



14th International Seabird Group Conference

Liverpool 3rd – 6th September 2018



Conference Program Book





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Welcome Message

On behalf of the Seabird Ecology Group at the University of Liverpool (SEGUL), we would like to welcome you to Liverpool and the 14th International Seabird Group Conference. We are proud to host this event in our unique, dynamic and fascinating city. We hope you will have an opportunity to explore our famous cathedrals, UNESCO world heritage designated docks and the equally famous Superlambananas. Fortunately, the conference also coincides with the Liverpool Biennial Festival of Contemporary Art, which is taking place throughout the city. Liverpool is a thriving destination for science and we follow a series of International conferences over the past two years, including the British Ecological Society, Joint Assembly, Behaviour, Association for the Study of Animal Behaviour and the Challenger conferences.

This year's conference is set to be the biggest Seabird Group conference to date, and we were inundated with applications for oral and poster presentations. In fact, we were unable to accommodate all submissions for posters and, as we wanted to allow everyone an opportunity to present, we have introduced a new format of 'virtual poster'. These can be found in the atrium and the poster hall and we hope these will stimulate discussions with the presenters. Ensuring diversity and equality across the conference has been a priority to us. We are incredibly proud to have been able to offer free childcare places, thanks to registration fees and our sponsors. The sponsors have also helped support a record number of travel grants, with additional help from The Seabird Group. When evaluating abstract submissions, we removed all identifying information and each was assessed by three independent members of the Scientific Committee. We are pleased that our selection procedure was only based on the quality of candidates and their research. The programme features slightly more oral presentations by female researchers, which reflects the proportion of females who submitted abstracts. A high number of talks by Early Career Researchers emerged from the process which bodes well for an exciting conference and the future of The Seabird Group.

Knowing that people often get hungry at poster sessions, which can limit their poster viewing stamina, this year we have decided to provide dinner at both the welcome reception and the poster session on Tuesday. We hope this will enable people to enjoy the posters while enjoying their food! The conference party will be held in the fashionable Baltic Triangle district, and an eclectic range of street food and small plates will be served. No visit to Liverpool would be complete without reference to the Beatles, and we will be entertained by a Beatles tribute band before the DJ takes over.

If you have any questions throughout the conference, any member of SEGUL will be happy to help – just look out for the conference t-shirts. Finally, we would like to thank The Seabird Group, our sponsors, the Scientific Committee, session chairs and you for coming!

Sam & Jon

(Samantha Patrick and Jonathan Green, University of Liverpool)



The Committees

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Jonathan Green (University of Liverpool)
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Sarah Burthe (CEH)
Steve Votier (University of Exeter)

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www.seabirdgroup.org.uk

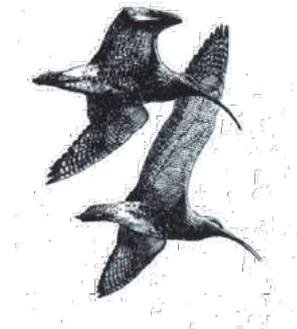


Paul Bartlett - Wildlife Artist

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Exhibitors



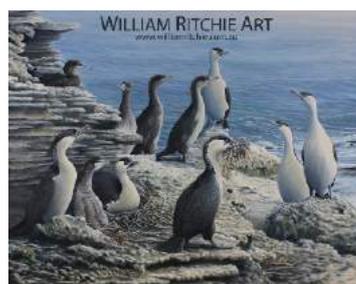
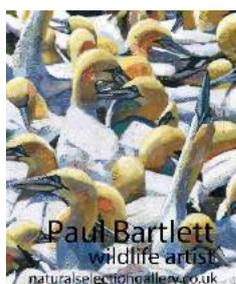
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Plenary Speakers

CLEO SMALL

Monday 3rd 18:00-19:00

Global seabird conservation: hoisting the mast for hope on a stormy sea



Most seabird populations and species are declining, many to globally threatened levels. At sea, commercial fisheries and pollution are taking their toll; on land, alien invasive predators and habitat disturbance and destruction are impacting many colonies. Climate change may cause (or exacerbate) problems in both domains. However, the last two decades have also seen notable successes in eradicating alien predators (mainly on uninhabited islands) and in finding solutions to seabird bycatch in longline and trawl fisheries. I will present the view from BirdLife International on whether we have reasons to be optimistic for the future of the world's seabirds, by reviewing some current and prospective global initiatives, including the development of new research and monitoring techniques, as well as pioneering collaborations involving governments, non-governmental organisations, scientists and civil society.

Cleo Small is Head of the BirdLife International Marine Programme, which she has been involved with for the past 10 years, and led for the past 5. The work of the BirdLife International Marine Programme includes the Albatross Task Force, the European Seabird Task Force, a programme of work to find solutions to bycatch in gillnet fisheries, work to identify and protect the world's marine Important Bird and Biodiversity Areas (IBAs) and, on behalf of scientists worldwide, coordination of the Seabird Tracking Database. Cleo's passion is searching for solutions to reduce human impact on the environment, with a background at Cambridge University and Yale University, where she studied Natural Science in combination with Social and Political Science.



Plenary Speakers

ANA SANZ- AGUILAR

Tuesday 4th 09:00-10:00

Seabird survival: critical moments and mortality drivers

Seabirds typically show a delayed reproduction and low breeding success. Their low reproductive output is compensated by long lifespans (i.e. high survival). However, there are critical moments in their life associated with increased mortality, such as early life and reproduction. Survival can differ between individuals depending on their sex, age, breeding experience, or intrinsic quality. The environmental conditions (e.g. food availability, climate, predators) experienced during their life can cause direct mortality but also influence their future survival prospects. Finally, accidental mortality caused by anthropogenic factors is jeopardizing the future viability of numerous seabird populations.



Ana Sanz-Aguilar is a postdoc in the Population Ecology Group at the Mediterranean Institute for Advanced Studies (IMEDEA) where she works on long-term studies of demography and population dynamics. She received her PhD from the University of the Balearic Islands in 2009 on the integration of life history traits with ecosystem management in European Storm Petrels. Ana Sanz-Aguilar held a Marie Curie Fellowship at CNRS, Montpellier, studying population dynamics of different life-history tactics in response to global change threats using state of the art modelling techniques, statistical tools and behavioural information. She continues to work on the theoretical and applied aspects of animal ecology (mainly seabirds), demography and population dynamics with emphasis on conservation biology.



Plenary Speakers

THEIRRY BOULINIER

Wednesday 5th 09:00-10:00

Host-pathogen interactions in space and time: seabirds as key models to address basic and

Seabirds are well known to be hosts of a diverse set of parasites and pathogens. Most seabird species are also widely distributed, migratory, long-lived, colonial and site faithful. Such characteristics mean seabirds are potentially important model systems for investigating host-parasite interactions at a hierarchy of temporal and spatial scales. Key issues regarding the ecology and evolution of these interactions notably concern factors affecting dispersal of hosts and parasites among colony patches, but also local interactions between individual hosts and parasites, which can involve the transgenerational transfer of immunity through the egg. Using studies conducted with kittiwakes and the tick *Ixodes uriae*, but also other seabird species, notably the Indian yellow-nosed albatross and sub-Antarctic skua, I will illustrate how important of basic and applied questions can be addressed using such systems, with implication from comparative immunology to conservation.



Thierry Boulinier is Director of Research at CNRS, Montpellier, where he has worked in the Department of Evolutionary Ecology since 2005. Thierry Boulinier's research focusses on spatial population ecology issues, on topics dealing with behavioural ecology, population dynamics, community ecology, immunology and disease ecology. He has notably been working with colonial seabirds (notably black-legged kittiwakes in northern Norway) to explore processes involved in the evolutionary ecology of dispersal and of a transgenerational response to parasitism: the maternal transfer of antibodies. He believes in the strength of combining observational, experimental and modelling approaches. He is now also working with Indian yellow-nosed albatrosses and skuas in the sub-Antarctic. Thierry Boulinier is deputy director of OSU OREME: the Mediterranean Research Observatory of the Environment, Associate Editor of the Journal of Animal Ecology and Academic Editor of PLoS One.



Plenary Speakers

KYLE ELLIOTT

Thursday 6th 13:45 - 14:45

Keeping alight the ocean's brightest fires of life



Animal ecology is shaped by energy costs, as is clearly shown by the diversity of life histories among seabirds. For example, albatrosses have some of the lowest flight costs, at or near resting, and can sail across oceans. In contrast, auks have exceptionally high flight costs, leading some of the extinct auk genera to follow their southern hemisphere analogues, the penguins, into flightlessness. The talk will highlight recent discoveries in seabird energetics from the cellular and molecular levels to its pivotal role in ecology and evolution.

Kyle Elliott is an Assistant Professor and Canada Research Chair in Arctic Ecology at McGill University, Montreal, Québec, where he has been since 2015. Through ecological energetics, Kyle Elliott studies avian predators as indicators of ecosystem health. His research uses cutting-edge methods to understand the links between physiology, behaviour and fitness, predominately in the Arctic where the impacts of climate warming are greatest. From an undergraduate in mathematical physics, Kyle Elliott did his PhD at the University of Manitoba on patterns in the physiology and behaviour of aging birds. In 2015, he received the Ned Johnston Young Investigator Award from the American Ornithologists Union for his outstanding record of research and leadership.



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Conference Information

Venue

The conference is based in the University of Liverpool's Central Teaching Lab, with all talks, including plenary sessions, taking place in the Chadwick Lecture Theatre. The poster session on Tuesday evening will be in the GFlex. See page 14 for a floorplan of the CTL and page 15 for a map of the campus.

Workshops

Using UAVs in Seabird Research and Monitoring

Monday 3rd September, 14:00 – 17:30

Rapidly advancing drone technology offers opportunities and challenges to both seabird researchers and the relevant regulatory bodies. This workshop will bring together experts in the practise and policy of using UAVs for seabirds, to share best practise on the design of UAV surveys to capture useful imagery whilst minimising disturbance. We aim to combine our experience with UAVs, to guide their future use and inform the development of policy.

Early Career Workshop (facilitated by Daniel Holden, D2U Coaching)

Monday 3rd September, 14:00 – 17:00

Our Early Career Workshop is open to all those who consider themselves to be early on within their research careers. This includes anyone from undergraduate to post-doctoral level, and the non-academic equivalent too. The workshop will feature an interactive session on how your personality is relevant to your research, a fun and engaging panel discussion and a networking element. Our six panelists will be covering topics including securing your first post-doctoral position, success outside the university environment, success outside of research, winning grants, managing collaborations and success in the media.

The panelists:



Sophie de Grissac



Liz Humphries



Thierry Boulinier



Phil Collins



Kate Parr



Tim Guilford



Using Bioacoustics as a Seabird Research Tool

Thursday 6th September, 13:00 – 13:40

Unattended acoustic monitoring is a non-invasive and cost-effective tool for seabird research. Learn how to use the Song Meter SM4 recorder in conjunction with Kaleidoscope software for efficient analysis of mass amounts of acoustic data. Both free and paid versions of the software will be covered.



Poster reception

Our poster reception, generously sponsored by HiDef Aerial Surveying, will take place in the GFlex from 17:30 on Tuesday 4th.



Conference Party

On the evening of Wednesday 5th, our conference party kindly sponsored by Xerius tracking will be held in Constellations (Greenland Street). Tickets for the dinner must have been purchased in advance – please speak to one of our conference helpers for more information. We hope you look forward to joining us for dinner, a drink and music supplied by The Pretend Beatles!



Social Media

We encourage you to tweet thoughts, experiences, photos, questions and selfies over the week using the hashtag #Seabirds18

Luggage Storage

On the last day (Thursday), we have a space available to store luggage until the end of the conference. Please see the map on page 14 or ask a conference helper to help locate the luggage store.

Wi-Fi Access

You can connect to Wi-Fi on campus via the following three options:

1. Public Wi-Fi



For the conference venue we recommend that you use the **WiFi Guest** service powered by Sky WiFi (The Cloud). It's just like when you use this service in other public places or hotels - simply register your details to get connected.

To connect to WiFi Guest (Sky WiFi):

- Select **WiFi Guest** from the list of available WiFi networks
- Open your web browser – the Sky WiFi landing page will appear. Click **Get Online**
- Log in, or register if you're a first time user, to gain access

You can view the places where Sky WiFi is available on this [Sky wifi map](#).

2. Visitor from another academic institution

If you are visiting from an institution in the **eduroam** scheme, you can login eduroam Wi-Fi service using your usual username and password.



that participates to the secure

If you require further information or support you should contact your own IT helpdesk.

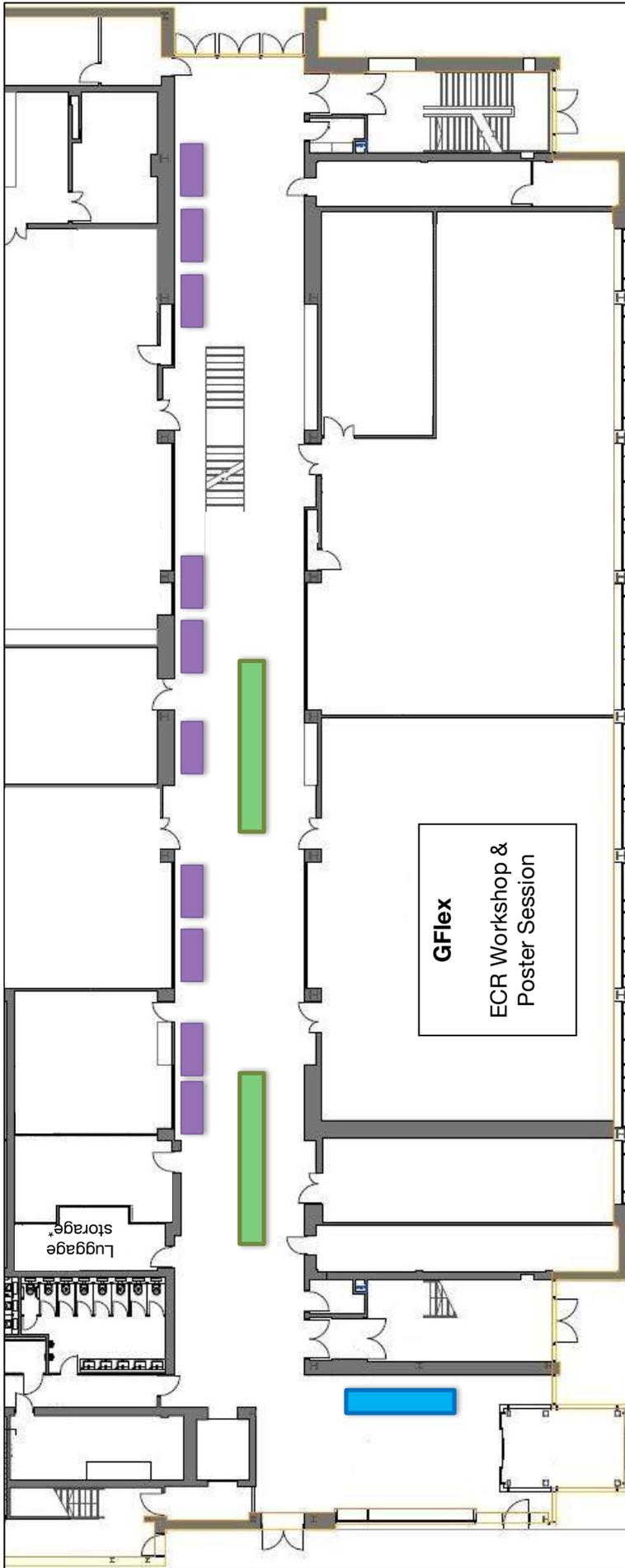
3. GUESTNET

If you are unable to log into the Sky Wifi (the Cloud) or Eduroam then you can access the **GuestNet** using the attached Guestnet Username and password. Guestnet provides access to the Internet for visitors who need authorised access for up to 7 days.

- Select **GuestNet** from the list of available WiFi networks
- Click **Connect**
- Open your web browser – such as internet explorer and you will be prompted to log in using your unique username and password.



Central Teaching Lab



Key

 Registration Desk

 Refreshments

 Exhibitors

More seating is available upstairs

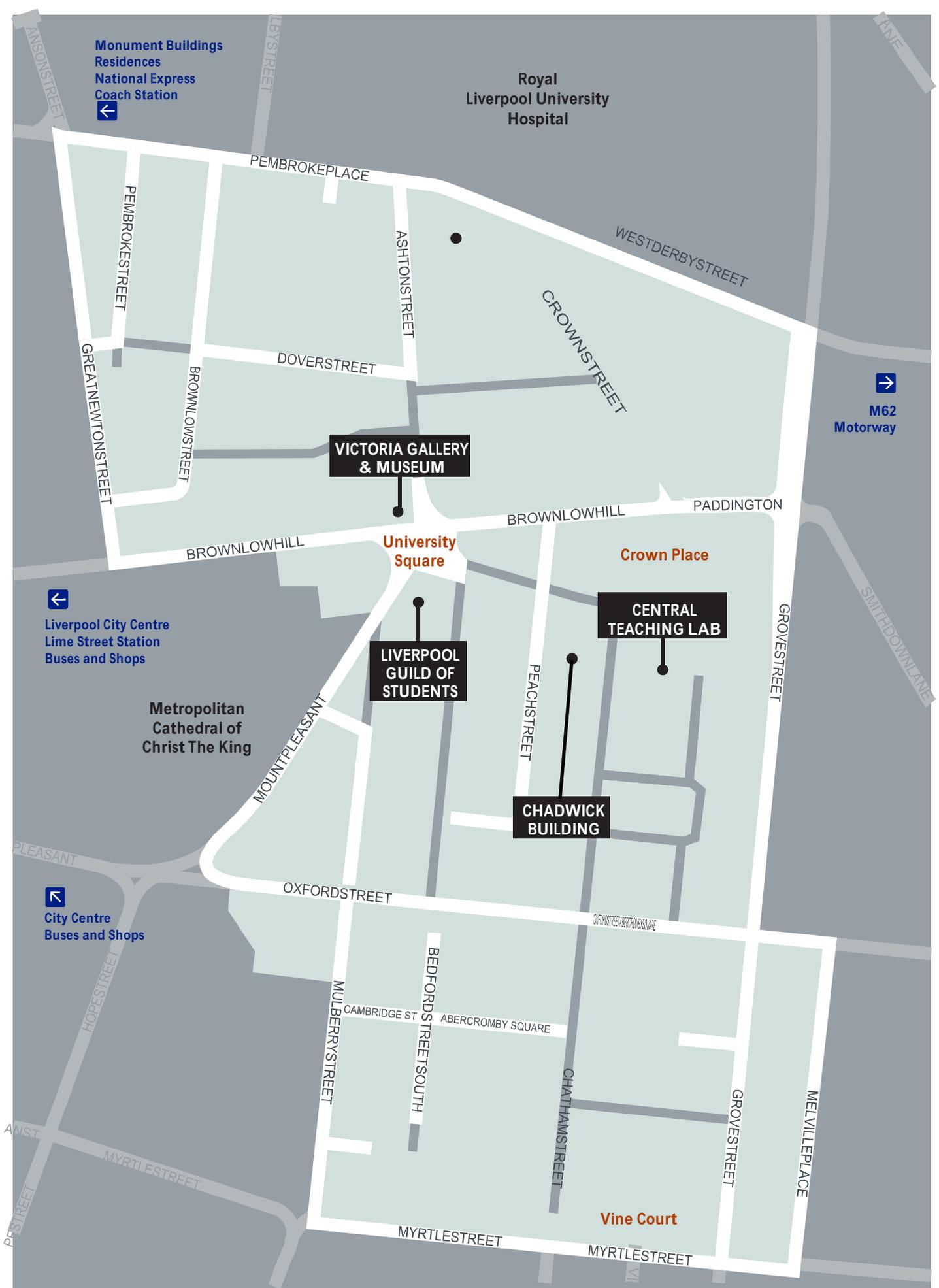
*Luggage storage for final day only



Chadwick Lecture Theatre

Talks & UAV Workshop





Programme

Monday 3rd September

12:00 – 14:00	Doors opening and registration
14:00 – 17:00	Workshop: Using UAVs in seabird research and monitoring
OR	
14:00 – 17:30	Workshop: for Early Career Researchers
17:00 – 18:00	Registration
18:00 – 19:00	Plenary lecture: Cleo Small (chaired by Steve Votier)
19:00 – 21:00	Welcome reception

Tuesday 4th September

08:30 – 09:00	Registration	
09:00 – 10:00	Plenary lecture: Ana Sanz-Aguilar (chaired by Samantha Patrick)	
10:00 – 10:45	Session: Across scales and species I (chaired by Ewan Wakefield)	
10:00 – 10:15	Ingrid Pollet	Colony overlap in foraging areas and offshore habitat by incubating Leach's Storm-Petrels <i>Oceanodroma leucorhoa</i> in the Northwest Atlantic.
10:15 – 10:30	Shannon Whelan	Contrasting effects of climate on phenology of two sub-Arctic marine predators
10:30 – 10:45	Mark Bolton	Spatial scales of marine conservation management for breeding seabirds
10:45 – 11:15	- B R E A K -	
11:15 – 12:45	Session: Across scales and species II (chaired by Ewan Wakefield)	
11:15 – 11:30	Cat Horswill	Comparative demography of UK seabirds
11:30 – 11:45	Alice Trevail	The consequences of environmental heterogeneity for foraging behaviour and reproductive success
11:45 – 12:00	James Waggitt	Ecologically informed and dynamic distribution maps for seabird communities in the north-eastern Atlantic Ocean
12:00 – 12:15	Karine Heerah	Characterization of the foraging habitats of three endangered seabird species during the breeding season
12:15 – 12:30	Katherine Keogan	Patterns and drivers of breeding phenology across multiple seabird species in the North Atlantic
12:30 – 12:45	Hallvard Strøm	Large-scale tracking of seabirds in the Northeast Atlantic – SEATRACK
12:45 – 13:55	- L U N C H -	
13:45 – 15:30	Session: Conservation & Management (chaired by Ellie Owen)	



13:45 – 14:00	Maria Dias	Combining tracking data and habitat models to identify marine Important Bird and Biodiversity Areas for penguins: how, where, when and why
14:00 – 14:15	Emma Critchley	Assessing the distribution and vulnerability of seabirds at sea to inform marine spatial planning
14:15 – 14:30	Peadar O’Connell	How seabird science can have policy impact
14:30 – 14:45	Stephanie Good	Does “best practice” exist when setting management objectives for fisheries-related impacts on seabirds?
14:45 – 15:00	Tom Hart	The use of time lapse cameras in seabird ecology
15:00 – 15:15	Vicky Warwick-Evans	Using habitat models for chinstrap penguins <i>Pygoscelis antarctica</i> to advise krill fisheries management during the penguin breeding season
15:15 – 15:30	Ellie Owens	Using digital photography and citizen science to describe spatial variation in puffin diet

15:30 – 16:00

- B R E A K -

16:00 – 17:30	Session: Environmental Drivers in Seabird Ecology I (chaired by John Arnould)	
16:00 – 16:15	Xavier Meyer	Sea-surface temperature and thermocline shape the temporal organization of foraging behavior in an inshore seabird, the little penguin
16:15 – 16:30	Eugénie Tessier	Foraging decisions of marine predators: availability or density of prey?
16:30 – 16:45	Julie Miller	The importance of tuna and marine productivity for tropical seabirds
16:45 – 17:00	Grace Sutton	The benefits of dining alone: animal-borne video cameras provide insights into foraging decisions by Macaroni Penguins
17:00 – 17:15	Timothee Poupart	Foraging ecology of a winter breeding species, the Fiordland penguin
17:15 – 17:30	Daniel Johnston	Investigating the foraging habitat of black guillemots in relation to tidal stream turbines
17:30 – 21:00	Poster reception (<i>sponsored by HiDef Aerial Surveying Ltd</i>)	

Wednesday 5th September

08:30 – 09:00	Registration	
09:00 – 10:00	Plenary lecture: Thierry Boulinier (chaired by Sarah Burthe)	
10:00 – 10:45	Session: Intrinsic drivers of behaviour and demography I (chaired by Sarah Wanless)	
10:00 – 10:15	Rhiannon Austin	A sex-influenced bimodal foraging strategy in a pan-tropical seabird
10:15 – 10:30	Gavin Arneill	Low statistical power to detect population change in burrow nesting seabirds: a case for adapting existing monitoring methods
10:30 – 10:45	Marie Claire Gatt	The role of behaviour and personality in carry-over effects in a long distance migratory seabird



10:45 – 11:15		- B R E A K -
11:15 – 12:45 Session: Intrinsic drivers of behaviour and demography II (chaired by Sarah Wanless)		
11:15 – 11:30	Marwa Kavelaars	Simultaneous tracking in lesser black-backed gulls: equal investment in parenting?
11:30 – 11:45	Nathan Pacoureau	Age, density, prey, and climate drive the demographics of an apex predator
11:45 – 12:00	Stephanie Harris	Personality and foraging specialisation in an Arctic marine predator
12:00 – 12:15	Lucy Garrett	Friends with benefits: the importance of chick sociality for survivorship in a precocial seabird
12:15 – 12:30	Teri Jones	Social movement and foraging in a colonial seabird
12:30 – 12:45	James Grecian	Understanding the ontogeny of foraging behaviour: insights from combining marine predator bio-logging with satellite-derived oceanography in hidden Markov models
12:45 – 13:45		- L U N C H -
13:45 – 15:30 Session: Physiology and Bioenergetics (chaired by Lewis Halsey)		
13:45 – 14:00	Philipp Boersch-Supan	Breaking the mould after moult: opportunistic central-place foraging in an otherwise rigid annual movement cycle
14:00 – 14:15	Susanne van Donk	Energetic consequences of foraging in different habitats
14:15 – 14:30	Ruth Dunn	A Model to Estimate Field Metabolic Rate in Seabirds
14:30 – 14:45	Elseph Sage	Terrestrial uplift shapes flight routes of generalist gulls (<i>Larus fuscus</i> , <i>Larus argentatus</i>) in typically flat landscapes
14:45 – 15:00	Bethany Clark	Is scavenging lazy? Energetic expenditure in seabird foraging behaviour
15:00 – 15:15	Amandine Gamble	Circulation of avian cholera among endangered seabirds: the predating and scavenging brown skua as an epidemiological bridge on Amsterdam Island
15:15 – 15:30	Olivia Hicks	The cost of parasitism to maintenance, behaviour and reproductive success in a free-ranging seabird
15:30 – 16:00		- B R E A K -
16:00 – 17:30 Session: Human-Seabird Interactions I (chaired by Morten Frederiksen)		
16:00 – 16:15	Saskia Wischnewski	Seabirds and Windfarms: New Insights from a Kittiwake Case Study
16:15 – 16:30	Ana Payo-Payo	Predictable Anthropogenic Food Subsidies Decouple Inter-Specific Temporal Synchrony
16:30 – 16:45	Lauren Roman	Population impacts of plastic ingestion in Procellariiforme seabirds
16:45 – 17:00	Matt Guy	Seabird mediated influence of marine resource management on the terrestrial ecosystem
17:00 – 17:15	Mark Miller	Capturing realism in population assessment

17:15 – 17:30	Morten Frederiksen	Quantifying the impact of hunting and oiling on Brünnich's guillemots <i>Uria lomvia</i> in the Northwest Atlantic
17:30 – 18:00	Seabird Group AGM	
18:00 – 19:00	- B R E A K -	
19:00 - late	Conference party (sponsored by Xerius Tracking)	

Thursday 6th September

09:30 – 09:45	Registration	
09:45 – 10:45	Session: Environmental Drivers in Seabird Ecology II (chaired by Halvard Strøm)	
09:45 – 10:00	Tommy Clay	Behavioural responses of albatrosses to local wind conditions
10:00 – 10:15	Ruben Fijn	Combining camera monitoring and GPS-tracks: Sandwich Terns show us where their food is
10:15 – 10:30	Rahel Maren Borrmann	Postnatal dispersal in juvenile lesser black-backed gulls <i>Larus fuscus</i> : comparison with movement patterns of adults and implications for the development of migration
10:30 – 10:45	Virginia Morera-Pujol	Unraveling the drivers of at-sea foraging distribution in a long-range seabird
10:45 – 11:15	- B R E A K -	
11:15 – 12:45	Session: Human-Seabird Interactions II (chaired by Maria Dias)	
11:15 – 11:30	Maria Bogdanova	Impact of visitor disturbance on breeding Atlantic puffins and Arctic terns
11:30 – 11:45	Tom Evans	Identifying shared movement patterns among individuals and species: the diversity and types of foraging trips used among four sympatrically breeding gull species
11:45 – 12:00	Liam Langley	Responses to anthropogenic perturbations: Influence of landfill closure on gull foraging behaviour
12:00 – 12:15	Georg Nehls	From effects to impacts: Analysing displacement of Red-throated Divers (<i>Gavia stellata</i>) from offshore wind farms using aerial surveys and tracking data
12:15 – 12:30	Astrid Potiek	Population models to assess the cumulative impacts of wind farm developments in the southern North Sea on seabirds and migrating waterbirds
12:30 – 12:45	Chris Thaxter	GPS and accelerometer data reveal insights into fine-scale behaviour of gulls at offshore wind farms
12:45 – 13:45	- L U N C H -	
13:00 – 13:40	Workshop: Using bioacoustics as a seabird research tool	
13:45 – 14:45	Plenary: Kyle Elliott (chaired by Jon Green)	
14:45 – 15:15	Prizes and closing	



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Guillemots	11g GPS+UHF
Gulls	11g GPS+UHF
Penguins	24g & 32g GPS
Gannets	31g GPS+GSM



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Oral Abstracts

Low statistical power to detect population change in burrow nesting seabirds: a case for adapting existing monitoring methods.

Gavin Arneill*, Chris Perrins, Matt Wood, David Murphy, Luca Pisani, Mark Jessopp, John Quinn

*University College Cork, Ireland

Seabird population monitoring programs are often hampered by large and difficult to access colonies, with spatially variable distribution patterns that require a large amount of time in the field to census. This is further complicated in some species that are nocturnal and burrow-nesting. We explored the sampling effort required to (a) obtain abundance estimates with a high degree of confidence, and (b) detect population declines under different biological scenarios. We undertook a census of Manx shearwater using tape-playback surveys on four islands off Ireland and Wales. Abundance estimates from sub-sampling less than 50% of all plots vary dramatically, leading to unacceptable uncertainty in population estimates. However, confidence in estimates is improved by using a stratified sampling approach. Power analyses suggested that random sampling generally gives low statistical power to detect both overall population declines and density-dependent declines as large as 50%, due to large variation in abundance between plots. However, focussing sampling effort in areas of highest density dramatically increased power to detect year on year population decline. Careful selection of consistent monitoring plots dramatically improves the power to detect change in a matched pairs framework. We discuss ways current approaches can be adapted to improve confidence in abundance estimates.

A sex-influenced bimodal foraging strategy in a pan-tropical seabird.

Rhiannon E. Austin*, Federico De Pascalis, John P.Y. Arnould, Jane Haakonsson, Stephen C. Votier, Gina Ebanks-Petrie, Tim Austin, Greg Morgan & Jonathan A. Green

*University of Liverpool, UK

To successfully exploit resources, animals must be adapted to operate under phenotypic and environmental constraints. The strategies that predators use to locate prey are therefore diverse, particularly for central-place foragers that must balance investment in reproduction and self-maintenance. Magnificent frigatebirds (*Fregata magnificens*) are pan-tropical seabirds, known for their unusual morphology and feeding ecology, which display strikingly unequal levels of parental care (males deserting offspring months before females). Using GPS-GSM loggers, bird-borne cameras and dietary data, we investigated the foraging ecology of chick-rearing magnificent frigatebirds from a population in the Cayman Islands. Results indicated use of two main foraging strategies: i) coastal trips where individuals target reef species and engage in kleptoparasitism, and ii) offshore trips during which birds feed on schooling pelagic prey. Differences in strategy use were linked to sex, with males roaming further from nests, and showing a higher propensity to forage offshore. Video data further indicated that foraging with conspecifics was more prevalent in coastal environments. We suggest that observed variation in behaviour may be mediated by sex-based differences in parental roles, and/or size differences leading to intraspecific competition. Our study sheds new light on the importance of foraging flexibility and coastal feeding in this enigmatic species.



Breaking the mould after moult: opportunistic central-place foraging in an otherwise rigid annual movement cycle

Philipp Boersch-Supan*, Helen Peat, Phil Trathan

*British Trust for Ornithology, The Nunnery, Thetford, UK

Matching energy requirements during the annual reproductive cycle with resource availability is of paramount importance to the survival of animals and their offspring. Behavioural plasticity may allow for adaptive responses to variable timing in resource availability, although adaptive responses may be limited by the absence of local cues for migratory species, and/or the need to match multiple periods of high energy demand to a single peak in resource availability. We used an automated identification and weighing system to monitor a colony of c. 400 pairs of macaroni penguins (*Eudyptes chrysolophus*) at Bird Island, South Georgia between 2008/09 and 2016/17, during which annual prey availability varied substantially. We estimated breeding and moulting phenology for marked and unmarked birds, as well as foraging success and body mass change for marked individuals. The timing of breeding varied little between seasons, indicating rigid behavioural patterns. However, weighbridge records revealed a period of intense central-place foraging after the completion of moult. The participation in and duration of this previously undocumented behaviour was related to the foraging success during the pre-moult excursion. In prey-rich years penguins were more likely to delay their winter dispersal for longer.

Impact of visitor disturbance on breeding Atlantic puffins and Arctic terns

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Encouraging human access to wildlife areas is a key element of generating public support for nature conservation, and has educational and economic benefits. However, human presence also causes disturbance which has negative effects on wildlife. To resolve this conflict, conservation practitioners need to devise appropriate visitor access strategies. This requires quantifying the impact of different visitor regimes on the population of interest. We developed a model estimating the effect of visitor disturbance on breeding success of Atlantic puffins and Arctic terns on the Isle of May NNR, mediated via changes in chick provisioning rates and chick body mass, under different scenarios of visitor numbers, visit durations and timings. Puffin provisioning rates and breeding success were affected in the vicinity of visitor hotspots, but effects on population-level breeding success were small (1.7% decline under highest disturbance scenario) since most nesting burrows were not located close to visitors. In contrast, Arctic terns were highly susceptible to disturbance, with provisioning rates and breeding success greatly reduced as visitor numbers and durations increased. Consequently, effects on population-level breeding success were substantial (32% decline under highest disturbance scenario). Our findings highlight the potential utility of quantitative analysis of fitness-related traits to inform the management of public access to seabird colonies.



Postnatal dispersal in juvenile lesser black-backed gulls *Larus fuscus*: comparison with movement patterns of adults and implications for the development of migration

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Although several recent studies have tracked individual movement patterns in adults of large gull species, the postnatal dispersal of juveniles remains poorly understood. Continuous, detailed tracking data are still missing, despite the importance of the postnatal period in the development of the migration strategy that an individual may follow for the rest of its life. We instrumented 10 juvenile lesser black-backed gulls prior to fledging on the island of Spiekeroog, Germany, in the North Sea in 2017. GPS/GSM devices were used to record an overall 126130 positions over 61 to 229 days. There was wide variation in timing of dispersal (birds left the wider surroundings of the colony after 28 to 106 days) and in subsequent movement patterns and wintering destinations. Initial dispersal was on varied compass bearings from south to southwest, and the juveniles reached their main wintering site after 36 to 106 days, visiting 2 to 4 stopover sites en route. Eight birds used the same wintering site as at least one other tracked individual in Algeria, Morocco, and Spain. Results are discussed in light of available information on migration of adult lesser black-backed gulls, and implications for the development of individual movements strategies and habitat specialisation.

Is scavenging lazy? Energetic expenditure in seabird foraging behaviour

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Many species use anthropogenic resources but there are potential costs to scavenging, including food of low nutritional value, risk of bycatch and vulnerability to a loss of food. These costs are often presented as a trade-off with the benefit of easier foraging, but the relative energetic costs of scavenging are unknown. Here we quantify the energetics of foraging in northern gannets *Morus bassanus* using bird-borne video cameras to differentiate scavenging from natural foraging, and accelerometry to calculate dynamic body acceleration as a proxy for energy expenditure. We found a high incidence of scavenging, with over half of recorded dives occurring at boats. However, we find no difference in mean dynamic body acceleration between scavengers and non-scavengers. We use behavioural classification to investigate the drivers of foraging trip energy budgets, finding that the most energetically important behaviour is flapping flight as it accounts for 24% of foraging trip time budgets, while plunge diving and subsequent take-off account for less than 1%. Specialist scavengers are common and do not appear to save energy while foraging, and as such, populations could be left vulnerable to rapid reductions in available resources, in the form of discards, resulting from ongoing changes in EU policy.



Behavioural responses of albatrosses to local wind conditions

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Winds shape the energetic landscapes of soaring seabirds and constrain foraging and migration strategies. Yet, while the relationships between wind speed components and flight are fairly well established, it is unclear to what extent birds adjust their fine-scale time-activity budgets in response to local wind conditions. Indeed, low-pressure systems cause ocean surface winds to be highly variable over small time-scales, and presumably, birds should make optimal decisions to minimize movement costs. In this study, we investigate the effect of local winds on the behavioural decisions of wandering albatrosses *Diomedea exulans* tracked with GPS loggers from the Crozet archipelago, during seven consecutive incubation periods (2010-2016). We extracted concomitant meteorological data from the ERA-5 atmospheric-ocean model and used hidden-markov models to categorize foraging trips into discrete segments associated with transit, rest and search behaviours. Wind speed and direction relative to the direction of travel, influenced both flight speeds and the probability of transitioning between states, such that birds were more likely to switch to flight or continue flying with increased wind speeds. Our results also suggest that birds choose routes principally to optimize flight, providing novel insights into the role of weather on the movements and foraging decisions of wide-ranging seabirds.

Assessing the distribution and vulnerability of seabirds at sea to inform marine spatial planning

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Ireland and the UK hold internationally important numbers of breeding seabirds, many of which are threatened. In order to mitigate the risks from anthropogenic activities to these populations we need robust information on species' at-sea distributions, which can be challenging. We collected GPS tracking data, and aerial survey data for a range of seabird species, and compared these to predictive distribution models based on seabird foraging radii. There was generally good agreement between all three methods of assessing at-sea distribution (e.g. auks and Manx shearwaters). We used predictive distributions for the entire seabird community to conduct a gap analysis on current marine protected areas (MPAs) in the region. This showed that, often threatened, pelagic species are likely to have significantly less coverage from protected areas (mean 13 % of population occurring within MPAs) than coastal species (mean 32 % of population within MPAs). Our findings also show that most species have lower coverage from Special Protected Areas (designated specifically for seabirds) than other protected area types. We then developed and applied vulnerability indices to predicted distributions to identify areas of greatest risk to seabird populations and inform designation of future MPAs.



Combining tracking data and habitat models to identify marine Important Bird and Biodiversity Areas for penguins: how, where, when and why

Maria Dias*, Ana P.B. Carneiro, Annette Scheffer, Norman Ratcliffe, Victoria Warwick-Evans, Phil Trathan, Jonathan Handley, Elizabeth Pearmain, Antje Steinfurth, Alexander L. Bond, Karine Heerah, Charly Bost

*BirdLife International, Cambridge, UK

Tracking individual animals has become one of the main methods to identify hotspots for marine conservation, such as marine Important Bird and Biodiversity Areas (mIBAs). However, in many locations tracking data are unavailable due to logistical constraints, and/or the colonies that are studied may not be the most important in terms of conservation priorities. We investigate the use of habitat models to overcome this limitation. We have compiled >1000 individual tracks for five penguin species breeding in the Antarctic and Sub-Antarctic (Chinstrap, Adélie, Gentoo, Macaroni and Northern Rockhopper penguins) to 1) identify mIBAs using a standardised, published approach developed for flying seabirds and adapted for penguins and 2) compare the results with hotspots identified using predicted distribution maps derived from habitat models. Results showed a high overlap between the areas identified as important using observed distributions (mIBAs) and by predicted distributions, revealing that habitat preference models can be used with confidence to identify marine IBAs for penguins. We provide a new method for designating a network of marine IBAs for penguins, based on outputs from habitat models when tracking data are not available. This can contribute to an evidence-based approach to inform fisheries management and for the conservation of birds.

A Model to Estimate Field Metabolic Rate in Seabirds

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For free-ranging animals, field metabolic rate (FMR) is the total sum of their energy expenditure over a specified period. This quantity is a key component of ecological processes at every biological level. We applied a phylogenetically informed meta-analytical approach to identify the large-scale determinants of FMR in seabirds during the breeding season, utilising data from 64 studies of energetics in 47 species of seabird, and use these data to create a model to estimate FMR for any seabird population. We found that FMR was positively influenced by body mass and colony latitude and that it increased throughout the breeding season from incubation to brood to crèche. FMR was not impacted by the number of breeding pairs at the colony or average species brood size. Based on this model, we present an app through which a variety of specialist and nonspecialist users can generate estimates of FMR in breeding seabirds. We encourage the use of this app to complement behavioural studies and increase understanding of how energetic demands influence the role of seabirds as driving components of marine systems.

Identifying shared movement patterns among individuals and species: the diversity and types of foraging trips used among four sympatrically breeding gull species

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Bio-logging data promises to facilitate understanding how sympatric species coexist and use their environment, yet the complexity of such data makes it challenging to exploit this potential. We illustrate a novel analytical approach with a data set of four concurrently GPS-tracked sympatrically breeding gull species (*Larus argentatus*, *L. canus*, *L. fuscus fuscus*, *L. marinus*) from a coastal site. We show how common patterns of foraging activity can be identified and quantified across individuals and species. Similar foraging trips were grouped together using a hierarchical clustering analysis ran on the principle components of summary metrics extracted for each trip. Diversity indices and overlap measures quantified how the different types of foraging trips were shared or unique among individuals and species. Common types of foraging trips included: using agricultural fields around dawn in *Larus canus* and *L. argentatus*; highly directed long distance trips to landfill sites in *L. argentatus* and *L. marinus*; and more tortuous inshore marine trips in *L. canus* and *L. fuscus*. Gulls varied at individual and species levels in how many types of trips they performed corresponding to variation in foraging specialisation. This study points to how rich bio-logging data sets can be used in community ecology research.

Combining camera monitoring and GPS-tracks: Sandwich Terns show us where their food is

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Seabirds are useful indicators of marine ecosystem processes, and studying seabird diets can shed light on natural or human-induced variability in food-web composition. However, obtaining diet information from remote bird colonies is often challenging. Since 2009, the foraging ecology of Sandwich Terns was studied in a Dutch colony based on visual observations of prey deliveries as well as with GPS-tracking to identify offshore foraging locations. In 2017, we extended our observations with a continuously recording high-resolution camera that was targeted to record prey deliveries of birds with GPS-loggers. A total of 34 returns of birds with GPS-loggers were captured on camera of which the prey-item could be identified. Body lengths of provisioned fish varied between 3-11 cm. Clupeids constituted 79% of the delivered items, 21% were Ammonites. Inspection of the GPS-tracks belonging to each prey-item revealed that prey-items of different length classes were spatially segregated at sea. By combining GPS-data and camera footage we not only obtained detailed knowledge on the whereabouts of tracked birds, but we could literally see what they were looking for at those locations and obtain spatial data on prey availability.



Quantifying the impact of hunting and oiling on Brünnich's guillemots *Uria lomvia* in the Northwest Atlantic

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Brünnich's guillemot is a numerous pan-Arctic seabird, but several Atlantic breeding populations are declining. The species is subject to traditional harvests in the important wintering areas off West Greenland and Newfoundland, and to chronic oil pollution off the east coast of Canada. Until recently, knowledge on migration routes and winter distribution has been insufficient to assess the impact of these mortality sources on specific breeding populations. We collate existing information on hunting and oiling mortality, as well as new data on age distribution in the hunting bag. Based on the results of recent tracking studies, we construct a spatially explicit population model that allocates hunting and oiling mortality to breeding populations and estimates the impact on their growth rate. Annual population growth rate is depressed by 0.010 – 0.039 by anthropogenic mortality sources. In addition to local breeders, hunting in Greenland mainly affects declining breeding populations in Svalbard and Iceland, while hunting and oiling in Newfoundland mainly affects guillemots breeding in Arctic Canada and north-west Greenland. The strongest impact is predicted on the small breeding population in Atlantic Canada, which winters mainly on the Newfoundland Shelf and thus is exposed to both hunting and oiling.

Circulation of avian cholera among endangered seabirds: the predating and scavenging brown skua as an epidemiological bridge on Amsterdam Island

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Infectious diseases threaten wild animal populations, notably seabirds. Identifying the different components of a reservoir community is key to understand the circulation of infectious agents. Predating and/or scavenging birds such as skuas have the potential to act as epidemiological bridges, enhancing the circulation of infectious agents among other seabird colonies and mammal populations. On Amsterdam Island (Indian Ocean), avian cholera is causing recurrent die-offs of albatross and penguin nestlings. We combine movement ecology with eco-epidemiology to assess whether brown skuas in this system could represent bridges among seabirds (albatrosses, penguins) and mammals (rats, seals). We notably consider behavioural processes potentially involved in the circulation of infectious agents, such as foraging territoriality. The results suggest that, at the height of the epizootics, skua movements do not connect the endemic Amsterdam albatross population to the local epidemiological network, contrary to the other local colonial species. Additionally, this study illustrates how predator and/or scavenger species can be used as sentinels to detect infectious agents in wild settings. These results have important implications regarding our understanding of infectious agent circulation at an inter-specific level and potential applications in conservation considering the impact of avian cholera on seabird populations.



Friends with benefits: the importance of chick sociality for survivorship in a precocial seabird

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Social aggregations of chicks often occur in avian species with mobile (precocial) young. Chicks are left alone by both parents that forage at sea, and may or may not be guarded by other returning parents during feeding. The hypothesised benefits of associating with other chicks during abandonment include: reduced predation, increased thermoregulation, and social information transfer. However, few studies have analysed the impacts of social group size on chick survivorship. This study investigates chick sociality in a colonial seabird, the sooty tern. We examined chick social group size and the extent to which this changed over time, as well as the effects of sociality on survivorship. Our initial findings suggest the number of chick associates or friends has important survival consequences during the post-hatch to fledging stage. Social group size varied with chick age, becoming smaller as chicks neared fledging. Our results indicate that social group size may be a response to predation pressures during the most vulnerable life stages. Our study also highlights the importance of including social life-history traits in reproductive success estimates of species with precocial young.

The role of behaviour and personality in carry-over effects in a long distance migratory seabird

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Animal personality – repeatable interindividual differences in behaviour – has recently attracted attention in explaining ecological and evolutionary phenomena in a variety of animal taxa, such as movement decisions and breeding success. The Cory's Shearwater *Calonectris borealis* is a long-distance migrant which displays a variety of migratory strategies at the population level, with individuals being largely consistent in their migratory behaviour despite the possibility of changing strategies. We explore whether the Cory's Shearwater exhibits behavioural syndromes and if individual behaviour is linked to life history strategies and/or fitness using a unique tracking dataset of more than 100 individuals of known breeding success over two consecutive years coupled with assessments of boldness and aggression responses during temporally separated life history stages. While individuals are consistent in their behaviour type within a life history stage they are not necessarily so between seasons. This is not in accordance with the assumptions describing an individual's personality. Conversely, behaviour appears to be a product of condition following return migration - rather than a predictor of migratory strategy - and has consequences on the success of the following breeding attempt, suggesting that it may play a role in the carry-over effects between seasons.



Does “best practice” exist when setting management objectives for fisheries-related impacts on seabirds?

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Incidental capture in fisheries is one of the main threats to seabird populations. In 1999 the Food and Agriculture Organization of the United Nations (FAO) released the International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA-Seabirds). It builds on the FAO Code of Conduct for Responsible Fisheries, which aims to minimise negative impacts, particularly endangered species, with use of selective gear. Neither document prescribes thresholds for management action. The IPOA-Seabirds indicates that States should “...determine if a problem exists with respect to incidental catch of seabirds. If a problem exists, States should adopt a National Plan of Action (NPOA) for reducing the incidental catch of seabirds...”. They do not define what constitutes a “problem”, leaving this up to individual states. States have therefore taken a variety of approaches in identifying if there is a seabird bycatch problem and in developing management responses. We review thirteen NPOAs to test for consistency in setting objectives for managing fisheries impacts. We have also identified methods used to determine if those objectives are being met - highlighting best practice, where it exists, in both objective setting and assessing impacts.

Understanding the ontogeny of foraging behaviour: insights from combining marine predator bio-logging with satellite-derived oceanography in hidden Markov models

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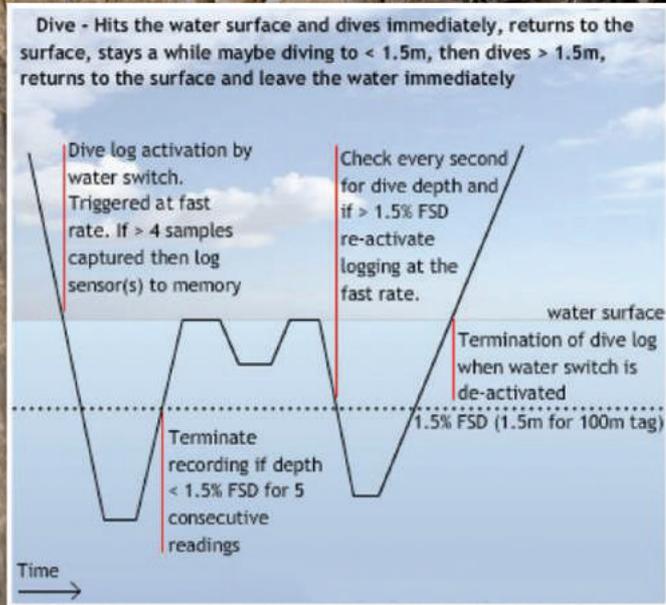
The development of foraging strategies that enable juveniles to efficiently identify and exploit predictable habitat features is critical for survival and long-term fitness. In the marine environment, meso- and sub-mesoscale features such as oceanographic fronts offer a visible cue to enhanced foraging conditions, but how individuals learn to identify these features is a mystery. In this study, we investigate age-related differences in the fine-scale foraging behaviour of adult (aged ≥ 5 years) and immature (aged 2-4 years) northern gannets (*Morus bassanus*). Using high-resolution GPS-loggers, we reveal that adults have a much narrower foraging distribution than immature birds and much higher individual foraging site fidelity. By conditioning the transition probabilities of a hidden Markov model on satellite-derived measures of frontal activity, we then demonstrate that adults show a stronger response to frontal activity than immature birds, and are more likely to commence foraging behaviour as frontal intensity increases. Together, these results indicate that adult gannets are more proficient foragers than immatures, supporting the hypothesis that foraging specialisations are learned during individual exploratory behaviour in early life. Such memory-based individual foraging strategies may also explain the extended period of immaturity observed in gannets and many other long-lived species.



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Seabird mediated influence of marine resource management on the terrestrial ecosystem

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Mobile link-species couple discrete ecosystems by interacting with the biotic and abiotic environment at both locations. As a result, any perturbations in one ecosystem has the potential to influence the other. Seabirds, such as great skuas, act as a mobile link-species coupling the marine with the terrestrial environment, by depredating fish and depositing large amounts of excreta in their breeding colonies. Through observational and manipulation studies undertaken in Shetland we demonstrate the effect of great skuas on the blanket bog on which they form breeding colonies. Plant community dominance shifted from dwarf shrub to grass species under high skua abundance and we examine the underlying mechanisms behind this change. Great skuas in Shetland have benefited from commercial fisheries discards resulting in an artificially inflated population. Changes in marine resource management have resulted in reduced food availability and prey switching. This alternative foraging strategy is unlikely to sustain such large great skua populations and result in shifts in plant community dominance within breeding colonies, decrease grazing potential and alter vegetation structure with likely consequences for arthropod communities.

Personality and foraging specialisation in an Arctic marine predator

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Individuals within a population often show specialisations in behaviour, a phenomenon best demonstrated in the foraging behaviour of marine predators. The degree of specialisation shown by an individual may in part be explained by intrinsic factors such as age or sex, but other sources of variation are less well known. Animal personality, or consistent individual differences in behaviour, has been shown to link to differences in movement behaviour. Here, we examine the relationship between personality and foraging specialisations in the black-legged kittiwake (*Rissa tridactyla*). Using novel object tests, we measured personality in kittiwakes breeding at five different colonies in Svalbard, and deployed GPS loggers to capture data on their repeated foraging trips at sea. Firstly, we examine the relationship between personality and foraging behaviour in kittiwakes. Shy birds tended to range further from the colony, but otherwise showed no differences in their foraging trips to bold individuals. We then measured the variability individual kittiwakes show in their foraging behaviour, and the relationship between this variability and personality. Bold individuals showed lower variability in their range and locations of foraging patches, indicating bold individuals are more specialised. Associations between personality and foraging specialisations may be an important mechanism underlying relationships between personality and fitness.



The use of time lapse cameras in seabird ecology

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Remote cameras are becoming increasingly used in the study of seabird ecology. Cameras provide time series observations on a colony or subset of a colony to determine phenology, reproductive success, predation and nest attendance patterns. However, there are data challenges associated with processing large image sets, which may be in the order of 10,000 to 100,000 images per site per year. Here, calling on examples from the Arctic, Antarctic and temperate regions, and using two citizen science platforms Penguinwatch and Seabirdwatch, we present workflows, computer vision and subsequent machine learning approaches for parameter extraction. We demonstrate how breeding phenology, reproductive success and nest attendance vary with location/environmental covariates, providing insights into assessing the effects of climate change across the biogeographic range of species.

Characterization of the foraging habitats of three endangered seabird species during the breeding season

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In the Southern Ocean, the potential impact of anthropogenic environmental changes is concerning as several populations of seabirds are declining. At the population level, the specific causes of these declines are poorly known, hampering efficient conservation strategies. We aimed to characterize the at-sea foraging habitats used during the breeding periods by three endangered seabird species at Amsterdam Island, South Indian Ocean: the Northern Rockhopper Penguin *Eudyptes moseleyi*, Indian Yellow Nosed Albatross *Thalassarche carteri* and Sooty Albatross *Phoebastria fusca*. Argos satellite tags deployed on the three species at Amsterdam Island provided at-sea locations the egg incubation and chick rearing periods for several years and individuals (Northern Rockhopper Penguin: $n_{inc}=4$, $n_{chick-rearing}=9$, $n_{year}=2$; Yellow Nosed Albatross: $n_{inc}=45$, $n_{chick-rearing}=26$, $n_{year}=7$, Sooty Albatross: $n_{inc}=11$, $n_{chick-rearing}=10$, $n_{year}=4$). For each stage, overall habitat usage was characterized using utilization distribution kernels while time spent per sector was used as a reliable proxy of preferred foraging areas. Habitat use models revealed that the distributions of the three species were related to bathymetric, hydrological features and accessibility from the colony. These results provide critical information for conservation and management approaches, such as defining Important Biodiversity and Bird Areas and Marine Protected Areas.



The cost of parasitism to maintenance, behaviour and reproductive success in a free-ranging seabird

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Parasites are ubiquitous and have major fitness consequences for their hosts. Often effects are sub-lethal, making it hard to quantify these costs to individuals. However, ignoring these effects reduces our understanding of the host's ecology, as parasites can drive a large array of fitness-related traits. Using an energetics approach, we are able to understand the trade-off between investment of energy to an immune response and that invested in activity required for foraging and reproduction. We use a wild population of European shags *Phalacrocorax aristotelis* to demonstrate the measurable cost of intestinal parasites on reproductive success. We find that the number of fledglings successfully raised is negatively related to parasite burden. By way of mechanism we found an increase in resting metabolic rate and cost of flight behaviour with higher parasite burdens. Individuals with higher flight costs spend a smaller proportion of their time-budget in flight, presumably due to increased flight and maintenance costs associated with higher parasite loads. However we see no effect of parasitism on daily energy expenditure, suggesting an energy ceiling and the need to balance increased costs with reduced activity. This work provides evidence of the fitness effects of sub-lethal parasitism to a free-living population.

Comparative demography of UK seabirds

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The ecological and socioeconomic costs of biodiversity loss are globally recognized, yet current rates of population decline greatly outpace our ability to directly monitor threatened species across their range. The scale of this problem means we cannot hope to expand national or global conservation efforts by additional data collection alone and we need to identify unifying trends from existing datasets. Here, we use a hierarchical, Bayesian approach that combines multispecies data to reconstruct time-series of life-history profiles for seabird populations with error-prone and fragmented observations. We resolve the functional relationships between traits, and examine thresholds of population size below which demographic rates become consistently reduced and more variable. This provides an indicator of the minimal population sizes needed to sustain stable seabird dynamics into the future.

Investigating the foraging habitat of black guillemots in relation to tidal stream turbines

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Inshore diving seabirds such as black guillemots *Cephus grylle* are potentially vulnerable to alterations in their foraging habitat by tidal stream turbines. These devices may affect their foraging habitat by shifting tidal flow patterns, altering benthic composition and forming reefs. Assessing how these changes may affect black guillemots is currently difficult due to a lack of knowledge regarding their foraging habitat preferences. Using GPS tracking, and chick diet monitoring, this study addresses this knowledge gap by identifying black guillemot foraging locations, and the associated environment and prey. Thirty five breeding adult black guillemots were tracked during the 2016/17 breeding seasons on the Scottish islands of Stroma (in proximity to ongoing turbine installations) and North Ronaldsay. Tracks revealed that individuals have a clear preference for specific foraging locations, with variation between individuals in terms of foraging depth, tidal dynamics and benthic composition. Using predictive biotope maps and tidal models these habitats were identified as deep/high tidal energy/kelp habitats and shallow/low energy/sandy habitats. Diet and nest monitoring established links between prey and the associated chick weights/nest success. This combined knowledge of habitat and prey will allow the potential impacts of environmental alteration by tidal turbines to be better assessed and potentially quantified.

Social movement and foraging in a colonial seabird

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Social foraging strategies can reduce the time and energy costs associated with locating and capturing prey, particularly in highly spatially and temporally variable environments. Indeed, animals may benefit from social foraging through a variety of mechanisms, such as cooperative hunting, as well as via information obtained through observation of others. However, despite the ubiquity of conspecifics in the environment of colonial species, few studies have investigated social foraging and collective movements in such colonial-living animals. We simultaneously GPS tracked 85% of all breeding individuals from a small colony of Australasian gannets (*Morus serrator*) to investigate the spatial and temporal aggregations of individuals across both commuting and foraging behaviours and tested for individual roles in social movements. When individuals forage concurrently at-sea, we found that individuals share foraging patches significantly more often than expected by chance. However, individuals vary in their propensity to commute and forage socially, highlighting the importance of considering individual variation in social behaviours when studying foraging and movement behaviours. Through combining analysis of social movement and foraging we provide a first analysis of individual-level social associations and the implications of these associations on social information use and group movements in foraging seabirds.

Simultaneous tracking in lesser black-backed gulls: equal investment in parenting?

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Parental care increases offspring survival, but comes at a cost for the parents. However, in biparental species an individual only has to pay the costs for its own parental investment, while the contribution of the partner comes for free. The decision on the relative contributions by each parent is consequently a battleground for a substantial evolutionary conflict of interests, as each parent benefits if its partner works harder. It is thus of importance to take the partner's reproductive decisions into account, and to cooperate successfully in order to maximise reproductive output. We studied how pairs of lesser black-backed gulls, a long-lived monogamous seabird species, achieve an appropriate division of parental care and whether equality in care affects offspring growth and reproductive output. To this end, we deployed both parents with GPS devices, allowing us to follow the parental activities, with a focus on their investment in self-maintenance and foraging, in high resolution throughout the complete reproductive season. We found a high variability in the division of care between pairs, which coincided with among individual differences in foraging specialisation and foraging habitat. Parental cooperation improved offspring development, which became particularly evident when parents experienced harsh environmental conditions.

Patterns and drivers of breeding phenology across multiple seabird species in the North Atlantic

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Environmental conditions in marine ecosystems are highly dynamic, causing fluctuations in resource availability across space and time. To ensure successful reproduction, individuals may respond to cues which allow them to adjust timing of breeding to better match suitable conditions later in the season. This may be particularly important for organisms with long breeding seasons, such as seabirds, which would benefit from predicting food resources several weeks prior to laying. In the North Atlantic, factors driving breeding phenology have been identified for some seabird populations, but it remains unclear whether these apply across their geographic range. Breeding phenology may reflect conditions at breeding grounds, overwintering areas, or both: the effects of which may be masked by testing a single driver of phenology at a certain point in time. Thus, we lack holistic understanding of the spatiotemporal scales at which seabirds may respond to environmental change. Using a novel approach, we combined 47 long-term datasets on breeding phenology from 9 species across 30 years, to identify predictors (species, breeding or wintering grounds) among populations. Understanding the degree of synchrony in timing of breeding among populations will help resolve the spatial scale at which extrinsic cues drive phenology in this ocean basin.



Responses to anthropogenic perturbations: Influence of landfill closure on gull foraging behaviour.

Liam Langley*, Steve Votier, Stuart Bearhop, Niall Burton, Chris Thaxter, Emily Scragg, Tim Frayling, Alex Banks

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Anthropogenic habitat modification has created novel opportunities for generalist species but may have unforeseen costs. Several gull species have undergone rapid demographic expansion, partly in response to an increase in availability of anthropogenic food resources; however landfill closures are set to diminish these subsidies and further alter the resource landscape. Using precision GPS tracking data from breeding Lesser Black-backed Gulls (*Larus fuscus*), we investigate the foraging response of these generalists to the closure of a major landfill site. We reconstruct foraging movements before and after landfill closure and test for changes in foraging range, foraging effort, foraging site fidelity and route fidelity. Another key question is the extent of individual foraging specialisation and how this may influence a bird's ability to switch to alternative foraging habitats in response to changes in the resource landscape. We also therefore investigate how habitat selection changes in response to landfill closure. Understanding how gulls change their foraging behaviour in response to the loss of key anthropogenic resources will allow us to better address conservation and management issues arising from impending changes in resource availability.

Sea-surface temperature and thermocline shape the temporal organization of foraging behavior in an inshore seabird, the little penguin.

Xavier Meyer*, Andrew J. J. MacIntosh, Andre Chiaradia, Akiko Kato, Francisco Ramirez, Cédric Sueur, Yan Ropert-Coudert

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Under climate change, seabirds can provide a means to monitor rapid changes in the marine environment. An emerging approach uses fractal analysis to assess structural complexity in behavioural sequences, yet identifying how such complexity is affected by intrinsic and extrinsic parameters remains underexplored. Here, we examined how diving parameters and complexity in the temporal organization of foraging sequences in little penguins (*Eudyptula minor*) are influenced by sea-surface temperature (SST), water stratification and wind speed in the central Bass Strait over 10 breeding seasons (2001 to 2012). While wind speed was unrelated to diving behaviour, little penguins in colder and less stratified waters exhibited more stochastic foraging sequences but also lower foraging efficiency, higher mean dive depth and lower numbers of dives than individuals foraging in warmer and more-stratified waters. This can be interpreted as birds allocating a greater proportion of their diving activity to exploration when prey patches are less predictable in colder and less-stratified waters. Our approach linking environmental conditions and fractal complexity in behaviour provides novel information about the influence of the environment on behavioural processes in diving seabirds.



The importance of tuna and marine productivity for tropical seabirds

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Foraging with tuna is a well-documented seabird strategy, referred to as facilitated foraging. However, despite this behaviour being considered almost obligatory in nutrient-poor tropical waters, little data exist on its relative importance to individual colonies. Therefore, we tracked wedge-tailed shearwaters *Ardenna pacifica* from a tropical and subtropical colony to compare foraging behaviour relative to oceanographic covariates and predicted distributions for multiple tropical tuna species and age-classes, simulated by an existing ecosystem model (SEAPODYM). Shearwaters from both colonies undertook long trips to deep, pelagic waters close to seamounts and foraged most often at fronts and eddies. Micronektonic and adult tuna age classes were highly correlated in space, representing likely facilitated foraging opportunities for shearwaters. Shearwaters consistently foraged in areas with higher predicted adult skipjack and micronektonic tuna densities and avoided adult bigeye tuna. Long trips in the tropics targeted oligotrophic waters with higher tuna densities. Long trips in the subtropics targeted enhanced productivity, but in some years shifted to target the same oligotrophic, tuna-dense waters used by tropical conspecifics. We conclude that facilitated foraging with tuna is consistently important to the tropical breeding population and becomes increasingly important to the subtropical population in years of low marine productivity.

Capturing realism in population assessment

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Assessment of seabird populations requires continued appraisal of how realism is captured. Population Viability Analysis is a common tool, but outcomes are sensitive to assumptions about density-dependence, environment and demography. If it were possible to quantify, using empirical data, estimates for regulatory population processes there could be an associated increase in realism in predictions. Using state-space models fitted to population time-series from three sympatric seabird populations selected for their diverse life histories, we observed the extent to which their dynamics are driven by environmental stochasticity and density-dependence. We conducted an exhaustive PVA across credible scenarios for intrinsic and extrinsic population regulation, simulated as a closed and re-seeded system. Estimates of anthropogenic mortality, applied along a scale of precaution, were applied both proportionally and as a fixed quota. Results revealed clear environmental regulation in two of our three species. Closed versus re-seeded models showed a large divergence in outcomes, with sharper declines in closed simulations. Mortality type affected decline, with fixed quota inducing greater population decline comparative to proportional. Sharp declines occurred under very precautionary applications of mortality. This work used empirically derived, realistic parameterisation scenarios and found real risks of decline, to real populations even under very precautionary mortality.



Unraveling the drivers of at-sea foraging distribution in a long-range seabird

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Foraging distributions of colonial central place foragers are shaped not only by environmental factors but also by population parameters: larger colonies will deplete resources around the colony and will therefore have larger foraging areas, but parapatric competition will often cause spatial segregation, leading to little overlap among foraging areas of neighbouring colonies. This spatial structure has been well established for medium-range seabirds, such as gannets, but the effects of these factors on the foraging distributions of long-range birds such as shearwaters remain unclear. We GPS-tagged 92 adult Cory's shearwaters (*Calonectris borealis*) from three neighbouring colonies in the Canary Islands: Veneguera (Gran Canaria), Timanfaya (Lanzarote) and Montaña Clara Islet (Chinijo Archipelago) during the chick rearing season of 2015. Using innovative point pattern analysis, we modelled the foraging locations of birds in relation to a large set of environmental, individual and population variables to infer their at-sea distribution during breeding. Our results showed that there is little spatial segregation between individuals of different colonies in the main foraging areas. Interestingly, our model suggested that some factors besides environmental variables can affect foraging distributions, underlining the relevance of including population and individual parameters in species distribution models to effectively understand their underlying causes.

From effects to impacts: Analysing displacement of Red-throated Divers (*Gavia stellata*) from offshore wind farms using aerial surveys and tracking data

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Red-throated Divers (*Gavia stellata*) wintering in European marine waters are amongst the most sensitive species to anthropogenic disturbances. In this study, diver displacement from offshore wind farms in a main staging area in the German Bight, partly declared as SPA, was investigated using large-scale digital aerial video surveys and satellite tracking of individuals caught at site. Results from habitat modelling indicate a large-scale displacement response of Red-throated Divers following a gradient of reduced densities extending 10 km. Tracking data revealed extensive home ranges of several thousand square kilometres of Red-throated Divers in the German North Sea and though displacement effects of wind farms are rather strong, they affect only part of individual home ranges. However, detailed investigations of individual tracks also indicated changes in movement patterns depending on the distance to the closest wind farm. Displacement effects from offshore wind farms are related to population development in the area and discussed in the context of species conservation and future OWF planning decisions. It is concluded that approaches to monitor wind farm effects should consider both large-scale movement patterns of mobile seabirds as well as large-scale effects from offshore wind farms.



How seabird science can have policy impact

Peadar O'Connell*,

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Informing policy is an important but often difficult goal for conservation science where key messages need to be carefully extracted from research and presented appropriately to specific audiences. The RSPB is in an excellent position to do this as science and policy occur within the same organisation. One of RSPB's most ambitious science projects to date has been tracking seabirds from breeding colonies around the UK. This work has provided incredible insights into the lives of these seabirds but also, due to the sheer scale of data, it has allowed additional analyses to be conducted that can help identify important areas at sea for birds and where they may be most at risk from different marine activities. This information has enormous applicability in advocacy for seabird conservation where the aim is to inform national and regional policies or activities. This talk will explore the process by which RSPB use the results from conservation science to advocate for seabird conservation, such as marine protected areas and ecosystem based marine planning, using the seabird tracking work as an example.

Spatial scales of marine conservation management for breeding seabirds

Steffen Oppel*, Mark Bolton, Ana Carneiro, Maria Dias, Jonathan A. Green, Juan F. Masello, Ellie Owen, Richard A. Phillips, Petra Quillfeldt, Annalea Beard, Sophie Bertrand, Jez Blackburn, P. Dee Boersma, Alder Borges, Annette C. Broderick, Paulo Catry, Ian Cleasby, Elizabeth Clingham, Jeroen Creuwels, Sarah Crofts, Richard Cuthbert, Rachel Davies, Delia Davies, Ben Dilley, Herculano Andrade Dinis, Justine Dossa, Mike Dunn, Marcio Efe, Annette Fayet, Leila Figueiredo, Adelcides Pereira Frederico, Carina Gjerdrum, Brendan J. Godley, Jose Pedro Granadeiro, Tim Guilford, Keith Hamer, Carolina Hazin, April Hedd, Leeann Henry, Marcos Hernández-Montero, Jefferson Hinke, Nobuo Kokubun, Eliza Leat, Laura McFarlane Tranquilla, Benjamin Metzger, Teresa Militão, Gilson Montrond, Wim Mullié <>, Oliver Padget, Elizabeth Pearmain, Ingrid Pollet, Klemens Puetz, Flavio Quintana, Norman Ratcliffe, Robert Alfredo Ronconi, Peter Ryan, Sarah Saldanha, Akiko Shoji, Jolene Sim, Cleo Small, Louise Soanes, Akinori Takahashi, Phil Trathan, Wayne Trivelpiece, Jan Veen, Ewan Wakefield, Nicola Weber, Sam Weber, Laura Zango, Jacob González-Solís, John Croxall

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Knowing the spatial scales at which effective species management can be implemented is fundamental for conservation planning. We examined the space use patterns of Atlantic seabirds to provide guidance on whether conservation management approaches should be tailored for families with different movement scales. We synthesised tracking data from 5419 adult breeding individuals of 52 different species in ten families that were collected between 1998 and 2017. We quantified how far seabirds ranged from their colony, and to what extent individuals from the same colony used the same areas at sea. There was evidence for substantial differences in patterns of space use among the ten studied seabird families, indicating that several alternative conservation management approaches are needed. Several species exhibited large foraging ranges and little aggregation at sea, indicating that area-based conservation solutions would have to be extremely large to adequately protect such species. Short-ranging and aggregating species such as cormorants, auks, penguins, and gulls would benefit from conservation approaches at relatively small spatial scales during their breeding season. However, improved regulation of fisheries, bycatch, pollution and other threats over large spatial scales will be needed for wide-ranging and dispersed species such as albatrosses, petrels, storm petrels and frigatebirds.



Using digital photography and citizen science to describe spatial variation in puffin diet

Ellie Owen*, Sian Haddon, Chris Cachia-Zammit, Georgia Longmoor, Oliver Prince, Fritha West, Robert Hughes

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Puffins are one of the most photographed of British birds but concern is mounting as low productivity and steep declines are recorded in former strongholds of their European range. Poor breeding success at some UK sites has been linked to low food availability but puffin diet data is only available for a handful of colonies. Smartphones and digital cameras have increased opportunities to take and share high quality photographs. We combined the people-power of visitors to puffin colonies with advances in camera technology by inviting citizen scientists to submit photographs of puffins carrying prey from colonies across the British Isles. We advertised the project over broadcast and social media and at colonies. Uptake was high with 602 “Puffarazzi” volunteers submitting 1402 pictures from 39 colonies and picture quality excellent with 97% of pictures useable for prey identification. A team of six interns identified the species and size composition of prey in each photograph and recorded their level of confidence associated with their identification. We present the resulting data, showing what coverage is possible using volunteers and providing the first UK scale assessment of spatial variation in puffin diet, and share our experience in citizen science projects using digital photography.

Age, density, prey, and climate drive the demographics of an apex predator

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Ecologists widely acknowledge that a complex interplay of endogenous and exogenous factors impact demographic processes and that individuals respond differentially according to their age, ultimately shaping the population dynamics of wild species. Here we provide an insight of the mechanisms affecting four vital rates (survival, breeding, successfully breeding with one, and with two chicks) of an apex Antarctic marine predator population by combining longitudinal time series of know-age individuals, abundance data, climatic and prey abundance covariates. We found evidence for age-related changes in the four vital rates studied with traits smaller and with a larger temporal variance at younger ages. Results clearly evidenced an impact of extrinsic factors, with a direct influence of local climate (summer sea ice concentration) and of available prey resources (penguins), and of intrinsic factors (size of the breeding population). More covariate effects were found on reproductive traits than on survival traits, and age classes responded differentially to these effects, the younger age classes being more sensitive than the older ones. Using a half a century dataset, we provide a compelling evidence to support the importance of considering multiple causal effects when studying demographic process in seabirds and the impact of environmental variability.



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Predictable Anthropogenic Food Subsidies Decouple Inter-Specific Temporal Synchrony

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Predictable anthropogenic food subsidies (PAFS) can buffer the influence of environmental stochasticity on animal populations. As a result, originally environmentally synchronized systems can become uncorrelated. We investigate the consequences of European policies implementation — aiming at the progressive reduction of landfill human waste — on interspecies temporal synchrony of two sympatric marine top predators with different foraging strategies: one marine opportunistic specialist — the Scopoli's shearwater — versus one opportunist generalist — the Yellow-legged gull). Using data collected over 15 years, cross-correlation analysis and a state-based Markov chain modelling approach, we identified periods in which egg volume variations — as an indication of food accessibility at any given year — were coupled to investigate the hypothesis that PAFS disrupt synchrony of systems otherwise correlated. Our results show that perfect synchrony occurs after the disappearance of the largest local open-air landfill indicating that coupling is mediated by shared environmental signals and that PAFS can mask interspecific synchrony.

Colony overlap in foraging areas and offshore habitat by incubating Leach's Storm-Petrels *Oceanodroma leucorhoa* in the Northwest Atlantic.

Ingrid Pollet*, April Hedd, Robert Mauck, Neil Burgess, Chantelle Burke, Carina Gjerdrum, Mark Mallory, Laura McFarlane Tranquilla, William Montevecchi, Gregory Robertson, Robert Ronconi, Dave Shutler, Sabina Wilhelm

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Spatial ecology of small seabirds is only recently being investigated with increasing miniaturization of tracking devices. Leach's Storm-Petrel is a species in decline in Atlantic Canada, for which the causes of decline are still unclear. We tracked Leach's Storm-Petrels during incubation with geolocators in 2013 and 2014 from seven colonies, and with GPS in 2016 and 2017 from four colonies, in parts of their breeding range in Atlantic Canada. Individuals made foraging trips of 4.0 ± 1.4 days into pelagic waters, 400 to 830 km from colonies. Foraging ranges were shorter at lower latitudes. Core areas used by the different colonies did not overlap significantly, though most birds foraged over waters > 1,950 m deep with average chlorophyll a concentrations of 0.6 mg/m³. Sea surface temperatures of foraging areas ranged from 11-23°C among colonies. Tracking from four of the seven colonies overlapped with offshore oil and gas operations, three of which have experienced declines in recent decades. Future work should prioritize modelling efforts to better understand the multiple factors likely driving the species' declining in the North-West Atlantic, the core of the species' distribution.

Population models to assess the cumulative impacts of wind farm developments in the southern North Sea on seabirds and migrating waterbirds

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Offshore wind farms may affect birds by direct mortality due to turbine collisions, or by indirect mortality through habitat loss. The rapid growth in offshore wind farms in recent decades calls for studies into the cumulative impacts of these developments and specific consideration should be given to the impact on the population level. A recent cumulative impact assessment of existing and proposed wind farm developments identified 15 bird species for which the predicted additional mortality due to offshore wind farms was close to the provisionally applied threshold as calculated by Potential Biological Removal (PBR). These species were red-throated diver, Bewick's swan, brent goose, common shelduck, lesser black-backed gull, great black-backed gull, herring gull, kittiwake, great skua, Eurasian curlew, black tern, Sandwich tern, guillemot and razorbill. In the current follow-up study, we constructed Leslie matrix models for these species, and show how long-term effects of additional mortality on the population-level can be assessed, incorporating various factors such as density dependence, stochasticity between years and uncertainty in various parameters.

Foraging ecology of a winter breeding species, the Fiordland penguin

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Income breeding species reproduce when resource availability is most favourable. Correspondingly, in temperate and polar seabirds, the majority of species breed during spring/summer. While there are a few exceptions worldwide of winter-breeding, the highest concentration (17 species) occurring in New Zealand, little is known of the factors which lead to this unusual strategy. The Fiordland penguin (*Eudyptes pachyrhynchus*), endemic to New Zealand, has one of the smallest penguin populations and breeds in late-winter, in small dispersed groups. How the nominally lower food availability at this time and low population density affects the foraging ecology of this reportedly schooling prey-consuming species is not known. In the present study, the at-sea movements, foraging behaviour and isotopic niche of Fiordland penguins from Open Bay Islands were determined during two breeding seasons. Individuals ($n = 37$) foraged up to 42 ± 5 km from the colony on trips of 43 ± 6 h, with dive depths of 22 ± 3 m. While their dive rate (1160 ± 5 m·h⁻¹) revealed a similar foraging effort to other *Eudyptes*, isotopic analyses suggest a different trophic niche. Fiordland penguins, therefore, may be benefitting from local prey resources uniquely abundant in winter to meet reproductive needs.



Population impacts of plastic ingestion in Procellariiforme seabirds

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Plastic pollution is an environmental problem at a global scale. Seabirds commonly mistake plastics for food, with more than 400 species known to ingest plastic and 99% of all seabird species predicted to ingest plastic by 2050. Recent marine debris risk modelling has highlighted the oceanic region between the Southern Ocean and the Tasman sea as the highest risk region for marine debris and seabird interaction globally. Despite the potentially significant conservation issue that plastic ingestion poses to seabirds globally, very little is known of extent and impact of plastic ingestion among Australasia's 66 Procellariiforme seabirds, and nothing is known about the mortality or sub-lethal health impacts that result from plastic ingestion. Here I will present results of my PhD research, combining the largest study of plastic ingestion globally in Procellariiforme seabirds to date with the world's first plastic ingestion health impacts laboratory experiment using a model bird species. We conducted necropsies over four years covering over 1700 seabirds of 53 species, and undertook a laboratory experiment studying multi-generational impacts of plastic ingestion on avian development, reproduction and endocrine system. I will present the findings of these two studies and discuss the implications for seabird populations.

Terrestrial uplift shapes flight routes of generalist gulls (*Larus fuscus*, *Larus argentatus*) in typically flat landscapes

Elsbeth Sage*, Willem Bouten, Bart Hoekstra, Kees Camphuysen, Judy Shamoun-Baranes

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The foraging movements of generalist gull species are increasingly constrained by human activity, both at sea, where species such as lesser black-backed gulls, *Larus fuscus*, are expected to forage, and inland, where they are increasingly found feeding on anthropogenic food sources. Terrestrial atmospheric dynamics differ significantly compared to at sea and the ability of gulls to aerially traverse such a landscape is not well understood, but we expect these adaptable fliers utilise air movements opportunistically to save energy during flight. We investigate the degree to which large gulls (*Larus fuscus*, *Larus argentatus*) utilise fine scale low altitude lift created by upward deflections of wind moving over landscape features. Using accelerometer measurements in conjunction with GPS tracking, soaring flight is identified and analysed with respect to the modelled uplift in the landscape. The relationship between the energy available from terrestrial uplift and the flight routes taken suggests that gulls have an advanced knowledge of their aerial surroundings and the benefits to be gained from them. We show that in a landscape constantly under the influence of anthropogenic alteration, the structure and elevation of our landscape has not only a terrestrial but also an aerial impact on flight route connectivity and costs.



Large-scale tracking of seabirds in the Northeast Atlantic – SEATRACK

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Many seabird species conduct extensive seasonal migrations, often between different marine ecosystems or between marine areas under different national jurisdictions. Until recently, it has been difficult to follow the seasonal movements. The development of Global Location Sensor (GLS) loggers has greatly enhanced our ability to track seabirds during this period, making it possible to document "hotspots" and characterize the at-sea ecology of seabirds. However, to take full advantage of this development there is need for a multi-year/-site/-species design. The SEATRACK program (2014-2018) with participants from Norway, UK, Faroes, Iceland and Russia aim to identify the year-round distribution and movements of 11 species of seabirds breeding in 36 colonies encircling the Northeast Atlantic. Output from the program include maps of important marine habitats for the different populations, and quantification of how changes in environmental conditions in non-breeding areas affect demographic trends. By 2017 almost 9,000 loggers had been deployed and data from 3,200 retrieved loggers have been analyzed and compiled (<http://seatrack.seapop.no/map/>). The design and major data products from the SEATRACK program are presented as well as visualizations of the seasonal marine habitats and migration pattern of Atlantic puffins, Brünnich's guillemots, common guillemots and black-legged kittiwakes.

The benefits of dining alone: animal-borne video cameras provide insights into foraging decisions by Macaroni Penguins

Grace Sutton*, Charles-André Bost, Kane Mitchell, Scott Adams, Abbas Kouzani, John P.Y. Arnould

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Search effort and energy expenditure are greatly influenced by the abundance and distribution of prey. Information on this has long been inferred from behavioural responses of predators or indirect indices of prey abundance. However, such methods rarely provide the temporal and spatial resolution required to accurately measure the prey-field changes necessary for detecting predator responses. Technological advances in the miniaturisation of animal-borne video cameras now provide the ability to observe predator-prey interactions. Using animal-borne video data loggers, tri-axial accelerometers and time-depth recorders, this study investigated the hunting effort of female Macaroni penguins (*Eudyptes chrysolophus*) in response to prey type and patch density. Breeding individuals from Kerguelen Islands consumed mainly subantarctic krill, expending a greater foraging effort at higher density prey patches. Interestingly, prey capture rate per dive increased significantly the longer individuals stayed at the prey patch, potentially reflecting increased hunting efficiency with patch depletion. Surprisingly, individuals exhibited mainly solitary feeding suggesting hunting of less mobile prey may not require associations with conspecifics while foraging as has been observed in other penguin species consuming schooling fish. This provides new insights into how penguins respond to variability in prey abundance, crucial for predicting how their population may respond to environmental change.

Foraging decisions of marine predators: availability or density of prey?

Eugénie Tessier*, Yves Cherel, Nolwenn Béhagle, Gildas Roudant, Charles-André Bost
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In the marine environment, the prey distribution is patchy, resulting from interactions between physical and biological processes. Marine predators should have advantage to at-sea distribute and forage in the areas with the highest reward in order to maximize their foraging success. Few studies have however compared the foraging patterns of predators in relation to prey abundance and availability through real-time oceanographic surveys. During 2013/2014, the research cruise MYCTO offered a unique opportunity to collect simultaneous data on the foraging movements of tagged, diving predators (king and macaroni penguins) and their prey (mesopelagic crustacean and fish abundance) assessed through acoustic survey coupled with scientific trawls, in the three dimensions of the ocean. The study was performed right on and outside the foraging spots of predators, at the east of Kerguelen, southern Indian Ocean. Penguins used the most profitable habitat and not the richest, prospecting especially in the branch of cold water of the Antarctic Circumpolar Current. The choice of foraging area was not driven by the total biomass available but by resource available per unit of foraging time. The results are discussed with respect to the predictions of optimal diving theories and the potential use of diving predators as bio-samplers.

GPS and accelerometer data reveal insights into fine-scale behaviour of gulls at offshore wind farms

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Wind farms pose a direct collision risk to birds. The extent of collision risk may vary between species and sites due to differences in birds' use of sites, flight altitudes, flight speeds and behaviour, yet we still lack fundamental understanding of how birds behave and interact within wind farms. We used high resolution GPS and accelerometer data to examine the behaviour of Lesser Black-backed Gulls *Larus fuscus* from a declining coastal colony at South Walney, UK, within nearby operational offshore wind farms. We compare different methods for assessing behaviour: (i) Hidden Markov Models and Expectation-Maximization Binary Clustering based on GPS data; and (ii) a previous classification based on accelerometer data (Shamoun-Baranes et al. 2016), both informed by GPS altitude. Based on analysis of accelerometer data, birds primarily spent their time within wind farms in flapping and gliding flight or resting on the sea; very slow movements were also recorded around individual turbines, with occasional movements between turbines. Modelling of GPS data suggested similar behaviours, but some differences in their extent, e.g. in likely foraging bouts. By better understanding species' behaviour within wind farms, this work will provide the basis for collision risk estimates to be refined.

The consequences of environmental heterogeneity for foraging behaviour and reproductive success

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Environmental heterogeneity is ubiquitous in nature, and shapes the uneven distribution of resources to predators. Optimal foraging theory predicts that an animal's ability to exploit resource patches is key to success, however the potential costs and benefits of foraging in a heterogeneous environment to fitness are difficult to test empirically. Here, we test the effect of environmental heterogeneity on foraging behaviour and reproductive success in 15 colonies of black-legged kittiwakes throughout their UK range. We find that environmental heterogeneity was associated with increased overlap of foraging areas between individuals, longer foraging trip duration, and more time spent actively foraging whilst away from the colony. These results suggest that heterogeneity increases competition between individuals, which explains why we also found lower population breeding success in heterogeneous environments. Given that reproductive success exerts an important influence on population dynamics, our result that foraging in heterogeneous environments comes with high fitness costs suggests that environmental heterogeneity may ultimately control species distributions.

Energetic consequences of foraging in different habitats

Susanne van Donk*, Judy Shamoun-Baranes, Willem Bouten, Jaap van der Meer, Kees Camphuysen

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Generalist seabirds consist of individuals which utilise various prey types or foraging sites. Every prey type requires different foraging skills and knowledge and can have advantages and disadvantages. For instance, feeding on high caloric anthropogenic foods such as rubbish and fishery discards appears to be beneficial for reproductive success in a generalist seabird, the herring gulls. However, such preys might come with relatively high foraging costs, as competition for these prey types is fierce and might involve risks for injury. Other prey types that are available for the gulls, like shellfish, are less profitable in terms of calories but might be easier to obtain. In this paper, we investigate whether foraging in an anthropogenic foraging habitat is energetically costlier than foraging in other foraging habitats like intertidal area or agriculture and natural areas, during chick rearing. To answer this question, we use data from GPS trackers with tri-axial acceleration measurements. These allow us to quantify time-energy budgets, representing energetic expenditure during foraging trips of herring gulls for each habitat. Our results showed that foraging in anthropogenic habitat is indeed energetically more costly and we consider the consequences of these costs through human induced changes in the food landscape.



Ecologically informed and dynamic distribution maps for seabird communities in the north-eastern Atlantic Ocean

James Waggitt*, Peter Evans, Jan Geert Hiddink

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Quantifying spatial and temporal variations in the distribution of seabirds is a fundamental component of their conservation. A common approach uses vessels or aircraft to record animals along transect lines, and species distribution models or geostatistical interpolation to produce density surfaces. However, individual surveys cannot record distributions at annual, seasonal and continental scales. The tendency to use spatiotemporally explicit information when constructing density surfaces also produces outputs representing instantaneous distributions at the time of surveys or the intensity of survey effort, rather than overall distributions. This study uses a combination of methods to produce density surfaces of 12 species at a monthly and 10km resolution over 30 years in the north-eastern Atlantic. First, 1.6 million kilometers of surveys were collated from 15 sources. Second, ecologically informed species distribution models based on relevant environmental variables were developed. This approach produced sensible estimations of population sizes and distributions in the study area, whereas temporal variations in these measurements were as expected. These widely applicable approaches provide inputs into a range of complementary analyses into ecosystem-level processes, as well as management strategies aiming to identify and mitigate impacts on populations.

Using habitat models for chinstrap penguins *Pygoscelis antarctica* to advise krill fisheries management during the penguin breeding season

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Marine ecosystems are increasingly threatened by anthropogenic disturbance, so understanding where marine predators forage is vital for ecosystem-based marine spatial planning. One of the main challenges in achieving this goal is obtaining a comprehensive description of a species distribution from incomplete tracking data. Using habitat models to understand which variables influence the distribution of predators at-sea can enable us to predict the distributions of un-tracked populations, and thus help to identify any potential threats they may face. In the Southern Ocean the expanding krill fishery has the potential to impact penguin populations. We show that the foraging distribution of breeding chinstrap penguins can be predicted using two simple variables; the distance to the colony and a measure of the direction of travel towards the shelf-edge, whilst avoiding high densities of *Pygoscelis* penguins from other colonies. Additionally, we find that the chinstrap penguins breeding on the South Orkney Islands use areas which overlap with frequently used krill fishing areas. With this in mind, we recommend the implementation of monitoring schemes to investigate the effects of prey depletion on predator populations, and to ensure that management is addressed at spatial and temporal scales relevant to ecosystem operation.



Contrasting effects of climate on phenology of two sub-Arctic marine predators

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Climate change is shifting phenology of organisms across the globe, and these shifts disproportionately affect polar regions. Phenotypic plasticity could buffer the effects of climate change on populations. However, responses to climate change may be different for seabirds that associate with sea-ice compared with non-ice associated seabirds, as the response of pagophilic seabirds is likely to trace ice breakup through which food becomes accessible. We use long-term data to examine laying date plasticity in two sub-Arctic seabirds: thick-billed murres (*Uria lomvia*) and black-legged kittiwakes (*Rissa tridactyla*). Thick-billed murres laid earlier in years with earlier sea-ice break-up, while black-legged kittiwakes laid later in years with higher Pacific Decadal Oscillation index, which is associated with warmer oceanic conditions. Thus, climate change will likely advance timing of reproduction in thick-billed murres, but delay reproduction in black-legged kittiwakes. Our findings highlight that climate change can have a range of effects on phenology.

Seabirds and Windfarms: New Insights from a Kittiwake Case Study

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Offshore wind energy is predicted to be the second fastest growing renewable energy sector in the EU by 2020. Consequently, there is an urgent need to improve our understanding of the vulnerability of marine wildlife to such developments. Here we present recent results and future plans for the RSPBs multi-year seabird tracking work in the UKs largest mainland seabird colony, adjacent to some of the biggest offshore wind energy developments planned globally. Aiming to strategically fill knowledge gaps around environmental risk assessments, we recently found, for example, that the vulnerability of Black-legged kittiwakes (*Rissa tridactyla*), a species that's predicted to be especially at risk of windfarms, is i. not homogenous across space: There is a substantial variation between behaviour specific offshore distributions. ii. not constant within distinct parts of the breeding season: There is a continuous increase of foraging range and shift in offshore distributions of birds tracked up to 30 days across chick rearing. iii. not affected by nest failure: Although failed birds increase trip duration and distance, range is not affected, and failed birds visit the same sites as active breeders. Results show that adding behaviour information and tracking individuals for longer, including after failure, can improve predictions.

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Poster Abstracts

Factors influencing prey capture rates and foraging efficiency in little penguins

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Knowledge of the factors that influence hunting success and foraging efficiency in predators is central to understanding how their populations may respond to environmental change. The waters off south-eastern Australia, one of the fastest warming oceanic regions in the world, are expected to experience oceanographic changes that will impact the diversity, distribution and abundance of prey for many marine predators. In the present study, little penguins (*Eudyptula minor*) from two colonies in the region experiencing divergent oceanographic conditions were instrumented with a combination of GPS, accelerometer and dive behaviour data loggers to investigate the intrinsic (sex, mass, morphometry, behavioural consistency) and extrinsic (environmental, breeding stage) factors influencing prey capture rates and foraging efficiency. Data were obtained from 192 individuals (including 56 with multiple deployments), during 374 foraging trips, throughout the breeding seasons of 2012-14. Site and year were found to have the greatest influence on prey capture rates and foraging efficiency, reflecting the spatial and temporal differences in prey type observed in recent animal-borne camera studies. However, the results also indicated an influence of morphometry and sex, suggesting the way shape and size impacts an individual's foraging efficiency may be prey-type dependent.

Stable isotope analyses reveal inter- and intra- specific foraging niche segregation during different reproductive periods in two sympatrically breeding storm-petrel species

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For pelagic seabirds food abundance in marine foraging areas is considered patchy and unpredictable, forcing the birds to wander the ocean searching for areas with high food abundance during all reproductive stages. Studying foraging ecologies of pelagic species can be hard, as many are only available when they come to land to breed. We studied two small, sympatrically breeding pelagic seabirds on King George Island, Antarctica; Wilson's (*Oceanites oceanicus*, WSP) and black-bellied storm-petrels (*Fregetta tropica*, BBS). Stable isotope analyses were done on samples of chick down and under-tail-coverts, and adult tail feathers grown during the non-breeding period. $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ signatures generally differ between foraging areas while $\delta^{15}\text{N}$ increases systematically with trophic level. Preliminary results from analyses of isotopic niche partitioning (with SIBER in R) revealed differences in winter foraging ecology within and between species. The foraging strategy during egg production and chick provisioning did not seem to differ for WSP and overlapped with BBS isotopic niches during egg production. BBS chicks seemed to be fed on higher trophic levels compared to WSP chicks. Sex had no influence on any foraging strategy. These results seem to imply that birds breeding in the same area can have distinctly different foraging ecologies.



Do extreme environmental factors affect the population ecology of Manx shearwaters and Black-legged kittiwakes on Skomer Island?

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Weather directly impacts productivity and adult survival of seabirds, and as extreme weather events are set to increase in frequency and intensity this may become an important factor in population persistence. The aim of this study is to investigate the impacts of extreme weather events on Manx shearwaters and Black-legged kittiwakes on Skomer Island, Pembrokeshire, where these seabirds have been studied for decades. Between them, Skomer and nearby Skokholm hold more than half the global population of Manx shearwaters, therefore the Skomer population is of vital international importance. Black-legged kittiwakes are in nationwide decline, including on Skomer, and a recent European assessment has listed them as vulnerable. The existing dataset will be analysed, along with data from weather stations, to explore the impact extreme weather events have had on the long-term population dynamics of these species. Preliminary results will be presented from statistical analysis on the associations between productivity, survival and varying weather conditions. As our climate becomes more variable and unpredictable the effects of extreme weather may add more sustained pressure to seabirds already facing decline, confounding the multiple threats they currently face and potentially inhibiting any chance of recovery.

feeding-strategies of Great Black-backed gull pairs determines population-level impacts of predation on Atlantic Puffins

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Predatory species are regularly controlled by conservation managers through culls in order to alleviate threats to species of conservation concern. However, the efficacy of culls is hugely variable especially in species where predators exhibit great variation in feeding-strategy. Additionally, management may be further complicated where predatory species are also protected. Great Black-backed gulls (GBBG) (UK amber-listed) are known to predate Atlantic Puffins (UK red-listed and globally 'Vulnerable') however, the importance of Puffins in GBBG diets and the resulting impact on Puffin populations are poorly understood. Through analysing pellets of regurgitated prey remains from GBBGs on the Isle of May in 2017 we demonstrate that the distribution of Puffins in GBBG diet is bimodal, indicating individual specialism such that 5.5% of GBBGs predated 57% of Puffins. We also show that specialist gulls predate significantly more adult Puffins than generalists and hence have the greatest potential to drive declines in Puffin populations. Overall, we demonstrate that in order to devise effective management strategies for problematic predatory species, determining the presence and extent of feeding specialism is vital.



The first Irish GPS tracking of Atlantic puffins reveals a novel form of foraging

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Under optimal foraging theory, an animal aims to gain the most benefit (energy) for the lowest cost. In marine systems, where prey distribution is patchy, seabirds often optimize search efficiencies using a random walk with a skewed distribution of step lengths resulting in clear patterns of Area Restricted Search. Here we present results from the first GPS tracking of puffins in Ireland suggesting an alternative foraging strategy. Puffins travelled an average of 16.6km +/-7.1km to foraging grounds, and upon arrival decreased speed (average 2.6 km/h) and undertook directed easterly or westerly travel for approximately 6 hours. Speeds were consistent with drifting on tidal currents, and abrupt changes in direction correlated with slack tide. Concurrently deployed dive loggers showed dives throughout drifts. Daily energetic expenditure was calculated for drift foraging as well as undertaking the same trip using flight, mixed effects regressions showed that the drift strategy was significantly more energetically efficient ($\chi^2_{21}=49.208$, $R^2=0.459$, $p<0.001$). The use of tidal flows in this manner is previously unreported in seabirds and we suggest that the drift strategy provides puffins with an efficient method of movement between prey patches consistent with optimal foraging theory.

Colony attendance in Great Cormorants: Variation in relation to age, sex and breeding status

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Knowledge about age-specific phenology is of relevance for understanding a species' life history. We use data on date of first and last observation of more than 5000 colour-ringed Great Cormorants (*Phalacrocorax carbo sinensis*) observed in a Danish breeding colony. Daily observations of colour-ringed individuals were carried out from an observation tower throughout each of 22 seasons. Despite extensive year-to-year variation in timing of arrival, we found clear differences between sexes and among age-classes in their timing of arrival to and departure from the colony. Among breeding active individuals, males arrived approximately one week before females, but females remained slightly longer in the colony than males. Among breeders, older males arrived up to two weeks earlier than younger males, whereas older females only arrived a week earlier than younger individuals. The age-related differences in arrival times diminished from the first to the second part of the study period. The timing of departure from the colony advanced markedly over the years, regardless of age, sex and breeding status. These changes were probably related to an increasing shortage of food over the study period.

Developing a passive acoustic monitoring technique for Australia's most numerous seabird, the short-tailed shearwater (*Ardenna tenuirostris*)

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In order to determine seabird population dynamics and the factors influencing them, well-coordinated monitoring systems are required. However, estimating population sizes and trends can be difficult due to logistical constraints in accessing remote breeding sites, wide geographic breeding ranges and, in many cases, burrow-nesting species. The short-tailed shearwater (*Ardenna tenuirostris*) is Australia's most numerous seabird, with a population size estimated to be 23 million across several hundred offshore breeding colonies in south-eastern Australia. In light of the expected global warming-induced oceanographic changes in the region, there is an urgent need to develop a reliable, inexpensive population monitoring tool for this burrow-nesting species. In the present study, acoustic recorders were deployed at 10 breeding sites, covering a range of nesting densities, over two breeding seasons. Vocal activity was recorded (1 min every 10 min) from sunset to sunrise each day and 5 acoustic indices were developed. Patterns in activity were analysed to determine the most accurate period to correlate with burrow density and occupancy estimates (within a 10 m radius of recorders) in December (incubation) and March (chick-rearing). A predictive relationship between occupied burrow density and vocalisation rate will be derived to facilitate a low-cost, widely-deployable monitoring tool for ecosystem managers.

Tracking seasonal movements of guillemots and razorbills in relation to offshore wind farms

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A principal mechanism underpinning the effects of marine renewable energy (MRE) developments on top predators is displacement from favoured habitats. To date, research on displacement of UK seabirds has focussed on the summer breeding period, yet many species spend some or all of the non-breeding period in UK waters, and there is considerable uncertainty surrounding displacement effects during this time. To achieve electricity generation targets from MRE in a sustainable way, it is therefore critical to address this knowledge gap. At 13 colonies in the northern UK, we used geolocation to track the 2017-18 winter movements of two species considered potentially susceptible to displacement effects: the common guillemot and razorbill. These data allowed us to quantify year-round movements and distribution, and identify key sites used by birds from multiple breeding populations at different periods of the year. Understanding when and where birds from different populations aggregate in winter is central to estimating risk from MRE development outside the breeding season. Our preliminary findings provide key insights into the spatio-temporal interactions between guillemots and razorbills and MRE development, and therefore contribute to the sustainable delivery of offshore renewable energy and effective conservation policy.





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Lack of synchrony between seabird breeding phenology at two colonies in the Norwegian and Barents Seas

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Variability in seasonal timing of reproduction is well documented, but we lack a deeper understanding of the physical and biological mechanisms driving marine predator phenology and at what spatial and taxonomic scales this variability and these drivers are operating. We build on previous phenological studies with a more comprehensive investigation of temporal trends using three of the longest seabird phenology time series in Norway. We found no significant changes in hatching timing in our three data sets (annual averages per species and colony; Atlantic puffin *Fratercula arctica* 1978–2016 at Røst and 1980–2016 at Hornøya, and black-legged kittiwake *Rissa tridactyla* 1995–2016 at Hornøya). Nor did we find evidence for spatial synchrony in timing for puffins between the two colonies, and only slight synchrony between puffins and kittiwakes breeding at the same colony. We further tested for the effect of biologically relevant oceanographic and climate variables on breeding timing, and found different variables to best explain breeding timing in each of our data sets. These results are important in the context of changing physical environmental conditions, especially because phenology is linked to reproductive success and can therefore impact population dynamics and viability.

Island or rooftop: where is the better place to live for gulls?

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Since the first cases in the 1970s, the colonization of towns and industrial sites by gulls has developed considerably in France, first on the coast and then inland. This phenomenon of urbanization of gulls is particularly important in Brittany. Currently, about sixty Breton municipalities are concerned and three species nest on the rooftops, i.e. in descending order of numerical importance, the Herring Gull *Larus argentatus*, the Lesser Black-Backed Gull *L. fuscus* and the Great Black-Backed Gull *L. marinus*. The population growth in urban areas contrasts sharply with the decline recorded in natural colonies since the 1980s and breeding success of urban gulls is much greater than that in natural colonies. Current hypotheses for differences between island and urban colonies are based on differences in the level of interspecific predation and differences in abundance of food resources. Too many knowledge gaps however remain, not allowing to identify the explanatory factors with certainty. More precise data are needed on food and foraging ecology, survival of young individuals and adults, dispersal of individuals according to their natal colony, comparing urban and natural colonies.

Using predictions of statistical models to define the size and shape of marine Special Protection Areas for foraging seabirds - can you believe it?

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The predictions of habitat association models, based on analyses of the foraging locations of breeding terns around several colonies in the United Kingdom, have been used as the basis on which the boundaries to a suite of marine Special Protection Areas (SPAs) have been derived. Public consultation revealed widespread support for the potential SPAs, but scepticism amongst some respondents about the reliability of the models' predictions and concern that boundaries were too extensive and simply 'caught all'. Here we describe a programme of field surveys around the UK confirming the model-predicted presence of foraging terns at the proposed alongshore and seaward boundaries of several of these marine SPAs, and also in many places of intense human activity e.g. marinas, docks etc. that have been included within SPA boundaries. This verification work provides support for the decision to adopt a model-based approach to define the boundaries of these marine SPAs.

Lost in an ocean of data? A new tool for combining tracking data with oceanographic variables in a single click

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Tracking individual birds and combining with data on oceanographic variables is a fundamental approach for studying seabird ecology and behaviour. There are several webtools and statistical packages available to deal with the acquisition and storage of these types of data, but integrating the two remains a challenge. Common uncertainties include the level of spatial and temporal resolution of oceanographic data needed (monthly? weekly? daily?) and how to include data for pseudo-absences (randomly generated or using correlated random walks). The E04WildLife platform is a new webtool designed to facilitate this data integration for seabird researchers. Based on the tracked bird locations, the platform automatically extracts several oceanographic variables (e.g. chlorophyll-a, eddy kinetic energy, sea level anomaly, and sea surface temperature), using data from the new Sentinel satellites and other sources. It provides several options for extracting data on pseudo-absences, and user-defined solutions for temporal and spatial resolution. This platform is also connected to the Seabird Tracking Database (STD), hosted by BirdLife International and now with more than 11 million locations for 116 species. By hosting your data in the STD you can easily access this new tool and extract the oceanographic data – in a single click.



Geographic variation in foraging behaviour of Brünnich's guillemot breeding in Greenland

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Foraging behaviour is strongly influenced by environmental factors and the availability of prey. Thus it is to be expected that geographically separate populations who experience significantly different ecological conditions will also differ in foraging strategies. Many studies however, have only focused on single locations, and thus findings from these studies might only apply to that place at the specific time of execution. With the development of new technologies as well as novel statistical methods we are now able to identify fine scale behaviours and quantify how animals use foraging patches. In this project, we use movement data collected with GPS and Time Depth Recorders to *investigate the geographic variation in the foraging ecology of Brünnich's guillemot (Uria lomvia)* from six breeding colonies along a latitudinal gradient of approximately 2000 km, on the west coast of Greenland. Specifically, we test the hypothesis that changes in patch use exhibited by individuals differs with respect to colony size and environmental factors such as bathymetry, sea surface temperature and primary production.

Spatial fidelity and prey predictability in foraging breeding seabirds

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There is now ample evidence that many seabird populations show individual specialization in foraging behaviour, and spatial fidelity in particular, sometimes across breeding seasons. It is often hypothesized that seabird spatial fidelity is linked to the spatial predictability of prey or prey habitats. Here we examine this question on two “extreme” empirical cases. First, we investigate the levels and persistence of individual fidelity in tropical seabird populations, where prey distribution is assumed to be unpredictable for many top-predators including human fishermen. In particular we report persistent individual fidelity in long ranging frigatebirds over longer time scales than expected, especially compared to short ranging sympatric boobies targeting similar prey. We propose different hypotheses to explain these patterns. In a second step, we investigate spatial predictability in black-browed albatrosses, a species with high and long-lasting individual foraging fidelity, and a strong attraction to fishing boats. We show that despite boat predictability, individual black-browed albatrosses did not specifically return to encountered boats from one trip to the next. Their interactions thus appeared to mainly reflect opportunistic boat encounters within their preferred foraging sector. Overall, our results suggest that prey predictability is not sufficient to predict alone spatial fidelity in seabirds.



Estimating seabird flight heights with LiDAR

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Collision mortality is regarded as a key potential impact of wind farms on seabirds. An important component for assessing collision risk is an estimate of bird flight heights, in particular the proportion of birds which fly within a turbine rotor swept area. A range of methods exist for either measuring or estimating bird flight heights, but validation of these flight heights appears to be limited or lacking, resulting in questions over the accuracy of estimates. Recent developments in the application of Light Detection and Ranging (LiDAR) technology offer the potential to collect precise estimates of seabird flight heights when combined with the use of digital imagery to identify individual birds to species level. We carried out a field trial of aircraft-mounted LiDAR as a tool to collect flight height information and develop approaches to analysing the resultant data. LiDAR has the potential to provide large spatial and temporal sample sizes of seabird flight heights on-site across multiple species and age groups. These data can be used to provide 3d maps of seabird flight heights. As a proxy for behaviour, such maps may have applications beyond the assessment of collision risk, for example in relation to Marine Spatial Planning.

Quantifying the Influence of Energy Windscares on Seabird Distributions

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The spatial distribution of predators is often linked to prey location, but prey patch quality is variable. The energetic cost of accessing a patch contributes to its value and thereby influences the spatial structure of a predator population. However, species distribution models (SDMs) do not account for movement and thus ignore habitat accessibility. To accommodate for accessibility, we applied the energy landscape conceptual model, which quantifies movement costs in heterogeneous environments. Specifically, we analyzed the influence of winds on the movements, energetics, and distribution at sea of the Red-footed Booby (*Sula sula*). In May–September 2016, we tracked fifteen 15 breeding birds at the Kilauea Point National Wildlife Refuge, HI with combination GPS/accelerometer devices. By regressing acceleration-derived energy costs against wind conditions and other variables, we developed an environmental flight cost model. We applied this flight model in an anisotropic (directional) least-cost-path analysis to quantify the cost-of-transport throughout the colony's foraging territory as a function of wind. Preliminary results indicate the energy windscape model better predicts foraging area selection among tracked birds than spatial null models. We will further evaluate this method by developing a MaxEnt SDM and test its predictive capacity using data collected at two additional tracked colonies.



Contrasting foraging strategies of two sympatric tropical boobies

Federico De Pascalis*, **Rhiannon E. Austin***, Stephen C. Votier, Jane Haakonsson, Gina Ebanks-Petrie, John P.Y. Arnould, Greg Morgan, Jason Newton, Jonathan Green

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Tropical seas represent some of the most oligotrophic marine environments and, in contrast to temperate and polar regions, little is known about how seabirds locate food in these challenging environments. Using a suite of bio-loggers (GPS, TDRs, saltwater immersion, accelerometers and video loggers) and dietary data (isotopes and regurgitates), collected over two years, we compared the foraging behaviour of two closely related Sulids: the red-footed booby *Sula sula* and brown booby *Sula leucogaster*. These species breed on neighbouring islands in the Caribbean, and differ in population size and body size, with smaller-bodied red-footed boobies nesting in greater numbers. Despite within-population variability in foraging strategies, we found marked inter-specific differences, and evidence of niche segregation. Brown boobies foraged in highly coastal environments (largely in mixed-species aggregations), while red-footed boobies predominantly engaged in extensive offshore trips. Our results suggest that differences in space use may be related to diet, or intra- and inter-specific competition driven by population size and differences in body size, respectively. Furthermore, we observed different responses in breeding success of the two species to varying environmental conditions between years, which indicate that pelagic red-footed boobies may be more sensitive to environmental perturbation than their coastal-foraging brown counterparts.

Movements and distribution of Mandt's Black Guillemot respond to recent reductions in sea ice in the Western Arctic

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During the nonbreeding season, the Arctic subspecies of Black Guillemot, *Cephus grylle mandtii*, utilizes the margins of Arctic sea ice as a cryopelagic proxy for the shoreline habitats typically utilized by the genus. We monitored the nonbreeding movements and activities of guillemots breeding on Cooper Island, Alaska from 2011 to 2017, a period of major changes in the seasonal formation and extent of Arctic sea ice due to atmospheric warming. After breeding, birds go to the pack ice edge and then move south with the ice edge in a facultative migration in fall and winter, with individuals roosting on the sea ice an average of 5 hours a day. The only directed migration occurs in early summer as birds leave the ice edge and move north over the pack ice to breeding colonies. Recent major reductions in sea ice extent have resulted increased annual variation in the timing of migration and location of wintering areas. Overwinter survival of breeding birds has remained similar to earlier decades indicating prey availability at the sea ice edge has not been affected by the reductions in sea ice.

Energy dynamics and morphologies of two sympatric breeding colonies of brown boobies and masked boobies on the cays of Anguilla, Caribbean

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When two closely related species compete for the same limited resource, one will out compete the other (the competitive exclusion principle). However, niche partitioning allows multiple species to co-exist in the same environment by reducing inter-specific competition. Sympatric species can use different foraging areas, different foraging techniques, different oceanographic habitats or consume different prey. Since body size structures trophic interactions it also probably structures niche partitioning. For example, larger species are associated with diving deeper and catching larger prey so body sizes facilitates different foraging behaviours which target different prey populations. Sympatric breeding colonies of masked boobies (*Sula dactylatra*) and brown boobies (*Sula leucogaster*) occur on the cays of Anguilla in the Caribbean. Previous studies of booby species have shown differences in habitat preference and foraging techniques. Our study investigates whether there are differences in the morphologies and energy expenditure between the same species on two neighbouring islands which may be facilitating vastly different community dynamics. The present study presents both a novel booby species comparison and a novel investigation of distinct sympatric booby communities breeding on separate islands at the same time.

The foraging strategies of Atlantic puffins: population differences and consequences for breeding success

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Atlantic puffins *Fratercula arctica* are a common and key species of Atlantic seabirds, but their small size and sensitivity has so far prevented to track their foraging movements, resulting in a poor knowledge of their foraging ecology. Puffins have been declining dramatically in the last few decades, especially in the northern parts of their range, and are now endangered in Europe. Reasons for the declines are still not fully understood, but are likely linked with resource availability during breeding. We use state-of-the art micro-GPS loggers to track for the first time the foraging movements of chick-rearing puffins at three colonies in different marine areas (Skomer in the Celtic Sea, Westmann Islands in the Atlantic and Grimsey in the Greenland Sea) with high, medium and low breeding success respectively. We use an ethoinformatics approach to estimate behaviour from the spatial data, combined with data from nest cameras to monitor feeding patterns, and the type and amount of prey caught for the chick. We reveal the foraging patterns of the species and compare the foraging strategies of the three populations with the ultimate aim to try and understand what factors are driving their differences in breeding success.

Effects of sex and senescence on foraging behaviour in two closely-related albatross species

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Foraging performance is widely hypothesized to play a key role in shaping age- and sex-specific demographic rates, yet the behavioural patterns underpinning such changes are poorly understood. Albatrosses show considerable sexual size dimorphism, are among the longest-lived vertebrates, and demonstrate extensive age-related variation in survival, breeding frequency and success. Although there is some evidence for age-specific foraging behaviour in these seabirds, it remains unclear to what extent these patterns are consistent between sexes and among species, and whether they underpin differences in survival or reproductive performance. Here we use data collected over two decades from populations of black-browed and grey-headed albatrosses, *Thalassarche melanophris* and *T. chrysostoma*, breeding at Bird Island, South Georgia (54°00'S, 38°03'W), to investigate the effects of age and sex on variation in their foraging behaviour in light of their differing life-history strategies. More specifically we compare the foraging trip parameters, activity patterns and habitat preferences of individuals differing in age (10-36 years) and sex, and examine evidence for spatial segregation during the breeding season. By trying to understand the differences between these closely related species, we gain insight into the ecological and evolutionary forces shaping sex-specific variation in ageing patterns.

Ecological segregation of two small Procellariiform species in south-eastern Australia

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Information on how similar-sized sympatric species niche segregate can provide insights into how their respective populations will respond to environmental change, especially at the outer reaches of their range. Two small procellariiforms, the common diving petrel (*Pelecanoides urinatrix*) and the fairy prion (*Pachyptila turtur*), breed sympatrically on Kanowna Island (39°10'S, 148°16'E), south-eastern Australia. In the present study, differences in timing of breeding, at-sea movements, foraging behavior, and trophic niche were examined to investigate ecological segregation between these species. Prions raised chicks in early summer whereas, in contrast to conspecifics further south, diving petrels were found to breed in late-winter. While both species made daily foraging trips up to 125 km to the west of the colony on the shallow continental shelf during early chick-rearing, prions also foraged at the continental shelf-edge 300 km away during 3-4 day trips from early chick-rearing onwards. The behavioural differences corresponded with separation in trophic niche identified from the stable isotope analyses of blood. This niche segregation may lead to differential responses by the two species to environmental changes in what is one of the fastest warming oceanic regions in the world.



The use of seabird to monitor marine contamination in the MSFD context in France

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Seabirds, as top predators of the marine ecosystem, are largely used as bioindicators of chemical contamination worldwide. In the context of the Marine Strategy Framework Directive (MSFD), the Good Environmental Status (GES) of marine waters is defined by 11 descriptors including the descriptor 8 (D8) on chemical contaminants. In France, for this descriptor, contaminants are monitored in fish, molluscs and sediment, and several biomarkers and ecotoxicological parameters are assessed in fish, bivalves and gastropods. Our objective was to assess the possibility to use seabirds for the D8 of the MSFD along the French marine sub-regions. We considered and synthesized the information regarding seabird diversity, their distribution, the on-going ecological programs of seabird monitoring and the different projects regarding chemical survey using seabirds in France. It appears that at least 3 groups of species should be considered to cover the different compartments of marine ecosystems, i.e. gulls for coastal habitats, terns for epipelagic habitat and shearwaters (Mediterranean) and gannets (Atlantic) for oceanic habitats. We thus propose for these species a dedicated monitoring program to state the GES for seabird contamination (sampling protocol, recommendations for breeding colonies selection, spatial and temporal frequency), and propose GES indicators.

Resource Utilisation in Herring and Lesser Black-Backed Gulls

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Population dynamics can be strongly affected by environmental change and one such factor with a strong influence on populations is food availability. Herring gulls, *Larus argentatus*, have declined in the UK by more than 50% since 1970, whilst their close relatives the lesser black-backed gulls, *Larus fuscus*, were increasing in numbers till 2000 but are now also experiencing steep declines. Reasons for these declines are not fully understood, however such decreases suggest substantial environmental change. Fitness impacts of changes in resource use have been observed in gulls but consequences of this for their abundance have not been studied. This study therefore investigates the effects of resource use on the population dynamics of both species. Data on diet from across the UK, spanning over 150 years, were collected via stable isotope analysis of gull feathers and variation in resource use examined in relation to spatio-temporal patterns of population change. By examining resource utilisation, this study will attempt to characterise one of the underlying mechanisms determining abundance, understanding of which is critical for these two gull species currently experiencing declines.



Inter-colony variation in flight characteristics of Great Black-backed Gulls inhabiting coastal areas of the Baltic Sea and the Kattegat: lessons for offshore collision risk models

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In order to combat climate change, governments are setting up ambitious plans to increase the production of renewable energy. Models predicting the potential effects of wind farms on birds generally assume an 'average' bird per species. This includes among others variables describing flight behaviour, such as flight height, speed, fraction of time in flight and nocturnal activity. Recently, many studies were initiated to gain more knowledge on the flight behaviour of large gulls such as Lesser Black-backed Gulls, but still little is known about Great Black-backed Gulls. Here we present the outcomes of two GPS-studies conducted in two different colonies of Great Black-backed Gulls around the Baltic Sea and the Kattegat and show how the resulting flight characteristics influence the outcome of a collision risk model. Generally, flight speeds, fraction of time in flight and nocturnal activity turned out to be lower than expected. However, offshore flight altitudes were higher than previously estimated by visual observations. Moreover, flight altitudes showed a large difference between the two colonies, leading to a 150% difference in the number of modelled collision victims. Our results highlight within-species differences in flight behavior and are a warning for the risks of generalization.

Influence of photoperiod on the migration of pair members of Brünnich's guillemots breeding in the Arctic

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Proper timing of daily activity has adaptive value and can be closely linked to abiotic factors, such as photoperiod. Brünnich's guillemots (a.k.a. thick-billed murre, *Uria lomvia*) maintain synchronized activity rhythms when breeding, even during the continuous light of polar summer, suggesting that timing of activity between mates is important. During the non-breeding season, Brünnich's guillemots are subjected to a range of photoperiods. A lengthening of the photoperiod can initiate spring migration in some birds, leading to the potential to influence arrival time at the colony. Therefore, we asked if breeding pairs were found in locations during the non-breeding season with photoperiods of similar duration and phase (photoperiods that begin and end simultaneously) and if they began migration back to the colony synchronously. We attached geolocation sensors (GLSs) to each member of 10 pairs that were breeding at two colonies in Greenland during polar summer and obtained 13 breeding-pair-years of data. The results will provide insight into the mechanisms affecting migration of this Arctic seabird breeding during the continuous light of polar summer.



Nutritional, immunological and oxidative adaptations under anthropogenic pressure in breeding Adelle penguins (*P. adeliae*) at Antarctic Peninsula: a biochemical and proteomic approach

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Environmental factors such as, anthropogenic activity may induce changes in the physiology, health status and energetic demands on seabirds. The colony of Adelle penguins (*Pygoscelis adeliae*) at Hope Bay, Antarctic peninsula, breed close to a research station and thus, exposed to high levels of human activity (DZ area). There is a low disturbed area (LDZ), geographically protected, where penguins also breed. To elucidate which are the physiological adaptations to impacted environments, we determined, between zones, nutritional, immunological, oxidative parameters and the level of proteins expression using proteomic methods, in serum. Body mass, total proteins, albumin and triglycerides were higher in LDZ, while uric acid and glucose in the DZ. Higher IgY level, γ -globulin fraction and hemmaglutinating activity were observed in penguins from the DZ, indicating that elevated immune responses are relevant in this area. Penguins from DZ showed higher levels of fructosamine and γ -glutamyltransferase activity, indicating that oxidative stress occurs. Antioxidant and immunological proteins, were highly expressed in the DZ individuals demonstrating that penguins exposed to high disturbance level overexpress proteins related to antioxidant and immune functions. Altogether, this would constitute an energy costly physiological strategy to maintain an adequate body condition against the unfavourable conditions in high impacted zones.

Spatial versus niche partitioning in Irish seabird communities

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To reduce interspecific competition for limited prey resources, seabirds often exhibit resource partitioning through occupying different areas or ecological niches. The ObSERVE aerial survey programme investigated seasonal patterns of space and niche partitioning in seabirds in the western Irish sea in summer, autumn and winter 2016. After accounting for spatial autocorrelation in the data, we found strong correlations between seabird density and species richness ($r=0.51$, $P<0.01$) in summer. High density areas in summer also contained high feeding guild diversity ($r=0.47$, $P<0.01$) suggesting the occurrence of niche partitioning. Despite similar or higher mean densities of seabirds in the non-breeding season, spatial correlations of density with species richness, and density with feeding guild diversity were much weaker than in summer (all $r<0.34$). Strong spatial correlations in Chlorophyll-a between seasons ($r=0.5-0.8$, all $P<0.001$) suggested predictable areas of productivity, but we found no evidence for higher seabird density in high productivity areas. Our results suggest that seabird communities show greater niche separation during the breeding season due to constraints of central place foraging. When this constraint is lifted in the non-breeding season, seabirds are able to forage further afield, reducing interspecific competition through spatial partitioning.



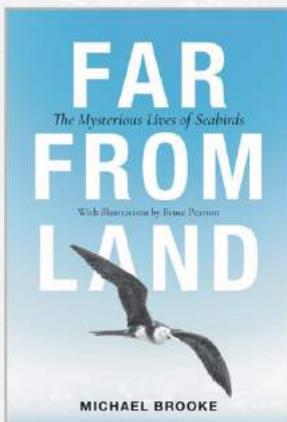
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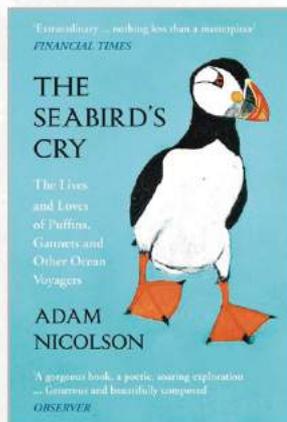
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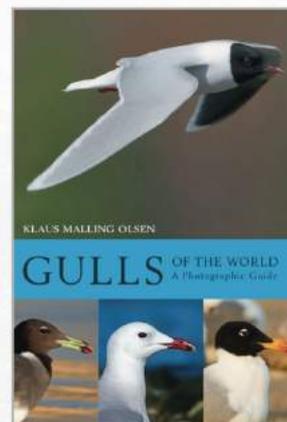
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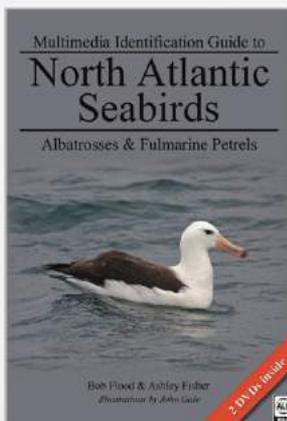
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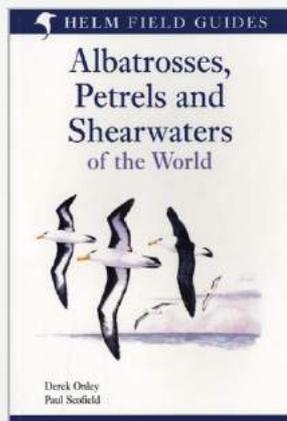
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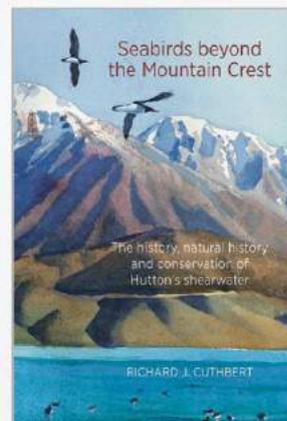
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Deep Scattering Layers, the feeding ground of Antarctic deep-diving predators

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During the day, myctophids (lanternfish), krill, squid and jellyfish form layer-like aggregations in the mesopelagic zone (200-1000m deep) to reduce exposure to visual predators. These layers, known as deep scattering layers (DSLs) can be detected by echosounders. Myctophids are very abundant in DSLs and play a key trophic role for predators. In the framework of the Commission for the Conservation of Antarctic Marine Living Resources, pressing management issues arise because myctophids make up to 90% of the diet of deep-diving predators such as King Penguins (*Aptenodytes patagonicus*, dive depth >350m) and Southern Elephant Seals (*Mirounga leonina*, dive depth >1500m). More data on DSLs are needed to develop a biogeographic zonation and understand likely future responses to climate change before any large-scale exploitation begins. A unique data set of DSLs geographic variability in depth and intensity throughout the Southern Ocean was collected during the Antarctic Circumnavigation Expedition (ACE), along with CTD data and satellite remote sensing. We also collected position and depth data from predators on South Georgia and Kerguelen as the ship approached each island. The tracking data are co-located with the DSLs landscape to better understand predator-prey interactions and inform conservation management.

King penguins rapidly attain normothermia when they return to the colony

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The marine environment is a thermoregulatory challenge for penguins. Although the trunk is well insulated, the large flippers are not. Thus, a set of counter-current heat exchange control temperature of these regions to reduce heat loss in water or act as thermal windows for flexible heat transfer when ashore. King penguins use regional heterothermy when foraging, however, little is known about changes in body temperature when individuals return to the colony. The energy saving hypothesis suggests that hypothermic birds will maintain peripheral vasoconstriction until they reach normothermia whereas the thermal window hypothesis predicts that birds will increase blood flow to appendages to regulate heat exchange and avoid hyperthermia. We therefore compared internal and peripheral temperatures in insulated and uninsulated body areas of hypothermic and normothermic king penguins in captive and free-living conditions. We show that the temperature of insulated as well as uninsulated peripheral tissues rapidly reach normothermia, independent of initial state. Peripheral reperfusion as indicated by temperature does not appear to affect restoration of internal temperature. However, the properties of each tissue underlines different reasons to blood flow restoration. These results provide valuable insights into thermoregulation of penguins on land, where future changes in climate are expected.

A swimming avian migrant – extraordinary low year-round flight activity of an Arctic seabird

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The annual cycle of birds consists of a sequence of energetically demanding life-history stages such as breeding, moult and migration. The exact timing of these life-history stages in a seasonal environment is essential for survival and reproductive success. Long-lived seabirds such as albatrosses, penguins and auks meet particular challenges in fitting different life-history states into the annual cycle, and different adaptations to resolve the tight circannual program have evolved. Brünnich's guillemots have a unique breeding strategy where the chick, not yet fully grown and flightless, start the post-breeding migration by swimming with the male parent to sea. During the post-breeding migration, both males and females also undergo a complete moult making them flightless. Thus, extraordinarily, the males engage in breeding activity (chick provisioning), migration and moult at the same time, while females limit themselves to migration and moult. Here we report on the peculiar circannual life-history pattern of guillemots. We quantify the distance moved during moult migration, as well as the daily proportion of time spent on foraging and flight behaviour during the entire non-breeding season using light-based geolocation and high-resolution activity loggers.

Roseate Tern LIFE Recovery Project. Improving conservation prospects of the roseate tern population in Western Europe

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The Western European population of roseate tern (*Sterna dougallii*) has been steadily increasing, but is still confined to four main colonies. The Roseate Tern LIFE Project focuses on improving the breeding success in the remaining colonies, while restoring historical sites in preparation for potential expansion. The practical work includes habitat creation, predator management, biosecurity and monitoring. Management is underpinned by several studies. The demography study revealed that the population growth rate at Coquet depends on immigration from Rockabill, whereas the Irish colonies are driven more by productivity and the survival of juveniles/adults. Sandeel and alternative prey species reviews led to the development of prey hotspot areas for future management. Analyses of 25-years of tern diet data from Anglesey revealed an increased intake of clupeids in their so far sandeel dominated diet. Spatial utilisation distribution of Arctic and roseate terns was studied using a combination of GPS tags and boat tracking. Wintering hotspots in Ghana were surveyed and confirmed that illegal tern trapping is still ongoing in places, although it is less intensive. Geolocators were also deployed to understand roseate tern migration patterns. International Roseate Tern Conservation Strategy is under preparation, underpinned by development and sharing of best practice.



Guillemot individual consistency - selecting for space or environment outside the breeding season?

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Quantifying consistency in inter-annual movement behaviour is needed to understand the ability of migrants to adjust to rapid environmental changes. Additionally, if an individual selects for specific space or environmental niche has consequences for the species' potential to adapt to perturbations. Using light level geolocation, we tracked more than 600 individuals up to 6 years from 8 breeding sites in the Northeast Atlantic. Overall both species seem to use specific staging areas rather than select specific environments with a clear seasonality visible due to life history traits. However, our results indicate that guillemots utilizing the marginal sea ice zone are able to shift geographic space use between years on a regional scale. This suggests that guillemots have consistent movement behaviour and generally select the same wintering areas making them potentially more vulnerable to rapid changes and human impacts.

Nest characteristics affect breeding performance of a burrow-nesting seabird species breeding in Antarctica

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Nest characteristics are rarely considered in the context of avian breeding success. Only few studies show that the selection of nest characteristics by breeding pairs may be an important trait in breeding biology, likely to evolve in response to environmental conditions. The Wilson's storm-petrel (*Oceanites oceanicus*) is the smallest known seabird breeding in the Antarctic. Due to the extreme weather conditions in its breeding habitat, the characteristics of the nest burrow are expected to critically affect hatching success, chick growth and chick survival. In this study, we examine links between the breeding success of Wilson's storm-petrels and the nest characteristics, in terms of location, orientation, wind and snow exposition, and thermal conditions. We collected data in the Wilson's storm-petrel breeding colony on King George Island, South Shetlands, during the Austral summer of 2017 and 2018. The preliminary results indicate the importance of nest isolation. After warming the nest with a warm object (i.e. egg or chick; tested experimentally with an artificial object), a high cooling rate is associated with significantly lower hatching success. These results emphasize the importance of nest characteristics in breeding biology, in particular for species breeding under the severe conditions of the polar summer.

Microplastic contamination in Atlantic Puffins

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Microplastics consist of small particles or fibres of plastic (typically less than 5mm in diameter) that are widespread in marine ecosystems through plastic pollution. The effect of ingesting microplastics on marine predators is poorly documented – large pieces are known to cause obstructions, but the accumulation of tiny particles through the food chain may also be damaging. Here, we examine the Atlantic Puffin (*Fratercula arctica*) for evidence of microplastic contamination, and investigate whether the presence of microplastics has had an impact on their breeding success on Skomer Island. We measure the levels of microplastics in the puffins' food source (sand eels), soil collected from their burrows, and the faeces of both adults and chicks using a variety of sampling methods, considering not only the quantity but also the composition of the particles. We use this data to draw links between these different variables and the number of chicks raised per nest.

Long-term diet composition of black-browed and grey-headed albatrosses in relation to environmental change

William F. Mills*, Stuart Bearhop, Yves Cherel, Louise Ireland, Helen J. Peat, Stephen C. Votier, Claire M. Waluda, José C. Xavier, Richard A. Phillips

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Changes in the diet of higher predators, such as seabirds, often reflect variation in the environment. Long-term monitoring can therefore help in understanding the response of seabirds and their prey to environmental change. Here, we analyse two of the longest time-series available for sub-Antarctic or Antarctic seabirds; over 20 years of diet data from black-browed and grey-headed albatrosses sampled at Bird Island, South Georgia. We compare diet composition and relate annual changes to variation in the environment, including global oceanographic indices [Southern Annular Mode (SAM) and Southern Oscillation Index (SOI)], acoustic estimates of Antarctic krill abundance, and remotely-sensed oceanography from the main foraging areas. Our results show that the two albatrosses feed on broadly similar prey but the proportion of prey types and specific composition differs between species and among years. Grey-headed albatrosses feed mainly on cephalopods (41% by mass), followed by crustaceans (28%) and fish (25%), whereas black-browed consume mainly crustaceans (41%), followed by fish (32%) and cephalopods (20%). By relating annual diet variation to environmental indices we aim to understand if recently demonstrated relationships between such indices and demography of these two threatened albatross populations are mediated by relative prey availability and the ability to switch to alternative prey.

Diet diversity in seabirds varying with ecological conditions

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Ecologists have long used niche theory to describe the ecology of a species as a whole, for instance with respect to diet. In some species populations can specialise on very specific diets even if the species as a whole has a much wider diet niche. Diet specialisation differs between seabird species. Theory also predicts that diet specialisation may change when conditions become tough: foragers may become either more generalist or more specialised. Here I want to explore the spatial and temporal differentiation in seabird in relation to food supply and competition using a diet dataset compiled from the literature across several seabirds in the Northern Atlantic. We expect populations to be more specialised than the species as a whole and between-population differences to vary across species and to be driven by local circumstances.

Quantifying nest incorporation of anthropogenic debris: recommendations for monitoring and standardisation

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The presence of anthropogenic debris in the marine environment is a globally recognised issue, which impacts species negatively through entanglement and ingestion, particularly seabirds. Despite widespread knowledge that seabirds incorporate such debris into their nests, quantitative studies are lacking. To improve our understanding on how this issue affects seabirds there is an urgent need to monitor nest incorporation of debris. Globally, we found just 13 studies that provided empirical data on nest incorporation of debris, from just seven species across eight countries. The majority of these studies focused on single species, colonies and years, with little standardisation on how metrics on the type, colour and quantity of incorporated debris were reported. We therefore have limited data to identify spatial and temporal patterns among species. Here, we provide recommendations for standardised monitoring and reporting of metrics on prevalence, quantity and debris source, to facilitate comparisons and improve our knowledge on this environmental issue. We also present preliminary results on the prevalence of debris incorporated into seabird nests from across the UK, collected during the 2018 field season in collaboration with the 'Seabirds Count' national census, and from targeted fieldwork focused on the Northern Gannet.

Pinpointing what aspect of prey biology drives variation in black-legged kittiwake breeding success

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In recent decades, seabird numbers have dropped all around the UK. This is thought to have been caused mainly by a decline in forage fish, in particular the lesser sandeel (*Ammodytes marinus*), an important prey for seabirds. However, there is often not a very strong correlation between coarse-scale sandeel abundances and seabird population dynamics, but instead seabirds may be responding to more fine-scale changes in timing and energy content of the sandeels. Here, we compare measures of sandeel abundance, energy content and timing with detailed information on black-legged kittiwake (*Rissa tridactyla*) breeding success and diet, with the aim of assessing how sandeel stock changes are reflected in kittiwake diet as well as identifying which sandeel measures best predict kittiwake breeding success. We make use of several empirical datasets as well as output from a bioenergetics model of sandeels. Knowing what measure of sandeels shows the strongest correlation with kittiwake breeding success is of key importance as different measures, such as for example timing or energy content, may respond differently to changes in environmental conditions. This knowledge thus enables us to improve our predictions for how environmental change will impact kittiwakes and other sandeel predators in coming decades.

Experiences with use of drones in monitoring colonial coastal birds along Danish coasts

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Denmark has breeding colonies of several species of gulls and terns as well as colonies of cormorants and auks. The colonies of several of these species are difficult to monitor, and lack of precision of counts can lead to uncertainty about trends in local breeding populations. With the rapid development of UAS (small unmanned Aircraft systems) or drone's new opportunities have arisen and there is now a great interest in learning about the advantages as well as disadvantages of applying drone's as a monitoring tool. We applied drones as a monitoring tool and tested it against traditional ground counting methods. We also recorded how different species of coastal breeding birds responded to the use of drones. We found drones to be a very useful tool under most conditions. However, the structure of the vegetation and the "lay out" of the breeding site posed a challenge in some areas, making it difficult to reach the colony and/or detect the breeding individuals.



Between ice and ocean; Effects of Great Skua (*Stercorarius skua*) and Arctic Skuas (*Stercorarius parasiticus*) on primary succession at retreating Breidarmerkurjokull glacier, SE-Iceland.

Sigurlaug Sigurdardottir*, Bryndis Marteinsdottir, Olga Kolbrun Vilmundardottir, Freydis Vigfusdottir

*University of Iceland, Iceland

Icelandic glaciers have retreated due to climate change for over 100 years, resulting in appearance of vast abiotic areas in the sub-glacial terrain. Primary succession in such abiotic areas is limited primarily by a lack of nutrients. Seabirds nesting in the area may play a vital role in primary succession by nutrient transfer from sea to land. However, ongoing seabird population decline could affect these processes. Here, we examine the effects of nutrients transferred by Great Skuas and Arctic Skuas on primary succession at Breiðarmerkursandur glacial moraine in SE-Iceland. We will measure plant diversity and density and collect soil samples at different distances from nest sites and compare nest density along 8 age groups of moraine deposits from 1890-2012. We predict that plant diversity and density, and soil nutrient levels, decrease with distance from the nests. Nest density is expected to be higher on older moraines. This study will demonstrate the importance of seabird input into terrestrial ecosystems, by examining effects on local vegetation growth and rates of soil formation within moraine soils. These results enhance our understanding of the interplay between marine and terrestrial ecosystems, which are important with faster retreating glaciers and significant changes in sea bird population.

Are tropical seabirds really foraging for unpredictable resources?

Louise Soanes*, Jonathan Green, Mark Bolton, Farah Mukhida, Lewis Halsey

*University of Roehampton, UK

When two closely related species compete for the same limited resource, one will out compete the other (the competitive exclusion principle). However, niche partitioning allows multiple species to co-exist in the same environment by reducing inter-specific competition. Sympatric species can use different foraging areas, different foraging techniques, different oceanographic habitats or consume different prey. Since body size structures trophic interactions it also probably structures niche partitioning. For example, larger species are associated with diving deeper and catching larger prey so body sizes facilitates different foraging behaviours which target different prey populations. Sympatric breeding colonies of masked boobies (*Sula dactylatra*) and brown boobies (*Sula leucogaster*) occur on the cays of Anguilla in the Caribbean. Previous studies of booby species have shown differences in habitat preference and foraging techniques. Our study investigates whether there are differences in the morphologies and energy expenditure between the same species on two neighbouring islands which may be facilitating vastly different community dynamics. The present study presents both a novel booby species comparison and a novel investigation of distinct sympatric booby communities breeding on separate islands at the same time.

How do urban gulls use the urban environment? Habitat use of urban Lesser Black-backed Gulls *Larus fuscus*

Anouk Spelt*, Cara Williamson, Judy Shamoun-Baranes, Emily Shepard, Peter Rock, Shane Windsor

*University of Bristol, UK

Urbanisation of the landscape affects animal populations negatively worldwide but could be advantageous for others. Large gulls traditionally exploit islands or coastal areas, however in the United Kingdom urban nesting saw rapid population increases from the mid-1980's onwards. Several possible explanations have been put forward yet studies with fine-scale movement behaviour of urban gulls are scarce. Therefore, the aim of this study was to quantify how urban gulls utilise urban environments and surrounding areas. We tagged 11 Lesser Black-backed Gulls with GPS units for two breeding seasons (2016/2017) and combined this with land use maps. Interestingly, despite the proximity of marine areas (~10km) the gulls only made use of terrestrial environments, but they did move outside of urban areas, with almost one-third of their time away from the nest spent in agricultural lands. As the breeding season progressed, the gulls made increasing use of urban environments, however this extent differed per individual. Additionally, distinct behaviours were associated with different habitats as gulls on agricultural fields spent most of their time walking, but in the city centre they mostly sat and waited. Our work demonstrates that urban gulls use their environment differently depending on the habitat type, breeding phase and individual.

Foraging behaviour of northern rockhopper penguins north and south of the sub-tropical front: Implications for the species' long-term resilience to environmental perturbations

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Despite the proximity between northern rockhopper penguins' breeding sites in the South Atlantic, the geographic distance separating Gough Island from the Tristan da Cunha archipelago means that Gough is the only breeding site for this species south of the Sub-tropical front placing the island in sub-antarctic waters. Penguins were tracked at sites on either side of the Sub-tropical Front: Nightingale (north) and Gough (south) during their annual cycle in 2012/13 and 2013/14 and again on Nightingale in 2016/2017. Penguins displayed discrete foraging behaviours, distributions, and habitat use during both the breeding and non-breeding seasons. While Nightingale penguins showed high variability in foraging locations during incubation and over-winter migration and dispersed widely across the South Atlantic, penguins on Gough displayed strong directionality with high continuity, travelling south/southeast into the Antarctic convergence. Northern rockhoppers will face new challenges in the coming decades as climate change continues to alter their marine environment. Identifying important foraging areas is essential to predict the species' long-term resilience to such perturbations, particularly when sub-populations are depending on spatially and ecologically distinct areas throughout their life cycle. Effective conservation therefore may require site-specific actions when pressures may exert themselves differently at for the species critical sites.



King penguins asleep amidst a large noisy colony

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After spending a number of weeks at sea, king penguins return to land where they are in search of a quiet place to rest. However, king penguins live right on the shore within large colonies, amidst all the chattering chaos of penguins calling to find their chick or partner. Previous studies show that king penguins have a remarkable sense of hearing, as they can easily locate their chick and partner by listening to their specific calls. Despite all of this, penguins still sleep within their colony and when asleep they are vulnerable to threats. Therefore, when a king penguin sleeps, does it listen for specific sounds to respond to and move away from? And will it ignore non-threatening sounds all together? For our study we played 16 sound stimuli to both asleep and awake (non-breeding) king penguins. These stimuli increase in volume over time. We recorded the time it took for the penguin to respond and if/when it moved away from the speaker. Our study found that sleeping penguins responded significantly faster to the stimuli than did awake penguins, suggesting that penguins are more 'alert' asleep than when awake. Further findings will be discussed in the presentation.

Genomics detects unappreciated ocean-basin and island-scale population structure in a circumpolar seabird - the white-chinned petrel

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Genomic data have the potential to increase our understanding of the connectivity and evolutionary history of seabird populations. Population connectivity and the potential to identify seabirds' source population can have significant management implications, particularly for species affected by incidental fisheries bycatch. We assessed population-genetic structure across the circumpolar range of white-chinned petrels (*Procellaria aequinoctialis*) to help understand their evolutionary history and assist management. Following range-wide comprehensive sampling (all eight breeding islands across three oceanic basins), we applied genomic (genotyping-by-sequencing or GBS; 60,709 loci) and standard mitochondrial-marker approaches (cytochrome b and 1st domain of control region). We identified three genetically-distinct white-chinned petrel groups, split by ocean basin: those from islands in the south Atlantic were differentiated from populations in the south Indian Ocean, and from the New Zealand subspecies identified previously. Differentiation among ocean basins was low/moderate but significant, and showed a pattern of isolation-by-distance. Our GBS data also revealed unexpected population-genetic differentiation at very fine scales, promising to distinguish island provenance of bycatch petrels around New Zealand. Genomic data were key in revealing substantial previously unidentified genetic structure in white-chinned petrels, highlighting the possibility of important but undetected structuring in other wide-ranging circumpolar species.



Interactive telomere dynamics and survival in the blue-footed booby (*Sula nebouxi*)

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Telomere dynamics are increasingly used as an indicator of individual quality in ecological systems. We explored telomere dynamics in a long-lived tropical seabird, the blue-footed booby (*Sula nebouxi*). Initial findings demonstrated a cross-sectional negative relationship with chronological age (adults aged 2-22) and strong heritability through the mother. Parental telomere lengths interacted to predict chick recruitment. We also found strong assortative mating by telomere length, raising questions about the function and mechanism of this assortment, and its relation to the effect on chick recruitment. In this study we compare birds from the initial sample to chicks and adults from 2017, including longitudinal sampling where possible. We predict that telomere length in fledglings will be predictive of their change in telomere length to adulthood. We also predict that telomere changes during the nestling phase will predict survival and perhaps be correlated to the interaction of parental telomere lengths providing a mechanism for the effect of parental telomeres on chick recruitment probabilities.

Vagrancy and population growth of the Lesser Black-backed Gull

Lucinda Zawadzki*, Richard Veit

*University of Oxford, UK

Lesser Black-backed Gulls (*Larus fuscus*), have a dramatic and well-documented history of vagrancy to North America. Individuals were first detected in North America during the mid-20th Century, and increased in occurrence in the 1990s. While no breeding pairs have been found, they continue to appear in increasing numbers, with over 1000 individuals present each year. We hypothesized that the mechanism underlying increased abundance in North America is repeated vagrancy, driven by population growth in Greenland, Iceland, and Europe. We related annual incidence of vagrancy to North America, to annual estimates of population growth in Europe. Population growth in Greenland and Iceland were correlated with vagrancy to North America, while population growth in the UK correlated negatively with numbers of vagrants. Greenland's increasingly large source population, coupled with known migratory tendencies of the Lesser Black-backed Gull, have likely led to their expansion to North America. These continued instances of vagrant movement in Lesser Black-backed Gulls illustrate this species' propensity to disperse, and their ability to adapt to future changing climatic conditions via movement. Understanding these movements is becoming increasingly important as many species face challenges that threaten their continued survival.



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Virtual Poster Abstracts

Protection of seabirds in England I: new marine Special Protection Areas

Alex Banks*, Richard Caldow, Mel Kershaw, Helen Rowell

*Natural England, UK

Following a long process of site identification, data collection, collation, analysis and public consultation, 2017 saw the classification of eight new marine Special Protection Areas (SPAs) in English waters. The sites are a mixture of significant seaward extensions to existing coastal SPAs and completely new SPAs, together covering more than 850,000 ha of marine habitat from Cornwall to Northumberland. They afford protection at sea to over 250,000 breeding birds including terns, gulls and auks, and over 400,000 birds in the non-breeding season including seaducks, divers and grebes. Creation of these SPAs in the marine environment enables us to set out detailed requirements for the effective protection of these birds and their supporting marine habitats through our conservation advice packages for each site (see companion poster). Advice covers determinants of seabird condition including food availability, predation and disturbance. Plans or projects within the SPAs, or with connectivity to them because of the mobility of the birds, must be carefully assessed to ensure impacts to birds or supporting processes are minimised, mitigated or compensated. These SPAs represent a major breakthrough for the conservation of these birds and their marine habitats.

Foraging habitat use in breeding Caspian Terns (*Hydroprogne caspia*) of the Baltic Sea

Martin Beal*, Patrik Byholm, Susanne Åkesson

*Lund University, Sweden

In the Baltic Sea region, the Caspian Tern (*Hydroprogne caspia*) is considered a near-threatened species. In order to build an understanding of this species habitat and space use requirements during breeding, Caspian Terns were tracked at multiple breeding sites using GPS. In particular, tracking data was used to identify water-types, based on bathymetry, preferred for use during foraging activity. Caspian Terns, in general, preferred foraging in shallow water, while inter-individual variation suggests that there is a degree of flexibility in habitat choice. These estimates provide the first tracking-based descriptions of Caspian Tern foraging ecology from multiple locations in the Baltic region.

Using 19th century collections for 21st century science: museum based seabird research

Alexander Bond*,

*The Natural History Museum, UK

Museum collections are archives of the natural world, and generally an under-used resource in seabird biology. With a wide array of preparation types, including skins, skeletons, preserved specimens, eggs, nests, and genetic material, they can help answer questions of global change, taxonomy and systematics, ecology, breeding biology, and conservation. The Natural History Museum in Tring, UK, is among the largest collections in the world with >1 million specimens covering >95% of avian taxa, including extinct and endangered species. I will present two examples of how museum collections can inform current seabird conservation and management: understanding the origins of bycatch of Flesh-footed Shearwaters (*Ardenna carneipes*), and determining levels and trends of mercury in Ivory Gulls (*Pagophila eburnea*). I will also highlight the efforts to make the NHM collections available digitally. Most material at the NHM is from the late 19th and early 20th century, and there are as-yet unexplored opportunities for visitors to seabird colonies to enhance and add to the NHM's collection for the benefit of the wider ornithological community.

Monitoring seabird diet and foraging activities at South Stack, Anglesey: are there consistent interspecific differences?

Melissa Costagliola-Ray*,

*Bangor University, UK

Seabirds are sensitive to changes in food availability; particularly during the breeding season due to the energy constraints imposed by central place foraging. Breeding seabird colonies are subject to increasing anthropogenic disturbances (such as the erection of MREI's), known to induce significant changes to the prey assemblages found within the offshore marine environment. It is therefore crucial to understand the breeding season of seabird species, as dietary and provisioning information have wide reaching applications in terms of the management of these human disturbances. Currently, a detailed knowledge of the breeding season of two particularly vulnerable auk species, common guillemots and razorbills is lacking. Therefore, this thesis aims to quantify and compare both dietary preferences and delivery rate of prey of the aforementioned species across the breeding season at South Stack, Anglesey. In doing so, this thesis provides empirical evidence of the species-specific dietary preferences and provisioning rates, indicating that these closely related species have the potential to respond differently to human disturbances. This research has the potential to be used as a baseline for long-term study, assessing the possible implications of future disturbance upon the survival and reproductive success of common guillemots and razorbills at South Stack.



What do my parents eat?

Wouter Courtens*, Eric W. M. Stienen, Robin Daelemans, Marc Van de walle, Hilbran Verstraete, Nicolas Vanermen

*Research Institute for Nature and Forest, Brussels, Belgium

Since 1992 we studied the dietary requirements of Sandwich Tern chicks and the consequences of changes therein for their growth and survival in various European colonies. However, for a long time it wasn't known what the parents themselves feed on. Therefore, in 1996 we started sampling adult faeces in Belgian and Dutch colonies. Food remains found in the faeces provided clues on the food composition of the adult terns, both in terms of species composition and prey length. From 2013 onward, we took consecutive faeces samples from the start of egg-laying until the fledging of the chicks. This allowed to understand the changes in food composition throughout the breeding season, which could be compared to the chick diet. In 2016, we started collecting faeces from adult Sandwich Terns from as much European colonies as possible, which gives an idea of the adult diet on a large spatial scale. Sandwich Terns proved to be dedicated pelagic fish specialists through space and time and may provide very useful insight in the small pelagic fish communities that are otherwise not monitored. Faeces sampling is a simple and non-invasive method that can be used to monitor the prevailing food situation around seabird colonies.

Temporal and spatial trends of POPs in marine birds from the Pacific coast of Canada

John E. Elliott*, Aroha Miller, Mark Hipfner, Laurie Wilson, Kyle H. Elliott, Ken Drouillard, Jonathan Verrreault, Sandi Lee

*Environment and Climate Change Canada, Delta, BC, Canada

There is a continuing need to monitor ecosystem contamination by xenobiotic compounds, particularly those, such as POPs, which are persistent and accumulate in food chains. Eggs of aquatic and predatory birds have proven to be an efficient and effective means of measuring and tracking POPs as they are transferred from the female bird to the egg via yolk lipid. Here we report and discuss data from long term monitoring of seabird eggs from the northeast Pacific. For this program, the marine system was divided, and representative species selected. The nearshore subsurface is monitored using two cormorant, *Phalacrocorax*, species, *auritus* and *pelagicus*, both feed on a variety of benthic and pelagic fish. The offshore subsurface is monitored using the rhinoceros auklet, *Cerorhinca monocerata*, a feeder mainly on small pelagic fishes, with the offshore surface species, the Leach's storm-petrel, *Oceanodroma leucorhoa*, which feeds mainly on surface plankton and larval fishes. At three breeding colonies each along the Pacific coast of Canada and at four year intervals 15 eggs are collected and analyzed as five pools of 3 eggs each. Data will be presented on long term temporal trends and spatial variation for representative legacy and more recent POPs, and use of stable isotopes to factor the possible role of dietary variation. Spatial variation in sources of POPs in the North Pacific will be examined by use of samples taken from birds which were fitted with geolocation devices to track annual movements.



Image-capture technology for monitoring seabirds

Jessica George*, Jonathan A. Green

*University of Liverpool, UK

The importance of ocean monitoring is increasing, particularly in the face of climate change. Seabirds are ideal monitors; they are top predators of marine ecosystems, thus providing information concerning the rest of the ecosystem. However, many populations are challenging to study as they live in remote locations or are negatively affected by human presence so finding alternative, reliable techniques is therefore imperative. The use of technology, such as drones and time-lapse cameras, are becoming increasingly prevalent substitutes for monitoring, yet, the accuracy of these techniques is still not clear. The accuracy and efficiency of these image-capture technology methods were compared. The use of an unmanned aerial vehicle allowed for the largest coastal Great Cormorant (*Phalacrocorax carbo*) colony in the UK to be censused and mapped. This information can be used to help with management of this protected population, which was identified to be over 100 breeding pairs larger than previously thought. However, despite the success of this case study, these techniques are not always effective and success is greatly dependent on photo quality which itself depends on a combination of distance and pixel resolution. Therefore, consideration is needed before embarking on similar projects using image capture technology.

Estimating Seabird Bycatch in Gillnet Fisheries in the Danish Øresund using remote electronic monitoring

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*DTU Aqua – National Institute of Aquatic Resources (Danish Technical University), Denmark

In Denmark, gillnet fisheries are liable for the drowning of numerous non-target air-breathing species, including seabirds. Nevertheless, the overall impact of bycatch on marine seabirds is yet unknown. Sparse or incomplete data on incidental catches from small-scale gillnetters prevents managers to gain a comprehensive overview of the importance of seabird bycatch in Danish waters, which is however the first necessary step towards the implementation of efficient mitigation measures. Here, we used remote electronic monitoring (REM) devices on a sample of three gillnet vessels operating in the Øresund Strait between Sweden and Denmark to estimate the impact of gillnet fishing on seabirds. Through the analysis of video data from 2010 to 2017, we established that eider duck (*Somateria mollissima*) had the highest mortality rate, followed by great cormorant (*Phalacrocorax carbo*), common guillemot (*Uria aalge*) and razorbill (*Alca torda*). Other species were also caught in smaller numbers. Our results show a clear spatial and seasonal variability in the bycatch of seabird species, and identify the underlying environmental and operational factors that can explain these levels. We anticipate that this study will serve as a starting point to assess the extent of seabird bycatch for the entire Danish gillnet fleet.



Top predator eradication boosts body-size and mass of mesopredators

B. John Hughes*,

*University of Birmingham, UK

One outcome of top predator eradication is an increase in mesopredator population size. Here, we use Feral Domestic Cats (top predator) and Black Rats (mesopredators) in insular ecosystems on seabird islands to identify another outcome of top predator eradication. This study assessed the impact of cats on the body-size and mass of rats. Body-size matters for we know that larger predators kill and eat larger prey. We reviewed the literature and collected data on the body-size and mass of rats on bird islands with and without cats and use a meta-analysis to determine if the presence of cats had impacted rat biometrics. We found that rats on islands without cats were both significantly heavier and body-size larger than on islands with cats. We hypothesised that cats suppressed the mean body-size and mass of rats. We tested our findings on Ascension Island, South Atlantic. Biometrics of rats were recorded when rats were mesopredators and again after cats were eradicated and rats becoming the top predator. We found that rats were significantly heavier and body-size significantly larger following cat eradication and that there was a tenfold increase in the number of rats eating seabirds.

Foraging behavior of Razorbills *Alca torda* during chick-rearing at the largest colony in the Baltic Sea

Natalie Isaksson*, Thomas J. Evans, Olof Olsson, Susanne Åkesson

*Lund University, Sweden

Bio-logging has allowed for the foraging behavior of seabirds to be studied in detail. However, some alcids such as razorbills *Alca torda* are less well-studied in this respect. Our study used a combination of GPS and TDR devices to record the foraging behavior of razorbills during chick-rearing at the largest colony in the Baltic Sea, at the island of Stora Karlsö. The breeding site is shared with common guillemots *Uria aalge*, in equal numbers. We predicted that dive metrics and activity for the razorbills would be similar to those reported at another colony in the southern Baltic Sea. We found that, aside from dive shape, foraging behavior was consistent with that reported elsewhere. Interestingly, dives were primarily U-shaped and dive depth had a bimodal distribution. There was a clear diel foraging pattern and a higher proportion of shallow dives at night. Flying and diving accounted for 31% of the overall time activity budget. Our study points towards greater variability in diving behavior of razorbills in the Baltic than expected, thereby enhancing overall understanding of razorbill foraging. Finally, the results highlight new areas of interest for further studies at the site, especially in tandem with the sympatrically occurring common guillemot.



Application of aerial photography to estimate the distribution of wastes in the breeding sites of Adelie penguins

Jeong-Hoon Kim*, Hyun-Cheol Kim, Jae-In Kim, Chang-Uk Hyun, Jin-Woo Jung, Hosung Chung

*Korea Polar Research Institute, South Korea

Cape Hallett Station was established in 1956 by New Zealand and the United States on Seebee Hook but the main building was destroyed by fire in 1964. The station was operated by American scientists till 1973 as a summer base. Both countries dismantled structures, cleaned up and removed bulk wastes from 2003 to 2006. Adelie penguins recolonized the site where the station was occupied. Cape Hallett, including Adelie penguin colonies (around 64,000 pairs) was designated as an Antarctic Specially Protected Area (No. 106). Although this area was cleaned up, there is still plenty of waste left to be removed. To examine the distribution and type of the wastes which are remained on Seebee Hook, we analyzed aerial photographs taken by drone. A total of 494 wastes were detected in the image. Most of them were metallic (45.1%) and wooden (47.0%) wastes. About 15.7% of metallic and 7.8% of wooden wastes were located inside of penguin colonies. The bulky wastes were wooden box, concrete block and abandoned fuel drum. Six drums (85.7%) of seven were located inside the colonies. To manage the penguin breeding sites should evaluate the harmfulness of remained wastes through the long-term monitoring.

The ecology, behaviour and physiology of urban gull

Rebecca Lakin*,

*University of St Andrews , UK

Herring and Lesser Black-backed gulls are increasingly utilizing anthropogenic sites for nesting and foraging, which has resulted in growing reports of wildlife conflict across Europe. This research aims to understand the mechanisms underlying gulls' adaptations to urban environments and will focus on the influence of early life experiences on offspring phenotypes. Fieldwork will involve monitoring breeding parameters in urban areas (East Scotland) as well as within colonies at more traditional sites (e.g. the Isle of May, Firth of Forth). Measures of stress physiology and behavioural traits will provide insights into the influence of anthropogenic site use and diet on the behavioural and physiological development of chicks raised in urban versus marine environments. GPS loggers will also be deployed to explore variation in adult foraging areas between birds nesting at the traditional sites versus those breeding in urbanized habitats. The findings are likely to be important when devising practical management schemes that aim to reduce urban gull conflict.

Contribute to Public Health England's Tick Surveillance Scheme and help us learn more about ticks in the UK

Ticks on seabirds

Seabirds can be important carriers of ticks, but are less well-studied compared to other animal hosts. The high mobility of seabirds and the large distances that they travel may result in them having a greater role as tick carriers than previously considered. High tick burdens may also affect the overall health of seabird colonies.

We are aiming to learn more about ticks on seabirds whilst they are in the UK, to help us understand more about the tick species they are carrying, and whether they may be responsible for importing non-native tick species into the country.



Figure 1. Puffin with ticks on its face. Photo credit: Sheila Sear

Tick Surveillance Scheme

As ticks can transmit diseases to humans and animals, it is important to know where they can be found and when they might be active. Public Health England's Tick Surveillance Scheme collects data on ticks in the UK, which helps to inform our public health advice on ticks.

The scheme allows PHE to:

- Monitor tick distribution on a national scale
- Detect when ticks are active
- Identify the human and animal hosts that different tick species feed on
- Detect imported and unusual tick species
- Respond directly to public health queries about ticks

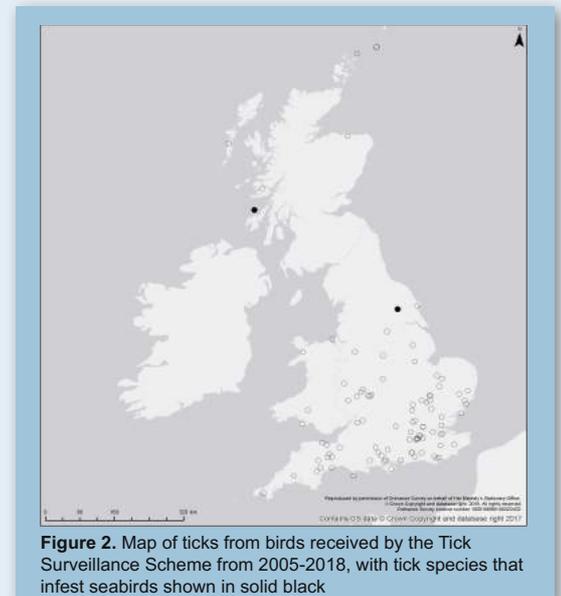


Figure 2. Map of ticks from birds received by the Tick Surveillance Scheme from 2005-2018, with tick species that infest seabirds shown in solid black

Send us your ticks

Whilst there are historical records of ticks infesting seabirds in the UK, there is a dearth of more recent records. Please send us any ticks that you may find, we will let you know what species you have submitted to the scheme, and you can help increase our knowledge of seabird ticks in the UK.

For more information on ticks and how to take part in the scheme, please visit

www.gov.uk/guidance/tick-surveillance-scheme or email us at tick@phe.gov.uk



Figure 3. *Ixodes hexagonus* females

Assessing the habitat use of a diving seabird in a dynamic environment

Abigail R. Mickelfield*, Louise M. Soanes, Alice M. Trevail & Jonathan A. Green

*University of Liverpool, UK

Seabird tracking studies are focused on a few specific breeding sites which do not necessarily take into account the range of dynamic environmental factors found in the marine environment. Puffin Island possesses a shallow bathymetry and high tidal range, which has the potential to influence the diving behaviour and foraging patterns of its seabird populations. TDR and GPS data were collected from nine European Shags (*Phalacrocorax aristotelis*) to investigate how they utilise the unusually dynamic habitat at Puffin Island. Dives were categorised as benthic or pelagic based on the proportion of bottom time and their proximity in depth to the previous dive in a sequence. The data were combined with tidal information to assess the influence of changing tides on foraging locations. Shags at Puffin Island are predominantly benthic divers, accounting for 92% of all dives. During high tide, dives were made furthest from the colony and dive efficiency was found to be lowest. Increasing the understanding of seabird foraging and habitat use in dynamic environments is vital for making decisions about the conservation needs of individual seabird populations. It can also be used as an indicator for other marine species and is therefore fundamental in the planning and designation of marine protected areas.

Reintroducing Nesting Eider Sea Ducks to Storæmåsøy Island, Norway.

Henriette Naess Ebbensen*, Isabella Passamano

*Vega Archipelago World Heritage Foundation, Norway

The project is to restore nesting conditions and reestablish a perennial nesting colony of eider sea ducks on Storæmåsøy, an uninhabited island in the Nordic Sea. The island was surveyed for predators and available nesting areas. No predator appeared resident. The western portion of the Island is appropriate for nesting, being low and rocky with access to the sea and protected by a bluff. Thirty nesting husets were built of natural materials (rock and seaweed) with traditional techniques. Each huset is located within 30 meters from the sea and constructed to blend into the landscape. Husets have an interior space of 1 to 3 cubic feet with a single opening large enough for one female duck to pass. The gaps are filled with seaweed to make the interior dark. Crushed dry seaweed is placed in the huset as nesting material. Three females nested. One nested in a huset, laying nine eggs. This female and all nine eggs were taken by a predator. Another nested, but was taken by a predator without laying eggs. A third female nested under a barn, laid and hatched four eggs. The female and all four ducklings went to sea.

Urban sea gulls: behavioural adaptations of two sea gull species (*Larus fuscus* and *Larus argentatus*) in Liverpool

Olga Pavlova*, Torsten Wronski

*Liverpool John Moores University, UK

To date, urban sea gulls are increasingly considered a nuisance to city dwellers, property owners, maintenance staff and city councils. Different methods to repel gulls from buildings in European cities have been invented and applied, but with little or no success. To improve our knowledge on the behavioural adaptation of urban gulls, we intend to compare the behaviour of urban and rural gulls as exemplified by two species, i.e. the Lesser black-backed gull and the Herring gull. In a first step, we attempt to compare flight responses of gulls breeding and foraging in their natural habitat to those in urban environments.

Secondly, it is envisaged to compare intra- and interspecific competition of urban and rural gulls with other bird species whilst being fed with human food waste. Concurrently, we will study the nesting behaviour of urban and rural gulls, using camera trapping technology. It is expected that urban gulls show higher rates of bold and aggressive behaviour compared to those living in rural, natural habitats. Irrespective of the results of our experiments and observations, the accumulated information will help pest controllers and city councils to establish advanced repelling methods and thus reduce human-wildlife conflict in city environments.

Mitochondrial phylogeography in seabirds, dealing with duplication, heteroplasmy and pseudogenes in the Procellariiformes

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Mitochondrial DNA has been an important tool to investigate the phylogeography of seabirds. In 2005, Abbott et al discovered that a stretch of the mitogenome of *Thalassarche* albatrosses, including *cytb*, *nad6* and the Control Region (used as markers in phylogeography) was duplicated. Since this discovery, few studies have focused on the phylogenetic extent of this pattern within the Procellariiformes. Our population-level sequencing of mtDNA in Audubon Shearwater (*Puffinus lherminieri*) also suggested duplication within the mitogenome. Whole mitogenome sequencing confirmed duplication, but revealed a different gene arrangement, compared to albatrosses. In addition, we found evidence for the presence of heteroplasmy (two different mitogenomes found within the same individual) and the prevalence of numts (nuclear pseudogenes of mitochondrial origin) in this species. Preliminary mitogenome assembly for 4 genera of Procellariiformes across 2 families indicate that mitochondrial duplication patterns are widespread within the order, suggesting a complex evolution of the mitogenome within the group. In this communication we evaluate, based on data from *P. lherminieri*, if numts, heteroplasmy and gene duplication can significantly blur phylogeographic investigations, and discuss the consequences on published studies on the group.



LIFE for Little Terns

Linda Wilson*, George Candelin, Mark Bolton, Sue Rendell-Read

*RSPB, The Lodge, Sandy, UK

The Little tern *Sternula albifrons* is an Amber listed Bird of Conservation Concern and has undergone an estimated 23% decline in the UK over the last two decades. Since 2014, RSPB has been leading an EU LIFE+ partnership project to improve the conservation status of little terns in the UK through targeted action at the most important colonies to tackle threats such as human disturbance, predation, habitat change and tidal flooding. However, to understand how different management scenarios will influence the population trajectory for little terns we need information on key demographic rates such as age of first breeding and juvenile and adult survival rates, for which we currently have little information.

Therefore another key component of the project has been to set up a new colour-ringing and resighting programme to provide vital information on little tern demography, with the aim of informing our longer term UK little tern conservation strategy. In 2018, the final year of the project, we assess the extent to which our conservation measures have been effective in improving the productivity of little terns, and reflect upon the challenges and insights provided during the first five seasons of our colour-ringing initiative.



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William Ritchie 2018

List of Delegates

Delegate name	Affiliated institution
Orea Anderson	Joint Nature Conservation Committee
Tycho Anker-Nilssen	NINA- Norway
Gavin Arneill	University College Cork
John Arnould	Deakin University
A.N.M.A. Ausems	University of Gdansk- Dept. of Vertebrate Ecology
Rhiannon Austin	University of Liverpool
Michael Babcock	RSPB Bempton Cliffs
Bryony Baker	University of Gloucestershire
Helen Baker	JNCC
Alex Banks	Natural England
Martin Beal	Lund University
Ashley Bennison	MaREI- University College Cork
Aurelie Blanck	Agence Française pour la Biodiversité
Philipp Boersch-Supan	BTO
Maria Bogdanova	Centre for Ecology & Hydrology
Mark Bolton	RSPB
Sarah Bond	Bangor University
Alex Bond	Natural History Museum
Anne-Sophie Bonnet-Lebrun	University of Cambridge
Katherine Booth Jones	British Trust for Ornithology Northern Ireland
Thierry Boulinier	CEFE CNRS-Université Montpellier
Elisa Bravo Rebolledo	Bureau Waardenburg
Katherine Brownlie	Deakin University
Ed Bryant	Pathtrack Ltd
Lila Buckingham	CEH
Zofia Burr	University Centre in Svalbard
Sarah Burthe	Centre For Ecology & Hydrology
Bernard Cadiou	Bretagne Vivante
Richard Caldow	Natural England
Peter Carr	Institute of Zoology
Alice Carravieri	University of Liverpool
Chris Challiss	Cefas Technology Ltd, UK
Marianna Chimienti	Aarhus University
Bethany Clark	University of Exeter
Bjarke Clausen	Aarhus University



Delegate name	Affiliated institution
Tommy Clay	University of Liverpool
Ian Cleasby	RSPB
Liza Cole	National Trust for Scotland
Julien Collet	CNRS Chizé - Univ. La Rochelle
Aonghais Cook	British Trust for Ornithology
Melissa Costagliola-Ray	MSc Bangor University
Emma Critchley	University College Cork
Max Czapanskiy	USGS/SFSU
Sarah Dalrymple	Cumbria Wildlife Trust
Francis Daunt	CEH
Sophie de Grissac	Swansea University
Federico De Pascalis	University of Liverpool
Zoe Deakin	Cardiff University
Sarah Deans	Biotrack
Giacomo Dell'Omo	Technosmart Europe
Maria Dias	BirdLife International
Roger Dickey	Army Ornithological Society
George Divoky	Cooper Island Bird Observatory
James Duckworth	University of Liverpool
Ruth Dunn	University of Liverpool
Norith Eckbo	University of Oslo
Kelly Edwards	University of Roehampton
John Elliott	University of British Columbia- Vancouver
Kyle Elliott	McGill University
Tom Evans	Marine Scotland Science
Richard Facey	Natural Resources Wales
Annette Fayet	University of Oxford
Ruben Fijn	Bureau Waardenburg
Glen Fowler	Biotrack
Caitlin Frankish	British Antarctic Survey
Morten Frederiksen	Aarhus University
Jannie Fries Linnebjerg	-
Aymeric Fromant	Deakin University
Amandine GAMBLE	CEFE - Université Montpellier
Graeme Garner	Natural Power Consultants Ltd
Lucy Garrett	University of Birmingham
Marie Claire Gatt	University of Lisbon



Delegate name	Affiliated institution
Jessica George	University of Liverpool
Natasha Gillies	University of Oxford
Gildas Glemarec	DTU Aqua
Bethany Goddard	APEM Ltd
Stephanie Good	University of Exeter
James Grecian	University of St Andrews
Jonathan Green	University of Liverpool
Tim Guilford	University of Oxford
Matthew Guy	University of Stirling
Abel Gyimesi	Bureau Waardenburg- The Netherlands
Lewis Halsey	University of Roehampton
Erpur Hansen	S-Iceland Nature Res. Centre
Mike Harris	CEH
Stephanie Harris	University of Liverpool
Tom Hart	University of Oxford
Molly Heal	-
Vickie Heaney	Isles of Scilly Wildlife Trust
Karine Heerah	CEBC-CNRS
Hannah Hereward	Cardiff University
Martin Heubeck	Shetland (retired)
Olivia Hicks	University of Liverpool
Kate Hogan	University of Liverpool
Catharine Horswill	University of Glasgow
Andrew Howarth	Pathtrack Ltd
Paul Howden-Leach	Wildlife Acoustics
B. John Hughes	Army Ornithological Society
Liz Humphreys	British Trust for Ornithology Scotland
Andrés Ibañez	Ornithology Section- La Plata Museum
Natalie Isaksson	Lund University- BirdLife Sweden
Valeria Jennings	Technosmart Europe
Mark Jessopp	University College Cork
Daniel Johnston	University of Highlands and Islands
Fiona Jones	University of Oxford
Teri Jones	University of Liverpool
Marwa Kavelaars	University of Antwerp
Katharine Keogan	University of Edinburgh
Melanie Kershaw	Natural England



Delegate name	Affiliated institution
Jeong-Hoon Kim	Korea Polar Research Institute
Marcin Kowalczyk	Ecotone
Horst Krummenauer	GÖFA
Aili Labansen	GNIR / AU
Rebecca Lakin	Univeristy of St Andrews
Liam Langley	University of Exeter
Tom Lawson	Second Nature
Julia Lawson	Second Nature
Camille Le Guen	University of St-Andrews
Agnès Lewden	University of Leeds
Patrick Lindley	Natural Resources Wales
Ulrik Lötberg	BirdLife Sweden
Chantal Macleod-Nolan	RSPB
Rahel Maren Borrmann	Research and Technology Centre (FTZ)
Roddy Mavor	None
Dominic McCafferty	University of Glasgow
A McCluskie	RSPB
Thalassa McMurdo Hamilton	IOZ / UCL
Renata Medeiros	Cardiff University
Hannah Meinertzhagen	Exeter University
Benjamin Merkel	Norwegian Polar Institute
Xavier Meyer	Kyoto University
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Abigail Mickelfield	University of Liverpool
Will Miles	SOTEAG
Julie Miller	University of Glasgow
Billy Mills	University of Exeter & British Antarctic Survey
Virginia Morera-Pujol	U. of Barcelona
Matthew Murphy	Natural Resources Wales
Ruedi Nager	University of Glasgow
Georg Nehls	BioConsult SH GmbH & Co. KG
Mark Newell	Centre For Ecology & Hydrology
Malcolm Nicoll	Institute of Zoology- ZSL
Sue O'Brien	JNCC
Peadar O'Connell	RSPB
Nina O'Hanlon	Environmental Research Institute- UHI
Agnes Olin	University of Glasgow/University of Strathclyde



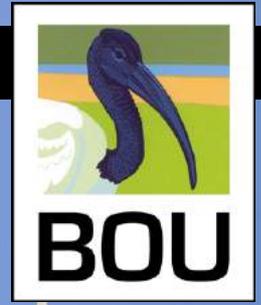
Delegate name	Affiliated institution
Ellie Owen	RSPB
Nathan Pacoureau	CEBC - CNRS
Oliver Padget	University of Oxford
Isabella Passamano	Houston Ornithological Society
Samantha Patrick	University of Liverpool
Olga Pavlova	Liverpool John Moores University
Esther Pawley	Natural England
Ana Payo-Payo	University of Aberdeen
Lizzie Pearmain	BirdLife International
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Marie Riddervold	Aarhus University
Julie Riordan	Wildlife Trust of South West Wales
Lauren Roman	University of Tasmania
Helen Rowell	Natural ENgland
Lise Ruffino	Joint Nature Conservation Committee
Elsbeth Sage	University of Amsterdam
Ana Sanz-Aguilar	IMEDEA (CSIC-UIB)
Cristina Sellarés	National Trust for Jersey - Birds On The Edge
Laura Shearer	Coast Care
Alien Shreeve	Natural Power Consultants Ltd
Dave Shutler	Acadia University
Sigurlaug Sigurðardóttir	University of Iceland
Cleo Small	Birdlife International marine programme
Bartosz Śmiechowski	Ecotone
Wesley Smith	RSPB
Louise Soanes	University of Roehampton
Anouk Spelt	University of Bristol
Karen Spencer	University of St Andrews
Julia Springett	Devon Birds
Antje Steinfurth	RSPB
Eric Stienen	Research Institute for Nature and Forest (INBO)
Hallvard Strøm	Norwegian Polar Institute



Delegate name	Affiliated institution
Grace Sutton	Deakin University
Martyna Syposz	OxNav
Mark Tasker	-
Chris Taylor	:o)
Eugénie Tessier	Centre d'Etude Biologique de Chizé - CNRS
Chris Thaxter	British Trust for Ornithology
Rob Thomas	Eco-Explore
Kate Thompson	Scottish Natural Heritage
Danni Thompson	N/A
Lucas Torres	Université de La Rochelle (France)
Alice Tremain	University of Liverpool
Glen Tyler	SNH
Susanne van Donk	Royal Netherlands Institute for Sea Research NIOZ
Tessa van Walsum	University of Roehampton
Andrew Veale	Unitec
Stephen Votier	University of Exeter
Helen Wade	Scottish Natural Heritage
James Waggitt	Bangor University
Ewan Wakefield	University of Glasgow
Sarah Wanless	CEH
Robin Ward	NIRAS
Victoria Warwick-Evans	BAS
Andrew Webb	Hi Def Aerial Surveying
Shannon Whelan	McGill University
Linda Wilson	RSPB
Shane Windsor	University of Bristol
Steph Winnard	RSPB
Saskia Wischniewski	RSPB
Matt Wood	University of Gloucestershire
Hannah Wood	ZSL Institute of Zoology
Rebecca Young	UNAM

Seabirds and sustainable renewable energies

11 October 2018
Peterborough, UK



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Keynote speakers



Bob Furness



Nicolas Courbin



Karen Hall



Francis Daut



Steve Votier
@SVotier

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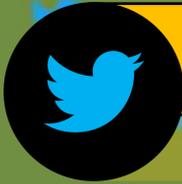
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Darryl Jones
@MagpieJonesD



Nicky Clayton
@nickyclayton22



Dom McCafferty
@DomMcCafferty



Farah Ishtiaq
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Paul Sweet
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Kyle Horton
@Kyle_Horton



Jane Reid



James Grecian
@JamesGrecian



Andrea Flack
@anflack



James Gilroy
@j_gilroy1



Tamar Lok
@TamarLok



Henri Weimerskirch

MONDAY		TUESDAY		WEDNESDAY		THURSDAY	
		09:00-09:15	Plenary	Ana Sanz-Aguilar	Plenary	Thierry Boulinier	Break
		09:15-09:30					
		09:30-09:45					
		09:45-10:00					Tommy Clay
		10:00-10:15	Across scales and species	Ingrid Pollet	Intrinsic drivers of behaviour and demography	Rhiannon Austin	Environmental drivers in seabird ecology (II)
		10:15-10:30		Shannon Whelan		Gavin Arneil	Ruben Fijn
		10:30-10:45		Mark Bolton		Marie Claire Gatt	Rahel Maren Borrman
		10:45-11:00	Break				Virginia Morera-Pujol
		11:00-11:15					
		11:15-11:30		Cat Horswill		Marwa Kavelaars	Maria Bogdanova
		11:30-11:45		Alice Trevail		Nathan Pacoureau	Tom Evans
		11:45-12:00	Across scales and species	James Waggitt	Intrinsic drivers of behaviour and demography	Stephanie Harris	Human - Seabird interactions (II)
		12:00-12:15		Karine Heerah		Lucy Garrett	Liam Langley
		12:15-12:30		Katharine Keogan		Teri Jones	Georg Nehls
		12:30-12:45		Hallvard Strøm		James Grecian	Astrid Potiek
		12:45-13:00					Chris Thaxter
		13:00-13:15	Break				
		13:15-13:30					
		13:30-13:45					
		13:45-14:00		Maria Dias		Philipp Boersch-Supan	
		14:00-14:15		Emma Critchley		Susanne van Donk	
		14:15-14:30	Conservation and Management	Peadar O'Connell	Physiology and Bioenergetics	Ruth Dunn	Plenary
		14:30-14:45		Stephanie Good		Elspeth Sage	
		14:45-15:00		Tom Hart		Bethany Clark	
		15:00-15:15		Vicky Warwick-Evans		Amandine Gamble	
		15:15-15:30		Ellie Owen		Olivia Hicks	
		15:30-15:45	Break				
		15:45-16:00					
		16:00-16:15		Xavier Meyer		Saskia Wischniewski	
		16:15-16:30	Environmental drivers in seabird ecology (I)	Eugénie Tessier		Ana Payo-Payo	
		16:30-16:45		Mark Miller		Lauren Roman	
		16:45-17:00		Grace Sutton		Matt Guy	
		17:00-17:15		Timothee Poupart		Julie Miller	
		17:15-17:30		Daniel Johnston		Morten Frederiksen	
		17:30-18:00	Registration				
		18:00-19:00	Plenary	Poster session			Break
		19:00-21:00	Welcome Reception				Conference Party

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