethically in terms of accurate data interpretation and balancing the benefits of scientific gain with the costs of animal disturbance. Supported by NSF ANT 1043454.

PD-03

Bio-logging: a tool for integrating non-target top predators into an ecosystem approach to fisheries

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Bio-logging has revolutionized our understanding of animal behavior. The present challenge is to find methods to analyse the large datasets collected through bio-logging and to use these data for conservation. A current interest in conservation biology is to integrate the needs of non-target species into fisheries management. Non-target species can be marine top predators which are not harvested by fisheries, but which depend for food on commercially exploited fish species. In the Benguela upwelling, a community of endemic seabirds dependent on small pelagic fish is threatened, in part because of exploitative competition with an industrial purse seine fishery. The purpose of this study is to develop energetic models for the Benguela seabirds in space and time. Data-loggers were deployed on breeding adults in order to build time-energy budgets for the seabirds. Fish consumption at sea was calculated in a two dimensional spatial landscape for each species. Ultimately, the aim is to integrate these models into an ecosystem approach to small pelagic fisheries in South Africa that accounts for the needs of these seabirds. Methodological issues are discussed, in particular the question of estimating the needs of juveniles, immatures and non-breeding adults, for which bio-logging data is still scarce.

PD-04

An automated approach towards measuring time-activity budgets in colonial seabirds

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Seabird proxies have the potential to act as useful and cost-effective indicators of the state of the marine environment. Seabird time-activity budgets, in particular, reflect short-term changes in prey conditions. In this study an automated technique for long-term continuous recording of cape gannet, *Morus capensis*, time-activity budgets using VHF transmitters was tested. Our results demonstrate that radio-transmitters attached to leg-rings had no impact on adult foraging trip and nest attendance durations, breeding success or chick growth. Furthermore, frequencies of nest attendance and foraging trip durations estimated by the VHF logging system were no different to those estimated from hourly direct observations. Using Time-Depth Recorders we were able to assess the time that birds rested on the sea surface in relation to foraging trip duration. Trip duration during chick rearing was clearly an accurate proxy for foraging effort. Thus the VHF monitoring system provides a simple method of accurately assessing the time-activity budget of a colonially breeding seabird. This approach has wide-scale applicability for many colonially-breeding seabirds, and can provide sensitive, real-time indicators of prey abundance for fisheries management.

PD-05

Wireless Remote Animal Monitoring (WRAM) - A new international database e-infrastructure for management and sharing of telemetry sensor data from fish and wildlife

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New tracking technologies have become available to ecologists, allowing real-time data capture from an increasing number of species and animals. To realize the potential of the data, researchers must be able to share data and collaborate with the global research community. The Wireless Remote Animal Monitoring (WRAM) database system contains 93.4 million positions and other sensor data and is used by 31 user groups from 8 countries, tracking 15 species und 2149 individual animals. The infrastructure represents the Swedish national data node for real-time telemetry sensor data from fish and wildlife. It consists of 2 parts: 1) The WRAM Data Warehouse (WDW) is a high performance data warehouse for real-time 'big data' as position, acceleration, or heartbeat data from fish and wildlife. 2) The WRAM Data Broker is the single-sign-on web interface federating the WDW with other similar databases around the world as MoveBank, EuroDeer or CAnMove, to enable seamless querying and data sharing. Query results are also accessible through ODBC in a temporary database, enabling users to use local analysis tools for further analyses. Here, we give an overview over the different parts of the e-infrastructure, including automated data capture tools, database models, data sharing approaches, and visualization tools.

PD-06

Consequences of biotelemetry drag and the applicability of data to tag-free animals

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Biologging technologies have provided researchers with a suite of research tools to address questions about animal ecology, behavior, and physiology. For example, satellite-linked transmitters can provide information on aquatic organisms' vertical and horizontal movement patterns over time, as well as the amount of time spent in different locations and/or depths, thereby generating valuable insights into their habitat requirements. Attachment of instruments, however, affects the very data which is sought as a window into the animal's daily activities. Wind tunnel studies have revealed that biologgers attached dorsally to aquatic animals can increase drag by 1-10% for archival tags and up to 80-120% for animal-borne cameras or multiple tags seated in automatic detachment devices. Increases in drag cause a proportional increase in power output or a reduction of the animal's velocity. Both scenarios have ecological consequences for a diving aquatic organism and, as measurement affects performance, the applicability of the data to tag- free animals should be examined. Electronic tags are clearly valuable tools for ecological research, although considerations for the potential to affect the natural behaviors of the research subject must be made for both for the welfare of the animals and for the applicability of collected data to wild populations.

PD-07

Using High-frequency accelerometers to resolve fish activity and behavior in response to environmental variation

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Micro-accelerometer tags can be deployed on (aquatic) animals in the wild to provide high- resolution quantitative information on animal locomotion, activity and behaviour. One challenge of using the technology lies in the development of automated methods that relate accelerometer signals to a range of movement patterns, and their relation to variations in ambient environmental variables. First, we use data from high-frequency micro-accelerometer tags deployed on fish to demonstrate analytical techniques that can be used to extract information on behavior (feeding, escape) and activity (swimming) in the time and frequency domains with special consideration given to the nonlinear and non-stationary nature of the data. Second, we use data from accelerometers (50 Hz), deployed along with pop-up satellite tags (logging pressure, temperature and light) on Shortnose Sturgeon, to demonstrate how activity estimates provide insights into the tagged animal's immediate post-tagging response and subsequent activity response to variations in the local environment. Immediate post-tagging behaviour is highly variable among individuals. Subsequent activities patterns change systematically among individuals in relation to ambient light level, temperature structure and current velocity. Finally, we demonstrate that simple algorithms have the potential for incorporation into a microprocessor for on-board processing to log in situ event-scale information on animal activity.

PD-08

Innovative software for track analysis and behavior detection for wildlife from GPS together with other sensors

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Recent developments in GPS technology such as EGNOS and PPS mean that tracking data from GPS is much more accurate than a few years ago. In the EU-funded E-Track project, several academic and industrial partners worked together to take advantage of this new technology and create software (TrackLab) that both seamless integrates the track data with visualization and analysis software, as well as enabling import of other data streams such as 3D accelerometer data. This has enabled detection of specific behaviours and analysis of the behaviour of the animals in a number of species. The behavior detection and analysis will be illustrated with several short case studies including Canada geese (night-time behaviour, position of dominant birds in flock), sea eagle fledglings (analysis of first flights), zebras and wildebeast (movement patterns in relation to resource hotspots) and cows (grazing and habitat use).

PD-09

A new insight into biomechanics and energetics: Magnetometer and/or gyroscope?

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Fine-scale studies of kinematics and energetics of locomotion require estimates of the specific acceleration (SA) generated by animal movements. Accelerometers measure SA and orientation which can vary widely and continuously in aquatic animals. In steady swimming, overall body posture varies slowly in comparison with stroking rate and so this component can be removed from the accelerometer signal by high-pass filtering. However, this filter does not remove orientation changes at the stroking rate leading to biased SA estimates. This may be a particular problem for large animals as SA will decrease with body size while rotations may not. Gyroscopes measure differential-orientation independent of SA and so instantaneous-orientation predictions are possible. However, gyroscopes require relatively high power, have time-varying offsets and may generate noise. Magnetometers also provide information about orientation and are insensitive to SA but are typically low-sampled to derive heading making them unsuitable to track fast movements. Here, we show that high-sampling rate magnetometers can be used to derive orientation dynamics during steady swimming enabling, in combination with accelerometers, an estimate of SA. We use data from a tag with synchronously sampled triaxial magnetometers, accelerometers and gyroscopes on a free-swimming whale to compare the SA estimates derived from these sensors.

PD-10

Using Mahalanobis distance to summarise multi-sensor tag data

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Multi-sensor tags can yield long time-series of animal behaviour data, but the observed data-streams are often dependent on one another in complex ways. These rich datasets present analytical challenges: it can be difficult to summarise data effectively and efficiently while accounting for non-independence of observations, and even trickier to detect changes in behaviour in response to an experimental or environmental stimulus. While state-space models offer one sophisticated way to approach the problem, there are few simple, straightforward analytical methods to identify such change-points in complex multivariate datasets. We describe using Mahalanobis distances to reduce multivariate tag data to a univariate time-series while accounting for correlations between data streams, providing a summary of overall behaviour and facilitating change-point detection. Applying our methods to simulated cetacean tag data (including data derived from depth sensors, accelerometers, magnetometers and hydrophones), we illustrate their effectiveness in summarising data from species with different behaviour patterns and time-scales. The simulation study also compares the effectiveness of several Mahalanobis-distance-based metrics for detecting behaviour changes of different types and durations, providing guidance for the application of these methods to assess cetacean behavioural responses to disturbance.

PD-11

Development of a miniature event recorder with inertial sensors and its application to the feeding ecology of a reef predator, white-streaked grouper *Epinephelus ongus*

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Acceleration data-loggers are a useful tool to categorize behaviors in free-ranging animals, and recently applications have been done to identify burst behaviors. Recent studies suggested that it would be possible to identify burst behaviors in fish (feeding strikes and escape responses) if the sampling frequency was sufficiently high (>100 Hz). However, the recording duration is limited by battery and memory size, and becomes extremely short if the sampling frequency is high. Therefore, we developed a miniature event recorder (8 g in air) that consists of a 3-axis accelerometer (400 Hz) for threshold detection, and an additional accelerometer (1~1000 Hz) and a 3-axis gyroscope (1~1000 Hz) for data recording. This device remains in a dormant low- power mode until a burst motion is detected (i.e., an event), which will then initiate data recording for a short period of time. A total record duration of 4 days can be achieved by setting the sampling frequency to 500 Hz and recording period to 5 seconds, given 30 events per day. We will also present the results of a study that applied this device to identify feeding behaviors of the reef predator, white-streaked grouper *Epinephelus ongus*.

PD-12

Characterizing uncertainty in the bio-logged paths of sea mammals

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GPS coordinates are commonly logged at a relatively sparse and irregularly spaced set of points along the swimming paths of tagged sea mammals, leaving the locations in between unknown. The missing paths can be reconstructed using additional data (from accelerometers, gyroscopes, depth recorders, and magnetometers) and the dead reckoning algorithm (DRA)-but the DRA yields seriously biased path estimates. We have developed a new method called "data fusion" that greatly reduces the bias by combining the DRA and GPS data. Data fusion is based on the assumption that both data sets are trying to estimate the true path-and calculates well-calibrated error bands (i.e., 95% bands include about 95% of the GPS sites). We will use simulated data to illustrate the applicability of our method to a wide variety of species, and will demonstrate its applicability to accurately reconstruct the foraging paths of northern fur seals (with confidence limits). We will describe the R software we have written to implement it, and will discuss another discovery from our analysis-that the sampling frequency of the biologging tags can be substantially reduced without altering the reconstructed paths, pointing to the possibility of improved tag design and reduced power consumption.

PD-13

Integration of a miniaturized conductivity sensor into an animal-borne instrument

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Relating marine mammal movements and behavior to fine-scale ocean structure requires oceanographic information on similar spatial and temporal scales. The appropriate environmental information is usually not readily available especially in high latitude oceans. One way to solve this mismatch is to deploy oceanographic sensors on the animals themselves to obtain in-situ information without any spatial or temporal lag. In this study, we modified an existing miniature conductivity-temperature sensor and incorporate it into the proven design of a Satellite Relay Data Logger. Conductivity measurements are based on electrodes limiting the measured external field and are therefore not influenced by the attachment method. This methodology provides for ecosystem studies of a range of marine animals (e.g. large cetaceans, fish, birds) that are not currently feasible. Here, we show the performance of the instrument package collecting data to demonstrate it can obtain data of sufficient quality to investigate the links between animal behavior and local physical conditions.

PD-14

Broken-stick modelling as a tool to infer change-points in migratory animal tracks

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Interpreting animal behaviour from bio-logging surveys does not only rely on technological devices deployed but also on analytical tools subsequently employed. Here our goal was to link non-breeding to breeding ecology in a migratory species. In that aim we needed to isolate the staging versus migrating phases of the individuals at sea. We used a « broken-stick» modelling technique to detect change-point in trends within a series of data, and show its potential to segment noisy (light-based geolocation) animal tracking data into different migration phases. This technique relies on beta regression with 'betareg' package in R. Importantly, the model provides confidence intervals around each estimated date of transition, computed with likelihood ratio tests. We tracked alcid birds (rhinoceros auklets, n=33) during their non-breeding period over 3 successive years. Average dates when the birds reached the wintering areas were similar between years (~11 December), however winter staging interval varied conspicuously across years, and later average homing decision date impacted arrival timing ashore for breeding. This method may be of prime interest to bio-loggers aiming at understanding the links between successive movement phases, especially when lack of accuracy in the locations makes it difficult to manually identify turning-points in animal tracks.

PD-15

A smart-phone application to determine laying date and predict hatching time from eggs

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We developed a smart-phone application suitable for field studies which could help researchers working on marine birds to instantaneously determine laying date and predict hatching time of eggs from their study birds. Eggs are placed in a specifically designed box, containing a sensitive balance and are photographed using a common smart-phone. After taking the picture the application immediately returns the density of the egg based on its volume calculated from the picture and the mass obtained by the balance. Since density of the eggs decreases with progressing incubation, based on this relationship the application estimates at which stage of the incubation is the egg. The application was developed, calibrated, and tested on Scopoli's shearwaters but calibration on other species is also possible for other single-egg laying species. Other uses of this application are also discussed.

PD-16

Flight and foraging behaviour: the albatross around the neck of geo-location

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Light-level geo-location (GLS) devices are commonly used to track seabirds due to their long battery life, small size and low cost. However, compared to alternative techniques (ARGOS or GPS) this approach has reduced location accuracy, with precision for albatross previously calculated with a mean error of 186±114km. Here, we present a new method for handling two common problems that influence location accuracy; light-interference and the effect of foraging behaviour. Light-interference is caused by shading of the tags' light sensor. As location is derived from the twilight light curve, any shading during this period has ramifications for the accuracy of the resulting estimated locations. Additionally, the quantity of foraging activity can influence the potential distance an individual is likely travel between two twilight segments, so accounting for this will further refine location estimates. We investigate these problems across several species, which display differing at-sea behaviours utilising a summary of Macquarie Island albatross tracking data (1999-2010, n=10), highlighting important Southern Ocean foraging areas. Refining and improving methodology for the analysis of GLS derived locations will result in broader application of this technology and finer scale investigation into the oceanographic features of key seabird foraging areas to aid prediction of biological 'hotspots'.

PD-17

Seasonal changes in activity of free-ranging piscivorous Eurasian perch: a long-term high-resolution biotelemetry study

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Recent advances in biotelemetry technology allow us to track animal behaviour with unprecedented details in the wild. Using a state-of art 3D acoustic telemetry system, we tracked wild Eurasian perch (*Perca fluviatilis*) in a natural lake over 12 months to investigate seasonal changes in their behaviour and individual differences in movement patterns. To that end, we installed 20 acoustic hydrophones in a natural lake (Kleiner Döllnsee, 25 ha, Germany), and recorded the positions of 16 adult piscivorous female perch at high rates (up to 9-s intervals) from September 2009 to September 2010. From the position data, we investigated the seasonal trends in their behaviour over a year, and explored in relation to the environmental variables. To assess fine-scale movement patterns, we fitted a two-state hidden Markov model (active and non-active) on individual movements, with time as a covariate. We found that individuals exhibit marked differences in the movement patterns, as well as the transition probability between the active and non-active states over time. This study is the first application of hidden Markov models applied to long-term high-resolution biotelemetry data to infer the seasonal changes in behavioural patterns of wild animals.

PD-18

How buoyancy change is reflected to instantaneous angular velocity in diving seabirds?

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The posture of diving seabirds fluctuates simultaneously with the flipper beating because of the moment resulting from the counteracting force to the beating. Diving seabirds, as breath-hold divers, are obligate to follow the changes in buoyancy with the depth. Moreover, the counteracting force by flipper beating will be large when the buoyancy is large, and the vice versa. Hence, the moment caused by the flipper beating will be different with the buoyancy and depth change. Because unnecessary rotation should lead to the energy loss, it is important to understand the strategy for regulating the rotation. Here, we have attached a gyroscope data logger to the back of free-ranging three species of diving seabirds (*Pygoscelis adeliae, Cerorhinca monocerata,* and *Uria lomvia*), and quantified instantaneous angular velocity (200 Hz) acting on their body during the descent to the bottom. It was found that the fluctuations in the angular velocity were negatively correlated with depth as the birds descend, in all three species. Fluctuations in angular velocity at certain current depth (e.g. 10 m) were positively correlated with maximum dive depth, suggesting buoyancy regulation in relation to target depth.

PD-19

Integrating acoustic sensors and radio telemetry to infer intra- and inter-specific relationships in neotropical ground-dwelling birds

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Direct interactions between individuals play a critical role in how animal populations and ecological communities are structured. Yet little is known about such interactions and their consequences in natural environments for many animal species. Birds sing as they move through their territories to signal to rivals that their territory is occupied. Using acoustic sensors we can record and localise acoustically communicating animals and determine spatial and temporal activity and interactions between individuals. Radio telemetry on the other hand, can aid in understanding spatial and temporal activity during times when animals are not vocally active. We used song recordings, including from acoustic sensors, and radio telemetry to track individuals and map territory occupancy of Mexican antthrush (*Formicarius moniliger*), a monomorphic species where female song appears indistinguishable from male song. We used playback experiments and telemetry to study the function of song in intra- and inter-sexual interactions and present results from those experiments. Combining acoustic and spatial sensors can provide new insights into how individuals in a population interact. Implementing acoustic sensors with peer-to-peer proximity loggers will allow us to examine spatial and temporal interactions within but also among species in a community of vocally active, ground-dwelling rainforest birds.

PD-20

Tracking the fine-scale real-time movements of smooth-hound sharks in a shallow water estuary

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A new tracking system has been built to track the exact paths sharks take within a shallow water estuary. Each surface-float houses a GPS receiver, radio module, and microcontroller, and is towed around Pauatahanui Inlet by smooth-hound sharks (*Mustelus lenticulatus*). The floating tags are mobile end points within a mesh network of routers that pass GPS sequences sent with appended tag number and battery voltage from the tags through the routers to a coordinating computer on land. The coordinating computer sorts the positional data by shark name, builds KML files, sends emails when tag battery voltage gets low, or when a shark starts to leave the estuary, giving the scientist time to swap or remove the tags. This presentation will present and describe the first of these fine-scale tracks. Preliminary results show tracking scales as small as several metres enabling studies of fine scale movements and behaviours.

PD-21

Using long-term tracking data to understand social dynamics and predict human-crocodile conflict

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The estuarine crocodile *Crocodylus porosus* is an apex predator within freshwater and coastal ecosystems throughout southeast Asia and Australasia. In areas where crocodiles come into contact with people there is often conflict, and management strategies are in place to control this potentially dangerous species. Effective management requires an in-depth understanding of crocodile ecology; particularly the drivers for movement, the spatio-temporal structuring of populations and patterns of usage in areas regularly frequented by people. Biotelemetry studies have shown previously that crocodiles vary greatly in their usage of space, however these studies have been greatly restricted by small sample sizes. Using subcutaneous acoustic transmitters (n = 114 crocodiles) and an array of fixed acoustic receivers (n = 45 receivers), we examined how patterns in crocodile space-usage varied over a 5-year period. Our results showed that crocodiles demonstrate a high degree of site fidelity, with home range and travel distance predicted by life history characteristics. Space sharing between crocodiles varied according to the stage of the breeding season; indicating male-male competition and mate attraction. Finally crocodile usage of a popular swimming area exhibited strong parallels with historical incidences of crocodile attacks. These findings illustrate the importance of long-term tracking studies to inform species management.

PD-22

Assessing the accuracy of animal-borne CTD tags under laboratory and in-situ conditions

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Conductivity Temperature and Depth – Satellite Relay Data Loggers (CTD-SRDL, manufactured by SMRU) are deployed on marine vertebrates with the assumption that resulting oceanographic data are comparable to those collected by ship-based methods. We tested this assumption by comparing temperature and conductivity offsets produced by the manufacturer calibration under both laboratory and in-situ conditions. Furthermore, we tested the impact of tag attachment and deployment on sensor accuracy. In the laboratory, tags performed within the stated accuracy of ± 0.005°C for all temperatures except those below 0°C, which is outside the manufacturer calibration range and should be a concern when attaching SRDL tags to animals in waters < 0°C. Conductivity accuracy was higher than the manufacturer's stated ± 0.01 mS/cm under both laboratory and in-situ conditions. Once tags were attached to a seal, there was a large offset in both temperature and conductively which is likely associated with sensor delay and disruption of the field surrounding the conductivity sensor. Finally, we recalibrated the instruments after a 9-10 month deployment, improving the mean absolute offset from 0.017 to 0.002°C for temperature and from 0.091 to 0.023 mS/cm for conductivity. Therefore, we recommend recalibration after recovery and before re-deployment.

PD-23

The Whale Lander and SpicyTalk – A solution for recording high-resolution behavior from cetaceans for days to weeks with a recoverable, archival transmitting tag

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Numerous studies have demonstrated the value of tags that record high-resolution 3D movements and acoustics of cetaceans. Suction cup attachment, however, typically limits recordings to < 1 day. We developed the "Whale Lander" to determine if small darts can hold large packages on cetaceans for longer periods (> 1 day to 2 weeks). The Whale Lander (tea-cup shaped, 8.9 cm diam., 6.5 cm tall) included an Argos transmitter, FastlocGPS receiver, 3-axis accelerometer and magnetometer, light-level, temperature, and depth sensors. Three barbed titanium darts (4 mm diam.) were designed to penetrate 6.7 cm for attachment. We deployed Whale Landers onto five short-finned pilot whales off Hawaii, implanting LIMPET-style darts into blubber below the dorsal fin. Tags were eventually shed by whales, 5-14 days after attachment. To recover the floating tag, approximate location was obtained from the most recent Argos message. Within 4-6 km, Argos transmissions of GPS snapshots were intercepted with an on-board Argos receiver connected to a computer running SpicyTalk (Wildlife Computers), decoding and then solving for position (within 50m) using ephemeris/almanac data from a GPS receiver, facilitating successful recovery of all five tags. This test provided valuable behavior data and stimulated the next step of including a triggerable remote-release.

PD-24

Combining opportunistic re-encounter data with known fate mortality data in vital rate telemetry: linking implanted satellite transmitters to stationary receivers

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First generation implantable Life History Transmitters (LHX tags, Wildlife Computers) were developed to transmit post-mortem data on dates, locations and causes of mortality in Steller sea lions. Second generation LHX tags additionally will provide temperature-based data on birth events in female hosts, to provide age at primiparity and lifetime birth event counts. However, UHF transmitters cannot uplink to satellites from within the host body and thus data is only retrieved after LHX tags are liberated from the deceased host. Such end-of-life data recovery constrains experimental designs. A promising solution may be periodic short-range transmissions from implanted tags to shore-based automated receiving stations. For host species with high terrestrial site fidelity such as Steller sea lions this may allow telemetric detection of parturition on an annual basis irrespective of the eventual life span of individuals, reducing a potential sampling bias. Furthermore, opportunistic tag links to receiving stations would allow combining and comparing known fate with mark-re-encounter approaches for the estimation of survival rates.

PD-25

Efficient abstracting of dive profiles using a broken-stick model

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It is often necessary to compress data from animal-borne sensors for storage or transmission. Conductivity-Temperature-Depth Satellite Relay Data Loggers (CTD-SRDLs) sample time and depth at high resolution before abstracting the 1-dimensional dive trajectory (dive profile) using a broken-stick model (BSM). This method can efficiently summarise a curvilinear trajectory, using a piecewise-linear shape, but at low iteration numbers, may mask important biological features. We present a method for measuring the relative uncertainty associated with abstracted profiles, by calculating a confidence zone and a goodness-of-fit index (dive zone index, DZI). We validate our results with a case study using dives from elephant seals (*Mirounga* spp.). We found that the proportion of the high-resolution time-depth samples that is represented by the number of BSM points in the abstracted profile, increased by 53.5% (53.2-53.8, 95% CI) for each point. There was a strong correlation between the DZI and the residual sum of squares (RSS) for the difference between the true and abstracted profiles, and the DZI varied systematically between dive types. Our results suggest that the information remaining after abstraction, is sufficient to infer the relative goodness-of-fit of the BSM profile, and that the DZI can be used as a proxy for the RSS.

PD-26

Contacts in the wild: innovations in biologging and the study of interactions among animals

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Interactions between individual animals is a broad concept covering a range of ecological interactions within communities and ecosystems, e.g. host-pathogen interaction and disease transmission, parent-offspring relation, mating, social behaviour and predator-prey dynamics. Recent innovation in biologging has allowed to directly measure, for the first time, this component of animal ecology, by detecting 'contacts' between animals and estimating the distance among them. The technology of use is referred to as 'proximity detection devices' or 'wireless sensor networks', and in essence is based on bi-directional radio transmission among 'units' (or nodes). However, the application of radio transmission to the detection of contacts is not straightforward, since it is influenced by a number of external (i.e., environmental) and internal (i.e., device-based) factors. Here we present an innovative approach aimed to calibrate contact-rates versus distance between nodes. We show that there is a basic difference between the results obtained under strictly controlled conditions, and in the field (i.e., on animals). Distance cannot be precisely measured as it strongly depends on transmission power. Precision and accuracy depend on distance between nodes, and transmission power. Preliminary resolution assessment and calibration of the technology are necessary for a successful use of contact detection devices in ecological research.

PD-27

Robust algorithms for underwater tracking of pelagic fishes

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Underwater tracking of pelagic fishes is classically performed using light level, water temperature and depth measurements obtained from archival or pop-up tags. However, errors in the so-estimated positions remain large (typically > 100 km) and most extant positioning algorithms stop functioning in the rather common situation where part of the measurements are missing or problematic, in particular when the fish remains at depths where light is too dim to detect sunrise/ sunset events. We present two new approaches that provide robust estimates of underwater trajectories: (1) the Grid filter, a Bayesian estimator that provides the animals' trajectory under the form of time series of the spatial distribution of the probability of presence of the tracked individual, and (2) the Viterbi algorithm that determines the trajectory maximizing the overall likelihood of the complete series of (light, temperature, depth) observations. The performances of the two approaches are evaluated using unique datasets obtained from elephant seals carrying tags providing Argos or GPS fixes used as ground truth, and (light, temperature, depth) measurements allowing independent underwater positioning. The robustness of the two methods is demonstrated by artificially degrading the used data sets and measuring the resulting degradation of the estimated underwater positions.

PD-28

Evaluating estimates of space-use determined using GPS and passive acoustic telemetry

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Underwater passive acoustic telemetry is becoming the preferred technology for investigating animal movement in aquatic systems, however much of the current statistical tools for telemetry data were established from global positioning system (GPS) based data. To understand the appropriateness of these tools for use in passive acoustic studies, acoustic transmitters and GPS- based data-loggers were deployed simultaneously on 14 free-ranging estuarine crocodiles *Crocodylus porosus*. The large body-size of estuarine crocodiles and the frequency by which these animals spend at the water-air interface permitted the simultaneous collection of GPS and acoustic data over a 90-day period. Animal location was determined continuously by acoustic telemetry through the position of static underwater receivers (n = 21, deployed over 47 km), whereas GPS-based data-loggers recorded individual location twice daily. Despite acoustic telemetry generating significantly lower estimates of travel distance and home range, the same relationships between space-use and body size were found regardless of the telemetry technology used. We offer new guidelines on how to improve the accuracy and precision of estimates of space use obtained using passive acoustic telemetry and discuss the limitations of synthesising data gathered using different animal tracking technologies.

PD-29

iSAT: tracking marine life from the surface

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New discoveries in the field of animal ecology, especially in the marine realm, are driven by the development of new technologies. Various fields of marine science are experiencing an increased presence of autonomous systems in their operations, and bio-telemetry is not the exception. In this paper, the Integrated Satellite and Acoustic Telemetry system is presented. iSAT is an innovative device that combines the advantages of radio frequency wireless communications and global positioning with the underwater tracking capabilities of sonar systems. From a vessel at the surface, where radio channels are available to transmit data and/or receive commands, an ultra-short-baseline array of transceivers detects the direction of an acoustically tagged animal. iSAT is benefited from our experience gained using current satellite and acoustic technology. Its tracking system can be adapted to detect different communication schemes used by commercial marine bio-logging companies. iSAT is designed to study the movements of marine megafauna, and to improve the coarse resolution of the information provided by state-of-the-art global-scale tracking devices.

PD-30

Animal-borne camera loggers: Investigation for use in gentoo penguin foraging ecology

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Previously, direct observations, through the use of animal-borne camera loggers, have been limited to larger animals. This study tested the effectiveness of miniaturised video cameras, for studying gentoo penguin (*Pygoscelis papua*) foraging ecology at the Falkland Islands. Specifically, this study trialled cameras for potential use in future studies, at sites with concurrent dietary investigations using stomach content analysis. We investigated potential duration of cameras, image quality and the possibility of (i) detecting prey capture events (ii) identifying intra/interspecific interactions (iii) identifying potential prey. Cameras were deployed at two sites across the Falklands (Cow Bay, n=6; Bull Roads, n=2). Cameras were attached to the back of the bird anteriorly to the ridge of the thoracic vertebrae. Cameras recorded for 30mins to 3hours. Image quality was clear, and prey capture events, intra/interspecific interactions and potential prey items were identified. These results indicate that, video cameras for the use of studying gentoo penguin foraging ecology are a viable option. Factors such as light intensity and ocean turbidity may hinder the use of cameras; however, with improvements in technology these concerns may be overcome. It is clear that camera deployments could lead to a better understanding of the trophic ecology and behaviour of penguins.

PD-31

Parametric approach to the telemetry tags design for marine animals

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Animal telemetry has good potential in monitoring of marine ecosystems, prediction of global climate changes, and assessment of anthropogenic pressure on sea environment. Telemetry tags development remains a challenge, though, due to a number of factors that must be taken into account. Parametric approach in tag design process utilizes a formal procedure of optimization of tag performance to the set of variables having hierarchical structure. Primary variables present parameters and constraints associated with taxonomy of a target species. It includes characteristic size, swimming speed, surface properties, etc. Secondary variables are associated with the goals of specific telemetry study including deployment time and instrumentation package. Tag design process starts from development of a basic prototype providing best fit of the frontal area, size, and weight of a tag to the biology of a target species. The goal of that stage is to minimize tag impact on swimming performance and energy budget of a tagged animal. The next stage anticipates optimization of a tag prototype to the appropriate set of electronic components for specific telemetry study. The benefit of proposed approach is that once developed species-specific tag prototype can be adapted to the specific goals with reduced time and cost of development.

PD-32

Improved discoverability and usability of bio-logging data collected by the Australian Integrated Marine Observing System

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The Integrated Marine Observing System (IMOS, www.imos.org.au) is a research infrastructure project to monitor the open oceans and coastal waters around Australia and off Antarctica. To quantify the impacts of various ocean processes (e.g. upwellings, ENSO, climate change) on marine ecosystems, IMOS continuously deploys a range of acoustic, GLS and satellite tags on fish, marine mammals and seabirds. Those bio-logging data are subsequently made freely and openly available through the IMOS Ocean Portal (http://imos.aodn.org.au/). To facilitate data accessibility and usability by marine ecologists and oceanographers, IMOS has developed a new open source information infrastructure that allows users to search, subset, and download aggregated data in three simple steps. A test case will illustrate the most interesting features of this new web interface and provide an opportunity to demonstrate recent developments in a free and interactive 3D data visualisation technique.

PD-33

Sperm whale response to tag boat presence: biologically informed hidden state models quantify lost feeding opportunities

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To assess the effects of tagging operations on the functional behaviour of sperm whales, we developed a hidden state-switching model to incorporate biological knowledge and multivariate biologging data. Estimated behavioural states of 12 sperm whales off Norway included foraging, recovery and resting states, as well as a less defined 'silent active' state. There was high agreement between state estimates and expert classifications of behaviour. Sperm whales spent less time at surface (-34%) and more time in the active non-foraging state (+60%) in the presence of tag boat than during post-tagging baseline period. We did not find changes in foraging success from buzz rate or locomotion effort from ODBA given behavioural state. Candidate time-decaying models were not supported, indicating a short-term tagging effect that ended as soon as the tag-boat left the whales. Changes in time budgets during tagging operations suggest costs in terms of lost feeding opportunities and recovery time at surface, and that behavioural records can be impacted by the operation required to attach biologging devices. Our functional state approach proves effective to quantify disturbance in terms of time and energy allocation and is based upon general principles that can be applied to other species and biologging applications.

PD-34

The effects of radio transmitter attachment on the behaviour and energetics of captive long-tailed ducks (*Clangula hyemalis*) during winter

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The attachment of external devices can have negative consequences for the health and fitness of subjects but these effects are often overlooked. In preparation for a field study with small sea ducks, we investigated the effects of two types of radio-transmitter attachments on the activity budgets and energy metabolism of captive long-tailed ducks (*Clangula hyemalis*) during winter. We conducted behavioural observations and concomitantly measured oxygen consumption rates while ducks rested on water. After recording baseline values, three groups of five birds were either sham handled (Control) or had transmitters attached with subcutaneous anchors ('Prongs') or Tesa tape/sutures. Following transmitter attachment, we observed significant changes in activity budgets of Prong and Tesa birds with both groups reducing locomotor activity (-58%/-54%) and time spent in water (-48%/-35%), but increasing maintenance behaviour (+98%/+151%). While Tesa bird behaviour eventually returned to normal, Prong bird behaviour did not. Energy metabolism of ducks resting on water tended to increase in Prong/Tesa birds after transmitter attachment, albeit not significantly. The behavioural changes associated with transmitter attachment in our captive ducks and the energetic consequences could significantly alter the energy budget of this small sea duck in the wild, with potential consequences for survival.

PD-35

Unravelling the secrets of tuna locomotion

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The migratory capacity of tunas is amongst the most impressive of all swimming animals with bluefin tunas regularly crossing ocean basins. As a result, tunas are often considered to be among the most efficient swimmers of our oceans. At the Tuna Research and Conservation Center we have studied the numerous specialisations related to efficient swimming in this interesting group of fishes. This talk will outline the strides we have made in understanding the biomechanics of tuna swimming and how biologging technologies have played an integral role in our improved models for thunniform locomotion. We will present data on the swimming behaviour, biomechanics and hydrodynamics of juvenile pacific bluefin tuna and highlight our recent discoveries of how tuna swim.

PD-36

Using weather radars to monitor continent-wide aerial patterns of animal movement

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Billions of insects, birds and bats use the aerosphere for migration, dispersive movements or foraging. This enormous transport of biomass plays a key role in ecological connectivity, yet monitoring these movements is technically very challenging. Individual tracking devices have been increasingly used over the last decade but these are currently only suitable for relatively large organisms and their associated costs limits monitoring to a very small section of the aerial animal community. Radars provide a tool for investigating and quantifying movement patterns over a wide range of organisms (birds, bats and insects), across communities and populations. However, research efforts in this field have often been local and uncoordinated. A network of operational weather radars is continuously recording atmospheric conditions all over Europe and ENRAM - The European Network for the Radar surveillance of Animal Movement, has been recently established in order to explore the potential for coordinated, large scale studies of the aerial movements of animals. Here, we present a case study of mass migration of birds tracked studied using several national weather radars in the Netherlands and Belgium simultaneously. We discuss the opportunities that a large sensor network can provide for movement ecology research at the continental scale.

PD-37

Carrying a tag. What a drag

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More often than not it is expected that animal-borne sensors do not cause departure from normal behavior or that negative effects are not important. If animals do not operate normally there are implicit implications for data interpretation as well as potential issues regarding animal welfare. We aim to quantify increases in drag on juvenile grey seals resulting from carrying a GSM Phone tag and relate this to a relative change in energetic cost or to behavioural adaptations animals employ to overcome increased drag. Over an 8-week period six captive juvenile grey seals (3♂ & 3♀) were exposed to an experimental feeding setup with access to ambient air separated from a food delivery system by a 120m return swim. Air access was isolated to a breathing chamber connected to an open-flow respirometry system allowing dive-by-dive analysis of swim energetics. Along with energetic cost of swimming, swim speed and swim kinematics were compared for each animal with and without the presence of a neck mounted GSM phone tag.

PD-38

Balancing under the high wire; a study into transmitter antenna effects on a waterbird species, the western grebe

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External tracking devices fitted to waterbirds, whether they dive deep or only remain near the surface, can greatly affect them with the most critical effect being an increase in drag. While implanted tags have been considered to be a good alternative to reduce the underwater drag, a recent tracking study performed on western grebes (*Aechmophorus occidentalis*) using implantable satellite tags suggested the contrary. Within the first year, satellite contact was lost with 44-56% of the birds which was assumed to be due to bird mortality or device failure. Considering the bird mortality hypothesis, there are many ways how implantable tags could have compromised the birds and potentially caused their death and that includes increased drag. Even with implantable tags, we suspect that the drag associated with the only external feature, the antenna, remains substantial and can still greatly impact the bird. In this study, we assessed how antenna through its length, diameter, angle, and flexibility can influence the drag experienced by a bird in underwater as well as in air conditions. In addition to drag, we have looked at another less obvious aspect of how antenna can affect implanted birds which is through potential vibrations.

PD-39

Informal networks and stakeholder participation add value to European sea bass population studies

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Over the course of the past two decades, the mass release of archival tags in UK and adjacent waters has generated sufficient individual data records to provide insights into population level processes in several species of commercial and recreational interest. The success of tagging programmes in generating population descriptors depends on a number of factors, which may be species-specific, e.g. species resilience to tagging, or which may be fishery specific, e.g. relating to the fishing effort or the willingness of fishers to return tags. The European sea bass, *Dicentrarchus labrax* is a high-value, high-profile species targeted both by commercial fishers and recreational anglers, particularly in the UK and France. Adult bass migrate annually to offshore waters where international fleets operate, but tend to return to the same coastal location where persistent localized exploitation could potentially result in stock depletion. Expansion of bass populations (and fisheries) during the 1990s followed a sequence of strong year classes, and increasing sea temperatures. Here we describe how informal collaboration between targeted national research programmes and engaged stakeholders is adding value to studies of bass population dynamics through focused archival tagging, stakeholder-led mark-recapture experiments and the collection of natural tags for supplementary geospatial analyses.

PD-40

Reducing impact: design features to minimize hydrodynamic forces for suction cup tags on swimming animals

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Bio-logging tags are an important tool for the study of marine mammals, but superficial tags inevitably increase hydrodynamic loading. For tags on fast-swimming animals substantial forces can be generated potentially affecting behavior and energetics, or promoting early tag removal. Streamlined forms have been used to reduce loading, but these designs can accelerate flow over the top of the tag. This asymmetric flow results in large lift forces (normal to the animal) that become the dominant force component at high speeds. In order to reduce lift and minimize total hydrodynamic loading this work presents a comparison of design features that reduce flow speed differences above and below the housing (e.g., channels) and that redirect the flow to counter lift (e.g., fins). Hydrodynamic loading of four tag designs that use a combination of flow control elements, arrangements of a fin and channel together with a hydrodynamic body, were compared using computational fluid dynamics (CFD). The design with both fin and channel performed best, eliminating all lift force and generating up to 80 N of downward force in simulated 10 m/s aligned flow.

PD-41

Development of a head-mounted satellite-linked PIT tag reader for seals and sea lions

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Biologists speculate that an increased population of harbor seals feeding on salmon smolts may have caused the observed decline in Chinook and Coho abundance in the Salish Sea. Passive Integrated Transponders (PIT tags) are often implanted in juvenile salmonids and used for population tracking, however they also provide a unique opportunity to assess the level of smolt predation by seals. We have designed and built a prototype that contains electronics capable of identifying and logging PIT tags ingested by seals, and transmitting this information to a satellite. This prototype is battery powered and designed to be suitable for head-mounting to a harbor seal. Phase I feasibility testing aimed to determine the capabilities of the prototype on captive harbor seals. The information gained will be used to determine the necessary RFID sampling rate/power consumption and guide the development of a field-ready instrument. The final prototype will be capable of logging the time and identification numbers of seal-ingested PIT tags, with the ability to transmit that information via the AROGS satellite network. From those data, researchers will be able to accurately estimate smolt predation rates, and identify which individual stock is impacted by seal predation based on ingested PIT tag IDs.

PD-42

Merging expert knowledge and machine learning: towards an interactive virtual laboratory for classifying bio-logging data

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Bio-logging technology enables us to monitor locations, behaviour, and physiology of animals throughout their daily routines and annual cycles. Animal ecology experiences an explosive increase of data for a wide range of species and research questions. The interpretation and classification of these new types and large volumes of data is essential but not trivial. Especially the comprehension of accelerometer data is complex and certainly not intuitive. We developed an interactive Virtual Laboratory to facilitate ecologists, with no special training in artificial intelligence or statistical classification, to develop and apply their classification models that translate bio-logging data into behavioural classes. It allows users to import, annotate and merge their data and to visualize and evaluate the characteristics and statistics of data and classifications. The Virtual Laboratory is built around the Weka data mining software and it also contains a library of sample data to inspire and train the researcher. Results show the value of an interactive environment that generates the feedback to the researcher needed to improve the model structure and to obtain reproducible classifications. We expect that high quality interpretation and classification of data will contribute to a further increase of the applicability of bio-logging data for answering ecological questions.

PD-43

Toward a U.S. Animal Telemetry Network for U.S. oceans, coasts, and great lakes

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Aquatic animal telemetry and tracking is the science of elucidating the behavior of animals as they move through the world's oceans and lakes. Telemetry and tracking devices yield detailed data regarding the physical environment through which the animals are moving. Sometimes this can be done in near-real time - true telemetry - and in other tags the data are stored for later acquisition. Animal species tagged range from 20-gram salmon smolts to 150-ton whales. Detailed observations of animal movements and their aquatic environment, have significantly improved our understanding of ecosystem function and the evolutionary constraints of species. These data are critical for preventing extinctions, preserving biodiversity and implementing ecosystem-based management of living resources. Animal-borne sensors have come of age and deliver high-resolution physical oceanographic data at a relatively low cost. A U.S. national Animal Telemetry Network (ATN) through the U.S. Integrated Ocean Observing System (U.S. IOOS) will implement a range of operational telemetry technologies that enable monitoring of a host of aquatic life over multiple temporal and spatial scales. This work focuses on how to integrate an ATN into the U.S. IOOS program and what benefits this will have for U.S. oceans, coasts and great lakes.

PD-44

Using tidal and vertical datum corrections when comparing tag dive depths to local bathymetric data (or how we stopped our seals from burrowing)

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Tags can infer current depth below the surface of the water by measuring pressure. Bathymetric depths are often relative to Chart Datum (i.e. minimum water depth). The effects of these different vertical frames of reference and the tidal cycle can combine to cause significant discrepancies the in apparent distance of tags above the sea floor. Around Scotland many tidal ranges exceed 5m and bathymetric depths can be more than 2.5m shallower when given relative to Chart Datum instead of mean sea level (MSL). Tag depths areas shallower than 50m can thus sometimes appear to be more than 10% deeper than corresponding bathymetric values. In areas for which a tidal predication model is available and any differences between the bathymetry datum and MSL known the depths from tags can be adjusted to be relative to the sea floor instead of the surface. The steps involved will be shown using SMRU GPS Phone tag data from seals around Scotland, the POLPRED Hydrodynamic model and SeaZone TruDepth gridded bathymetry. The original apparent discrepancies and the effects of the adjustment are illustrated using MamVisAD 3D and Time/Depth views which demonstrate how such an approach can increase confidence in identifying benthic foraging from such datasets.

PD-45

The next generation of multi-sensor tags: improving attachments of non-invasive tags with bio-compatible glues and microstructure

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From Kooyman's 1963 wind-up kitchen timer TDR, multi-sensor tags have evolved significantly. These advancements have been driven by improved sensor and electronics technology and resulted in highly integrated systems. These tags will continue to improve and promising work has begun in three key areas: i) new sensors; ii) expanding uses of existing sensors; and iii) increasing attachment duration and reliability. Attachment duration has been limiting for cetaceans, because suction cups do not reliably remain attached for >24 hrs. Longer and more reliable attachments would increase the number and types of experiments available to researchers. We have pursued three methods to improve attachments of non-invasive tags to cetaceans: i) improve tag hydrodynamics; ii) incorporate bio-compatible glues; and iii) include micro structuring on some tag components to utilize hydrostatic forces to enhance adhesion; we present data on the latter two. To dislodge the tag by drag force required ca. 692 N using glues compared to only ca. 192 N with suction cups alone. To dislodge the tag with a lift force, the addition of glue increased adhesion by >20%. These cyanoacrylate glues perform well in an aqueous environment, making them ideal for improving suction cup attachments.

PD-46

Can weighbridges be used to determine breeding dates remotely?

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The nirvana in bio-logging is about detecting animal movements without changing its natural behaviour. While studying individual animals carrying external devices has dramatically increased our knowledge of their ecosystems, the use of external device can handicap their natural behaviour while it is hard to apply at population level, requiring larger sample sizes usually at prohibitive costs. Alternatively, radio-frequency identification (RFID) offers increasing opportunities to monitor a variety of terrestrial and marine species that must return to a central place location; such as seals, seabirds, some fish and even bees. Detections by fixed automated systems (e.g. antennas and weighbridges) provide huge datasets often used to estimate survival, dispersion or to understand foraging patterns. Here, we propose to use these automated detections to determine breeding chronology of little penguins. Based on a 12-year study and more than 500,000-detection dataset, we will calibrate and cross-validate different models to select best variables (e.g. ins and outs of the colony, departure times) and define most appropriated method (hierarchical classifications or sequence hidden Markov models) to detect transitions between breeding stages. Potentially, this relative low cost system could be used in several remote colonies simultaneously, with robust sample sizes, allowing broader studies comparing multiple populations.

PD-47

Improving Argos Doppler location using multiple-model smoothing

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Argos is a dedicated system for geo-localization and data collection of platform terminal transmitters (PTTs). The system operates in the fields of oceanography, wildlife monitoring and maritime safety. Argos exploits a constellation of polar-orbiting satellites recording the messages transmitted by the PTTs. The localization processing takes advantage of the Doppler effect on the carrier frequency of messages received by the satellites to estimate platform trajectories. In 2011, the real-time processing algorithm, relying on a Least Square adjustment, was replaced by a multiple-model Kalman filter. This last approach significantly increased the location accuracy for platforms located with a low number of messages. The present paper shows it is still possible to further enhance the location performances for such cases with a deferred-time algorithm relying on a multiple-model smoother instead of a filter. The location accuracy of the smoother is evaluated with a data set including over 200 platforms equipped by an Argos transmitter and a GPS receiver used as ground truth. This new processing targets Argos applications, such as wildlife tracking, where the trajectory analysis is done after the emitting period of the PTTs.

PD-48

Development and field testing a satellite-linked fluorometer for marine mammals

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Understanding the responses of marine mammals to spatial and temporal variability of primary productivity is fundamental for their conservation and for predicting how they will be affected by future climate change. Despite recent advances in biotelemetry, fluorometers have only recently been incorporated into transmitting systems. The purpose of this project was to incorporate a miniature fluorometer into a satellite-linked transmitter to provide measures of in situ phytoplankton fluorescence, which were used to calculate chlorophyll-a (chl-a), a proxy for primary productivity. After evaluating the suitability of commercially available fluorometers, the ECO PuckTM (WET Labs, Philomath, OR), which measures chl-a (0-75 µ g Chl/l), was interfaced with an archival instrument (i.e. SPLASH10), manufactured by Wildlife Computers, Redmond, WA. A series of laboratory and field trials were conducted to examine the fragility and orientation of the optics, monitor animal behavior, and assess if the interfaced prototype functioned properly. The archived data were also used to determine if the data reduction routines established for the Argos system were a sufficient summary of the data, and verify functionality of the Argos message generation by the transmitting unit. The final phase of this project will entail deploying a satellite-linked fluorometer on ice-associated seals in the Bering Sea.

PD-49

Construction of advanced biologging systems for high rates of data-recovery: a challenging study to clarify the dynamics of fish populations and communities

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The monitoring of marine top predators, primarily fish species, provides important insights into marine ecosystems. Recently, biologging techniques involving electronic data-storage tags and acoustic transmitters have been increasingly used to understand migratory fish movements and behaviours. The number of tags, however, is normally limited due to costs, and the tag recovery rate is still low. In this study, therefore, to reveal the population and community dynamics of fishes in open waters, we will develop a new variety of small, low-cost, large-data-capacity and multifunctional tags, and implement the high recovery rate of the data. This study consists of the following four development: (1) two types of archival tags (small-sized tags and customizable- multifunctional tags), (2) the energy harvesting system installed in the tag, (3) the data receiving system onboard multi-platforms, and (4) the inter-individual communication system based on hydro-acoustic methods. Lastly, combining them, we will develop a new biologging system and test the practical utility of this system using wild herrings and bonitos in open waters off Japan. The new technology will overcome the bottleneck of conventional biologging techniques, and will lead to a breakthrough in marine ecosystem studies.

PD-50

Use of land-based Argos receiving stations to improve data collection from satellite tagged marine animals

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Argos satellite telemetry has become a core technology for tracking marine animals and acquiring the environmental data (e.g., depth, temperature, oxygen, salinity) collected by increasingly sophisticated tags. The limited satellite availability at low to mid latitudes inherent in the Argos system, coupled with brief and sometimes infrequent surfacing behavior of the tagged animals, imposes a restriction on the amount of data that can be obtained. Here we describe experiments with whales and sharks that demonstrate the vastly improved data throughput obtained from autonomous land-based receiving and data logging stations ("motes"). For example, in a region with 22% satellite availability, a mote positioned at a height of 575 meters received 422% more data than the Argos system alone when the tagged whale was within range. Data were received by the mote when animals were as far away as 72.6 km from the station. We propose that establishing arrays of motes could significantly improve tracking results for many marine species and would be especially useful for acquisition of data collected by «animal oceanographers».

Workshops

WS-1

Body temperature measurement in free ranging animals

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Body temperature is widely used in ecological, veterinary and biomedical research. Methods to measure body temperature range from solid sensors, implanted or ingested devices to non-contact IR thermometry and thermal imaging. Increasingly researchers are seeking methods that can be used to non-invasively record and understand body temperature variation from different anatomical regions over relatively long periods of time. This creates high demand for rapid development of novel sensing techniques. Accordingly, the aim of this workshop is to share knowledge across different disciplines in laboratory and field settings to identify how different methods sample spatial and temporal variation in body temperature. Importantly this workshop will look to identify requirements for new instruments and software for the analysis of large datasets. It is anticipated that this workshop will attract researchers working on a wide range of species, including humans, as well as manufacturers of sensor and imaging systems.

09:00 - 09:20 *Introduction.*

09:20 - 09:40 Intra-abdominally radio telemetric devices and temperature data-loggers, mostly in birds, but also brown bears. **Esa Hohtola** (Department of Biology, University of Oulu, Finland).

09:40 - 10:00 Biotelemetric capsules and thermal imaging - practicability, significance and limits of two different methods for body temperature measurements in elephants. **Nicole Weissenböck** (Dept. of Integrative Biology & Evolution, Research Institute of Wildlife Ecology, University of Veterinary Medicine, Vienna, Austria).

10:00 - 10:20 Surface temperature as a proxy for internal temperature through neck collars in mouse lemurs. **Pauline Vuarin** (CNRS/Muséum National d'Histoire Naturelle, France).

10:20 - 10:40 Comparing subcutaneous to surface temperature in the chicken, with implanted dataloggers and thermal images. **Katherine Herborn** (Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, United Kingdom).

10:40 - 11:00 Thermal imaging in wild passerine birds and automatic processing of large data sets from thermal videos. **Paul Jerem** (Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, United Kingdom).

11:00 - 11:20 *Coffee break and informal discussion.*

11:20 - 11:40 Prediction of human core body temperature using non-invasive measurement methods. **Simon Annaheim** (EMPA, Swiss Federal Laboratories for Materials Science and Technology, Switzerland).

11:40 - 12:00 Long term body temperature measurement in wild tuna, using body temperature as proxy for physiological parameters and lab/field differences in application. **Adrian Gleiss** (Stanford University, USA).

12:00 - 12:20 Temperature measurements in free-diving pinnipeds and penguins. **Paul Ponganis** (Scripps Institution of Oceanography, Univ. California San Diego, USA).

12:20 - 12:40 Practical issues with temperature measurement in wild animals, and the use of temperature sensors to detect particular behaviours. **Brian Cresswell** (Biotrack, United Kingdom).

12:40 - 13:00 *Concluding discussion on sensor design and analytical methods.*

WS-2

How can bio-logging advance our understanding of flight?

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Bio-logging has provided fundamental insights into the ecology, physiology and biomechanics of flight, revealing movement patterns that theoreticians once considered impossible. New developments in sensor capability combined with further miniaturisation of devices mean that these types of advances are set to continue. This workshop will examine how bio-logging tools are changing our ability to study flight. It aims to provide an overview of some recent findings in this field, and stimulate new research by bringing experts and interested parties together to share information on emerging areas and techniques in data collection and analysis. The workshop will begin with a plenary and the two sessions that follow will consider how external factors, namely the physical environment and conspecifics, interact with (i) navigation capacity and (ii) motion capacity, respectively, to produce the movement path.

Movement ecology gets wings
Prof. **Ran Nathan**, plenary speaker
This perspectives talk will outline the principles of movement ecology and illustrate them with examples of work in Prof. Nathan's group, including incorporation of risk-sensitive behaviour into soaring flight theory, co-ordinated flight in vultures and jackdaws, and true navigation of non-migratory bats and birds.

Go with the flow or deal with drift?
Dr **Jason Chapman**
Insect orientation responses to the wind will be discussed with respect to (i) navigation over small spatial scales (homing flights of social insects); and (ii) windborne migration over large spatial scales (long-range seasonal movements). The talk will draw on data from harmonic radar studies of tagged bees and vertical- looking entomological radar studies of high-flying migrant moths.

Social behaviour and spatial navigation in a bat flock
Dr **Yossi Yovel**
This talk will discuss navigation and information transfer in collectively foraging bats, using data from an entire flock of free-living animals equipped with miniaturised GPS units with integrated microphones.

Co-operative (and not so co-operative) aerodynamics in flocking birds
Dr **Steve Portugal**
What are the consequences of group flight for individual performance and energetics? This talk will examine these issues in avian flocks using high-frequency accelerometer and GPS data, focusing on cluster and V formation flight.

Opportunistic flight behaviour of gulls
Dr **Judy Shamoun-Baranes**
This talk will examine the opportunist nature of gull flight, over sea and over land, exploring the effects of the physical environment from daily to seasonal scales, by combining atmospheric models with long-term, high-resolution data on movement paths (using GPS) and flight strategies (using accelerometry).

How wing morphology can affect soaring flight performance and energetics
Dr **Olivier Duriez**
The performance and energy costs of soaring flight will be examined using a combination of heart-rate, accelerometer and high-frequency GPS data from captive freely-flying raptors (vultures and eagles) with various wing and body morphologies (wing span, wing loading, aspect ratio).

Up close with high-soaring birds: What can fine-scale movements reveal about performance?
Dr Emily Shepard
This talk will explore what high resolution movement data from Andean condors (accelerometry, magnetometry, and environmental sensors) can reveal about performance envelopes, behaviour and the airspace these animals operate in.

WS-3

A picture is worth a thousand words: bio-logging as a tool for collecting video footage and still images of animal behaviour

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Nobel Laureate Niko Tinbergen was not only a naturally gifted observer of wild animals, but also a pioneer wildlife photographer and movie maker. Although critically aware of the scientific value of imagery, even he could not have foreseen how technological advances would come to revolutionise the study of animal behaviour in the 21st century. Nowadays, researchers are routinely equipping animals with miniature cameras, to collect detailed behavioural data in captivity and in the wild. Despite considerable progress in this area, however, major challenges remain: (1) image acquisition continues to be severely constrained by size-, battery- and memory limitations; and (2) image analysis requires innovative approaches, to extract relevant bio-logical information from vast imagery datasets. Interestingly, the increasing use of drones to collect image data on wild animals and their habitats highlights the blurring of boundaries between animal-attached (i.e, bio-logging sensu stricto) and robot-attached applications. This workshop showcases recent advances in the use of bio-logging devices for collecting image data, and aims at identifying future directions for image acquisition and analysis.

09:00 - 09:20	A new video camera activated by feeding motion for efficient recording of deep foraging behavior. **Yasuhiko Naito** (National Institute of Polar Research, Japan)
09:20 - 09:40	Using animal-borne cameras to study raptor hunting behavior. **Suzanne Amador Kane** (Physics Dept. Haverford College, USA)
09:40 - 10:00	Application of computer vision technique for understanding animal behavior and cognition. **Junichi Okuyama** (Kyoto University, Japan)
10:00 - 10:20	Using video cameras to understand seabird-fisheries interactions and enhance participatory management. **Amélie Lescroël** (Centre d'Ecologie Fonctionnelle et Evolutive, CNRS UMR5175, France)
10:20 - 10:40	The past, present and future of animal-borne imaging. **Christian Rutz** (University of St Andrews, United Kingdom)
10:40 - 12:00	*General discussion*.

WS-4

Wildlife Satellite Telemetry

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A recent meeting of the Satellite Communications Forum in Paris (convened by UNESCO/IOC) highlighted changes occurring in usage patterns of scientists using satellites to uplink data. This community of users includes meteorologists, oceanographers and wildlife trackers. An analysis of use and pricing structure showed that animal trackers now comprise the single largest user group of Argos customers and yet they also pay disproportionately higher rates than other users. Further, there are very distinct geographical differences in the cost of satellite access. Whereas many programs are turning to the use of Iridium or other satellite service providers, the low power output of most wildlife tracking tags means that Argos is the only viable option for most programs. Consequently, for wildlife trackers, it is essential that Argos system remains viable and affordable. The SatComm forum also highlighted the lack of a unified voice to advocate on behalf of wildlife trackers. This side event is designed to share information regarding the SatComm forum and to provide an opportunity to discuss different perspectives of the tracking community and to possibly formulate some form of advocacy group.

WS-5

Variability in the movement patterns of marine predator populations: physiological, behavioural and environmental drivers. A CLIOTOP WG2 workshop

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Many marine predator species and populations demonstrate spatial and temporal variability in their movement patterns and behaviours. Variability in the extent and timing of migration, habitats utilised and foraging behaviours within habitats for example, have been observed in fish, sharks, sea turtles, marine mammals and seabirds. These movement patterns and behaviours of species and populations have evolved in response to life history strategies and the need to maximize prey resources. When movement patterns and breeding timing are misaligned with critical food resources, populations can have reproductive failure - the match/mismatch effect. Identification of linkages between movement behaviours and temporal and spatial variability in environmental conditions and the potential for match/mismatch effects is fundamental to understanding how populations and species may respond to long-term environmental change.

This workshop will bring together researchers with datasets from species/populations of pelagic fish, turtles, marine mammals and seabirds, and examine variability in movement behaviour. During the session, researchers will firstly be expected to provide short overviews of datasets brought to the workshop and any pre-processing undertaken on datasets to ensure standardised formatting in preparation for analyses to be conducted during the workshop. Using state-of-the- art analytical approaches, researchers will then focus on (i) analyses of datasets aimed at exploring potential differences in the behaviour of species/populations and drivers (e.g. differences in their environment, differences in physiology) that might be associated with movement decisions over a range of scales and (ii) development of a synthesis paper exploring some of the physiological, behavioural and environmental drivers that may be associated with variability in observed movements during the course of the workshop. A synthesis paper will be finalised for publication in a peer-review journal following the workshop. A workshop report will also be produced to be published on the CLIOTOP and IMBER websites. The paper and report produced will contribute to the synthesis outputs of the international CLIOTOP program.

WS-6

Linking marine predator behavior to prey fields

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The overarching goal of this workshop is to provide a forum for the presentation and discussion of how to link marine predator foraging behavior to prey fields at various temporal and spatial scales. Prey distribution (depth, density, patch characteristics, biomass) is a primary factor influencing the distribution and behavior of marine predators; however, quantifying the prey fields of marine predators can be challenging for several reasons. First, marine predators may forage over large spatial and temporal scales making it difficult to monitor both predator and prey behavior simultaneously. Second, techniques for monitoring prey fields require may require specialized technology, equipment, and expertise. Third, integrating data streams from marine predator diving behavior with empirical data on prey fields can be challenging given the complexity of the data streams and the scales at which they are collected. Our workshop will address specific questions related to (1) tools and techniques (hydroacoustic surveys, stationary buoys, animal-borne cameras/sensors, tag technology and attachment methods) that can be used quantify marine predator prey fields, (2) determining appropriate scales (temporal, spatial) for monitoring prey fields, and (3) analytical methods (and challenges) for integrating data streams from marine predator behavior (diving, movement) with empirical data on prey fields.

Tracking fish: an overview of tag technology and attachment methods
Julie Nielsen

Using acoustics to inform on the nature of species interactions with a roving marine predator in two large marine ecosystems
Damian Lidgard
Bowen WD, Jonsen ID, Block B, Wilson S, Stokesbury M, Iverson SJ

Using animal-borne videos and accelerometers to examine the prey capture of marine predators
Akinori Takahashi

Understanding how the foraging strategies and energetic consequences of the world's largest bulk-filter feeder change as a function of prey distribution and density
Jeremy Goldbogen
Elliot Hazen, Ari Friedlander

An individual behavioral model of group foraging for patchy prey
Colin Ware

Listening for your supper: Eavesdropping marine predator opportunities presented by prey generated noise
Ben Wilson

Making tags work

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There is a constant need for smaller, smarter and more powerful tags in bio-logging science. To meet this need, tag builders and users are continually innovating in the design of hardware, software, and data processing algorithms. A large part of this innovation is invisible: if it works well we tend to forget that it exists and the technological details are seldom described sufficiently in papers. The idea of this workshop is to provide a forum to present and discuss these technical details. The workshop will encompass the hardware, software (both in situ and post-processing), and mechanical design of bio-logging systems, as well as practical issues arising from their use on different species. Emphasis will be on tricks of the trade to overcome limitations in bio-logging sensors and systems.

Topics will include some or all of:
- Smart tags: robust methods for in situ data processing
- Data compression for telemetry
- Sensor calibration: pre-, post-, and data-driven calibration methods
- Positioning: GPS, dead-reckoning and hybrid methods
- Low power sensors for long-term tags
- Describing orientation and movement with inertial, speed and heading sensors
- Robust data analysis algorithms
- Novel attachment methods
- Inferring behaviour or physiological status from tag data
- Low-cost bio-loggers

Participation is open to all but the workshop is particularly intended for scientists and engineers who specify, build or adapt tags or the data processing software that goes with them. Tag users or would- be users who want to understand more about the performance and limitations of bio-logging methods are also very welcome. The format will comprise an informal combination of invited and contributed short talks, as well as open discussion. Talks will not necessarily offer solutions - they may raise an issue or highlight a gap in our understanding. Depending on interest, outcomes could be a set of contributed algorithms, programmes and circuits, or a methods paper. The workshop will last a full-day and will include a lunch.

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