



13th International Seabird Group Conference

Edinburgh 6th – 9th September 2016



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| Tues | 6th | 08:45 |
| Wed | 7th | 09:15 |
| Thurs | 8th | 09:45 |
| Fri | 9th | 10:30 |
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| Wed | 14th | 11:00 |
| Thurs | 15th | No Sail |
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| Sat | 17th | 13:00 |
| Sun | 18th | 13:45 |
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| Thurs | 22nd | No Sail |
| Fri | 23rd | 11:00 |
| Sat | 24th | 12:30 |
| Sun | 25th | 14:00 |
| Mon | 26th | 09:15 |
| Tues | 27th | No Sail |
| Wed | 28th | 11:15 |
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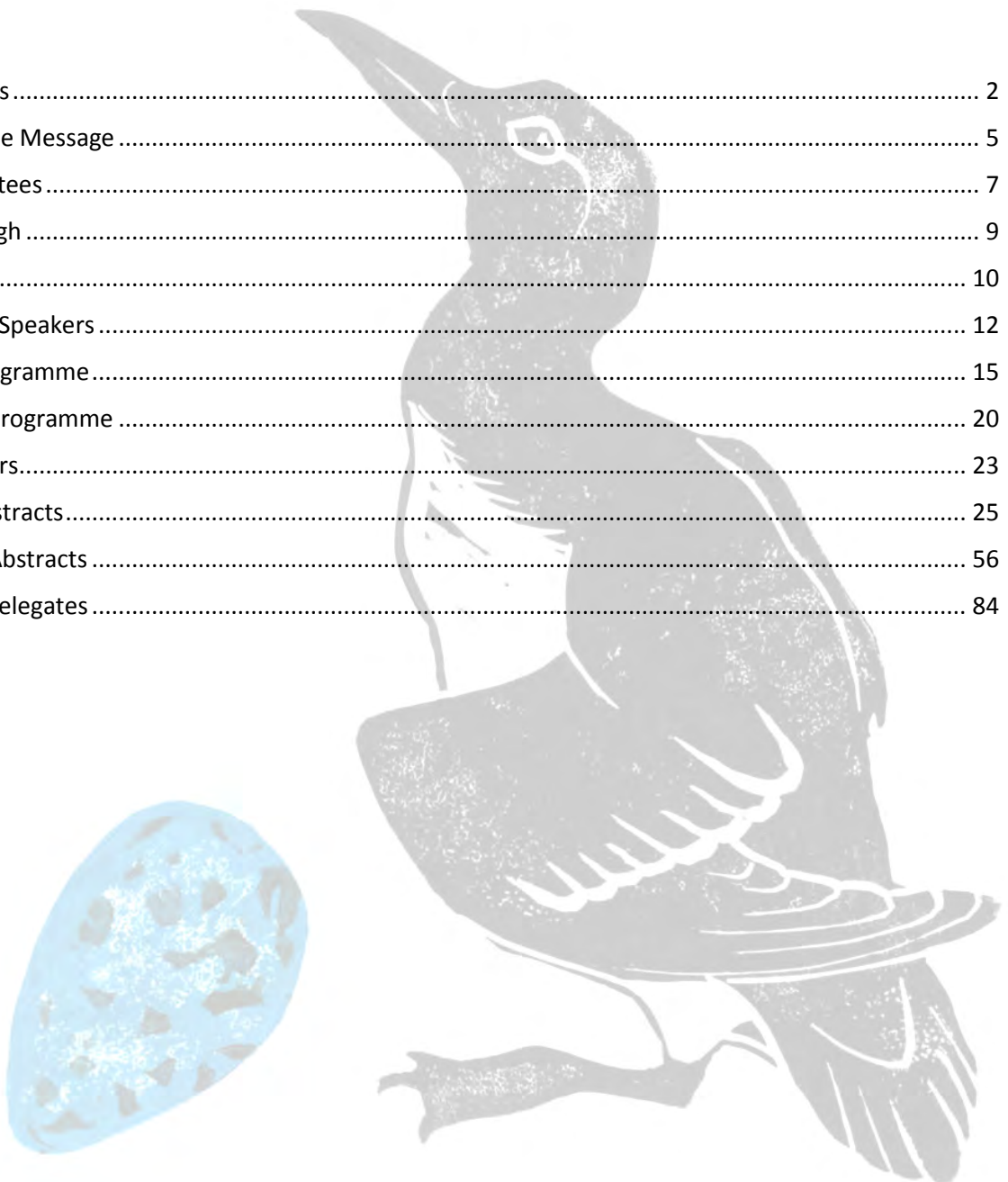


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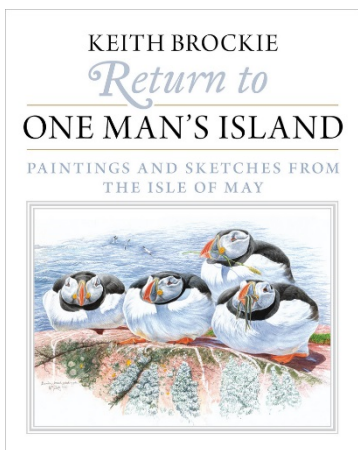
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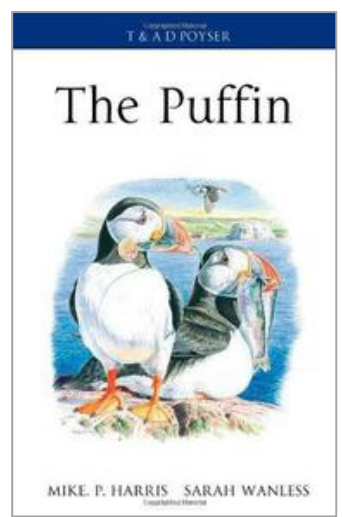
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Welcome Message

A big welcome to the 13th International Seabird Group Conference. We are delighted that so many of you have been able to make it (188 at the time of publication) and hope you all enjoy the packed programme.

We are very pleased to welcome four outstanding plenary speakers - Tony Martin, Emmanuelle Cam, Paulo Catry and Tim Birkhead. We have 57 other talks covering a range of topics including breeding ecology, life history, foraging ecology, winter and migration ecology, demography, conservation and the effects of fisheries and marine renewables. We have a special session on the Seabird Monitoring Programme to celebrate its 30th Anniversary. We also have 54 posters on a very wide range of topics. The conference opens on the evening of 6th with Tony's talk followed by a Welcome Reception, generously sponsored by the RSPB. The poster session is on the evening of the 7th, and the conference banquet and ceilidh, kindly sponsored by Natural Power, are on the evening of the 8th. We wish to thank the many other organisations who have sponsored the conference, and are pleased to welcome six exhibitors who will be selling books and journals and demonstrating the latest logger technology.

Maps of the venue location and floor plan can be found in this programme. Registration is at the Foyer, talks will take place in the Pentland Room, exhibitors will be in the Concourse, coffee in the Concourse and Centro and posters in the Prestonfield. There are also two large terraces with views of Arthur's Seat. We hope that it proves a comfortable and practical location.

We encourage people to tweet during the conference, using the hashtag [#seabirds16](#). Viola Ross-Smith will be actively tweeting throughout the conference from The Seabird Group account ([@TheSeabirdGroup](#)) so please retweet these as well as create your own.

WiFi is available throughout the venue without charge. Delegates will need to search for the WiFi provider "KeySurf". You will be asked to submit your mobile number / email address and to agree to the University's T&Cs. The connection lasts for 24hrs, so you will need to login every day.

For those who have booked on the excursion, a trip round the Bass Rock gannetry is an unforgettable experience. If you are staying on for a few days, Edinburgh is one of the most beautiful cities in the UK with plenty of history and excellent pubs and restaurants (useful links: www.visitscotland.com/destinations-maps/edinburgh; travel.sygic.com/United-Kingdom/Scotland/Edinburgh). It is surrounded by lovely countryside including the Pentland and Lammermuir Hills. Birders are recommended to head for the coast where wader migration is in full swing and passerine migration is just getting going. We particularly recommend Musselburgh, Aberlady Bay and John Muir Country Park. There is an excellent guide to the top sites here: www.the-soc.org.uk/our-headquarters/birdwatching-in-the-area.

We wanted to say a huge thanks to all those that have helped make this possible, in particular the Scientific, Local Organising, ECR and Society Committees, Deena Mobbs for designing the web site and conference programme, Jenny Sturgeon for illustrating the logo and the venue manager Louise Dryburgh for all her help and support.

Throughout the conference, members of the Local Organising Committee will be available to help so please don't hesitate to ask questions. We look forward to seeing you all in Edinburgh and hope you have an enjoyable conference.

Francis Daunt

Sue Lewis

www.seabirdgroupconference2016.info





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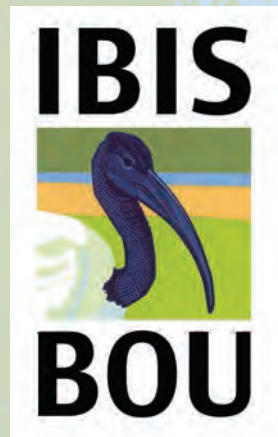
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Upcoming conferences:

Advances in avian tracking methods

#BOUsci16 | 12 October 2016



Avian tracking and population processes

#BOU2017 | 28–30 March 2017

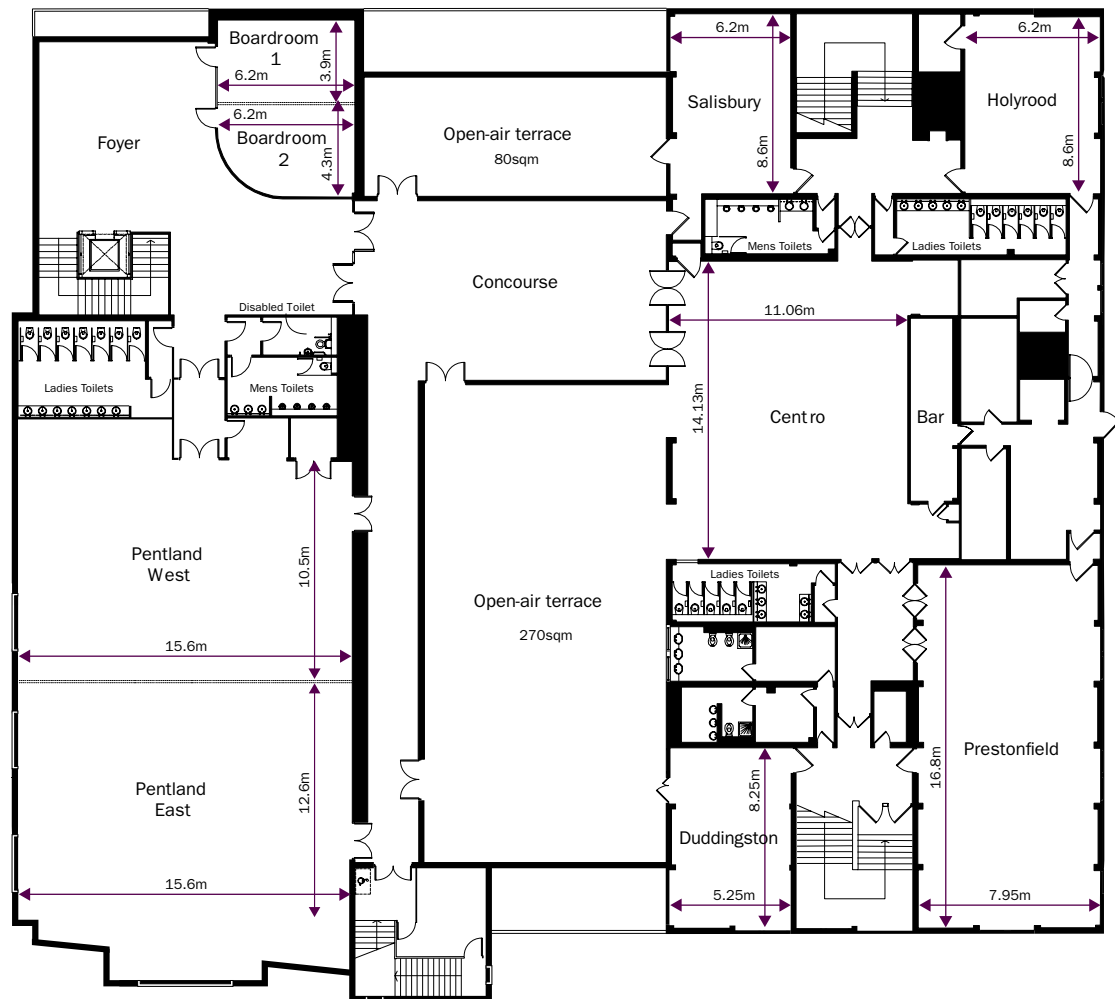


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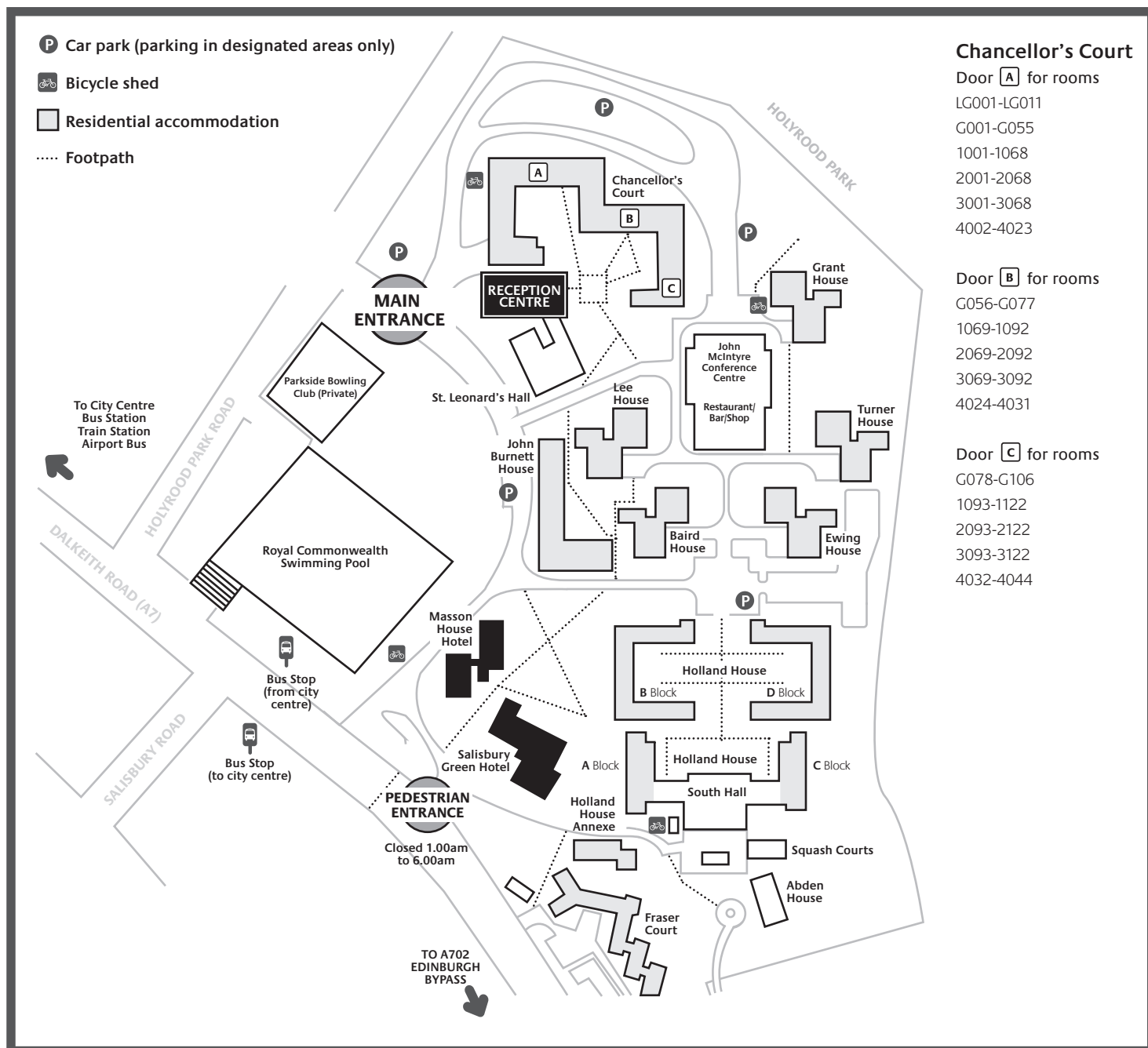


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Plenary Speakers

Tony Martin



Tony Martin is Professor of animal conservation at the University of Dundee and currently under secondment to the South Georgia Heritage Trust as Director of the South Georgia Habitat Restoration Project. Between 2011 and 2015 this project spread rodenticide bait by helicopter over more than 1,000 km² of the island, with the aim of eradicating brown rats and house mice from this UK Overseas Territory. Although it is too early to be sure of success in this, the world's largest rodent eradication campaign, it's looking good so far! Tony's interest in birds began as a boy, and his passion for seabirds was cemented in a series of undergraduate research trips to Hermaness NNR in Shetland, initially under the guidance of Mike Harris, whose gazelle-like pace across the moors was a source of awe and wonder.

A career in zoology started at the University of Sussex, but an opportunity to join the Sea Mammal Research Unit in Cambridge was irresistible and led to 30 years of work on cetaceans and other aquatic vertebrates, especially in polar regions and the Amazon. A decade of this, focussed on South Georgia, was with the British Antarctic Survey and offered months on legendary Bird Island with albatrosses, petrels and prions. It was at South Georgia, coming face-to-face with the catastrophic impact of invasive predators, that Tony first lost sleep trying to work out how rodents on the island might be vanquished. He lost a lot more many years later when asked to lead an £8m project with that one beguilingly simple objective.

Emmanuelle Cam



Emmanuelle Cam is a professor of evolutionary ecology and modeling at the University Toulouse III. As an undergraduate student, the fascination with long-term studies of seabirds in remote polar areas rapidly turned to fascination with a small population of individually marked kittiwakes in metropolitan France. If you are not afraid of heights, if you like the harsh climate of Finistère (Brittany, France), if you are stubborn enough to spend hours waiting until an incubating bird stands up, and if you come back day after day to collect data even though there is often a high risk of freezing to death, then you will be immersed in the life of an entire city where you personally know a lot of individuals, and their challenges with housing, conflicts between neighbors, alliances against intruders, cuckoldry, agitated and noisy children at home, food and household expenses, divorce, fights and injuries, consequences of widowhood, clutches or chicks lost to predation, exodus, etc.

Many seabird species are long-lived; understanding the relationship between the diversity of individual trajectories and fitness is a challenge with both fundamental and applied implications in evolutionary ecology and conservation biology. Long-term studies of individually marked animals have generated datasets raising particular difficulties inherent in the imperfect detectability of individuals (missing data). Looking backward, Emmanuelle considers herself very fortunate to have met the researcher who started the kittiwake project, and to be able to continue to work with him today. A second turning point in her scientific life is the warm welcome by experts in capture-mark-modeling in the USA; the clear awareness of the importance of such approaches and the incredible teaching skills of these researchers created very favourable conditions to work on kittiwakes in Brittany and on other seabird species (marbled murrelets in British Columbia, Audouin's gulls in Mallorca). The greatest irony, she finds, is that it is not easier to extract relevant signals from very rich and detailed datasets than from moth-eaten datasets with missing data.

Paulo Catry

Paulo Catry is a researcher at ISPA – Instituto Universitário, in Lisbon, where he also teaches under- and post-graduate courses on ecology and ornithology. After a first degree in biology in Portugal, Paulo moved to do his PhD in Glasgow, studying bonxies in Shetland and starting a lifelong passion for fieldwork based on small islands. He has pursued a broad interest in ornithology, co-authoring various reference books and atlases of Portuguese birds, and studying and publishing on species as diverse as robins, warblers, waterfowl, waders, parrots, raptors and a range of seabirds. Paulo has been working for over 20 years in Guinea-Bissau, dealing with practical issues related to biodiversity conservation (particularly sea turtles) and Protected Areas management, and he recently received a prize from national conservation authorities for this long-term commitment. Such conservation work has, on various occasions, extended to other West African countries, including Mauritania and Cape Verde. After a one-year contract with BAS working with albatrosses on Bird Island (South Georgia), in 2003 he started two intensive long-term demographic and ecological studies that are still running today: Cory's shearwaters on the Selvagens (Madeira) and black-browed albatrosses in the Falkland Islands. Spatial ecology and bird migration are his favourite research subjects. Much of Paulo's free time is spent looking after Mediterranean trees and bushes and enjoying local birdlife on a 1-hectare piece of land, in a remote and dry corner of the interior of Portugal.



Tim Birkhead

Tim Birkhead is a professor of behaviour and evolution at the University of Sheffield. His research on promiscuity and sperm competition in birds helped to re-shape our understanding of bird mating systems. Tim has been president of the International Society for Behavioural Ecology and the Association for the Study of Animal Behaviour. In 1992 he initiated the on-going biennial Biology of Spermatozoa (BoS) meetings. He has studied guillemots — mainly on Skomer — for over 40 years. As well as a passion for research, Tim is committed to undergraduate teaching and to the public understanding of science. His award-winning popular science books include *The Wisdom of Birds* (2008) (<http://wisdomofbirds.co.uk>) and *Bird Sense* (2012) (<http://bird-sense.com/>) and his book *The Most Perfect Thing: the Inside (and Outside) of a Bird's Egg* (<https://themostrapertthing.com/>) is short-listed for the Royal Society's Insight Investment Book Award. He is married and has three (fledged) offspring and a dog, enjoys walking, playing guitar and painting in his spare time.



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Oral Programme

Tuesday 6th September

12:00-14:00 Doors opening

14:00-17:00 EARLY CAREER RESEARCHER EVENT

17:00-18:00 Registration

18:00-19:00 Plenary lecture. Tony Martin, South Georgia Heritage Trust and University of Dundee - Invasive alien species on seabird islands: problems and solutions

19:00-21:00 WELCOME RECEPTION sponsored by
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Wednesday 7th September

08:30-09:00 Registration

09:00-09:45 Plenary lecture. Emmanuelle Cam, Université Toulouse III - The conundrum of life history trajectories: insights from a long-term study

09:45-10:45 MIGRATION AND WINTER ECOLOGY I

09:45-10:00 Rob Thomas A long-term study of migrating European storm petrels

10:00-10:15 Ana Carneiro Consistency in migration strategies and habitat preferences of brown skuas over two different years, a decade apart

10:15-10:30 Benjamin Merkel A tale of two guillemots – How variable is their habitat use during the non-breeding season?

10:30-10:45 Tone Reiertsen Evidence of sex segregated wintering areas in puffins

---- 10:45-11:15 Coffee break ----

11:15-12:45 SEABIRD MONITORING PROGRAMME

11:15-11:30 Mark Tasker The Seabird Monitoring Programme: a historical perspective

11:30-11:45 Georgia Connolly Seabird diet monitoring in the UK

| | | |
|-------------|--------------------|---|
| 11:45-12:00 | Liz Humphreys | The Seabird Monitoring Programme: scientists and volunteers working together to understand changes in seabird populations |
| 12:00-12:15 | Kate Searle | Use of SMP count data to test how intrinsic and extrinsic processes combine to drive patterns of seabird population dynamics in UK coastal waters |
| 12:15-12:30 | Martin Heubeck | The SMP 30 years on: taking stock, and planning for the future |
| 12:30-12:45 | General discussion | |

---- 12:45-13:45 Lunch break ----

13:45-15:30 BREEDING ECOLOGY AND LIFE HISTORY I

| | | |
|-------------|-------------------|--|
| 13:45-14:00 | Alice Carravieri | Does mercury contamination affect breeding success in an Antarctic seabird? |
| 14:00-14:15 | Hanno Sandvik | Drift patterns of fish larvae link coastal morphology to seabird colony distribution |
| 14:15-14:30 | Olivia Hicks | Linking parasitism and life-history: novel questions with a novel energetic approach |
| 14:30-14:45 | Ingrid Pollet | What factors influence breeding success of Leach's storm-petrels? |
| 14:45-15:00 | Katharine Kite | Timing is everything – spatial and temporal variation in the breeding ecology and dispersal of the European shag (<i>Phalacrocorax aristotelis</i>). |
| 15:00-15:15 | Louise Soanes | Linking asynchronous breeding and foraging behaviour in tropical seabirds |
| 15:15-15:30 | Jannie Linnebjerg | Growth, not mortality, drives the 'intermediate' parental care strategy in murrees |

---- 15:30-16:00 Coffee break ----

16:00-17:15 CONSERVATION

| | | |
|-------------|------------------------|--|
| 16:00-16:15 | Freydis Vigfusdottir | What do recent changes in Icelandic marine environment mean for Icelandic seabirds? Overview, case studies and prospects |
| 16:15-16:30 | Nicky McArthur | A New Zealand conservation story of a globally unique seabird, Kaikoura's Titi, the Hutton's shearwater |
| 16:30-16:45 | Emma Critchley | Modelling seabird diversity hotspots using foraging range and population sizes |
| 16:45-17:00 | Yuliana Bedolla-Guzmán | Comprehensive seabird conservation program on Mexican islands |
| 17:00-17:15 | Steffen Oppel | Using globally threatened pelagic birds to identify priority sites for marine conservation in the South Atlantic Ocean |
| 17:15-17:30 | Poster Speed Talks | |
| 17:30-20:30 | POSTER RECEPTION | |

09:00-09:45 Plenary lecture. Paulo Catry, MARE (Marine and Environmental Sciences Center) and ISPA (Instituto Universitário) - Dancing in the moonlight: effects of light regime on seabird activity patterns

09:45-10:45 MIGRATION AND WINTER ECOLOGY II

- 09:45-10:00 Sarah Burthe Does extreme weather disrupt individual migration strategies in a partial migrant?
- 10:00-10:15 Nina O'Hanlon Multi-colony non-breeding distributions and resource use of a generalist seabird
- 10:15-10:30 Annette Fayet Worldwide migratory strategies of Atlantic puffins: behavioural differences and environmental drivers on a global population scale
- 10:30-10:45 Morten Frederiksen Migratory connectivity of great cormorants in Europe

---- 10:45-11:15 Coffee break ----

11:15-12:45 FORAGING ECOLOGY & MOVEMENTS I

- 11:15-11:30 Nina Dehnhard Soaring with the wind? Foraging behaviour of sympatric Antarctic fulmarine petrels in East Antarctica in relation to habitat characteristics
- 11:30-11:45 Elizabeth Morgan Individual consistency within and between years in the foraging behaviour of European shags: some birds do change their spots
- 11:45-12:00 Ashley Bennison Local ecology changes foraging behaviour in northern gannets: a machine-learning approach to determining the differences between colony foraging metrics
- 12:00-12:15 Richard Howells From days to decades: long and short term environmental conditions affect the diet composition of a seabird top-predator
- 12:15-12:30 Alice Trevail Does environmental predictability play a role in shaping individual foraging behaviour?
- 12:30-12:45 Matthew Carroll Cross-validation of at-sea survey and GPS tracking methods to determine marine distribution of seabirds

----12:45-13:45 Lunch break ----

13:45-15:30 BREEDING ECOLOGY AND LIFE HISTORY II

- 13:45-14:00 Alex Bond Egg size during a century of change in northern rockhopper penguins
- 14:00-14:15 Katharine Keogan A global meta-analysis of seabird breeding phenology: are birds adjusting their breeding season?

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| 14:15-14:30 | Cátia Santos | “Honey, I think I contaminated the kids”: a lesser black-backed gull field study on the effect of maternal foraging and breeding strategies and offspring quality. |
| 14:30-14:45 | Agnes Olin | Effects of changing environmental conditions and intrinsic variation on the breeding success of northern fulmars |
| 14:45-15:00 | Marwa Kavelaars | Parental strategies in a changing world - How intrinsic and extrinsic factors impinge on parental care in lesser black-backed gulls |
| 15:00-15:15 | Åshild Idsø | Breeding success in Atlantic puffins at Hjelmsøya, northern Norway: effects of food availability and climate variation |
| 15:15-15:30 | George Divoky | Increasing mates in a decreasing population: opportunistic polygyny in the black guillemot |

---- 15:30-16:00 Coffee break ----

16:00-17:15 DEMOGRAPHY AND POPULATION GENETICS

| | | |
|-------------|---------------|--|
| 16:00-16:15 | Deborah Pardo | Demographic buffering in declining populations: can pre and non-breeders save the grey-headed albatross? |
| 16:15-16:30 | Rémi Fay | From early-life to senescence: individual heterogeneity in a long-lived seabird |
| 16:30-16:45 | Dimas Gianuca | Influence of allochryony on the population trajectories of northern and southern giant petrels |
| 16:45-17:00 | Matt Wood | Climatic variation and demography of Manx shearwaters in the Irish Sea |
| 17:00-17:15 | Hila Levy | Keeping it close to home: the phylogeography of the gentoo penguin |
| 17:15-17:30 | Gemma Clucas | Are penguins really all that philopatric? |

17:30-17:45 LIFETIME ACHIEVEMENT AWARD CEREMONY

17:45-18:30 SEABIRD GROUP AGM

18:30-19:00 Free

19:00-23:00 CONFERENCE BANQUET AND CEILIDH sponsored by Natural Power



Friday 9th September

09:00-10:45 FISHERIES AND RENEWABLES

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|-------------|------------|---|
| 09:00-09:15 | Helen Wade | Obligated to land? Vulnerability of Scottish seabird populations to a discard ban |
|-------------|------------|---|

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| 09:15-09:30 | Davide Gaglio | Why greater crested terns are winning the race: comparing Benguela-endemic seabirds that compete with fisheries |
| 09:30-09:45 | Kirstin Fangel | Spatio-temporal variations in seabird bycatch: Incidental bycatch in the Norwegian coastal net-fishery |
| 09:45-10:00 | Emily Nelson | Responses of marine top predators to an offshore wind farm: a cross-taxon comparison |
| 10:00-10:15 | Alex Banks | The Seabird Mapping & Sensitivity Tool – SeaMaST |
| 10:15-10:30 | Julie Miller | Assessing impacts of offshore wind farms on seabird populations of Special Protection Areas |
| 10:30-10:45 | Cat Horswill | Should models used to predict population change incorporate density-dependence mechanisms? A case study based on seabirds and wind farms |

---- 10:45-11:15 Coffee break ----

11:15-12:45 FORAGING ECOLOGY & MOVEMENTS II

| | | |
|-------------|---------------------|---|
| 11:15-11:30 | Emily Shepard | Fine scale flight strategies of gulls in urban airflows indicate risk and reward in city living |
| 11:30-11:45 | Bethany Clark | Sensory ecology of foraging gannets: new insights from 3D tracking and accelerometry |
| 11:45-12:00 | Saskia Wischniewski | Exceptionally large foraging ranges in provisioning Manx shearwaters (<i>Puffinus puffinus</i>): a triple foraging strategy facilitated by environmental variables? |
| 12:00-12:15 | Jude Lane | High flying birds: sex-specific three-dimensional foraging behaviour of a top marine predator |
| 12:15-12:30 | Anders Mosbech | Foraging strategy of little auks during chick rearing in Northwest Greenland |
| 12:30-12:45 | Ellie Owen | Breeding together, feeding apart: sympatric seabirds exploit mutually exclusive home ranges |

----12:45-13:45 Lunch break ----

13:45-14:30 Plenary lecture. Tim Birkhead - University of Sheffield - Long-term guillemots: counting, sperm and eggs

14:30-15:00 PRIZE-GIVING AND CONFERENCE CLOSE



Poster Programme

Heidi Acampora - The use of preen oil to monitor Persistent Organic Pollutants (POPs) in common terns (*Sterna hirundo*) in Ireland

Christophe Barbraud - A multi-decadal study of pre-breeding survival of black guillemots in a rapidly changing Arctic

Sigurd Benjaminsen - Foraging trips and dive depth indicates prey type in chick rearing common guillemots

Martin Berg - Have ecosystem changes altered the trophic niche of the fluttering shearwater (*Puffinus gavia*)? - A 134-year stable isotope record from feathers and prey collected in the Hauraki Gulf, New Zealand

Julie Black - Seabird conservation: where do marine SPAs fit?

Aur lie Blanck - MSFD seabirds marine monitoring programme in France

Francois Bolduc - GPS tracking reveals the off-colony distribution of nesting razorbills in the St. Lawrence Estuary, Canada

Francois Bolduc - Models of northern gannet at-sea distribution in Canadian waters using the GeoAviR R package

Rahel Borrmann - GPS tracking of breeding great black-backed gulls reveals high consistency in foraging patterns

Michael Brooke - Exceptionally long foraging trips of Murphy's petrels in the tropical Pacific – no gain for the pain?

Julia Bublichenko - The great cormorant (*Phalacrocorax carbo sinensis*) expansion into the western part of the Gulf of Finland, Russia

Claudia Burger - Effects of shipping traffic on the spatial and temporal distribution of seabirds in the Baltic Sea

Bernard Cadiou - New data about the secret life of the wandering prebreeding European storm petrels at colonies

Richard Caldow - A comparison of alternative sources of maps of breeding seabird distribution at sea

Ana Carneiro - Seabird Tracking Database: Science and conservation avenues

Marianna Chimienti - How do I catch my fish? Multiscale foraging strategies in seabirds

Signe Chr.-Dalsgaard - Foraging habitats of European shags in contrasted marine environments

Harriet Clark - Can novel 3G-GPS tags reveal the foraging movements of an untracked seabird population with apparently nowhere to go?

Aonghais Cook - Seawatching as a potential monitoring tool

Wouter Courtens - Up shit creek: new sampling method reveals foraging decisions of a specialised seabird

Federico De Pascalis - Boring but useful: a case study of time lapse photography

George Divoky - Chasing Ice: Mandt's black guillemot's year-long association with Arctic sea ice

Steve Dudley - How social are ornithologists?

Ruth Dunn - Black-legged kittiwakes as an ecological indicator: can we link foraging behaviour, environmental variability and reproductive success?

Tom Evans - Diving with a backpack: a detailed study of tag effects in the common guillemot

Kirstin Fangel - How many did you catch? The Norwegian Seabird Bycatch Project 2008-2015

- Katharina Fließbach** - Vulnerability of seabirds to ship traffic in German North and Baltic Seas
- Dimas Gianuca** - Comparative trials of luno leads and traditional line weighting in the Brazilian pelagic longline fishery
- James Grecian** - Age-related differences in the foraging behaviour of a long-lived marine predator
- Martin Heubeck** - Thirty-eight years of monitoring show a large-scale oil development has had little long-term impact on local seabird populations
- Tamora James** - Pair formation and divorce: Exploring the population dynamic consequences of individual heterogeneity
- Adam Kane** - Flying fertilizer – how shifts in foraging area can change nutrient distributions
- Kerstin Kober** - Proposed new marine protection areas for seabirds and waterbirds in the UK
- Jim Lennon** - Atlantic puffin – adult survival rates on the Shiant Islands
- Richard Luxmoore** - Censusing puffin colonies – a trial of the different methods available on the island of Mingulay
- Elizabeth Masden** - Investigating the ecology of black guillemots in relation to marine renewable energy
- Elizabeth Morgan** - Farne Island shags don't share with their neighbours.
- Aevar Petersen** - Long-term study of black guillemots in Iceland
- Olesya Pshenichnikova** - Parakeet auklet (*Aethia psittacula*) – is the monotypic species actually monotypic?
- Olesya Pshenichnikova** - Intraspecific genetic differentiation in the ancient murrelet (*Synthliboramphus antiquus*)
- Mark Rehfish** - Surveying the seabirds of Ka'ula Island, Hawai'i, using high resolution digital aerial oblique imagery
- Pia Ricca** - Migration patterns, distribution and activity during the nonbreeding season of black-legged kittiwakes *Rissa tridactyla* from Canna Island, Scotland
- Julie Riordan** - Long-term changes in common guillemot chick diet on Skomer Island, Wales
- Alex Robbins** - Going with the flow: seabird usage of high-energy tidal environments from shore-based vantage points
- Kathryn Ross** - Developing methodologies for surveying urban gulls
- Dilek Sahin** - High migration counts in Turkey suggest the existence of undiscovered colonies of the Yelkouan shearwater
- Blanca Sarzo** - A first Bayesian survival modeling of the largest colony of common guillemot at the Baltic Sea
- Alejandro Sotillo** - Diet effects on chick development of lesser black-backed gulls
- Hallvard Strøm** - Large-scale tracking of seabirds in the Northeast Atlantic – SEATRACK
- Philip Taylor** - Restoring and securing seabird islands – RSPB's seabird island restoration project
- Chris Thaxter** - Tracking lesser black-backed gulls from three colonies reveals seabird-wind farm interactions over multiple scales
- Alejandra Toledo** - Nest site selection and individual quality in Caribbean seabirds
- Helen Wade** - Flying over rivers in the sea: understanding why seabirds forage in energetically demanding tidal races
- James Waggitt** - Understanding and predicting spatio-temporal variations in marine top-predator distributions in European waters, at regional and decadal scales.
- Susan Waugh** - Seabird trophic level shifts from the 1920s to 2010s for shelf-feeding endemic species in the NZ region

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Oral Abstracts

The Seabird Mapping & Sensitivity Tool – SeaMaST

Alex Banks¹, Gareth Bradbury², Bob Furness³ & Mark Trinder³

¹Natural England, UK; ²WWT Consulting, UK; ³MacArthur Green, Glasgow, UK

Developed in response to the expanding marine renewable energy industry, SeaMaST is a freely available Geographic Information tool designed to provide evidence on seabird distribution in waters around England, and to map seabird sensitivity to impacts from offshore wind farms. Data were compiled from offshore boat, visual aerial and digital aerial surveys spanning the period 1979–2013. Density Surface Models were produced to predict bird densities across a 3 x 3 km² grid covering English territorial waters. Coefficients of Variation were estimated for each grid cell density, as an indication of confidence in modelled density predictions. Offshore wind farm sensitivity scores were compiled for seabird species present in English territorial waters. The comparative risks to each species of collision with turbines and displacement from sea areas supporting operational turbines were reviewed and scored separately, and the scores were multiplied by the bird density estimates to produce relative sensitivity maps. The sensitivity maps reflected well the amassed distributions of the most sensitive species. We present examples of the use of SeaMaST in impact assessment, marine spatial planning, conservation and scientific research, also describing application to wider geographic areas and other relevant human activities.

Comprehensive seabird conservation program on Mexican islands

Yuliana Bedolla-Guzmán, Alfonso Aguirre-Muñoz, Federico Méndez-Sánchez, Antonio Ortiz-Alcaraz, Luciana Luna-Mendoza, Araceli Samaniego-Herrera, Julio Hernández-Montoya, María Félix-Lizárraga, Evaristo Rojas-Mayoral, Flor Torres-García, Mariam Latofski-Robles, Alejandra Fabila-Blanco, Ana Montiel-Arteaga, Fernando Solís-Carlos, Alfonso Hernández-Ríos, Esmeralda Bravo-Hernández, David Cosío-Muriel & Fernando Pérez-Castro

Grupo de Ecología y Conservación de Islas, Ensenada, Baja California, México

Mexico occupies the third place in diversity and the second place in endemic species of seabirds in the world. Its nearly 4,500 islands are surrounded by very productive waters and are key breeding sites for seabirds. On some of these islands, seabird populations were extirpated by invasive mammals, and were also affected by DDT and oil spills. Over the past two decades, we have been conducting a comprehensive and intensive restoration program including the removal of invasive mammals, followed by social attraction techniques to attract back seabirds and habitat improvement through reforestation. All these efforts are based on sound science from our research on the islands. Furthermore, environmental education, outreach and island biosecurity are also part of our program.. We are currently working with 24 seabird species on 16 groups of islands all over Mexico. To date, we have successfully removed 58 populations of invasive mammals on 37 priority islands. Seabird recovery has been a major outcome. Some extirpated populations have returned to their breeding sites and decremented populations have increased their numbers after the eradication campaigns and implementation of social attraction techniques. We have identified management and conservation priorities published on a National Island Strategy, first of its type in the world. Our encouraging results and achievements highlight the importance of a long-term conservation program to restore all islands and seabird breeding colonies in Mexico.

Local ecology changes foraging behaviour in northern gannets: a machine-learning approach to determining the differences between colony foraging metrics

Ashley Bennison¹, Mark Jessopp¹, Stuart Bearhop², Steve Votier³, Ewan Wakefield⁴ & Keith Hamer⁵

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Seabird researchers often identify key foraging areas using movement metrics within GPS tracking data. However, rarely are there any data from immersion loggers to inform or validate these predictions. We tracked Northern gannets (*Morus bassanus*) from Great Saltee (Ireland), Bass Rock (Scotland), and Grassholm (Wales) using a combination of GPS and time depth recorders (TDR). Machine-learning techniques were employed to build generalized boosted regression models of foraging dives based on movement patterns of birds in each colony. Models had good predictive power of dive events, with step length and turning angle accounting for 28.15% +/-0.964 and 2.56% +/-0.307 of model power in all colonies respectively. However, tortuosity values varied in importance across colonies with Celtic Sea colonies relying on values calculated over shorter distances than those in the North Sea. The predictive power of models built on data from one colony dropped considerably (average loss of >95% of predictive power) when applied to other colonies. That our models use the same metrics with differing levels of importance implies differences in behavior associated with foraging in different regions. This is discussed in terms of the local ecologies of the Celtic Sea and North Sea.

Long-term guillemots: counting, sperm and eggs

Tim Birkhead

University of Sheffield

This talk will draw together several themes that have directed and driven my research, including *how we know what we know about birds* (and in this case, seabirds), and the all-too common idea that our current knowledge is the truth rather than 'the truth for now'. I shall start with numbers: counting seabirds; how and why we do it, and why we *need* to do it. I shall then move on to a brief bout of promiscuity and how that fired an interest in the processes that determine how eggs are fertilized. The final part of the talk considers the product of both promiscuity and monogamous marriage: the egg – and the pyriform egg of the common guillemot in particular. Using examples from two main seabird colonies, Bempton Cliffs in Yorkshire and Skomer in Pembrokeshire, I shall look at the way eggs — large numbers of them — fueled our knowledge of guillemot reproductive biology and population biology and the way that knowledge was shaped first by folklore and later by citizen science and finally by professional scientists.

Egg size during a century of change in northern rockhopper penguins

Alexander L. Bond¹, Gregory T.W. McClelland^{1,2}, Trevor Glass² & Peter G. Ryan³

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Variations in egg size can have considerable effects on individuals later in life, affecting hatching success, chick growth, and survival. Understanding how species' egg size has changed over time may therefore provide information on current population processes. northern rockhopper penguins (*Eudyptes moseleyi*) breed on the islands of Tristan da Cunha, where they have declined significantly in the last century. We measured 1029 eggs from museum collections and field sites from 1873-2014 to first develop a discriminant function for separating A- and B-eggs, and then apply it to eggs of unknown laying sequence. A discriminant function based on length and breadth successfully classified the laying sequence of 91% of eggs (n = 254). Eggs with breadth > 65 mm and width > 50 mm were classified as B-eggs. Applied to museum specimens, and controlling for colony location, we found no change in the volume, length or breadth of larger B-eggs, or in the volume or breadth of A-eggs, but A-eggs' length increased by >2 mm (~3%) over the time series. Eggs from Gough Island were consistently the largest and those from Alex/Nightingale Islands the smallest, potentially reflecting the latitudinal gradient and different oceanic regimes exploited by penguins breeding at these sites.

Does extreme weather disrupt individual migration strategies in a partial migrant?

Sarah Burthe¹, Jane Reid², Mark Newell¹, Hannah Grist², Carrie Gunn¹, Mike Harris¹, Jenny Sturgeon², Sarah Wanless¹ & Francis Daunt¹

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Many climate models are predicting an increase in climate variability and frequency of extreme weather events, which may have profound effects on the demography of animal populations. Migration strategy is a key mechanism underpinning demographic effects of environmental perturbations. In partial migrants, profound demographic heterogeneity might occur due to spatial variation in conditions or intrinsic differences between residents and migrants. Yet few studies have quantified whether partial migrants alter their migration strategy in response to extreme weather, and the demographic consequences of such decisions. Here we quantified the consequences of two concurrent severe winters on a partially migratory population of European shags (*Phalacrocorax aristotelis*). Using intensive year-round resightings of colour-ringed individuals, we found that residents had lower survival than migrants during the first winter, but higher survival in the second winter. Despite these demographic effects, individuals did not alter their migration strategy. However, we found that individual migration strategies differed in the following winter. Our study demonstrates that extreme weather can have immediate effects on demography and carry-over effects on migration strategy, suggesting potentially profound implications of future increases in the frequency of extreme weather on populations of mobile species.

The conundrum of life history trajectories: insights from a long-term study

Emmanuelle Cam

Université Toulouse III

The syntheses on studies of individually marked vertebrates have provided evidence that a minority of individuals contributes most offspring to future generations. Studies of seabirds have largely contributed to document inter-individual variation in longevity, number of successful reproductive events, and arrangements of failed and successful reproductive events before death. The question of the causes of the diversity of pathways in longitudinal trajectories is shared across disciplines focusing on longitudinal data, e.g., econometrics, social and biomedical sciences. Among the processes that can drive the dynamics of reproductive outcomes in life history trajectories, two processes with different interpretations have been identified in other disciplines: state-dependence and heterogeneity. Recently, heterogeneity has become salient in life history studies because of evidence of heritability of 'latent traits', which are used in statistical models to account for heterogeneity in demographic parameters among individuals. I review the different stages of research on the dynamics of reproductive outcomes and overall fitness in seabirds, with a particular emphasis on a long-term study from kittiwakes. I draw parallels between the questions addressed in different disciplines, and review similarities and differences between methods of statistical inference. I draw on insights from other disciplines to identify potential avenues for research on life histories.

Consistency in migration strategies and habitat preferences of brown skuas over two different years, a decade apart

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At-sea movements and activity patterns of brown skuas from South Georgia were analysed in two winters, a decade apart, to examine the degree of consistency in migration strategies and habitat preferences during the non-breeding period. Oceanographic habitat preferences of tracked skuas were determined using a robust model accounting for availability. At the population level, brown skuas were broadly consistent in their choice of wintering areas and habitat preferences, although the distribution extended further east in 2012 than in 2002. Skuas preferred areas associated with static oceanography, which may explain the consistency between years in habitat use. There was no significant effect of year on departure dates from South Georgia, but birds returned earlier to the colony in 2002. Migration schedules varied according to breeding status, with failed birds departing earlier than birds that bred successfully. Although failed birds travelled further from the colony, there was little variation in dates of return. Brown skuas spent a much higher proportion of time sitting on the water than other seabirds, and the number of flight bouts per day was surprisingly low. The selection of static features by brown skuas may indicate that skuas may have less flexibility to track environmental changes than species that use dynamic cues.

Does mercury contamination affect breeding success in an Antarctic seabird?

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Mercury (Hg) is a global pollutant reaching remote environments through atmospheric transport and deposition. Hg is an endocrine disruptor, and is known to impair reproduction in vertebrates. Seabirds as predatory species accumulate high quantities of Hg through food intake. Yet, effects of Hg on seabird reproduction are poorly studied, especially in Antarctica, where increasing environmental perturbations challenge animal populations. Here we test whether breeding success is affected by blood Hg levels in adult Antarctic petrels (N = 267) from an inland Antarctic colony (Svarthamaren, Dronning Maud Land). In order to investigate the proximate mechanisms underlying this relationship, we also measured the blood baseline concentrations of corticosterone (CORT), a glucocorticoid hormone that can act as a mediator of avian reproductive investment decisions. Hg effects on baseline CORT levels could thus result in breeding failure. Studying the impact of Hg on Antarctic seabird reproduction is pivotal especially in the context of ongoing climate change that is predicted to modify Hg distribution patterns in polar ecosystems.

Cross-validation of at-sea survey and GPS tracking methods to determine marine distribution of seabirds

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As the rate and extent of offshore development increases, it is ever more important to quantify seabird distributions. Historically, this was done using boat-based line transects, but satellite telemetry is increasingly being used. It is therefore important to understand how these methods compare. Here, we estimated the distribution of razorbills (*Alca torda*) and guillemots (*Uria aalge*) using boat-based data collected in the Minch in June 2015, and Global Positioning System (GPS) tracks of birds breeding on the Shiant Islands during the same period. Boat data were modelled as a smooth function of latitude and longitude; kernel densities were estimated from GPS data. Similarity between the resulting distribution estimates was assessed using proportional home range overlap, Spearman's rank correlations, the Bhattacharyya Affinity and the Utilisation Distribution Overlap Index. Similarity between methods was high for razorbills but moderate/low for guillemots. Both methods showed high densities north of the Shiant Islands, but only boat surveys detected high densities elsewhere. For razorbills but not guillemots, daytime GPS distributions matched boat surveys better than night-time distributions. Mismatches between the methods are potentially attributable to the small number of birds GPS-tracked, the necessity of completing boat surveys in good light and weather conditions, and the differing analytical methods.

Dancing in the moonlight: effects of light regime on seabird activity patterns

Paulo Catry

MARE (Marine and Environmental Sciences Center) and ISPA (Instituto Universitário)

Most predators on Earth use visual cues for foraging, while many prey seek the cover of darkness. Under moonlight, vulnerable prey escape to darker parts of the environment, and visually limited animals (i.e. all visually-guided animals) find it easier to carry out various tasks linked to reproduction and survival. Furthermore, the moon drives tides, changes gravitational forces and geomagnetic fields, and provides a regular timer, potentially useful as a direct cue or as a *zeitgeber* for entraining biological rhythms. We might therefore expect lunar cycles to have a major influence on life on Earth, but do they? Like virtually all other researchers of the animal kingdom, ornithologists tend not to see too well at night-time, and have traditionally considered birds as mostly diurnal. With respect to seabirds, it has long been known that some species tend to be nocturnal when visiting their nesting colonies. However, only with the recent development of tracking and activity data-loggers has a clearer picture of the extent of nocturnal activity of seabirds begun to emerge. I will review aspects of nocturnality in seabirds, with a particular focus on the effect of the moon, and its potential to modulate colony attendance, foraging activity, diet, and migratory behaviour. Some of the most detailed examples will be drawn from my work with a predominantly diurnal seabird (Cory's shearwater) and with a predominantly nocturnal one (Bulwer's petrel). I will suggest that the study of nocturnal behaviour and of the effects of the moon is in its infancy, with many unknowns still lurking in darkness.

Sensory ecology of foraging gannets: new insights from 3D tracking and accelerometry

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Northern gannets (*Morus bassanus*) locate sparse, mobile prey and fishery discards across vast areas, but their sensory mechanisms are poorly understood. Gannets visually detect prey before plunge diving, lack external nostrils and have small olfactory bulbs, suggesting that vision is key. However, we do not know if olfaction plays a part at larger spatial scales. We investigated the relative contributions of vision and olfaction using a combination of GPS, altitude, acceleration and dive depth loggers. Given that olfactory cues get weaker with height and visual cues get stronger, changes in height in the lead up to foraging predict the relative importance of these sensory mechanisms. Therefore, we used 3D movement tracks from 27 birds to investigate how flight height influences the distance at which birds respond to prey-rich ocean fronts and fishing vessels. However, adjustments in altitude may also be related to environmental conditions as gannets take advantage of wind and thermals. To account for this, we used accelerometers to measure fine scale movements, even individual wing beats, to allow us compare deliberate height gains with energy-saving soaring. Understanding gannet sensory ecology and energetics will help predict responses to changing fisheries policy and prey distribution.

Are penguins really all that philopatric?

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Recent advances in next generation sequencing technology have opened the floodgates for generating genomic data from non-model organisms. Here we present an unprecedented dataset consisting of thousands of genome-wide single nucleotide polymorphisms (SNPs) from over 350 emperor, king, gentoo, chinstrap and Adélie penguins sampled across their ranges. By comparing many species and using so many molecular markers, we are able to detect population structure at the finest scales and identify the mechanisms driving patterns of population differentiation or lack thereof. We find that for the majority of species and over very large spatial scales, population structure is extremely weak. This indicates that individuals are dispersing regularly between colonies, challenging the notion of high levels of natal philopatry in most species. We use this data to infer relative migration rates between populations, and hence detect extrinsic and intrinsic barriers to gene flow in the different species. The results from this study suggest that penguin populations should, on the whole, be considered as metapopulations, the boundaries of which we define.

Seabird diet monitoring in the UK

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Declines in UK seabird abundance and productivity are well recorded. In many cases, it is believed that changing food supplies drive declines, but our understanding is limited by scarcity of seabird diet data. Here we review the extent of seabird diet monitoring in the UK, from peer-reviewed and grey literature. We then make recommendations for improving future diet monitoring. The most extensive records are from SMP key sites, with guillemot, shag, razorbill, kittiwake and puffin the best monitored species. Methods were primarily visual observation and collection of regurgitates or fish. A limitation of these datasets was data availability, notably the lack of a central database. Systematic monitoring has also occurred at several other sites, including St Kilda (guillemot), Handa (great skua) and Long Nanny (little and Arctic terns). Short-term monitoring has occurred via PhD projects and academic research at several sites, but methods, durations and reporting methods vary. Recommendations to improve monitoring include promoting continuation of existing studies and standardised reporting, expanding auk visual monitoring to increase spatial coverage, and trialling new technologies. More broadly, we suggest it would be beneficial to produce a central database for seabird diet studies to improve data standardisation and availability.

Modelling seabird diversity hotspots using foraging range and population sizes

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Seabird surveys at sea can be costly and intensive work. On the other hand, predictive distribution models have the potential to allow a quick assessment of distributions on a large scale, and can help identify biodiversity hotspots for further investigation. This information is vital for conservation efforts as it will allow for more rapid risk assessment and inform allocation of marine protected areas. Here we report on a predictive distribution model that uses a foraging radius approach, taking into account colony location and size, as well as species foraging behaviour. We generate predictive at-sea abundance and distribution maps for all Irish seabirds at a 1km square resolution, for both individual species and feeding guilds. Predictions are validated with tracking data for some key species. Results show how the importance of specific regions varies dramatically for different species and guilds. South west Ireland is highlighted as particularly important in terms of breeding seabird biodiversity, with abundances of up to 40 individuals/km² offshore. An open-access online GIS platform has been developed concurrently to enable stakeholders, including fossil fuel and renewable energy sectors, to identify, manage and mitigate potential at-risk hotspots where vulnerable species occur.

Soaring with the wind? Foraging behaviour of sympatric Antarctic fulmarine petrels in East Antarctica in relation to habitat characteristics

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Antarctic fulmarine petrels, as all procellariiform seabirds, rely heavily on wind for their energy-efficient, gust-soaring flight. According to physics, flight speeds are highly dependent on wind speeds but also wing span and wing loading (mass per surface area). With global climate change, wind patterns in the Southern Hemisphere are predicted to change, as is the amount and distribution of sea ice, a critically important foraging habitat for most Antarctic wildlife. Identifying the currently utilized foraging habitat and whether wind conditions affect the travel time to foraging sites – or even the choice of potential foraging sites - will help to make predictions about future distribution patterns. During the austral summer 2015/16, we simultaneously GPS-tracked incubating and chick-rearing southern fulmars (*Fulmarus glacialis*), Antarctic petrels (*Thalassoica antarctica*) and cape petrels (*Daption capense*) in the Prydz Bay region (East Antarctica). The three species differ in their mass and wing loading, with southern fulmars being approximately twice as heavy as cape petrels. We will present the species' foraging distribution in relation to environmental habitat characteristics. Flight paths will be analysed in conjunction with simultaneously measured data (by remote sensing) on wind speed and direction, and inter-specific differences discussed in the context of the birds' morphology.

Increasing mates in a decreasing population: opportunistic polygyny in the black guillemot

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Shared parental duties in nest guarding, incubation and chick provisioning, while utilizing distant and frequently unpredictable prey, necessitates a monogamous breeding strategy in seabirds. Surprisingly, regular opportunistic polygyny has been observed recently at a colony of Mandt's black guillemots (*Cepphus grylle mandtii*) in Arctic Alaska when a previously increasing population was declining by 50% due to decreases in annual extent of summer sea ice. In the period of colony decline with limited recruits, small numbers (<5% per year) of paired site-owning males courted and copulated with unattended widowed females at adjacent sites. Eggs laid in the widow's site were incubated by both the polygynous male and widow but usually failed to hatch, as the polygynous male incubated only intermittently. However, in 2015 a 4-year old male breeding for the first time paired with two widowed females at adjacent sites and incubated eggs, provisioned young and fledged chicks at both nest sites. Successful opportunistic polygyny was possible due to the nearshore feeding habits of guillemots (*Cepphus* spp.), with more frequent incubation shifts and chick provisioning, and is unlikely to occur in more pelagic seabird species.

Spatio-temporal variations in seabird bycatch: incidental bycatch in the Norwegian coastal net-fishery

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The general decline of seabird populations worldwide raises concerns and an urge for untangling the many drivers involved. Although multiple factors are interacting to cause the observed declines, increased mortality from incidental bycatch in fisheries has proven to be important for many species. Yet, the bulk of published knowledge is derived from long-line fisheries whereas bycatch in gillnet fisheries usually is less studied and even overlooked in some areas. We present seabird bycatch data from a 10 year long time series of fishery data from an area and a fishery with no prior estimates of seabird bycatch: The Norwegian coastal small-vessel gillnet fishery. We found in general high estimates of incidental bycatch, although not exceeding estimates reported from long-line fisheries targeting the same fish species. We did however find a comparatively higher diversity of both surface-feeding and diving seabirds killed in the gillnet fishery, suggesting this is a more general threat to wider range of populations. We were also able to predict spatio-temporal trends of seabird bycatch, allowing for effective mitigation measures such as ambulant protected areas.

From early-life to senescence: individual heterogeneity in a long-lived seabird

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Heterogeneity in demographic traits within populations have strong implications for both long-term evolutionary processes and current population dynamics. Such among individual variation may arise from genetic factors or early-life developmental conditions having long-term phenotypic effect. Using finite mixture capture recapture modeling, we investigated individual heterogeneity in demographic traits from early-life to senescence in a long-lived seabird, the wandering albatross. Results provided strong support for individual heterogeneity in our study population with some individual showing higher immature survival probability, higher recruitment rate, higher breeding success at the first reproduction and both higher reproductive rate and reproductive success during adulthood. These “higher quality individuals” consistently outperformed others individuals without apparent survival cost until 30 years-old. However, after this age, males, but not females, from “high quality” group showed accelerated senescence suggesting a sex-specific cost of high reproductive rate. Additionally, results suggested among-cohort variation in individual quality. This cohort effect suggests that at least a part of individual heterogeneity come from early-life environmental condition. Investigating natal environment, we found that population size at birth was negatively related to cohort quality. This result shows that early-life population density may impact long-term individual performances well beyond the juvenile stage as recently documented.

Worldwide migratory strategies of Atlantic puffins: behavioural differences and environmental drivers on a global population scale

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While the typical avian migrant travels to a single destination for the winter, dispersive migrants can follow a variety of routes and visit many destinations, sometimes with large variations between populations. The extent to which factors such as intra-specific competition or environmental conditions shape population-specific winter distribution is unknown; and whether and how these factors can affect migratory behaviour, and ultimately fitness, remains to be understood. Here we use a large dataset of 259 geolocator tracks of migrating Atlantic puffins *Fratercula arctica* collected at 13 colonies across their whole breeding range to address these questions on a global population scale. We reveal the worldwide non-breeding distribution of puffins, measure inter-colony connectivity, and identify important hotspots. In addition, we use immersion data collected by geolocators to estimate individual activity budgets and winter energy expenditure. We investigate how local environmental conditions may influence non-breeding behaviour, and whether colony location or size can explain the striking inter-colony differences in range, route diversity, activity budgets and environmental conditions we observe. Our results may not only have important implications of the conservation of puffins, recently red-listed by the IUCN, but may also help understand the drivers of seabird colony distribution on large oceanic scales.

Migratory connectivity of great cormorants in Europe

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Understanding the links between breeding and wintering populations (migratory connectivity) is critical for conservation and management. For birds, assessments of migratory connectivity and the composition of wintering populations has traditionally been based on recoveries of dead ringed birds. However, this task is complicated by spatial and temporal variation in the probability that a dead ringed bird is found and reported. Estimation of exchange rates between breeding and wintering populations therefore requires sophisticated statistical methods. We developed a novel Bayesian mark-recovery model to estimate these exchange rates for the first time in a long-lived bird, the great cormorant (*Phalacrocorax carbo sinensis*) in Europe. We found that breeding populations in northern Europe mix extensively in their wintering areas in central and southern Europe, although more easterly breeding birds also tended to winter further east. Over the 30-year study period, there was a trend towards wintering further west for some populations, possibly related to the rapid growth of easterly breeding populations. There is thus not a stable one-to-one link between breeding and wintering populations, and this has important implications for cormorant management.

Why greater crested terns are winning the race: comparing Benguela-endemic seabirds that compete with fisheries

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High energetic demands in seabirds make them sensitive to changes in prey availability and this is often reflected in their diet. In the Benguela system (Southern Africa) the populations of endemic seabirds which rely on small pelagic commercial fish, have all decreased over the last few decades and are listed as threatened. In contrast the population of the greater crested tern *Thalasseus bergii* has increased over the same period. To better understand these conflicting trends since 2013, we have investigated the diet of swift terns in the Western Cape, South Africa. Diet was assessed using a novel non-invasive methodology that uses digital photography. More than 24,000 prey items were recorded and standard lengths of fish were estimated. Results show that the main prey is anchovy (70%) which averaged 80 mm long. However, a wide range of other prey was also captured. Fine and large-scale temporal variation of swift tern diet was assessed and compared to data previously collected in the Western Cape. Understanding how swift terns cope with local reductions in pelagic fish availability in comparison to the other endemic seabirds is vital for assessing the impact of commercial fisheries on seabird populations and fish stocks.

Influence of allochry on the population trajectories of northern and southern giant petrels

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Synchronizing timing of breeding with optimal environmental conditions is critical, especially at high latitudes. The northern (NGP, *Macronectes halli*) and the southern (SGP, *M. giganteus*) giant petrels are dominant predator-scavengers in the Southern Ocean. Despite comparable life-histories, at South Georgia numbers of NGP have increased whereas those of SGP have decreased slightly. Possible explanations include higher availability of fur seal carrion for adult NGPs (which breed 6 weeks earlier), or higher mortality of SGP on pelagic longlines, given their greater overlap with this fishery. Here we investigated the effects of fisheries, carrion availability and environmental variation on life history traits of NGP and SGP at Bird Island, and used matrix models to project population trajectories. Although survival was similar in the two species, breeding success was lower for SGP. Projected population trajectories followed the trends observed from nest counts, indicating that the lower population growth of SGP resulted from poorer breeding success. Moreover, the number of fur seal pups born each year significantly influenced the breeding success of both species. Hence, it appears that because of allochry, SGPs are less able to exploit the seasonal peak in carrion availability, with repercussions for chick survival, and clear implications for population trajectories.

The SMP 30 years on: taking stock, and planning for the future

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A central aim of the SMP is to ensure that breeding success data are collected to provide an annual assessment of the conservation status of UK seabirds at a regional and national scale. A key assumption is that the methodology is robust enough for comparisons within and among colonies to highlight spatio-temporal differences under changing environmental conditions. After 30 years, it is timely to evaluate the programme and consider if it is fit for purpose for the next 30 years. The Shetland Oil Terminal Environmental Advisory Group (SOTEAG) monitoring programme has contributed breeding success data on five species to the SMP for 30 years. The data are very high quality (absolute consistency of observers and high intensity of annual checks). They indicate that breeding success of most species has declined markedly. In many cases, the number of birds breeding in a monitoring plot has also decreased, and in kittiwakes some monitoring plots have become extinct. The aim of this talk is to use the Shetland programme to highlight methodological issues. Specifically how: 1) methods may need to be adapted to cope with reduced numbers of breeding pairs/monitoring plots; 2) monitoring intensity can affect estimated breeding success; and 3) additional monitoring metrics can be extracted from existing data.

Linking parasitism and life-history: novel questions with a novel energetic approach

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Many species exhibit reproductive skew with some individuals consistently more successful than others. The mechanisms underpinning this skew are often poorly understood yet can help us understand how individual variation can have consequences for population level changes. Recent work has illustrated that parasitism may play a crucial role in driving reproductive skew but may have differential impacts in different environmental conditions. We suggest that our understanding of how parasitism interacts with both intrinsic drivers and environmental conditions to determine breeding performance can be greatly improved by considering energetics, since many life-history processes can be quantified through their impacts on rates of energy use and gain. Using a novel endoscope technique to quantify parasite load and bio-logging devices to estimate behaviour-specific energy expenditure in European shags we are able to determine the energetic cost of parasitism and understand how individual responses may vary with changing environmental conditions. Here we present analyses on a population of European shags that suggest that the cost of different behaviours varies with parasite load, as does the amount of time allocated to them. This work provides a potential mechanism linking the energetic cost of parasitism to its role in driving reproductive skew.

Should models used to predict population change incorporate density-dependence mechanisms? A case study based on seabirds and wind farms.

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International commitments to reduce global carbon emissions within the next 5 to 10 years are reliant upon rapid expansion of renewable energy developments, especially offshore wind farms. Negative interactions between wind turbines and marine birds have received considerable attention in recent years, and European member states are now required to fully assess potential impacts to local and regional bird populations prior to constructing a wind farm. Population modelling approaches are routinely used to numerically evaluate how such populations may be affected by proposed wind farms, and currently there is debate about whether to incorporate density-dependence processes. Regulatory feedback mechanisms can strongly influence the predicted population-level response, and could therefore determine whether a proposed wind farm is granted permission. In this study we reviewed the evidence for compensatory (i.e. negative density dependence) and depensatory (i.e. positive density dependence) regulation of 31 marine bird species, and used published indices of species-specific vulnerability to wind farms in order to assess whether such mechanisms may mitigate population-level effects. Compensatory regulation was reported across all of the demographic processes and focal groups considered, however regulation of productivity was highly context-dependent with a similar number of studies reporting compensatory, depensatory and insignificant effects.

From days to decades: long and short term environmental conditions affect the diet composition of a seabird top-predator

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Marine systems are experiencing pronounced changes, mediated through variations in long-term mean environmental conditions and short-term weather effects. Crucially, populations will experience these impacts simultaneously, but studies tend to focus on one or other of these mechanisms. As climate models predict both these impacts to fluctuate in the future, it is imperative the effects on animal populations are quantified concurrently. Seabirds are vulnerable to both direct impacts such as extreme weather, operating over short time scales (hours or days), and indirect impacts such as bottom-up effects of climate on prey, generally occurring over longer periods (months to decades). The relative importance of these factors for seabird demography, and underlying mechanisms such as diet, remain poorly understood. Using a 30 year dataset (863 samples) we tested dietary trends, and associated environmental drivers, over a range of temporal scales, in determining diet composition of European shags *Phalacrocorax aristotelis* breeding on the Isle of May, south-east Scotland. We found a dramatic decline in the proportion of sandeel in the diet, and a concurrent dietary diversification. Furthermore, diet composition was related to long-term environmental conditions, seasonality, and daily weather. These results highlight the vulnerability of seabirds to both long- and short- term environmental change.

The Seabird Monitoring Programme: scientists and volunteers working together to understand changes in seabird populations.

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Annual monitoring is fundamental to understanding the drivers underlying the dramatic population changes observed in some of our seabirds. We focus on two demographic parameters collated by the Seabird Monitoring Programme (SMP). Breeding success data are collected at a large number of colonies around the UK and tend to reflect environmental conditions experienced during the breeding season. Alongside abundance data, the collection of breeding success data is a key output from SMP and may provide an early warning of declines. It has played an important role in understanding regional variation in the health of the UK's seabird populations and in the development of European MSFD and OSPAR indicators. Data on survival are more limited, reflecting the need for intensive ringing and subsequent effort into resighting and/or recapture of birds, but it is the main demographic parameter influencing population trends in long-lived birds. There is an urgent need for increased investment in ringing initiatives that will improve our estimates of survival rates if we are to understand the impacts various pressures such as climate change and renewables. We identify gaps in our knowledge and discuss the significant challenges in recruiting the next generation of volunteers.

Breeding success in Atlantic puffins at Hjelmsøya, northern Norway: effects of food availability and climate variation

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Climate change works through changes in the availability of preferred prey in Atlantic puffins breeding in a northern Norway colony. Both the proportion of herring and cod larvae brought to the chicks were positively correlated with the abundance of cod and herring larvae abundance the same year. Commonly used climate teleconnection indexes like NAO explained weakly the breeding success of puffins at Hjelmsøya the last ten years. Food availability, though, was explained significantly by prebreeding NAO and EAWR indexes. Food availability was studied both using estimated larvae year class strengths and simulated drift patterns of the larvae from the spawning grounds. Cod larvae abundance in the North Atlantic, weighted by larvae drift patterns, had a significantly positive effect on the breeding success. Thus, even if the large-scale climate patterns does not explain breeding performance strongly, such patterns might work through the availability of prey.

Parental strategies in a changing world - how intrinsic and extrinsic factors impinge on parental care in lesser black-backed gulls

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Parental care increases offspring survival, but comes at a cost for the parents. Parents therefore face a trade-off between increased investment in current or future reproduction, and have to take numerous factors into account to optimise their decisions. Our research focuses on these parental strategies, and addresses how reproductive decisions are related to environmental variation in food accessibility, how individual specialisation in resource use constraints parental care, and how individual decisions depend on the partner. We study this in a wild population of individually marked lesser black-backed gulls, a long-lived migratory seabird with a high level of inter-individual variation in resource use. We combine different approaches such as UvA-BiTS GPS devices, stable isotope analyses and behavioural observations to answer our research questions. We found a high level asymmetry in the contribution to parental care within couples, strong foraging specialisation, and among-individual differences according to breeding site history. The consequence thereof for optimal parental decision rules will be discussed.

A global meta-analysis of seabird breeding phenology: are birds adjusting their breeding season?

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Environmental conditions in marine ecosystems are highly dynamic, causing fluctuations in availability of resources across space and time. These fluctuations are exacerbated by long term local, regional and large scale climatic trends, and are expected to increase as climate change escalates. To ensure successful reproduction, seabirds should adjust laying to avoid becoming mismatched with resources. Numerous studies have demonstrated trends in breeding phenology and identified some of the environmental drivers, yet we lack a clear understanding of the regional and global variation. A holistic understanding is therefore needed to assess the likely demographic consequences of phenological change among the world's seabird populations. We combined 100+ long-term data sets on breeding phenology, representing a wide-ranging and diverse subset of seabird species. Using a phylogenetic meta-analysis we (i) identified trends in breeding phenology across regions, taxa and life-histories, and (ii) quantified the underlying environmental factors. We present results which demonstrate the effects of phylogeny on plasticity of breeding phenology, and analyses of local and large scale climate cues driving breeding phenology on a global scale. These results provide a much needed synthesis of the effects of a dynamic climate on seabird breeding phenology in the face of increasingly extreme climatic events.

Timing is everything – spatial and temporal variation in the breeding ecology and dispersal of the European shag (*Phalacrocorax aristotelis*).

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In view of seabird decline, it is important to understanding the spatial variation in their breeding success and to understand both the scale at which such variation occurs and the extent and scale of dispersal among colonies. To explore this, brood sizes, hatch dates and natal and breeding dispersal of marked individuals of European shags (*Phalacrocorax aristotelis*) were recorded on five islands within 30 miles of each other in southeast Scotland. There was significant variation in both timing of breeding and brood size across the islands but no significant seasonal pattern to brood sizes. There was almost no breeding dispersal and, whilst natal dispersal movements were recorded, there was no consistent pattern of dispersal to or from islands with differing timing of breeding or brood sizes. The prospecting behaviour of immatures revealed a higher concentration of immatures on one island. The lack of links between timing of breeding, brood size and dispersal may suggest that (a), spatial variation in breeding metrics recorded during this one year study may not reflect longer-term variation, (b) dispersal decisions may be made without information on local breeding conditions and/or (c) benefits of philopatry may outweigh potential benefits of dispersal.

High flying birds: sex-specific three-dimensional foraging behaviour of a top marine predator

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Three-dimensional analysis of foraging behaviour has revealed that northern gannets (*Morus bassanus*) fly at different heights when commuting compared to actively foraging. Although a monomorphic seabird, previous work has revealed differences in the foraging behaviour of male and female gannets. However, little is known about how gannets use elevation during foraging or whether males and females fly at different heights. We fitted GPS and barometric pressure loggers to chick-rearing adult gannets on Bass Rock in summer 2015. We analysed 90 trips made by 11 male and 8 female birds. Here we present the first analysis of activity-specific and spatially-specific flight heights for male and female gannets. Offshore wind turbine infrastructure is anticipated to increase greatly in the North Sea within the next decade. Northern gannets forage in locations and at heights that pose a risk for potential collision with offshore wind turbines. We examine how sex-specific foraging behaviour, including elevation, may affect the potential risk wind turbines present to male and female gannets.

Keeping it close to home: the phylogeography of the gentoo penguin

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Climate change, fisheries pressure on penguin prey, and direct human disturbance of wildlife have been implicated in causing major shifts in penguin abundance and distribution. In this study, we use genetic techniques, as opposed to mark-recapture studies, to describe the population structure across a large latitudinal range in the Southern Ocean, revealing the extent to which shifts in abundance and occupancy result from changes in demographic rates or migration among suitable patches of habitat. Using multilocus microsatellite genotype data from 510 gentoo penguins (*Pygoscelis papua*) from 14 colonies along the Scotia Arc and Antarctic Peninsula, together with mitochondrial DNA data, we find strong genetic differentiation between colonies north and south of the Polar Front, coinciding geographically with the taxonomic boundary separating the subspecies *P. p. papua* and *P. p. ellsworthii*. Using a discrete Bayesian phylogeographic approach, we show that southern gentoos expanded from a possible glacial refuge in the centre of their current range, colonising regions to the north and south through rare, long-distance dispersal. Our findings show that this dispersal is important for new colony foundation and range expansion in a seabird species that is normally highly philopatric, but for which persistent oceanographic features serve as barriers to movement.

Growth, not mortality, drives the 'intermediate' parental care strategy in murre

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Seabirds in the auk family show wide variation in the age at which offspring leave the nest. The Ydenberg model explains such variation in terms of a foraging-predation risk trade-off, and assumes that offspring energy gain is low at the colony but that safety is high. To directly test those model assumptions, we attached time-depth recorders to murre (*Uria* spp.) parents (fathers, which do all parental care at sea, and mothers; N = 14 of each). Except for departure, the mortality rate at sea was similar to the colony. However, energy gained by the chick per day was ~2.1 times as high at sea compared to at the colony because the father expended less energy and so could direct more food to the offspring. Compared to the mother, the father spent ~2.6 times as much time diving per day and dove in lower quality foraging patches. We provide a simple model for optimal departure date based only on (1) the difference in growth rate at sea relative to the colony and (2) the assumption that post-fledging survival is related to growth rate. Differences in energy gain in the nest relative to away from the nest likely play a strong role in determining parental care strategies in birds.

A New Zealand conservation story of a globally unique seabird, Kaikoura's titi, the Hutton's shearwater

Nicky McArthur

Trustee Hutton's Shearwater Charitable Trust, NZ

The Hutton's shearwater (*Puffinus huttoni*), listed as endangered by the IUCN, is the only alpine-nesting seabird in the world. The once abundant species has suffered a rapid decline in both number and range which has been anecdotally attributed to introduced mammals such as pigs (*Sus scrofa*), red deer (*Cervus elaphus*) and goats (*Capra hircus*). Hutton's shearwater colonies are now limited to only two nesting sites situated high above the snowline in the Seaward Kaikoura ranges of New Zealand (1200m-1800m asl). Intensive, ongoing vertebrate pest control and population monitoring is being undertaken in the remaining wild colonies to protect and manage birds, chicks and eggs during the nesting season (October to April). A charitable trust has also been established and has driven fundraising and community awareness events which have resulted in the establishment of a predator proof fence on the Kaikoura Peninsula to protect the new manmade shearwater colony. Whilst terrestrial management strategies have helped arrest the population declines, oceanic challenges and impacts on shearwater populations such as set-net fishing, migration and feeding patterns are still undefined and require further research.

Invasive alien species on seabird islands: problems and solutions

Tony Martin

South Georgia Heritage Trust and University of Dundee

The damaging impact of alien fauna on island ecosystems has long been recognised. The extinction of hundreds of bird species was wholly or partly due to predators introduced by humans, with rodents, cats and mustelids among the most destructive. Ground- and burrow-nesting seabirds are of course especially vulnerable to such predation. Though relatively few seabird extinctions have occurred hitherto, the survival prospects of many has been compromised by their disappearance from invaded islands. Additionally, some insular endemics have been pushed to perilously low numbers, such as Tristan albatross and Henderson petrel, and could disappear in our lifetimes. Although the situation is dire, there are now reasons for hope and optimism. In the space of my professional lifetime, the prospects of eradicating alien predators from even large islands have been transformed from almost non-existent to feasible. In this talk I will follow the progress of the world-wide fightback against the aliens, and the wondrous results which can follow. Once the preserve of governments and only the largest NGOs, even the most challenging of islands can now be tackled by modest organisations with dedication and good planning, as the recent rodent eradication project on South Georgia has demonstrated. Invasive eradications offer a great bang for a conservation buck, and the intoxicating prospect of rolling back centuries of human-related damage in the blink of an eye.

A tale of two guillemots – how variable is their habitat use during the non-breeding season?

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Few studies have investigated the repeatability in winter behaviour of seabirds. How flexible or consistent a species is in their non-breeding behaviour in time and space has implications for their potential adaptability in a changing climate. Further, it has important consequences for conservation. Marine protected areas are only useful if they actually encompass the species they try to protect. The two seabird species, common and Brünnich's guillemots have among the highest flight costs ever recorded for vertebrates and exhibit very contrasting population dynamics in the North East Atlantic. However, little is known about inter annual variability of non-breeding behaviour in these contrasting species. Therefore, using more than 600 light level logger tracks of more than 400 individuals from 9 colonies, encompassing the Barents, Norwegian and North Seas, in 7 years of tracking, we aim to understand the spatial and temporal variability in their winter behaviour to be able to identify areas of primary importance for these seabird species outside their breeding season and assess the consistency of use of these areas.

Assessing impacts of offshore wind farms on seabird populations of Special Protection Areas.

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The offshore wind industry in Europe is assessed for impacts to seabird populations. Legally, populations of designated species present at Special Protection Areas (SPA) are protected in the UK under the requirement that the population remains as a viable component of the site. Two related approaches are commonly used to evaluate the severity of these impacts. Potential Biological Removal (PBR); based on the equilibrium principle of Maximum Sustainable Yield (MSY) and the more dynamic approach of Population Viability Analysis (PVA). There is some debate as to which of these approaches better informs the regulators about the viability of populations. PBR contains a “population recovery” correction to the viable harvests recommended under MSY. We assessed the sensitivity of the PBR recommendations subject to commonly used values of the population recovery correction. We generated recommended PBR harvests for different seabird species and then included those in a stochastic PVA tailored to each species. This allowed us to quantify population viability subject to these harvests. We report here on the propensity of the PBR recommendations to satisfy/violate the criteria commonly used to define viability in SPA populations.

Individual consistency within and between years in the foraging behaviour of European shags: some birds do change their spots

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Consistency and flexibility in foraging behaviour play vital roles in species’ responses to variable and changing environments. A growing body of work has revealed high levels of individual consistency in a range of seabirds but so far, most studies have focused on within-season variation in far-ranging species that feed close to the water’s surface. Here we explore individual repeatability in the foraging behaviour of a short-ranging benthic predator, the European Shag (*Phalacrocorax aristotelis*) across two consecutive breeding seasons in the Farne Islands, UK. Individual birds were highly consistent in their foraging locations and diving behaviour within each year. Some birds had similarly high levels of consistency between years but others changed their foraging locations and diving behaviour from one year to the next. We will discuss what factors might affect the level of inter-annual repeatability expressed by individuals, and explore the conservation implications of our findings.

Foraging strategy of little auks during chick rearing in northwest Greenland

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An estimated 80 % of the global little auk population breeds in the coastal landscape bordering the north water polynya in high Arctic northwest Greenland, and from this main breeding area very little is known on foraging behavior. Little auks are feeding on lipid-rich copepods associated with cold arctic waters, and are potentially important for monitoring and assessing the impact of the ongoing warming of the Arctic. Here we present the first results from GPS tracking of breeding little auks in northwest Greenland, involving data from four different breeding colonies. We examine time budgets, foraging trip patterns and habitat preferences at foraging areas, including comparison with zooplankton data collected simultaneous with the GPS tracking on transects through the main foraging areas. Results are discussed in relation to the rich information published on little auk foraging behavior in the Svalbard Area.

Responses of marine top predators to an offshore wind farm: a cross-taxon comparison.

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The number of offshore wind farms is rapidly increasing as they constitute a significant component of global renewable energy strategies. A key concern is displacement of marine top predators from important habitat during offshore wind farm construction and operation. We present the first cross-taxon evidence for no significant long-term displacement from a UK offshore wind farm for two broadly-distributed species of conservation concern : guillemot (*Uria aalge*) and harbour porpoise (*Phocoena phocoena*). Data were collected during boat-based line transect surveys across a 360 km² study area that included the Robin Rigg offshore wind farm. Surveys were conducted over ten years across the pre-construction, construction and operational phases of the development. We estimated changes in guillemot and harbour porpoise abundance and distribution in response to offshore wind farm construction and operation using generalised mixed models to test for evidence of displacement. Both guillemot and harbour porpoise were present across the study area throughout all three development phases, providing evidence for no wide-scale displacement during construction and operation. There was a significant reduction in harbour porpoise within the Robin Rigg offshore wind farm during construction, but numbers returned to pre-construction levels during operation. Guillemot abundance remained similar across all development phases.

* indicates speaker

Multi-colony non-breeding distributions and resource use of a generalist seabird

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Research on seabird movements and resource use is often restricted to the breeding season when individuals are constrained to the colony. However, different stages of the annual cycle are often inextricably linked, with events occurring during the non-breeding season continuing to influence individuals and populations during subsequent stages. To improve our understanding of a species' biology and to manage populations of conservation concern it is therefore important to move beyond single season research. We investigated the non-breeding season of a widespread, generalist coastal seabird, the herring gull *Larus argentatus*, which has declined across the UK in recent decades. Using GPS tracking and feather stable isotope data we aim to compare the non-breeding distribution and resource use of herring gulls from five colonies across south-west Scotland and Northern England. These colonies have experienced contrasting historic population trajectories therefore we predict that individual variation in non-breeding distribution and resource use will differ to a greater extent between than within colonies. We also predict that, due to potential differences in energy requirements and intra-specific competition, variation will occur between males and females, and individuals differing in body size. These insights will help in determining the drivers behind the population declines of herring gulls.

Effects of changing environmental conditions and intrinsic variation on the breeding success of northern fulmars

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Understanding the effects of environmental variation on survival and reproductive rates, as well as how and why these effects may differ between individuals, is key for predicting the impacts of environmental change on seabird populations. Our study looked at how the reproductive success of northern fulmars was influenced by environmental and between-individual variation, using long-term demographic data from a colony in Orkney, Scotland. A strong positive effect of past breeding success on current breeding success probabilities suggested that there were clear, consistent differences between individuals in their propensity to breed successfully. Breeding experience also had considerable influence on breeding success, with evidence of nonlinear effects. Unexpectedly, the environmental variable considered, the North Atlantic Oscillation index, had no clear effect, contradicting previous studies. However, there was considerable year-to-year variation in breeding success with some signs of a negative temporal trend, indicative of other unidentified environmental drivers warranting further study. Interestingly, the males that seemed to cope best with these negative trend effects were those with intermediate breeding experience as well as those with intermediate past breeding success. The latter could potentially be explained by adaptive intermittent breeding.

Using globally threatened pelagic birds to identify priority sites for marine conservation in the South Atlantic Ocean

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The Convention on Biological Diversity aspires to designate 10% of the global oceans as Marine Protected Areas (MPAs), but so far few MPAs protect pelagic species in the high seas. To protect these species, transparent scientific approaches are required that identify areas with high biodiversity value. Here we used tracking data from all globally threatened seabirds breeding in a centrally located archipelago (Tristan da Cunha) to provide guidance on where MPAs could be established in the South Atlantic Ocean. We combined year-round tracking data from six species, and used systematic conservation planning tools to delineate areas that would protect the largest proportion of each population. The areas used most intensively varied among species and seasons. Combining the areas used by all six species suggested that the most important 10% of the South Atlantic encompassed areas south of South Africa, around the central South Atlantic between 30°S and 55°S, and near South America. Only a small proportion of the identified areas overlapped with any of the existing MPAs in the South Atlantic. The conservation of highly mobile pelagic species cannot be achieved by single countries, but requires a multi-national approach at an ocean-basin scale.

Breeding together, feeding apart: sympatric seabirds exploit mutually exclusive home ranges.

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A recurrent question in ecology is how the spatial distribution of individuals differs from that of their populations. Minimally-overlapping individual or group home ranges have long been recognised as the norm in territorial species. Latterly they have also been predicted and observed in non-territorial foragers, such as seabirds. Tracking is used widely to study seabird distributions but some species remain poorly understood due to their sensitivity to tracking techniques. Using novel tracking methods, we quantified individual home ranges in one such species, the black guillemot. By comparing within-individual and between-individual similarity in the home ranges of 17 adults and 2 immatures tracked during two breeding seasons from a colony in the Orkney archipelago, we show that individual foraging site fidelity (IFSF) was very high in adults over the entire tracking period (1-17d), even at small scales (500m) but immature birds showed more nomadic tendencies. Birds foraged within 10km of the colony, in shallow waters between islands, where resources were presumed to be relatively spatiotemporally predictable. Some individuals frequently used manmade objects for resting. Our results put black guillemot at the extreme end of non-territorial colonial central place foragers known to exhibit IFSF and imply that marine renewable developments could impact individuals asymmetrically.

Demographic buffering in declining populations: can pre and non-breeders save the grey-headed albatross?

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Life-history theory predicts that in long-lived species, individuals reduce current reproduction to ensure future survival and reproduction if environmental conditions degrade, but other buffering mechanisms may appear in declining populations. Here we investigate two key cryptic components of populations: pre-breeders and non-breeders. The grey-headed albatross population at South Georgia (50% global numbers) has declined by 60% in 30 years. Breeding is typically biennial providing some flexibility in non-breeders. We hypothesised that in response to this decline, pre-breeders may recruit earlier and adults may skip breeding less frequently. Using a multi-event model and 6000 individuals ringed since 1976, we detected a significant cohort effect on recruitment rate, with birds not only recruiting earlier but at a much higher rate. There was a significant negative relationship between recruitment rate and population size. We found that non-breeders specialising in attending the breeding colony instead of staying at sea during the breeding season had significantly higher survival, and tended to have higher breeding success. They were also less affected in years of poor environmental conditions and showed different senescence trajectories. Ecological and evolutionary changes are discussed while matrix models were used to identify if such buffering mechanisms would help the population recover.

What factors influence breeding success of Leach's storm-petrels?

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Environmental factors influence movements of birds, which in turn affect on their reproductive success. In this study, using automated VHF telemetry, we followed foraging movements of Leach's storm-petrels (*Oceanodroma leucorhoa*) to and from two breeding colonies in Nova Scotia, Canada, and related those movements to breeding success and to local and global weather variables. Our goal was to identify whether local weather and oceanic conditions influenced movements and reproductive success of Leach's Storm-Petrels. During incubation, adults whose eggs did not hatch had shorter incubation bouts on average than adults whose eggs did hatch. Adults whose chick did not fledge had foraging trips of longer duration than adults who successfully fledged a chick. Higher sea-surface temperature (SST), lower SST anomalies, and lower chlorophyll-a concentration in local foraging areas resulted in longer foraging trip duration and lower reproductive success. On a global scale, an increasing North Atlantic Oscillation (NAO) index, was related to a decrease in annual reproductive success for Leach's storm petrels at these colonies, which is a concern for Leach's storm-petrel populations in view of increasing trends in the NAO index in recent decades

Evidence of sex segregated wintering areas in puffins

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Knowledge of different migration patterns and the drivers behind them are crucial to understand seabird biology and their relationship to the marine environment. A potential driver of dispersive migration is sex segregation, which may be explained by competition or differences in foraging niche or energy requirements between the two sexes. We present a study of the non-breeding distribution of male and female puffins deployed with light level loggers in 2012 and 2013, from the colony Hornøya in North-east Norway. The results showed clear differential winter distribution of female and male puffins, but no differences in their autumn distribution. Investigations of sea surface temperature in male and female migration routes showed differences between the sexes. Additionally, activity (flight, diving and resting) and energy budgets were estimated to document any differential costs related to the different migration strategies. We discuss our findings in the view of sex segregated migration theories and conservation and management implications.

* indicates speaker

Drift patterns of fish larvae link coastal morphology to seabird colony distribution

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Colonial breeding is an evolutionary puzzle, as the benefits of breeding in high densities are still not fully explained. Although the dynamics of existing colonies are increasingly understood, few studies have addressed the initial formation of colonies, and empirical tests are rare. Based on a high-resolution coupled ocean-circulation model and an individual-based larval-drift model, the distribution of seabird colonies along the Norwegian coast can be explained by variations in the availability and predictability of fish larvae. The modelled variability in concentration of fish larvae is, in turn, predicted by the topography of the continental shelf and coastline. The advection of fish larvae along the coast thus translates small-scale topographic characteristics into the spatial distribution of top-predator breeding sites. Our findings provide empirical corroboration of the hypothesis that seabird colonies are founded in locations that minimise travel distances between breeding and foraging locations, thereby enabling optimal foraging by central-place foragers.

“Honey, I think I contaminated the kids”: a lesser black-backed gull field study on the effect of maternal foraging and breeding strategies and offspring quality.

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Resource acquisition and allocation are key elements of life-history variation, yet certain foraging strategies may increase exposure to environmental contaminants (e.g. Mercury-Hg), which may induce shifts in the cost-benefit balance of consuming particular food items. The lesser black-backed gull (*Larus fuscus*) is a species with high individual variation in foraging strategies, known to opportunistically feed on a wide range of marine and terrestrial prey which are expected to differ in contaminant load. In order to understand how variation in female foraging strategies and timing of breeding may connect to Hg burden in eggs and chicks, a population of *L. fuscus* was monitored in Zeebrugge (Belgium, 51°2'N, 03°11'E) during 2012 and 2013 breeding seasons. Eggs, down feathers and primary feathers of the chicks were collected to assess the isotopic signatures of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$), and to determine total Hg burden. In addition, full clutches were switched between early and late nests in a cross-foster experiment. Consumption of marine prey during egg-laying increased in late breeding females, resulting in eggs and hatchlings with higher Hg burden. Experimental results showed, however, that chick quality (i.e. growth) was mostly determined by parental quality rather than timing of breeding.

Use of SMP count data to test how intrinsic and extrinsic processes combine to drive patterns of seabird population dynamics in UK coastal waters

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Seabird population size has been monitored by the Seabird Monitoring Programme (SMP) across the UK for over three decades. This creates opportunities to test key concepts of animal population dynamics, such as how deterministic and stochastic processes interact to shape the abundance of animals over time and space. An emerging tenet from terrestrial macroecological studies has demonstrated both positive (temporal variation in climate) and negative (spatial variation in food resources) relationships between environmental stochasticity and the strength of direct and delayed density dependence in populations. However, these relationships are yet to be tested in marine systems for higher trophic level species. We developed state space Ricker population models for 11 species of breeding seabirds in UK waters using time-series of colony counts dating back to the 1960s from the Seabird Monitoring Programme. These models estimated both the intrinsic rate of population increase and the strength of direct and delayed density dependence in each population. We then correlated the relative strength and spatial pattern of density dependence with different sources of environmental stochasticity such as temporal variation in climate, spatial variation in resources, synchronicity of resources and community structure. We identify some striking spatial patterns in the strength of direct and delayed density dependence in UK waters, which are consistent across several of the species studied. We also demonstrate the complex nature of potentially counteractive forces of environmental stochasticity on population dynamics in these species.

Fine scale flight strategies of gulls in urban airflows indicate risk and reward in city living

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Birds modulate their flight paths in relation to regional and global airflows in order to reduce their travel costs. Birds should also respond to fine-scale airflows, although the incidence and value of this remains largely unknown. We resolved the 3-dimensional trajectories of gulls flying along a built up coastline, and used computation fluid dynamic models to examine how gulls reacted to airflows around buildings. Birds systematically altered their flight trajectories with wind conditions to exploit updraughts over features as small as a row of low-rise buildings. This provides the first evidence that human activities can change patterns of space-use in flying birds by altering the profitability of the aircscape. At finer scales still, gulls varied their position to select a narrow range of updraught values, rather than exploiting the strongest updraughts available, and their precise positions were consistent with a strategy to increase their velocity control in the face of crosswind gusts. While the urban environment may be 'profitable' for soaring flight, it is also likely to entail risks. Overall, airflows around fine-scale features have profound implications for flight control and energy use, and consideration of this could lead to a paradigm-shift in the way ecologists view the urban environment.

Linking asynchronous breeding and foraging behaviour in tropical seabirds

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In temperate seabird populations, most individuals attempt to breed annually, even if poor foraging conditions lead to complete breeding failure. Observed differences in foraging behaviour between years have given a mechanistic understanding of how birds respond, or fail to respond, to this inter-annual variability in oceanic conditions. However for tropical seabirds which breed in asynchronous peaks which can occur at any time of year, we know almost nothing about the oceanic conditions which conspire to induce a breeding peak and how the foraging behaviour of seabirds might vary among these peaks. One possibility is that breeding only occurs when foraging conditions are optimal, so we might expect little variability in foraging behaviour between breeding peaks. Here we present data from three breeding populations of brown booby (*Sula leucogaster*, 6 breeding peaks) and masked booby (*S. dactylatra*, 3 breeding peaks) from Anguilla, British West Indies. Both species showed considerable variability in foraging behaviour (trip length, duration and distance travelled), within and between populations. Yet, despite showing no overlap in foraging areas, foraging trip characteristics were more similar between populations in the same breeding peak than within populations between peaks. Influences of oceanic conditions (sea surface temperature, primary productivity) both during foraging periods and preceding breeding peaks will be discussed.

The Seabird Monitoring Programme: a historical perspective

Mark L Tasker

Joint Nature Conservation Committee, Aberdeen, UK

In the early 1980s, information on breeding seabirds in Britain and Ireland was both out of date and/or scattered. The most obvious need was a new census of all species and a collation of all historical abundance information – hence the establishment of the Seabird Colony Register. Population abundance is though a reflection of the population processes of recruitment and mortality (along with emigration and immigration) and these processes will react faster to external issues than abundance. Measuring recruitment is though difficult and breeding success can be easier to monitor. After further methodological development, the Seabird Monitoring Programme, co-ordinated across multiple organisations, was established. This allowed simple breeding success measures to be gathered at a wide range of colonies. This was coupled with more detailed studies at key colonies in eastern Scotland, the northern islands and south Wales. The SMP needed relatively little financial input and has provided some key conservation evidence and has placed human pressures into context. The SMP and seabird studies overall have recently suffered from budget cuts and perhaps a lack of use of the findings. Conservation issues persist and the perspectives from the SMP would surely be essential in understanding causes and therefore underpinning management requirements.

A long-term study of migrating European storm petrels

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European storm petrels *Hydrobates pelagicus* (Atlantic subspecies *H. p. pelagicus*) have been studied for 27 years during their northwards migration past the coast of Portugal in late spring. This study is unusual among seabird studies as it focuses on the ecology of migration at a site distant to the breeding colonies. The body mass of storm petrels varies substantially from year to year, and this variation is strongly linked with sea surface temperature in the months prior to the birds' arrival in Portuguese waters. Body mass regulation during migration appears to be a complex response to climate-driven variation in food availability. A combination of molecular analysis and more traditional approaches to studying diet revealed evidence of inshore foraging at night, and a more coastal diet than often assumed. Migrating storm petrels were found to have a diverse diet, including deep-water fish species that are presumably obtained from fishery discards, as well as surface-water pelagic fish and some evidence of terrestrial input. In particular, sardine *Sardina pilchardus* appears to be a key prey species for storm petrels during migration past Iberia. We highlight the value of long-term studies of seabirds in monitoring the cascading impacts of environmental change across marine ecosystems.

Does environmental predictability play a role in shaping individual foraging behaviour?

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Seabird tracking studies have revealed that individual foraging specialisations occur globally and across a huge range of species. However, variation in the magnitude of individual specialisation between species and populations is poorly understood, as are the underlying mechanisms of such variation. Here, we examine the importance of environmental predictability, indicative of resource stability and availability, in shaping foraging consistency in black-legged kittiwakes. By comparing the behaviour of individuals from multiple colonies governed by different oceanographic regimes, we will investigate whether the stability of the environment drives behaviour among individuals. This study explores whether resource availability may vary the optimal foraging strategy within and between populations, providing a mechanism through which different levels of consistency may emerge. These results are particularly important as they will increase our understanding of the origins of individual behaviour and its consequences at a time of environmental change and worldwide declines in populations of marine species.

What do recent changes in Icelandic marine environment mean for Icelandic seabirds? Overview, case studies and prospects

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Iceland supports a large proportion of North Atlantic breeding seabirds and, while surveys of seabird abundance and demography in Iceland are limited, some data exists, mostly in grey literature, giving evidence of declines in several species. Here we present an overview of recent research on Icelandic marine environment, in relation to a review of Icelandic seabird data available to date. Last 15 years, waters around Iceland warmed substantially and northward range shift was measured for many fish species along with a decline in euphausiid abundance. At least 10 seabird species south and west of Iceland experienced particularly poor breeding success, but some studies indicated better success in the north. However, most recent case studies indicate a worsening situation in the north during a period of northward movement of main prey after a displacement of the polar sea front. Although, particularly one species has benefitted from influx of new fish species in Icelandic waters, available information for 24 species show that the most important prey species overall was sandeel and then capelin in the north. Icelandic capelin and sandeel stocks have been at low levels and as long as that situation persists, poor performance of most Icelandic seabird species is expected.

Obligated to land? Vulnerability of Scottish seabird populations to a discard ban

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As numerous seabird species forage on discards from commercial fishing vessels, they are potentially vulnerable to changes in fisheries management and policy. This includes the implementation of the EU Landings Obligation, which intends to ban discarding of commercial fish species. At an ecosystem level, these changes are likely to be positive. However, seabirds that scavenge on discards may be negatively affected by the reduction of a food source. Better understanding of the ecosystem-level impacts of these changes requires greater knowledge of the interactions between seabirds and fisheries. We combine UK-wide vessel monitoring system (VMS) data (2010 to 2012) with GPS tracking data from four scavenging seabird species. We use state-switching models to identify relationships between fishing vessels and northern fulmars *Fulmarus glacialis*, great skuas *Stercorarius skua*, northern gannets *Morus bassanus* and black-legged kittiwakes *Rissa tridactyla* from colonies around Scotland. We identify which species interact with fishing vessels, assess the distance over which vessels influence foraging behaviour, and investigate whether birds benefit energetically by scavenging from fishing vessels. This information is crucial to predict how Scottish seabird populations may respond to changes in fisheries policy, which is particularly important in an ecosystem-based approach to fisheries management.

Exceptionally large foraging ranges in provisioning Manx shearwaters (*Puffinus puffinus*): a triple foraging strategy facilitated by environmental variables?

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Trip strategies of central place foraging seabirds are dependent on breeding stage. While incubating birds are not constraint by provisioning needs, chick rearing adults have to ensure regular returns to the nest causing a smaller foraging range. It has been suggested that alternating between short provisioning and longer (self-)foraging trips aids balancing their own and their offspring's energy requirements. This dual foraging strategy is highly variable across species and colonies. First GPS tracking of dual foraging Manx shearwaters from the Irish west coast (N=56) shows a surprisingly high proportion of exceptionally long provisioning trips to the Mid-Atlantic ridge (range=1459km). These cause a larger range during chick rearing than during incubation. Model based clustering of all chick rearing trips proposes three rather than two distinct strategies: 1.) Short distance and duration (N=101.). 2.) Short to medium distance and long duration (N=25). 3.) Long duration and distance trips (N=14). However, models including intrinsic drivers such as adult or chick body condition were not able to sufficiently predict trip choice. We therefore suggest that the third trip strategy is driven by a combination of increased offshore productivity and wind conditions facilitating energy efficient travel to such sites later in the season

Climatic variation and demography of Manx shearwaters in the Irish Sea

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As long-lived species with k-selected life-history strategies spending much of their lives at sea, seabird demographic rates should be affected by environmental perturbations. Productivity is expected to be more sensitive than survival rates, yet climate has been found to affect seabird survival rates more frequently than reproductive success. We utilised a 36 year, individual-based, capture-recapture dataset from Manx shearwaters on Skomer Island to test how climatic variability affects survival, using a multi-state mark-recapture modelling framework. Knowledge of the trans-equatorial migration of the Skomer population from geolocator studies allowed us to investigate the influence of climate on demography at both large and local scales, during both the summer breeding season in the Irish Sea and the wintering season off the southern Argentinian coast. Reproductive status was known for 20 years of the study, allowing us to investigate reproductive skipping decisions and the effect of breeding status on associations between survival and climatic variation. Survival of non-breeders was higher with warmer SST in breeding areas, and 35% lower than breeders. Breeding adult survival and transitions between breeding/non-breeding were unrelated to climatic variables. Productivity was more strongly influenced by environmental variation: negatively associated with both the El Niño Southern Oscillation the previous winter and the negative phase of the NAO in breeding areas. Our results for Skomer are consistent with theory prediction that seabirds buffer the effects of environmental change by passing costs to their offspring. We will also present results of our survival analyses from Bardsey Island and Copeland. More work is needed to understand the effects of weather on seabird demography if we are to predict the future impact of predicted patterns of climate change.

Poster Abstracts

The use of preen oil to monitor Persistent Organic Pollutants (POPs) in common terns (*Sterna hirundo*) in Ireland

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Persistent Organic Pollutants (POPs) are anthropogenic chemicals which are ubiquitous in the environment. Although banned, many of these compounds persist due to their chemical nature and are found in practically all environmental matrices across the globe. Seabirds, as high trophic level organisms are more prone to exposure to these compounds through bio-accumulation and bio-magnification. As a result, seabirds have been used as bio-monitors for contaminants such as POPS. Using feathers to monitor contaminant loads in birds has been shown to be an efficient and non-destructive method of analysis. However, it has also been shown that for seabirds, most POPs found in feathers originated from the preen oil gland. A preen oil swab is a minimally invasive and perhaps as/or more efficient in detecting contaminant accumulation in seabird tissues, due to its lipid soluble nature. This study has focused on common terns (*Sterna hirundo*) breeding on Rockabill Island, Ireland, to: (1) investigate and report the contaminant load in this species at their breeding site, (2) compare two different sampling methodologies: preen oil swabs versus chest feathers and (3) compare the contaminant loads in live birds versus starving, dead birds.

A multi-decadal study of pre-breeding survival of black guillemots in a rapidly changing Arctic

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Our understanding of demographic processes in seabird populations is mainly based on analyses of traits of the adult component of populations. Early-life demographic traits are poorly known mainly for methodological reasons. Yet, survival of juvenile and immature individuals is critical for the recruitment into the population and thus for the whole population dynamic. This bias currently restrains our ability to fully understand population dynamics of seabirds and life history theory. We used a multi-decadal data set (1975-2015) of a long-lived species, Mandt's black guillemot (*Cephus grylle mandtii*), obtained at Cooper Island in Arctic Alaska where all fledglings have been banded since 1975. Mandt's black guillemot is one of the few arctic ice-obligate seabirds. Its breeding and nonbreeding habitat have undergone dramatic changes during the time-series of our database and the colony has declined by 50% in the last 25 years. Using capture-mark-recapture multi-state models we estimate juvenile and immature survival and test for sex, age and individual effects on these parameters and identify environmental factors affecting those traits. We also investigated the effect of fledging body condition on juvenile survival and the environmental factors potentially driving this demographic trait using climatic covariates.

Foraging trips and dive depth indicates prey type in chick rearing common guillemots.

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Time-depth recorders (TDR) and global positioning systems (GPS) loggers were deployed during the 2013 chick rearing period at Hornøya, north of Norway, to test the hypotheses that common guillemot (*Uria aalge*) foraging behaviour differs between prey species, and that foraging behaviour and foraging areas change in accordance to the prey composition. Foraging behaviour analysed from trips included activity in the water column during the final dive bout and final dive, trip duration, maximum distance from colony, direction of flight (bearing) and the length of trip from departure to return (total path length). Three prey species dominated: capelin (*Mallotus villosus*), sandeel (*Ammodytes* sp.) and herring (*Clupea harengus*). Feeding watches revealed significant changes in prey composition through the breeding season. In general, herring were caught after short bouts and shallow dives, capelin during short trips, long bouts and deep dives, and sandeel at more distant locations with long bouts and shallow dives. Two important foraging areas were identified, one just north of the colony, the other at a greater distance north-west of the colony. Capelin was associated with the first area, and sandeel with the latter. A discriminant analysis revealed a relationship between behaviour during a foraging trip and prey species caught.

Have ecosystem changes altered the trophic niche of the fluttering shearwater (*Puffinus gavia*)? - A 134-year stable isotope record from feathers and prey collected in the Hauraki Gulf, New Zealand

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Commercial fishing has had a critical impact on marine ecosystems in northern New Zealand, and while the direct effect appears evident on fish communities, it has been difficult to evaluate the magnitude of the effects on top predators such as seabirds. We intend to combine data on the breeding biology, foraging ecology and measurements of delta13C and delta15N isotopic values from contemporary and historic samples of the endemic fluttering shearwater (*Puffinus gavia*) breeding in the Hauraki Gulf in northern New Zealand. We ask whether this short-ranging piscivorous seabird has changed its diet composition in response to shifts in food availability over a 134-year period, and whether detected changes may be explained by increased fisheries landings. Sampled feathers come from beached birds collected in the Hauraki Gulf from 1881-2011 as well as breeding birds on Burgess Island in the outer Hauraki Gulf in 2013 and 2015. To determine whether temporary changes in stable isotope ratios just reflect changes in baseline environmental values, we also plan to analyse muscle tissue from prey fish collected in the same region. With the result from this study, we hope to help explain the anthropogenic impact on regional population declines of other piscivorous seabird species.

Seabird conservation: where do marine SPAs fit?

Julie Black

Joint Nature Conservation Committee, Aberdeen, UK

The UK is currently in the process of identifying and classifying marine Special Protection Areas (SPAs) for marine birds, as a requirement of the EU Birds Directive. After a very brief overview of upcoming marine SPAs around the UK, this talk will discuss how such protected areas can deliver conservation for widely dispersed and mobile species such as seabirds. It will summarise key differences between different types of protected areas and what the role of each should be in contributing towards conservation of populations. The talk will focus on how conservation objectives for these new marine SPAs aim to assist with the conservation of seabirds for which the sites will be classified. Individual marine protected areas for seabirds will not, alone, protect an entire population. Nevertheless these areas can assist with conservation of seabird species by protecting key habitats and resources for seabirds and access to these; and the sites, along with existing terrestrial SPAs and wider conservation measures, can cumulatively contribute to the protection of the wider population.

MSFD seabirds marine monitoring programme in France

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The Marine Strategy Framework Directive (MSFD) requires that member States establish and implement coordinated monitoring programmes for the ongoing assessment of their marine waters environmental status. The French Marine monitoring programme was adopted in June 2015 for the North Sea, Celtic Sea, Bay of Biscay and western Mediterranean Sea. The monitoring programme dedicated to seabirds is divided into five sub-programmes: waterbirds, breeding sea birds, marine seabirds, stranding of seabirds and interactions between seabirds and human activities. These sub-programmes include different surveys that are recommended in order to monitor parameters used to compute indicators for population size, distribution, population demographic characteristics and ecosystem structure. Those indicators will allow periodic assessments (every six years) of the ecological status of functional groups of seabirds. The seabird monitoring programme also plans to investigate the impacts of different pressures on seabirds, such as contaminants, litter, bycatch and offshore renewable energy developments. The seabird monitoring programme will integrate existing surveys that must be maintained as well as new methodological developments to implement new monitoring activities in the future.

Telemetry indicates important feeding areas to nesting Razorbills in the St. Lawrence estuary, Canada

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The St. Lawrence estuary has been identified as one of four areas of primary sensitivity to oil spills in Canada. This classification results from high shipping traffic, a funnel-shaped geography, and the presence of many potential environmental sensitive issues. About 55% of all razorbills nesting in Canada are found in the St. Lawrence system (near 50,000 pairs), with about 8% of them in the estuary. The Canadian Wildlife Service monitors seabird colonies since the 50's, but areas important to sustains these nesting seabirds populations remain largely unknown. I fitted GPS loggers on 19 razorbills from two colonies during incubation in 2015. I found that razorbills leaved the colony about 6 times/day (range=3-11) for trips that last 33 minutes on average (range = 14-76 min, individual average). They use a variety of dispersion strategies during these trips out at sea. They do many short trips close to the colony, but also sometimes 20-70 km trips down the estuary, depending on the colony locations and distance to coast.

Models of northern gannet at-sea distribution in Canadian waters using the GeoAviR R package

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Knowledge of seabird at-sea distribution is paramount to identify density hotspots and potential effects of anthropogenic and environmental changes. We used the northern gannet as a model species for its wide usage of the Canadian waters between April and November. Data were collected between 2006 and 2014 on ships of opportunity using distance sampling. The GeoAviR R package allowed us to build distribution models of gannets using a 100 x 100 km grid, NAFO fishery zones, and density surface modelling. The package use a Bayesian one stage approach to fit both the distance and abundance model at once. The three distribution models and their associated coefficients of variation sometimes showed differences related to both the selected spatial units and environmental covariates.

GPS tracking of breeding great black-backed gulls reveals high consistency in foraging patterns

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Establishing a breeding population in an already inhabited ecosystem should be challenging. It requires efforts of adaptation, especially when there are other, often closely-related species already occupying relevant ecological niches. Great black-backed gulls *Larus marinus* were recorded breeding at the coast of the German North Sea for the first time in 1988. Their numbers increased slowly but constantly. With 67 breeding pairs alone in the northern part (province of Schleswig-Holstein) in 2014 and an overall positive population trend, we can consider them now as settled. In this study, we plan to deploy GPS loggers on ten adult great black-backed gulls during the breeding season 2016. The aim is to investigate individual foraging strategies of breeding adults during incubation and chick-rearing. Isotope signatures of feathers and blood shall provide further information. We expect great black-backed gulls to exploit habitats and food sources in the surroundings of their colony, such as the open sea, fish trawlers, intertidal flats of the Wadden Sea, and possibly agricultural areas as well as landfills. European herring gulls *L. argentatus* and lesser black-backed gulls *L. fuscus* breeding in this area frequently exploit terrestrial habitats. Nevertheless, we expect great black-backed gulls to feed more on marine prey items.

Exceptionally long foraging trips of Murphy's petrels in the tropical Pacific – no gain for the pain?

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Little is known about the foraging strategies of tropical petrels. In June-July 2015 we tracked 10 Murphy's *Pterodroma ultima* and 1 Henderson petrel *P. atrata* from Henderson Island during incubation using light-weight GPS and immersion loggers, and examined whether longer trips were associated with greater foraging intensity and mass gain. Murphy's petrels pursued two foraging strategies, with short trips (mean trip length 5998 km, 9 days, n = 6) to the SW of the island, and long trips (13052 km, 17 days, n = 5) east towards the coast of Peru. Birds departing on long trips left with lower body mass (341 g vs. 418 g) but also returned with lower body mass (412 g vs. 490 g), and long trips therefore do not appear to be rewarded by higher energetic efficiency. Henderson petrels had mean incubation shift lengths of 11.3 days (range 4 - 22 days, n = 8), and may travel on average 2565 km, a considerably shorter distance than Murphy's petrels. These data indicate that the gadfly petrels of Henderson Island mostly forage outside the marine reserve proposed around the Pitcairn Islands in 2015, and ocean-wide management will be necessary to conserve the marine environment.

The great cormorant (*Phalacrocorax carbo sinensis*) expansion into the Western part of the Gulf of Finland, Russia

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Observations were carried out in the western part of the Gulf of Finland, Baltic Sea (Russia) in 1994-2014. Among the dominant and abundant colonial sea birds the great cormorant demonstrates the most expressive long-term trend of intensive growth of population. Cormorants appeared for the first time in 1991-1994 near the Russian shoreline (Kurgalsky peninsula) from western regions of Baltic countries. The first two breeding colonies were discovered on rocky islands – the Dolgy Reef and the Bolshoy Fiskar - in 1994. Presumably they were being formed from 1985 to 1990. The colonies had amounted 1000-1300 nests by 1994 (Gaginskaya, 1995). The species has been widely spread by now everywhere in the Gulf. There were recorded 3900 nests in 2006; 5000 nests in 2010 (Gaginskaya, Rychkova, 2011); 6400 nests in 2012; 8200 nests in 2013; and 9500 nests in 2014 (Bublichenko, Kouzov, 2016), while several large colonies occurred to be abandoned. Presently species is extending eastward. The most far eastern breeding colony appeared in 2014 in the Vyborg Bay (78 nests). Nowadays more than 9000 pairs are nesting in the Russian part of the gulf. According to the data on dynamics of temperature, the rapid cormorants expansion is caused by climate warming.

Effects of shipping traffic on the spatial and temporal distribution of seabirds in the Baltic Sea

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Shipping traffic is a major anthropogenic factor in coastal and offshore waters of Europe. Some seabird species are known to respond to shipping traffic, by either avoidance or attraction, but detailed information on species and their specific spatial and temporal response is still missing. So far, environmental impact studies rarely take this factor into account when assessing seabird distributions. AIS-signals provide information on ship type, presence, status or speed at sea. Here, we explored the possibilities for using AIS-data in modelling seabird distributions. We aimed to investigate the effects of vessel type, speed and traffic volume on the small-scale distribution of seabird species. Seabird data were obtained by digital aerial surveys in an area of high traffic volume in the Baltic Sea. We expect the presence of species like divers and sea ducks to be negatively related to the presence of ships, whereas gulls, which often feed on discards, are expected to reach higher densities around vessels, especially fishing vessels. The utilization of detailed vessel data could help to better explain spatial and temporal distributions of seabirds and will add to our understanding of the impacts of shipping traffic on seabird populations.

New data about the secret life of the wandering prebreeding European storm petrels at colonies

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The behaviour of young European storm petrels *Hydrobates pelagicus* during their wandering prebreeding years remains poorly known because the large majority of birds are ringed as full grown and not as chicks. However, in the Molène archipelago, Brittany, France, controls and recoveries of about 1,000 storm petrels of known age, i.e. 28% of the 3,600 chicks ringed since 1997, allow to investigate the cycle of presence at colonies and biometrics of young wanderers. Weight, wing-length, cloacal width, state of the brood patch and primary moult of individuals aged 1, 2, 3 years old or more were compared to birds of unknown age mist-netted at night or birds controlled as breeders. The results highlighted significant differences and were used to assess the respective proportion of breeders and non-breeders amongst birds caught during mist-netting at night as well as to assess the sex-ratio of these wanderers. More males than females appear to visit the colonies when 2 years old. About 75% of the birds mist-netted during the incubation period could be prospecting wanderers. Storm petrels first breed when 3, 4 or 5 years old. One of the next steps of this long-term study will be to build a demographic model taking into account the age structure of the population of prebreeding prospectors.

A comparison of alternative sources of maps of breeding seabird distribution at sea.

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Our ability to assess the impact of human activities at sea on breeding seabird populations requires a good understanding of the distribution of seabirds at sea. The European Seabirds at Sea dataset is a comprehensive resource on which much of our current understanding of the distribution of seabirds at sea is based. Recently, visual and digital aerial surveys conducted in association with offshore renewable energy developments have added considerably to the ESAS evidence base. These data have been combined with ESAS data in the SeaMaST project funded by Natural England to generate species and season specific density maps in English waters. Analysis of seabird tracking data gathered under the FAME and STAR projects has allowed the development of gap-free maps of the density of four breeding seabirds around the whole of the UK. For these species, there are now three alternative density maps. RSPB in conjunction with Natural England have undertaken a comparison of the maps generated by these three alternative evidence sources to identify areas of concordance and of disagreement. This work will inform understanding of the scale and distribution of, and likely explanations for, areas of similarity and disagreement and hence how best to interpret these alternative sources of information.

Seabird tracking database: science and conservation avenues

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Seabirds are amongst the most threatened birds in the world. Impacts are varied and widespread, but the major cause of many population declines at sea are incidental mortality in fishing operations and pollution. Biologging technology have greatly improved our knowledge of at-sea distribution patterns and behaviour of seabirds since the 1990s. The Global Seabird Tracking Database, formerly known as Tracking Ocean Wanderers, was established in 2003 and is now the largest collection of seabird tracking database in existence. Managed by BirdLife International, the database holds over 6 million data points from 91 species. By pooling data from multiple studies, often from different species, colonies and geographies, it is now possible to address seabird conservation questions for mitigating threats at sea, including the establishment of an effective, evolving network of protected areas that will safeguard against future biodiversity loss. This work will showcase the database and provide two examples of outputs that have resulted from the compilation of this data; the first, a spatial and temporal overlap analysis of seabird distribution and fishing effort in the ICCAT area, and the second, an example of how tracking data has been used for the definition of the boundaries for marine Important Bird and Biodiversity Areas in west Africa.

How do I catch my fish? Multiscale foraging strategies in seabirds

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New tracking technologies enable understanding of the multiscale foraging behaviour of individual predators and provide important information on underwater movements and strategies. Knowing how movement decisions are made has the potential to enhance understanding of both fine and medium scale processes governing predator movements and habitat selection. Using analyses of data from high resolution tracking devices (GPS, TDRs and Accelerometer) on two seabird species (razorbills (*Alca torda*) and common guillemots (*Uria aalge*)) we highlight the foraging strategies of these predators at different scales. Movement decisions made while moving between and within patches of prey, and searching and locating prey both above and below water resulted in different foraging strategies. Common guillemots, diving at depths >200 m, searched for and located prey in both the water column and on the seabed. Razorbills located fish schools in shallow waters (maximum diving depth 18 m) while floating on the water surface and then dived to exploit their prey. The scales at which foraging behaviours change are expected to be influenced by the type, distribution and location of preferred prey, giving insights on how foraging behaviour may vary depending on the quality of habitat patches and on the potential effects of habitat changes.

Foraging habitats of European shags in contrasted marine environments

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Seabirds feeding in inshore waters can be affected by a multitude of anthropogenic factors such as displacement and habitat loss due to e.g. establishment of tidal and wave renewable energy plants and potential conflicts with kelp harvesting. Identifying important feeding habitats and knowledge on how seabirds utilize these areas during the breeding season is essential in order to understand possible effects of such habitat alterations. During the last decade tracking studies have become an important tool to assist in marine conservation planning and for identifying spatial overlap between marine species and anthropogenic threats. In the present study, we use GPS- and TDR-loggers to explore the foraging behaviour of breeding European shags during five succeeding breeding seasons at two different Norwegian shag colonies, with contrasting dietary preferences. Our aim was to develop predictive models of habitat use of shags and to examine how difference in diet translates into differences in habitat utilization. We use abundance and distribution of shags as a function of distribution of kelp, benthic substrate and bathymetry to identify patterns in foraging habitat selection and to determine which habitat types are most preferred by birds from the two colonies.

Can novel 3G-GPS tags reveal the foraging movements of an untracked seabird population with apparently nowhere to go?

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As global GSM network coverage continues to improve, GSM-GPS tags potentially provide a highly effective means of animal tracking. Most recently, novel tags have been developed that utilise the capacity of 3G networks to transfer large quantities of data at low cost. When compared to archival tags, this approach provides benefits of reduced colony disturbance and data loss, yet there are currently few studies documenting its use on seabirds. We evaluated the ability of 3G-GPS tags to define the at-sea distribution of Northern gannets from two colonies in Alderney. Specifically we assessed the reliability of spatial data and subsequent reconstructed gannet tracks. We also quantified the foraging ranges and destinations of gannets from the Ortac colony for the first time. Previous studies showing colony-specific home-ranges in gannets suggests that individuals from Ortac might be restricted in their foraging ranges by neighbouring colonies. We therefore investigated whether spatial segregation occurs between Alderney gannet colonies as predicted. Additionally, potential overlap between offshore activity and foraging ranges was examined. This study fills key gaps in our knowledge of important areas for gannets in the English Channel, whilst also suggesting the applicability of 3G-GPS tags for future seabird tracking studies.

Seawatching as a potential monitoring tool

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Seawatching is a popular pastime amongst birders leading to suggestions of its potential as a monitoring tool. However, a key criticism is that the data collected don't really mean anything. We analyse data collected from Holme Bird Observatory which have been collected as part of an intensive and standardised scheme over a number of years. We use these analyses to produce indices which are then compared to regional indices based on abundance counts from local colonies. We found that sea-watching indices from HBO were a good match for wider regional and national population trends, and could be used to infer population changes at a regional scale. Seabirds are declining globally but populations are often hard to monitor as they may breed on remote islands or other hard to reach locations. Our results suggest that seawatching may be a cost-effective approach with which to monitor populations of species which are otherwise hard to reach.

Up shit creek: new sampling method reveals foraging decisions of a specialised seabird

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Because of the practical difficulties associated with diet sampling of adult seabirds, only few studies have examined the diet of adults and chicks simultaneously. Here we report on a new and easy method to collect consecutive samples of faeces of adult Sandwich Terns *Thalasseus sandvicensis*, allowing comparison of the adult and chick diet throughout the breeding season. Our three year pilot study in the Southern North Sea shows that the adult diet varied through the breeding period. In the first weeks after egg-laying, adults primarily fed on sandeel, clupeids and nereid worms, although most energy was obtained from sandeel. Clupeids became increasingly important, sometimes already during the incubation period. The composition of the chicks' diet closely followed that of the adults, suggesting that adults did not select different prey species for their chicks. However, the length of the prey items found in the adult diet was much smaller than that fed to the chicks. Adults thus adapt prey size (and not prey species) to the energetic demands of their growing chicks, and feed on a small fish size throughout the breeding season themselves. These results correspond with the optimal foraging theory.

Boring but useful: a case study of time lapse photography

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Seabirds are important bioindicators of the marine environment, but reaching their isolated and remote breeding populations is often difficult, expensive and time consuming. The use of remote time-lapse photography to record seabird behaviour at colonies is a novel and potentially effective way to reduce researcher effort while collecting valuable data. However, the feasibility of this approach is not yet clear. As part of a wider study, five time-lapse cameras (Ltl-Acorn 5210MC) were deployed throughout a colony of black-legged kittiwake (*Rissa tridactyla*) on Puffin Island (North Wales) during 2013 and 2014. A subsample of birds was marked with orange picric acid and equipped with accelerometers. Approximately 100,000 frames, covering both incubation and chick rearing periods, were analysed from ten nests, five from 2013 and five from 2014. These data were very useful in assessing ecological parameters associated specifically with the nest such as productivity, attendance, predation and disturbance. However, we recommend that care must be taken when inferring behaviours away from the nest such as foraging trip duration.

Chasing ice: Mandt's black guillemot's year-long association with Arctic sea ice

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Mandt's black guillemot (*Cephus grylle mandtii*) is one of the few Arctic ice-obligate seabirds. Recent decreases in summer sea ice have reduced breeding success and colony size in Arctic Alaska, but little is known about the effect of recent changes in sea ice extent and composition in the nine-month nonbreeding period (September-May). To examine movements and the seasonal importance of sea ice to nonbreeding Mandt's black guillemots, we deployed and recovered geolocators (n=45) on individuals at a breeding colony in Arctic Alaska during 2011-2015. Guillemots moved north to the marginal ice zone in the Beaufort and Chukchi seas immediately after breeding, moved south to the Bering Sea during freeze-up in December, and wintered in the Bering Sea in January-April. Annual variation in movements and distribution were related to differences in sea ice extent and concentration. Most birds occupied the marginal ice zone in regions averaging 30-60% sea ice concentration, with little seasonal variation. Birds regularly roosted on ice in all seasons averaging 5h d⁻¹, primarily at night. By utilizing the marginal ice zone, with its roosting opportunities and associated prey, black guillemots, typically a nearshore species, can remain in the Arctic during winter when littoral waters are ice-covered.

How social are ornithologists?

Steve Dudley¹ and Jen Smart²

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Social media is a fast-moving technology and now plays an increasing role in research, including ornithology. Researchers who have embraced social media have discovered that it is much more than a social networking opportunity, but it can be an important tool for their research needs at the research, publishing and networking levels. Social media is now an important tool to disseminate research results. The arrival of individual article metrics now means there are developing metrics which will allow researchers, institutes, funders and others to measure the outreach and public impact of individual pieces of research. Ornithology, more than many other research areas, requires the input of the wider ornithological and birding communities. These communities are social and many exist as clubs or societies. Social media has seen these groups, as well as many more individuals traditionally outside of these groups, move online en-masse, embracing social media and web-based technology for information exchange, bird recording and data collection. Social media enables ornithologists to engage with, and mobilise, this online community for research projects. Our poster will look at the use of social media by ornithologists and how social media are driving individual article metrics in scientific publications.

Black-legged kittiwakes as an ecological indicator: can we link foraging behaviour, environmental variability and reproductive success?

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Under the increasing threats of anthropogenic impacts and climate change, shifts in marine ecosystem health have been assessed using the study of seabird ecology. The black-legged kittiwake, *Rissa tridactyla*, has undergone recent population declines and is considered a good marine ecological indicator due to its abundance and oceanic nature. However, few studies have attempted to link foraging behaviour, environmental variability and reproductive success over several years. Data on kittiwake foraging behaviour was collected using GPS data loggers on Puffin Island, Wales throughout the 2010-2015 breeding seasons. This was analysed alongside remotely sensed environmental and oceanographic data that aimed to reflect potential prey availability. Analyses revealed inter-annual variation in foraging trip parameters, locations of foraging effort and environmental variability. In contrast, intra-annual foraging was focused in similar areas with little variation in foraging trip parameters. Core foraging areas were within deep, gradually sloping waters close to Puffin Island, and the effects of SST and chlorophyll- α concentration on predicting foraging locations were small. Kittiwake productivity was unrelated to both environmental variability and forage trip parameters. Therefore, a wide breadth of complimentary future monitoring is recommended in order to assess the implications of environmental change on kittiwake populations and wider ocean health.

Diving with a backpack: a detailed study of tag effects in the common guillemot

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There have been few in-depth investigations of tag effects on diving behaviour, with most previous tag effect studies more cursory. We investigated the influence of carrying a GPS device for chick-rearing common guillemot (*Uria aalge*). Our study followed a randomized cross-over design, each experimental bird (n = 11) followed for two consecutive periods of ≥3 days, one with both a back-mounted GPS and a small leg-mounted time-depth recorder (TDR), the other with a TDR alone. Additionally the condition of un-tagged controls (n = 5) was monitored. Data from TDRs allowed us to infer how the GPS device affected foraging behaviour and diving performance. GPS-equipped guillemots lost ca. 1% of body mass per day, significantly higher than both controls and TDR-equipped birds. Overall the GPS-equipped guillemots did not show large differences in behaviour. Mass loss is likely partly explained by increased diving costs, with increased post-dive recovery times and more dives performed per diving bout. These amongst other behavioural indices suggest subtle but significant impairment of diving performance for GPS-equipped birds, with consequent mass loss a cause for concern. However, the overall patterns of behaviour measured for device-equipped diving seabirds are likely to be largely representative of non-tagged birds.

How many did you catch? The Norwegian Seabird Bycatch Project 2008-2015

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Over the last decades, population sizes of many seabird species in the Northeast Atlantic have declined markedly, including many of those inhabiting Norwegian waters. There is therefore an urgent need to assess anthropogenic mortality factors, including unintentional bycatch in marine fisheries. This poster presents methods and results of The Norwegian Seabird Bycatch Project that was established in 2008. The project was initiated with a literature review forming the basis for further studies. In the first data collection (2009-2011) we explored methods suitable for assessing three small-vessel fisheries: cod and lumpfish fisheries and the Greenland halibut longline fishery. These fisheries caught an estimated 11 000 birds in one year, with northern fulmars *Fulmarus glacialis* and black guillemots *Cephus grylle* being the most common. In the next phase, we studied bycatch in more detail in the small-vessel demersal longline fishery for Greenland halibut over three years where estimated total bycatch averaged about 100 birds annually. We also conduct further studies of the bycatch in lumpfish gillnet fisheries and a time-series analysis of bycatch data from a national reference fleet of coastal gill-net fisheries. The poster discusses the methodological and empirical findings and relevant applications in terms of fishery regulations and mitigating actions.

Vulnerability of seabirds to ship traffic in German North and Baltic Seas

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The German North and Baltic Seas are important resting and foraging sites for a high number of seabirds. Ship traffic in these waters is already intense, constituting a threat to sensitive seabird species through disturbance. Along with the intensified construction and maintenance of offshore windfarms vessel activity will even further increase. Currently, Marine Spatial Planning (MSP) is progressing to combine conservation needs and anthropogenic activities, but is still lacking sufficient knowledge about the effects of ship traffic on seabirds. Hence, we investigate the impact of passing ships on distribution patterns, individual flight reactions and habitat loss of seabirds. Here we (1) analyze species-specific as well as area-specific flush distances of an array of seabirds sensitive to human disturbance; (2) estimate energetic implications based on species-specific duration of flight reactions; and (3) develop a ship traffic sensitivity index for seabirds. For this, we use experimental disturbance in the course of ship-based seabirds at sea counts and relate the measured flush distances and flight durations to environmental parameters and vessel densities. The results will be used to enable MSP to appropriately account for the negative effects of ship traffic on sensitive seabird species in future planning schemes.

Comparative trials of lumo leads and traditional line weighting in the Brazilian pelagic longline fishery

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Increasing the sink rate of baited hooks in pelagic longline fisheries, through proximal placement of weights, is crucial for reducing seabird mortality. However, placing weights at short distances from the hook increases the risk of accident to crew members due to weights flying back in the event of a line break. Lumo leads are alternative weights designed to slide in the event of a line break and therefore prevent accidents, were tested in the Brazilian pelagic longline fishery in 2015. We conducted 32 sets, monitoring a total of 26,377 hooks. Catch rates of target fish species, seabird bycatch and sink rates were compared among three treatments: (1) lumo lead 60g at 1.0m from the hook; (2) lumo lead 60g at 3.5m and (3) traditional 60g weighted swivel at 3.5m. There was no difference in the catch rate of target species among treatments. Lumo leads placed at 1.0 m from the hook sank faster and had the lowest seabird bycatch rate (0.11). The high seabird bycatch on treatment 2 (0.33) and 3 (0.85) suggests that combining night setting with 60g weights at 3.5m from the hook is not enough to reduce seabird bycatch in the SW Atlantic to negligible levels.

Age-related differences in the foraging behaviour of a long-lived marine predator

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The way that animals move and interact with their environment is a fundamental, yet poorly understood process. For long-lived species, gaining foraging experience is crucial to long-term fitness. Many seabirds exhibit delayed maturity with a period of learning before recruitment to a breeding population. Understanding age-related differences in movement patterns and foraging behaviours is therefore a key question. In this study, we use high-resolution GPS-loggers to track the fine-scale movements of both adult and immature northern gannets (*Morus bassanus*). Immature gannets spent more time away from the colony than adult birds, and were less consistent in both the departure angle and terminal location of foraging trips. Nevertheless, there was no difference in the total distance travelled or the size of the foraging area. Using state-switching models, we identified the movement characteristics linked to foraging, commuting and resting behaviours. During foraging trips, immature gannets spent a greater proportion of time resting, and less time foraging or commuting than adult birds. Immature gannets also travelled slower than adult birds. These differences may arise as a result of inexperience by individuals still learning the requisite foraging skills for recruitment into breeding populations, or be the consequence of breeding-imposed time constraints on adults.

Thirty-eight years of monitoring show a large-scale oil development has had little long-term impact on local seabird populations

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In 1978 the Shetland Oil Terminal Environmental Advisory Group (SOTEAG) began a programme of seabird monitoring, designed to detect any impact of the recently-built Sullom Voe Terminal (SVT) and its associated tanker traffic on local seabird populations. This has continued to date, funded by industry (67%) and the local authority (33%), with independent academic oversight; SOTEAG's monitoring is complemented by that undertaken by other organisations. The main elements of the project are to a) monitor numbers and population trends of breeding seabirds throughout Shetland; b) monitor numbers of seaduck and diving seabirds wintering in standard inshore survey areas; c) undertake monthly beached bird surveys to monitor chronic oil pollution offshore, including sampling and analysis of oiled seabird feathers; d) respond to, and undertake population impact assessments of, oil pollution events. Notable tanker incidents involved the *Esso Bernicia* at the SVT (1,200 t of heavy fuel; December 1978) and the *Braer* in southern Shetland (84,000 t of Gullfaks crude; January 1993). Following the *Esso Bernicia* spill, there was medium-term recovery of the local breeding population of black guillemots *Cephus grylle* but a continued, local reduction in wintering numbers of great northern divers *Gavia immer*. There was no evidence of any long-term impact of the *Braer* spill on wintering or breeding seabird populations. We have seen reduced chronic offshore oil pollution, in common with other North Sea regions, with recent samples mainly comprising fuel oil residues. Overall, there have been substantial population reductions for some breeding species, for reasons unrelated to SVT activities, or the oil industry in general.

Pair formation and divorce: exploring the population dynamic consequences of individual heterogeneity

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An underlying assumption in many hypotheses seeking to explain pair formation and divorce is that quality varies between individuals. Under this assumption, decisions about the quality of a partner have the potential to influence processes such as pairing and divorce. For example, an individual may seek a partner of optimal quality, subject to constraints on the availability of potential mates and the detectability of partner quality. Such discrimination during pairing is likely to lead to a degree of correlation between the quality of partners. Choices relating to partner quality may also influence decisions to divorce, as when the benefits of seeking a better quality mate outweigh the costs of changing mate. The dynamics of these processes may in turn influence population dynamics, for example, if the reproductive success of pairs depends on pair quality. We develop a two-sex population model to explore the population dynamic consequences of individual heterogeneity in quality. The model is based on an avian life history incorporating a long lifespan, monogamous pairing, low fecundity and delayed onset of reproduction, consistent with many species of seabird. We investigate the impact of different assumptions about the interactions between individual quality and demographic processes such as reproduction, divorce and pairing.

Flying fertilizer – how shifts in foraging area can change nutrient distributions

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Animals provide a host of services that contribute to a functioning global ecosystem. Notable among these is the ability to spread nutrients. Many species, particularly birds, are highly mobile and are thus capable of transferring material, through defecation, over huge spatial scales and across habitat boundaries. Such bird derived nutrients can have significant impacts on the primary productivity in the area they are deposited. Humans can affect the preferred foraging areas of these animals though by inadvertently providing food e.g. at dumps or with discards. This will have a consequence on the input and distribution of animal derived nutrients into the environment. Here we model the effect of a shift from an aquatic to a terrestrial foraging habitat in herring gulls (*Larus argentatus*). We create a population that no longer avails of fishery discards and has moved inland in search of food. Our system combines GIS data with an agent-based model that accurately reflects the flight characteristics of the species. With it we are able to determine the change in the distribution and uptake of gull derived nutrients depending on their foraging location.

Proposed new marine protection areas for seabirds and waterbirds in the UK

K. Kober, J. Black & J. Lawson

Joint Nature Conservation Committee, Aberdeen, UK

For more than a decade the Joint Nature Conservation Committee have, in collaboration with the other statutory nature conservation bodies (Scottish Natural Heritage, Natural England, Natural Resources Wales and the Department of the Environment for Northern Ireland) collected, collated and analysed data on the distribution of seabirds and waterbirds around the UK. This work has led to a suite of areas being considered as possible marine protected areas for birds in inshore and in offshore waters. Several possible sites have been publicly consulted upon recently, or are still under consideration for consultation. The poster aims to provide an overview of the proposals, where they are and which species they aim to protect. The poster complements an oral presentation submitted by Julie Black on the conservation aims of the new site proposals.

Atlantic puffin – adult survival rates on the Shiant Isles

Jim Lennon and members of the Shiant Auk Ringing Group

Shiant Auk Ringing Group, Shiant, UK

The Shiant Auk Ringing Group re-commenced seabird monitoring on the Shiant Isles, Outer Hebrides, in 2008. It's a SPA containing 10% of the UK puffin population (BOCC4 status red). We initiated studies on puffin and razorbill using BTO's Retrapping Adults for Survival methodology, allowing standardised analysis of data. Adult auk survival studies are mainly on east coast sites. Both species are monitored annually through standard netting in two colonies in June/July. The puffin slope is netted twice; a week apart. Nets are contour set at eight marked pegs for two hours each. Birds are checked for rings and sample biometrics taken. Data suggest an annual adult survival rate of 0.9, similar to Steventon et al in 1970/80s. Razorbills are similarly netted on a beach. This RAS started in 2010 and data is yet to be analysed, but recaptures are lower than the puffins. Both will inform monitoring post the black rat eradication in 2015. Ringing provides long-term data on populations that are in need of conservation. Good adult survival rates help long-lived seabird species survive periods of low recruitment resulting from fluctuations in climate and food. They also inform policy, which helps prioritise key sites like the Shiant for conservation.

Censusing puffin colonies – a trial of the different methods available on the island of Mingulay

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Being burrow-nesters, puffins are notoriously difficult to survey accurately. The recommended method of counting occupied burrows, best achieved by locating the incubating bird with an arm, stick or burrowscope, is not available where the nests are in deep sand, located on inaccessible cliffs or under boulders. Mingulay, a Special Protection Area in the Outer Hebrides, has a large puffin colony that has never been counted effectively. Part of the colony is in readily accessible on gentle slopes in Mingulay Bay but the majority of the puffins nest on steep and extremely high cliffs and stacs on the west side of the island. A 3-year PhD study trialled time-lapse photography to estimate colony attendance at two locations on the island. It revealed clear diurnal and multi-day cycles in colony attendance but failed to provide a usable estimate of colony size. Various attempts to estimate burrow occupancy at the only three accessible locations are discussed and are compared with counts of birds visible above ground or swimming on the sea close to the colony. Peak counts of swimming birds probably give the most reliable estimate of colony size for inaccessible colonies.

Investigating the ecology of black guillemots in relation to marine renewable energy

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The black guillemot *Cephus grylle* is a diving seabird, widespread in northern latitudes, including the UK and Ireland, and with over 37,000 individuals in Scotland. Compared with other diving seabirds, the black guillemot has been little studied meaning there is limited ecological or behavioural information available. In addition, this species has been highlighted as potentially vulnerable to marine renewable energy developments. Potential affects may be through collision with operational parts and also displacement from foraging areas. Several projects are underway at the Environmental Research Institute to improve our understanding of black guillemot ecology. We will use GPS tags to determine the fine scale movement of black guillemots during the breeding season in the Pentland Firth and Orkney Waters, an area within which tidal energy projects are planned. Additionally, using data loggers that record the amount of time birds spend in and out of the water, we aim to collect data on the behaviour of individuals during the non-breeding season to understand the risk that tidal turbines may pose to this species. We will provide an overview of these projects as well as future planned research on this species, and present preliminary findings from the 2016 field season.

Farne Island shags don't share with their neighbours

Elizabeth Morgan, Keith Hamer

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Colony specific segregation in foraging areas has been recorded in far-mid ranging seabird species on a UK wide scale. We investigate whether such processes operate at smaller scales, in a short-ranging species, the European shag (*Phalacrocorax aristotelis*). Biotelemetry devices were deployed on birds nesting practically within sight of each other on separate islands. Over the two year study period, complete GPS and dive data were gained from 365 trips (from 21 birds) nesting on one island and 284 trips (23 individuals) from another island, just 2km further offshore. Birds' core foraging areas overlapped significantly less than expected based on accessibility and availability of suitable foraging habitat. These segregation patterns were more pronounced within years than across years. Our results suggest segregation processes which are not simply driven by utilisation of the most easily accessible resources close to nesting locations. Other mechanisms such as density dependent competition may be influencing foraging decisions during the chick-rearing period. This may drive differences in foraging behaviours between islands; Outer island birds tended to travel further and dive deeper than inner island birds. Our results contradict those reported at other colonies, which highlights the importance of site specific considerations when evaluating marine management decisions.

Long-term study of black guillemots in Iceland

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Black guillemots have been studied on Flatey island, Iceland, since 1974. The colony increased to peak numbers of 530 pairs. Since 1987 a continued decline has levelled at 80 pairs in 2012-2015. Breeding success has also seriously declined, or by some 40% on average over the 40 years. Through the years various breeding biology parameters have been studied, e.g. nest-site and natal fidelity, nest-site use, causes of breeding failure, survival, and age of first breeding. Also colony attendance and census methodology. Over 20 thousand ringed birds have given important data on distribution outside the breeding season. Studies have been carried out on parasites and viruses, also organochlorine contamination. Studies on possible causes of population changes have been emphasized, such as bycatch, tourism, and puffin ticks. This study was one of the first to describe the different foods of adult and chicks. Foraging ecology in relation to climate change is of present interest. The main focuses now are: (1) breeding success; (2) foods of young; (2) feeding frequency; (3) butterfish availability; (5) adult foraging areas. These data are compared to the same parameters in the 1970's.

Parakeet auklet (*Aethia psittacula*) – is the monotypic species actually monotypic?

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The parakeet auklet is a small planktivorous alcid (Alcidae, Charadriiformes) that breeds on islands and coastlines of the North Pacific. Until now this species was supposed to be monotypic (Gaston & Jones, 1998), but molecular analysis has not yet been conducted. We analyzed mitochondrial control region fragment (427 bp) to estimate the differentiation between birds from Asia (Talan I., Kuril Is., north-eastern waters of Kamchatka, Commander Is.) and America (Aleutian Is.), totally N=59. We found a significant difference between auklets from Aleutian Is. and from all other colonies excluding the geographically nearest Commander Is. ($F_{ST}(\text{Aleutian Is.}-\text{Talan I.})=0.109$, $F_{ST}(\text{Aleutian Is.}-\text{Kuril Is.})=0.231$, $F_{ST}(\text{Aleutian Is.}-\text{Kamchatka})=0.168$, $P<0.017$; $F_{ST}(\text{Aleutian Is.}-\text{Commander Is.})=0.051$ $P>0.017$ after BY-correction). However, birds from Commander Is. did not differ from all other birds ($P>0.017$ in all pairwise comparisons). It is considered that mtDNA reflects historical differentiation, so differences found between Asian and American colonies could be the result of the expansion from two different refugia – Asian and American, during the last glacial maximum (approximately 22000-17000 years ago), after which Asian auklets colonized colonies of the Sea of Okhotsk and Commander Is., while American ones – Aleutian Is. Perhaps, now gene exchange exists between Aleutian and Commander Is. Supported by RFBR №14-04-01138.

Intraspecific genetic differentiation in the ancient murrelet (*Synthliboramphus antiquus*)

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The ancient murrelet is a small alcid (Alcidae, Charadriiformes) that breeds in the North Pacific. Based on slight morphometric differences, L.S. Stepanyan (1972) proposed separating murrelets from Commander Is. into a unique subspecies. Pearce et al. (2002) analyzed mtDNA variability and found no differentiation between birds from Asian and American colonies, but without taking Commander birds into account. We analyzed mitochondrial control region fragment (431 bp) and 4 microsatellite loci to reexamine intraspecific differentiation and to estimate the position of Commander ancient murrelets among birds from other parts of the range. We analyzed samples from Asia (Talan I., Kuril Is., north-eastern waters of Kamchatka), Commander Is. and America (Aleutian Is.), totally N=99. We found no significant intraspecific differentiation in mtDNA analysis ($P>0.017$ in all pairwise comparisons). However, the analysis of pairwise genetic differentiation (R_{ST}) in microsatellite DNA and the Bayesian analysis in STRUCTURE revealed two genetic clusters: one consisting of Commander ancient murrelets, the other - of Talan and Kuril birds ($R_{ST}=0.217$ and $R_{ST}=0.111$, respectively, $P<0.017$). Birds from geographically nearest Aleutian Is. and Kamchatka partly mixed with Commander murrelets. Despite this, we did not find strong evidence in favour of subspecies status for Commander birds. Supported by RFBR №14-04-01138.

Surveying the seabirds of Ka`ula Island, Hawai`i, using high resolution digital aerial oblique imagery

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The first systematic surveys of the seabirds of Ka`ula Island have been carried out between 2012-2016, an island very difficult to survey using standard methods due to major safety issues. High resolution digital imagery gathered by nadir (vertical) survey complemented by oblique survey allowed the birds on top of the volcanic tuff cone as well as those present on the cliff faces to be recorded. The surveys recorded the following peak numbers of individuals: 3 black-footed albatross, 100 Laysan albatross, 314 red-tailed tropicbird, 1415 great frigatebird, 3696 red-footed booby, 526 masked booby, 867 brown booby, 7137 brown noddy, 22 black noddy and 14,635 sooty tern. The two species of albatross are Near Threatened (IUCN Red List). During the surveys up to 11 critically endangered (C1) Hawai`ian monk seals were recorded on the island (ca 1% of world population) as well as large numbers of humpback whales offshore. As well as presenting the survey results and placing them in a wider Hawai`ian context, the strengths and weaknesses of this novel use of oblique imagery for seabird colony survey will be described. The method is of great value for seabird colonies that are difficult of access or present on site hazards.

Migration patterns, distribution and activity during the nonbreeding season of black-legged kittiwakes *Rissa tridactyla* from Canna Island, Scotland

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Until recently, knowledge of seabirds has been rather restricted to the breeding season, yet pressures during the nonbreeding season may significantly impact seabird breeding success and population demographics during moulting and overwintering. This study tracked black-legged kittiwakes *Rissa tridactyla* from Canna Island, Scotland, using combined geolocators and wet-dry sensors to identify migration routes, the timing and location of winter moulting, and overlap with anthropogenic impacts. Three migration strategies were evident in this population: 1) residents, where birds remained around the UK; 2) short-distance migrants, where birds travelled no further than the Central Atlantic, west of the mid-Atlantic ridge; and 3) long-distance migrants, where individuals reached North America. Long-distance migrants departed the colony on average 19 days earlier than residents, and 9 days earlier than short-distance migrants. Activity data revealed a potential moulting period following departure from the colony for some individuals, which could indicate key conservation areas. The three migration strategies experienced significantly different levels of anthropogenic impacts, indicating that subsections of the population will be differently affected by human activities. Further understanding of the nonbreeding dispersal of kittiwakes will enable improved predictions on the drivers of migration and how conditions during the nonbreeding season may be affecting population productivity.

Long-term changes in common guillemot chick diet on Skomer Island, Wales.

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Seabird diet studies show that commercial fishing and climate change are reducing the abundance and availability of prey species for many northern hemisphere seabirds, resulting in changed diets, reduced breeding success and population declines. Long-term standardised observational data will be used to show changes in the diet of common guillemot (*Uria aalge*) chicks on Skomer Island, Wales. Foraging ranges of chick-rearing adult guillemots in 2010 and 2011 are also reported. We found that most chick-rearing adult guillemots foraged within the Celtic Sea in a south-westerly direction and within approximately 31km of Skomer Island. Chick diet has remained relatively consistent over the past forty years, with chicks fed mainly clupeids (*Clupea harengus* and *Sprattus sprattus*) (86%), sandeels (*Ammondytes tobianus*) (12%) and gadids (*Gadus morhua*) (2%). From 1992, the proportion of low quality gadids increased as the proportion of high quality clupeids decreased. Our findings suggest a shift in chick diet on Skomer Island which has the potential to impact breeding success in the future.

Going with the flow: seabird usage of high-energy tidal environments from shore-based vantage points

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Tidal turbines are a potential hazard to diving seabirds while they are foraging underwater. Birds may encounter and collide with these devices, which could result in injury or death. Others may avoid the devices, or even harness prey associated with them, with implications for their foraging efficiency. Seabird foraging and diving preferences within high-energy tidal streams (HETS) may have important behavioural and ecological implications. The knowledge base on these preferences is still limited. Our study seeks to develop understanding of seabird foraging and diving behaviour within a HETS. We undertook site scan and focal observations from shore-based vantage points along of Bluemull Sound, Shetland. Data were collected during the breeding season in 2011 and 2012, and during winter in January 2012. Diving species observed included European shag, northern gannet, black guillemot, common guillemot and Atlantic puffin. European shag and black guillemot were the most frequently observed species in the breeding and non-breeding season. We present results on spatial and temporal use of this HETS, for some of the key seabirds, identifying under which tidal conditions species may be more likely to encounter tidal turbines. This should lead to a more accurate assessment of the impacts of marine renewable energy developments.

Developing methodologies for surveying urban gulls

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There have been three censuses of the breeding seabird populations of Britain and Ireland: Operation Seafarer (1969-1970), the Seabird Colony Register (1985-88) and Seabird 2000 (1998-2002). Seabird Monitoring Programme (SMP) partners are currently working together to deliver the next of these periodic censuses: 'Seabirds Count'. Each previous census has seen improvements in methods and new population estimates. For *Seabirds Count*, one group where there is a need for improved methods is urban gulls, predominantly herring gulls *Larus argentatus* and lesser black-backed gulls *L. fuscus*. While urban nesting gulls have been surveyed by Seabird 2000¹ and previously^{2,3}, the spread in species' distributions to urban habitats apparent from 'Bird Atlas 2007-11'⁴ and concerns regarding the accuracy/efficacy of some previous approaches⁵ have highlighted the need for a robustly designed survey methodology. We report on the development of methods that would enable the delivery of key objectives relating to urban gulls as part of *Seabirds Count*, including both national and site-level population estimates. The project encompasses 1) a review of existing methodologies, including land-based and remote techniques; 2) a review of current knowledge on the distribution of urban nesting gulls in Britain and Ireland; 3) the development of proposals for the design and implementation of surveys.

High migration counts in Turkey suggest the existence of undiscovered colonies of the Yelkouan shearwater

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Assessing the population size of nocturnal burrow-nesting seabirds is challenging, and for many species the global population size is poorly known. The Yelkouan shearwater is a globally threatened seabird species endemic to the Mediterranean, and its global status assessment lacks any information from the Eastern Mediterranean. Between 2010 and 2016 we conducted counts at an important migration bottleneck (Bosporus, Turkey) and observed up to 90044 birds passing within a few hours in early February 2015. However, during early February adult Yelkouan shearwaters are already at their breeding colonies in the western Mediterranean. We therefore simulated the current size of the non-breeding population based on existing demographic parameters and a range of population sizes to explore how many non-breeders would be available for counts in early February. Assuming the highest survival and productivity estimates, and the maximum of the global population estimate, the non-breeding segment comprised only 38350 individuals, and could therefore only account for 43% of the number of observed individuals. This result suggests that there might be large undiscovered breeding populations of this species in the Mediterranean or the Black Sea. We recommend further efforts to assess the breeding status of Yelkouan shearwaters in areas where no data exist.

Bayesian Cormack-Jolly-Seber models for juvenile survival analysis in common guillemot

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Adult survival is an important life-history trait in long-lived species. Survival, and understanding survival probabilities are crucial for modelling population dynamics. The common guillemot (*Uria aalge*) is a pursuit-diving and widespread seabird species in the colder parts of the Atlantic and Pacific oceans. The largest colony of guillemots in the Baltic Sea is located at the Swedish island of Stora Karlsö, west of the island of Gotland, hosting around two-thirds of the total Baltic Sea population with around 10,000 breeding pairs. In contrast to others colonies, chicks from Stora Karlsö come back to the colony before reaching sexual maturity. This behaviour is a valuable source of information to study both juvenile and adult survival. The data used in our study has been collected through monitoring programs carried out between 1987 until 2014 and correspond to a total of 35.558 ringed guillemots and 10.878 resightings from 4.424 different individuals. Each year chicks are captured and ringed in summer after jumping from the ledges at an age of about 20 days. Also, along the reproductive period (May to July), resightings with telescopes and binoculars are made from above the breeding ledges with minimal disturbance. The statistical analysis uses longitudinal absence/presence data to estimate the annual probability of resighting of an alive and ringed guillemot and the annual local survival probability through Bayesian Cormack-Jolly-Seber (BCJS) models. They are formulated in terms of state-space models which take into account the system process that describes the temporal underlying biological process and the observational process for the resighting in connection to the system process. The objective of this study is to estimate annual survival probabilities and resighting probabilities at ages one, two, three and four on common guillemots through Bayesian Cormack-Jolly-Seber models.

Diet effects on chick development of lesser black-backed gulls

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Lesser black-backed gulls *Larus fuscus* breeding in the Belgian coast are observed to exploit discarded fish from demersal trawlers, urban and industrial food waste, and soil dwellers such as earthworms, insects and moles at agricultural fields or urban parks. Each of these food sources is exploited with different frequencies per individual bird and period of the breeding season: incubation, early and late chick rearing, and post-fledging. The Terrestrial Ecology Unit of Ghent University is studying what drivers lead gulls to forage on a certain food source at a particular area, and whether these foraging strategies have an impact on fitness. GPS tracking data reveal that a majority of lesser black-backed gulls forage inland, looking for soil invertebrates and human refuse. However, fishery discards are a key component of the diet provided by most gull parents to their chicks. Some food types, such as industrial food waste, are used as a secondary, or replacement, food source. We have tested the effects of the amount and type of food provided to a chick on its development in captivity rearing experiments. These results shed light on the consequences of each foraging strategy for the offspring, in comparison to the costs of foraging at different habitat types.

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

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Global Location Sensor (GLS) loggers have greatly enhanced our ability to track seabirds in the non-breeding season, and have rapidly generated important new knowledge concerning at-sea ecology. To take full advantage of this new technology, there is a need for multi-year, multi-site and multi-species studies, which is also in line with one of the recommendations from the second World Seabird Conference to “scale up” modern seabird research. In a unique four-year program (2014-2018) with participants from Norway, UK, Faroes, Iceland and Russia, we aim to identify the non-breeding distribution and movements of seabirds breeding in colonies encircling the Barents, Norwegian and North Seas, and to study how changes in environmental conditions in wintering areas affect their demography and population trends. More than 2000 GLS loggers were deployed on 11 species breeding in over 30 colonies in 2014 and 2015. In 2015, the first year of recapture, we retrieved ca. 800 loggers whose data have been downloaded and processed. Co-ordinated tracking studies open up for a wide variety of seabird studies, and in this presentation, we will outline SEATRACK’s over-arching objectives, study design, and preliminary results.

Restoring and securing seabird islands – RSPB’s seabird island restoration project

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The RSPB has embarked on a programme of work to restore islands where invasive non-native species (INNS) are having an impact on the native seabird populations, and secure those that are currently INNS free. This is building on the success of previous projects (such as Ramsey and Lundy) and is now led by the flagship Isles of Scilly Seabird Recovery, and the Shiant Isles Restoration Projects. Alongside these pioneering eradication projects we also aim to develop practical biosecurity best practice guidelines, applicable for use on UK seabird islands, and run training events for landowners, managers, staff, volunteers and visitors. Following the completion of the work on the Shiant Isles and Isles of Scilly, the programme plans to extend this important work to other islands and a prioritisation exercise has been undertaken to inform these next steps in both restoration and biosecurity. This poster will present the two flagship projects, their challenges, solutions and successes. It will also present some of the key findings in the biosecurity best practice guidelines, presenting approaches which can be instigated on study sites, reserves and elsewhere. Some key findings from the island prioritisation exercise will be shown and options for next islands will be discussed. This poster is intended to raise awareness for INNS and biosecurity, and to start a discussion about how the UK best protect its native seabird islands.

Tracking lesser black-backed gulls from three colonies reveals seabird-wind farm interactions over multiple scales

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To minimise the impacts of climate change, a rapid expansion in renewable energy developments including wind farms is currently taking place. As a result, there is a need to understand the scale of potential impacts from such developments on biodiversity and species' populations. Using GPS telemetry, we investigated the movements of 74 lesser black-backed gulls *Larus fuscus*, a species previously highlighted as sensitive to collision risk, from three UK Special Protection Areas (SPAs) over three different spatio-temporal scales: (1) Locally during breeding, (2) Within operational wind farms, and (3) Throughout the year over breeding and wintering ranges. Gulls used local offshore wind farm areas most during early chick rearing, usage varying between years in relation to breeding success. High-resolution data revealed birds regularly flew at turbine height within wind farms but rarely entered the three-dimensional rotor sweep. Across the annual cycle, potential risk, defined as the distance travelled at collision risk height, was mapped and combined with wind turbine density to determine wider-scale spatially-explicit vulnerability. This study is providing a fuller picture of wind farm interactions, allowing better assessment of potential impacts of wind farms on our internationally-important seabird populations.

Nest site selection and individual quality in Caribbean seabirds

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For colonial seabirds, nest site selection generally consists of choosing a suitable location among the wide range of available sites within the colony. Nest site-quality has the potential to influence fitness, by having an effect on breeding performance and output. Thus the selection of an appropriate nest site can be a trait determinant for an individual's quality. We assessed the influence of environmental factors within the colony on several proxies of fitness in brown and masked boobies (*Sula leucogaster* and *S.dactylatra* respectively) breeding on Dog Island, Anguilla, British West Indies. We hypothesized that the ambient temperature of the selected nest site and the availability of shade from the surrounding vegetation are important factors influencing hatching success, chick growth and chick survival, mediated by nest site selection. Other parameters, such as nest-density, and the location within the colony (peripheral vs centric), were also taken into account. Colonies were monitored from the beginning of breeding until chicks fledged, and this information was combined with temperature data collected by thermocron loggers (iButtons) and environmental variables from nest surroundings (such as presence of cover to give shade), and spatial data as occupation rates and location within the colony.

Flying over rivers in the sea: understanding why seabirds forage in energetically demanding tidal races

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Understanding how seabirds use high current flow tidal races is key to establishing why some seabirds chose to forage in energetically demanding environments, and identifying how seabirds might be affected by tidal-stream renewable energy developments. Current techniques used to survey the use of tidal races by seabirds suffer from an inability to accurately locate birds in space and a reduced ability to detect birds as the distance from observer increases. These issues prevent robust fine-scale habitat modelling that could elucidate why seabirds forage in tidal races, and overlap with renewables. We developed and tested a novel method using a camera-mounted unmanned aerial vehicle (UAV) to survey seabirds using a tidal race on the north coast of Scotland. On-board GPS accurately located birds in space and UAV transects ensured consistent detection throughout the survey site. Camera images reveal seabird associations with surface-visible hydrodynamic processes, potentially indicating relationships between foraging behaviour and habitat. GPS locations can be combined with hydrodynamic model data, current flow measurements and information on prey to understand the drivers underlying seabird foraging in tidal races. This information is crucial to assess potential impacts of tidal-stream energy developments and establish why seabirds forage in these extremely dynamic environments.

Understanding and predicting spatio-temporal variations in marine top-predator distributions in European waters, at regional and decadal scales

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The increasing exploitation and use of the marine environment by humans creates a need to manage anthropogenic activities in a sustainable manner. Marine top-predators (seabirds, cetaceans and pinnipeds) are charismatic species of great public interest, with high commercial and recreational importance. The conservation of top-predators is thus seen as a priority among many management agencies. However, the offshore and cryptic distributions of marine top-predators mean that identifying threats is often problematic. Understanding the mechanisms driving spatial and temporal variation in the distribution of top-predators is crucial to their protection. Our contribution to the NERC funded Marine Ecosystem Research Programme (MERP) project aims to understand this spatial and temporal variation at regional (North-East Atlantic) and decadal (1980s-2010s) scales. This aim will lead to three main products: (1) the quantification of overlap between top-predator communities and anthropogenic activities, identifying which and when species and activities show potential conflict; (2) descriptions of the biophysical properties within areas characterised by high diversity and/or biomass of top-predators, highlighting areas which may be suitable for protection as Marine Protected Areas (MPAs); and (3) predictions of community-level responses to various environmental scenarios (linked with climate change and management strategies), leading to the recommendation of suitable management approaches. To provide these products, we are collating a multitude of existing datasets documenting the distributions of top-predators, prey species and biophysical processes across our study region and period. By identifying mechanistic links between biophysical processes, prey characteristics and the distribution of top-predators, our research will provide decision makers with the knowledge needed to conceive targeted and empirically-informed management strategies, reducing the risk of negatively impacting top-predator populations within this region.

Seabird trophic level shifts from the 1920s to 2010s for shelf-feeding endemic species in the NZ region

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Feathers from museum specimens from six New Zealand endemic seabird species were sampled for their carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) stable isotopes. We investigated changes in the isotope values through time, with earliest samples from the 1880s, although most samples were from the 1920s to the present day. The species were selected because they are known to frequent the continental shelf region as their principal feeding habitat, and the availability of food in this habitat has changed with the advent of industrial fishing from the 1950s onwards. For the $\delta^{13}\text{C}$ data, we corrected values for the 'Seuss effect', taking into account increased levels in atmospheric carbon over the sampling period. There was a significant 'decade' effect, and species differed significantly from each other in their $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values over time, with a tendency for decreasing $\delta^{13}\text{C}$ values, and increasing $\delta^{15}\text{N}$ values over time.

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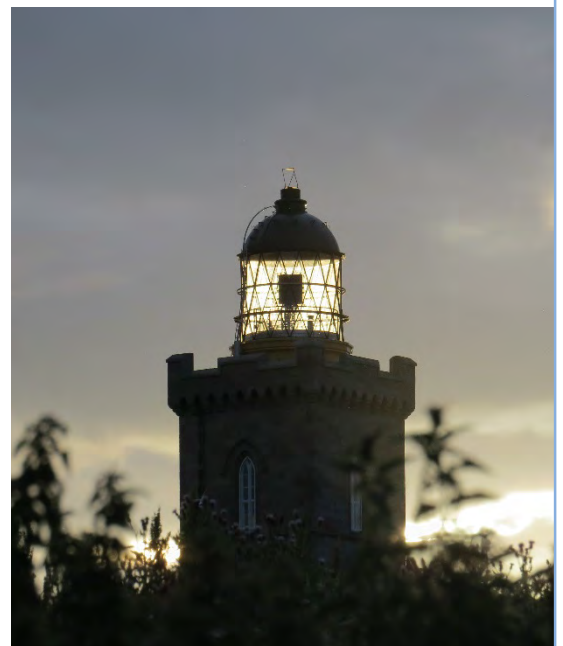


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