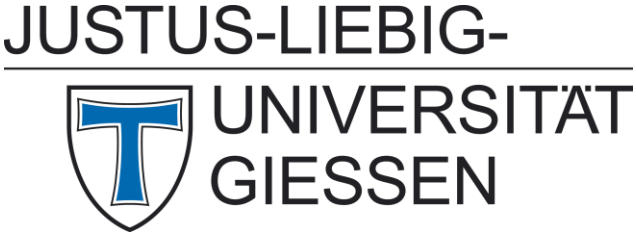
Programme and Abstracts

EOU 2022

13th European Ornithologists' Union Congress

Online Conference
March 15th 2022

ORGANISERS:



https://conference.eounion.org/2022/

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Apart from correcting for obvious typos, the abstracts are published as they were submitted by their authors.

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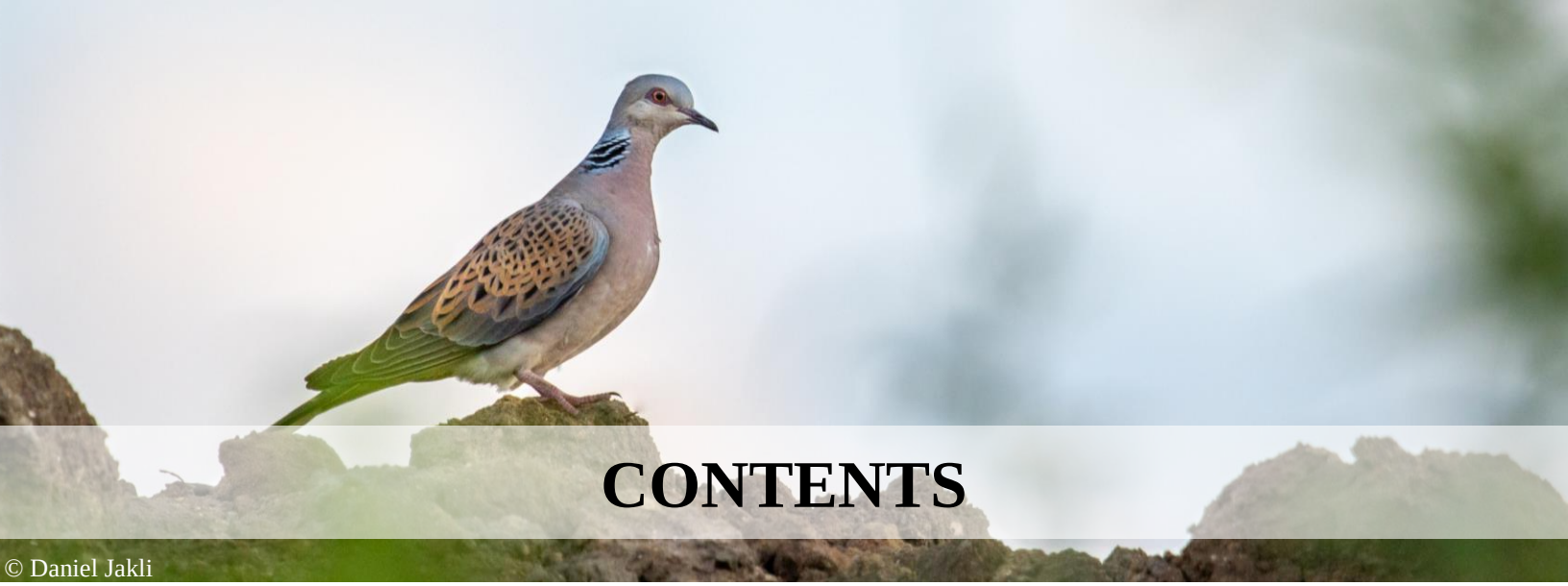

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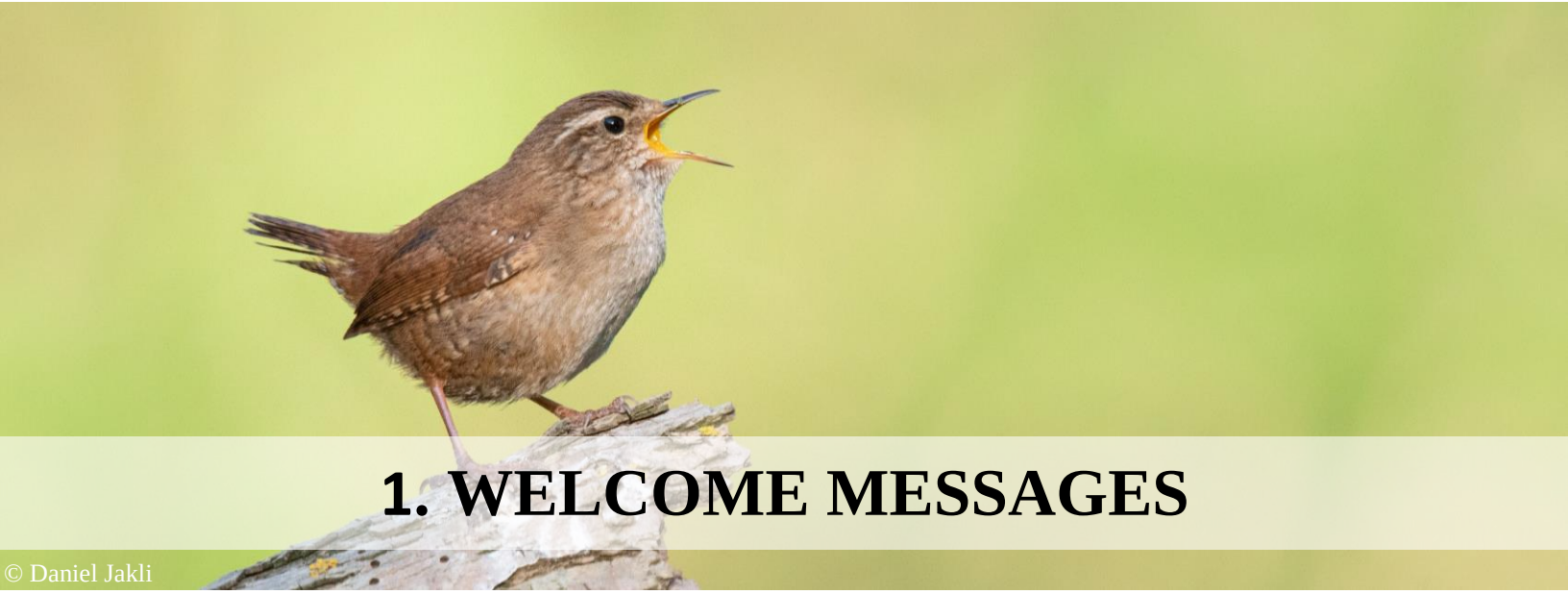
GENERAL INFORMATION



1. WELCOME MESSAGES

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1.1 Message from the EOU President

The local organising committee headed by Petra Quillfeldt and Tobias Erik Reiners, have worked extremely hard to realise the 13th EOU Congress as an arena for discussing scientific results, sharing ideas and plan conservation actions in person. After one re-scheduling, from August 2021 to March 2022, we had to realise that it was impossible to continue the plans for a congress in real life. We sincerely hope that this was the last time the virus, known as Covid-19, restricted our possibilities to meet, interact and engage in social activities, one of the basic needs of humans. Again, I am full of admiration for the hard work devoted to plan for the congress by the local organising committee and the scientific committee, irrespective of the harsh circumstances. One of the results is this abstract book compiled by the head of the scientific committee, Dan Chamberlain. Since self-pitying is very counterproductive, instead enjoy reading this book and participating in the one-day online congress on the 15th of March and look forward. Still, it is soon spring and time to start to plan your studies to be presented at the 14th EOU Congress.

Jan-Åke Nilsson
President

1.2 Message from the local organisers

In light of the crises like Covid-19, climate change and biodiversity loss, international scientific exchange and co-operation is more important than ever. This especially includes times when personal meetings are impossible and borders are closed. We feel very sorry that we could not invite you all to meet here personally, and have some time and the chance to meet over a cup of coffee and chat in between the time of the scientific programme. Unfortunately, this will have to wait until the next meeting. We were really keen to foster the personal exchange between all of you, but also to show you some of our beautiful bird conservation sites in our federal state. We are hoping that the online meeting can transmit at least some of the spirit of scientific conferences. Our preparation would not have been possible without many helpers and their perseverance during the very long conference planning period of nearly two years with numerous ups and downs. We especially would like to thank: Sarah Gärtner, Michael Beensen, Jon Rolfes, Yvonne Schumm, Reinhard Stüdemann and the HGON and JLU administration staff.

Petra Quillfeldt & Tobias Erik Reiners
Local organisers

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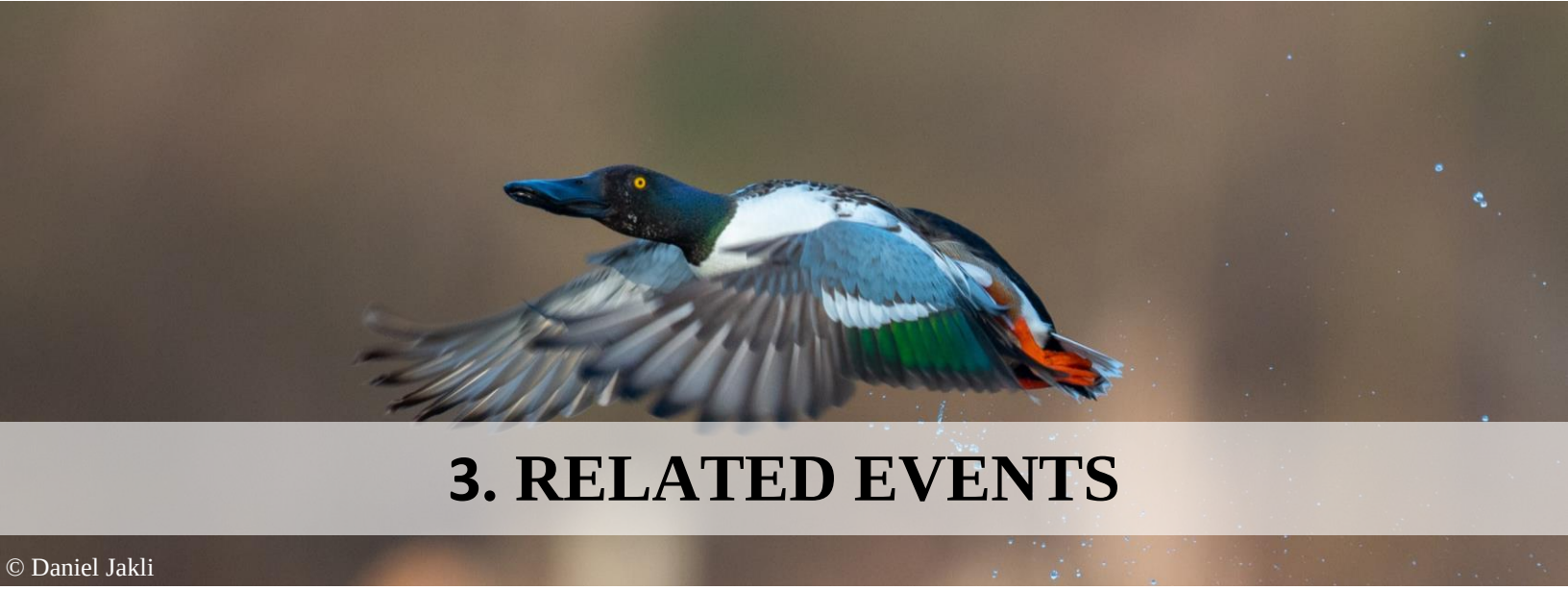
2. ORGANISERS

2.1 Local Organising Committee

- Petra Quillfeldt (JLU)
- Tobias Erik Reiners (HGON)
- Michael Beensen (HGON)
- Jon Rolfes (HGON, JLU)
- Sarah Gärtner (HGON)
- Reinhard Stüdemann (HGON)
- Dana Ahrens (HGON)
- Yvonne Schumm (HGON, JLU)

2.2 Scientific Programme Committee

- Dan Chamberlain, University of Turin, Italy (Chair)
- Tamer Albayrak, Burdur Mehmet Akif Ersoy University, Turkey
- Elena Arriero, University Complutense of Madrid, Spain
- Jan Engler, Technische Universität Dresden, Germany
- Jordi Figuerola, Estación Biológica de Doñana – CSIC, Spain
- András Liker, University of Pannonia, Hungary
- Sara Lupi, Universty of Veterinary Medicine, Vienna, Austria
- Mark Mainwaring, University of Montana, USA
- Alfonso Marzal Reynolds, University of Extremadura, Spain
- Zóltan Németh, University of Debrecen, Hungary
- Jan-Åke Nilsson, Lund University, Sweden
- Andreas Nord, Lund University, Sweden
- Peter L. Pap, Babes Bolyai University, Romania
- Suvi Ruuskanen, University of Jyväskylä, Finland
- Petra Sumasgutner, University of Vienna, Austria



3. RELATED EVENTS

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Online symposium, March 14th, 15:00 to 18:00 CET

Causes and consequences of phenotypic variation in anthropogenic environments

Conv*enors: Pablo Capilla-Lasheras*[1], *Megan Thompson*[2] *& Pablo Salmón*[3]

[1] University of Glasgow, UK
[2] Centre d'Ecologie Fonctionelle et Evolutive, CEFE, CNRS-UMR, France & Université du Québec à Montréal, Canada
[3] University of Basque Country, Spain

Abstract

In the last century, human activity has changed the world at an unprecedented pace and its influence is virtually present in every ecosystem. Bird species living in anthropogenic environments face the novel challenge of coping with ecological conditions that their evolutionary history did not prepare them for. Despite significant effort made to understand the overall response of birds to anthropogenic stressors, the causes and consequences of individual variation in these responses are not fully understood. For example, recent studies evidence a higher degree of phenotypic variation for certain traits in populations dwelling in anthropogenic environments in comparison with those in more natural environments. What are the causes and implications of this increase in phenotypic variation? Answering this and other related questions will require to study the response to anthropogenic disturbances at the individual level. However, challenging, investigating individual variation in the context of adaptation to anthropogenic stressors will shed new light on the mechanisms underpinning evolutionary responses to current environmental change and the resilience of avian populations in the "Anthropocene".

The aim of this symposium is to highlight the importance of anthropogenic environments in shaping individual variation and the potential role of individual variation in promoting adaptation to these novel environments, including contributions from a broad range of biological processes to provide an integrative overview of the field, with emphasis on novel avenues of research and collaboration. We further aim to highlight the eco-evolutionary importance of the study of variation (not only mean trait values) and to promote collaboration between several European teams working on the effects of anthropogenic stressors in avian systems. This symposium would be well-timed to encourage sharing of knowledge and to foster new collaborations, which is crucial given the global significance of human-driven ecological change.

Programme

15:00	**Pablo Capilla-Lasheras** - Opening and introduction
15:05	**Marta Szulkin** - Life on our doorstep: avian urban ecology and evolution
15:35	**Megan Thompson -** Urbanization increases phenotypic variation in tits across European cities
15:50	**Johan Kjellberg Jensen -** Interactive effects of abiotic and biotic microhabitat characteristics on the physiology of urban great tits (*Parus major*)
16:05	**Jessica Jimenez-Peñuela** - Effects of anthropization and blood parasite infections on house sparrow health
16:20	**Pablo Capilla-Lasheras** - Individual variation in chronotypes of urban and non-urban bird populations
16:35	Break
16:45	**Zuzanna Jagiello** - The extended urban phenotype: impact of anthropogenic waste on nest design and avian fitness
17:00	**Sabrina Mai** - Sequence variation of DRD4 and its relation to flight initiation distance in Greylag Geese *Anser anser*
17:15	**Pablo Salmón** - Colouration differences in urban great tits across Europe: insights from correlational, experimental, and meta-analytical approach
17:30	**Melanie Lidner** - Seasonal timing of reproduction in great tits; using selection lines to study the potential for an evolutionary response to global warming
17:45	**Aude Caizergues** - TBC
18:00	**Megan Thompson** - Closing remarks

Online symposium, March 16th, 09:00 to 11:45 CET

Past and Current Drivers of Forest Bird Population Trends across Europe

Conv*enors: Jiří Reif*[1] *& Johannes Kamp*[2]

[1] Institute for Environmental Studies, Faculty of Science, Charles University, Prague, Czechia
[2] Conservation Biology Department, Georg-August-University Göttingen, Germany

Abstract

Forest birds represent a major part of European avifauna containing many species highly specialized to different kinds of forest habitat, as well as generalist species colonizing isolated woody patches in urban areas or farmland. However, the drivers of population change of forest birds remain understudied, compared to other groups such as farmland birds. At the same time, there are indications that forest bird populations show divergent temporal trajectories in different European regions. These differences may result from following mechanisms: (i) approaches to forest management leading to variable increases in wood volume over the past 200 years, (ii) impacts of extreme events such as bark beetle outbreaks, windstorms or fires, which are all predicted to increase in the future (iii) velocity of gradual climatic changes such as temperature warming and rainfall redistribution. By inviting speakers from different European regions, this symposium aims to deepen our understanding to the processes involved in shaping the observed population changes of forest birds.

Programme

09:00	**Jiri Reif** - Introduction
09:05	**Johannes Kamp -** The implications of 200 years of change in forest management and forest disturbance for birds in Europe
09:35	**Urška Ratajc -** Simultaneous population increase intensifies interactions in competitive *Strix* owls
09:55	**Nino Maag -** Wood warbler population trends across Europe in relation to increasing mast seeding frequency
10:15	Break
10:30	**Juan Carlos Senar -** Predicting Citril Finch response to climate change: An analysis of survival and recruitment rates in relation to meteorological covariates
10:50	**Martijn Versluijs -** Improving the conservation status of boreal forest birds in Fennoscandia
11:10	**Malcolm Burgess -** Demographic and environmental drivers of long-term population dynamics of British breeding Pied Flycatchers revealed
11:30	**Johannes Kamp -** Summing up
11:45	End of symposium

Online symposium, March 17th, 16:00 to 18:10 CET

Coping Strategies of Mountain Birds to Environmental Variability

Conv*enors: Susanne Jähing*[1] *& Arnaud Barras*[2,3]

[1] tier3 solutions GmbH, Leverkusen, Germany
[2] Swiss Ornithological Institute, Sempach, Switzerland
[3] University of Bern, Switzerland

Abstract

Globally, high-elevation ecosystems are exposed to some of the most acute environmental impacts in response to a rapidly changing climate. Shifts in climatic conditions are characterized by linear increases in ambient temperature, but also by multidirectional changes in precipitation regimes punctuated by more extreme weather events such as storms, droughts, and severe temperature challenges. Inter-annual variability and stochasticity of weather events form an integral component of temperate mountain ecosystems, with mountain birds having evolved specific adaptations to cope with these rapid and unpredictable environmental fluctuations. Yet, we know very little about these adaptive strategies, such as flexibility in life-history or behavioural traits, and whether they are sufficient to cope with increasingly extreme climate events. Mountain birds are also predominantly migratory, and therefore variable conditions on the migration route and non-breeding grounds may impose additional stressors that reduce the ability for individuals and populations to cope with changing climate conditions. A better understanding of mountain bird ecology across the annual cycle is thus crucial to a sound forecasting of their response to future environmental change, and hence to the implementation of effective conservation management. This symposium will present state-of-the-art research on the ecology of birds in temperate mountain ecosystems, with a special focus on how various species respond to increased environmental variability

Programme

16:00	**Susanne Jähnig -** Greetings and introduction
16:05	**Devin de Zwaan -** The adaptive capacity for alpine birds to respond to climate and climate-induced stressors across the annual cycle
16:35	**Riccardo Alba -** Avalanches create unique habitats for birds in the European Alps
16:55	**Chiara Bettega -** Partial migration strategy of the White-winged Snowfinch and its correlation with winter weather
17:15	**Martha Maria Sander -** Effects of early springs on the timing and success of breeding in an Alpine migratory songbird
17:35	**Christian Schano -** Parental foraging performance of a climate-sensitive, high-alpine bird
17:55	**Arnaud Barras -** Summing up and discussion
18:10	End of symposium

PROGRAMME

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4. PROGRAMME

4.1 Programme: Online Conference, March 15th, 09:00 to 17:30 CET

Please click here to join the Zoom-Meeting: EOU Online Conference

09:00	**Link opens**	
09:30	Conference introduction	***Jan-Åke Nilsson*** EOU President
	Chair: Jan-Åke Nilsson	
09:45	From science to conservation and back	***Tobias Erik Reiners*** HGON e.V., Germany
10.45	Break	
	Chair: Dan Chamberlain	
11:00	Show me the honey: the natural history of a bird-human mutualism	***Claire Spottiswoode*** University of Cape Town, South Africa University of Cambridge, UK
12:00	The real genius of birds: ecological and evolutionary implications of innovative behaviours	***Daniel Sol*** CREAF-CSIC, Spain
13:00	Break	
	Chair: Barbara Helm	
14:00	How migrating birds find their way: compasses and maps	***Nikita Chernetsov*** Zoological Institute RAS St. Petersburg State University, Russia
15:00	Behavioural ecology of birds in urban environments	***Veronika Bókony*** Lendület Evolutionary Ecology Research Group, Hungary
16:00	Break	
	Chair: Alfonso Marzal	
16:15	Moult: an essential, but underrated, process with multiple effects on a bird's biology	***Lukas Jenni*** Swiss Ornithological Institute, Switzerland
17:15	Break	
17:30	AGM (Annual General Meeting)	

4.2 Electronic posters

The opportunity to upload an electronic poster on the conference website was given to participants who had a contribution accepted for the EOU conference, i.e. not just poster presenters, but also oral session and symposium speakers.

The electronic posters can be viewed online at under the following link:

https://conference.eounion.org/2022/poster-presenters/

Please note that the posters can only be viewed during the time period from 15th to 25th March.

The NHBS sponsors a poster prize, which is awarded to one of the electronic posters chosen by the Scientific Programme Committee.

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Symposium 2: Understanding Life-history Trade-offs and Variation in Senescence Patterns: established and Candidate Mechanisms

Conveners: Christina Bauch, Blanca Jimeno and Elisa Badas

Symposium 3: Causes and Consequences of Phenotypic Variation in Anthropogenic Environments

Conveners: Pablo Capilla-Lasheras, Megan Thompson and Pablo Salmón

Symposium 4: Coping Strategies of Mountain Birds to Environmental Variability

Conveners: Susanne Jähnig and Arnaud Barras

Symposium 5: Living in the Anthropocene: Challenges for Migratory Species

Conveners: Aldina Franco and Inês Catry

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Conveners: Crinan Jarrett, Chima Nwaogu and Barbara Helm

Symposium 7: Evolutionary Ecology of Cognition in the Wild

Conveners: Eva Serrano Davies and John Quinn

Symposium 8: Metabolic Adaptions under the Surface

Conveners: Andreas Nord and Suvi Ruuskanen

Symposium 9: Past and Current Drivers of Forest Bird Population Trends across Europe

Conveners: Jiří Reif and Johannes Kamp

Symposium 10: The Potential of Ecoacoustics for Large-scale Bird Monitoring

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Oral Session 3: Behaviour I

Oral Session 4: Diet & Foraging I

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Oral Session 15: Nesting & Breeding

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Oral Session 17: Conservation II

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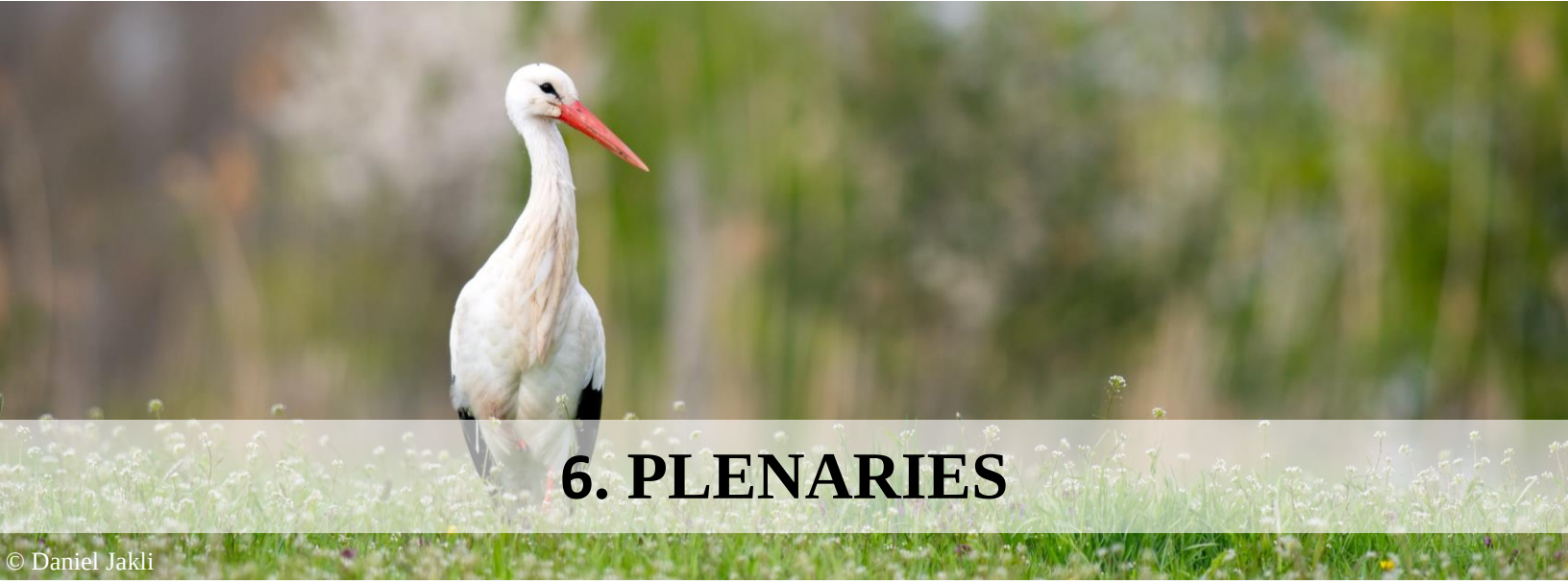

6. PLENARIES

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P-1

From science to conservation and back

Tobias Erik Reiners

Hessische Gesellschaft für Ornithologie und Naturschutz (HGON e.V.), Echzell, Germany

Since the beginning of the field of Conservation Biology in the 80ties, there is an immanent discrepancy between scientific recommendations and conservation actions accomplished so far. Conservation seem to have failed in many ways. Even earlier in the 70ties, before the term biodiversity had become common term, the ornithologists society of Hesse (HGON - Hessische Gesellschaft für Ornithologie und Naturschutz) was founded. Since the beginning of the society, a strong scientific emphasis was implemented in the founding statue. The founders realized that successful practical conservation needs knowledge. This included a not only precise description of the bird population trends but also the support of student thesis and conservation research. In this talk, I will present several past and current monitoring and conservation projects of our NGO, and how science influenced practical conservation. Furthermore, I will give some future ideas how scientific evidence and recommendations can be better transferred to NGOs, conservation administration and political parties. It is urgently needed to tightly close the gap between science and practical conservation.

P-2

Show me the honey: the natural history of a bird-human mutualism

Claire Spottiswoode

University of Cape Town, Cape Town, South Africa. University of Cambridge, Cambridge, United Kingdom

Greater Honeyguides are remarkable mutualistic partners of our own species, whom they lead to wild bees' nests. Honeyguides know where bees' nests are located and eat beeswax, whereas human honey-hunters know how to subdue the bees and open the nest, exposing wax for the honeyguides and honey for the humans. Human and Honeyguide populations vary intriguingly in whether and how they rely upon, communicate with and reward one another, and how their mutualism influences the surrounding ecosystem. This talk will share our team's research from Mozambique and Tanzania that investigates how such learnt traits influence how the mutualism is maintained, giving rise to a hypothesis of cultural coevolution between species. Reciprocal learning may have led to a geographical mosaic of honeyguide behavioural variation that maps onto the cultures of their human partners, across those places in Africa where this part of our own evolutionary history still thrives.

P-3

The real genius of birds: ecological and evolutionary implications of innovative behaviours

Daniel Sol

CREAF-CSIC, Barcelona, Spain

Many animals are capable of solving problems by learning new behaviors, a form of intelligence known as innovation. While being innovative has obvious benefits, given that animals that are frequently exposed to new challenges, only a few species are considered to be highly innovative. The evolutionary origin of such a capacity is puzzling if we think that innovating means responding to problems that the animal has rarely experienced before, and is therefore unlikely to be selected by itself. Solving this puzzle is however crucial to understanding the ecology and evolution of animals because the ability to innovate has the potential to profoundly alter the relationship of animals with their environment. It follows that innovation can be relevant in a variety of processes such as range expansions, migratory movements, extinctions and speciation events. In this talk I will use birds to discuss recent progress in our understanding of the evolutionary origin of innovativeness and to highlight some of the implications for their ecology and evolution.

P-4

How migrating birds find their way: compasses and maps

Nikita Chernetsov

Zoological Institute RAS, St. Petersburg, Russian Federation. St. Petersburg State University, St. Petersburg, Russian Federation

Billions of birds move between their breeding and non-breeding quarters annually, often covering hundreds and thousands of kilometres. To perform these feats, the birds need a positioning system

(a map) and a compass system, as conceptualized by Gustav Kramer some 70 years ago. Most students of avian navigation agree that migratory birds are able to use the sun, the star pattern and the geomagnetic field for compass orientation. Current advances in this area mainly concern the molecular, cellular and neurobiological bases of magnetoreception which remained enigmatic until very recently. Another intriguing topic in the study of avian compass systems is how different systems interact and result in migrating birds choosing the correct direction of flight on the basis of multiple sources of information. Unlike compass systems, there is less agreement on the physical nature and sensory basis of positioning systems of long-distance migrants. Two kinds of maps seem to be relevant for migrating birds: magnetic maps and olfactory maps. For a long period, these two hypotheses were considered to be alternative and mutually excluding. It seems that the proponents of both hypotheses were right to some degree: migrating birds seem to use both magnetic and olfactory positioning systems, possibly at different spatial scales. Positioning system based on the gradients of the geomagnetic field alone cannot account for the remarkable spatial accuracy of navigation shown by migrating birds. Fine-tuning must be based on another physical and this sensory principle, and it is entirely possible that this is olfaction.

P-5

Behavioural ecology of birds in urban environments

Veronika Bókony

Lendület Evolutionary Ecology Research Group, Plant Protection Institute, Centre for Agricultural Research, Eötvös Loránd Research Network, Budapest, Hungary

Urbanization is one of the most salient forms of human-induced environmental changes currently affecting Earth's biota. The past two decades have seen a flourishing of evolutionary-ecological research aimed at understanding the effects of habitat urbanization on wild animals at the individual and population levels, and birds have been playing a major role as model organisms in this endeavour. This plenary provides an overview of characteristic examples of how urbanization changes the birds' morphology, physiology, and behaviour, and how this might contribute to their adaptation to city life in terms of exploiting novel resources, dealing with predation risk and human disturbance, withstanding heat stress, and raising offspring in an altered "foodscape". I will highlight the similarities and differences in avian responses to urbanization by comparing the findings on two species: the Great Tit, a former forest specialist that has colonized urban habitats in the previous century and is generally perceived as a pleasant bird by the public, and the House Sparrow, a human commensalist that has been evolving in anthropogenic habitats for thousands of years and has traditionally been regarded as a pest. I will also point out the most important knowledge gaps that future research needs to fill for a comprehensive understanding of the mechanisms behind and the consequences of phenotypic changes observed in urban populations.

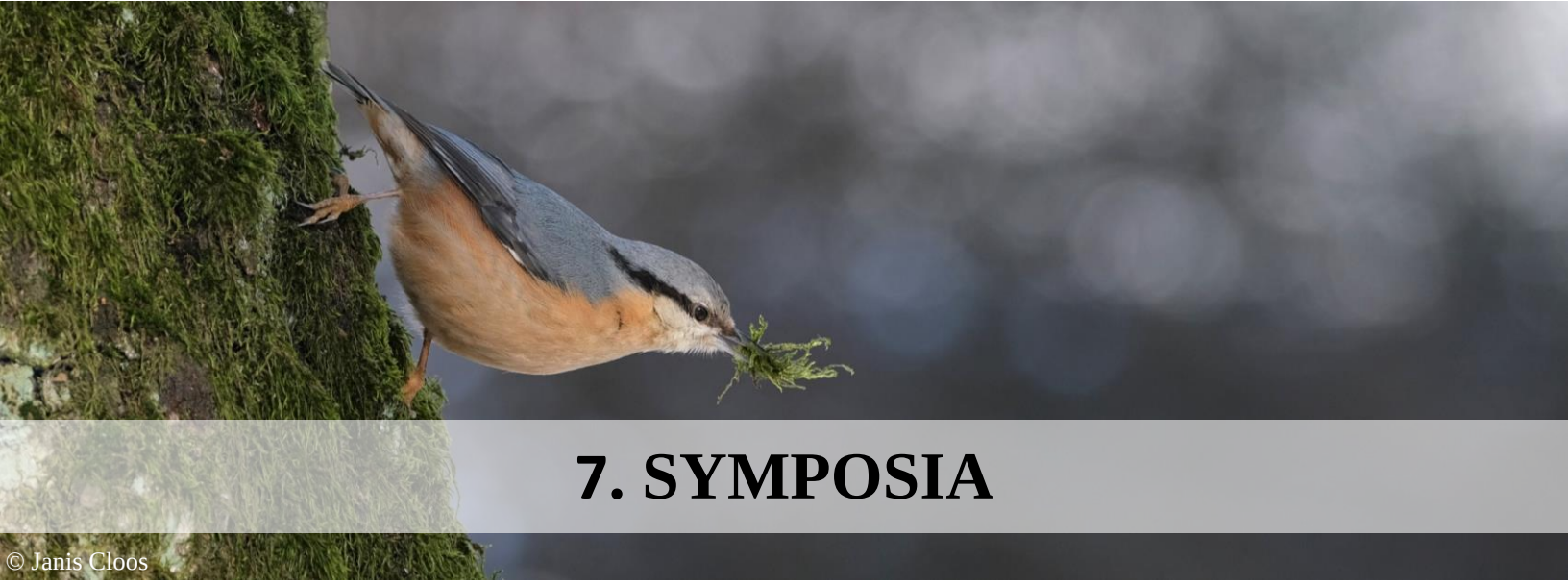
P-6

Moult: an essential, but underrated, process with multiple effects on a bird's biology

Lukas Jenni

Swiss Ornithological Institute, Sempach, Switzerland

Feathers, being dead structures, are subjected to wear and hence must be replaced periodically during moult. However, the replacement of feathers presents several difficulties: feathers cannot grow continuously, like hair or claws; feathers can only be renewed from follicles existing since embryonic times; feathers can only be replaced after the old one has fallen off; a growing feather must finish growth, it cannot interrupt growth. Therefore, the replacement of feathers inevitably results in temporary gaps in the plumage which vary in number depending on the number of concurrently growing feathers (i.e., moult speed). In this talk, I will explore the constraints imposed by moult during the moult period, such as the question how energetically expensive moult is, what the physiological consequences and interactions with other processes are, and how moult can be fitted into the annual cycle. I will also show how conditions during moult affect the quality of the new feathers, ornamental and non-ornamental, and hence the performance of the individual bird, aspects which are particularly interesting for behavioural ecologists.



7. SYMPOSIA

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Symposium 1: The Eurasian-African Bird Migration Atlas: Towards Improved Understanding of Movement Patterns and More Effective Conservation Management

Conveners: Stephen Baillie[1] and Franz Bairlein[2]

[1]British Trust for Ornithology, UK. [2]Institute of Avian Research, Wilhelmshaven, Germany

Flyway scale knowledge of the movement patterns of migratory bird populations is central to understanding their ecology and population dynamics and for their conservation and management. The Eurasian African Bird Migration Atlas, to be published online in February 2022, provides the first European scale analysis of the migrations and movements of some 300 species, based on ring recoveries and tracking data. This symposium will provide an overview of this recently published atlas and will provide a synthesis of the large-scale migration patterns and connectivity shown by different species and species groups. We will address the quantification of migratory connectivity and the extent to which migration patterns have changed over time. We will also consider direct implications for conservation and management, including implications for the management of hunted populations and the impacts of killing by man. We welcome complementary contributions documenting large-scale movement patterns and addressing the continental-scale management of migratory populations.

S1-1

The Eurasian African Bird Migration Atlas – documenting migration and movements using ringing and tracking data

Samantha Franks[1], Wolfgang Fiedler[2], Stephen Baillie[1]

[1]British Trust for Ornithology, Thetford, United Kingdom. [2]Max Planck Institute of Animal Behavior, Centre for Animal Marking “Vogelwarte Radolfzell”, Radolfzell, Germany

The online Eurasian African Bird Migration Atlas project (due late February 2022) provides vital information for conservationists and ecologists. At its core, the Atlas is an online tool documenting the movement patterns of some 300 bird species based on over 100 years of ringing data from the EURING databank, as well as tracking data from Movebank. The Atlas draws on data from all major European Ringing Schemes and the core project team involves researchers from nine European countries. We outline how these data have been analysed to provide a robust picture of the migration patterns of different species and populations using large-scale and long-term ring recovery data, with tracking data additionally providing more detailed movement information for certain species and populations. The Atlas is based around maps showing the overall migratory connectivity patterns of different regional populations, how these patterns vary according to different seasons, seasonal movements throughout the annual cycle, and patterns according to cause of recovery. There are also a range of infographics documenting the nature of the dataset and potential biases in time and space. While acknowledging the potential biases resulting from different recovery causes, we show how the Migration Atlas outputs can be combined to understand avian movement patterns, and that for most species the available data provide a robust picture of bird migration. Within the Atlas project as a whole, these species-specific recovery analyses are linked to more detailed analyses of migration timing, migratory connectivity, impacts of illegal killing and long-term changes in movement patterns.

S1-2

What can migratory connectivity tell us about a species' propensity to adapt to a changing environment, and how do we ensure accurate qualification of its strength?

Stephen Vickers, Aldina Franco, James Gilroy

University of East Anglia, Norwich, United Kingdom

Understanding migratory connectivity (MC) can have important conservation implications, including influencing a migratory species' propensity to adapt to a changing environment. The utility of connectivity metrics depends on their accurate quantification, yet little attention has been given to how spatial sampling designs influence the accuracy of our estimates. Using simulations, we demonstrate that unbiased inferences about population-scale connectivity using the Mantel method can only be made under certain sampling regimes, and that common sampling designs may generate considerable bias. Even if bias is avoided, the applicability of MC as a tool for predicting responses to environmental change largely remains an assumption. Fundamentally, quantifying MC strength simplifies a complex spatiotemporal pattern into a single snapshot in time. Whilst this simplification is useful, it overlooks that the underlying dynamics of connectivity are driven by multi-generational ecological processes that are poorly understood. We use further simulations to illustrate how dispersal mechanisms, particularly in the non-breeding range (where they remain largely unquantified), drive and maintain observable connectivity. Unlike dispersal on the breeding range where offspring are inextricably spatially linked to their parents (e.g., through a nest site), dispersal on the non-breeding range involves a mix of both heritable and non-heritable components.

These components both contribute to observable MC, but only the heritable component can facilitate inter-generational changes in non-breeding distributions. Understanding the proximate mechanisms driving migratory change is therefore essential if we are to make links between MC and species' propensity to adapt to a changing environment.

S1-3

Patterns of migratory connectivity in the European-African migration system

Niccolò Fattorini, Roberto Ambrosini

Department of Environmental Science and Policy, University of Milan, Milan, Italy

Migratory connectivity represents the linkage among individuals migrating between breeding and nonbreeding areas where they spend different phases of their annual life cycle. The strength of migratory connectivity is thus the extent by which individuals mix while migrating. Within the framework of the CMS/EURING European-African Bird Migration Atlas, we investigated patterns and strength of migratory connectivity in 137 bird species through the analysis of ring recoveries. First, we filtered ringing encounters collected over more than a century according to spatiotemporal and condition-specific criteria. Then, we quantified migratory connectivity using the Mantel correlation coefficient between orthodromic distance matrices among individuals. A k-means cluster analysis determined the degree of clustering for assessing the process determining migratory connectivity. The strength of migratory connectivity showed interspecific variability, with most species exhibiting a significant connectivity. Phylogenetic, geographical and ecological differences between species contributed to explain the strength of migratory connectivity. A sensitivity analysis was also performed for each species, showing that our methodology is robust for small samples and across different encounter conditions (i.e., alive recaptures or dead recoveries). Quantifying the strength of migratory connectivity will improve our understanding of avian migration and, from a more practical point of view, will assist in bird conservation and management at the population level. Our work showed that ringing data are an excellent tool to perform analyses of migratory connectivity.

S1-4

Modelling the historical and seasonal timing of intentional killing of birds by man across the Eurasian-African flyway

Caterina Funghi[1], Lorenzo Serra[1], Roberto Ambrosini[2], Fernando Spina[1]

[1]Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano dell'Emilia, Italy.
[2]University of Milan, Milano, Italy

The Eurasian-African Bird Migration Atlas project involves a module on intentional killing of birds by man. A better knowledge of the intentional killing, especially when illegal, has become an urgent conservation issue. The EURING Data Bank is a key resource to analyse and assess which species are most seriously affected by deliberate killing and which regions should be prioritized for conservation actions. Here, we applied binomial mixed models accounting for spatial autocorrelation to recovery dates of shot birds, filtering for conditions and circumstances of recovery to assess the temporal dynamic of intentional killing in different geographical areas of Europe and Africa. Our analysis tested weather the intentional killing of three key groups of species increases progressively during the two main migration periods (January-May and August-November). We choose groups of species whose hunting activity is differently regulated by the Wild Birds Directive (1979/104 EEC, 2009/147 EC): birds of prey (strictly protected), ducks (largely huntable), and songbirds (largely protected). The results of our models were interpolated producing the first temporal maps of intentional killing across the Eurasian-African flyway, based on ~120 years of ringing recoveries. This unprecedent view on the spatio-temporal changes of intentional and illegal killing of birds has important conservation implications and represents a new perspective to prioritize conservation actions in the Palaearctic-African migration system.

S1-5

Long-term changes in the movement patterns of European migrants

Kasper Thorup, Tom Romdal

University of Copenhagen, Copenhagen, Denmark

There is great need for assessing and understanding how populations react to global change. Baseline data are needed for detecting such changes but few historical data sets exist. Ringing and re-encounter data have been systematically collected for more than 100 years back in time and can provide information on changes in movement and migration patterns. Based on data from the Eurasian African Bird Migration Atlas, we present changes in migration patterns over time for species with good spatial and temporal coverage. Our main focus is on migration distance but also on latitudinal and longitudinal changes. We restrict our analyses to birds recovered dead, analysing both the full data set and the subset of birds ringed during breeding and recovered during winter. For example, for the White Stork *Ciconia ciconia* wintering is now more often recorded in Southwest Europe than before 1970 when more individuals were recorded in South and East Africa. Furthermore, the proportion of storks recorded as being hunted are now less than 2% compared to almost 30% in the early 20th century. The work describes the observed changes but necessarily leaves many open questions regarding causes. As such it provides a basis for future research on relating changes in migration patterns to climate and land use changes.

Symposium 2: Understanding Life-history Trade-offs and Variation in Senescence Patterns: established and Candidate Mechanisms

Conveners: Christina Bauch[1], Blanca Jimeno[2] and Elisa Badas[1]

[1]University of Groningen, The Netherlands. [2]University of Castilla La Mancha, Spain

Senescence, a gradual age-specific decline in contribution to fitness has been observed across taxa, including birds. However, the onset and rates of senescence differ among species, populations and individuals. Variation in senescence patterns can arise due to different life-history strategies or differing resource allocation trade offs, and one key current challenge is to quantify and explain such differences. However, the mechanisms that underlie senescence patterns still remain understudied, yet they are crucial to increase our understanding of how differences in senescence patterns arise. Examples of underlying mechanisms are oxidative stress or telomere dynamics, which have been successfully related to key life-history traits such as reproduction and lifespan. The study of other mechanisms such as mitochondrial function or epigenetic processes (i.e. DNA methylation and epigenetic clock) within this framework is in its infant stage, but on the rise as a promising avenue for senescence research. The purpose of this symposium is to give an overview of the current research on the –established and candidate – mechanisms underlying variation in senescence patterns. Thus, it will provide a multidisciplinary and integrative perspective on the present and future of the senescence research, by bringing together researchers representing a wide array of methodologies and approaches. This diversity will allow for a deeper understanding of how different mechanisms driving senescence are interconnected and their relative contribution to senescence patterns. As this knowledge is, however, limited, our aim is to stimulate co-operations among experts from different but complementary disciplines, while creating a niche for discussion and enlightenment for all researchers interested in the field. The session shall further engage early career researchers from different nationalities in fruitful discussions with senior researchers hopefully leading to collaborations.

S2-1

Senescence and life-history trade-offs: the importance of taking an integrative approach

Britt Heidinger

North Dakota State University, Fargo, USA

The pace of senescence, an age-related decline in physiological function and fitness, varies greatly among individuals and understanding the factors that contribute to this variation is of central important to researchers in diverse biological fields. At the organismal level, allocation trade-offs often influence the rate of senescence, where increased investment in growth and reproduction often comes at a cost to investment in self-maintenance. At the molecular and cellular levels, several key mechanisms are emerging as important potential mediators of these trade-offs. However, these results are not universal and there is a growing appreciation that understanding the

factors that contribute to variation in senescence will require integrative studies that span levels of organization. I will first discuss mechanisms likely to be important in mediating senescence related life-history trade-offs in birds. I will then introduce several important considerations for future research including study design, the timing and stage of sample collection, and possible tissue-specific effects, while highlighting the importance of taking an integrative approach.

S2-2

Color morph-specific dynamics and intergenerational effects in telomere length in a long-lived bird

Chiara Morosinotto[1,2], Staffan Bensch[2], Antoine Stier[3], Natacha Garcin[3], Suvi Ruuskanen[4,3], Patrik Karell[1,2]

[1]Novia University of Applied Sciences, Tammisaari, Finland. [2]Lund University, Lund, Sweden. [3]University of Turku, Turku, Finland. [4]University of Jyväskylä, Jyväskylä, Finland

Telomere length, an indicator of senescence and of future survival prospects, has been shown to be heritable but can also be affected by environmental, parental and epigenetic effects. How phenotypic traits linked with fitness are associated with telomere dynamics within and across generations is still unclear. A phenotypic marker closely associated with physiological traits and fitness is melanin-based color polymorphism, which in Tawny Owls *Strix aluco* is highly heritable and strongly associated with adult survival. Pheomelanic (brown) Tawny Owl adults have shorter telomeres and faster telomere shortening than grey adults, as well as lower survival in harsh environmental conditions. To understand how the different telomere dynamics in adulthood affect offspring performance we looked at intergenerational variation in telomere length. We show that telomere length is strongly inherited from both parents and negatively associated with father age. Moreover, we found that mitochondrial density, a measure of cell respiration, was higher in parents of the brown color morph. In offspring, neither telomere length nor mitochondrial density was color morph-dependent. In Tawny Owl adults both telomere dynamics and mitochondrial density are thus morph-specific, which is in line with the previously observed morph-specific life-history strategies. Brown adults indeed have faster telomere shortening and higher mitochondrial density, but also invest more in reproduction than grey parents, since brown parents produce heavier fledglings. We propose that morph-specific telomere dynamics and mitochondrial function may be linked with morph-specific reproductive trade-offs, but that these physiological differences between morphs are not passed on to the offspring.

S2-3

Oxygen and telomeres: experimental elucidation of oxidative stress effects in life history evolution

Elisa P Badas, Simon Verhulst

University of Groningen, Groningen, Netherlands

Oxidative stress -the imbalance between antioxidants and reactive oxygen species (ROS) generated during aerobic respiration- has often been hypothesized to play a central role in disease and life history evolution, including ageing. However, whether oxidative stress modulates patterns of growth, ageing or survival is still an enigma, largely because the high reactivity of ROS makes oxidative stress difficult to measure. In addition to this, the experimental manipulation of oxidative stress levels without toxic side effects has also proven difficult. I propose to elucidate oxidative stress effects on (cellular) ageing and key fitness components using a novel non-invasive experimental approach that bypasses the side effects of pharmacological approaches. To this end, male captive Zebra Finches were exposed to hyperoxic air (which is known to increase oxidative stress) in a specially designed cabinet for 6 weeks. First, the effects of this manipulation on sexual ornamentation and markers of oxidative stress will be discussed. Second, I will present preliminary data on a follow-up experiment: by applying the same hyperoxic treatment to nestlings I tested how oxidative stress affects cellular ageing (telomere attrition). This was combined with the administration of antioxidants in a 2x2 design, to verify that the observed effects of hyperoxia can be attributed to oxidative stress. These results will shed light on the conundrum of the roles of oxidative stress in life history evolution and telomere dynamics. I will discuss the long-standing question whether the effect of oxidative stress in vitro is also observed in vivo, at physiological oxidative stress levels.

S2-4

Mitochondrial coupling efficiency: a candidate mechanism underlying variation in life-history trajectories?

Antoine Stier

University of Turku, Turku, Finland and University Lyon, Lyon, France

Understanding why variations in animal life histories exist, have evolved and what are the underlying physiological mechanisms remains a key challenge for biologists. Mitochondria are the powerhouse of eukaryotic cells, providing ~90% of the cellular energy as ATP, but they also produce reactive oxygen species (ROS) that can damage biomolecules and hasten the ageing process. A mechanistic trade-off exists between the efficiency at which mitochondria convert nutrients to ATP and the amount of ROS being produced, which has the potential to shape animal life histories by influencing on one side the amount of energy (ATP) available to invest in immediate performance (*e.g.* growth, reproduction), and on the other side the rate of cellular damage hastening ageing and decreasing long-term performance and survival. Individuals with consistently higher mitochondrial efficiency would therefore be predicted to have a fast *pace of life* characterized by high reproduction rate, fast growth, early maturity and short lifespan. Yet, empirical tests of this appealing hypothesis remain scarce at best. I will first present data from captive and wild bird species showing the existence of a within-individual consistency in mitochondrial traits. In captive zebra finches, mitochondrial efficiency was experimentally decreased using a chemical treatment (2,4-dinitrophenol) over the lifespan of individuals. I will present the impact of such treatment on life-history traits including lifespan and the limitations of such an experimental approach. Finally, I aim to present preliminary data on correlative links

between mitochondrial efficiency and life-history traits in wild bird populations at both the within- and between-species levels.

S2-5

Temporal stability of DNA methylation marks in birds: lessons learned for research on senescence

Kees van Oers, Melanie Lindner, Marcel Visser, Krista van den Heuvel, Bernice Sepers

Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, Netherlands

Epigenetic mechanisms are those molecular mechanisms that affect gene expression without changes in the DNA sequence. The value of epigenetic mechanisms is increasingly recognized, also in relation to questions in ecology and evolution. Epigenetic research on birds in their natural habitats is still in its infancy, but is needed to answer questions regarding the origin of epigenetic marks and their role in shaping phenotypic variation and evolution. The flexible nature of epigenetic marks thereby opens up the possibility that such changes are adaptive, while at the same time can be the consequence of environmental variation. This is also relevant for studies on ageing and senescence, since epigenetic marks then function as signals of ageing via accumulation of methylation over time, but at the same time may aid organisms to cope with changing circumstances throughout their lifetime. In this presentation, we would like to give an overview of the current status of epigenetic research, mainly focusing on DNA methylation. For this, we use the current status in the literature and data of our great tit system to show examples of how methylation patterns may affect phenotypes and fitness, how they may change over time and how that relates to changes in gene expression. This will hopefully inspire future studies on a possible role for epigenetic variation in explaining age-specific declines in fitness in birds.

Symposium 3: Causes and Consequences of Phenotypic Variation in Anthropogenic Environments

Conveners: Pablo Capilla-Lasheras[1], Megan Thompson[2] and Pablo Salmón[3]

[1]University of Glasgow, UK. [2]Centre d'Ecologie Fonctionelle et Evolutive, CEFE, CNRS-UMR, France & Université du Québec à Montréal, Canada. [3]University of Basque Country, Spain

In the last century, human activity has changed the world at an unprecedented pace and its influence is virtually present in every ecosystem. Bird species living in anthropogenic environments face the novel challenge of coping with ecological conditions that their evolutionary history did not prepare them for. Despite significant effort made to understand the overall response of birds to anthropogenic stressors, the causes and consequences of individual variation in these responses are not fully understood. For example, recent studies evidence a higher degree of phenotypic variation for certain traits in populations dwelling in anthropogenic environments in comparison with those in more natural environments. What are the causes and implications of this increase in phenotypic variation? Answering this and other related questions will require to study the response to anthropogenic disturbances at the individual level. However, challenging, investigating individual

variation in the context of adaptation to anthropogenic stressors will shed new light on the mechanisms underpinning evolutionary responses to current environmental change and the resilience of avian populations in the "Anthropocene".

S3-1

Life on our doorstep: avian urban ecology and evolution

Marta Szulkin

University of Warsaw, Warsaw, Poland

By 2050, 7 out of 10 people will be living in urban areas. Urban space is thus of intrinsic interest to humans worldwide, biologists included. It is also an environment with radically altered ecological dynamics relative to original natural habitat. Here, I will present evidence illustrating the profound effects of urbanisation on wildlife, with a particular focus on birds. First, I will set the scene by discussing methodological strengths and challenges of capturing environmental and biological variation in an urban setting. Second, I will show how city life affects the phenotype, microbiota and fitness in a gradient of urbanisation in the city of Warsaw, Poland, and discuss estimates of selection differentials quantified in low and highly urbanised environments. I will also discuss the extent to which the Covid-19 pandemic altered reproductive decisions and life-history trait variation in 2 passerines breeding in a European capital city. Third, I will discuss the concept that urban environments represent globally replicated, large-scale disturbances to the landscape, thereby providing an ideal opportunity to study parallel evolution in natural populations. By using Great Tits *Parus major* and Blue Tits *Cyanistes caeruleus* as study systems, I will present data on the effect of urbanisation in a suite of biological traits measured in a replicated framework of 8 cities. Finally, I will close off by discussing how cities represent a fascinating frontier for investigating parallel evolution across the Tree of Life.

S3-2

Urbanization increases phenotypic variation in tits across Europe

Megan Thompson[1,2], Pablo Capilla-Lasheras[3], Davide Dominoni[3], Denis Réale[1], Anne Charmantier[2]

[1]Université du Québec à Montréal, Montréal, Canada. [2]Université de Montpellier, Montpellier, France. [3]University of Glasgow, Glasgow, United Kingdom

Numerous studies have explored how urbanization affects the mean phenotypes of populations, but it remains unknown how urbanization impacts phenotypic variation, a key target of selection that shapes, and is shaped by, eco-evolutionary processes. We examined how urbanization may affect phenotypic variation of morphological traits using data on Great and Blue Tits (*Parus major*, *Cyanistes caeruleus*) from a collaborative network of researchers across 13 different European forest and city pairs. Urbanization was found to decrease the mean and increase the variance across morphological traits suggesting that city birds tend to be smaller, but more variable, than their

forest counterparts. The strength of this trend tended to vary across morphological traits, but not between the species or sexes. We show that environmental heterogeneity affects the amount of phenotypic variation quantified in city tits and, thus, highlight the importance of considering phenotypic variation at multiple levels (e.g., within and between field sites and cities). The potential causes and consequences of urban-modified phenotypic variation are discussed.

S3-3

Interactive effects of abiotic and biotic microhabitat characteristics on the physiology of urban Great Tits *Parus major*

Johan Kjellberg Jensen[1,2], Ann-Kathrin Ziegler[1], Lucía Gloria Jiménez Gallardo[3], Christina Isaxon[4,5], Jenny Rissler[4,5,6], Caroline Isaksson[1]

[1]Department of Biology, Lund University, Lund, Sweden. [2]Centre for Environmental and Climate Science, Lund University, Lund, Sweden. [3]Department of Biodiversity, Complutense University of Madrid, Madrid, Spain. [4]NanoLund, Lund University, Lund, Sweden. [5]Ergonomics and Aerosol Technology, Lund University, Lund, Sweden. [6]Bioeconomy and Health, RISE Research Institutes of Sweden, Lund, Sweden

The reproductive output and offspring condition of urban passerines are generally lower compared to their rural conspecifics. Yet an understanding of the underlying mechanisms of this pattern has until recently been speculative. Current studies have added evidence to the food limitation hypothesis, which states nutrition to be the limiting factor. However, knowledge on which characteristics of the local urban environment that cause this, biotic and abiotic, is needed in combination with detailed physiological measures to elucidate the full picture. Here, we sampled Great Tit *Parus major chicks* in a paired urban-rural population for several oxidative stress markers and nutritional measures, which we correlated to fine-scale microhabitat vegetation and air pollution measurements. We observed significant differences in habitat quality not only across environment types, but also within the urban area, suggesting a large variation between broods and their responses to the local urban habitat. Our findings highlight the need of a holistic approach in studies of the urban environment, which includes novel vegetation as well as anthropogenic stressors such as air pollution. Combining such factors with physiological responses offers further insight to the underlying mechanisms of the restrained reproduction in urban passerine birds.

S3-4

Individual variation in chronotypes of urban and non-urban bird populations

Pablo Capilla-Lasheras[1], Claire Branston[1], Pat Monaghan[1], Simon Babayan[1], Barbara Helm[2,1], Davide Dominoni[1]

[1]Institute of Biodiversity, Animal Health and Comparative Medicine. University of Glasgow, Glasgow, United Kingdom. [2]Institute for Evolutionary Life Sciences, Groningen, Netherlands

Urbanisation is increasing worldwide, dramatically changing landscapes not only spatially (e.g., habitat fragmentation) but also temporally. In particular, the presence of artificial light at night in urban environments can alter natural 'lightscapes' and interfere with the detection of natural light cycles, consequently altering daily behavioural and physiological rhythms. Our understanding of how urbanisation affects avian biological rhythms is hindered by the fact that most studies to date are conducted during or just before the breeding season and investigate single species. Relatively few studies have simultaneously compared the effects of urbanisation on avian rhythms across different seasons (e.g., pre- and post-breeding) and species. Here, we investigate individual variation in chronotypes (i.e., consistent individual differences in the timing of daily biological events) of urban and non-urban populations of six passerine species in autumn (i.e., post-breeding) and winter (i.e., pre-breeding). Specifically, we use automated radio telemetry to continuously monitor individual bird activity and skin temperature; thereby quantifying biological rhythms in behaviour (i.e., timing of daily activity onset) and physiology (i.e., timing of morning rise in body temperature) in urban and non-urban habitats. Our findings show that urban populations exhibit earlier onset of activity, higher activity during the night, and decreased activity during the day than non-urban populations. These results are generally consistent across species and across seasons. We will further discuss the intrinsic (e.g., eye size) and environmental (e.g., weather) factors modulating these effects, as well as the alignment between urban effects on behavioural and physiological rhythms across species.

S3-5

Effects of anthropization and blood parasite infections on House Sparrow health

Jéssica Jiménez-Peñuela[1], Martina Ferraguti[2], Josué Martínez-de la Puente[3,4], Caroline Isaksson[5], Ramón C. Soriguer[1,4], Jordi Figuerola[1,4]

[1]Estación Biológica de Doñana (EBD-CSIC), Seville, Spain. [2]Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, Amsterdam, Netherlands. [3]University of Granada, Granada, Spain. [4]CIBER of Epidemiology and Public Health (CIBERESP), Madrid, Spain. [5]Lunds Universitet Naturvetenskapliga fakulteten, Lund, Sweden

Habitat anthropization affects the interactions between organisms influencing ecological processes like pathogen transmission with detrimental effects on many bird species. It alters the incidence and distribution of vector-borne parasites, as well as the susceptibility of vertebrates to infectious diseases through its effects on host immunocompetence. Here, we determined the relationships between habitat anthropization and parasite infections with body condition, the composition of plasma fatty acids and the oxidative status of wild juvenile House Sparrows *Passer domesticus*. We identified *Plasmodium*, *Haemoproteus* and *Leucocytozoon* infection status in 2043 birds captured in urban, rural, and natural habitats from southern Spain. Birds from urban habitats had higher levels of fatty acids and oxidative lipid damage (measured as TBARS) but lower body condition than those from rural habitats. Antioxidant enzymes activity was negatively associated with bird's body condition. *Plasmodium* infected juveniles showed a lower proportion of ω-6 PUFAs, a higher proportion of ω-3 PUFAs and lower activity of antioxidant enzymes (GPx, SOD and GR). *Plasmodium*-infected birds from natural habitats showed a lower ω-6/ω-3 ratio and tended to have a higher proportion of ω-3, while *Plasmodium* and *Haemoproteus* infected birds from urban habitats showed a higher body condition. Low availability of good quality food, more

pollutants and other stressors may prevent urban birds from fulfilling their physiological requirements during development, influencing their capacity to fought infections and their cost. Our results suggest that blood parasite infections and habitat anthropization negatively affect different parameters reflecting the health status and physiological conditions of urban-dwelling bird species that is declining across Europe.

Symposium 4: Coping Strategies of Mountain Birds to Environmental Variability

Conveners: Susanne Jähnig[1] and Arnaud Barras[2]

[1]tier3 solutions GmbH, Leverkusen, Germany. [2]University of Bern, Switzerland

Globally, high-elevation ecosystems are exposed to some of the most acute environmental impacts in response to a rapidly changing climate. Shifts in climatic conditions are characterized by linear increases in ambient temperature, but also by multidirectional changes in precipitation regimes punctuated by more extreme weather events such as storms, droughts, and severe temperature challenges. Inter-annual variability and stochasticity of weather events form an integral component of temperate mountain ecosystems, with mountain birds having evolved specific adaptations to cope with these rapid and unpredictable environmental fluctuations. Yet, we know very little about these adaptive strategies, such as flexibility in life-history or behavioural traits, and whether they are sufficient to cope with increasingly extreme climate events. Mountain birds are also predominantly migratory, and therefore variable conditions on the migration route and non-breeding grounds may impose additional stressors that reduce the ability for individuals and populations to cope with changing climate conditions. A better understanding of mountain bird ecology across the annual cycle is thus crucial to a sound forecasting of their response to future environmental change, and hence to the implementation of effective conservation management. This symposium will present state-of-the-art research on the ecology of birds in temperate mountain ecosystems, with a special focus on how various species respond to increased environmental variability.

S4-1

Adaptive capacity of alpine birds to respond to environmental stressors across the annual cycle

Devin de Zwaan

University of British Columbia, Vancouver, Canada

Cold-adapted, alpine breeding species are generally considered vulnerable to the effects of climate change. Many alpine species are also migratory, experiencing different environmental stressors across the annual cycle at both high and low elevations where climatic patterns are becoming increasingly decoupled. Given the climatic variability that characterizes high elevation habitats, alpine birds may have some capacity to cope with stochastic and severe environmental conditions through flexible behaviours and life-history strategies. An open question in alpine bird research is whether these coping strategies are sufficient to maintain reproductive output under a rapidly

changing climate. Specifically, we have a limited understanding of: 1) severe weather effects during different life-history stages, 2) cumulative effects of environmental stressors across the annual cycle, and 3) whether coping strategies may increase vulnerability to additional stressors such as predation risk. I will summarize our current understanding of coping strategies employed by alpine birds to respond to environmental variability across the annual cycle. Using an alpine breeding population of Horned Lark *Eremophila alpestris* in northern British Columbia, Canada as a case study, I will then demonstrate how: 1) the severity and timing of weather events differentially influence offspring development, 2) alpine birds may moderate parental care and breeding phenology in response to prevailing conditions, and 3) year-round weather effects interact with predation risk to influence breeding success. I will conclude by highlighting promising future research directions and how we may be able to predict climate vulnerability among alpine species.

S4-2

Identifying drivers of change in mountain bird populations in Europe

Riccardo Alba[1], Tim Kasoar[2], Dan Chamberlain[1], Graeme Buchanan[3], Des Thompson[4], James W. Pearce-Higgins[2,5]

[1]Department of Life Sciences and System Biology, University of Turin, Turin, Italy. [2]Conservation Science Group, Department of Zoology, University of Cambridge, Cambridge, United Kingdom. [3]RSPB Centre for Conservation Science, Royal Society for the Protection of Birds, Edinburgh, United Kingdom. [4]Scottish Natural Heritage, Edinburgh, United Kingdom. [5]British Trust for Ornithology, Thetford, United Kingdom

Mountain ecosystems retain high levels of biodiversity, but are vulnerable to environmental and climate change. However, few assessments of environmental change have been conducted in these areas in comparison to other more accessible biomes. In this study, we systematically reviewed the existing literature for 34 species identified as montane, in order to quantify which drivers of environmental change have been most consistently associated with positive or negative population responses. We extracted data from 453 studies and derived an impact score that measured the balance of positive or negative effects of a given potential driver on the populations of a given species. Raptors and gamebirds were the most studied species, whilst mountain specialists and arctic-alpine species were little studied. The analyses reported significant negative impacts of hunting, collision with energy generation infrastructures and predation by competitive species. The effects of drivers mediated over longer temporal scales, like climate and land-use changes, were less well supported. Analysis of trends in drivers found evidence of increasing temperatures and vegetation encroachment, whereas agricultural impacts decreased, which was largely related to abandonment of grazing. In addition to these specific results, the lack of fine-grained studies investigating ecological mechanisms and population responses to widespread impacts was noted, as was the need to collect more detailed and longer-term data on species' requirements and on the impacts bird populations face.

S4-3

Partial migration strategy of the Snowfinch *Montifringilla nivalis nivalis* and its correlation with winter weather

Chiara Bettega[1], Maria Delgado[1], Jaime Resano-Mayor[2,3]

[1]Biodiversity Research Unit, Mieres, Spain. [2]Institute of Ecology and Evolution, University of Bern, Bern, Switzerland. [3]Grup d'anellament PARUS, Lliçà d'Amunt, Spain

To track variability in resource availability, species can undertake seasonal movements. Among them, partial latitudinal migration is a common strategy in birds. Here, a proportion of the population moves from breeding to winter grounds, while the remaining individuals stay year-round on the breeding grounds. In order to understand population structure and dynamics, it is essential to study how and why some individuals migrate while others stay. High-mountain birds are among the most threatened by climate change. Despite this, they are still poorly studied and for some species little is known about their migration strategies. Through the analysis of stable hydrogen isotopes of feathers, we investigated the migratory pattern of an emblematic alpine songbird, the White-winged Snowfinch, and its relationship with weather. Isotopes values were used to assess the probability that snowfinches wintering in the Spanish Pyrenees and the Cantabrian Mountains have a breeding origin in the Alps. Thus, we analysed whether winter weather conditions in the Alps may affect their southward movements. We found that the majority of wintering individuals in the Spanish Pyrenees and the Cantabrian Mountains had a high probability to originate from breeding populations in the Alps. Moreover, movement propensity to the south was more likely in winters where the average monthly temperature was particularly low in the Alps. Thus, Snowfinches seem to adopt a partial migratory strategy, with different patterns both among and within populations, that may have important implications in terms of population connectivity, dynamics and structuring, especially under a scenario of global warming.

S4-4

Effect of early springs on the timing and success of breeding in an Alpine migratory songbird

Martha Maria Sander[1], Dan Chamberlain[1], Camille Mermillon[2], Riccardo Alba[1], Susanne Jähnig[1], Domenico Rosselli[3], Christoph Meier[4], Simeon Lisovski[5]

[1]Department of Life Sciences and Systems Biology, University of Turin, Turin, Italy. [2]Centre d'Etudes Biologiques de Chizé, La Rochelle Université, Villiers-en-Bois, France. [3]Ente di Gestione delle Aree Protette delle Alpi Cozie, Salbertrand, Italy. [4]Swiss Ornithological Institute, Department of Bird Migration, Sempach, Switzerland. [5]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Polar Terrestrial Environmental Systems, Potsdam, Germany

Advance in the onset of spring is a particular challenge to migratory birds that must time their arrival without knowing the conditions on the breeding grounds. This is amplified at high elevations where resource availability, which is linked to snowmelt and vegetation development, shows much annual variation. With the aim of exploring the effects of variability in the onset of local resource availability on reproduction, we compared key life history events in an Alpine

population of the Northern Wheatear (*Oenanthe oenanthe*) between years of contrasting timing of snowmelt. Based on remote sensed images, we identified 2020 as an exceptionally early snowmelt and green-up year compared to the preceding year and the long-term average. Individuals tracked with light-level geolocators arrived well before the snowmelt in 2020 and clutch initiation dates across the population were earlier in 2020 compared to 2019. However, observations from a citizen science database and nest monitoring data showed that the arrival-breeding interval was shorter in 2020, thus the advance in timing lagged behind the environmental conditions. While hatching success was similar in both years, fledging success was significantly reduced in 2020. Our results show that, despite the timely arrival at the breeding grounds and a contraction of the arrival-breeding interval, Wheatears where not able to advance breeding activities in synchrony with environmental conditions in 2020. We show that the negative effects of changing seasons in Alpine migratory birds might be similar to birds breeding at high latitudes, despite their shorter migratory distance.

S4-5

Parental foraging performance of a climate-sensitive, high-alpine bird

Christian Schano[1,2], Fränzi Korner-Nievergelt[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]University of Zurich, Zurich, Switzerland

In order to rear their offspring successfully, birds breed when food is most abundant. Food availability hence affects the timing of breeding, but also influences parental foraging performance of temperate-zone breeding birds. Because nestling growth highly depends on the foraging performance of their parents, feeding effort strongly determines reproductive success. We investigated aspects of the foraging performance in a population of a high-alpine bird specialist, the White-winged Snowfinch, *Montifringilla nivalis*. First results indicate potential sex-specific differences in feeding rates with females feeding less frequently than males in a nest box population in the Swiss Alps. Although posterior distributions of the model coefficients were broad for daily temperature and snow cover around the nest, feeding rates positively correlated with the number of chicks per nest and with daily precipitation sum. We hypothesise that snowfinches adjust their feeding rates according to the number of chicks they raise and discuss a higher physiological demand of the chicks or changing food accessibility as possible reasons for an increased feeding rate with higher daily precipitation sums. We further characterise the qualitative and quantitative composition of food over the course of snowmelt during chick-rearing and discuss possible implications of climate change on parental foraging performance, especially under the light of previous studies on the apparent survival of snowfinches as a climate-sensitive alpine bird species.

Symposium 5: Living in the Anthropocene: Challenges for Migratory Species

Conveners: Aldina Franco[1] and Inês Catry[2]

[1]University of East Anglia, UK. [2]CIBIO/InBIO, University of Porto and University of Lisbon, Portugal

The increasing human transformation of the face of the earth poses many challenges and diverse threats to migratory birds, especially those that travel long distances. Anthropogenic landscape changes that affect bird populations include conversion of habitats, declines in resource availability, exposure to pollution, variation in climatic suitability and increased risk of collision with buildings and energy infrastructure. Species traits influence the degree of exposure and vulnerability to these anthropogenic threats but there are diverse responses that are poorly understood, probably linked to the characteristics of migration (e.g. connectivity, migratory pathways and phenology of migration). Understanding birds' exposure to these threats and its consequences will be essential to better design measures that minimize their detrimental impacts on bird populations. Given the scale of the observed changes that occur across large areas, it is surprisingly difficult to assess migratory birds' vulnerability to different anthropogenic threats. New animal movement data and modelling approaches can aid with this task. This symposium will give an overview of the exposure and vulnerability of migratory bird species to multiple anthropogenic threats and, will examine their contribution to explain bird population trends.

S5-1

Spatially explicit risk mapping reveals anthropogenic impacts on migratory birds

Claire Buchan[1], James Gilroy[1], Inês Catry[2,3,1], Aldina Franco[1]

[1]University of East Anglia, Norwich, United Kingdom. [2]Universidade de Lisboa, Lisbon, Portugal. [3]Universidade do Porto, Porto, Portugal

Migratory birds – especially long-distance migrants – are declining faster than non-migratory species. Migrants' movements through multiple ranges may render them particularly vulnerable to anthropogenic threats, but the spatial distribution and population-scale effects of these threats have not been quantitatively assessed. We combined remote-sensed data and expert opinion to map sixteen anthropogenic threats relevant to migratory birds across Europe, Africa and the Middle East – including the first pan-Continental assessment of relative hunting pressure. By combining each threat map with morpho-behavioural traits-based weightings (reflecting relative threat susceptibility), we created species-specific risk maps for 103 Afro-Palaearctic migratory birds breeding in Europe. We then related population trends to combined threat exposure scores across species' ranges, to assess the extent to which our layers capture drivers of population declines, and the relative importance of breeding and non-breeding risk exposure. The maps represent a valuable resource for spatial analyses of anthropogenic threats to migratory birds, and, ultimately, targeted conservation actions.

S5-2

Biologging as a tool to help conservation of avian biodiversity keep pace with renewable energy development in the race for zero carbon electricity

Jethro George Gauld

University of East Anglia, Norwich, United Kingdom

It is imperative that we transition to an energy system based on renewable energy and reduce greenhouse gas emissions to avoid runaway climate change. However, poorly designed and situated wind turbines and power lines can impact negatively on birds through direct mortality such as collision and electrocution as well as indirect impacts on the population through displacement and disturbance. Migratory bird species may experience the combined effect of these impacts from multiple developments within key migration routes, stopover sites, wintering grounds and breeding sites. Established methods used to assess the impacts of individual energy developments work well but are labour intensive and therefore difficult to scale up to assess the impact of multiple projects in the landscape. With many nations seeking to achieve net zero carbon emissions by 2050 or earlier, the scale and pace of new development now requires assessment of the potential cumulative impact at regional and flyway scales to highlight regions where additional EI development is likely to significantly increase the risk to bird populations. In this talk Jethro will present work from his PhD detailing how biologging technology can help improve spatial planning of new wind farms and power lines through collision sensitivity mapping, identify collision risk hotspots to more effectively target mitigation to reduce risks from existing infrastructure and detect collision mortality in real time.

S5-3

Explaining and predicting trans-Saharan bird migration under global change

Christine Howard[1], Thomas Mason[2], Philip Stephens[1], Silke Bauer[3], Stephen Bailie[4], Jennifer Border[4], Chris Hewson[4], Alasdair Houston[5], James Pearce-Higgins[4], Stephen Willis[1]

[1]Durham University, Durham, United Kingdom. [2]Bristol Zoological Society, Bristol, United Kingdom. [3]Swiss Ornithological Institute, Lucerne, Switzerland. [4]British Trust for Ornithology, Thetford, United Kingdom. [5]Bristol University, Bristol, United Kingdom

Global declines in the populations of migratory species have been attributed largely to climate change and anthropogenic habitat change. Identifying the threatening processes driving population declines, however, is complicated due to the reliance of migratory species on multiple locations during their annual routines. In particular, the impacts of environmental changes on migratory journeys remain largely unstudied. Dynamic programming models are an individual-based approach, which can be used to explain current patterns of migration and to predict how birds will need to adapt migratory journeys spanning novel environmental conditions. Here, we show how spatially explicit dynamic programming models, conditioned on species' traits, and applied over open landscapes, can be used to model the routes and phenology of the migratory journeys of a trans-Saharan migrant species, the Common Cuckoo (*Cuculus canorus*). The routes and timings of Cuckoo migrations simulated by our models match closely those of satellite tracked birds. We demonstrate how our approach can identify the magnitude of threats to trans-Saharan migrant species during their migratory journeys, and thus where in those journeys' populations are critically limited. We also show how these models can be used to predict how migratory birds will need to adapt their migratory journeys to future environmental change, and the consequences of not doing so.

S5-4

Impacts of climate change on the distance, duration and stopovers of bird migrations

Kieran Lawrence, Stephen Willis

Durham University, Durham, United Kingdom

For migratory species, which spend the year in at least two separate locations, climate-induced range shifts may lead to increased migration distances, as breeding and non-breeding ranges move apart. This is likely to increase the duration of migration, requiring more refuelling stopovers. Such changes may have deleterious impacts on populations, through direct mortality and phenological carry-over effects. Despite this, few studies have explored the potential implications of climatic changes on global avian migrations. Here, we utilise a combination of species distribution modelling and flight range equations to model migration for the world's long-distance migratory birds, at the start and the end of the century. We compare current and future migration distance, stopover number and duration globally and contrast changes to the Americas, AfroPalearctic and Australasian flyways, and across taxa.

Symposium 6: Dealing with Tough Seasons: A Comparison of Annual Cycle Strategies in African Residents & Afro-Palearctic Migrants

Conveners: Crinan Jarrett[1], Chima Nwaogu[2] and Barbara Helm[3]

[1]University of Glasgow, UK. [2]FitzPatrick Institute of African Ornithology, South Africa. [3]University of Groningen, The Netherlands

Ornithologists commonly view tropical habitats as stable environments which allow year-round breeding and moult of resident birds, and survival of overwintering higher-latitude migrants. This view is an oversimplification of seasonality in Africa because conditions fluctuate often quite dramatically, for example in terms of precipitation, temperature, and resources. Birds residing in the Afrotropics, whether year-round or temporarily, must endure these conditions and fit their annual cycle events to them, either by evolving annual schedules, or by flexible adjustments in time and space. In this symposium, we wish to understand how environmental seasonal fluctuations in Africa affect the scheduling of annual cycle stages in residents and migrant visitors. We will bring together African and European researchers to review our current understanding of seasonality in Africa, and to discuss the effects of seasonal fluctuations on timing of breeding, movements, and over-wintering behaviour in resident and migrant birds.

S6-1

Fitting birds' annual cycle events to seasonal fluctuations in the Afro-tropics

Chima Nwaogu[1], Crinan Jarrett[2], Barbara Helm[3]

[1]Fitzpatrick Institute for African Ornithology University of Cape Town, Cape Town, South Africa. [2]Institute of Biodiversity, Animal Health & Comparative Medicine, University of Glasgow, Glasgow, United Kingdom. [3]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands

The diversity of avian life histories in the Afro-tropics is well acknowledged, but the seasonal processes that may shape such diversity are underappreciated. Our understanding of annual cycles rests mainly on north temperate ornithology, where daylength is considered the key driver of environmental seasonality. This bias drives the notion that Afro-tropical environments which show little annual variation in daylength are 'stable' – an oversimplification of seasonality that may influence our understanding of the selection pressures that shape life histories. Biotic and abiotic factors, including precipitation, temperature, food, mates, hosts, and parasites can fluctuate dramatically, creating tough seasonal conditions to which birds inhabiting the Afro-tropics, permanently or temporarily, must adapt their annual cycles. Drawing examples from our own field data and the limited published accounts, we consider variation in the timing of key annual events, including breeding, moult, and movement patterns, but also in immune function and body mass. Our findings indicate that some events show greater seasonal consistency than others, with the extent of seasonality varying locally and among individuals. Optimizing the avoidance of tough seasons while capitalising on resources provided through the seasonality of lower-level organisms like plants, insects, and parasites may underlie the timing of annual cycle events in wild birds. African year-round and individual-level phenology data are scarce, so identifying the periodic occurrence of annual cycle events over carefully chosen Spatio-temporal environmental gradients is crucial for determining their underlying drivers.

S6-2

Spatial-temporal behaviour of an Intra-African migratory bird species, the African Cuckoo *Cuculus gularis* in relation to resource availability

Soladoye Iwajomo[1], Mikkel Willemoes[2,3], Ulf Ottosson[4], Roine Strandberg[2], Kasper Thorup[3]

[1]Department of Zoology, University of Lagos, Lagos, Nigeria. [2]Department of Biology, Lund University, Lund, Sweden. [3]Center for Macroecology, Evolution and Climate, Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark. [4]A. P. Leventis Ornithological Research Institute, Department of Zoology, University of Jos, Jos, Nigeria

The arrival and departure of many intra-African migratory bird species across Africa coincides with the arrival of the rains and this period is usually characterized by an improvement in vegetation greenness and consequently changes in food resource availability for breeding birds. Similarly, home range size has been documented to be related to resource availability. However, for migratory brood parasitic bird species this is likely to also reflect the distribution of nests of host species. Studies investigating these patterns among intra-African migrant species are scarce. In this study we use data from a tracking study to investigate how estimates of home range size based on kernel density and minimum convex polygon as well as duration of stay at stopover sites in the African Cuckoo *Cuculus gularis* vary in relation to Normalized Differential Vegetation Index (NDVI); a proxy for primary production and food availability. Our result reveal that departure from breeding ground in central Nigeria coincided with improved vegetation greenness at the first stopover site

utilized while arrival at the non-breeding sites in Northern Cameroon and Central African Republic also coincided with the period of increase in NDVI. Home range size was mostly larger on breeding than on the non-breeding ground although not significantly different. The relationships between home range estimates and vegetation greenness was not consistent among individual birds. For a migratory brood parasite like the African Cuckoo, increase in vegetation is likely not only an indication of food resource availability but perhaps also more breeding birds to parasitize on.

S6-3

The influence of rainfall, leafing phenology and sunrise time on the breeding seasonality of an equatorial songbird: the Stripe-breasted Tit *Melaniparus fasciiventer*

Phil Shaw

University of St Andrews, St Andrews, United Kingdom

The links between rainfall, leaf production and breeding activity have been little studied in equatorial rainforest birds, which are often assumed to be relatively aseasonal breeders. At 1°S in Bwindi Impenetrable Forest, Uganda, Stripe-breasted Tits *Melaniparus fasciiventer* showed a bimodal breeding pattern, coinciding with the region's two annual dry seasons. High rainfall in September–November preceded a rise in new leaf production in November–December, likely raising caterpillar abundance during the drier months of December–February, when most tit broods were in the nest. Laying was thus positively correlated with leaf production in the preceding month, but was also linked to changes in daylight time. At this latitude, day length varies by just 7 min p.a., while the timing of sunrise varies (bimodally) by 31 min p.a., perhaps providing a more tractable temporal cue both for breeding residents and departing Palearctic migrants. To investigate possible links between laying and photic cues I recorded the median date on which first clutches were laid during October–March and April–September. The two median laying dates fell 138–139 days after the last date on which sunrise had occurred at 07:05, consistent with the suggestion that changes in sunrise time (rather than day length) might act as a *Zeitgeber* for breeding in equatorial birds. Breeding activity thus appeared to be linked to seasonal variation in sunrise time, and peaked during what are often considered to be the 'tougher' dry seasons, reflecting the phenology of leaf production among local rainforest tree species.

S6-4

Revive and fuel in a dynamic retreat: a field study on how seasonality in Africa shapes annual-cycle decisions of the migratory Pied Flycatcher

Janne Ouwehand[1], Armel Asso[2], Wender Bil[1], Sander Bot[1], Christiaan Both[1], Bronwyn Johnston[1], Yvonne Verkuil[1], Elena Zhemchuzhnikova[1]

[1]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands. [2]University Nangui Abrogoua, Abidjan, Côte d'Ivoire

‘Being at the right time at the right place’ is a well-known mantra in migration ecology. Despite its general importance, few researchers investigated resource dynamics outside the breeding season of Afro-Palearctic migrants. To understand how seasonality at the wintering grounds shapes annual-cycle decisions, we studied Pied Flycatchers *Ficedula hypoleuca* in Ivory Coast during late winter in 2017-2020. We describe seasonal dynamics in rainfall, arthropod availability in March-April, diet, and experimentally tested if food availability alters migration decisions. We found year-variation in the onset and amount of rainfall at the end of the dry season, when birds perform a partial moult and fuel for spring migration. Seasonal fluctuations in potential food resources for flycatchers occurred, albeit trends varied among arthropod groups and sampling locations. Food manipulations in 2019 revealed that birds receiving plenty of food in March-April, showed earlier onset and shorter fuelling duration, and started spring migration earlier than control birds. Most birds from 2019 accumulated mass considerably earlier and faster compared to control birds from 2020. This supports the notion that birds adjust fuelling trajectories to local (or artificial) food conditions. Food limitation on wintering grounds can thereby constrain timely departure, and potentially hamper the advancement of migration schedules in response to climate warming at their breeding grounds. Since DNA-barcoding of faeces revealed that c.70% of the wintering diet existed of (insufficiently monitored) ants and Lepidoptera, it remains to be investigated if rainfall effectively mediates availability of these prey-items, and at which scale food constraints are most prominent.

S6-5

Hypervariable climatic cycles drive extreme demographic patterns and life-history traits in Madagascar's Plovers

William Jones[1], Sama Zefania[2], Tafitasoa Mijoro[3], Brett Sandercock[4], Joseph Hoffman[5], Robert Freckleton[6], Oliver Krüger[5], Tamás Székely[1,7]

[1]University of Debrecen, Debrecen, Hungary. [2]Institute of Higher Learning Menabe, Morondava, Madagascar. [3]University of Toliara, Toliara, Madagascar. [4]Norwegian Institute for Nature Research, Trondheim, Norway. [5]University of Bielefeld, Bielefeld, Germany. [6]University of Sheffield, Sheffield, United Kingdom. [7]University of Bath, Bath, United Kingdom

It has been said that the only constant with Madagascar’s climate is change. The island is famed as a global biodiversity hotspot and experiences frequent, although irregularly timed, cycles of drought. As a result, the organisms that live in Madagascar have had to evolve extreme traits to cope with this extreme climatic stochasticity. In this study, we use utilised a 17-year dataset on the demography and breeding biology of three species of plover from south-western Madagascar (the Madagascar Plover *Charadrius thoracicus*, the Kittlitz’s Plover *C. pecuarius* and the White-fronted Plover *C. marginatus*). We found that all three species have evolved responses to climatic variation, however each species employs a different suite of traits from adjusting their timing of breeding, adjusting the clutch-sizes, or skipping breeding altogether. In addition, all three species have extremely high adult survival rates which is likely another adaptation to living in a hypervariable environment. With the frequency, duration, and intensity of drought conditions in Madagascar likely to increase in the coming decades this ongoing climatic stochasticity is likely to test the resilience of Madagascar’s plover populations to the extreme. This is of particular concern for the

endemic and threatened Madagascar Plover, which is already a species of conservation concern due to increasing rates of habitat degradation.

Symposium 7: Evolutionary Ecology of Cognition in the Wild

Conveners: Eva Serrano Davies[1] and John Quinn[2]

[1]Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, The Netherlands. [2]University College Cork, Ireland

Cognition refers to the processes by which animals collect, retain and use information from their environment. These processes play a major role in driving behaviour, and thus understanding the causes and consequences of variation in cognitive performance is a major research objective in biology. The field of animal cognition has expanded rapidly over the last 10 years, and our understanding of the role of ecological and social factors in driving the evolution of brains and cognitive abilities has been greatly enhanced by comparative studies encompassing a wide range of taxa. However, progress at the level of the individual is only beginning to emerge within non-human species. A handful of recent studies have begun to explore the relationship between variation in individual cognitive performance and fitness under natural conditions. Moreover, bird model species are playing a central role in formulating and testing hypotheses about the causes and consequences of variation in cognitive performance. In this symposium we aim to bring together ornithologists interested in taking an individual based approach on the role of cognitive variation in ecological and social factors. We aim to highlight the potential that studies on birds have to advance the field of animal cognition with a program that will present exciting new finds, covering a broad range of approaches and topics.

S7-1

The evolutionary ecology of cognition in the wild

John Quinn

University College Cork, Cork, Ireland. Environmental Research Institute, Cork, Ireland

Historically birds were often seen as being inferior to other vertebrate taxa in their “intelligence” or—to be less anthropomorphic—in their cognitive capacities, that is, in the way that they process, store and use information gained from their environment. But from the classic work on food caching in marsh tits and vocal learning in passerines, to more recent studies on tool use and episodic memory in Corvids, this perception of inferiority has been firmly put to rest. Despite this progress, our understanding of what determines individual cognitive performance in the wild, and what this means for their functional behaviour and fitness, remains poorly understood. Arguably the main reason for this deficit is that studying cognition in wild populations is full of challenges, including: i) getting subjects to participate in tasks in sufficient numbers; ii) observing or recording performance; and iii) controlling for confounding factors such as motivation. This overview will describe some of the ways in which these challenges are being tackled, including the identification of suitable systems for direct observation, the wild-captivity-release approach, and the automated

measurement of performance. It will also highlight some of the findings that have been made using these approaches, with particular emphasis on research in one of the most widely studied bird species in Europe, the Great Tit *Parus major*, and suggest some areas where future research is likely to provide new insights into the behaviour, ecology, and evolution of birds in the wild.

S7-2

Cognitive abilities and brain size in Red-backed Shrike *Lanius Collurio*

Joanna Bialas, Łukasz Dylewski, Zuzanna Jagiello, Marcin Tobolka

Poznań University of Life Sciences, Department of Zoology, Poznan, Poland

Processes of cognition determine many behavioural traits that affect both animal ecology and evolution, including such crucial behaviours as habitat selection, food choice, predator defense or mate choice. Many studies have shown that differences in brain size indicate cognitive abilities in many species of birds and other taxa, including humans. However, studies of individual differences in brain size, cognition and fitness consequences of these differences are extremely rare. The main goal of this project was to reveal if cognition depends on brain size and if their variation at the intraspecific level is related to important processes that influence individuals' fitness, such as habitat selection, prey selection, or innovativeness in changing environment. By focusing on breeding population of Red-backed Shrike, we examined if brain size affect habitat choice, with hypothesis: individuals with bigger brains are nesting in safer habitats (i.e. lower predation rate) therefore achieve higher breeding effect and breeding success than birds with smaller brains. We also investigated the relation between brain size and innovativeness in foraging and nesting behavior. By experimentally providing: 1) abundant, easy to catch prey and 2) ubiquitous, durable nest materials we investigated if birds with bigger brains are more innovative than small-brained birds.

S7-3

Birds flexibly learn that herbivore-induced plant volatiles indicate prey location, even at neighbouring trees that communicate about presence of insects – an experimental evidence

Katerina Sam[1,2], Anna Mrazova[2,1]

[1]Biology Centre, Czech Academy of Sciences, Ceske Budejovice, Czech Republic. [2]University of South Bohemia, Ceske Budejovice, Czech Republic

When searching for food, birds can use herbivore-induced plant volatiles (HIPVs) as an indicator of arthropod presence. Their ability to detect HIPVs was shown to be learned, and not innate, yet the flexibility and generalization of learning remains unclear. We studied if, and if so how, naïve and trained Great Tits discriminate between herbivore-induced and non-induced saplings of Scotch elm and cattley guava. Trained birds preferred the herbivore-induced saplings of the plant species they were trained to. Naïve birds did not show any preferences. Our results indicate that the attraction of Great Tits to herbivore-induced plants is not innate, rather it is a skill that can be

acquired through learning, one tree species at a time. In a follow-up experiment, we showed that similarly specific is the communication by HIPVs between plants species. In an out-door experiment with two oak species, we showed that oak saplings "talked" about the presence of arthropods only to nearby saplings (up to 2m) of the same species. Birds were attracted significantly more to the sender of the signal than to neighbouring conspecific trees. They did not pay any attention to neighbouring trees of different species, or conspecific species standing further away. We thus confirmed chemical communication via HIPVs between the plants as well as between plants and birds, and point out the conditions under which it is happening.

S7-4

Cognitive and behavioural determinants of innovativeness in the Paridae family - a between and within species approach

Utku Urhan[1,2], Anders Brodin[1], Kees van Oers[2]

[1]Lund University, Department of Biology, Lund, Sweden. [2]NIOO-KNAW, Wageningen, Netherlands

Innovation ability is considered to be a key factor in the ability to solve novel problems. Species that possess this ability are more likely to be able to adapt to extreme environmental changes. This ability, however, varies between species, populations, and even individuals within populations. Although studies on innovativeness have indicated its importance for adaptation and fitness, it is still largely unclear why some animals are capable of coming up with extraordinary solutions to problems whereas others are not. What then, causes these differences? We tested whether the occurrence of this variation is due to innovation being a combination of several correlated cognitive and behavioural specialisations that have evolved for specific functions other than innovation but act together to allow animals to innovate. We tested this in three members of the Paridae family: the Great Tit *Parus major*, Blue Tit *Cyanistes caeruleus*, and Marsh Tit *Poecile palustris*. These species are closely related but show fundamental differences in foraging behaviour and cognitive abilities. Using both between and within-species approaches, we tested how performance in several behavioural and cognitive tasks co-vary with performance in innovative problem solving tasks. To further study environmental factors and within species variation, we investigated whether there is a difference in innovation ability between urban and rural great tits populations. Urban areas are relatively new, with concentrated human activity, and thus require continual adaptation to new conditions.

S7-5

Fitness consequences of individual variation in spatial reversal learning performance in wild Great Tits *Parus major*

Krista van den Heuvel, Kees van Oers

NIOO-KNAW, Wageningen, Netherlands

Cognitive flexibility allows animals to readily acquire new information under circumstances where learning contingencies change rapidly. As such, cognitive flexibility is thought to be beneficial in variable, but predictable environments. This raises the question whether there are direct fitness consequences of variation in cognitive flexibility. In order to address this, I studied cognitive flexibility of wild Great Tits in a long-term natural study population, for which fitness and pedigree data is available over a long time span. Spatial cognitive abilities are important for Great Tits, in order to learn and memorize the location of food sources. We assessed cognitive flexibility with a spatial reversal learning task, in which the location that is associated with a reward is reversed after initial learning. We tested whether the performance in this task is associated with fitness components such as reproductive success, offspring recruitment and adult survival. To further understand the evolution of cognitive flexibility, I assessed the heritability of a reversal learning performance task by the use of animal models. Here we present the combined results on the fitness consequences and the heritability of spatial reversal learning, giving better insight into the evolutionary potential of this cognitive trait.

Symposium 8: Metabolic Adaptions under the Surface

Conveners: Andreas Nord[1] and Suvi Ruuskanen[2]

[1]Lund University, Sweden. [2]University of Jyväskylä, Finland

Metabolism refers to the molecular processes that sustain all life: the conversion of food to energy to run cellular processes, the conversion of food/fuel to building blocks for proteins, lipids, nucleic acids, and some carbohydrates and eliminating waste products, including harmful substances. Often metabolism is measured at the whole animal level as metabolic rate. Currently we have quite good understanding on the environmental and intrinsic determinants of whole-animal metabolic rate, and how it links to animal performance. Yet, to understand animal performance e.g. under challenging conditions, and potential evolutionary changes, we need to understand the molecular process in more detail. The symposium focuses on metabolic adaptations related to energy, essential molecules and waste, which take place at the cellular level. We thrive to understand the causes and consequences of individual variation in such key metabolic functions. For example, in the gut, a major part of animal's metabolic functions is performed by gut micro-organisms that are essential for digestion, energy and nutrient acquisition. Within cells, mitochondria are the key organelles in producing energy, and thus key links to organism performance. Our knowledge on the causes and consequences of variation in mitochondria has increased in the last years. This symposium will bring together researchers working on different aspects of metabolism, which will stimulate new research avenues and serve as an important first step in catalysing future collaborations addressing a more complete view on birds' energy acquisition and expenditure.

S8-1

Beyond descriptions: future directions in wild gut microbiome research

Gabrielle Davidson

University of Cambridge, Cambridge, United Kingdom

Emerging research on 'wild microbiomes' points to links between diet, habitat, host physiology and phylogeny. Observational and descriptive studies of avian microbiomes provide important groundwork for developing and testing predictions regarding evolutionary and ecological processes associated with microbes and their hosts. However, the directionality of these effects is not always clear. How can we differentiate the causes from the consequences of microbiome variation? Here I will argue that the gut microbiome may be an important trait mediating behavioural plasticity in wild birds via microbial metabolites and the so-called microbiome-gut-brain axis, but that evidence supporting this theory is lacking. Using Great Tits *Parus major* as an example study system, I will highlight the benefits and limitations of manipulative studies for pinpointing causal relationships between behaviour and the gut microbiome. Alongside logistical and methodological challenges, I will discuss laboratory-inspired techniques, including metabolomics that may be applied to wild systems while maintaining a balance between ecological validity and robust causal inference.

S8-2

Flexibility and resilience of Great tit *Parus major* gut microbiomes to changing diets

Kasun Bodawatta[1], Inga Freiberga[2], Katerina Puzejova[2], Katerina Sam[2,3], Michael Poulsen[1], Knud Jønsson[1]

[1]University of Copenhagen, Copenhagen, Denmark. [2]Biology Centre of Czech Academy of Sciences, Ceske Budejovice, Czech Republic. [3]University of South Bohemia, Ceske Budejovice, Czech Republic

Gut microbes play important roles in nutrient management and can change in response to host diets. The extent of this flexibility and the concomitant resilience is largely unknown in wild animals. To untangle the dynamics of avian-gut microbiome symbiosis associated with diet changes, we exposed Great Tits *Parus major* fed with a standard diet to either a seed, a mealworm or a mixed diet for four weeks, and examined the flexibility of gut microbiomes to different diets. To assess microbiome resilience (recovery potential), all individuals were subsequently reversed to a standard diet for another four weeks. Cloacal microbiomes were collected weekly and characterised through sequencing the v4 region of the 16S rRNA gene. Initial microbiomes changed significantly with the diet manipulation, but the communities did not differ significantly between the three diet groups, despite multiple diet-specific changes of specific bacterial genera. Reverting birds to the standard diet led only to a partial recovery in gut community compositions. Most of the bacterial taxa that increased significantly during diet manipulation decreased in relative abundances after diet reversal; however, bacterial taxa that decreased during the manipulation rarely increased after diet reversal. These findings support that gut microbiomes play a role in accommodating dietary changes experienced by wild avian hosts. Furthermore, partial community recovery implies that ecologically relevant diet changes (e.g., seasonality and migration) open gut niches that may be filled by previously abundant microbes or replaced by different symbiont lineages, which has important implications for the integrity and specificity of long-term avian-symbiont associations.

S8-3

The effects of early-life conditions on the gut microbiome and short-term survival in the Great Tit *Parus major*

Martta Liukkonen[1], Suvi Ruuskanen[1], Kirsten Grond[2], Nina Cossin-Sevrin[3], Mikaela Hukkanen[3]
[1]University of Jyväskylä, Jyväskylä, Finland. [2]University of Alaska Anchorage, Anchorage, USA. [3]University of Turku, Turku, Finland

The gut microbiome is essential for vertebrate health, and the abundance of specific groups of microbes is considered a powerful proximate mechanism affecting host fitness. The gut microbiome composition is defined at a young age, and dysbiosis at a young age could result in both short-term and long-term effects in the gut microbiome composition and function. We investigated whether the early-life conditions (brood size and diet quantity) influence the Great Tit gut microbiome composition and if it affects the short-term (survival to fledging) fitness and long-term (adult) survival. Great Tit nestlings' gut microbiome undergoes profound shifts during their early life and its composition has been linked to nestling fitness. As the previous and the quantity of diet has been connected to gut microbiome composition and overall fitness in passerines, we hypothesised that in large broods where parents generally provide less food for their offspring, the poor diet will result in a lower alpha diversity in the gut microbiome thus, resulting in a lower weight and negatively affecting the short-term fitness and moreover, the long-term survival. Additionally, our cross-fostering study design allowed us to determine if the gut microbiome composition is more affected by the environment than genetics. Our results bring new knowledge about the host gut microbiome dynamics in wild bird populations and how the nestling environment can influence short-term fitness via gut microbiome composition.

S8-4

Can growth conditions predict adulthood blood mitochondrial function?

Pablo Salmón[1,2], Neal J. Dawson[1], Caroline Millet[1], Colin Selman[1], Pat Monaghan[1]

[1]University of Glasgow, Glasgow, United Kingdom. [2]University of Basque Country, Bilbao, Spain

There is a wealth of evidence for the impact that early-life conditions have on individuals' later-life phenotype and performance. However, the mechanisms linking these two stages are not fully explored outside laboratory model organisms. Mitochondria are believed to be a key player in this link, as they not only fuel the cellular processes but are also involved in health and age-related disorders. However, the study of mitochondrial physiology to date is mainly based on the use of invasive methods, such as tissue biopsies, or terminal sampling, which limits its implementation in eco-evolutionary studies. Recent work on avian models highlights the relevance of using red blood cells (RBCs) instead. This technical advance allows resampling of individuals across time with no long-term implications for their welfare. Here, we experimentally modified the early-life growth trajectory of nestling Zebra Finches *Taeniopygia guttata*, inducing a group of nestlings to accelerate their growth between 7 and 15 days of age, the main phase of body growth. We then measured their mitochondrial functioning in RBCs twice during adulthood, at 250 and at 635 days old. This experimental setup enables us to simultaneously test at the individual level if growth

conditions had i) long-term effects on mitochondrial function; ii) explore the presence of age-related changes in RBCs mitochondrial function, and iii) evaluate the within-individual consistency of RBCs mitochondrial function. These results will provide new perspectives on the relevance of the use of minimally invasive techniques to evaluate mitochondrial physiology and its environmental sensitivity.

S8-5

Giving fuel to the metabolic engine: glucocorticoids linking environmental variation and metabolic rate within individuals and across species

Blanca Jimeno

University of Castilla La Mancha, Ciudad Real, Spain

Glucocorticoid hormones are widely used as indicators of 'stress' and animal welfare, and the large variation that they show within individuals and across species has been a prevalent research topic in ecology. Although understanding the factors underlying this variation becomes a critical step towards interpreting glucocorticoid measurements, the nature of these factors and whether they prevail across environmental contexts remains under debate. Widely acknowledged but yet often overlooked is the fact that glucocorticoids allow for synthesis and mobilization of fuel substrates and fluctuate together with changes in energetic demands, shifting energy balance towards processes needed to overcome perceived or anticipated challenges. Thus, differences in energy acquisition and management may be a fundamental driver of glucocorticoid variation, and glucocorticoid measurements may provide us with relevant information on metabolic responses to environmental changes often difficult to quantify in the wild. In this talk I will present a compilation of results on the association between circulating glucocorticoids and metabolic rates in birds; within-individuals and among species, and across spatial and temporal scales. I will also discuss current limitations and remaining questions when studying the mechanisms underlying this association, and give an overview of exciting research avenues that will expand our understanding of how environmentally-driven glucocorticoid regulation may mediate variation in metabolic rate.

Symposium 9: Past and Current Drivers of Forest Bird Population Trends across Europe

Conveners: Jiří Reif[1] and Johannes Kamp[2]

[1]Charles University, Prague, Czechia. [2]Georg-August-University Göttingen, Germany

Forest birds represent a major part of European avifauna containing many species highly specialized to different kinds of forest habitat, as well as generalist species colonizing isolated woody patches in urban areas or farmland. However, the drivers of population change of forest birds remain understudied, compared to other groups such as farmland birds. At the same time, there are indications that forest bird populations show divergent temporal trajectories in different European regions. These differences may result from following mechanisms: (i) approaches to forest management leading to variable increases in wood volume over the past 200 years, (ii) impacts of extreme events such as bark beetle outbreaks, windstorms or fires, which are all

predicted to increase in the future (iii) velocity of gradual climatic changes such as temperature warming and rainfall redistribution. By inviting speakers from different European regions, this symposium aims to deepen our understanding to the processes involved in shaping the observed population changes of forest birds.

S9-1

The implications of 200 years of change in forest management and forest disturbance for birds in Europe

Johannes Kamp

University of Göttingen, Department of Conservation Biology, Göttingen, Germany. Dachverband Deutscher Avifaunisten (DDA), Münster, Germany

Forest disturbance regimes are governed by human activities and natural forces. Over the past 200 years, forest management patterns have changed across Europe, but with much regional variation. Traditional management techniques such wood pasture and coppice were abandoned in most areas, resulting in less disturbance, higher wood volume and darker, cooler stands. Clear-cuts in high forests are still common anthropogenic disturbances across Eastern and Northern Europe, but have been prohibited more recently in parts of Central Europe (e.g. all across Germany) following a transition to "close-to-nature" forestry. Both developments have led to a decreased availability of young successional stages to birds. With climate change, natural forest disturbance is now predicted to increase through extreme events such as windstorms and fire, drought-induced dieback, and bark-beetle outbreaks. This will likely be a turning point, opening up many mature forests again. While the impact of old-growth loss on bird diversity and communities has often been studied, less is known about the influence of the decadal "darkening" of forests and the potential new opening due to climate change on open-country birds. This is interesting, because the group comprises many declining and threatened species, including several species commonly considered farmland birds. In my talk, I will review the evidence for bird responses to these changes in disturbance patterns and management. I will also synthesize results from a number of own studies in remaining coppice systems and areas affected by very large windthrow events and bark-beetle outbreaks.

S9-2

What do we know about birds from long-term studies in primeval forest?

Dorota Czeszczewik

Siedlce University, Siedlce, Poland

The vast majority of ornithological research in forests is short-term and is carried out in managed tree stands. This limits our ability to understand patterns of temporal variation in bird populations under natural conditions. Based on research conducted for nearly half a century in the primeval stands of the Białowieża National Park (Poland), I will summarize: the results of 45-year study on

the breeding bird assemblages, and the results of a 30-year study on the breeding biology one of the most numerous secondary-cavity nester, *Ficedula albicollis* compared to several other organisms (trees, mice, insects) and climate change. Abundance trends of individual bird species during 45 years were highly variable (19 of 30 species increased while *Ficedula hypoleuca*, *F. parva* and *Phylloscopus sibilatrix* experienced the strongest declines). Despite dynamic changes in abundance, the entire breeding bird community has so far appeared to be stable, especially in deciduous habitats, however, we observe a constant but slow changes in coniferous stands - where habitat transformations are most pronounced. Based on the 30-years study on *F. albicollis* and other organisms we found cascading effect of climate change in relations to five of six studied organisms. With the fast global changes taking place in the environment at a global scale, such long-term study allow us to better understand and predict the effects of these changes.

S9-3

Wood Warbler population trends across Europe in relation to increasing mast seeding frequency

Nino Maag

Swiss Ornithological Institute, Sempach, Switzerland

Populations of the Wood Warbler *Phylloscopus sibilatrix*, a ground-nesting woodland passerine, have been declining in western Europe since the 1980s and more recently also in central Europe. Population declines may relate to mast seeding events, i.e., synchronized fruiting events of tree species, which have become more frequent over the past decades. After years with high seed abundance, predation pressure on Wood Warblers increases and leads to lower nesting success. We use matrix population models to investigate how lower reproductive rates in years after mast seeding events influence wood warbler population growth across Europe. Wood Warblers may depend on a certain frequency of years with low predation pressure for recovery and population persistence.

S9-4

Bird communities in forest clear-cuts

Dafne Ram[1], Åke Lindström[1], Lars B. Pettersson[1], Paul Caplat[2]

[1]Lund University, Lund, Sweden. [2]Queen's University, Belfast, United Kingdom

While dominated by forests, Sweden’s landscape is interspersed with open habitats. This mosaic landscape changes when farmland is abandoned or forest is planted or cut, creating a dynamic forest-farmland interface. Forest clear-cuts are a good example of this changing habitat, where forest is cut and within several years the forest is replanted or naturally regenerated. Since production forest is such a large part of the Swedish landscape, there is a significant amount of clear-cut land at any time in Sweden. We want to know how this man-made open habitat is utilised by birds, and what characteristics of the clear-cut and surrounding landscape influences the bird

communities found there. Using the network of the Swedish Bird Survey, we surveyed over 400 forest clear-cuts, up to 10 years after harvesting, throughout the country. 71 different species were observed including several red-listed species. Additionally, several species traditionally associated with farmland have been observed in forest clear-cuts. While farmland birds have seen large declines in the Europe and in Sweden, it would be interesting to see the potential of clear-cuts for these species. Since clear-cutting will likely remain the common forestry method in Sweden, we hope to be able to gain insights into the bird communities occurring there and to give recommendations on how to benefit birds in forest clear-cuts.

S9-5

Improving the conservation status of boreal forest birds in Fennoscandia, a future perspective

Martijn Versluijs

The Helsinki Lab of Ornithology Finnish Museum of Natural History, University of Helsinki, Helsinki, Finland

Climate change has both direct and indirect effects on forest ecosystems, e.g. affecting productivity, species distributions, nutrient and water cycles, food webs, and natural disturbances, but it will also influence forest management and land-use strategies. It has already been shown, that the current changes in climate, lead to a northwards shift in species distribution and causes changes in populations. Nevertheless, how boreal forest bird populations are affected combined by forestry and climate change is unknown. In this study I review how future land-use and climate change will affect the abundance and distribution of boreal bird species in Finland. A forest landscape model (FLM) (i.e. Landis-II) is used to simulate forests landscape changes over the next 100 years, under different climate change and management scenarios. Then, a Hierarchical Modelling of Species Communities (HMSC) framework will be used to retrieve information regarding bird habitat associations and model changes in species distribution and abundance. I expect to find that both forest harvesting and climate changes impact the forest landscape and will have a large impacts on bird communities. Additionally, due to habitat changes, populations of northern boreal species will decrease, as well as their distribution range. Southern species are expected to move further northwards. This study will help to understand the impact of human activity on the boreal ecosystem, and to develop adaptive forest management to better preserve biodiversity at a larger spatial scale in a changing climate context.

Symposium 10: The Potential of Ecoacoustics for Large-scale Bird Monitoring

Conveners: Sofia Biffi[1] and Jan Engler[2]

[1]Universty of Leeds, UK. [2]Technische Universität Dresden, Germany

Birds are known to be useful ecological indicators, and scaling-up efforts for monitoring bird species movements and behaviours is essential to assess thoroughly the health of ecosystems and understand the decline of bird populations in relation to global change. Passive acoustic sensors

are becoming an increasingly important tool for surveying sonorous species such as birds. In the case of birds, acoustic methods indeed have many advantages over traditional surveying methods: some species are much more clearly detectable by sound than by vision or other indicators; and acoustic devices can collect data for long periods of time, in a non-intrusive way, at a lower cost, can be deployed on a large spatial scale, and can decrease the observer bias in data collection. The acoustical monitoring of bird populations has been limited historically by technological costs and constraints, but is now facilitated by the combined development of Autonomous Recording Units (ARUs) and machine learning techniques. ARUs have ample battery life and storage capacity, allowing to collect large amounts of data; however, the processing of their biological information is very labour intensive. Today, the use of Machine Learning algorithms allows to cost-efficiently automatise bird population monitoring over continuous, long periods of time, either by extracting ecologically-relevant information directly from the soundscape (e.g. ecoacoustic indices) or through the identification of bird songs in the data (using especially Convolutional Neural Networks). While automated soundscape analysis is a promising route for bird population monitoring, its development is still at its infancy: the robustness and reliability of algorithms should be improved, and there are some challenges regarding the evaluation of their accuracy and relation to traditional measures of biodiversity. In this symposium we aim at providing a platform for discussing the recent advances in ecoacoustics, and the theoretical and technical challenges that still need to be overcome. Our symposium will bring together researchers from ecology, bioacoustics as well as machine learning, to cover a holistic perspective of this promising field of research.

S10-1

Automatic bird song identification with the Xeno-canto bird sounds platform

Bob Planqué

Xeno-canto Foundation for Natural Sounds, The Hague, Netherlands

The xeno-canto.org website is an open platform to share recordings of bird sounds. Thousands of recordists have amassed over half a million recordings from around the globe, all shared under open Creative Commons licenses. One of its main missions has been to provide better ways to negotiate large collections of sounds, and to give people new means to identify recordings to species. In this talk we will discuss the current state of affairs, our involvement in the LifeCLEF recognition challenges, and future developments in the area of automatic identification.

S10-2

Hedgerow age and bird activity in dairy landscapes: a case study using automated acoustic monitoring

Sofia Biffi[1], Jan Engler[2], Bill Kunin[1], Guy Ziv[1]

[1]University of Leeds, Leeds, United Kingdom. [2]Technische Universität Dresden, Dresden, Germany

Hedgerows are historically a key component of farming landscapes in Europe, and an integral part of British lowland farmland. They provide various ecological services, such as carbon sequestration, biological control of crop pests, and support biodiversity of flora and fauna alike. In particular, birds use hedgerows for foraging, breeding, and as refuge from predators. Because of their ecological benefits, hedgerow planting is encouraged throughout Europe as part of agri-environment schemes that compensate farmers for the adoption of environmentally friendly measures. This study aims at investigating the effects of hedgerow age on the activity and diversity of birds in improved grassland landscapes in Cumbria, England. We remotely collected recordings at dawn and throughout the day for four weeks using autonomous recording units (AudioMoths) deployed on hedgerows of three different age categories and performed automated species identification of the soundscapes using a freely available Convolutional Neural Network (BirdNET) specifically designed to handle large quantities of field recordings. After checking the performance of the software in the study sites, we assessed how metrics of bird communities may change in association to hedgerow characteristics when accounting for the surrounding landscape, to investigate the time it takes for the bird community to exhibit strong changes after the initial stages of hedgerow planting. This study provides an example of how passive acoustic monitoring and automated species identification can process large amounts of data to provide ecologically meaningful guidance for the design of agri-environment schemes, helping to assess their long-term impact in the landscape.

S10-3

First attempts to gather data on shorebird breeding productivity using Audiomoth acoustic recorders

David Jarrett[1], Steve Willis[1], Mark Wilson[2]

[1]University of Durham, Durham, United Kingdom. [2]BTO Scotland, Stirling, United Kingdom

Low breeding productivity is a primary cause of decline in many shorebird populations in Europe. However, gathering reliable data on the breeding productivity of shorebirds is challenging due to their cryptic breeding habits, the precocious nature of chicks and the potential for pairs to re-lay following nest failure. Because many species of shorebird make diagnostic alarm calls when they have dependent young, the recent development of low cost, low power, programmable acoustic recorders (Audiomoths) provides a potential new method of gathering data on wader breeding productivity. In the 2021 breeding season we deployed Audiomoths at Eurasian Curlew, Eurasian Whimbrel, Eurasian Oystercatcher and Northern Lapwing breeding grounds to build a library of different shorebird vocalisations across the breeding season. These sites were also monitored using established wader breeding productivity survey methods to understand the stage of the breeding cycle at which the vocalisations were likely made. In this talk we will cover the various practical challenges and methodological considerations related to audio recording on breeding grounds using Audiomoths, initial attempts to build automatic call identifiers, and the feasibility of using Audiomoths to gather data on productivity in different situations.

S10-4

Data-driven ecoacoustics: how to improve the quality of training datasets to automatically monitor bird populations

Félix Michaud, Sylvain Haupert, Jérôme Sueur

Institut de Systématique, Évolution, Biodiversité (ISYEB), Muséum national d'Histoire naturelle, CNRS, Sorbonne Université, Paris, France

One of the major challenges in ecoacoustics is to infer species occurrence in soundscape recordings where signals greatly overlap. So far, most bird sound detection algorithms in such recordings have used deep learning methods. Such algorithms need a substantial amount of data to be ready for inference. For example, the Birdclef2020 challenge dataset represents 70,000 files for 960 species. The most common paradigm for the dataset rather considers the quantity of audio data over the quality of it. However, noise in the dataset can lead to slow down training, to reduce the algorithm performance for detection and to unequal detection performance between bird species. Here, we show how to increase training data quality through appropriate signal detection and classification. By the use of an automatic detection of regions of interest in the spectrogram, followed by clustering, our algorithm isolates bird sounds. A test was run on a dataset built on a selection of the xeno-canto online collection which is extensively used in bird sound classification. The performance enhancement for bird sound detection was evaluated with a convolutional neural network architecture.

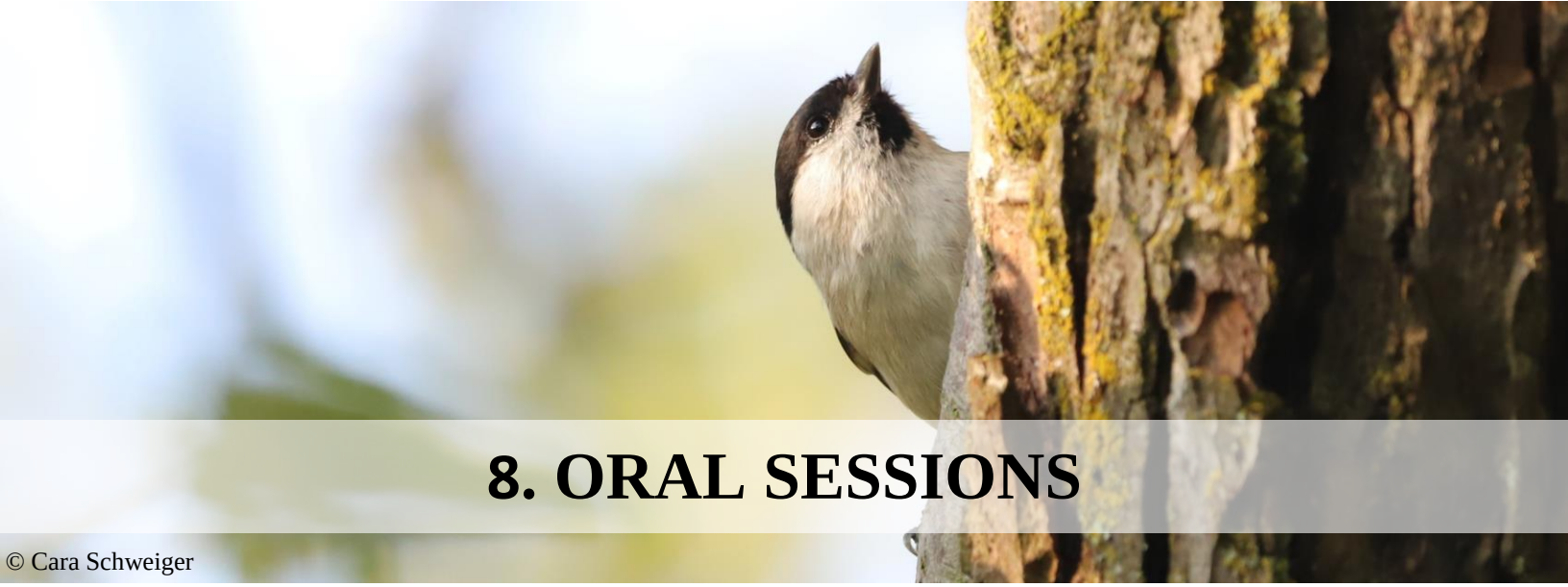
S10-5

The effectiveness of forest birds detection in bioacoustic monitoring

Dominika Winiarska, Paweł Szymański, Katarzyna Łosak, Tomasz Osiejuk

Adam Mickiewicz University, Poznań, Poland

Passive acoustic monitoring is used commonly in the research and conservation of various animals groups, amongst which birds are the most popular. Even though knowledge in this field is quite advanced, the maximum detection distances of numerous birdsongs are not known yet. We investigated the maximum detection distances of 30 diurnal and 12 nocturnal bird species living in Poland based on the differentiation of their song/call characteristics. The study examined sound propagation with the transmission experiment in coniferous and deciduous forests in various conditions throughout the breeding season (March to June). Speaker and microphones were deployed on a transect of 500 m length, and the experiments were conducted in the morning right after dawn chorus or in an hour after sunset, accordingly. The study consisted of 1-minute playback of two types of song/call for each species, as the speaker was consecutively placed at the height of 3, 6, 9 m to simulate natural singing conditions of various species. It seems that diurnal species that are louder are possible to detect at the distance of 400 m, while quieter ones vanish at 150 m in general, but those values differ according to the type of forest and time of the season. Night conditions reveal that loud species are hearable even at 500 m, while quieter ones are not detectable at 400 m.



8. ORAL SESSIONS

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OS-1

The determinants of migratory connectivity: a wild bird common garden experiment

Koosje Lamers[1], Janne Ouwehand[1], Marion Nicolaus[1], Jan-Åke Nilsson[2], Christiaan Both[1]

[1]University of Groningen, Groningen, Netherlands. [2]Lund University, Lund, Sweden

Climate change is forcing animals to adapt their seasonal activities. Migrant songbirds are particularly vulnerable to climate change due to their complex annual cycle, and a major puzzle piece still missing in our understanding of how they may adjust their annual timing schedules, are the wintering grounds. Many migrant species display migratory connectivity: breeding populations winter in different parts of the wintering range. However, wintering sites are hypothesized to constrain the timing of spring departure, because their food conditions vary seasonally depending on rainfall, which may arrive at different moments at different wintering sites. Wintering sites can thus potentially impact timing, but it is unknown what drives this variation in wintering sites between populations. In a unique wild bird common garden experiment, we test the extent to which between-population variation in wintering sites is determined genetically or by rearing environment, and investigate the links between migratory time-schedules and wintering and breeding sites. Over the course of a five-year long experiment, we translocated Pied Flycatcher *Ficedula hypoleuca* females and eggs from the Netherlands to Sweden, hereby creating a free-living population of birds of Dutch, half-Dutch, and Swedish descent in our Swedish study population. We also tracked unmanipulated Dutch birds from the Netherlands and Swedish birds from Sweden, and now compare their migratory journeys and destinations to those of Dutch and half-Dutch birds raised in Sweden to answer what drives migratory connectivity.

OS-2

Birds of three worlds: moult migration to high Arctic expands a boreal-temperate flyway to a third biome

Antti Piironen[1], Antti Paasivaara[2], Toni Laaksonen[1]

[1]University of Turku, Turku, Finland. [2]Natural Resources Institute Finland, Oulu, Finland

Knowledge on migration patterns is key for understanding the dynamics of migratory populations and evolution of migratory behaviour. Bird migration is usually considered to be movements between breeding and wintering areas, while less attention has been paid to other long-distance movements such as moult migration. Here, we show that boreal breeding Taiga Bean Geese *Anser fabalis fabalis* migrate annually during the breeding season to the high Arctic for wing moult. Both non-breeding and unsuccessfully breeding individuals moult migrate, meaning that a large part of the population gathers at the moulting sites annually for three months. Moult migrants migrate later in the autumn than successful breeders, and their overall annual migration distance was over twofold compared to the successful breeders. Additionally, migratory connectivity between breeding and moulting sites is very low, indicating that individuals from different breeding grounds mix with each other on the moulting sites. Moult migration makes the Arctic an equally relevant habitat for the population as their boreal breeding and temperate wintering grounds, and links ecological communities in these biomes. The destination of moult migration, the island of Novaya Zemlya, holds radioactive contaminants from various sources, which might still pose a threat to the moult migrants. Additionally, moult migration exposes the population to the rapid impacts of global warming to the Arctic ecosystems. Generally, these results show that moult migration may essentially contribute to the way we should consider bird migration and migratory flyways.

OS-3

Climate in eastern and western Africa sequentially shapes spring passage of long-distance migrants across the Baltic coast

Magdalena Remisiewicz1[1,2], Les G. Underhill[2,3]

[1]Bird Migration Research Station, Faculty of Biology, University of Gdansk, Gdansk, Poland. [2]Department of Biological Sciences, University of Cape Town, Cape Town, South Africa. [3]Biodiversity and Development Institute, Cape Town, South Africa

Attributed mostly to earlier springs since 1980, many migrant bird species have been returning to Europe earlier. They use a variety of wintering quarters in Africa. We tested whether timing of spring passage also responded to climate indices in the different non-breeding areas. We developed 13 large-scale climate indices for Africa and Europe averaged over relevant months in the year before spring migration. We mistnetted from 1982 to 2017 at Bukowo, Baltic Sea coast, Poland.

Using daily totals between 1 April and 15 May we derived an Annual Anomaly (AA) for several trans-Saharan migrants, and modelled the time series of overall AAs and their sub-periods as response variables in multiple regression models; year and the 13 climate indices were explanatory variables. Spring migration timing of Lesser Whitethroat was related only to the Indian Ocean Dipole and Southern Oscillation Index in the previous August–October. These indices operate in eastern Africa where this species winters. In the other species, spring migration was related to these indices and to the Sahel Precipitation Index. This corresponds with wintering areas in both eastern and western Africa. Relationships to these climate indices changed sequentially during spring, suggesting that populations of these species on passage form a consistent and sequential pattern of mixtures from different parts of Africa. We suggest that the drivers of phenological shifts in passage of species are not only earlier springs in the north but also changes in climate indices on the wintering grounds and at stopovers in Africa.

OS-4

Too much change at too many places? Two Australasian shorebird species show individual advancements in migration initiation but not in their arrival at the breeding grounds

Simeon Lisovski[1], Jesse Conklin[2], Phil Battley[3], Ken Gosbell[4], Marcel Klaassen[5]

[1]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany. [2]University of Groningen, Groningen, Netherlands. [3]Massey University, Palmerston North, New Zealand. [4]Victorian Wader Study Group, Melbourne, Australia. [5]Deakin University, Geelong, Australia

Globally, bird migration is occurring earlier in the year, consistent with climate-related changes in breeding resources. Although often attributed to phenotypic plasticity, there is no clear demonstration of long-term population advancement in avian migration through individual plasticity. Using long-term observations (>10 years) from Ruddy Turnstones *Arenaria interpres* from Tasmania migrating to eastern Siberia, and Bar-tailed Godwits *Limosa lapponica* departing New Zealand towards Alaska, we show that migration initiation advanced significantly in both species, and that within-individual advancement was sufficient to explain this population-level change. However, tracking data also suggests that earlier departure did not lead to earlier arrival or breeding in the Arctic, due to prolonged stopovers in Asia. We demonstrate that plastic responses can drive population-level changes in timing of long-distance migration, but also that behavioral and environmental constraints en route may yet limit adaptive responses to global change.

OS-5

Go west: the discovery of a new migration route in an Asian passerine bird

Paul Dufour[1,2], Christophe de Franceschi[3], Paul Doniol-Valcroze[3], Frédéric Jiguet[4], Maya Guéguen[2], Julien Renaud[2], Sébastien Lavergne[2], Pierre-André Crochet[3]

[1]University of Gothenburg, Gothenburg, Sweden. [2]Laboratoire d'Ecologie Alpine, CNRS, Université Grenoble Alpes, Grenoble, France. [3]Centre d'Ecologie Fonctionnelle et Evolutive, CNRS, Université de Montpellier, Montpellier, France. [4]CESCO, UMR7204 MNHN-CNRS-Sorbonne Université, Paris, France

The evolution of migration routes in birds remains poorly understood as changes in migration strategies are rarely observed on contemporary time scales. The Richard's Pipit *Anthus richardi*, a migratory songbird breeding in Siberian grasslands and wintering in Southeast Asia, has only recently become a regular autumn and winter visitor to Western Europe. Here, we examine whether this change in occurrence merely reflects an increase in the number of vagrants, that is, "lost" individuals that likely do not manage to return to their breeding grounds, or represents a new migratory strategy. We show that Richard's Pipits in southwestern Europe are true migrants: the same marked individuals return to Southern France in subsequent winters and geo-localization tracking revealed that these birds originate from the western edge of the known breeding range. They make an astonishing 6,000 km journey from Central Asia across Eurasia, a very unusual route among Siberian migratory birds. Climatic niche modeling using citizen-science data suggests that the winter niche suitability has increased in southwestern Europe for the species, which may have led to increased winter survival and eventual successful return journey and reproduction of individuals that initially reached Europe as autumn vagrants. This illustrates that vagrancy may have an underestimated role in the emergence of new migratory routes and adaptation to global change in migratory birds. Whatever the underlying drivers and mechanisms, it constitutes one of the few documented contemporary changes in migration route, and the first longitudinal shift, in a long-distance migratory bird.

OS-6

The legacy of conserved wintering ranges in long distance migrants: implications on the genetics of migration

Staffan Bensch

Lund University, Lund, Sweden

It has repeatedly been observed that migration routes seem to follow the routes of how the breeding ranges are assumed to have been colonized since after the last glaciation. One of the most striking examples is the wheatear that has colonized North America from both west and east, but still returns

to African for wintering although suitable and more nearby winter quarters should be in Central or South America. A possibility is that major changes of migrations routes are constrained by the genetic program controlling migration. In other situation migration patterns appear to change quickly; within the last century central European blackcaps have started to winter on the British Isles rather than in the Mediterranean area. If migration direction can change this fast it is a paradox that many other species show migration patterns that carrying a signal that goes back to the last ice age. In this talk, I will discuss these conflicting patterns and their implications for our understanding of the genetic control of migration.

OS-7
Physiological consequences of growing up during a heatwave

Elin Persson, Andreas Nord

Department of Biology, Lund University, Lund, Sweden

With a changing climate comes warmer periods all around the year and an increase in the frequency of heatwaves. This affects animals in different ways. In birds, changes in environmental temperature during the developmental period before or after hatching, which is expected during heatwaves, can directly affect growth, metabolism and temperature tolerance of the offspring. However, we know little about how these changes remain in adulthood. This is important to fully understand the fitness effects caused by heatwaves. For example, if birds adapt non-reversible to extreme weather conditions experiences in the juvenile stage, they may be maladapted to the prevailing environmental context of their adult ranges. We, thus, investigated if any phenotypic consequences of the thermal environment in early life remain in adulthood. This was achieved by raising Japanese Quail under simulated heatwave, or normal, conditions until they had reached 50% of adult body mass and in a common garden afterwards. We then measured thermophysiological responses to variation in environmental temperature, at the end of the heatwave treatment and again in adulthood. Here we detail the short and long-term effects of heatwaves on morphology and on the physiology machinery responsible for keeping the birds warm or cool, in temperature regulation. This study gives new insights into how birds cope with increasing temperatures, if phenotypic effects are lasting and under which circumstances such responses are adaptive or maladaptive.

OS-8

Early life climate effects on life history components and life expectancy across Europe in a color polymorphic species

Gian Luigi Bucciolini[1], Chiara Morosinotto[1,2], Peter Ericsson[3], Lars-Ove Nilsson[4], Al Vrezec[5], Karel Poprach[6], Ingar Jostein Øien[7], Henk Jan Koning[8], Patrik Karell[1,2]

[1]Novia University of Applied Sciences, Ekenäs, Finland. [2]Department of Biology Lund University, Lund, Sweden. [3]Sågvägen 24, Fagersanna, Sweden. [4]Lingonstigen 14B, Karlsborg, Sweden. [5]Department of Organisms and Ecosystems Research, National Institute of Biology, Ljubljana, Slovenia. [6]Faculty of Science, Department of Development and Environmental Studies, Palacky University Olomouc, Olomouc, Czech Republic. [7]Norwegian Ornithological Society, BirdLife Norway, Trondheim, Norway. [8]Belkmerweg 37, Burgerbrug, Netherlands

Global climate warming is altering the environment of many organisms, leading to changes in selective pressures and animals will need to adapt to these new environmental conditions to persist. Populations with genetically based color polymorphism are ideal study systems in terms of microevolutionary responses to environmental change. In Tawny Owls, *Strix aluco*, two melanin-based color morphs exist, brown and grey morphs, associated to different fitness, physiological and behavioral traits. Previous studies observed that breeding life span (BLS) and lifetime reproductive success (LRS) in Finland were morph-dependent while the survival between morphs was climate-dependent. Here, we tested if the winter climate before the breeding career affected life history components, and if they differed between morphs in six European countries across a latitudinal gradient. We found a great variability in morph frequency with more **grey** individuals in Finland and Norway and more **brown** individuals in Netherlands and Czech Republic. Brown morphs across Europe tend to have a shorter BLS than grey, regardless of temperature before first breeding. Brown individuals starting the breeding career after cold winters have lower LRS than grey individuals, whereas after warmer winters they have higher LRS than grey ones. These results suggest that in Tawny Owl, harsh climate in early life has differential effects on fitness of the morphs. Thus, at a large geographical scale, different genotypes (i.e., color morphs) show different life history strategies according to climatic conditions.

OS-9

Influence of temperatures on autumn migration timing of Garden Warbler *Sylvia borin* at the southern Baltic coast

Agata Pinszke, Magdalena Remisiewicz

University of Gdańsk, Gdańsk, Poland

Some migrant birds have advanced their autumn migration in response to increasing temperatures caused by climate change. We aimed to determine any long-term changes in the autumn migration timing of immature long-distance migrant Garden Warbler at the Polish Baltic coast using mistnetting data from the Operation Baltic ringing stations at Bukowo-Kopań and Mierzeja Wiślana from 1965–2018. We calculated the dates when 10, 25, 50, 75, and 90% of all immature Garden Warblers were caught in autumn each year. We also used multiple linear regression models where the percentiles were response variables and calendar year and 12 bi-monthly mean temperatures in spring, summer and autumn on migration routes and breeding grounds were explanatory variables. At Bukowo-Kopań the passage of 75 and 90% of captured immature Garden

Warblers advanced by 10–12 days, at Mierzeja Wiślana by 7 days for 90% of captured birds. The dates of these percentiles were later the higher the mean summer temperatures in Finland and southern Scandinavia. Warm summers might encourage juveniles to stay longer at the breeding grounds to mature and fatten before migration, which would increase their chances of surviving migration. These percentiles also advanced more the higher the mean spring temperatures in southern Europe and the higher the mean summer temperatures locally and in Norway; these effects were strong at both stations. Warm springs and summers might encourage early spring arrival and nesting of adults, early hatching of clutches, which grow fast and are ready to depart early, thus passage ends early.

OS-10

Effects of season and ambient temperature on Great Tits *Parus major*. How cold and hot spells seasonally affect their physiology and behaviour?

Roger Colominas-Ciuró[1,2], Krzysztof Kowalski[2], François Criscuolo[1], Weronika Jadach[2], Mathilde Lejeune[1], Małgorzata Jefimow[2], Anna Kowalczewska[2], Anna S. Przybylska[2], Eva Serrano-Davies[3], Sandrine Zahn[1], Michał S. Wojciechowski[2]

[1]Dept. Ecology, Physiology & Ethology. Institut Pluridisciplinaire Hubert Curien (IPHC-CNRS-UMR7178), Strasbourg, France. [2]Department of Vertebrate Zoology and Ecology. Faculty of Biological and Environmental Sciences. Nicolaus Copernicus University, Toruń, Poland. [3]Department of Animal Ecology. Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, Netherlands

Animals constantly interact with environments which seasonally change throughout their lives, triggering physiological and behavioural adjustments to acclimatize to those changes. Such adjustments might reflect predictable ecological changes or otherwise, may be a consequence of environmental fluctuations. Ongoing climate change seems to increase the frequency and strength of extreme and unpredictable weather events worldwide (e.g. heat and cold waves), which also impact animals and their ecosystems. Overall, animal responses to extreme and unpredictable environmental changes have been previously reported. But, so far, there is insufficient information on the effect of season on the proximate physiological and behavioural mechanisms underlying animal responses to changes in abiotic conditions. Therefore, here we tested the effect of season (summer and winter) on Great Tit *P. major* performance while exposed to seasonally unpredictable cold and heat spells. To do so, birds were kept under seasonally changing photoperiod and exposed then to heat and cold spells both in winter- and summer-like conditions. We repeatedly measured markers of homeostatic load (e.g. metabolic rate, evaporative heat loss, stress), health (e.g. oxidative status and leukocytes), life expectancy (i.e. telomere length) and behaviour (e.g. exploration). Our results show that both physiological and behavioural traits significantly differed between seasons and temperature acclimation regimes. For example, whereas an imbalance in bird oxidative status was found to depend on season and temperature, telomere length was not

influenced by any of the tested abiotic conditions. In conclusion, our results emphasize the importance of seasons and the need to integrate them in future studies.

OS-11

Impacts of weather and nest-dwelling ants on bird-ectoparasite interactions

Marta Maziarz[1], Richard K. Broughton[2], Przemek Chylarecki[1], Grzegorz Hebda[3]

[1]Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland. [2]UK Centre for Ecology & Hydrology, Wallingford, United Kingdom. [3]University of Opole, Opole, Poland

Progressive climate change is a global emergency. Although urgently needed, it is challenging to understand the consequences of the long-term weather change on species living in intricate ecological networks. This is because direct impacts of weather on particular species may have also indirect effects on other organisms through their interspecific relationships. Host-parasite interactions are common interspecific relationships existing between birds and the invertebrates inhabiting their nests. Similar to many other organisms, birds and the nest-dwelling ectoparasites are both reliant on suitable weather conditions for successful reproduction. As such, ambient temperature and rainfall may affect both the hosts and their ectoparasites, and the interactions between them. The activity of other nest-dwelling invertebrates, such as predatory ants, may also depend on weather and shift the host-parasite interactions by reducing the abundance of ectoparasites within bird nests. To better understand the implications of climate change, we investigated weather effects on host birds and the cohabitants of their nests. We explored (i) the impact of ambient temperature and rainfall on the prevalence and abundance of blowflies *Protocalliphora* spp. in Wood Warbler *Phylloscopus sibilatrix* nests. (ii) We tested whether the presence of ants reduced nest infestation with blowflies under a range of ambient temperatures, and (iii) whether the changes in blowfly infestation influenced the survival and growth of Wood Warbler nestlings. The results show how weather conditions may shift the interactions between birds and the invertebrates inhabiting their nests, and provide valuable information on possible implications of the long-term weather change.

OS-12

Whole-body and subcellular consequences of winter cold

Andreas Nord[1], Carmen C. Garcia Diaz[1], Imen Chamkha[2], Eskil Elmér[2]

[1]Department of Biology, Lund University, Lund, Sweden. [2]Department of Clinical Sciences, Lund University, Lund, Sweden

Small birds in the northern temperate zone face a converging series of environmental challenges when autumn turns to winter, because it is costlier to stay warm when it is cold at the same time as short days restrict the time available for resource acquisition. It is believed that the little bird in winter relies strongly on rest-phase hypothermia, a controlled reduction in body temperature, to save energy. However, this is speculative since there are few empirical studies of the physiological regulation and energetic significance of hypothermia in northern birds. Even less is known about analogous adaptations of the cellular machinery responsible for fuelling the birds' body before and during bouts of hypothermia. We, thus, studied how the use of hypothermia changed with variation in air temperature and how this contributed to energy conservation in winter-adapted Great Tits in southern Sweden. Then, we investigated simultaneous changes to cellular bioenergetics by assessing how hypothermic body temperature impacted mitochondrial respiration – the main contributor to energy production in animals. We show that the energetic significance of rest-phase hypothermia was far less conducive for winter survival than a well-developed capacity for heat production. Even moderate hypothermia lowered working capacity at the subcellular level. However, this was compensated for by functional changes to mitochondrial function, which restored fuel production rate despite lower overall energy consumption. To these ends, our study clarifies previous misunderstandings by shedding new light onto the long-standing enigma of how small birds survive the northern winter.

OS-13

Mechanisms behind conspecific attraction in a nomadic passerine

Shannon Luepold[1,2], Hanna Kokko[2], Alex Grendelmeier[1], Gilberto Pasinelli[1,2]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]University of Zürich, Zürich, Switzerland

Conspecific attraction during habitat selection is common among animals, but the ultimate reasons for this behavior often remain enigmatic. Using a playback experiment, spatial statistics and mate choice models, we tested the following three hypotheses for conspecific attraction during the breeding season in male Wood Warblers *Phylloscopus sibilatrix*: the habitat detection hypothesis, the social informational cascade hypothesis, and the female preference hypothesis. These hypotheses make different predictions with respect to the relative importance of habitat and social cues, how spatial variation in male density is aligned with spatial variation in habitat quality, and whether benefits accrue as a consequence of aggregation. Spatial variation in habitat quality was the best predictor of male density. When disentangling effects of aggregation from those of habitat, the former (competitor presence) impacts male mating success negatively. Males were not more aggregated than expected based on spatial variation in habitat quality. Our results thus indicate the habitat detection hypothesis as the most likely explanation for observations of spatially clustered males in Wood Warblers. Our study highlights how consideration of the process by which animals detect and assess habitat, together with the potential fitness consequences of resulting aggregations, are important for understanding conspecific attraction and spatially clustered distributions.

OS-14

Environmental drivers shape aggression networks among raptor nestlings

Benedetta Catitti[1,2], Urs Kormann[1], Martin Grüebler[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]University of Zurich, Zurich, Switzerland

Aggression among siblings can regulate brood reduction under adverse environmental conditions. One way to achieve this is to direct the attacks towards the marginal, weakest sibling as conditions worsen. However, when food provisioning is unpredictable nestlings don't have cues about future food availability and thus, may redirect their efforts into obtaining the highest possible hierarchical position to ensure future access to food. Brood reduction can thus consequently occur either directly through aggression or indirectly through starvation. Here, we use a novel analytical framework to investigate the role of siblings' aggression in a wild population of Red Kite *Milvus milvus* nestlings. We investigate the pecking propensity among siblings in relation to their age difference, adrenal response (proxied by H/L ratio) and food provisioning. In general, marginal nestlings had the highest mortality, but received the least attacks. When food provisioning was low, senior nestlings targeted aggressions towards slightly younger siblings, but spared considerably younger siblings. Junior nestlings attacked senior siblings when the age difference was small but avoided it when it was large. Finally, aggressions were not directed to specific age-classes under ample food supply. Further, senior birds experiencing higher adrenal response reduced their aggression towards junior siblings. Our results suggest that antagonistic nestling behaviour is triggered by adverse environmental conditions and targeted towards siblings with similar competitive ability. Thus, siblings' aggression is not a direct mechanism of brood reduction in Red Kites, but rather a behaviour to maintain the nestling hierarchy under adverse environmental conditions.

OS-15

Is vocal communication a key to coordinated parental care in a monogamous seabird?

Marion Devogel[1], Antoine Grissot[1], Dorota Kidawa[1], Marcelo Araya-Salas[2,3], Katarzyna Wojczulanis-Jakubas[1]

[1]University of Gdańsk, Gdańsk, Poland. [2]Universidad de Costa Rica, San José, Costa Rica. [3]Cornell University Cornell Laboratory of Ornithology, Ithaca, USA

While most bird species exhibit bi-parental care, with both parents adjusting theirs workload in respect to each other, still little is known of how this adjustment is achieved. Vocal communication has recently been pointed out as a potential mechanism of such parental care adjustment in songbirds. Here we examine the role of partners' vocal interactions in the parental care of a

monogamous seabird, the Little Auk *Alle alle*. Little Auks' breeding partners share their parental duties equally and in a coordinated manner; during the whole breeding period they frequently meet at the nest and vocalize together, which makes it a perfect system for studying the role of vocal communication in parental coordination. We investigate whether the temporal and acoustical structure of the partners' vocal interaction in the nest predict its output (relief or not of the incubating partner), and whether they are related to the duration of the previous and subsequent incubation bouts. Our results are the first attempt to answer such questions in seabirds, and we believe they constitute a solid background for both examining the mechanisms regulating parental care and the importance of vocal communication between avian breeding partners.

OS-16

Preen oil and smell of the Pied Flycatcher

Marc Gilles, Tim Schmoll, Barbara Caspers

Bielefeld University, Bielefeld, Germany

Birds possess a specialized gland, the preen gland, that secretes a waxy mixture called preen oil. Preen oil is a major source of avian body odour and may be involved in chemical intra-specific communication (e.g. sexual signalling during mate choice) and inter-specific communication (e.g. olfactory crypsis during incubation). We analysed the chemical composition of preen oil of a common passerine, the Pied Flycatcher *Ficedula hypoleuca*. In females sampled twice during the breeding season, we found seasonal changes but no within-individual similarity in preen oil composition. In breeding pairs sampled during nestling rearing, we found sex differences but within-pair similarity, suggesting that partners smell alike. These results allow us to speculate on the function of preen oil in this species, and bring new insights in the chemical ecology of birds.

OS-17

White wing stripe in blue tits – an ornament or a signal amplifier?

Katarzyna Janas[1], Paulina Gaweł[2], Anna Łatkiewicz[1], Dorota Lutyk[3], Lars Gustafsson[4], Mariusz Cichoń[1], Szymon Drobniak[1]

[1]Jagiellonian University, Kraków, Poland. [2]NA, Kraków, Poland. [3]NA, Warsaw, Poland. [4]Uppsala University, Uppsala, Sweden

In many bird species, size and spectral characteristics of achromatic patches are thought to play a signalling role in a mate choice. Despite the blue tit *Cyanistes caeruleus* is well-studied model species, its white wing patch has never been examined in the context of sex-specific trait expression. Therefore, we investigated greater covert's dots, creating the wing patch, for the

presence of sexual size dimorphism and dichromatism. Further, we analysed its correlations with current body condition and crown colouration - a trait with established role in sexual selection. We found significant sexual dimorphism in the dot size, independent of covert size, and sexual dichromatism in both white dot and blue outer covert's vane spectral characteristics. UV chroma of covert's blue vane was positively correlated with crown UV chroma and males current condition, which suggest a white stripe may play a role of the blue signal amplifier. Moreover, qualitative analysis of microstructure of white and blue areas of feather revealed the presence of channel-type ß-keratin spongy structure in both parts, with lack of melanosomes within the white dot as the main difference. This indicates that the white colour of covert dots results from the simple mechanism of withheld deposition of melanosomes in distal barbs. Future studies should focus on elucidating the function of the blue tit wing stripe and explaining the selective pressures that led to its emergence.

OS-18

Social transmission of auditory risk recognition in a wild bird population

Jakub Szymkowiak

Population Ecology Research Unit, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland

Eavesdropping on predator calls to assess predation risk is ubiquitous in birds. However, the specific mechanisms through which individuals acquire the ability to recognize that specific sounds convey information about a threat remain largely untested under natural conditions. In a series of field experiments, I tested whether an ability to recognize predator calls in birds can be socially transmitted among neighbors occupying adjacent territories during the spring breeding season. First, I found that Wood Warblers *Phylloscopus sibilatrix* can learn to recognize unfamiliar, complex sounds (samples of punk rock songs) as cues of a threat via acoustic-acoustic association, that is, by associating the unfamiliar sounds with alarm calling reaction of conspecific neighbors. Next, I tested how distance between conspecific territories during the breeding season affects eavesdropping on alarm calls, as spatial distribution of individuals within a population is likely to be one of key constrains on the possibilities for social learning via acoustic cues under natural conditions. Leveraging playback experiments, fine-scale data on territory distribution, and social network analysis revealed that conspecific eavesdropping in Wood Warblers is distance-dependent. However, there are ample opportunities for information transfer among individuals during the breeding season, as even though they are bound to distinct territories, they form a population-wide eavesdropping network. Jointly, these results show the importance of eavesdropping on conspecific alarm calls and learning via acoustic-acoustic association as important mechanisms of information flow and social transmission of anti-predator behavior in wild bird populations. (National Science Centre, Poland, grant no. 2018/31/D/NZ8/00080).

OS-19

How shearwaters prey. New observations of foraging behaviours using bird-borne video cameras

Lucie Michel

Justus Liebig University, Giessen, Germany

Conventional bio-logging techniques used for ethological studies of seabirds have their limitations when studying detailed behaviours at sea. This study uses animal-borne video cameras and reveals the fine-scale behaviour of a Mediterranean seabird as it forages, associates with conspecifics and other species, and interacts with fisheries. The study was conducted on Scopoli's Shearwaters *Calonectris diomedea* breeding on Linosa Island in summer 2020. Foraging was video recorded from the seabirds' point of view using lightweight cameras mounted on the birds' backs. Video recordings allowed observations of fine-scale behaviours that would have gone unnoticed with conventional tracking devices. Foraging events could be categorised by prey type into "natural prey" and "fishery discards". Analysis of the video footage suggests that there are behavioural differences between the two prey categories. These differences suggest that foraging effort may vary between natural prey and consumption of fishery discards, providing new arguments for discussing energy trade-offs and choice of foraging strategy. These observations highlight the importance of combining tracking technologies to obtain a complete picture of seabird behaviour at sea, which is essential for understanding the impact of foraging strategies and seabird-fishery interactions.

OS-20

Temporal variation in the diet of the endangered Long-tailed Duck *Clangula hyemalis* in the eastern Baltic coastal waters

Paola Forni[1], Darius Daunys[1], Julius Morkunas[1], Mindaugas Dagys[2]

[1]Klaipeda University, Klaipeda, Lithuania. [2]Nature Research Centre, Vilnius, Lithuania

Long-tailed Duck *Clangula hyemalis* is an endangered species wintering in the Baltic Sea. The population decline around 65% was estimated for the last three decades. The introduction of round goby *Neogobius melanostomus* into the eastern Baltic Sea impacted the benthic communities, particularly those formed by blue mussels in hard-bottoms. Reduction of the blue mussel biomass led to the shift in the benthophagous sea duck’s diet to new prey. This has been documented earlier for hard-bottoms, but the differences from extensive sandy coastal areas remained unknown. Therefore, the aim of this study was to assess the extent of the diet change of the Long-tailed Duck in two principally different habitats, primarily formed by hard and soft-bottoms and colonized by distinct benthic communities. We analysed stomach content of 251 Long-tailed Ducks bycaught in

gillnets from 2016 to 2020 in areas of hard and soft-bottom habitats and compared these results with those published by Žydelis and Ruškyte (2005). The results show a change in the diet in the hard-bottom during the last two decades, shifting from the blue mussel to *Hediste diversicolor*, barnacles, and fish. In soft-bottom, however, the diet remained similar over time. There was no evidence of significant differences in the diet neither among sex nor different age. At the same time, despite the noted changes in the diet the body condition changed neither over time nor between habitats. This confirms high feeding flexibility of the Long-tailed Duck and adaptation to the changes in prey availability by shifting their diet.

OS-21

Trophic niche overlap in mixed bird colonies relying on artificial nests

João Gameiro[1], Teresa Catry[2], Joana Marcelino[3], Aldina Franco[4], Jorge Palmeirim[5], Inês Catry[6]

[1]Ce3c, Faculty of Sciences, University of Lisbon, Lisbon, Portugal. [2]CESAM, Faculty of Sciences, University of Lisbon, Lisbon, Portugal. [3]CEABN, Instituto Superior de Agronomia, Lisboa, Portugal. [4]University of East Anglia, Norwich, United Kingdom. [5]cE3c, Faculty of Sciences, University of Lisbon, Lisbon, Portugal. [6]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos e Instituto Superior de Agronomia, Vairão and Lisbon, Portugal

Although successful at recovering endangered populations, conservation actions based on nest provisioning seldom consider how they shape the composition of communities and alter interspecific interactions. Specifically, the extent to which dietary overlap within these communities may affect the conservation of target species has rarely been assessed. In Southern Europe, large-scale nest-site provisioning aimed at recovering Lesser Kestrels *Falco naumanni* populations attracted several bird species forming mixed breeding assemblages, likely promoting interspecific competition for resources during breeding. Here we used Stable Isotope Analysis ($\delta^{15}N$ and $\delta^{13}C$) to assess inter- and intraspecific dietary segregation in these assemblages and investigate the mechanisms allowing species coexistence. We examined resource partitioning and trophic niche overlap among Lesser Kestrels, Common Kestrel *Falco tinnunculus*, European Roller *Coracias garrulus*, Barn Owl *Tyto alba*, Little Owl *Athene noctua*, and Spotless Starling *Sturnus unicolor*; and within species between parents and their offspring. Similar isotope ratios and highly overlapped niches, particularly among lesser kestrels, rollers, and starlings, suggest limited dietary segregation and use of similar prey. Within species, parent-offspring segregation was marked across all species. Our results indicate that species breeding in these assemblages occupy similar ecological niches, despite a potential increase in competition. High-resource availability in the area may guarantee coexistence but the viability of mixed-species groups may be compromised in areas with limited resources, which are predicted to expand with ongoing human and climate-induced changes. Conservation practices based on nest provisioning need to consider the ecological niches of target and sympatric species as well as their interactions.

OS-22

You are what you eat? Long-term effects of diet in an opportunistic bird of prey, the White-tailed Eagle

Carina Nebel[1], Camilla MS Ekblad[1], Fabio Balotari-Chiebao[2], Torsten Stjernberg[3], Toni Laaksonen[1]

[1]Department of Biology, University of Turku, Turku, Finland. [2]Novia University of Applied Sciences, Ekenäs, Finland. [3]Finnish Museum of Natural History, University of Helsinki, Helsinki, Finland

Conditions experienced during early life can have long-term individual consequences by influencing dispersal, survival, recruitment and productivity. The type and diversity of prey species consumed can have such long lasting effects. In the Åland Islands, a large archipelago in the northern Baltic Sea, the White-tailed Eagle *Haliaeetus albicilla* is an opportunistic forager that feeds mainly on birds (69.6%, 66 species) and fish (27.3%, 17 species). The types of prey are expected to differ in their quality from a nutritional, biochemical and energetical perspective. Furthermore, different species of birds and fish contain different types and amounts of accumulative pollutants for which top predators like white-tailed eagles are especially susceptible. In the present study, we evaluate how prey composition – the proportion of fish in the diet and the diversity of prey species brought to the nest – affects apparent survival rates of White-tailed Eagles in the Åland Islands. We use data from eagles that were ringed and sexed as nestlings, and about 5000 prey individuals that were collected from their natal territories by the WWF white-tailed eagle working group during the annual breeding surveys between May – June. By using capture-recapture models to estimate survival rates from their later resightings, we analyze how the diet of a nestling is associated with its long-term survival. We discuss the importance of variation in early-life diet in predators in general and how the opportunistic foraging behavior of the White-tailed Eagle in the Åland Islands is contributing to the species' success in the area.

OS-23

Who ate what? Diet composition of Common Woodpigeons, European Turtle Doves and Stock Doves determined by next-generation sequencing of plant and metazoan DNA in faecal samples

Yvonne R. Schumm[1], Juan F. Masello[1], Jennifer Vreugdenhil-Rowlands[2], Dominik Fischer[3], Klaus Hillerich[4], Petra Quillfeldt[1]

[1]Department of Animal Ecology & Systematics, Justus Liebig University, Giessen, Germany. [2]Lewestraat 52, Kloetinge, Netherlands. [3]Clinic for Birds, Reptiles, Amphibians and Fish, Veterinary Faculty, Justus Liebig University, Giessen, Germany. [4]Röntgenstraße 7, Groß-Umstadt, Germany

A detailed analysis of diet composition is crucial to understand the feeding ecology and habitat requirements, as well as to manage and protect species. Conventional methods, mainly relying on visually identifying diet items, may suffer from misidentification of similar-looking preys and low taxonomic resolution. Moreover, they are often invasive, negatively affecting the studied animal. Alternative and more accurate results can be obtained with molecular tools nowadays. We used next-generation sequencing (NGS), a powerful and non-invasive tool for diet reconstruction through DNA metabarcoding, to investigate the diet of European Turtle Doves *Streptopelia turtur*, Stock Doves *Columba oenas* and Common Woodpigeons *C. palumbus*, sampled in Germany and the Netherlands. Primers targeting the second internal transcribed spacer (ITS2) region of plant nuclear DNA and the mitochondrial cytochrome c oxidase subunit 1 (COI) region of metazoan DNA, isolated from faecal samples, provided a complete picture of the food items ingested, and of the dietary overlap between the three species. A diverse range of plant species (Class Spermatopsida) dominated the diets, while metazoan DNA was present very rarely. With this molecular approach, species of cultivated and wild plants to be known present in the columbids diets could be confirmed and some new plant taxa, previously not listed as known food items, could be found. High variability in consumed plant taxa among the species was detected. In particular, for the rapidly declining Turtle Dove, the observed regional variation in the diet composition might be important for the application of proposed conservation plans, like tailored seed mixtures.

OS-24

Earlier emergence of specific prey items reduces growth in high-Arctic Red Knot chicks

Thomas Lameris, Misha Zhemchuzhnikov, Jan van Gils

Royal Netherlands Institute for Sea Research (NIOZ), Den Burg (Texel), Netherlands

The Arctic is facing the most rapid climate warming on the planet, with large implications for ecosystems and its inhabitants. Increasingly smaller body sizes in Red Knots as recently observed on their wintering grounds is correlated with earlier snowmelt in their high-arctic breeding grounds, and hypothesized to result from impoverished food conditions during growth. We test this hypothesis using data on juvenile growth and availability of insect prey collected during 1990-1992 and 2018-2019 in high-Arctic Russia. We find that chick growth was slower in years with earlier snowmelt. A diet analysis revealed that chicks were largely dependent on craneflies as main prey item, and were growing poorly when less craneflies were available to them. The emergence of craneflies was strongly correlated with date of snowmelt, resulting in a phenological mismatch between cranefly availability and the chick growth period in years with early snowmelt. Our study shows that migratory birds may be vulnerable to phenological mismatches, especially when they are relying on specific prey items.

OS-25

Malaria parasites of different geographic origins altered the resting metabolic rate of Common Siskins in different ways

Maria Erokhina[1,2], Andrey Bushuev[1,2], Vaidas Palinauskas[3], Elena Platonova[1,3], Alexander Davydov[1], Andrey Mukhin[1]

[1]Biological Station Rybachy of Zoological Institute RAS, Rybachy, Russian Federation. [2]Department of Vertebrate Zoology, Faculty of Biology, Moscow State University, Moscow, Russian Federation. [3]Nature Research Centre, Vilnius, Lithuania

After invading a vertebrate host, the parasite imposes its energetic demands on the host, forcing it to reallocate its energy resources between the immune response and other life-history traits reducing its fitness. The opposite energetic consequences of infestation of the organism with *Plasmodium* (Haemosporida) can be expected: an increase of the metabolic rate due to the cost of the immune response or its decrease because of the destruction of the erythrocytes by hemoparasite. The degree of changes in metabolic rate may also depend on the duration of host-parasite coevolution. In our study, we infected two groups of juvenile Siskins *Spinus spinus*: one with locally transmitted *Plasmodium relictum* (lineage SGS1), and the other with an African *P. ashfordi* (GRW2). We used flow-through respirometry to estimate resting metabolic rate (RMR) of infected siskins. One week after infection, the RMR of all experimental birds decreased. However, by the next measurement, there was a sharp increase in RMR followed by a further slight increase, which continued until the end of the experiment. Birds from the group infected with *P. ashfordi* had a higher RMR compared to birds from the *P. relictum* group. Birds with an initially high RMR tended to reduce it, while individuals with a low initial RMR tended to increase it. It seems that a malarial parasite, new to the host, causes the mobilization of energy resources in naïve birds, which may lead to rapid depletion and even death. This work was supported by the Russian Science Foundation (20-14-00049).

OS-26

Immune challenge reduces activity levels for up to three weeks in free-living Common Blackbirds *Turdus merula*

Rosie J Lennon, Josefin Gunnarsson, Shivani Ronanki, Arne Hegemann

Lund University, Lund, Sweden

Long-term impacts of immune challenges in free-living birds are rarely measured due to the difficulty in obtaining these type of field data. As such, very little is known about the potential changes to long-term immune function or individual activity in the days, weeks and months following an immune challenge, and consequently how this may affect broader aspects of avian

ecology. In this study, free-living common Blackbirds *Turdus merula* were injected with lipopolysaccharide (LPS) to simulate a bacterial infection. These individuals, along with a control group that were not injected, were blood-sampled and fitted with accelerometers and/or Motus VHF tags to monitor their behaviour. Birds were recaptured and resampled approximately one year after the immune challenge. As expected, immune-challenged birds were found to be less active than their control counterparts within the first 24h. However, this reduced activity lasted for a further 19 days before both groups showed similar activity levels again. No difference was detected in long-term activity levels between the two groups during the following winter and spring after the immune challenge. These data suggest that the activity of individuals after an immune challenge is altered for a significantly longer time-period than previously thought. This may have implications for several annual-cycle stages, including breeding and migration when higher energy budgets are required. Repeated blood samples taken before and after the immune challenge will allow for the examination of any long-term changes to immune function, which will also be discussed here.

OS-27

Variation in immune defences in Barnacle Geese with different migratory strategies: a common garden experiment

Wei-Xuan Peng[1], Götz Eichhorn[2,1], Henk van der Jeugd[2], Fred de Boer[1], Kevin Matson[1]

[1]Wageningen University and Research, Wageningen, Netherlands. [2]Netherlands Institute of Ecology, Wageningen, Netherlands

Seasonal immunological variation is expected in migratory birds, since migration results in individuals experiencing environments (e.g., during breeding, stopover, and overwintering) that can differ in food resources and parasite pressures. While such seasonal variation has been documented, the role of genes (evolution) versus the environment (ecology) in driving the variation is not well understood. In the latter case, acute physiological responses associated with new environments or migration-related physical activity might lead to altered immune defences. The Barnacle Goose *Branta leucopsis* is a good model for studying these topics. In its eastern flyway, this species typically overwintered in temperate Europe and bred in the Russian Arctic. Since 1980s, a new non-migratory population has become established in the Netherlands. We conducted a common garden experiment to compare monthly changes in immune defences in individuals from the migratory and non-migratory populations. Moreover at moments corresponding to spring migration, moult, and autumn migration, we also measured immune defences before and after bouts of physical activity in individuals from both populations. Predictions about baseline immunological variation include 1) lower defences in summer than winter in both populations, but 2) lower defences overall in migratory birds. Predictions about the immunological effects of physical activity include 1) lower defences after physical activity in both populations, 2) larger reductions during moult than during either migration, and 3) larger reductions overall in non-migratory birds.

Our results shed new insights into population-specific patterns of seasonal immunological variation and the effects of physical activity on immune defences.

OS-28

Telomere dynamics in wild Great Reed Warblers: malaria infection status and short early-life telomere length could potentially induce telomere elongation

David Gómez-Blanco, Maja Tarka, Dennis Hasselquist

Lund University, Lund, Sweden

Telomeres are DNA structures that protect the ends of eukaryotic chromosomes. Telomeres shorten over time and when becoming too short, cellular senescence is triggered. Over the last two decades, telomeres have rendered an increasing interest from researchers studying wild animals, including birds. Telomeres generally shorten over life, despite that there are known mechanisms that can be induced to elongate telomeres. There is currently a debate over to what extent telomere elongation occurs in wild animals: are the observed elongation events mainly artifacts caused by measurement errors, or do they have a biological meaning? We used a longitudinal approach to investigate how telomere length (TL) in blood cells change from 9 days to 1 year of age in relation to early-life TL and avian malaria infection in 203 wild Great Reed Warblers *Acrocephalus arundinaceus* hatched in Lake Kvismaren, Sweden. On average, TL decreased over the first year of life, but individuals with longer early-life TL and malaria infected showed faster shortening. Elongation of telomeres over the 1st year of life occurred in 13% of the individuals, occurring much less frequently in birds with longer TL in early life and infected with avian malaria parasites. These results support the view that telomere dynamics, and elongation in particular, is not a random process in wild bird populations, suggesting that it could be a mechanism to mitigate problems that may arise when blood cell telomeres become too short.

OS-29

Zebra Finches respond to a simulated infection by reducing heat loss across the body surface

Gary Burness[1], Simon Tapper[1], Joshua Tabh[1], Glenn Tattersall[2]

[1]Trent University, Peterborough, Canada. [2]Brock University, St. Catharines, Canada

In response to a simulated infection, small birds often become hypothermic. However, our understanding of the mechanisms underlying this response is limited to mammals, in which hypothermia (when it occurs) is driven by a reduction in heat production rather than increased heat loss at the surface. We immune-challenged Zebra Finches *Taeniopygia guttata* with an inflammatory agent (lipopolysaccharide, LPS) and monitored body temperature using temperature-

sensitive passive-integrated transponder (PIT) tags. We measured changes in body mass, activity and food intake (energy balance), and used thermal imaging to monitor heat loss across the eye region, bill, and legs. LPS-injected individuals reduced activity and food intake, and maintained body mass. In contrast to previous studies of Zebra Finches, we found that LPS-injected individuals maintained a relatively constant body temperature (rather than become hypothermic). This response coincided with a reduction in peripheral heat loss, particularly across the surface of the legs, as opposed to changes in energy balance. We suggest that a reduction of peripheral heat loss is an underappreciated component of the sickness-induced thermoregulatory response of small birds.

OS-30

Sexual dimorphism in immune function and oxidative physiology across birds: the role of sexual selection

Péter László Pap[1], Csongor István Vágási[1], Janka Pénzes[1], Krisztián Szabó[2], Nóra M. Magonyi[3,4], Gábor Á. Czirják[5], Orsolya Vincze[1,6]

[1]Babes-Bolyai University, Cluj Napoca, Romania. [2]University of Veterinary Medicine Budapest, Budapest, Hungary. [3]University of Pécs, Pécs, Hungary. [4]Plant Protection Institute, ELKH, Budapest, Hungary. [5]Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany. [6]MTA Centre for Ecological Research-DRI, Debrecen, Hungary

Sex differences in physiological parameters are commonly reported in animals of various taxonomic position. While it is commonly accepted that males are generally more immunocompromised and supposed to be more exposed to oxidative stress than females, contradictory patterns arise between species, ages, season and parameters. The generality of sex differences across species and its causes thus remains to be explored. Here we performed a field-based assessment of sex differences in measures of immunity, oxidative physiology and blood oxygen carrying capacity focusing strictly on breeding birds (101 species). Using this data, we explore the role of sexual selection and parental care shaping sex-specificity in physiology during breeding. We show that superior female immunity is more common across birds, manifesting in natural antibodies and white blood cell numbers, but not the bactericidal capacity of the blood and complement system. Contrary, males have generally higher packed cell volumes than females. No general sex bias could be detected in oxidative physiology and no phylogenetic effects could be detected in the sex bias of any of the measured physiological parameters. Sex differences in immune parameters were associated with sexual size dimorphism, with the larger sex exhibiting higher white blood cell counts, but lower agglutination score. Sexual dichromatism, mating system or parental roles had no influence on sex-specificity in any of the measured parameters. Importantly, female-biased immunity remained highly significant after accounting for sexual dimorphism, dichromatism or mating and parental care, indicating the limited contribution of sexual selection in shaping cross-species differences in physiological sex differences.

OS-31

Hidden movements of long-distance migrants: pre-migratory flights in the Northern Wheatear

Zephyr Züst[1], Heiko Schmaljohann[1,2], Annika Peter[2]

[1]Institute of Avian Research, Wilhelmshaven, Germany. [2]University of Oldenburg, Oldenburg, Germany

Prior to and during migration, long-distance migratory songbirds develop navigational tools, such as magnetic and landscape maps, which they use to successfully return to their breeding area the following spring. Moreover, many songbirds transition from being active diurnally and stationary at the breeding area to being active nocturnally and highly mobile during migration. This transitional period remains highly understudied; despite a wealth of knowledge on migrants' ability to utilise navigational tools, little is known about how birds create magnetic and landscape maps. In particular, whether and to what extent juveniles and adults undertake exploratory "pre-migratory flights" to prepare for migration is almost wholly unknown. Here, we present evidence of a long-distance migrant songbird, the Northern Wheatear *Oenanthe oenanthe*, undertaking such nocturnal "pre-migratory flights". Using a breeding population of Northern Wheatears on the island of Norderney, we tagged 37 adults and 104 juveniles on the nest with coded radio-transmitters, and followed their individual movements leading up to fall migration using a network of automated radio receiving stations (https://motus.org) in the German Bight. Of the 114 tags with usable detections, 71 birds conducted pre-migratory flights (50 juveniles / 21 adults). However, of the nearly 1000 flights detected, juveniles performed 90% of them, and flew longer per flight than adults did. Our findings document pre-migratory flights in unprecedented detail. We suggest that pre-migratory flights play an important role in migration preparation, e.g., by providing individuals with experience in generating and using navigational tools before departing for their wintering grounds.

OS-32

The Vocal Activity Rate: a useful acoustic index for monitoring the migration and predation pressure of the European Bee-eater through passive acoustic monitoring

Gerard Bota[1], Juan Traba[2,3], Francesc Sardà-Palomera[1], David Giralt[1], Cristian Pérez-Granados[4,2]

[1]Forest Science and Technology Centre of Catalonia, Solsona, Spain. [2]Terrestrial Ecology Group (TEG-UAM), Department of Ecology, Universidad Autónoma de Madrid, Madrid, Spain. [3]Centro de Investigación en Biodiversidad y Cambio Global (CIBC-UAM), Universidad Autónoma de Madrid, Madrid, Spain. [4]Ecology Department, Alicante University, Alicante, Spain

The Vocal Activity Rate (VAR, vocalizations per time of unit of recording) is an acoustic index that has proven to be useful for estimating bird density from sound recordings. Here, we aimed to: i) assess the utility of VAR for estimating European Bee-eater *Merops apiaster* density, and ii) to characterize the migration pattern and predation pressure of the bee-eater at beehives, as well as its impact on honeybees foraging activity. For this purpose, we deployed Autonomous Recording Units (ARU) coupled to hive remote monitoring systems in different apiaries in Catalonia (NE Spain) during bee-eater post-breeding migration. We found a positive relationship between VAR and number of Bee-eaters and number of Bee-eaters performing hunting attempts; both visually counted by observers around beehives. These results suggest that VAR is a good estimator of both Bee-eater abundance and predation pressure. According to temporal variation of VAR, migration intensity increased from June until late August when it peaked, decreasing afterward until late September. Weekly VAR was positively correlated with the % complete bird observations checklist uploaded to Ornitho.cat (citizen-science platform) including Bee-eater observations, used as an independent source of migration timing. Hourly honeybees flow was negatively associated with the VAR detected during the same period, suggesting that Bee-eater predation inhibits honeybees foraging activity. Preliminary results indicate that this inhibition did not affect the final production of the hives. Our results show that VAR may be a comparable and cost-efficient way for bird monitoring at large temporal and spatial scale, including its availability to solve ecological questions.

OS-33

Quantitative year-round modelling of the movements of European waterfowl

Jacob Davies[1], Gabriel Gargallo[2], Rob Robinson[3], Stephen Baillie[3]

[1]BTO Scotland, Stirling, United Kingdom. [2]Catalan Ornithological Institute, Barcelona, Spain. [3]BTO, Thetford, United Kingdom

Avian influenza (AI) poses a significant threat to agriculture, resulting in the deaths of millions of poultry worldwide every year. Migration of wild birds, particularly waterfowl, constitutes one mechanism by which AI is spread geographically. Thus good quantitative measures of waterfowl movements are needed in order to predict the potential spread of AI outbreaks. Here we report European scale movement modelling results for five species of ducks, five geese and two swans based on ring recovery data from the EURING databank. These quantitative analyses complement a new online migration mapping tool that provides visualizations of the movements of 50 EFSA target species based on data from EURING and EuroBirdPortal. We construct two models of seasonal movements for each of our twelve study species, one based on the long-distance movements of migratory populations and one based on short distance dispersal movements which are generally non-directional. For long-distance movements we use quantitative methods to assign ring recovery records to different populations. For each of these populations we then quantify its distribution for each month or half month. Information on short-distance movements is generally averaged across populations after initial checks for homogeneity. Finally, we combine our

estimates of migratory movements and dispersal to estimate the probability and magnitude of movements between different European regions. This work provides a novel assessment of seasonal flux in patterns of bird movements across Europe, with potentially wide application to migration studies. Here we discuss our initial findings, the limitations of our approach and potential future developments.

OS-34

Multi-sensor loggers reveal details on the annual cycle of alpine Northern Wheatears

Yann Rime[1,2], Raphaël Nussbaumer[3], Martin Briedis[1,4], Christoph Meier[1], Maria Sander[5], Martin Buchmann[6], Simeon Lisovski[7], Dan Chamberlain[5], Valentin Amrhein[2], Felix Liechti[1]

[1]Swiss Ornithological Institute, Bird Migration Department, Sempach, Switzerland. [2]Department of Environmental Sciences, Zoology, University of Basel, Basel, Switzerland. [3]Cornell Lab of Ornithology, New York, USA. [4]University of Latvia, Riga, Latvia. [5]University of Turin, Turin, Italy. [6]Unterer Sand 12, Waldböckelheim, Germany. [7]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Potsdam, Germany

The Northern Wheatear *Oenanthe oenanthe* is one of the few high-alpine birds migrating south of the Sahara. While populations decrease in the lowlands of western Europe, they remain overall stable in the Swiss Alps but are subject to an upward elevational shift. The time window for breeding in the Alps is short, with strong variation in weather and snowmelt conditions between years influencing the breeding success and timing. Little is known about potential carry-over effects between migration timing and adaptations to the conditions in the alpine breeding grounds. Thanks to several years of collecting light-level geolocation data, we described the migration route of a population in the central Alps. Moreover, multi-sensor loggers recording air pressure and temperature unveiled details about the general migration timing, flight altitude and stop-over behaviour. The tagged individuals migrated south above the central Mediterranean to Tunisia before crossing the Sahara. Furthermore, we located the wintering area in the western Sahel region. The spring route was similar to autumn, but the duration of migration was shorter in spring. Arrival in the breeding region peaked in early May before snowmelt, allowing flexibility in the initiation of reproduction in adaptation to the local conditions. Our study provides novel information on the life cycle of the alpine Northern Wheatears, paving the way for a better understanding of the pressures undergone by the species in the Alps.

OS-35

Extreme altitude changes between night and day during migratory flights

Sissel Sjöberg, Dennis Hasselquist, Åke Lindström, Thomas Alerstam

Lund University, Lund, Sweden

Recent technical advances make it possible to study altitudinal behaviour throughout flights of individual migrants, and in several studies we have observed large variations in altitudes and surprisingly high flight altitudes. By using multisensor data loggers, we have recently shown that Great Reed Warblers *Acrocephalus arundinaceus* and Great Snipes *Gallinago media* fly on average several kilometres higher during diurnal (~ 4000 – 6000 m asl) compared to nocturnal parts of migratory flights (~ 2000 – 2500 m asl). These extreme diel altitude changes took place independent of season, climate zone, topography and overflown habitat. The reason for the changes are not fully understood, but potentially the threat of predation, benefits from extended vision range or the need for cooling under a heating sun cause the birds to climb to extreme altitudes during the day. Revealing the cause of this behaviour will help us understand biological and physiological constraints on bird flight.

OS-36

Costs and benefits of different migratory strategies in a partially migratory population

Inês Catry[1], Aldina Franco[2], Marta Acácio[2], Bruno Martins[1], Ana Payo-Payo[3], Francisco Moreira[1], Andrea Soriano-Redondo[1]

[1]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Porto, Portugal. [2]School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom. [3]School of Biological Sciences, University of Aberdeen, Aberdeen, United Kingdom

Bird migratory behaviour can be rapidly altered in response to changing environmental conditions. Use of landfill resources, together with the global increases of temperature, has likely facilitated the establishment of non-migratory White Stork *Ciconia ciconia* populations in Iberia, but the cost-benefits of residency and migration are largely unknown. We used GPS and tri-axial acceleration data of 75 adult white storks to investigate the energetic, behavioural and fitness consequences of different migratory strategies. Storks were classified as resident (local and dispersive) or migratory (trans-Mediterranean and trans-Saharan) if they remained in Iberia or crossed the Strait of Gibraltar after the breeding period. Our results show that annual displacement and annual energy expenditure was determined by the migratory strategy, with Sub-Saharan winterers travelling up to three times more and spending more energy than trans-Mediterranean and resident individuals. Trans-Saharan birds spent less time resting and more time soaring, especially during the wintering period, likely increasing energy expenditure. In addition, they increased time allocated to foraging in their wintering grounds and spent more energy foraging than all other birds. During the breeding season, Trans-Saharan migrants returned to their nests and laid eggs later which ultimately had consequences on the breeding success, as birds laying eggs later raised a lower number of fledglings. Finally, migratory individuals had lower annual survival rates than residents. Overall, our results show that resident individuals experience increased fitness compared to migratory ones,

which can explain the rapid rise in the proportion of resident individuals in this partially migratory population.

OS-37

Modelling population effects of different management scenarios on the European Turtle Dove as a tool for improving decision-making at the flyway scale

Carles Carboneras[1,2], Beatriz Arroyo[1], Àngels, Ma. Colomer[3], Léo Bacon[4], Matthieu Guillemain[5], Hervé Lormée[6], Antoni Margalida[1]

[1]Instituto de Investigación en Recursos Cinegéticos (IREC) (CSIC-UCLM-JCCM), Ciudad Real, Spain. [2]RSPB Centre for Conservation Science, Sandy, United Kingdom. [3]University of Lleida, Lleida, Spain. [4]Office Français de la Biodiversité, Juvignac, France. [5]Office Français de la Biodiversité, Arles, France. [6]Office Français de la Biodiversité, Villiers en Bois, France

The European Turtle Dove is a globally threatened species (IUCN:VU) that still can be hunted in 10 EU Member States. Population modelling showed current hunting levels to be unsustainable and contributing to the decline in the western flyway. Zero harvest, starting in 2021, was recommended in the context of an Adaptive Harvest Management Mechanism promoted by the European Commission. Hunters however argued that population stability could be achieved concomitantly with maintaining very limited levels of harvest, which would allow maintaining their investment in habitat improvements towards this species. PDP models (Population Dynamic P-System models) have proven to be useful tools to help decision-making for wildlife management. We used PDP-systems to generate turtle dove population trajectories considering different scenarios of harvest, in combination with several values for key demographic parameters (fecundity, survival) taken from the range estimated by an Integrative Population Model built on empirical data. Our results show that the western flyway population is likely to stabilise or increase slightly in the absence of hunting with current fecundity values. But (limited) harvest opportunities may exist if/when there is an increase in key vital rates. Levels of fecundity at the upper end of the confidence interval might allow some (limited) future harvest without jeopardising long-term population stability; therefore, the intervention focus should be on providing the right conditions through adequate habitat management. Model simulation of population trajectories through P-systems may help harmonise the conflict between hunters, conservationists, and policymakers, through a better understanding of the consequences of management decisions.

OS-38

The potential of fallow management to promote steppe bird conservation within the next EU Common Agricultural Policy reform

Ana Sanz-Pérez[1], Francesc Sardà-Palomera[1], Gerard Bota[1], Rahel Sollmann[2], Nuria Pou[1], David Giralt[1]

[1]Centre de Ciència i Tecnologia Forestal de Catalunya (CTFC), Solsona, Spain. [2]University of California, Davis, USA

Agricultural intensification promoted by the European Common Agricultural Policy (CAP) has driven the decline of farmland and steppe bird populations. Policy tools to improve the environmental performance of the CAP – including Agri-Environmental Schemes (AES) and Greening – have often failed, and the new EU agricultural reform (CAP post-2020) offers a new opportunity to integrate effective measures addressing farmland bird declines. Fallow land and its management have proven beneficial for endangered steppe bird species by providing good quality habitat, and therefore has potential to become an effective conservation measure. We used a Hierarchical Distance Sampling community model to evaluate the ability of different conservation regimes to increase the abundance of 37 bird species including endangered steppe birds and other farmland birds in 13,309 ha of fallow land in north-eastern Spain. The conservation regimes were based on different management prescriptions associated with AES, Greening and a local conservation measure promoting extensive fallow management targeting seven steppe bird species (Targeted Fallow Management, TFM). The positive effect of conservation measures increased as their design was more targeted to specific species. TFM increased the abundance of target and other farmland species, while AES and Greening had either no effect or negative effects on bird abundance, respectively. The success of TFM as a conservation tool highlights specific features of fallows and fallow management that enhance populations of endangered and common bird species. We translate our findings into specific guidelines that we recommend including within the new eco-schemes and AES present in the future CAP post-2020.

OS-39

Multi-scale landscape drivers of habitat selection in a farmland raptor along an agricultural intensification gradient

Giacomo Assandri[1], Jacopo G. Cecere[1], Maurizio Sarà[2], Carlo Catoni[3], Federico De Pascalis[4], Jennifer Morinay[1], Alessandro Berlusconi[5], Sara Cioccarelli[4], Alessandro Mercogliano[4], Aliona Pazhera[4], Anna Terras[4], Simona Imperio[1], Michelangelo Morganti[6], Diego Rubolini[4]

[1]Area per l'Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano Emilia, Italy. [2]Dipartimento di Scienze e Tecnologie Biologiche, Chimiche e Farmaceutiche, Università di Palermo, Palermo, Italy. [3]Ornis italica, Roma, Italy. [4]Dipartimento di Scienze e Politiche Ambientali, Università degli Studi di Milano, Milano, Italy. [5]Environment Analysis and Management Unit - Guido Tosi Research Group - Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy. [6]CNR-IRSA Consiglio Nazionale delle Ricerche - Istituto di Ricerca sulle Acque, Brugherio, Italy

Gradients of agricultural intensification in agroecosystems may determine uneven resource availability for consumers. In turn, variation in habitat availability may determine variation in consumers' habitat selection patterns, resulting in context-dependent habitat selection, including functional responses. We assessed the effect of gradients of landscape composition and configuration on habitat selection of a colonial farmland bird of prey, the Lesser Kestrel *Falco naumanni*. In the framework of four collaborative projects, including LIFE FALKON, we GPS-tracked 76 nestling-rearing individuals from 10 populations scattered along an agricultural intensification gradient. We detected marked differences in the strength of selection for different habitats compared to availability. Overall, non-irrigated croplands and semi-natural grasslands were the most preferred habitats at two spatial scales of habitat availability (colony surroundings and within individual home-range). Considering colony surroundings, Lesser Kestrels showed a preference for grassland compared to non-irrigated crops, whereas the opposite was the case within individual home-ranges. Croplands were generally used more than available at both spatial scales. The strength of selection for the two most used habitats varied markedly among individuals. At the colony scale, individual selection strength for grasslands increased with decreasing compositional diversity of the surrounding landscape, suggesting that agroecosystem diversification may at least partly buffer the loss of semi-natural habitats. Within home-ranges, higher cropland availability reduced the strength of individual preference for this habitat, suggesting a negative functional response likely due to density-dependent processes. Our findings highlight the importance of considering both individual and population-level differences in studies of habitat selection to inform species' conservation.

OS-40

How effectively can conservation measures aimed at improving reproduction help to conserve a long-lived raptor?

Jakob Katzenberger[1], Eckhard Gottschalk[2]

[1]Dachverband Deutscher Avifaunisten e.V., Münster, Germany. [2]Conservation Biology/Workgroup on Endangered Species, Georg-August Universität, Göttingen, Germany

Sufficient food in the nest environment and prey availability are crucial for a successful reproduction – not only for raptors like the Red Kite *Milvus milvus*. Food availability also influences juvenile condition and thereby possibly also fitness and mortality in later life. In order to improve food availability for red kites in the intensively used agricultural landscape, the project "Rotmilan-Land zum Leben" implemented agricultural and nest-protection measures and recorded red kite populations over large project areas throughout Germany. Based on more than 1000 Red Kite breeding attempts, we show how natural factors (weather, competition) influence reproduction and additionally estimate the effect of large-scale conservation measures on the species' reproduction. To assess possible further effects of food availability in later life, we analyse a separate dataset for correlations of long-term survival of pre-adult Red Kites with prey abundance on the regional scale in Germany. Ultimately, conservation measures have to be judged by their

long-term effectiveness in increasing a population's growth rate – we therefore reflect on our results in the overall context of Red Kite population dynamics. The joint project "Rotmilan-Land zum Leben" (www.rotmilan.org) was carried out from 2014-2019 by Deutscher Verband für Landschaftspflege, Deutsche Wildtier Stiftung and Dachverband Deutscher Avifaunisten as well as nine regional partners in Germany. Funding was provided from "Bundesprogramm Biologische Vielfalt" through the Federal Agency for Nature Conservation (BfN), with funds from the Ministry for the Environment, Nature Conservation and Nuclear Safety.

OS-41

The effect of land-use intensity in the Black-tailed Godwit breeding population density and in its key food abundance across natural and agricultural habitats in Europe

Miguel Silva-Monteiro[1], Hannes Pehlak[2], Sami Timonen[3], Michal Korniluk[4], Frederic Robin[5], Jelle Loonstra[6], Mo Verhoeven[6], David Kleijn[1]

[1]Wageningen University, Wageningen, Netherlands. [2]Estonian University of Life Sciences, Tartu, Estonia. [3]Oulu University, Oulu, Finland. [4]Zoorlogy Polish Academy of Sciences, Warsaw, Poland. [5]LPO France, Rochefort, France. [6]Groningen University, Groningen, Netherlands

The continental Black-tailed Godwit *Limosa l. limosa*, a grassland ground-nesting wader, have been steadily declining across all the habitats where it is known to breed, with low chick survival pointed as the main cause. Large and denser breeding populations occur mostly in intensively managed grasslands, but smaller and more scattered populations are common in extensively managed farmland and natural undisturbed wetlands such as bogs. Likewise the species demise, recent studies demonstrate that the populations of crucial invertebrates for both adults and chicks are also severely declining, in the so-called insect apocalypse. However, the link between the land-use intensity, local invertebrate abundance and the contrasting sizes of the breeding populations remains mostly unexplored. Why do denser populations occur in more intensively managed grasslands? Is the invertebrate community less abundant in more natural habitats? Using collected data from diverse key breeding sites present in Europe, we test how environmental variables, such as vegetation productivity or soil moisture, influence the invertebrate abundance and the size of Godwit breeding populations. We found that across countries, with increasing vegetation productivity certain invertebrate groups increased in abundance, while others increased in their biomass. Additionally, we found that the abundance of key chick-feeding invertebrates is the best explaining variable for the occurrence of larger and denser breeding populations. Our results indicate that efficient conservation management for larger and denser Godwit populations in agricultural grasslands should aim towards creating environmental conditions that would increase chicks survival by promoting invertebrate abundances.

OS-42

Spatio-temporal variation in Corn Bunting nesting ecology: consequences for conservation

Nils Anthes[1], Markus Handschuh[2], Julia Staggenborg[1]

[1]University of Tuebingen, Tuebingen, Germany. [2]Schloßstr. 12, 99820 Hörselberg-Hainich, Germany

Current efforts to support biodiversity in agricultural landscapes often remain insufficient to halt farmland bird declines. Even in areas with targeted conservation measures, population trends of many species remain negative. Notable exceptions include some waders or birds of prey, where nest protection schemes have led to substantial increases in reproductive rates. In farmland passerines, however, dedicated nest protection remains an exception. One reason may be that only insufficient information is available on the degree to which farming activity affects nest survival. We therefore studied spatio-temporal variation in nesting ecology of the Corn Bunting *Emberiza calandra* in several relicts of its "critically endangered" SW German population. We characterize variation in nesting ecology between habitats, years and landscape types, and link nesting phenology to nest site-specific agricultural schedules. Based on these findings, we evaluate the effectiveness of typical Corn Bunting conservation measures, such as the implementation of fallow areas or extensive mowing regimes, in supporting nest survival. From this, we derive optimized management strategies that may help to increase reproductive output in the few remaining strongholds of this species.

OS-43

Protocol development for the use of birds as bioindicators of micro- and nanoplastic pollution in terrestrial environments

Imogen Mansfield[1], S. James Reynolds[2], Tom Matthews[1], Iseult Lynch[1], Jon Sadler[1,2]

[1]School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, United Kingdom. [2]Centre for Ornithology, School of Biosciences, College of Life & Environmental Sciences, University of Birmingham, Birmingham, United Kingdom

Plastic pollution is a significant global environmental problem which has likely been heightened during the global COVID-19 pandemic, due to an unprecedented increase in the production of single-use plastic products such as face masks and gloves. Birds are effective bioindicators of plastic pollution because of their high mobility and occupation of multiple environments and trophic levels. Despite all plastic being fabricated on land, the majority of research of its interaction with birds has been limited to aquatic (predominantly marine) taxa. By performing a systematic review of literature on terrestrial birds as bioindicators of plastic pollution, we found that most studies have focused on mesoplastics (5-10 mm fragments) and macroplastics (< 1 m fragments).

Few studies have addressed microplastic (< 5 mm fragments) pollution in terrestrial bird species, while to the best of our knowledge, none has investigated nanoplastics (< 100 nm fragments). Due to their small size, micro- and nanoplastics can be readily internalised, potentially resulting in adverse toxicological impacts (e.g., inflammation). We have therefore designed field- and laboratory protocols to measure plastic load in some body compartments of birds (e.g., feathers, faecal sacs), and in nests collected from Blue Tits *Cyanistes caeruleus*, along an urbanisation gradient in Birmingham, UK. We have successfully used Nile Red staining to detect and quantify micro- and nanoplastics in feathers and faecal sacs, and have identified polymers across all three sample types, using Fourier-transform infrared spectroscopy and Raman spectroscopy. Future plans involve adapting such approaches to examine plastic load in many more somatic sites of their accumulation.

OS-44

Does aircraft noise or urban living affect tree sparrow health in early life?

Jaime Muriel[1], Iraida Redondo[2], Cristina de Castro Díaz[3], José I. Aguirre[3], Diego Gil[2], Lorenzo Pérez-Rodríguez[4]

[1]Instituto Pirenaico de Ecología — (IPE-CSIC), Jaca, Spain. [2]Museo Nacional de Ciencias Naturales (MNCN-CSIC), Madrid, Spain. [3]Facultad de Ciencias Biológicas, Universidad Complutense de Madrid, Madrid, Spain. [4]Instituto de Investigación en Recursos Cinegéticos, (IREC-CSIC, UCLM, JCCM), Ciudad Real, Spain

Urbanization constitutes one of the major transformations of natural habitats, creating new areas characterized by multiple potential wildlife stressors. Birds that live in highly anthropogenic environments are confronted with physiological and behavioural challenges caused by these stressors. Between these factors, noise pollution could interact with avian physiology, disrupting glucocorticoid secretion or even causing oxidative damage, which could compromise individual's health. Here, we compared the body condition, corticosterone levels, and oxidative status of three subpopulations of Tree Sparrow *Passer montanus* nestlings living in three different areas: a quiet rural area, a noisy rural area adjacent to Barajas airport, and a heavily urbanized area located in Madrid City. We found that rural-airport nestlings did not differ from their rural counterparts neither in body condition nor in stress levels. Indeed, they showed greater antioxidant levels. By contrast, urban nestlings were in lower condition and had lower antioxidant capacity than rural and rural-airport individuals, which may be due to the abundance and variety of pollutants in cities along with a poorer quality diet. Our results suggest that aircraft noise does not constitute a significant stressor for nestlings. However, urban conditions constitute a more challenging situation, negatively affecting different physiological systems. To disentangle the relationship between noise and its influence on wildlife is necessary to expand this type of study to more airports by replication and go for an experimental approach. Although nestlings may buffer these challenges in the short-term, further research should explore the long-term potential consequences of early exposure to these conditions.

OS-45

Environmental, geographical, and time-related impacts on avian malaria infection in introduced and native populations of *Passer domesticus*, a globally invasive bird

Martina Ferraguti[1,2], Sergio Magallanes[1], Jéssica Jiménez-Peñuela[3], Josué Martínez-de la Puente[4,5], Luz García-Longoria[1,6], Jaime Muriel[7], Tamer Albayrak[8], Staffan Bensch[6], Camille Bonneaud[9], Rohan H. Clarke[10], Gábor Árpád Czirják[11], Dimitar Dimitrov[12], Kathya Espinoza- Ramirez[13], John G. Ewen[14], Farah Ishtiaq[15], Jordi Figuerola[3], Wendy Flores-Saavedra[16,17], László Zsolt Garamszegi[18,19], Olof Hellgren[6], Dita Horakova[20], Kathryn P. Huyvaert[21], Henrik Jensen[22], Asta Krizanauskiene[23], Marcos R. Lima[24], Charlene Lujan-Vega[25], Eyðfinn Magnussen[26], Lynn B. Martin[27], Kevin Matson[28], Anders Pape Møller[29], Pavel Munclinger[30], Vaidas Palinauskas[31], Peter L. Pap[32], Javier Pérez-Tris[33], Swen C. Renner[34], Robert Ricklefs[35], Sergio Scebba[36], Ravinder N.M. Sehgal[37], Manuel Soler[38], Eszter Szöllősi[39], Gediminas Valkiūnas[31], Helena Westerdahl[40], Pavel Zethindjiev[41], Alfonso Marzal[1]

[1]Department of Anatomy, Cellular Biology and Zoology, University of Extremadura, Avda. Elvas s/n, 06006, Badajoz, Spain. [2]Department of Theoretical and Computational Ecology (TCE), Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, Science Park 904, 1098XH, Amsterdam, Netherlands. [3]Department of Wetland Ecology, Doñana Biological Station (EBD-CSIC), Avda. Américo Vespucio, 41092, Seville, Spain. [4]Department of Parasitology, University of Granada (UGR), Granada, Spain. [5]CIBER of Epidemiology and Public Health (CIBERESP), Madrid, Spain. [6]Molecular Ecology and Evolution Lab, Department of Biology, Lund University, Sölvegatan 37, SE-22362, Lund, Sweden. [7]Pyrenean Institute of Ecology - IPE (CSIC), Avda. Nuestra Señora de la Victoria 16, 22700, Jaca, Spain. [8]Department of Biology, Burdur Mehmet akif Ersoy University, 15100, Burdur, Turkey. [9]Centre for Ecology and Conservation, Biosciences, University of Exeter, Cornwall TR10 9FE, Penryn, United Kingdom. [10]School of Biological Sciences, Monash University, 3800, Clayton, Australia. [11]Department of Wildlife Diseases, Leibniz Institute for Zoo and Wildlife Research, Alfred-Kowalke-Straße 17, 10315, Berlin, Germany. [12]Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences, 2 Gagarin Str., 1113, Sofia, Bulgaria. [13]Laboratorio de Genética Molecular y Bioquímica, Universidad Científica del Sur , Panamericana Sur Km 19, Lima, Peru. [14]Institute of Zoology, Zoological Society of London, Regent's Park, NW1 4RY, London, United Kingdom. [15]Tata Institute for Genetics and Society, New InStem Building, NCBS Campus, GKVK Post, 560065, Bangalore, India. [16]Unidad de Sanidad Animal. Universidad Nacional Agraria la Molina, Lima, Peru. [17]Servicio Nacional Forestal y de Fauna Silvestre (SERFOR), Lima, Peru. [18]Institute of Ecology and Botany, Centre for Ecological Research, Alkotmány u. 2-4, 2163, Vácrátót, Hungary. [19]MTA-ELTE Theoretical Biology and Evolutionary Ecology Research Group, Institute of Physics, Eötvös Loránd University, Pázmány Péter sétány 1/A, 1117, Budapest, Hungary. [20]Czech Society of Ornithology (CSO), BirdLife, Na Belidle 252/34, CZ-150 00, Prague, Czech Republic. [21]Department of Fish, Wildlife, and Conservation Biology, Colorado State University, 80523-1474,, Fort Collins, USA. [22]Department of Biology, Centre for Biodiversity Dynamics (CBD), Norwegian University of Science and Technology (NTNU), N-7491, Trondheim, Norway. [23]Institute of Biosciences, Life Sciences Center, Vilnius

University, 7 Saulėtekio Ave, LT- 10257, Vilnius, Lithuania. [24]Department of Animal and Plant Biology, Biological Science Centre, State University of Londrina, CP 6001, 86057-970, Londrina, Brazil. [25]Aquatic Health Program, School of Veterinary Medicine, University of California, 944 Garrod Dr, CA 95616, Davis, USA. [26]University of the Faroe Islands, Faculty of Science and Technology Vestara Bryggja 15, FO-100, Torshavn, Faroe Islands. [27]Global Health and Infectious Disease Research Center, University of South Florida, FL 33620, Tampa, USA. [28]Wildlife Ecology and Conservation, Environmental Sciences Group, Wageningen University & Research, Droevendaalsesteeg 3, 6708 PB, Wageningen, Netherlands. [29]Laboratoire d'Ecologie, Systématique et Evolution, Université Paris-Sud, CNRS, AgroParisTech, Université Paris-Saclay, F-91405, Orsay Cedex, France. [30]Department of Zoology, Faculty of Science, Charles University, Albertov 6, 128 00, Prague, Czech Republic. [31]Nature Research Centre, Institute of Ecology, Akademijos 2, LT-08412, Vilnius, Lithuania. [32]Evolutionary Ecology Group, Hungarian Department of Biology and Ecology, Babeș-Bolyai University, Clinicilor street 5-7, RO–400006, Cluj-Napoca, Romania. [33]Evolution and Conservation Biology Group. Department of Biodiversity, Ecology and Evolution, Complutense University of Madrid, 28040, Madrid, Spain. [34]Ornithology, Natural History Museum, Burgring 7, 1010, Vienna, Austria. [35]Department of Biology, University of Missouri-St. Louis, MO 63130, St. Louis, USA. [36]Gruppo Inanellamento Limicoli (GIL, Napoli), Via Traversa Napoli 58, I-80078, Pozzuoli, Naples, Italy. [37]Department of Biology, San Francisco State University. 1600 Holloway Ave, CA 94132, San Francisco, USA. [38]Departamento de Zoología, Facultad de Ciencias, Universidad de Granada, E-18071, Granada, Spain. [39]ELTE, Eötvös Loránd University, Department of Systematic Zoology and Ecology, Behavioural Ecology Group, Eötvös Loránd University, Pázmány Péter sétány 1/C, 1117, Budapest, Hungary. [40]Department of Biology, Lund University, Ecology Building, 223 62, Lund, Sweden. [41]Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences 2 Gagarin Street, 1113, Sofia, Bulgaria

The increasing global spread of vector-borne diseases has resulted in serious worldwide public health concerns for humans and wildlife. We identified the ecological drivers affecting the prevalence and richness of avian *Plasmodium* parasites in House Sparrows *Passer domesticus*, a globally distributed songbird species. Overall, we analysed data from 2,220 individuals, sampled at 69 localities across all six continents where the species occurs. The influence of environmental setting (urbanization index), geography (altitude, latitude), and time (bird breeding season and years elapsed since introduction) were analysed. We predicted that sparrows in increasingly urbanised settings, and those in introduces populations, should exhibit lower infection prevalence and lower parasite richness. In support, we found that *Plasmodium* prevalence and lineage richness were higher in the native than in the introduced range. Although a positive association was found between parasite prevalence and the urbanization index for both native and introduced populations, a negative, non-linear association between *Plasmodium* prevalence and human population density for sparrows from the native populations was also found. Parasite prevalence from both native and introduced birds increased with the altitude. Parasite richness was also positively related with the number of years elapsed since the arrival of sparrows to the introduced areas. These results support the idea that House Sparrows were released from an important fraction of the parasites that limit their populations in the natural range (i.e., Enemy Release Hypothesis) during introduction, and

that novel host-parasite interactions at the invaded area are established over more extended periods of time (≥40 years post introduction).

OS-46

The effects of population density on induced immune response and physiological condition in well-adapted urban species

Maciej Kamiński, Amelia Chyb, Piotr Minias

Department of Biodiversity Studies and Bioeducation, Faculty of Biology and Environmental Protection, University of Łódź, Łódź, Poland

The morphological, behavioural or ecological traits of urban populations are shaped by highly transformed, man-made environment of urban developments. Several bird species thrive in city ecosystems, establishing numerous populations. Creating high density urban populations is considered to be a major indicator of synurbic species. However, dens congregations of conspecifics might facilitate pathogen transmission rate and deteriorate body condition and fitness. Those threats might be mitigated by increased immunocompetence. To test this assumption, we sampled 120 Feral Pigeons *Columba livia forma urbana* along population density gradient in city of Łódź (central Poland). We assessed induced immune response by performing phytohaemagglutinin (PHA) skin test, and we used blood haemoglobin concentration and scaled mass index (SMI) as indicators of the body condition. We found that higher induced immune response is associated with higher population density. Contrarily, both blood haemoglobin concentration and SMI were not affected by population numbers. Our results support the hypothesis that abundant city dwellers are adapted to cope with negative effects of living at high densities.

OS-47

The extended urban phenotype: impact of anthropogenic waste on nest design and avian fitness

Zuzanna Jagiello[1,2], Michela Corsini[3], Łukasz Dylewski[1], Juan Diego Ibáñez-Álamo[2], Marta Szulkin[3]

[1]Poznań University of Life Sciences, Poznan, Poland. [2]University of Granada, Granada, Spain. [3]University of Warsaw, Warsaw, Poland

Waste pollution, defined as non-biological products discarded in environment and including plastic pollution, is increasing with urbanization and human-induced land use change. Waste, and particularly plastic, impact wildlife at multiple biological levels, and is considered as a major threat against biodiversity. Recent studies highlight the use of anthropogenic materials by animals (e.g.

birds) during reproduction, for example during nest building. But there is limited data on whether this behavioral change related to the inclusion of waste into nest building covaries with the degree of urbanization, and whether it negatively affects fitness. By focusing on passerines breeding in a gradient of urbanisation, we examined which environmental factors act as predictors of mismanaged waste (1) in the environment and (2) in the nest material of two tit species: Great Tits *Parus major* and Blue Tits *Cyanistes caeruleus.* We further tested whether (3) the presence of anthropogenic material in the nest influences fitness, estimated as reproductive success. We show that the main driver of waste pollution and anthropogenic material in tit nests is human presence rather than the amount of impervious surface area (a proxy for urbanization). Our data also reveals, in both tit species, a clearcut shift from the use of natural nest materials (fur and feathers) to anthropogenic ones in a gradient of urbanisation. Interestingly, we report a clear negative effect of anthropogenic waste on the breeding success of Blue Tits, but not Great Tits, which suggests species-specific variation in the vulnerability of urban birds to waste pollution.

OS-48

Tawny Owl distribution in the urban nightscape: the effects of urban intensity, noise and artificial light at night

Giuseppe Orlando, Dan Chamberlain

University of Turin, Turin, Italy

Urbanisation is one of the most critical threats for natural ecosystems and biodiversity. Typical factors connected with the urban development include increases in built environment density, anthropogenic noise and artificial light at night (ALAN). Although their negative effects have often been described, few studies have focussed on nocturnal wildlife, especially on predators, which play a key role in ecosystems. Here, we investigated the effect of urban and woodland cover, anthropogenic noise and ALAN on the presence of the Tawny Owl *Strix aluco*, a common nocturnal predator. We conducted playback surveys along an urban gradient in Turin (Italy) to detect species presence and noise levels were measured with a sound level meter at the same time. For our study area, urban and woodland cover were calculated using a GIS software, while ALAN data was obtained from a light pollution map. We found a negative response to urbanisation and species occurrence was high in larger wooded areas. There was a significant negative relationship between Tawny Owl presence and each urban covariate. Overall, ALAN was the most influential factor. The species was mainly present in locations with a darker sky. Our findings suggest that the Tawny Owl can adapt and establish territories in urban environments as long as anthropogenic noise and light conditions are quiet and especially dark. Therefore, we recommend taking these factors in account for greenspace planning to sustain urban populations of Tawny Owls and to increase the quality of the nightscape, preventing excessive levels of noise and ALAN.

OS-49

Demographic and environmental drivers of long-term population dynamics of British breeding Pied Flycatchers revealed

Malcolm Burgess[1,2,3], Robert Robinson[4], Chloe Nater[5]

[1]RSPB Centre for Conservation Science, Sandy, United Kingdom. [2]PiedFly.Net, Devon, United Kingdom. [3]University of Exeter, Exeter, United Kingdom. [4]British Trust for Ornithology, Thetford, United Kingdom. [5]Centre for Biodiversity Dynamics, Norwegian University of Science and Technology, Trondheim, Norway

The demographic processes driving population dynamics are difficult to determine and quantify, and studies that do so are usually limited to single breeding populations. For migratory species in particular, lack of knowledge on demographic mechanisms prevents pinpointing during which part of the annual cycle populations are impacted, which, in turn, compromises our understanding of mechanisms, and for species of conservation concern the ability to devise management solutions. Throughout their British breeding range, populations of Pied Flycatchers *Ficedula hypoleuca* have been declining over recent decades. We aimed to identify demographic and environmental drivers of this large-scale decline through integrated analysis of mark-recapture and nest box survey data from seven populations breeding at latitudes encompassing the British distribution. We quantified the contributions of different demographic drivers to population dynamics, focusing particularly on drivers operating during the breeding versus non-breeding period of the annual cycle. Despite substantial variation in both averages of and environmental impacts on key demographic parameters across breeding locations, population sizes covaried, suggesting large-scale drivers affecting the migration and non-breeding, rather than breeding, stages as year-to-year variation in population growth rate and long-term population trends were driven primarily by annual survival and dispersal dynamics. Combined with an absence of time-trends in per-capita reproductive output, this indicates that breeding season trophic mismatch is unlikely to have had large-scale impacts on the British Pied Flycatcher population. This analysis develops a standardized workflow and data format to facilitate future cross-population analyses to better understand large-scale drivers of population change.

OS-50

Simultaneous population increase intensifies interactions in competitive *Strix* owls

Urška Ratajc[1,2], Al Vrezec[1,3,2]

[1]National Institute of Biology, Ljubljana, Slovenia. [2]Jožef Stefan International Postgraduate School, Ljubljana, Slovenia. [3]Slovenian Museum of Natural History, Ljubljana, Slovenia

The competition between the Tawny Owl *Strix aluco* and Ural Owl *Strix uralensis* is expected to increase in areas of sympatry due to climate change. In the period between 1998 and 2019, we studied their population dynamics in Dinaric beech forests of Mountain Krim (Slovenia), where the species are altitudinally segregated with Ural Owl dominating at higher elevations. The number of Ural Owl territories is moderately increasing (5.2 ± 1.2 %, $p < 0.01$) with no significant difference between the lower (below 700 m asl) and the upper part of the mountain (above 700 m asl). The Tawny Owl overall trend was stable (2.2 ± 1.1 % annual increase, $p = 0.059$), but increased significantly at higher elevations (8.3 ± 2.1 % annual increase, $p < 0.001$). We found an increase in saturation and overlapping of territories. Tawny Owl mean clutch size from nest-boxes on overlapping territories was significantly lower compared to the nest-boxes in the absence of the Ural Owl (2.9 ± 0.4 vs. 4.0 ± 0.3, $p < 0.05$). No significant effect was found in the Ural Owl. Nest-boxes in the lower part were strictly separated by species, while in the upper part 20 % of the nest-boxes were occupied by each species at least once. In two cases the Ural Owl even took over the active Tawny Owl's clutch. Our results suggest the intensification of the competitive interactions is already taking place in Dinaric forests and a strong shift in intraguild dynamics can be expected in the future.

OS-51

From the boreal forest to the Alps: space use during the breeding period in a forest specialist, the Pygmy Owl

Daniele Baroni[1], Jacopo G. Cecere[2], Massimo Bocca[3], Sofia Koliopoulos[4], Irene Vertua[5], Simona Imperio[2], Toni Laaksonen[1]

[1]University of Turku, Turku, Finland. [2]Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano Emilia, Italy. [3]Parco Naturale Mont Avic, Valle d'Aosta, Italy. [4]Università degli Studi di Torino, Torino, Italy. [5]Università degli Studi di Milano, Milano, Italy

Many secondary cavity nesters are declining in European forests. The lack of basic knowledge regarding their spatial ecology calls for studies aiming to find out the habitat requirements of the species. For the first time, we used miniaturized GPS-tags to study space use by the Eurasian Pygmy Owl *Glaucidium passerinum*, a forest specialist and secondary cavity user showing divergent population trends across Europe. During the breeding season 2021, we collected GPS data from 14 breeding males: 8 from the managed boreal forest in Finland, where there is evidence that the species is declining, and 6 from the Alps in Italy, where it is expanding its range. We found that home ranges are larger than previously assumed and that owls in the Alps have smaller home ranges (90% fixed KDE = 174.7 ± 60.4 ha) than in the boreal forest (331.4 ± 156.3 ha). Pygmy Owls strongly avoided open habitats and forest edges while performing relatively long hunting trips (4.66 ± 1.79 km per day in the boreal forest and 5.93 ± 1.98 in the Alps), and showed different activity rhythms according to the total daylight time. Our results suggest that the owls used different daily hunting areas. This may give an advantage in surprising the prey. In conclusion, GPS-tracking revealed Pygmy Owls needs for large and unfragmented forests, both in the boreal region and in

the Alps, and that the species also exhibits a certain degree of plasticity to adapt under these different environments.

OS-52

Density dependence in the incidence of extra-pair paternity in the Pied Flycatcher (*Ficedula hypoleuca*) in Western Siberia

Vladimir Grinkov[1], Alevtina Samorodova[1], Andreas Bauer[2], Maryana Belokon[3], Yuriy Belokon[3], Tatyana Ilyina[1], Helmut Sternberg[4], Michael Wink[2]

[1]Lomonosov Moscow State University, Moscow, Russian Federation. [2]Institute of Pharmacy and Molecular Biotechnology, Heidelberg University, Heidelberg, Germany. [3]Vavilov Institute of General Genetics, Russian Academy of Sciences, Moscow, Russian Federation. [4]OAG für Populationsforschung Braunschweig, Braunschweig, Germany

Extra-pair copulation (EPC) occurs in most socially monogamous bird species. The evolutionary, ecological, behavioural and physiological causes for the frequent occurrence of extra-pair offspring (EPO) in broods are still unclear. EPCs only occur when there is physical contact between individuals. Consequently, all factors that reduce encounters between individuals must affect the likelihood of extra-pair paternity (EPP). And if this is the case, then this effect should be apparent both in time (if there are significant changes in breeding density throughout years in a population) and in space (if there is any spatial heterogeneity in the number of contacts between individuals). Therefore, we investigated whether there is an effect of breeding density and location of the nest within a regular rectangular plot on the involvement of birds in EPC. Both factors affect the number of contacts with close neighbours. We checked paternity for six years (2005, 2013-2015, 2018, 2019) in Pied Flycatcher broods in Western Siberia. During these years, we controlled paternity in 370 nests. The breeding density of the species varied dramatically during this period. The mean distance to the nearest neighbour changed about two times. Changes in breeding density were related to changes in the rate of EPP. The proportion of nests with EPP and the ratio of EPO among nestlings change by a factor of five (0.235 - 0.048 and 0.104 - 0.019, respectively). Here we show that breeding density and nest location in the study area affect the EPP rate and the EPY ratio.

OS-53

The role of juveniles' social environment in range change of Icelandic Black-tailed Godwits

Joshua Nightingale[1,2], Tómas G. Gunnarsson[3], Böðvar Þórisson[3], Jennifer A. Gill[2], José A. Alves[1,3]

[1]Department of Biology & CESAM, University of Aveiro, Aveiro, Portugal. [2]School of Biological Sciences, University of East Anglia, Norwich, United Kingdom. [3]University of Iceland, South Iceland Research Centre, Laugarvatn, Iceland

Responding to multiple growing anthropogenic pressures on the environment, many bird populations have been observed to change in space and time through shifts in distribution and phenology. In long-lived, site-faithful species, much of this change is hypothesised to occur generationally. For example, the Icelandic Black-tailed Godwit has expanded both its breeding and wintering distributions in recent decades, a trend linked to climatic warming, as well as habitat changes on the breeding grounds. Previous research suggests that these shifts in distribution and migration timing mainly occur generationally, with new recruits to the population behaving differently to previous generations. In this study we explore the mechanisms driving a population's changing distribution, using a twenty-year dataset of colour-ringed Icelandic Black-tailed Godwit chicks. Through capture-mark-recapture models we explore the influence of individual variation in hatching date and natal origin on subsequent winter settlement, with a particular emphasis on juvenile godwits' first winters. We complement this long-term perspective with a study of recently-fledged juveniles on the breeding grounds in Iceland, quantifying how juveniles' access to experienced adults varies with fledging phenology, and in turn how this social environment influences subsequent winter settlement. Finally, we consider the role of these individual effects as possible drivers of this population expansion in response to environmental change. By examining the mechanisms underlying this population's response to environmental change, we aim to deepen our understanding of the challenges and limitations affecting other populations in the Anthropocene.

OS-54

The upper range limit and evational source-sink dynamics in a widespread songbird

Martin U. Grüebler, Johann von Hirschheydt, Fränzi Korner-Nievergelt

Swiss Ornithological Institute, Sempach, Switzerland

The formation of an upper distributional range limit for species breeding along mountain slopes is often based on environmental gradients resulting in changing demographic rates towards high elevations. However, we still lack an empiric understanding of how the interplay of demographic parameters forms the upper range limit in highly mobile species. Here, we study apparent survival and within-study area dispersal over a 700 m elevational gradient in Barn Swallows *Hirundo rustica* by using 15 years of capture-mark-recapture data. Annual apparent survival of adult breeding birds decreased while breeding dispersal probability of adult females, but not males increased towards the upper range limit. Individuals at high elevations dispersed to farms situated at lower elevations than would be expected by random dispersal. These results suggest higher turn-over rates of breeding individuals at high elevations, an elevational increase in immigration and thus, within-population source-sink dynamics between low and high elevations. The formation of the upper range limit therefore is based on preference for low-elevation breeding sites and immigration to high elevations. Thus, shifts of the upper range limit are not only affected by

changes in the quality of high-elevation habitats but also by factors affecting the number of immigrants produced at low elevations.

OS-55

Seasonal timing of reproduction in Great Tits: using selection lines to study the potential for an evolutionary response to global warming

Melanie Lindner[1,2], Irene Verhagen[3], Veronika N Laine[4], Jip JR Ramakers[3], Heidi M Viitaniemi[5], Phillip Gienapp[6], Arild Husby[7], Kees van Oers[1], Marcel E Visser[1]

[1]NIOO-KNAW, Wageningen, Netherlands. [2]GELIFES, Groningen, Netherlands. [3]WUR, Wageningen, Netherlands. [4]University of Helsinki, Helsinki, Finland. [5]University of Turku, Turku, Finland. [6]NABU, Bergenhausen, Germany. [7]Uppsala University, Uppsala, Sweden

In Dutch long-term study populations of Great Tits *Parus major*, global warming has led to a mismatch between the phenology of the birds and their prey, which resulted in directional selection for earlier reproduction. An evolutionary response in the seasonal onset of reproduction might rescue bird populations from the adverse consequences of global warming. To better understand the potential for such an evolutionary rescue, we need to identify the genes underlying laying dates and quantify the amount of genetic variation in those genes and their interaction with the environment. We used more than 2,000 genotyped wild Great Tits to (1) find genetic variants that underlie laying dates and their interaction with the environment in the wild and (2) to create selection lines for early and late laying dates via genomic selection. This method has never been used in a wild population and has indeed led to differences in laying dates between the lines in both the wild and aviaries. We housed the selection line birds in temperature- and photoperiod-controlled aviaries to additionally study the genomic and epigenomic basis of laying dates and its interaction with the environment under controlled conditions. Using a repeated sampling approach, we found evidence for a central role of short-term variation in DNA methylation in mediating the environmentally induced onset of egg laying. Our study combines quantitative genomics in the wild with (epi-)genomics under controlled conditions and is the most comprehensive study to date on the seasonal onset of reproduction of a wild vertebrate population.

OS-56

Sequence variation of DRD4 and its relation to flight initiation distance in Greylag Geese *Anser anser*

Sabrina Mai, Caroline Wittor, Stefan Merker, Friederike Woog

State Museum of Natural History, Stuttgart, Germany

Since 2002, a feral population of Greylag Geese *Anser anser* has established itself in Stuttgart, southwestern Germany. Living in the city parks (urban habitat), these geese show a marked tolerance towards human disturbance. Over the last decade, geese have also been sighted in the surrounding districts, for example in a recreation area (rural habitat). Measurements of flight initiation distances (FIDs) in the urban and rural habitats allow us to assess the wariness of the geese and to explore the genetic basis of this trait. Several studies have shown that sequence variations in the dopamine receptor D4 (DRD4) gene can be associated with wariness. Here, we analyse the genetic variability of DRD4 in Greylag Geese from urban and rural areas in southwestern Germany. To assess genetic diversity at this locus at a larger geographic scale, we also sampled autochthonous populations of Greylag Geese from several European countries. We found ten SNPs in the 491 bp-long sequence of DRD4, eleven different alleles and 36 unique genotypes. Out of these, we detected only nine alleles and 25 genotypes in southwestern Germany. Allele frequency was skewed, with two alleles reaching a combined frequency of 77 % in all geese. Comparing the individual allele frequencies of the most frequent four alleles between urban and rural habitats will allow us to test if it co-varies with the observed FIDs.

OS-57

Inconsistency between morphology and phylogeography in Woodchat Shrike *Lanius senato*r subspecies

Luca Ilahiane[1], Martina Nasuelli[1], Emiliano Pioltelli[2], Giovanni Boano[3], Marco Cucco[1], Marco Pavia[4], Arya Shafaeipour[5], Gary Voelker[6], Andrea Galimberti[2], Irene Pellegrino[1]

[1]Department of Science and Technological Innovation, University of Piemonte Orientale, Alessandria, Italy. [2]ZooplantLab, Department of Biotechnology and Biosciences, University of Milano-Bicocca, Milano, Italy. [3]Museo Civico di Storia Naturale, Carmagnola, TO, Italy. [4]Department of Earth Science, University of Torino, Torino, Italy. [5]Department of Biology, Faculty of Science, Yasouj University, Yasouj, Iran, Islamic Republic of. [6]Department of Ecology and Conservation Biology, and Biodiversity Research and Teaching Collections, Texas A&M University, College Station, TX, USA

Implementing the effort in understanding phylogeographic structures and taxonomic limits within animal groups is crucial in addressing several challenges of modern zoology. Despite avian phylogeography is deeply investigated in Western Palearctic, several families, such as shrikes, still display a complicated biogeographic pattern both between and within the species, requiring further insights. Woodchat Shrike *Lanius senator* is a long-distance migrant, who exhibits three morphologically well-recognizable subspecies, never investigated through genetic tools. Here, we aimed to define the phylogeographic structure of *Lanius senator* throughout its breeding range and to assess the genetic coherence of the described subspecies. We assembled a collection of samples representative for the species breeding distribution, analyzed using four mtDNA and two nuDNA markers. We did not find a clear phylogenetic structure with nuclear ODC and Myo, while all four mtDNA loci highlighted two main haplogroups: one including both the *L. s. senator* and L. s.

badius and the second consistent with *L. s. niloticus* only from the eastern part of the range. Surprisingly, individuals phenotypically assigned to *L. s. niloticus* from Israel are related to *senator*/*badius* haplogroup. Moreover, we have estimated a divergence time among the two haplogroups around Mid-Pleistocene Climate Transition. Our finding showed a mismatch in subspecies assignment between morphology and genetic, and a differentiation dynamic occurring between the eastern *L. s. niloticus* and all the other populations. Future investigations are needed to disentangle this inconsistency framework, through genome-wide data and filling sampling gaps.

OS-58

Complete mitogenome of the Reed Bunting *Emberiza schoeniclus* (Linnaeus, 1758), and the rapid radiation of "open forest" buntings

Iván Alambiaga[1], Juan S Monrós[1], Ferran Palero[1,2]

[1]Cavanilles Institute of Biodiversity and Evolutionary Biology, University of Valencia, Paterna, Spain. [2]Department of Life Sciences, The Natural History Museum, London, United Kingdom

A small group of *Emberiza* species originated by a shift in habitat preferences from sabanas and steppes towards open forests, right after the genus radiated across the Old World at the end of the Miocene (i.e. Clade II in Cai et al., 2021). The Reed Bunting *Emberiza schoeniclus* (Linnaeus, 1758), is the only *Emberiza* from that clade secondarily adapting to occupy Mediterranean wetlands, and some of its southern populations are severely threatened. Within the Iberian Reed Bunting (*E. s. witherbyi*) conservation program, we have obtained the first complete mitogenome of a Reed Bunting using PacBio. The combined analysis of all Clade II species revealed significant variation in the evolution of different mitochondrial genes, particularly for transition/transversion ratios and heterogeneity of the substitution rate across sites, ranging from 0.2 to 1.4 even within the same group of genes (NAD1-NAD6). Phylogenetic relationships were re-assessed based on individual gene sequences and only one third of them supported the *E. schoeniclus, E. pallasi* and *E. yessoensis* group, while 2/3 supported the *E. schoeniclus* and *E. pallasi* group. Positive selection was detected in several protein-coding genes, in particular, when testing the Reed Bunting with other species such as *E. pallasi* or *E. siemsseni*). Our results confirm that mitogenome sequences can be used to study phylogenetic relationships and detect cases of positive selection in open forest *Emberiza*.

OS-59

Carotenoid ketolase gene expression and bill redness altered by mito targeted antioxidant and thyroid hormone in Zebra Finches

Alejandro Cantarero[1], Pedro Andrade[2], Miguel Carneiro[2], Adrián Moreno-Borrallo[1], Carlos Alonso-Alvarez[1]

[1]National Museum of Natural Sciences, Madrid, Spain. [2]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Campus Agrário de Vairão, Vairão, Portugal

Ornaments can evolve to reveal individual quality when their production/maintenance costs make them reliable as 'signals' or if their expression level is intrinsically linked to condition by some unfalsifiable mechanism (indices). The latter has been mostly associated with traits constrained by body size. In red ketocarotenoid-based colorations, that link could, instead, be established with cell respiration at the inner mitochondrial membrane (IMM). The production mechanism could be independent of resource (yellow carotenoids) availability, thus discarding costs linked to allocation trade-offs. A gene coding for a ketolase enzyme (CYP2J19) responsible for converting dietary yellow carotenoids to red ketocarotenoids has recently been described. We treated male Zebra Finches with an antioxidant designed to penetrate the IMM (mitoTEMPO) and a thyroid hormone (triiodothyronine) with known hypermetabolic effects. Among hormone controls, MitoTEMPO downregulated *CYP2J19* in the bill (a red ketocarotenoid-based ornament), supporting the mitochondrial involvement in ketolase function. Both treatments interacted when increasing hormone dosage, indicating that mitochondria and thyroid metabolisms could simultaneously regulate coloration. Moreover, *CYP2J19* expression was positively correlated to redness but also to yellow carotenoid levels in the blood. However, treatment effects were not annulated when controlling for blood carotenoid variability, which suggests that costs linked to resource availability could be minor.

OS-60

Is colour variation and its correlates ancestral in raptors? Insights from a swarm of new genomes

Nayden Chakarov, Tony Rinaud, Meinolf Ottensmann, Oliver Krüger

Deptatment of Animal Behaviour, Bielefeld University, Bielefeld, Germany

In some taxa fitness appears to correlate strongly with one simple and visible trait. Colour variation in *Accipitriformes* may be such a case. Long-term datasets show that colour morph several buzzard and hawk species correlates with many traits which may contribute to the differential fitness while similar polymorphisms are common across the whole order. This poses several alternative hypotheses on how these correlations can arise and whether they are ancestral to the whole order. We are using detailed phenotypic analyses of buzzard plumage along with other more clearly defined polymorphisms. We combine these phenotypes with chromosome-level genome assemblies of several raptor species and resequencing of many individuals per species to perform genome-wide association and singleton-based selection analyses. Identified genomic regions corresponding to morph and fitness variation might predict traits which should correlate with colour because of pleiotropy or linkage. Eventually, we will discuss whether these polymorphisms

have arisen on multiple instances or whether this genomic variation is universal in the order of raptors and has played a key role for their fast speciation.

OS-61

Developmental plasticity drives the loss of migratory behaviour in White Storks

Marta Acácio[1], Inês Catry[2], Pedro Andrade[2], Francisco Moreira[2], Andrea Soriano-Redondo[2], João Paulo Silva[2], Philip W. Atkinson[3], Aldina M.A. Franco[1]

[1]School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom. [2]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, University of Porto, Porto, Portugal. [3]British Trust for Ornithology, Thetford, United Kingdom

Bird migration is changing as a result of recent environmental change and, in some species, juveniles are the main agents driving the shifts in migratory behaviour. White Storks *Ciconia ciconia*, once a classic example of a migratory species, have recently established resident populations in Iberia, likely facilitated by warmer winters and increased food availability on landfills. However, the mechanisms underlying the loss of migratory behaviour remain largely unknown. Between 2016 and 2020, we deployed GPS-Accelerometer loggers on 72 adult and 100 juvenile White Storks in Portugal and found that while 100% of juveniles migrated on their first year, only 24% of adults wintered in Africa. By combining genomic analysis with GPS-tracking data, we show that this change in behaviour towards residency is not likely to be genetically determined, as the genome of migrants and residents is largely undifferentiated, nor a result of adult phenotypic plasticity, as adults are highly consistent in migratory behaviour. Instead, we found evidence of developmental plasticity, since most juveniles decreased migratory distance, ultimately becoming resident, before reaching sexual maturity (3-4 years old). Moreover, juveniles were more likely to migrate shorter distances if, during the previous year, they performed slower autumn migrations, stopping more days on landfills, spending more energy in flight, and arriving later at the wintering grounds. We suggest that previous life experience of juveniles during critical developmental periods can drive profound populational changes through generational shifts, confirming that developmental plasticity is an important mechanism for birds to respond to rapid environmental change.

OS-62

Spring migration strategy, not weather, determines breeding parameters in a migratory songbird

Fraser Bell[1], Malcolm Burgess[2,1], Stuart Bearhop[1]

[1]University of Exeter, Exeter, United Kingdom. [2]RSPB, Sandy, United Kingdom

It is generally agreed that the conditions an individual experiences during migration have the potential to shape migratory strategies, which in turn have repercussions for lifetime reproductive success. Evidence to date has predominated from larger species, with examples correlating environmental conditions encountered during migration with survival or subsequent reproductive output. For passerine migrants however, we have limited understanding of these processes, which is a fundamental gap in our understanding of the potential mechanisms involved in population change. By using a combination of breeding and weather data alongside geolocator tracking data from Pied Flycatchers *Ficedula hypoleuca*, we determine how variation in spring migration strategy among individuals or in response to weather, affects subsequent breeding. Departure from main non-breeding areas in West Africa was highly variable between individuals, whilst not explained by weather, this variation had a strong influence on migration strategy, which in turn influenced breeding. Weather encountered during migration had little impact on subsequent breeding, but influenced the success of migratory flight over the Sahara desert. Overall, our results indicate that spring migration strategy is linked to breeding success in migratory passerines, and spring staging is likely a key element of this. This study suggests that individually variable processes relating to the West African non-breeding season likely have cascading effects on breeding, which may be a determinant of population change.

OS-63

Ontogeny of migration in a partially migratory raptor

Ying-Chi Chan, Stephanie Witczak, Patrick Scherler, Philipp Schwitter, Valentijn van Bergen, Urs G. Kormann, Martin U. Grüebler

Swiss Ornithological Institute, Sempach, Switzerland

Animal migrations worldwide are changing in response to rapid human-induced environmental changes. Transitions towards residency and shorter migration distances are observed in numerous species. In long-lived species, where such transitions could occur within an individual's lifetime, the trajectory of change is largely unknown. Transitioning from migration to residency could be gradual, where individuals shorten their wintering duration and migration distance with age. Alternatively, migratory behaviour could be fixed over years with an abrupt switch to residency. Here we describe how migratory behaviour changes with age in a partially migratory Red Kite *Milvus milvus* population breeding in Switzerland where an increasing proportion of birds remains resident year-round. Since 2015, we tracked movements of 460 juveniles and 78 adults using solar GPS transmitters across multiple years. Almost all juveniles migrate south in winter; older individuals are more likely to become resident, while some remain migratory in adulthood. Wintering duration abroad shortened gradually with age: juveniles stayed, on average, for > 4 months, while adults stayed for ca. 2 months. Wintering sites ranged from central France to the southern Iberian Peninsula; however, > 70 % of individuals showed high overwintering site fidelity. Arrival at the breeding areas became earlier with age, and migration speed significantly

increased from the first to the second spring migration. Therefore, the transition from migration to residency is gradual in time but not in space. Since migrants that arrived earlier at the breeding area bred earlier, benefits of early arrival may play a key role in shaping the changes in migratory behaviours.

OS-64

When to stop on an offshore island? How do weather conditions affect arrival fuel load and potential flight range of a short-distance migrant crossing the North Sea?

Natalie A. Kelsey[1], Ommo Hüppop[1], Franz Bairlein[1,2]

[1]Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany. [2]Max Planck Institute of Animal Behavior, Radolfzell, Germany

Depending on prevailing weather conditions and the birds' physiological state, crossing open waters to continue migration is risky for songbirds. The question arises as to what environmental conditions actually force birds with what physiological state to stop on remote islands, resulting in disruption of migration? Clarifying this question will help to understand the different migratory strategies observed and explain other migratory questions such as stopover duration, departure and migration timing. To answer this question, we caught 1,312 Common Blackbirds *Turdus merula* stopping over on the North Sea island Helgoland, Germany, during autumn and spring migration, and analysed their arrival fuel load, measured with the quantitative magnetic resonance (QMR) method, in relation to wind and relative humidity the night before arrival. We also calculated whether individuals would have successfully crossed the North Sea depending on wind conditions instead of landing on Helgoland. Among other results, we were able to show that unfavourable winds tended to affect the lean birds with low energy resources, while high relative humidity affected all birds, regardless of whether the arrival fuel load was sufficient for onward flight. Although only 9% of all blackbirds captured on Helgoland had insufficient fuel loads to allow safe onward migration in still air, in real wind conditions 30% of birds would not have been able to cross the sea successfully during autumn and 21% during spring migration. Furthermore, we discovered that part of the observed variance could be explained by age, sex and season, suggesting differentiated migratory strategies.

OS-65

Using barometric pressure for tracing migration patterns of a short-distance migrant, the Common Starling *Sturnus vulgaris*

Viesturs Vīgants[1], Ance Priedniece[1], Valts Jaunzemis[1], Ivo Dinsbergs[1], Elza Zacmane[1], Oskars Keišs[1], Martins Briedis[1,2]

[1]Laboratory of Ornithology, Institute of Biology, Riga, Latvia. [2]Department of Bird Migration, Swiss Ornithological Institute, Sempach, Switzerland

During the last decade classical light-level geolocation has revealed a plethora of new discoveries in bird migration, however when assessing geographic location, the margin of error is still relatively large. This opacity has limited the use of geolocators for tracking movements of short-distance migrants. Here, we integrate light-level geolocation with activity and barometric pressure tracking to describe migration behaviour of 11 Common Starlings *Sturnus vulgaris* from Latvia at high spatiotemporal resolution. To estimate geographic locations, the recorded pressure data was compared with remotely sensed surface-level atmospheric pressure at 0.25x0.25-degree grid cells available at The Copernicus Climate Change Service. Results indicated high correlation ($r>0.96$) between the recorded and remote sensed atmospheric pressure values from the breeding site, yielding a location estimate with maximum 30km error. All tracked birds wintered in the British Isles (~2000km from the breeding site) with stop-over sites near the southern coast of the Baltic Sea and the Wadden Sea. Starlings conformed to two distinct migration strategies with 6 of 11 birds departing right after the breeding season in early June, thus having three distinct migration phases during the annual cycle (summer-autumn-spring). The remaining 5 individuals stayed close to the breeding sites until late autumn comprising to classical autumn-spring migration behaviour. Interestingly, in contrary to the literature most long-distance migratory flights (~70%) were carried out at night with one individual completing most of the autumn migration in a single 22h-long flight. Even without the presence of mountainous barriers, maximum flight altitude reached up to 2500 masl.

OS-66

Not all birds dare "crossing the Himalaya" – barrier-avoidance migration of a small passerine in western China

Tianhao Zhao[1], Fumin Lei[2], Gang Song[2], Staffan Bensch[3], Magnus Hellström[4], Mariëlle van Toor[5], Zongzhuang Liu[6], Lisha Lyu[7], Guoming Zhang[8], Bregje Wertheim[1], Barbara Helm[1], Wieland Heim[9]

[1]University of Groningen, Groningen, Netherlands. [2]Institute of Zoology Chinese Academy of Sciences, Beijing, China. [3]Lund university, Lund, Sweden. [4]the Swedish Ornithological Society, Ottenby, Sweden. [5]Linnaeus University, Kalmar, Sweden. [6]Uppsala university, Uppsala, Sweden. [7]ETH Zurich, Zurich, Switzerland. [8]Qinghai University, Xining, China. [9]Turku University, Turku, Finland

Migration tracking of waterfowl, cranes and raptors in the Qinghai-Tibetan Plateau (QTP) region has mostly shown magnificent migrations across the highlands. However, to what extent this behavior can be generalized, especially for smaller migratory species is currently unclear. The Siberian Rubythroat *Calliope calliope* is a powerful model species to study migration responses to the QTP. Most populations breeding in Siberia and the Far-East occupy lowland habitats, whereas

the breeding population in western China is distributed among altitudes between 1500-3500m a.s.l. on the NE edge of the QTP. Recent tracks of Far-East Russian lowland-breeding Siberian rubythroats have revealed a relatively straight route to mainland South-East Asian wintering sites, without major barriers en route. We speculated that the western Chinese highland population therefore also takes a straight route, across high mountain ranges, and tracked these small passerines with two types of data loggers to compare their migration routes and altitudinal movements. We found that the highland population utilizes a detour along the intermediate hill-line of 1000-2000m a.s.l. in central China to bypass QTP and other complex mountain systems, prolonging their route from 2500km to 3300km. The birds gradually decrease altitude along the route, instead of going first up across high mountains and then straight down to wintering sites in Thailand. Our comparison between the two populations points to a potentially diverse range of strategies of the still largely unexplored Chinese migrant community, in response to geographical barriers in western China, as well to altitudinal differences between their breeding and wintering areas.

OS-67

What is driving the change in adult body size in the migratory Alpine Swift?

Giulia Masoero[1,2], Julien Martin[1], Pierre Bize[2]

[1]Department of Biology, University of Ottawa, Ottawa, Canada. [2]School of Biological Sciences, University of Aberdeen, Aberdeen, United Kingdom

Changes in adult body size have become a flagship response to climate change, but there is still little understanding about the contribution of developmental plasticity and microevolution at driving those changes. Using an outstanding >20 years database on adult and nestling Alpine Swifts *Tachymarptis melba* at breeding colonies in Switzerland, we investigated climate-induced changes in growth and in adult body size. The Alpine swift is a highly aerial bird (fly without landing up to 6 months during winter migration). Its body size and shape are thus expected to be under strong selection. As previously documented in North American migratory species, adult swifts showed a 2.9 mm (6.6%) increase in average wing length over the past 2 decades. We then used state-of-the-art statistical demographic models to identify whether this phenotypic change was due to the selective (dis)appearance of some phenotypes in the population or plastic responses at the adult stage. We also investigated climate-induced changes in nestling growth, and we applied animal models to measure trait heritability and get insights on microevolutionary changes. The outcomes of this research should help to understand in detail how early and adult life conditions can influence changes in body size and account for climate-induced changes in the phenotype of wild vertebrates.

OS-68

Long-term decrease in colouration: a consequence of climate change?

David López-Idiáquez[1,2], Celine Teplitsky[1], Arnaud Gregoire[1], Amelie Fargevieille[1], Christophe de Franceschi[1], Maria del Rey[1], Anne Charmantier[1], Claire Doutrelant[1]

[1]Centre d'Ecologie Fonctionnelle et Evolutive (CEFE-CNRS), Montpellier, France. [2]University of the Basque Country, Leioa, Spain

Climate change has been shown to affect fitness-related traits in a wide range of taxa; for instance, warming leads to phenological advancements in many plant and animal species. However, very few studies have explored the influence of climate change on social or secondary sexual traits such as coloured ornaments. Here, we use more than 5800 observations collected along a 15-year period on two Mediterranean Blue Tit subspecies (*Cyanistes caeruleus caeruleus* and *C. c. ogliastrae*) to explore whether climate change impacts their blue crown and yellow breast patch colourations. Our data suggests that colouration has become duller and less chromatic in both sexes over the past 15 years. In addition, in *C.c.ogliastrae,* but not in *C.c.caeruleus*, the decrease is associated with an increase in temperature at moult. Quantitative genetic analyses do not reveal any microevolutionary change in the colour traits along the study period, strongly suggesting that the observed change of colour over time was caused by a plastic response to the environmental conditions. Overall, Blue Tit colourations could become less conspicuous due to warming revealing climate change effects on sexual and social ornaments and calling for further research on the proximate mechanisms behind these effects.

OS-69

Longer breeding seasons do not increase fitness in Barn Owls *Tyto alba* under changing climatic conditions

Paolo Becciu[1], Alexandre Roulin[1], Andrea Romano[2]

[1]University of Lausanne, Lausanne, Switzerland. [2]University of Milan, Milan, Italy

Climatic changes, especially increasing temperatures, are affecting birds' phenology and reproduction at a global level. Studies showed that birds advanced the timing of migration and laying in response to earlier 'spring' events at breeding sites. A possible direct consequence is the lengthening of breeding seasons, which may increase re-nesting potential and therefore result in a larger annual fitness. However, we lack studies about temporal variation in the duration of breeding seasons and on its fitness consequences. By using over 2000 clutches of a Barn Owl population breeding in western Switzerland between 1990 and 2021, an area interested by a marked increase in annual temperatures during the study period, we observed an anticipation of first laying dates and lengthening of breeding seasons. The proportion of females laying multiple clutches increased

from 5% to 25%. Consequently, the mean annual eggs laid per female significantly increased. However, the mean annual number of fledglings remained unchanged, likely due to increasing failed clutches (from 7% to 23%). These trends were similar between yearling and older females, even if the former category increased by 30%. We showed that despite Barn Owls increased their laying effort, they achieve an annual fitness similar to the past decades, and that the age composition of the breeding population is markedly changing with time, thus indicating that an advanced and prolonged breeding season seems not to be beneficial for some species. Identifying causes and consequences of varying breeding phenology and annual fitness is crucial to predict populations' demography under warming climate.

OS-70

Decreasing wing length and winter body mass over the past 28 years in a cold-sensitive passerine bird: simple trends underlie complex relations with seasonal weather

Gaia Bazzi, Fernando Spina, Rosita Mantovani, Pierfrancesco Micheloni, Ezio Orfelini, Andrea Marcon, Lorenzo Serra, Jacopo G. Cecere, Simona Imperio

Area per l'Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA, Ozzano dell'Emilia (BO), Italy

The reduction of body size is among the most striking effects of the present climate change. The phenomenon is so widespread across different taxa to be regarded as the third universal response to global warming. Relying on almost three decades (1989-2016) of nation-wide Italian ringing data, we analysed trends in wing length and seasonal body mass in relation to temperatures and rainfall in a resident, cold-sensitive passerine, the Cetti's Warbler *Cettia cetti*. Wing length decreased over the study period by ca. 1.5% in males and 0.7% in females. A similar decline was observed also in winter and autumn body mass. Such trends are partially mediated by the manifold influences of temperatures and rainfall on body size and condition, with both direct and delayed effects, according to seasons. For example, higher temperatures of the same and/or previous season led to increasing body mass in spring and decreasing body mass in the other seasons. Furthermore, temperatures experienced during post-natal development had carry-over effects on adult wing length and body mass. Remarkably, weather conditions had a statistically significant effect on body mass even during the seasons when the trend of this variable across time was negligible. The intricate observed patterns suggest caution in drawing conclusions on the effects of global warming on morphological traits without considering the whole life- and annual cycles of animal species.

OS-71

Cumulative responses of northern winter bird populations to climate change: adaptations in morphology, habitat use and distribution

Laura Bosco[1], Aleksi Lehikoinen[1,2]

[1]Luomus - Finnish Museum of Natural History, Helsinki, Finland. [2]University of Helsinki, Helsinki, Finland

Responses to climate change are already visible among many taxa, whereby often distribution shifts have been investigated solely. On the other hand, studies testing the effects of climate change on multiple response types are still scarce. In this project we are focusing on three response types, by investigating how climate-change induced adaptations in morphology (i.e. wing length), habitat use and range distribution in northern winter birds are interacting with each other. Furthermore, we test whether those adaptations happen faster at higher latitudes – given the faster temperature increase further north, whether certain species guilds react stronger than others and whether there are trade-offs (negative) or cumulative (positive) relationships among the response types. We also compare measured changes to expected ones based on the observed temperature increase – as measure to quantify potential climatic debts. We use long-term bird monitoring and ringing data from 22 overwintering bird species in Sweden and Finland, spanning over the last five decades and covering >1500 km of latitude. Our results will help quantifying the magnitude at which species can show multiple adaptations to climate change, help understanding how they are inter-related and identify differences in response types among species and regions. Ultimately, our findings can contribute to future conservation measures for the protection of species under current and future climate change.

OS-72

Predicting Citril Finch response to climate change: an analysis of survival and recruitment rates in relation to meteorological covariates

Juan Carlos Senar[1], Antoni Borras[1], Mike Conroy[2], Josep Cabrera[1], Josep Cabot[1]

[1]Museu de Ciencies Naturals de Barcelona, Barcelona, Spain. [2]University of Georgia, Athens, USA

Climate change is a most important driver of forest bird population trends. Most work on the effect of climatic change on extinction risk of different species has been done modelling their future distributions. However, since it is the intrinsic ability of each species to withstand climatic shifts which determines vulnerability to environmental changes, a better approach is to analyse local population dynamics against meteorological covariates. We use a data set of 6,967 Citril Finches *Serinus citrinella*, a typical endemic coniferous forest bird, trapped at a Pyrenean locality from 1991 to 2014. We used survival and recruitment as an overall measurement of fitness, and related

both parameters to a set of meteorological variables using CJS and Pradel models of capture/recapture (CR). We found survival, both of adult and juvenile birds to be highly affected by the number of rain days during June, to the point that less of six rain days entails a negative population increase rate. No meteorological variable affected recruitment rate. Number of rain days in June has been reduced during the last 50 years, so that currently we have less than 6 days, and it is forecasted to be reduced in the Pyrenees by an additional 10-25% by 2050. Demographic parameters obtained from CR models and climate rain projections for the Pyrenees allowed us to predict that the species could be extinct in this area in the next 50 years. Results emphasize the usefulness of population dynamics approaches to analyse the extinction risk of different species.

OS-73

Ecology and behavioural biology of *Sylvia* species breeding in Cyprus

Nikolas Papanikolas, Thomas Hadjikyriakou, Matteo Sebastianelli, Alexander Kirschel

University of Cyprus, Nicosia, Cyprus

Many island endemics around the world have evolved from populations of colonists, but the impact of more recent island colonizers on incumbent congeners is little known, partly because of a dearth of examples of natural colonizations in the recent past. In Cyprus, Sardinian Warbler was first recorded breeding under 30 years ago, but has since rapidly expanded its breeding range to the entire island. Several studies have provided conflicting evidence of the possible impact the Sardinian Warbler colonization might have had on the endemic Cyprus Warbler, with some suggesting the interaction has driven widespread decline in the endemic, while others finding no evidence of resource competition. We investigated population dynamics and interspecific competition among the *Sylvia* warblers in Cyprus by performing surveys across the island covering five different habitat types across three seasons as well as assessing song variation between sympatric and allopatric populations and responses to simulated intrusions. Our results revealed a significant decline in Cyprus Warbler over a five year period, associated strongly with habitat disturbance, but also a negative association between Sardinian Warbler and Cyprus Warbler abundance, suggesting possible competition. Song variation and responses to playback are also consistent with direct competition between the species. Although Cyprus Warbler remains an abundant breeder on the island, the joint effects of habitat disturbance and an aggressive congener's colonization and expansion may threaten its continued existence.

OS-74

Heterogeneous selection on individual variation in male territorial aggressiveness

Stephen Salazar[1,2], Annabel Slettenhaar[2], Nynke Wemer[2], Julia Camacho García[3], Marco van der Velde[2], Maaike Versteegh[2], Jan Komdeur[2], Peter Korsten[1]

[1]Department of Animal Behaviour, Bielefeld University, Bielefeld, Germany. [2]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands. [3]Department of Biology, University of Antwerp, Antwerp, Belgium

Consistent among-individual behavioural variation is ubiquitous across the animal kingdom. Such among-individual variation has been shown to be heritable and to have fitness consequences, but its evolutionary maintenance within populations is poorly understood. Recent studies suggest that spatiotemporal heterogeneity in selection on behaviours (such as exploration) maintains their variation within populations. However, the mechanisms through which selection acts on such behaviours mostly remain a black box, also because test-setups for behavioural assays are often artificial. Selection on behaviours related to social competition, such as aggression, may be frequency or density-dependent as the costs and benefits of their expression likely depend on prevailing social conditions. In a wild population of Blue Tits *Cyanistes caeruleus*, we assessed individual variation in male territorial aggressiveness across three breeding seasons by simulating territorial intrusions at the start of breeding. We studied the associations between territorial aggressiveness and different components of male reproductive success including paternity gain/loss within and outside of their pair bond. We found that males consistently differed in their aggressiveness, but more aggressive individuals, in general, did not achieve higher (or lower) reproductive success. The correlations between aggressiveness and the different components of reproductive success differed in sign across different years, which varied in breeding density, as well as across different age classes of males. Our preliminary results indicate that selection on territorial aggressiveness differs across years and age classes, which may suggest a density-dependent mechanism maintaining among-individual variation in an ecologically relevant behaviour.

OS-75

Zinc sulfate-caused anosmia disrupts short-distance navigation in a breeding migratory songbird: a radio-telemetry study

Alexander Davydov[1], Maria Erokhina[1,2], Alexander Pakhomov[1], Andrey Mukhin[1], Dmitry Kishkinev[3]

[1]Biological Station Rybachy of Zoological Institute RAS, Rybachy, Russian Federation. [2]Department of Vertebrate Zoology, Faculty of Biology, Moscow State University, Moscow, Russian Federation. [3]School of Life Sciences, Keele University, Keele, United Kingdom

Birds are well-known navigators, but their sensory mechanisms required for navigation remain poorly understood. Evidence from recent displacement studies using Eurasian Reed Warblers *Acrocephalus scirpaceus*, a typical songbird migrant, suggested that these birds use magnetic navigation to determine and correct for a 1,000 km translocation but do not require an intact sense of smell for it. However, their ability to use olfactory navigation at short-distances has not been

directly examined in this species and remains understudied in songbirds. The aim of this study is to test if zinc sulfate-treated, anosmic reed warblers could perform homing to their nests after short-distance (<30 km) displacements. Return rates and timing was estimated for displaced and released anosmic and control birds using automated radio-telemetry. The homing performance of anosmic birds was impaired compared to control group (slower development of homing behaviour and lower return rates). This result suggests that in this long-distance songbird migrant olfactory cues and/or intact olfactory system are crucial for short-distance navigation, as opposed to long-distance navigation in the same species. This research was conducted with a support of RFS grant №17-14-01147 and RFBR grant 20-04-01059.

OS-76

Variation in behavioural and physiological chronotypes and their fitness consequences in Great Tits

Aurelia F. T. Strauß[1,2], Dmitry Kishkinev[3], Marcel E. Visser[2], Barbara Helm[1]

[1]University of Groningen, Groningen, Netherlands. [2]Netherlands Institute for Ecology, Wageningen, Netherlands. [3]Keele University, Staffordshire, United Kingdom

Birds cope with diel changes in their environments across the 24 h day by regulating behavioural and physiological processes, such as rest and activity, metabolism and body temperature. Individuals differ in timing of these processes, for example due to genes and environmental conditions. Individuals with consistent differences in diel timing have been categorised into chronotypes, along a spectrum from early to late. However, diel timing can be temporarily modified within individuals to cope with specific situations and thus, to gain higher fitness. This plasticity is thought to be higher for behaviour than for underlying physiology, raising the risk of internal desynchronisation within the individual. This study investigates individual consistency and plasticity of diel rhythms of activity and body temperature and associated fitness benefits and costs. Chronotype might affect fitness by overall timing, but also by differences in plasticity. For example, individuals could benefit from adjusting their timing in challenging situations. However, desynchronisation of behaviour and physiology could come with fitness cost and counteract this benefit. Here, we used remotely collected data on diel activity and skin temperature to determine between and within individual variation in wild Great Tits during the breeding season. For this, individuals were equipped with temperature-sensitive radio transmitters, while additional information on female incubation patterns was collected using small temperature loggers inside the nest. Additionally, fitness proxies were extracted from brood monitoring. Our study will give new insights into the relation between physiological and behavioural rhythmicity within and between individuals, and its consequences for fitness.

OS-77

Wind determines the long-term breeding success of an edge population of a top predator

Laura Gangoso[1,2,3], Duarte S. Viana[4], Adriaan M. Dokter[5], Judy Shamoun-Baranes[3], Jordi Figuerola[2], Sergio A. Barbosa[6], Willem Bouten[3]

[1]Department of Biodiversity, Ecology and Evolution, Complutense University of Madrid, Madrid, Spain. [2]Department of Wetland Ecology, Estación Biológica de Doñana, CSIC, Seville, Spain. [3]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherlands. [4]German Centre for Integrative Biodiversity Research (iDiv), Leipzig, Germany. [5]Cornell Lab of Ornithology, Cornell University, Ithaca, USA. [6]Instituto Português do Mar e da Atmosfera, Lisbon, Portugal

Climate variability can influence biodiversity at different levels of biological organization and is often associated with species distributions and diversity gradients. However, its mechanistic link to population dynamics is still poorly understood. Here, we unravelled the full mechanistic path by which a climatic driver, the Atlantic trade winds, determines the viability of a bird population. We monitored the breeding population of Eleonora's Falcons in the Canary Islands for over a decade and integrated different methods and data to reconstruct how the availability of their prey (migratory birds) is regulated by trade winds. We tracked foraging movements of breeding adults using GPS, monitored departure of migratory birds using weather radar and simulated their migration trajectories using an individual-based, spatially explicit model. We demonstrate that regional easterly winds regulate the flux of migratory birds that is available to hunting falcons, determining food availability for their chicks and consequent breeding success. By reconstructing how migratory birds are pushed towards the Canary Islands by trade winds, we explain most of the variation (up to 86%) in annual productivity for over a decade. This study unequivocally illustrates how a climatic driver can influence local-scale demographic processes while providing novel evidence of wind as a major determinant of population fitness in an apex predator.

OS-78

Within-colony spatial segregation during foraging: from patterns to processes

Jennifer Morinay[1], Louise Riotte-Lambert[2], Geert Aarts[3], Federico De Pascalis[4], Simona Imperio[1], Michelangelo Morganti[5], Carlo Catoni[6], Samuele Ramellini[4], Diego Rubolini[4], Jacopo G. Cecere[1]

[1]ISPRA, Ozzano dell'Emilia, Italy. [2]University of Glasgow, Glasgow, United Kingdom. [3]Wageningen University, Wageningen, Netherlands. [4]University of Milan, Milan, Italy. [5]CNR-ISRA, Brugherio, Italy. [6]Ornis Italica, Rome, Italy

In colonial species, spatial segregation of foraging sites between individuals from neighbouring colonies could emerge by exploiting public or private information and is likely a density-dependent

response to competition. Similarly, at a finer scale, intra-colony competition could lead to spatial segregation in the foraging distribution of different groups constituting sub-units of a colony (hereafter, subcolonies). Intra-colony spatial segregation received so far less theoretical and empirical support, despite its importance in shaping colony structure. We combined empirical and modelling approaches to (1) test for spatial segregation during foraging between individuals from different subcolonies of a colonial raptor, the Lesser Kestrel *Falco naumanni* and (2) assess the possible mechanisms underlying such a spatial segregation. By GPS tracking breeding individuals from two distinct subcolonies within a large colony, we studied subcolony differences in overlap of foraging home ranges, bearings when departing for a foraging trip, foraging trip metrics, daily energy expenditure, and foraging habitat selection. We then implemented an Individual Based Model (IBM) to assess whether memory and personal information could explain the observed patterns of spatial segregation among subcolonies. Individual home ranges from the two subcolonies partially but significantly segregated. Individuals from the two subcolonies showed different departure bearing and encountered different habitats, but did not follow one another when departing. Results from the IBM showed that memory and competition alone can lead to spatial segregation between subcolonies. Such within-colony spatial dynamics may have important consequences on the spatial arrangement of individuals within colonies and may be more widespread than currently envisaged.

OS-79

Gut microbiome disturbances of developing chicks are countered by the continuous inoculation of maternal microbiomes

David Diez-Méndez[1], Kasun H. Bodawatta[2], Inga Freiberga[1], Klečková Irena[1], Knud A. Jønsson[2], Sam Kateřina[1,3]

[1]Institute of Entomology (Biology Centre, Czech Academy of Sciences), České Budějovice, Czech Republic. [2]Natural History Museum of Denmark (University of Copenhagen), Copenhagen, Denmark. [3]Faculty of Sciences (University of South Bohemia), České Budějovice, Czech Republic

Gut microbial communities are complex and heterogeneous, playing critical roles for their animal hosts. Disruptions of these communities can lead to colonisation of harmful bacteria and dysbiosis that can have negative impacts on host's life-history strategies. Nestlings of wild birds show an almost sterile digestive track at hatching, but quickly being colonized by prenatal and environmental transfer of bacteria. However, consequences of the disruptions to this early colonisation of gut microbiomes are unknown in wild bird hosts. To fill this knowledge gap, we disrupted the gut microbial colonization in hatchlings from ten wild Great Tit *Parus major* nests by regularly applying antibiotics or probiotics to duplets during their first ten days of development. We further sampled nest microbiome and parental gut microbiome to assess their influence on the hatchlings' gut communities. We expected a negative impact in gut microbiome diversity and richness in antibiotic treated nestlings and preponderant *Lactobacillus*-related communities in probiotic treated ones. However, we found no measurable impact of the treatments on the diversity

or richness of the nestlings' bacterial communities, neither nestlings' growth. The nest environment was the main factor that influenced gut microbiome composition, and maternal gut microbiome was more influential on the nestlings' gut community structure than paternal microbiome. The continuous inoculation of microbial communities during the regular feeding events may explain the lack of treatment effect, pointing to a high resilience to disruptions. These feeding events would be led by the breeding females, the major contributor to the transmission of gut microbiome communities.

OS-80

Differences in integument colouration and circulating carotenoids in Eurasian Kestrels *Falco tinnunculus* along a gradient of habitat heterogeneity in Western Finland

Lukas Hochleitner[1], Erkki Korpimäki[2], Julien Terraube[2,3], Nayden Chakarov[4], Aurelie Coulon[5,6], Carina Nebel[2,7], Alexandre Villers[8], Christian Voigt[9], Petra Sumasgutner[2,10]

[1]Department of Integrative Biology and Biodiversity Research, University of Natural Resources and Applied Life Sciences, Vienna, Austria. [2]Department of Biology, Section of Ecology, University of Turku, Turku, Finland. [3]Global Change Ecology Research Group, University of the Sunshine Coast, Sippy Downs, QLD, Australia. [4]Department of Animal Behaviour, Bielefeld University, Bielefeld, Germany. [5]CEFE, CNRS, Université Montpellier, Montpellier, France. [6]Centre d'Ecologie et des Sciences de la Conservation (CESCO), Muséum national d'Historie naturelle, Centre National de la Recherche Scientifique, Sorbonne Université, Paris, France. [7]FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Cape Town, South Africa. [8]Office Français de la Biodiversité, Unité Avifaune Migratrice, Station de Chizé, France. [9]Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany. [10]Konrad Lorenz Research Centre (KLF), Core Facility for Behaviour and Cognition, Department of Behavioral and Cognitive Biology, University of Vienna, Vienna, Austria

Loss of habitat heterogeneity has led to global decline of farmland birds. One of these species is the Eurasian Kestrel *Falco tinnunculus* that occupies a higher trophic level and can thus be affected by reduced food availability or accumulative effects along food chain. Lower habitat heterogeneity might also influence Kestrel's diet diversity. Different prey items vary in their caloric and nutritional values as well as contents of micronutrients like carotenoids. These dietary antioxidants can be allocated to either health-related functions or to integument colouration. In this study we aim to unravel a potential interplay of prey abundance, diet diversity, circulating carotenoids, integument colouration and individual health-related parameters of adults along a gradient of habitat heterogeneity in western Finland. Surprisingly, our results show overall higher prey abundance and higher proportions of alternative prey in Kestrel's diet in more homogeneous habitat types. We also found more intense integument colouration in Kestrels with *Haemoproteus* infection and higher haematocrit level. Furthermore, integument colouration in females was stronger pronounced in more heterogeneous habitat types. Assuming that healthy individuals are able to allocate more carotenoids to integument colouration, it appeared that especially females in more

homogeneous habitat types had to cope with higher habitat specific stressors. Finally, circulating carotenoids increased in males and decreased in females, respectively, with increasing body condition and diet diversity. Our findings demonstrate a complex interplay between circulating carotenoids and diet diversity through habitat heterogeneity and its associated prey availability, and that integument colouration might properly reflect individual's health.

OS-81

Do maternally transferred thyroid hormones in avian egg yolks form a bundled trait or have different potential to respond to selection?

Bin-Yan Hsu[1], Tom Sarraude[1,2], Ton Groothuis[2], Suvi Ruuskanen[1,3]

[1]University of Turku, Turku, Finland. [2]Groningen Institute of Evolutionary Life Sciences, Groningen, Netherlands. [3]University of Jyväskylä, Jyväskylä, Finland

In lecithotrophic animals such as birds, egg yolks consist of various substances of maternal origin, collectively building up a complicated multivariate environment for embryonic development and inducing transgenerational developmental plasticity. Among such egg components, some maternally-transferred hormones are metabolic products of other hormones. These hormones are, therefore, likely not deposited in egg yolks independently of one another. One class of such substances are thyroid hormones (THs), whose two main forms – triiodothyronine (T3) and thyroxine (T4) – have been reported to be able to influence offspring phenotype in wild and captive birds. Since T4 is the precursor of T3, yolk T4 levels probably represent a ceiling for yolk T3. Nevertheless, several lines of evidence have pointed out that unlike T3, yolk T4 has a labile pattern over the laying sequence within individuals, suggesting a larger potential for phenotypic flexibility. Our data across 34 bird species also suggested that while these two yolk hormones appeared to be correlated with each other across species, within species the strength of correlation varies. Therefore, despite their biochemical constraints, the two yolk hormones might exhibit different intra-class correlations and may have different selective potential. Here, making use of our previously-collected data from individual level all the way to the species level, we plan to use multivariate mixed-effects models to evaluate the repeatability of yolk T3 and T4 and the variance in their correlation, aiming to explore whether they are two traits which may have different selection potential or actually one single trait.

OS-82

Inferring whole-organism metabolic rate from red blood cells in birds

Kasja Malkoc, Stefania Casagrande, Michaela Hau

Max Planck Institute for Ornithology, Seewiesen, Germany

Metabolic rate quantifies the energy expenditure needed to fuel almost all biological processes in an organism. Metabolic rates are typically measured at the whole-organism level (woMR) but these protocols are often impractical in field conditions and can elicit stress responses due to handling and confinement, potentially biasing resulting data. Recently, techniques to measure cellular metabolic rate (cMR) in mitochondria of blood cells have become available, suggesting that blood-based cMR – a measure unlikely affected by stress responses if blood samples are collected immediately after capture – can be a proxy of organismal aerobic performance. Using captive Great Tits *Parus major*, we tested the hypothesis that blood-based cMR correlates with woMR, by combining repeated blood sampling and respirometry during day-time to reflect ecologically relevant conditions. From blood samples, we measured erythrocyte cMR and plasma corticosterone concentrations. Despite the additional variance introduced by collecting MR measurements during the active phase, birds that had relatively low corticosterone concentrations, and displayed little locomotor activity throughout respirometry showed a positive correlation between cMR and woMR. By contrast, woMR and cMR covaried negatively in birds that increased corticosterone concentrations and activity levels substantially. Our findings highlight the importance of accounting for individual stress responses when measuring metabolic rate at any level. More importantly, they provide the first direct evidence that metabolism measured in a systemic tissue like blood can be informative of the overall metabolic status of an individual, making blood-based cMR a potentially suitable measure for field metabolic rates in birds.

OS-83

Inheritance of early life telomere length in Zebra Finch

Ye Xiong, Michael Tobler, Dennis Hasselquist

Lund University, Lund, Sweden

Heritability of telomere length (TL) varies between and within species. Studies on humans have estimates of TL ranging from 30% to 80%. Studies on birds have reported much higher heritability estimates (>90%), and much lower on long-lived myotis bats (<10%). To better understand how telomere length is inherited between generations, we designed a selective breeding experiment on captive Zebra Finches *Taeniopygia guttata*. We compared early life telomere length (eTL) of six days old embryos and 10 days old nestlings within and between nests and between parental telomere length group, parental age group and generations. This study attempts to untangle the genetic and non-genetic factors that may influence eTL. This will help us to understand how telomere length varies and find possibility of more flexible inheritance patterns of telomere length in vertebrates.

OS-85

A million nest boxes, how many natural cavities? The nest sites of three avian model species of ecology and evolutionary biology

Toni Laaksonen[1], Daniele Baroni[1], Jan Hanzelka[1,2], Aleksi Lehikoinen[3]

[1]University of Turku, Turku, Finland. [2]Charles University in Prague, Prague, Czech Republic. [3]University of Helsinki, Helsinki, Finland

Natural tree cavities form a critical resource for a large number of obligatory cavity-nesting species in the forests of the world. Many species have suffered from a drastic reduction of available cavities due to loss of forested area and cavity-bearing old trees. As a simple conservation means, artificial nest boxes have been provided, but their significance for different species compared to natural cavities in large geographic scales has remained unclear. Understanding the availability and distribution of the critical cavity resource is important not only for conservation, but also for putting into context the ecological and evolutionary studies conducted on cavity-nesters. Here, we examine the availability of natural cavities and nest boxes for three cavity-breeding model species of ecology and evolutionary biology in >200 000 km^2 of boreal forest biome in Finland. Using several different data, we estimate the number of nest boxes and natural cavities available, and the proportions of populations breeding in each. We show that the species show different levels of dependency on nest boxes and that the dispersion of nest boxes differently affects the distribution of the species across habitats. A two-year public campaign registered over a million nest boxes built by the public, showing an enormous potential of voluntary citizen conservation, while at the same time revealing the vulnerability of the species that now depend on the nest boxes. A continuous and sufficient natural supply of old trees (especially deciduous) in the future is needed for reducing the dependency of cavity-nesters on artificial nest sites.

OS-86

Secondary cavity nesters as habitat creators: diversity of arthropods in different types of cavity nests of boreal forests

Jan Hanzelka[1], Daniele Baroni[2], Toni Laaksonen[2]

[1]Institute for Environmental Studies, Faculty of Science, Charles University, Prague, Czech Republic. [2]Department of Biology, Faculty of Science, University of Turku, Turku, Finland

Nests of cavity-nesting birds form a habitat for other species such as various arthropods. Their community structure may depend on characteristics such as nest material, its stage of decomposition, and cavity type (nest box or excavated cavity, tree species). To disentangle how these parameters shape the arthropod communities, we collected one-season and several-seasons-accumulated nests of great tits and pied flycatchers from nest boxes and cavities excavated by

Great-spotted Woodpecker (in common aspen and Scots pine) in managed boreal forests of southwest Finland. We also collected nests and food hoards of the Pygmy Owl (PO) that is using the nest boxes in the study area. The highest arthropod taxa richness we found in PO nests (mean; sample size=8.0; 8) and food hoards (7.6; 8), followed by several-seasons-accumulated nests (6.3; 9) and nests in cavities (5.6; 13), while one-season nests in nest boxes hosted the lowest richness (4.4; 39). A correspondence analysis (CA) based on arthropod abundance indicated a separation of PO nests and nests in aspen cavities (containing considerably decomposed animal and plant matter) from the others. Constrained CA confirmed this pattern, showing that PO nests were characterized by Coleoptera larvae and adults (Staphylinidae, Histeridae, Trogidae), while aspen cavities nests were dominated by fly larvae (Syrphidae, Tipulidae) and diplopods. Our results show that there is variation in arthropod communities depending on tree species, cavity type, accumulation time and bird species building the nests. Excavators, nest box providers and secondary cavity nesters thus influence the habitat available for arthropods in the cavities and are important habitat providers.

OS-87

Use of geolocators for investigating the breeding ecology of a rock-crevice nesting seabird, the Little Auk *Alle alle*

Antoine Grissot[1], Clara Borrel[2,3,1], Malin Johansen[4], Hallvard Strøm[4], Katarzyna Wojczulanis-Jakubas[1]

[1]University of Gdańsk, Gdańsk, Poland. [2]L'Institut Agro (AgroCampus Ouest Rennes), Rennes, France. [3]Université de Rennes 1, Rennes, France. [4]Norwegian Polar Institute, Tromsø, Norway

Seabirds play a major role in both marine and terrestrial ecosystems and are commonly used as indicators of environmental quality of the oceans. The harsh environment they encounter imposes bi-parental care and flexibility in the parental involvement needed to ensure successful breeding, making their breeding ecology an interesting study case. Seabirds are however particularly hard to study as they spend most of their time at sea, beyond the reach of researchers. Modern technology greatly helps to fill gaps in our knowledge of seabird ecology, thanks to devices that remotely collect data on movement and behaviour. One such device, the miniaturised light-based geolocator or GLS, is primarily used to document seabird' movements and wintering grounds but extra sensors enable us to record their activity (in flight or at sea) and foraging patterns, which in turn can be of use in studies of breeding behaviour. In this study, we developed a method to study otherwise invisible behaviour in the nest chamber of a rock crevice-nesting seabird the Little Auk *Alle alle*. We used GLS data to identify key activity within the breeding period (egg incubation, chick brooding and feeding) and to assess breeding behaviour and parental care. We validated the method by comparing it to a well-established video recording method and found it of good reliability to study parental care. We also assessed behavioural and fitness consequences of GLS deployment and found short-term effects on bird behaviour but no effect on reproductive success.

OS-88

Fresh green sprigs in raptor nests – protection against parasites or ongoing nest construction? Insights from a long-term study on Common Buzzards *Buteo buteo*

Meinolf Ottensmann, Nayden Chakarov, Oliver Krüger

Bielefeld University, Bielefeld, Germany

Nests fulfil an integral role for reproduction in most bird species. With nest construction, including the choice of characteristics of nesting material, birds can modify the environment to improve conditions for raising their offspring. The use of fresh green plants (hereafter greenery) is a conspicuous trait that has been observed among diverse species, e.g., passerines and raptors. It is often argued that the placement of greenery is not part of nest construction itself, as plants are seemingly added after nest building is completed. This assumption together with the observation that utilised plants are often rich in secondary compounds has sparked a lot of interest in the study of its adaptive value. For instance, the nest protection hypothesis postulates that greenery could act as a repellent against parasites. However, empirical evidence remains inconclusive, and is mostly restricted to a few cavity nesting passerines. Here, we present insights from exploratory analyses of an unprecedented long-term dataset comprising more than 1,500 Common Buzzard *Buteo buteo* broods sampled over 17 consecutive years. While we found a weak, negative association between greenery prevalence and parasite infection intensity, other factors such as nestling age, body condition, habitat structure and annual variation were much more important. Additionally, and against expectation, we found no evidence for a preference of specific plants. Instead, variation in greenery composition predominantly reflected habitat heterogeneity. Altogether, our results suggest that greenery use in Buzzards is primarily relevant for strengthening the nest structure during brood rearing and not antiparasitic properties.

OS-89

Nest site selection by Wood Warblers *Phylloscopus sibilatrix* and ants in a temperate primeval forest: evidence of interspecific attraction?

Grzegorz Hebda[1], Richard K. Broughton[2], Luca Casacci[3], István Maák[4], Gema Trigos-Peral[5], Magdalena Witek[5], Marta Maziarz[5]

[1]University of Opole, Opole, Poland. [2]Centre for Ecology & Hydrology, Wallingford, United Kingdom. [3]University of Turin, Turin, Italy. [4]University of Szeged, Szeged, Hungary. [5]Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland

Nest site selection by birds could result from interspecific attraction between them and other animals, including invertebrates inhabiting bird nests. Interactions between birds and ants are rarely studied, and the rudiments of colonisation of bird nests by ants are poorly understood. A preference

by birds to nest close to ant colonies could promote ant colonisation of bird nests, and provide advantages for birds via nest sanitation or defence by ants. Ants might benefit from raising their own broods under more suitable thermal conditions in bird nests. We investigated the interactions between Wood Warblers *Phylloscopus sibilatrix* and ants that raised their broods within the bird nests. We explored whether cohabitation of birds and ants resulted from interspecific attraction between the two groups through their nest site choice. We tested whether (i) the occurrence of ant broods within bird nests was non-random, (ii) the cohabitation could be explained by the overlap in nest site choice of birds and ants, and/or (iii) if it resulted from the ants' attraction to nests of birds during cool and wet weather to raise their own broods under the advantageous microclimatic conditions. Our results indicate a one-sided attraction of non-random occupation of bird nests by ants, whereas nest placement by birds and ants hardly overlapped. We also show that the attractiveness of bird nests to ants increased during unfavourable weather conditions. The widespread distribution of nest-building birds and the associated temperature-dependent invertebrates suggests that similar associations may be more common across cool regions of the World.

OS-90

Nests reduce the energetic costs of brooding offspring for passerine birds in the tropics

Mark Mainwaring[1], Tom Martin[1], Blair Wolf[2], Bret Tobalske[1]

[1]University of Montana, Missoula, USA. [2]University of New Mexico, Albuquerque, USA

Reproduction is an energetically expensive activity for parents and keeping endothermic offspring at their thermal optima represents a significant energy cost. Avian offspring develop optimally at ~39˚C. The tropics are generally thought to provide warm ambient conditions that require less effort to keep offspring warm. Yet, the synergistic effects of high rainfall and winds that characterize the mid-montane tropics may exacerbate heat loss and mean that the energetic costs of keeping altricial offspring at optimal temperatures are substantially higher than previously imagined for the tropics. However, the building of enclosed and thus sheltered nests may enable birds to buffer the effects of adverse weather conditions. Here we provide experimental and observational evidence that ambient temperatures in the tropics are ~20°C below the thermal optima of 39˚C and that rainfall and wind synergistically combine to increase the energetic costs of keeping offspring at thermal optima. Meanwhile, those costs varied between nest types, with species building enclosed nests saving significantly more energy than species building open nests. Our measurements and experiments demonstrated that rainfall, wind and their synergistic effect induces convective cooling that dramatically increases the costs of keeping endothermic offspring at their thermal optima in tropical regions. However, nest design can mitigate those costs and provide an important way of enabling animals to adapt to adverse environmental conditions in biodiversity-rich, but anthropogenically-threatened, tropical regions.

OS-91

Instantaneous sampling of accelerometer data allows cost-effective insights into time budgets of wide-ranging raptors

Julia Hatzl[1], Matthias Tschumi[1], David Jenny[1], Loïc Pellissier[2], Kamran Safi[3], Petra Sumasgutner[4], Martin U. Grüebler[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]ETH Zurich, Zurich, Switzerland. [3]Max Planck Institute for Animal Behaviour, Radolfzell, Germany. [4]Konrad Lorenz Research Centre, Grünau, Austria

Accelerometer (ACC) sensors are used to identify body position and infer behaviours which is valuable for gaining insights into the secretive life of mobile animals. However, limitations in battery power have often resulted in comparably short periods of high frequency ACC data investigated so far, leaving us with snapshots of animal lives. This prevents us from understanding long-term changes in behaviours or time budgets over life-history stages. Here, we tested the potential of instantaneous sampling, i.e. recording behaviour at predetermined time intervals, to reliably calculate time budgets of juvenile Golden Eagles. In this study we trained a random forest algorithm on a ground-truthed falconry Golden Eagle dataset comprising of 3872 eight-second ACC-bursts. This algorithm was subsequently used to predict behaviours every 5 minutes for 44 free-ranging tagged juvenile Golden Eagles. Additionally, we validated identification of behaviours of free-ranging birds using a restricted data set of simultaneous field observations of behaviours. Within the nesting period predicted time budgets matched the observed data closely. Furthermore, following fledging correspondence between predicted time budgets were similar to observed time budgets, although slightly underestimating some rare behaviours. These findings show that instantaneous sampling of ACC data can be used to identify explicit behaviours with high certainty and assess behavioural time budgets. Yet, some limitations exist, and need to be accounted for, especially for rare behaviours. In conclusion our results suggest that instantaneous sampling offers a cost-effective solution to provide novel insights into the behaviours of elusive species over large spatial and temporal scales.

OS-92

Why my mother leaves me or rather why my father stays with me? A big question of the Little Auk chick

Katarzyna Wojczulanis-Jakubas, Dorota Kidawa, Martyna Cendrowska, Dorian Cordier, Antoine Grissot, Marion Devogel, Dariusz Jakubas

University of Gdańsk, Gdańsk, Poland

In a number of avian species adopting bi-parental care, one parent will desert the brood before its independence, but the reasons for such desertion, and why a particular parent does it but not the other, are usually poorly understood. This is particularly intriguing when desertion occurs in species where bi-parental care is crucial to raise the brood successfully. Here, we revise several hypotheses to explain the case of an Arctic seabird, the Little Auk *Alle alle*, in which females desert at the end of the nesting period, while males stay with the chick and accompanies its departure from the colony. Our to-date results do not support most of the available hypotheses: a) long and extensive parental care during short Arctic breeding season excludes *re-mating opportunity hypothesis*; b) similar physiological costs of breeding in males and females and energetic compensation during the egg production undermine *body reserves depletion hypothesis*; c) similar male and female survival rate and observed flexibility in the female's behaviour undermine *sex-biased overall costs of breeding hypothesis*; d) similar stress response of the sexes questions at some extent *a special role of the staying parent*. However, the *Willliam's hypothesis* about parent-offspring association via territory association by the parent seems a plausible explanation of the observed pattern. Indeed, our results clearly show male-biased time-investment into nest site guarding, thus, the male staying longer with the chick could simply be a natural consequence of his strong association with the nest site area.

OS-93

Morph-specific natal and breeding dispersal distances in relation to winter conditions and prey availability in a wild colour polymorphic raptor

Arianna Passarotto[1], Chiara Morosinotto[1,2], Jon E. Brommer[3], Esa Aaltonen[4], Kari Ahola[5], Teuvo Karstinen[6], Patrik Karell[1,2]

[1]Novia University of Applied Sciences, Ekenäs, Finland. [2]Evolutionary Ecology Unity, Department of Biology, Lund University, Lund, Sweden. [3]Department of Biology, University of Turku, Turku, Finland. [4]Vanhansahantie 13B 7, Lohja, Finland. [5]Tornihaukantie 8D 72, Espoo, Finland. [6]Juusinkuja 1, Kauniainen, Finland

Dispersal is a crucial process in birds' life that can be driven by both individual and environmental features, but phenotype-by-environment interactions are rarely investigated. Here, we studied natal and breeding dispersal in the Tawny Owl *Strix aluco*, a classic example of sedentary and highly territorial owl. This species also displays a melanin-based colour polymorphism associated with specific behavioural and physiological profiles and the two colour morphs (grey and brown) are predicted to be differently sensitive to climatic variation and prey availability. Using a 40 years dataset of a constantly monitored population, we explored variation in dispersal movements of these alternative phenotypes according to winter harshness and small mammal prey abundance. We found that winter conditions affect local natal dispersal distances of the two colour morphs. While the brown morph disperses further in milder winters, grey individuals disperse longer distances in colder winters. On the other hand, we found that morphs' breeding dispersal distances are predicted by prey abundance. When mammal abundance is higher, the brown morph shows a

higher probability to move to a nest further away. Our results suggest that both natal and breeding dispersal strategies are morph-specific in Tawny Owls and affected by different environmental variables. Post-fledging winter temperature influences distances travelled by young dispersers, whose survival depends on how fast they find a vacant territory once parental cares cease, whereas in territorial adults, which are typically site-tenacious, prey availability triggers breeding movements. These findings may shed light on possible evolutionary responses of heritable phenotypes to environmental changes.

OS-94

Historic ringing data reveals the role of magnetic cues in return migration

Joe Wynn

University of Oxford, Oxford, United Kingdom

The mechanisms that allow birds to return precisely to their breeding site year-on-year ('philopatry') are both remarkable and unsolved. It has been suggested that this ability could be predicated upon gradient cues varying through space, which could be learnt prior to departure and in turn used to precisely target the breeding site during return migration. Different parameters extracted from the Earth's magnetic field have been suggested as candidates for long-distance navigation, including magnetic inclination: the 'dip angle' between the Earth's magnetic field and the Earth's surface. Here, we present evidence that, for the first time, specifically implicates magnetic cues in avian philopatry. Using historic ringing data from a variety of bird species, we show that small (but measurable) shifts in the position to which birds return correlate with year-on-year shifts in the inclination of the Earth's magnetic field, suggesting that birds recall the location of the natal site relative to a magnetic gradient cue. We suggest that such a mechanism could in principle underpin return migration in species from across the avian phylogenetic tree, and more generally point to the utility of historic ringing and sightings data when exploring mechanisms of long-distance navigation.

OS-95

Higher activity in the nest is associated with increased exploratory behaviour and early onset of natal dispersal in juvenile Golden Eagles *Aquila chrysaetos*

Svea-Sophie Zimmermann[1], Martin U. Grüebler[1], Julia Hatzl[1,2], Kamran Safi[3], David Jenny[1], Matthias Tschumi[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]Department of Landscape Ecology, ETH Zürich, Zürich, Switzerland. [3]Department of Migration, Max Planck Institute for Animal Behaviour, Radolfzell, Germany

The first year of life represents a pivotal time in the life-history of altricial birds. Individual development and behaviour during the nestling and post-fledging dependence period (PFDP) can have critical effects on long-term decision-making, fitness, and survival. Yet, though individual differences of nestlings can already manifest in the post-fledging period, the relationship between nestling behaviour, movement patterns and the onset of natal dispersal as well as their underlying drivers remain understudied. We used high-resolution GPS and body-acceleration data of 35 juvenile Golden Eagles *Aquila chrysaetos* to investigate the influence of intrinsic factors and environmental conditions on activity, timing of fledging, exploratory behaviour and the onset of natal dispersal. Higher activity measured as ODBA (Overall Dynamic Body Acceleration), both in the nest and during the PFDP, was associated with earlier fledging, increased explorative behaviour and earlier emigration from the natal territory. Additionally, activity in the nest and during the PFDP were positively correlated. While males were more active and fledged earlier than females, females undertook more and longer excursions. Our results suggest that higher activity levels in the nest either reflect a bolder personality or better environmental conditions with carry-over effects on activity and exploratory behaviour during the PFDP, as well as the timing of emigration. Individual differences in activity and exploratory behaviour, as well as additional effects of sex thus seem to be indicative of early development of dispersal phenotypes with potential consequences for fitness and survival.

OS-96

Of normals, natural variation and nutcases: aberrant individual movement behaviour of tracked birds and what we can learn from it

Wolfgang Fiedler

Max Planck Institute of Animal Behavior, Radolfzell, Germany

Animal tracking with the help of electronic devices enables us to follow movements of animals in temporal and spatial resolutions that were unachievable before. This makes it possible to detect untypical, individual movement decisions that might have been overlooked or explained by methodical errors before. Examples of those untypical movement events can comprise rapid temporary back turns during migration, unexpected directions or aberrant timing. As a result of such untypical behaviour birds sometimes show up in untypical places or at untypical times and are registered and documented as rarities, but most of those cases likely have been overlooked so far. In my talk I will present examples mainly from a very large tracking dataset of the White Stork, but also from a few other studies, to discuss when and how we can be sure these cases are not artefacts due to tracking, what drivers might be acting and what we can learn from those cases. Some cases might even not be as unusual as we first thought. And after all, it is worth to remember that in order to promote innovation natural selection needs individuals behaving “beyond the normal” as a substrate to select on.

OS-97

Possible solution to reduce seabird bycatch in gillnet fishery

Julius Morkūnas[1,2], Rasa Morkūnė[3]

[1]Klaipėda University, Klaipeda, Lithuania. [2]Lithuanian Ornithological Society, Vilnius, Lithuania. [3]Klaipėda Unviersity, Klaipėda, Lithuania

Seabird bycatch in gillnets represents an important cause of human-induced mortality, especially in the Baltic Sea, a globally important area for wintering seabirds. Wintering seabird populations in the Baltic have declined significantly in recent decades. To find the solution to reduce seabird bycatch we tested two mitigation methods in Lithuanian coastal gillnet fishery. We performed 50 experimental fishing trips in the winter seasons of 2019-2020 with 4 fisheries enterprises. The first solution was setting gillnets only for night (from evening to the morning). The second tested solution was the installation of kites imitating birds of prey close to the nets; kites were equipped on the buoys each 150-300 meters. Totally 32 seabirds were bycaught in gillnet fishery during the studied wintering season, 28 of them were caught by control nets, 3 birds were caught in the gillnets with kites, and a single bird was caught at night setting. This mitigation of both tested methods can reduce bycatch from 8 to 10 times. There was no difference in target fish catch in comparison to control and threatened gillnets. The preliminary data shows that there is a possible mitigation solution to reduce bycatch of seabirds and not affect fish catch. However, to make a clear statement we need one more season of testing the mitigation in the field.

OS-98

Seasonal carry-over effects reveal reproductive costs in a shorebird species

Magali Frauendorf[1,2], Henk-Jan van der Kolk[1,2], Andrew Allen[1,2,3], Bruno Ens[4,2], Eelke Jongejans[3,1,2], Simon Verhulst[5], Sarah Cubaynes[6], Hans de Kroon[3,2], Kees Oosterbeek[4], Symen Deuzeman[4], Karin Troost[7], Martijn van de Pol[1,2]

[1]Netherlands Institute of Ecology, Department of Animal Ecology, Wageningen, Netherlands. [2]Centre for Avian Population Studies, Wageningen, Netherlands. [3]Radboud University, Department of Animal Ecology and Physiology & Experimental Plant Ecology, Nijmegen, Netherlands. [4]Sovon Dutch Centre for Field Ornithology, Texel, Netherlands. [5]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands. [6]CEFE, Univ Montpellier, CNRS, EPHEPSL University, IRD, Univ Paul Valéry Montpellier 3, Montpellier, France. [7]Wageningen Marine Research, Yerseke, Netherlands

Identifying the main drivers of population decline is challenging in migratory species, as they can be affected at different stages of the annual cycle that are geographically separated. Furthermore, the impact of environmental drivers at one site may not be directly apparent due to carry-over

effects (COEs). COEs have not been described often because of the challenges of tracking individuals over their annual cycle. Additionally, body condition, thought to be the state variable mediating COEs, has been limited only on body mass. Here, we investigate how winter body condition influences reproductive success in Eurasian Oystercatchers across the Netherlands and expand previous studies by considering a wider range of potential measures of body condition. We colour banded and measured the condition of 1574 individuals in the winters 2001-2018 and used citizen science observations from both wintering and breeding areas over a large spatial scale. We quantified a condition index using structural equation models, linked the winter condition to environmental drivers and related it to the reproductive success in the subsequent season. Results indicate a positive COE. Nests and chicks survived longer, when adults in the previous winter had a higher body condition. The individual condition in winter is mainly influenced by grassland proportion, the conspecific density, temperature and the cockle availability around the wintering ground. We suggest that COEs play an important role in explaining the variation in individual performance, help to clarify the relative importance of various environmental threats and therefore should receive more attention in population studies.

OS-99

Conspecific attraction in the Eurasian Wryneck *Jynx torquilla* – playback as a conservation tool?

Matthias Vögeli[1], Paula Schatte[2,1], Michael Lanz[1], Martin Schuck[3], Reto Spaar[1], Martin U. Grüebler[1]

[1]Schweizerische Vogelwarte, Sempach, Switzerland. [2]AG Angewandte Landschaftsökologie und Ökologische Planung, Institut für Landschaftsökologie, Westfälische Wilhelms-Universität, Münster, Germany. [3]BirdLife Schweiz, Zürich, Switzerland

Conspecific attraction has already been used as a suitable and cost-effective measure in avian species conservation. However, this mechanism has not yet been specifically investigated for woodpeckers (*Piciformes*), despite existing evidence of conspecific attraction in this order. In an experimental approach, we tested whether conspecific attraction using vocal playback increased the presence and breeding probability of the Wryneck *Jynx torquilla* on 51 experimental plots in Switzerland during two consecutive breeding seasons. Overall, wryneck occurrence was positively correlated to the proportion of vineyard. Playback treatment had a positive effect on visiting rate of nest box sites during prospecting but did not show any effect on territory establishment or breeding probability. However, the effect of the playback was independent of the measured habitat characteristics. We therefore hypothesize that habitat selection of the wryneck depends on both conspecific attraction and habitat quality, although conspecific attraction seems to be more important than habitat quality at the beginning of the settlement phase. Consequently, playback seems to be a useful conservation management tool to attract Wrynecks to suitable habitats.

OS-100

Tree-related Microhabitats (TreMs) from Białowieża bird perspective

Katarzyna Kamionka-Kanclerska, Oliwia Karpińska, Dorota Czeszczewik

Siedlce University of Natural Sciences and Humanities, Siedlce, Poland

In last decade, more attention has been paid to microhabitats related with trees (alive and dead), based on which the condition of the forest can be assessed. Currently, researchers use the classification according to Laurrieu et al. 2018 (Tree related microhabitats in temperate and Mediterranean European forests: A hierarchical typology for inventory standarization. Ecological Indicators 84:194-207). However, there is still a gap in knowledge about their direct use by birds. Aim of the study was to extend the existing TreMs classification based on the observation of microhabitats used by birds under primeval conditions. Field work was carried out in spring and autumn in the oak-lime-hornbeam stands of the Białowieża National Park (Poland). Data on the use of microhabitats by birds were collected by direct search for traces and with the use of camera traps. The study compares the currently used TreMs classification with the features of microhabitats used by birds. The most important observation is that birds use TreMs with smaller dimensions than described before. For example the minimum dimensions of rot-holes opening, allowing it to be classified as TreMs were 10 cm in diameter. From literature we know that such a limitation does not match the nesting preferences for at least six secondary cavity nesters. The exchange of experience between ornithologists studying forests biodiversity is necessary to adapt this tool to the requirements of birds in different forest conditions.

OS-101

Collaboration between farmers and ecologists: a unique social tool to increase pro-environmental behaviors

Estelle Milliet, Fabrizio Butera, Alexandre Roulin

University of Lausanne, Lausanne, Switzerland

In Europe 60% of common farmland birds are currently threatened due to habitat loss and fragmentation, mainly because of intensification and homogenization of agricultural landscapes. Despite the measures already implemented in most countries to promote on-farm biodiversity, nothing can be done without the involvement of farmers, who have to be willing and able to adapt their agricultural practices in an eco-friendlier way. To improve nature conservation, it is therefore of main importance to study the motivations of farmers towards pro-environmental behaviors. Taking advantage of our unique long-term collaboration with local farmers in our Barn Owl conservation project in western Switzerland, the present study aims to assess the impact of such relationship on the pro-environmental behaviors of farmers and the factors influencing them.

Through self-reported surveys, we observed that the better the opinion farmers have of science, the higher the self-reported ecological behaviors of farmers who collaborated with the project as compared to farmers who did not collaborate. By collaborating with scientists, farmers improve their scientific opinion, which then increases their ecological behaviors. This project is a unique interdisciplinary study, highlighting the importance of collaboration between farmers and scientists as an efficient tool to promote ecological behaviors. Moreover, it focuses on a group of people that is rarely considered in studies about pro-environmental behaviors, but who are one of the main contributors to the improvement that can be done for the environment. Merging social psychology and ecology, this project aims at reaching efficient agricultural conservation measures.

OS-102

Using web-portal data to identify population trends and infer causes

Daniel Fink[1], Alison Johnston[1,2], Amanda Rodewald[1], Matt Strimas-Mackey[1], Tom Auer[1], Shawn Ligocki[1], Wesley Hochachka[1], John Sauer[3], Lauren Oldham[1], Orin Robinson[1], Chris Wood[1], Steve Kelling[1]

[1]Cornell Lab of Ornithology, Ithaca, USA. [2]University of St Andrews, St Andrews, United Kingdom. [3]USGS Eastern Ecological Science Center, Laurel, USA

Monitoring changes in bird populations with data collected by "web portal" schemes is difficult because both the actual sizes of populations and the way that participants search for and report birds may change through time. The appropriate types of web-portal data and analysis methods, however, can be combined to provide information that complements formal bird monitoring schemes and provides new insights into change in population sizes and their causes. Here we share results from novel analytical approaches that allow web portal data to be used to estimate the percent-per-year changes in species' abundances at fine at fine spatial resolution. We have found substantial agreement in the directions and magnitudes of trends in bird populations independently calculated from analyses of formal monitoring data and semi-structured web-portal data from eBird in North America. The analytical methods that we are developing enable the calculation of spatially varying trends for change in species' abundances at fine resolution. In our presentation we will show examples of these spatially explicit trends and how they can be aggregated to compute mean trends across larger regions. Next, we will demonstrate how these trend estimates can be linked with landcover/habitat data to elucidate the drivers of population change. Finally, we will show that the landcover/habitat change model can be used to simulate the potential future impacts on populations of changes in environmental conditions.

OS-103

Your competitors' enemy is your friend? How the return of the Eurasian Eagle Owl *Bubo bubo* as an intraguild predator changes the dynamics in a raptor community in north-western Germany

Kai-Philipp Gladow, Nayden Chakarov, Oliver Krüger

Bielefeld University, Bielefeld, Germany

The presence or absence of intraguild predation (IGP) has a profound impact on the trophic structure of whole ecosystems; its presence can stabilize and diversify ecological communities. However, the specific mechanisms of intraguild predation influencing the dynamics of avian communities remain little known. This is mainlydue to two issues: first, to investigate IGP in relatively long-lived organisms like birds, long-term field data is needed but often scarce. Second, without changes in the community structure, it is hard to discern the influence of IGP from other ecological factors. We studied the raptor assemblage in a rural area (300 km²) in north-western Germany over 30 years. During the last 20 years, Eurasian Eagle Owls *Bubo bubo* re-colonized the region after local extinction. Since 2011, the breeding population of Red Kites *Milvus milvus* increased as well, indicating a positive influence by Eagle Owls on raptor assemblage diversity. This process provides a rare possibility to investigate the changes in the raptor community from two species, Common Buzzard *Buteo buteo* and Northern Goshawk *Accipiter gentilis*, to four species with a special focus on IGP. Here we show the impact of the return of the Eagle Owl as a superpredator known to kill and eat its competitors on the behaviour, breeding habitat niche and reproductive success of Common Buzzard, Northern Goshawk and Red Kite. We used our long-term dataset as well as newly collected data from the field including nearest neighbour analysis, habitat characterstics and aggression experiments.

OS-104

Spatial and dietary sources of elevated mercury exposure in White-tailed Eagle nestlings in an Arctic freshwater environment

Camilla Ekblad[1], Igor Eulaers[2], Ralf Schulz[3], Torsten Stjernberg[4], Jens Søndergaard[2], Jochen Zubrod[3], Toni Laaksonen[1]

[1]University of Turku, Turku, Finland. [2]Aarhus University, Aarhus, Denmark. [3]University of Koblenz-Landau, Landau, Germany. [4]University of Helsinki, Helsinki, Finland

Human-induced mercury (Hg) contamination is of global concern and its effects on wildlife remain of high concern, especially in environmental hotspots such as inland aquatic ecosystems. Mercury biomagnifies through the food web resulting in high exposure in apex predators, such as the White-tailed Eagle *Haliaeetus albicilla*, making them excellent sentinel species for environmental Hg

contamination. An expanding population of White-tailed Eagles is inhabiting a sparsely populated inland area in Lapland, northern Finland, mainly around two large reservoirs flooded 50 years ago. As previous preliminary work revealed elevated Hg levels in this population, we measured Hg exposure along with dietary proxies (δ^{13}C and δ^{15}N) in body feathers collected from White-tailed Eagle nestlings in this area between 2008 and 2018. Mercury concentrations were investigated in relation to territory characteristics, proximity to the reservoirs and dietary ecology as potential driving factors of Hg contamination. Mercury concentrations in the nestlings (4.97 – 31.02 µg/g) were elevated, compared to earlier reported values in nestlings from the Finnish Baltic coast, and exceeded normal background levels (≤ 5 µg/g) while remaining below the tentative threshold of elevated risk for Hg exposure mediated health effect (> 40 µg/g). The main drivers of Hg contamination were trophic position (proxied by δ^{15}N), the dietary proportion of the predatory fish pike *Esox lucius*, and the vicinity to the Porttipahta reservoir. All in all, we present results for poorly understood freshwater lake environments and show that more efforts should be dedicated to further unravel potentially complex pathways of Hg exposure to wildlife.

OS-105

Sex, landscape diversity and resource availability shape the seasonal space use of a migratory European raptor

Theresa Spatz[1], Jakob Katzenberger[2], Nicolas Frieß[3], Christian Gelpke[4], Eckhard Gottschalk[5], Martin Hormann[6], Steffen Koschkar[7], Thomas Pfeiffer[8], Stefan Stübing[4], Christoph Sudfeldt[2], Sascha Rösner[1], Dana G. Schabo[1], Nina Farwig[1]

[1]Philipps-University Marburg, Department of Biology, Marburg, Germany. [2]Dachverband Deutscher Avifaunisten e.V., Münster, Germany. [3]Philipps-University Marburg, Department of Geography, Marburg, Germany. [4]Hessische Gesellschaft für Ornithologie und Naturschutz e.V., Echzell, Germany. [5]Georg-August-University Göttingen, Conservation Biology, Göttingen, Germany. [6]HessenForst, Gießen, Germany. [7]Horka, Germany. [8]Weimar, Germany

Intrinsic and extrinsic drivers shape the space use of highly mobile raptors. Large proportions of raptors are migrants, shifting their activity ranges between summer and winter habitats, where they face different environmental conditions. Relating space use in summer and winter habitats to intrinsic and extrinsic drivers promises crucial insights into the ecology of migratory raptors. We investigated the seasonal space use of 43 Red Kites *Milvus milvus* tracked by GPS-transmitters across central and south-west Europe across seven years. We compared space use patterns, i.e. activity range sizes and daily flight distances, between summer and winter and assessed the influence of intrinsic (sex) and extrinsic factors (landscape diversity, primary productivity). We further compared the landscape composition and the use of the various land-use types within the activity ranges between seasons. Activity ranges and daily flight distances were smaller in summer than in winter. Females used larger activity ranges than males in summer, but smaller ones than males in winter, while flying shorter distances than males in both seasons. Regardless of the season, increasing landscape diversity led to increasing activity ranges, while increasing primary

productivity led to decreasing activity ranges. The landscape composition differed between seasons, with agricultural landscapes being used less in summer than in winter. We showed that intrinsic and extrinsic drivers shaped movement and led to differences in space and habitat use of migratory raptors between seasons. As both seasons facilitate a vital population, our findings underline the importance to consider the full annual cycle of migratory species for conservation management.

OS-106

Functional consequences of wetland degradation and climate change for breeding birds across different spatial scales

İbrahim Kaan Özgencil[1,2], Mehmet Arda Çolak[3], Melisa Soyluer[1], Melisa Metin[4], Gültekin Yılmaz[5], Alaz Uslu[2], Meryem Beklioğlu[4,6], Zuhal Akyürek[3], Christine N. Meynard[7], Korhan Özkan[5,6], Erik Jeppesen[4,5,6,8,9]

[1]Middle East Technical University, Department of Biological Sciences, Ankara, Turkey. [2]Simurg Bird Sanctuary, Ankara, Turkey. [3]Middle East Technical University, Department of Civil Engineering, Ankara, Turkey. [4]Middle East Technical University, Department of Biological Sciences, Limnology Lab, Ankara, Turkey. [5]Middle East Technical University, Institute of Marine Sciences, Mersin, Turkey. [6]Middle East Technical University, Centre for Ecosystem Research and Implementation (EKOSAM), Ankara, Turkey. [7]CBGP, INRAE, CIRAD, IRD, Montpellier SupAgro, Univ Montpellier, Montpellier, France. [8]Aarhus University, Department of Bioscience and Arctic Research Centre (ARC), Silkeborg, Denmark. [9]Sino-Danish Centre for Education and Research (SDC), Beijing, China

Human-caused habitat degradation and climate change affect birds worldwide, altering their community structure and delivery of ecosystem services. We investigated how breeding wetland bird communities responded to two decades of extensive wetland loss and degradation and climate change across different spatial scales in Konya closed basin, Turkey. We found that the loss in functional diversity at the basin scale was way more intense than the taxonomic loss, emphasizing the importance of considering multifaceted nature of biodiversity for deducing better conservation implications. We observed widespread taxonomic and functional diversity losses at the local scale. At the landscape scale, the communities became taxonomically and functionally more dissimilar. Given the decreased diversity at the local scale, these results indicate a subtractive heterogenization, implying that large-scale conservation efforts are required to preserve the remaining diversity. Changes in taxonomic and functional compositional beta diversity contrasted with a decreasing taxonomic nestedness and an increasing functional nestedness. We discovered that functionally distinct species, larger species, late-breeders, reed-nesters, diving species, and species with smaller brain mass were the losers and that higher trait plasticity did not confer any advantage to their bearers. Lastly, by using satellite imagery dating back to the mid-80s, we discovered that the lakes in the basin started to dry earlier probably because of a combination of human actions and climate change. We offer the earlier shrinking/drying of wetlands as a novel

mechanism for human actions and climate change to contribute to the decline of late-breeding endangered diving ducks in the region.

OS-107

Use of microclimate refugia areas by an endangered grassland bird

Rita F. Ramos[1,2,3,4], Aldina M.A. Franco[4], James J. Gilroy[4], João P. Silva[1,2]

[1]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Universidade do Porto, Campus Agrário de Vairão, Vairão, Portugal. [2]CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Laboratório Associado, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, Lisbon, Portugal. [3]Departamento Biologia, Faculdade de Ciências, Universidade do Porto, Porto, Portugal. [4]School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom

The term “climate refugia” is normally associated with areas where species persist during severe climatic change periods. We use, microclimate refugia referring to dynamic spatial-temporal areas species use to cope with elevated temperatures. These areas may enable species to persist in, otherwise, inhospitable landscapes. An example are the semi-natural grasslands, being climate vulnerable hotspots in Europe that host many threatened species. In this study we i) test if the Vulnerable Little Bustard *Tetrax tetrax* (LB) increases use of microclimate refugia with increasing temperatures; ii) assess which environmental features offer microclimate refugia opportunities. GPS data from 77 LB tagged between 2009 and 2019 were associated with land use and hourly temperature information at 30x30m resolution. 50.8% of the locations occurred at temperatures > 25ºC and 6.6% at more than 37ºC, indicating that this species is exposed to temperatures above their physiological thermal optimum. Locations with temperature at least 0.5ºC cooler than the surrounding landscape were defined as providing microclimate refugia. As predicted, LB increased the use of microclimate refugia at higher temperatures. However, less than 25% of the GPS locations provided refugia and LB used these rarely (> 10%). Locations with microclimate refugia occurred more frequently in hotter continental areas, indicating LB use refugia more often in warmer regions of its distribution. Microclimate refugia, used by this species, were areas with high proportion of herbaceous vegetation with small patches of trees and shrubs. Despite using microclimate refugia in a small proportion, possibly due to life-history and behaviour constraints, these areas may help Little bustards persist in extreme conditions.

OS-108

Fecundity of multi-brooded European Turtle Doves *Streptopelia turtur* in Spain: implications for population viability and conservation management

Beatriz Arroyo[1], Francesc Sardà-Palomera[2], Gerard Bota[2], Mario Fernandez-Tizon[1], Juan Lorente-Rejano[1], Helena Navalpotro[2], Lara Moreno-Zarate[1], François Mougeot[1], Carlos Santisteban[2], Miguel Delibes-Mateos[3]

[1]Instituto de Investigacion en Recursos Cinegeticos (IREC, CSIC-UCLM-JCCM), Ciudad Real, Spain. [2]Centre de Ciència i Tecnologia Forestal de Catalunya, CTFC, Solsona, Spain. [3]Instituto de Estudios Sociales Avanzados (IESA-CSIC), Cordoba, Spain

The European Turtle Dove *Streptopelia turtur* is a multi-brooded species considered "Vulnerable" due to marked population declines in recent decades. UK studies have shown declines to be associated with reduced fecundity caused by farmland intensification. Information on fecundity in Spain (largest European population and with less steep decline) is too scant, despite the critical importance of this parameter for adequately assessing population prospects under different management scenarios. Based on VHF/GPS tagged birds (2018-2021) we assessed Turtle Dove fecundity in four study areas with different habitat (ranging from farmland-dominated to woodland-dominated) in two regions of Spain. Average number of clutches per individual/season increased with the length of within-season monitoring period; for 32 birds that could be monitored throughout the whole breeding season it was 2.25 ± 0.98 (range 1-5). No significant differences were found among study areas or years. The likelihood of initiating another clutch declined linearly throughout the breeding season, but did not depend on success of the previous breeding attempt, nor varied among study areas. The average time between consecutive breeding attempts was 5.4 ± 6.1 days, being shorter after successful breeding attempts (no significant differences among study areas); in the case of 7 successful broods, a new clutch was laid even before the nestlings fledged. Average fecundity per bird and season was 2.30 ± 1.68 (range 0-6). Results suggest that fecundity may be more dependent on the length of the breeding season than on landscape configuration, and highlight the need of adequate tools for monitoring fecundity in multi-brood species.

OS-109

Experimental corticosterone increase negatively affects food intake but not body mass dynamics during autumn migration in a songbird

Arseny Tsvey[1], Irina Demina[1], Anastasia Volkova[1], Julia Loshchagina[2], Sergey Naidenko[3]

[1]Biological station Rybachy, Zoological institute RAS, Saint-Petersburg, Russian Federation. [2]Insitute of Geography RAS, Moscow, Russian Federation. [3]A.N. Severtsov Institute of Ecology and Evolution RAS, Moscow, Russian Federation

During seasonal migrations, birds regularly stop over to replenish their fuel stores. The rate of food consumption and the resulting fuel deposition rate (FDR) are crucial parameters which affect total migration speed and contribute to the overall success of migration. There are numerous indications that glucocorticoid hormone corticosterone is involved in control of these parameters, but its exact role (permissive, stimulatory or even suppressive) is actively debated. We applied fasting-refeeding protocol to model metabolic situation of migratory flight and subsequent refueling along with experimental increase in corticosterone levels to relate changes in hormone levels with changes in behavior (food intake, FDR and body mass dynamics) in European Robin *Erithacus rubecula* during autumn migration. Blood corticosterone concentration was modulated by means of beeswax implants. Body mass dynamics in the course of experiment and FDR during three refueling days did not differ between individuals implanted by corticosterone and by placebo implants. However, food intake was largely reduced in robins implanted by corticosterone implants, suggesting the suppressive corticosterone effect; this result contradicts our previous and a few other published data. The decline in food consumption was rather gradual, beginning with the time lag after implantation. The possible mechanisms of suppressive corticosterone effect and reasons why difference in food intake was not reflected in FDR and body mass dynamics are discussed.

OS-110

Genetic dominance plays role in Willow Warbler autumn migration direction

Kristaps Sokolovskis[1], Violeta Caballero Lopez[1], Max Lundberg[1], Åkesson Susanne[1], Tianhao Zhao[2], Staffan Bensch[1]

[1]Lund University, Lund, Sweden. [2]University of Groningen, Groningen, Netherlands

We tagged a total of 458 Willow Warblers *Phylloscopus trochilus* with light-level geolocators across entire Sweden and retrieved 73 tracks. We documented clear western migration routes from allopatric *P. t. trochilus* breeding in southern Sweden and clear eastern migration routes of *P. t. acredula* from arctic Sweden. Migration routes of hybrids from the migratory divide in Central Sweden show immense variation and even include birds that cross Sahara directly. Analysis of genotypes and migration routes of hybrids from the migratory divide reveals a strong genetic dominance effect with the western migration route being dominant over the eastern route. In addition, we show that autumn migration departure timing does not associate with genotype and is determined purely with breeding latitude.

OS-111

The relationship between temporal changes in DNA methylation levels and the expression of personality in wild Great Tits *Parus major*

Bernice Sepers[1,2], Kees van Oers[1,2]

[1]NIOO-KNAW, Wageningen, Netherlands. [2]WUR, Wageningen, Netherlands

Animal personality is defined as consistent between-individual variation in suites of behaviours and it has been found to explain individual differences in fitness. Besides between-individual variation, there are, despite its consistent nature, also within-individual sources of variation in animal personality. However, the mechanisms behind this have yet to be fully elucidated. Genetic variation has been known to play a role in the expression of personality, but this alone cannot explain variation in personality, especially not within-individual variation. A likely regulatory mechanism to be involved is DNA methylation. This biochemical mechanism can alter gene expression in response to genetic variation but also in response to environmental conditions without structural modifications of the DNA sequence. Furthermore, DNA methylation can change over short timescales. However, ecological research connecting natural variation in DNA methylation to behavioural trait variation is hardly present. To get insights into the relationship between DNA methylation and personality, we repeatedly assessed red blood cell DNA methylation levels in wild Great Tits *Parus major* by sampling individuals at the nestling stage and at the independent juvenile stage. In addition, we assessed the stress response, which is an early predictor of personality traits, and exploratory behaviour, which is a personality trait. This approach allowed us to explore whether temporal changes in DNA methylation levels might explain variation in the expression of personality, both within and between individuals. The results will provide unique insights into the origin and maintenance of consistent, yet plastic personality traits in wild populations.

OS-112

Quantitative genetics of multidimensional plasticity of spring phenology

Maria Moiron[1,2], Birgen Haest[3], Céline Teplitsky[2], Andreas Dänhardt[4], Sandra Bouwhuis[1], Anne Charmantier[2]

[1]Institute of Avian Research, Wilhelmshaven, Germany. [2]Centre d'Ecologie Fonctionnelle et Evolutive, Montpellier, France. [3]Swiss Ornithological Institute, Sempach, Switzerland. [4]Institute for Hydrobiology and Fisheries Science, Hamburg, Germany

Changing environmental conditions cause changes in the distributions of phenotypic traits in natural populations. Understanding the mechanisms responsible for these changes is crucial for predicting populations' viability. In this study we investigated individual and additive genetic variation in, and selection on, plasticity in three phenological traits: the timing of arrival from wintering grounds, the interval between arrival and initiation of breeding, and the timing of reproduction, in response to two environmental factors. We made use of 7438 observations of phenology from 1719 individuals of a long-distance migratory bird, the Common Tern *Sterna hirundo*, measured across 25 years, as well as information on the sea surface temperature at the wintering grounds and food availability at the breeding grounds. We found evidence for individual variation in multidimensional plasticity of arrival and laying dates, and, to a lower extent, additive

genetic variation in arrival date's reaction norm. The intercepts of the three phenological traits were under strong directional selection, favoring an earlier phenology, while the plastic adjustment of arrival date to fish availability was the only response under selection, favoring individuals that expressed greater plasticity. Altogether, there is little evolutionary potential for multidimensional plasticity in spring phenology in this natural population, but we expect our study population to increasingly comprise 'early birds' as sea surface temperatures rise and food availability decreases.

OS-113

Early life stress influences migratory life history strategies

Valeria Marasco[1], Stefan Graf[1], Bin-Yan Hsu[2], Michael Haemmerle[1], Gianni Pola[3], Leonida Fusani[1]

[1]University of Veterinary Medicine Vienna, Vienna, Austria. [2]University of Turku, Turku, Finland. [3]Istituto Sperimentale Zootecnico Per la Sicilia, Palermo, Italy

Stressful experiences during early development lead to substantial long-lasting effects on physiology and behaviour. However, the extent to which such organisational effects maximise fitness outcomes remain unclear. Studies suggest that they may be contingent on adult environmental circumstances. Using a migratory species, the Common Quail *Coturnix coturnix* as our study system, we tested the hypothesis that individuals exposed to challenging environmental circumstances (unpredictable food) earlier in life will anticipate expression of migratory behaviour and that such response will be stronger in individuals facing similarly challenging circumstances in adulthood. To this end, we combined key behavioural measures signalling the activation of the migratory phenotype (subcutaneous fat scores, and nocturnal migratory restlessness) with relevant metabolic and hormonal measurements (fatty acids profiling, corticosterone and thyroid hormones) using a repeated-measure study design. Our analyses suggest that the priming effects of early life stress exposure are contingent with the environmental circumstances experienced in adulthood pointing to a potential mechanism linking early life experience to future Darwinian fitness.

OS-114

Experimental ghrelin administration affects migratory behaviour in a songbird

Sara Lupi[1,2], Yolanda Morbey[2], Scott MacDougall-Shackleton[3], Hiroyuki Kaiya[4], Leonida Fusani[1,5], Christopher Guglielmo[2]

[1]Konrad Lorenz Institute of Ethology, University of Veterinary Medicine, Vienna, Vienna, Austria. [2]Department of Biology, Advanced Facility for Avian Research, University of Western Ontario, London, Canada. [3]Department of Psychology, Advanced Facility for Avian Research, University of Western Ontario, London, Canada. [4]Department of Biochemistry, National Cerebral and Cardiovascular Center Research Institute, Suita, Japan. [5]Department of Behavioural and Cognitive Biology, University of Vienna, Vienna, Austria

To migrate between breeding and wintering areas, birds are capable of rapid physiological and behavioural adjustments. Crucial decisions during migration are affected by many extrinsic and intrinsic factors. A change in energy status, once integrated in the brain, can result in the decision to prolong a stopover or resume migration. A network of hormones, including the gut-hormone ghrelin, signal metabolic fuel availability to the brain in vertebrates. Although research on ghrelin in migratory birds is still in its infancy, we recently showed that ghrelin is involved in the regulation of migratory disposition and food intake in captive warblers during spring stopover. In a new field radio-tracking experiment, we investigated the role of ghrelin on migratory behaviour in free-living Yellow-rumped Warblers *Setophaga coronata coronata* caught at a spring stopover site on the north shore of Lake Erie, Ontario, Canada. Specifically, we used an automated radio-telemetry system to track the birds and experimentally tested whether administration of acylated or unacylated ghrelin affect departure decisions and migratory movements. We found that manipulation of both acylated and unacylated ghrelin stimulated a quick movement away from the field site on release day, indicating that the hormone ghrelin communicates with the brain to mediate stopover departure decisions. Single peripheral injection of ghrelin caused transient and short-term effects on migratory behaviour. This study provides experimental evidence for a key role of ghrelin in the regulation of behavioural decisions during spring migration and offers a new perspective in the study of gut-brain communication in vertebrates.

OS-115

Moonlight angle and intensity affects morph specific hunting direction and success in Barn Owls *Tyto alba*

Kim Schalcher[1], Paolo Becciu[1], Robin Séchaud[1], Luis M. San-José[2], Alexandre Roulin[1]

[1]University of Lausanne, Lausanne, Switzerland. [2]University of Toulouse, Toulouse, France

The lunar cycle exposes nocturnal life to significant variations in light conditions, playing a key role in the evolution of color in nocturnal species. Unlike most nocturnal predators that tend to camouflage with the environment background, the Barn Owl *Tyto alba* is characterized by its unique color polymorphism ranging from ventral bright white to reddish brown. Although the selective pressures that lead to the maintenance of this white plumage are still debated, a recent study showed that Barn Owl morphs benefited differently from moonlight, with white owls triggering longer freezing time of their preys under moonlit conditions. Presumably able to take advantage of their brightness under, it remains unclear, however, how owls may benefit from

moonlight to hunt their prey at night. Using high-resolution data-loggers, we therefore recorded the foraging movements of 150 owls at 1 Hz GPS and 50 Hz accelerometer to investigate whether Barn Owl morphs differentially use moonlight angle and intensity to hunt their preys at night. This allowed us to identify hunting events, their success, and to calculate strike angles in relation to the moon position and its light intensity. Our results suggest that white owls may be able to take advantage of the moon's position to increase their hunting success by adjusting their striking position facing the moon. Our study provides essential missing information in the understanding of the maintenance of white plumage in nocturnal predators and raises new insight on the influence of the moon on the evolution of coloration in nocturnal species.

OS-116

Fostering the fine-grained revolution: microhabitat selection in a climate-sensitive species explained by remotely sensed variables

Corrado Alessandrini[1], Davide Scridel[2,3], Luigi Boitani[1], Paolo Pedrini[2], Mattia Brambilla[2,4]

[1]Department of Biology and Biotechnologies, Sapienza University of Rome, Rome, Italy. [2]MUSE – Museo delle Scienze, Sezione Zoologia dei Vertebrati, Trento, Italy. [3]ISPRA, Ozzano dell'Emilia (BO), Italy. [4]Lipu/Birdlife Italia, Parma, Italy

Fine-scale habitat selection modelling can allow a mechanistic understanding of habitat selection processes, enabling better assessments of impacts exerted by climate and habitat changes on biodiversity. Remote-sensing data provides an ever-increasing amount of environmental and climatic variables at high spatio-temporal resolutions, and a unique opportunity to produce fine-scale habitat models particularly useful in challenging environments; nevertheless, such models have been very scarce until now. Working at a 10 m-spatial resolution, we assessed the value of remotely-sensed data for investigating foraging habitat selection (in relation to topography, microclimate, land cover) in nestling-rearing White-winged Snowfinch *Montifringilla nivalis*, a high-elevation species highly sensitive to climate change. Adult Snowfinches foraged at locations with intermediate vegetation cover and higher habitat heterogeneity, avoiding both warm and cold extreme microclimates. Importantly, temperature interacted with other environmental drivers in defining habitat selection, highlighting trade-offs between habitat profitability and thermoregulation: Snowfinches likely adopted mechanisms of behavioural buffering against physiologically stressful conditions by selecting for cooler, shaded and more snowy foraging grounds at higher temperatures. Our results matched those from previous studies based on accurate field measurements, confirming the species' reliance on climate-sensitive microhabitats (such as snow patches and low-sward grassland, in heterogeneous patches) and proving the effectiveness of using remotely-sensed variables instead of field measurements: this modelling approach could provide large-extent, but yet fine-grained, habitat suitability models that could allow more accurate and robust biological insights, finer predictions of potential future changes, and more carefully targeted conservation strategies for any target species worldwide.

OS-117

Habitat use and foraging habitat selection of Northern Wheatears *Oenanthe oenanthe*

Thomas Müller[1,2], Yann Rime[1,3], Christoph Meier[1], Florian Knaus[2], Felix Liechti[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]Swiss Federal Institute of Technology, Zurich, Switzerland. [3]University of Basel, Basel, Switzerland

Alpine birds are experiencing habitat modifications caused by climate and land-use changes. For ground-dwelling insectivorous species, prey availability, composed of prey abundance and accessibility, is a critical factor influencing habitat suitability on a small scale. Prey accessibility is determined by visibility and access to bare ground while high prey abundance is often restricted to a short period, especially at high elevation. Therefore, breeding success depends on a match between food availability and demand. Changes in phenology may lead to a mismatch if migratory birds cannot adapt to the shifting vegetation development in time. In the Alps, the Northern Wheatear *Oenanthe oenanthe* undergoes an upward distribution shift, while the populations remain stable. To gain insight into the species' small-scale habitat use we mapped the foraging habitat preferences of 127 color-ringed individuals based on 550 foraging events during an entire breeding season. Short grass and bare ground are expected to be preferred throughout the season with stronger preferences during the feeding phase. During arrival and incubation, proximity of snow patches where prey abundance is high is likely to be preferred while in the post-breeding period, berries and extensively grazed meadows may be crucial habitat features. This study aims at giving a better understanding of how sensitive Northern Wheatears are to a changing alpine environment.

OS-118

Individual foraging site fidelity increases from incubation to nestling-rearing stage in a colonial raptor

Samuele Ramellini[1], Simona Imperio[2], Jennifer Morinay[2], Federico De Pascalis[1], Carlo Catoni[3], Michelangelo Morganti[4], Diego Rubolini[1], Jacopo G. Cecere[2]

[1]Dipartimento di Scienze e Politiche Ambientali, Università degli Studi di Milano, Milano, Italy. [2]Area Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano dell'Emilia, Italy. [3]Ornis Italica, Roma, Italy. [4]Consiglio Nazionale delle Ricerche – Istituto di Ricerca sulle Acque (CNR-IRSA), Brugherio, Italy

Within animal populations, individuals may show foraging specialization, exploiting only a fraction of the population's trophic niche. This could be observed also in colonially breeding, central-place foraging species. Foraging specialization may be achieved by consistently exploiting individual-specific foraging locations, which may differ from the ones used by other colony members, a process known as individual foraging site fidelity (IFSF). Analyzing foraging trips

from GPS-tracked breeding Lesser Kestrels *Falco naumanni*, we aimed to assess the repeatability in movement patterns, and the IFSF during both incubation and nestling-rearing stages. Individuals showed repeatable foraging movements, consistently travelled along similar commuting routes when targeting foraging grounds and exploited nearly-exclusive foraging areas. Individual repeatability and IFSF were higher during the nestling-rearing than incubation, likely reflecting an adaptation to the increased energetic demand resulting from frequent nestling-provisioning trips besides self-provisioning. Lower IFSF and repeatability in incubation may be due to the occurrence of long explorative trips, which may help finding productive foraging patches to be exploited in the nestling-rearing stage. By consistently exploiting previously visited foraging sites known to be productive, nestling-rearing individuals might increase their foraging efficiency, shortening the time for food searching and maximizing nestling provisioning rates.

OS-119

Opportunities and risks of exploiting dynamic oceanographic features in the smallest European seabird

Federico De Pascalis[1], Beatrice De Felice[1], Marco Parolini[1], Danilo Pisu[2], David Pala[3], Jennifer Morinay[4], Andrea Benvenuti[5], Alberto Ruju[6], Carmen Spano[6], Lorenzo Serra[4], Diego Rubolini[1], Jacopo Cecere[4]

[1]University of Milan, Milan, Italy. [2]Regione Pireddu Nieddu (snc), Stintino, Italy. [3]Azienda Speciale Parco di Porto Conte, Alghero, Italy. [4]3Area Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano dell'Emilia, Italy. [5]Ornis Italica, Rome, Italy. [6]6Area Marina Protetta Capo Caccia – Isola Piana, Alghero, Italy

Ocean mesoscale and submesoscale features, such as eddies and filaments, play a key role in the foraging ecology of marine predators, acting as aggregative structures for pelagic organisms. Pelagic seabirds may exploit these features to find profitable food patches in a dynamic and complex three-dimensional environment. Using miniaturized GPS-loggers, we investigated whether foraging habitat selection of the Mediterranean Storm Petrel *Hydrobates pelagicus melitensis*, was affected by different static and dynamic oceanographic features during the breeding period. Individuals performed long foraging trips (up to 1113 km) in a short time (1-2 days), covering large home-ranges (up to 34370 km^2), particularly during incubation. Different oceanographic features affected their at-sea distribution at different spatio-temporal scales. During incubation, individuals selected areas characterised by shallow waters and strong currents, conditions that may enhance vertical water mixing and increase food availability. During chick-rearing, they foraged closer to the colony, selecting shallow and productive areas, where increasing Lagrangian coherent structures and eddy kinetic energy enhanced foraging probability. These features could play an important role in storm petrels' foraging habitat selection, especially during chick-rearing, given their need to find predictable food patches in a short timespan. As a consequence, 45% of individuals ingested microplastics of different nature, mainly polyester, polyethylene and nylon. Indeed, microplastics are particularly abundant in the neuston, and their

spatial behaviour is similar to zooplankton, being concentrated by (sub)mesoscale features. Overall, our results suggest that marine circulation processes are key drivers of the at-sea distribution of this pelagic surface predator, with implications for conservation.

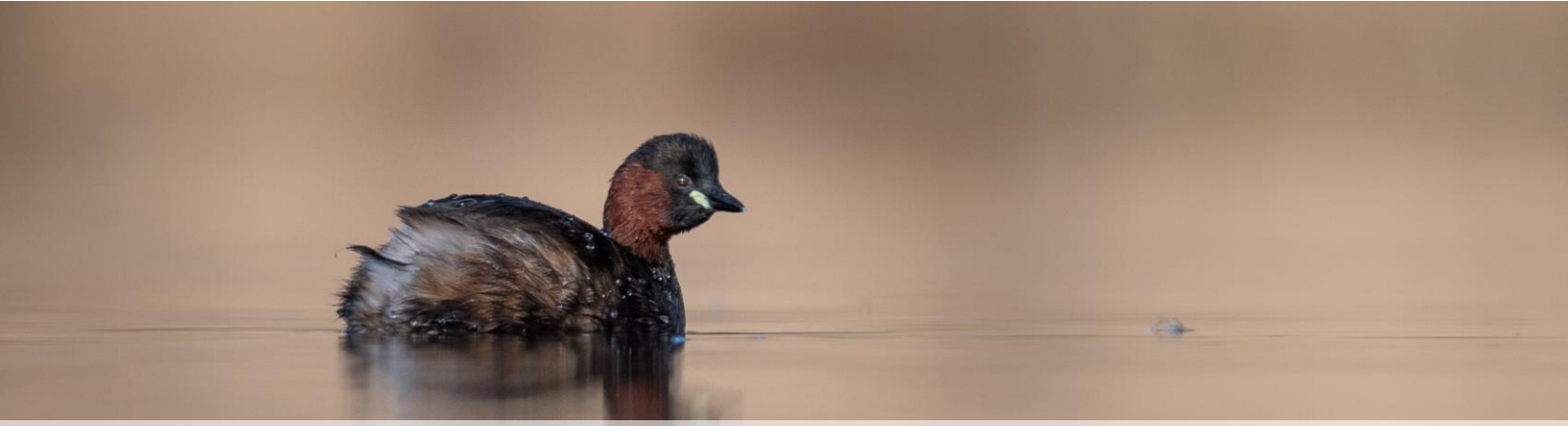
OS-120

Examining the interactive effects of boldness and wind conditions on foraging behaviour in the Wandering Albatross *Diomedea exulans*

Natasha Gillies[1], Henri Weimerskirch[2], Jack Thorley[1], Tommy Clay[3], Lucia Martin Lopez[1], Rocio Joo[4], Samantha Patrick[1]

[1]University of Liverpool, Liverpool, United Kingdom. [2]French National Centre for Scientific Research, Chize, France. [3]University of California, Santa Cruz, USA. [4]Global Fishing Watch, Mexico, Mexico

Animals that forage for ephemeral and heterogeneously-distributed resources, such as seabirds, should benefit from dynamically adjusting their behaviour to current environmental conditions. However, individual differences in animal personality, and associated pace-of-life variation, means that bolder individuals may benefit from investing in 'risky' strategies that afford short-term benefit at the expense of future survival, leading to consistent inter-individual differences in foraging tactics. Bold Wandering Albatross *Diomedea exulans* are known to invest preferentially in explorative foraging, thought to represent a high-risk, high-gain strategy, at the expense of patch exploitation, and vice versa for shy birds. Given that bolder birds allocate resources preferentially to current reproduction, we hypothesize they will maintain high foraging effort irrespective of wind conditions; in contrast, shy birds should minimize energy costs by flying preferentially with prevailing winds. Using a combination of a 10-year, high-resolution GPS dataset, individual measures of boldness, and hidden Markov models, we explore whether personality predicts movement responses of albatross to changes in wind. We show that wind conditions predict propensity to forage or commute between patches in all personality types. Bolder individuals are more likely to transition to commuting behaviour, and shy birds more likely to transition to and maintain foraging, following expectations of the exploration-exploitation trade-off. Our study advances understanding of selection and maintenance of inter-individual behavioural consistency, and individual-level responses to environmental conditions. As changes in wind conditions are already having profound effects on albatross distribution, such information is essential to determine the capacity for populations to deal with future environmental fluctuations.



9. POSTERS

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PP-1

Half a century of change in breeding phenology of 12 songbird species in Czechia

Peter Adamik[1,2], Denis Urbanský[3], Jaroslav Cepák[4]

[1]Palacky University, Olomouc, Czech Republic. [2]Museum of Natural History, Olomouc, Czech Republic. [3]University of Ostrava, Ostrava, Czech Republic. [4]National Museum, Prague, Czech Republic

We use an extensive dataset on bird ringing records of nestlings to reconstruct breeding phenology for 12 common species in Czechia from 1964 to 2017. Nonlinear responses in timing of breeding, length of breeding season and brood size were common. Ten out of 12 species showed significant trends in advancing their timing of breeding. In several species there was first a delay until ca the late 1970ies and after that a pronounced advancement in breeding. Eight out of 12 species extended the length of the breeding season. For brood size there were variable responses across species, often associated with timing of breeding, patterns of precipitation and spring temperatures. Temperature at the breeding sites had the strongest effect for all three phenological variables for the majority of species. For most species, the temperature in April was the most commonly selected time window, although in several cases longer time intervals were ranked as best predictors of breeding phenology. Climatic predictors from presumable non-breeding and stop over sites had usually low support.

PP-2

Phenotypic Characterization of Iraqi red pigeon

Baraa Al Hasan

Medical Laboratory Technology Department, College of Medical Technology, The Islamic University, Najaf, Iraq

The Iraqi red pigeon is one of the birds whose name is associated with the culture of the Iraqi people, and its breeding extends to the beginning of the last century. This type of pigeon is characterized by being a good flying pigeon that does not tend to make acrobatic movements during its flight and is dominated by a phenomenon that almost distinguishes it among other pigeon breeds, which is flying in the form of vertical circular waves at the beginning of its take-off and it continues in seconds on this then changes its flight to horizontal circles on its own lofts , the colors of this breed vary between red, blue, black and golden yellow, and all of these colors contain white, which is predominant and covers about 6% of the bird's body. However, it is unfortunate that there is no study documenting this strain in appearance or genetics until the present time. Because genetic cross-breeding between different breeds of pigeons with the Iraqi red pigeon become widespread during the last period, especially after 2003, this led to the loss of the characteristics of the old breed and made it threatened with extinction. Therefore, this study aims to determine the phenotypic characteristics of the Iraqi red pigeon.

PP-3

The threatened marsh passerine community of a Mediterranean wetland with hydrological problems: population dynamics and habitat selection

Iván Alambiaga[1], Manuel Carrasco[2], Carlos Ruiz[2], Francesc Mesquita-Joanes[1], Juan S. Monrós[1]

[1]Cavanilles Institute of Biodiversity and Evolutionary Biology, University of Valencia, Paterna, Spain. [2]Tablas de Daimiel National Park. Organismo Autónomo Parques Nacionales, Daimiel, Spain

Marsh passerines present high degrees of specialisation to wetlands, and many species are severely threatened as a consequence of the widespread deterioration of these systems. Analysing the habitat requirements of the different bird species that compose a community can be useful to avoid potential conservation conflicts resulting from species-specific requirements and achieve optimal conservation measures and wetland management. In this study we analyse the population dynamics and habitat selection of five threatened marsh passerines (Great Reed Warbler, Moustached Warbler, Reed Bunting, Savi's Warbler and Bearded Tit) in a Mediterranean wetland with persistent human-induced hydrological problems. Abundance of the target species and categorisation of the habitat were carried out in each of the more than 120 listening points conducted in Tablas de Daimiel (Spain) annually for 8 consecutive years. Great reed warbler populations declined by 90% during the study period while those of the reed bunting quadrupled; the remaining species experienced an initial increase in abundance but later declined in recent years. All the measured habitat variables (relative cover of common reed, saw sedge, bulrush, dry vegetation, open water and dry surfaces) were found to be important for the population dynamics of the target species. Despite having specific, even opposite, habitat requirements the abundance of focal species ultimately depended on the wetland water regime. Conservation implications are

discussed in order to provide relevant information for the conservation of marsh passerine communities.

PP-4

Parental coordination in the Little Auk *Alle alle* – within season consistency and effect of pair characteristics

Lauraleen Altmeyer[1,2], Katarzyna Wojczulanis-Jacubas[1], Antoine Grissot[1], Marion Devogel[1]

[1]Depatment of Vertebrate Ecology and Zoology, University of Gdansk, Gdansk, Poland. [2]University of Rennes 1, Campus Beaulieuc, Rennes, France

Male and female parental care considered in the context of parents' cooperation becomes a hot topic in behavioural ecology. Nevertheless, we are still far from understanding basic mechanisms of cooperative performance of the breeding partners. In this study we test the hypothesis that parental coordination of breeding partners, even if changes across the context (stage of breeding season) is a pair-specific trait, and is related to the strength of pair-bond. We focus on the Little Auk *Alle alle* - a seabird with typical traits of long-life history species (long-lived, long-term pair bonds, long and extensive bi-parental care). Using extensive video recordings of birds' behaviour collected in the field over the whole breeding season, and a complex analytic approach we found that the level of parental coordination is high and stable during the incubation period but decreases considerably during the chick rearing phase. Importantly, when analysing pairs coordination at each breeding period separately (incubation/chick rearing) pair identity does matter, suggesting importance of pair characteristic in the coordination mechanism. However, coordination of parental activities during the incubation is quite independent on the coordination exhibited during the chick rearing, which suggests parental flexibility, and is likely to be an adaptation to variable environmental conditions that the Little Auk experiences. Finally, pair-bond seem to play a role in the coordination of their parental performance, as pairs of stronger bonds seem to better coordinate their parental duties. Our results provide solid evidence on parental coordination in a seabird species, and highlight the importance of partners' familiarity on the performance of parental care.

PP-5

Landscape features override climate and topography in shaping taxonomical and functional diversity of avian communities in a heterogeneous Alpine region

Matteo Anderle[1,2], Chiara Paniccia[1], Mattia Brambilla[3,4], Andreas Hilpold[1], Stefania Volani[1], Erich Tasser[1,2], Julia Seeber[1,2], Ulrike Tappeiner[1,2]

[1]Eurac Research - Institute for Alpine Environment, Bolzano/Bozen, Italy. [2]University of Innsbruck - Department of Ecology, Innsbruck, Austria. [3]Museo delle Scienze - Sezione Zoologia

dei Vertebrati, Trento, Italy. [4]Fondazione Lombardia per l'Ambiente - Settore biodiversità e aree protette, Milano, Italy

Understanding and disentangle the effects of landscape composition and configuration, climate, and topography on bird diversity is necessary to identify distribution factors, potential impacts of land-use changes, and future conservation strategies. We studied bird taxonomic and functional diversity within the Biodiversity Monitoring South Tyrol at two spatial scales along gradients of land-use/land-cover (LULC) intensity and elevation. Also, we explored how environmental factors influence bird traits and threatened species. The model including all significant parameters regardless of their classification was the most supported one, denoting the synergetic effect of different types of environmental variables on bird communities. The models containing only LULC classes were always the most supported among the single-group models: as expected, LULC plays a crucial role in shaping local biodiversity and hence bird communities, even across broad landscape and elevation gradients. Our analyses also highlight the importance wetlands and open areas, of mosaics dominated by small patches in agricultural landscapes and settlements, the high values of ecotonal and structural elements in agricultural settings, and of continuous forests. Our study showed that to conserve bird diversity in the Alps, management practices promoting and maintaining small-patched landscapes, structural elements, and a mosaic of different LULC types should be supported, at the same time sustaining continuous forests. Additionally, it is particularly important to preserve or to improve the management of pastures, extensively used meadows and wetlands, and to stop excessive soil sealing. These measures might mitigate the impacts of global changes on bird diversity in European mountain areas.

PP-6

Dispersal in a fragmented Meadow Pipit population

Fabian Anger

Eberhard Karls University, Tübingen, Germany

Dispersal is an important phenomenon for the colonization of new habitats and the genetic structure of populations. I'm studying dispersal in an isolated and fragmented Meadow Pipit population in the Northern Black Forest. There are strong differences between breeding dispersal and natal dispersal. Breeding dispersal only occurs to a small degree, of up to 1 km which means that individuals only move short distances between breeding sites in two successive years. Most birds occupied exactly the same territory than in the year before. In contrast, young birds mainly settled in other habitat patches up to 8 km distant from their birthplaces. This means, that the connectivity of fragmented habitat patches is maintained by natal dispersal. Furthermore, I'm studying the spatial behaviour of Meadow Pipits after the breeding time until they move off to their wintering areas. Young Meadow Pipits could be found up to 18 km distant from their birthplace whilst adult birds were found only up to 5 km away from their territory during the breeding time. Until Meadow

Pipits move off to their wintering areas, they also appear in areas with no breeding occurrences. This might be an evidence of the importance of different habitats during the annual cycle.

PP-7

A study on avifaunal diversity in aquatic habitat and their adjoining areas of Ramnagar, Uttarakhand (Western Himalayas), India

Ashish Kumar Arya[1], Medha Durgapal[2], Vinay Singh[3], Manisha Bisht[3]

[1]Department of Environmental science, Graphic Era University, Dehradun, India. [2]G. B. Pant National Institute of Himalayan Environment, Almora, India. [3]Department of Zoology, D.S.B. Campus, Kumaun University, Nainital, India

Wetlands play an important role to provide a good and unique habitat for waterbirds. The present study deals with the observations of avifauna in the aquatic habitat and their adjoining areas of Ramnagar, Uttarakhand, India. The present study was carried out from January 2020 to December 2020. We recorded a total of 145 avian species belonging to 54 families during the study period. Among this, a total of 113 residents and 32 winter visitor species were identified. The percentage of resident and winter visitor avian species was 78.08% and 21.91%. During the study period, we also reported the four avian species viz., River Lapwing, River Tern, Great Hornbill and Alexandrine Parakeet are under the Near Threatened (NT) category and one species, namely Red-headed Vulture is critically endangered according to IUCN Red data book. Thus, the findings of this study suggest that the selected study area has avifauna diversity of utmost importance which should be conserved by implementing specific strategies.

PP-8

Fostering the breeding range expansion of central-eastern Mediterranean Lesser Kestrel populations

Michelangelo Morganti[1], Giacomo Assandri[2], Gaia Bazzi[2], Jacopo G. Cecere[2], Diego Rubolini[3], Roula Trigou[4], Nikos Tsiopelas[4]

[1]CNR-IRSA National Research Council – Water Research Institute, Brugherio (MI), Italy. [2]Area Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano Emilia (BO), Italy. [3]Dep. Environmental Science and Policies, University of Milan, Milan, Italy. [4]Hellenic Ornithological Society / BirdLife Greece, Athens, Greece

In Europe, the rise of spring temperatures is favouring a northward expansion of the Lesser Kestrel *Falco naumanni*. At the same time, the ongoing rainfall reduction is challenging the long-term conservation of the populations breeding in the southern regions. The LIFE FALKON project aims

to improve the conservation status of the Lesser Kestrel populations settled at the north-eastern edge of the species breeding range (Italy and Greece). In fact, these are crucial for the climate resilience of the EU population, but they are currently threatened by the demolition of the rural buildings in which colonies are settled. In the first phase, LIFE FALKON assessed the consistency of the breeding populations and the foraging habitat selection of target populations for the first time at these latitudes (up to 45°N). Subsequently, thanks to the wide net of supporters consolidated in the project's initial phase, more than 400 nest boxes were installed in the selected areas, mostly within Natura 2000 sites. Moreover, in the Po Plain (Italy), LIFE FALKON created new nesting opportunities by building five nesting towers. Hacking of chicks from southern populations was realised to establish the use of safe artificial nests among the northern population. The southern source population was identified by means of genetic and behavioural migration studies, according to IUCN guidelines. Dispersion behaviour of local and hacked fledglings have been compared using GPS/ARGOS devices. In parallel, LIFE FALKON is raising environmental awareness among the local communities through a targeted dissemination program.

PP-9

Reduction in nocturnal colony attendance during temporary light pollution events in a threatened seabird, the Yelkouan Shearwater (*Puffinus yelkouan*)

Martin Austad[1,2], Steffen Oppel[3], James Crymble[1], Paulo Lago[1], Dilek Sahin[1], Benjamin Metzger[1], Petra Quillfeldt[2]

[1]BirdLife Malta, Ta' Xbiex, Malta. [2]Justus-Liebig-Universität Gießen, Gießen, Germany. [3]Royal Society for the Protection of Birds, Cambridge, United Kingdom

Burrow nesting seabirds in the order Procellariiformes often attend colonies during the night and reduce activity during periods with bright moonlight. Artificial light pollution might affect colony attendance patterns. We tested for effects from a temporary light pollution source in front of a Yelkouan Shearwater Puffinus yelkouan colony in the Maltese Islands. Large cargo ships shelter and refuel in front of the colony in certain conditions, operations which require all deck lights to be switched on. Ship location and duration at the site was obtained from the database MarineTraffic, while light levels at the colony cliff face were measured autonomously. Moreover, we used Passive Integrated Transponders on shearwaters for four breeding seasons (2017-2020) to register departures and arrivals of individual birds. Ship presence increased cliff brightness, an effect similar to that of the full moon. Significantly fewer Yelkouan Shearwaters entered the breeding cave during brighter conditions as well as on nights with ships present when compared to nights before and after ship presence. Several of these events took place during the early chick provisioning period, with potentially serious implications of reduced colony attendance on breeding success. The study demonstrates the need for mitigation of light pollution at colonies with nocturnally active species, while further studies are required on the physiological and potential long-term effects of repeated light pollution events.

PP-10

The status of urban ecology in Africa: a systematic review

Adewale Gboyega Awoyemi[1,2], Juan Diego Ibañez-Alamo[1]

[1]University of Granada, Granada, Spain. [2]International Institute of Tropical Agriculture, Ibadan, Nigeria

Urbanization leads to biotic homogenization worldwide and Africa is projected to hold one of the largest urban expansion in the near future. To determine the state of African urban ecology, we did a detailed search of the literature on this topic in the last century. We found 275 papers (243 field studies, 18 reviews and 14 perspectives published in 154 journals), from where data were collected and tested to understand spatio-temporal patterns in knowledge and scientific focus. We overlaid the number of studies across urbanization gradient and ecoregions using QGIS, and tested how human population density and Gross Domestic Product (GDP) predicted the number of papers. We found a low turnout of papers and a dearth of knowledge about African urban ecology. Studies were conducted in 36 African countries, with South Africa alone accounting for 58% of all published papers, and that the studies were mainly city-based (47%), suggesting a lack of transnational research collaboration. The majority of studies mainly focused on animals (64%) and plants (32%), highlighting our limited understanding of other organisms such as monera, fungi and protista. Birds, in addition to mammals and insects, were the most studied animal groups. All ornithological studies were field-based, relating to animal behaviour, population and community ecology, human-wildlife conflict and wildlife diseases. GDP, but not population density, significantly predicted the number of published papers, suggesting a mismatch between urban development and ecological knowledge. We also found that applied fields, which are the impetus for driving policy change and formulation, were seldom studied.

PP-11

Abundance estimation of elusive species: comparing different approaches for Goldcrest and Firecrest

Julia Barczyk[1], Grzegorz Neubauer[2], Marta Cholewa[2], Tomasz Wesołowski[2]

[1]Department of Behavioural Ecology, University of Wrocław, Wrocław, Poland. [2]Laboratory of Forest Biology, University of Wrocław, Wrocław, Poland

Population size is one of the central issues in ecology and forms a basis for e.g., monitoring and protection. Yet, for many elusive bird species it remains poorly known how to get a reliable estimate of absolute numbers. One of the most accurate method to estimate bird abundance is territory mapping method combined with searching for nests. On the other hand, distance sampling models and other hierarchical models developed to estimate abundance corrected for imperfect

detection appeared to be promising in true abundance estimation. The aim of our study was to compare these approaches on two forest passerines - Goldcrest *Regulus regulus* and Firecrest *R. ignicapilla* - for which there is no effective method of finding nests. We conducted an intensive field study at the three plots in Białowieża Forest, Poland, in spring 2021. Our results provide support for modern hierarchical models, while increased effort with the territory mapping surveys increases detectability of the studied species.

PP-12

Singing in the darkness: moonlight modulates vocalization and activity at colony in Scopoli's Shearwaters

Paolo Becciu[1,2], Letizia Campioni[3], Arianna Longarini[4], Valeria Jennings[2], Giacomo Dell'Omo[2]

[1]University of Lausanne, Lausanne, Switzerland. [2]Ornis italica, Rome, Italy. [3]ISPA—Instituto Universitário, Lisbon, Portugal. [4]University of Pavia, Pavia, Italy

Moonlight modulates the behaviour and rhythm of many organisms. Procellariiformes (albatrosses, petrels, and shearwaters), and particularly shearwaters, are known to reduce their nocturnal activity (movements and vocalization) at the colony with increasing moonlight. Supposedly, this behaviour is a response to reduce predation risk. However, these two aspects of nocturnal activity are often analysed separately, thus limiting our understanding on how they are simultaneously regulated by moonlight. Here, we measured the vocalization activity at night and in-and-out movement rate of Scopoli's Shearwater *Calonectris diomedea*, attending the colony of Linosa (Pelagie archipelago, Italy) by using passive acoustic recorders and radar technology. We found that shearwaters activity at colony is strongly modulated by moon illumination and wind but at a lesser extent. Specifically, the Acoustic Complexity Index (ACI) decreased significantly (up to 90%) with increasing lunar illumination, even within the same night. Similarly, inbound movements decreased with increasing wind intensity although shearwaters kept flying over the colony (probably attending the nests) even with the maximum lunar illumination but reducing the traffic to a lower rate (< 50%). Our findings suggest that shearwaters respond strategically to lunar illumination by adjusting their vocal and movement activity while accomplishing the breeding duties.

PP-13

Caught red-handed: systematic occurrence of kleptoparasitism by Red-footed Falcon *Falco vespertinus* on Lesser Kestrel *Falco naumanni*

Alessandro Berlusconi[1,2], Diego Rubolini[3], Giordano Brambilla[3], Jacopo G. Cecere[4], Adriano Martinoli[1], Damiano Preatoni[1], Lucas A. Wauters[1], Alessio Martinoli[1], Michelangelo Morganti[2]

[1]Environment Analysis and Management Unit - Guido Tosi Research Group - Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy. [2]CNR-IRSA National Research Council – Water Research Institute, Brugherio (MB), Italy. [3]Department of Environmental Science and Policy, Università degli Studi di Milano, Milan, Italy. [4]Area Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Ozzano dell'Emilia (BO), Italy

Co-occurrence of ecologically similar species may lead to intra-guild competition. Kleptoparasitism, a foraging strategy where an individual from one species steals food items caught by individuals of another species, may arise as an outcome of this antagonism. Both Lesser Kestrel *Falco naumanni* and Red-footed Falcon *Falco vespertinus* have recently expanded their breeding range in Northern Italy. Currently, the Po Plain is the only known area in Europe where these two species breed sympatrically, potentially exploiting similar foraging habitats and trophic sources. To our knowledge, we described for the first time the systematic occurrence of Red-footed Falcon kleptoparasitism on Lesser Kestrel, based on two years observations (2020-2021), focused on foraging groups of Lesser Kestrels. Red-footed Falcon attacked the Lesser Kestrel in half of the cases when both species were observed foraging together, and that attacks were successful in 36% of the cases. Most (~61%) of the attacks were carried out by male Red-footed Falcons. The presence of red-footed falcon was unrelated to the size oF Lesser Kestrel foraging groups. The likelihood of an attack increased with increasing of prey capture rate by foraging Lesser Kestrel groups. The likelihood of being attacked by a Red-footed Falcon was higher for those Lesser Kestrels carrying prey of larger size. Overall, we suggest that kleptoparasitism by Red-footed Falcons is not an occasional behaviour, but rather a specific foraging strategy. Further studies are needed to assess whether this phenomenon affects fitness of the local Lesser Kestrel population.

PP-14

Year-round multi-scale habitat selection by Crested Tit *Lophophanes cristatus* in a lowland breeding area (Northern Italy)

Alessandro Berlusconi[1,2,3,4], Giulia Tesoro[1], Stefania Martini[5], Gabriele Pozzi[2], Gualtiero Guenzani[3], Diego Rubolini[5], Adriano Martinoli[1], Damiano Preatoni[1], Lucas A. Wauters[1], Alessio Martinoli[1], Michelangelo Morganti[4]

[1]Environment Analysis and Management Unit - Guido Tosi Research Group - Department of Theoretical and Applied Sciences, Università degli Studi dell'Insubria, Varese, Italy. [2]Parco Pineta di Appiano Gentile e Tradate, Castelnuovo Bozzente (CO), Italy. [3]Gruppo Insubrico di Ornitologia, Clivio (VA), Italy. [4]CNR-IRSA National Research Council – Water Research Institute, Brugherio (MB), Italy. [5]Department of Environmental Science and Policy, Università degli Studi di Milano, Milan, Italy

The Crested Tit *Lophophanes cristatus* breeds uncommonly in Italian lowlands. We used a multi-scale approach to study the year-round habitat selection of the species in a protected area of

Northern Italy sub-Alpine lowlands (Pineta's Regional Park of Appiano Gentile and Tradate), analysing different habitat features at each scale. At landscape scale, the species selects pure and mixed pine forests, especially in winter, and avoids farmlands and urban areas. At home-range scale, old pine woods with dense cover are selected; conversely, the species negatively selects woods composed of alien species in the breeding period. In addition, in this phase the shrub layer height is a good predictor of the species' occurrence. The characteristics of trees (D.B.H., cover, density) did not differ substantially between the two phenological phases, but in winter, models show a stronger effect of a positive selection in the presence of pine. At the foraging scale, the species was observed spending more time foraging in the canopies than in the understorey, using mostly the inner and middle canopies of scots pine *Pinus sylvestris*. Overall, the breeding habitat corresponds approximately to the wintering one. Opposite to what is normally observed in birds, in our study area, lowland crested tits are habitat specialists also in winter, selecting pinewoods even more intensely than in the breeding period.

PP-15

Links between wintering area and contamination level in a long-distance migratory seabird

Justine Bertram[1,2], Nathalie Kürten[1,2], Coraline Bichet[3], Peter J. Schupp[2], Sandra Bouwhuis[1]

[1]Institute of Avian Research, Wilhelmshaven, Germany. [2]University of Oldenburg, Oldenburg, Germany. [3]CNRS-Université de La Rochelle, Villiers-en-Bois, France

Over the past century, mercury levels in the environment have increased by 450% due to human activity. Organisms foraging at high trophic levels are particularly exposed to this increase. Assessing consequences of mercury exposure requires quantification of the levels of mercury uptake across the annual cycle. We used light-level geolocators to track 63 Common Terns *Sterna hirundo*, fish-eating migratory seabirds, from a breeding colony in northwest Germany to study whether individuals using different wintering grounds differed in their level of mercury contamination, assessed by using feathers grown at the wintering grounds. We found significant differences in mercury levels between birds wintering in three different upwelling systems along the African coast: mercury levels were highest in birds wintering in the Canary current, medium in birds wintering in the Guinea current and lowest in birds wintering in the Benguela current. An important next step will be to (i) assess the consistency of these differences and (ii) test whether there are carry-over effects on survival and reproductive performance.

PP-16

Migration is fuelled by higher year-round activity in migratory geese

Michiel Boom[1,2], Thomas Lameris[3], Nelleke Buitendijk[1], Sander Moonen[4], Kees Schreven[1], Peter de Vries[1], Bart Nolet[1,5], Götz Eichhorn[1], Henk van der Jeugd[1,2]

[1]NIOO-KNAW, Wageningen, Netherlands. [2]Dutch Centre for Avian Migration and Demography, Wageningen, Netherlands. [3]NIOZ, Den Hoorn, Netherlands. [4]WEnR, Wageningen, Netherlands. [5]University of Amsterdam, Amsterdam, Netherlands

By performing migrations between wintering and summering sites, animals are able to exploit seasonally varying environments, thereby maximizing lifetime reproductive success. However, performing migratory journeys comes with energetic costs, which have to be compensated within the annual cycle in order to maintain a balanced energy budget. An important mechanism to compensate for energetic expenses is to increase daily foraging time. Here we compare annual activity, a proxy for foraging time, of migratory and resident Barnacle Geese, and investigate when migratory geese compensate for the costs of migration. Additionally, we explored when geese are foraging outside daylight hours, which might indicate an energetic constraint. We used GPS-transmitters with accelerometers to collect activity data from free-living Barnacle Geese from a long-distance migratory population and a resident population. We found that migratory geese were more active year-round, especially during a 30-week period that covers the preparation for spring migration, breeding and moult, and onset of autumn migration. Measured over a full year, 80% of the activity occurred during daytime. During the non-breeding period, Barnacle Geese from both populations were also active outside daylight hours, but in migratory geese, the period of night-time activity was 7 weeks longer, and started already before autumn migration. This extended night-time foraging period may indicate that migratory geese face a longer energetic bottleneck that starts earlier in their annual cycle. Thus, a migratory lifestyle requires year-round higher activity levels, while a resident lifestyle appears more relaxed.

PP-17

The wetter the better? Impact of water management on prey availability for wet grassland breeding waders

Yves Bötsch, Louiza Krahn, Tim Remmers, Laruens Korossy-Julius, Jutta Leyrer, Christoph Zöckler, Philip Hunke, Hermann Hötker†

Michael-Otto-Institut im NABU, Bergenhusen, Germany

For agricultural purposes, wet meadows have been drained, with sustained negative effects on meadow breeding waders. In order to reverse the trend, conservation efforts focused on re-wetting wet grasslands in Northern Europe. We assessed how the flooded sections of a meadow compare to the dry sections in terms of prey availability, using a transect based sampling scheme. Most wet grassland breeding waders are specialised on foraging in the ground with their long bills, hence soil invertebrates were in the focus of the research. Also, they forage in shallow water bodies. These habitats within flooded meadows were also sampled for benthos. Finally, in order to address most feeding wader chicks, foraging on arthropods in the vegetation, we also sampled arthropods in the lower vegetation. We found that earthworms were almost completely absent in areas that

were flooded during winter. Areas without long periods of flooding were necessary for earthworm survival. Being one of the largest food items for waders, earthworms are a crucial part of wader diet, especially in early spring. Benthos is only available as prey in water bodies with increasing densities over the season. Hence, long lasting shallow water bodies are attractive for waders. We did not find clear differences in arthropod biomass between flooded and dry sites. Overall, re-wetting is beneficial for wet grassland breeding waders in many aspects, but a mix with dry sites should be favoured, as they serve as retreating sites for earthworms, which also speeds re-colonisation of flooded sites after they dried out.

PP-18

Acoustic recording for woodpecker population monitoring - Method development andcomparison

Gediminas Brazaitis, Kastytis Šimkevičius, Loreta Bisikirskienė

Vytautas Magnus University, Kaunas, Lithuania

The aim of our study was to develop efficient woodpecker monitoring methods based on acoustic recording. In total we used 30 Song Meter SM4. Our analysis consisted: (I) analysis of woodpeckers seasonal and morning activity; (II) comparison three methods of analysis (a) the record analysis by software Kaleidoscope Pro, (b) record manual expert evaluation and (c) traditional field census method; (III) development of monitoring method based on acoustic recording. We analysed seasonal and morning drumming activity of each woodpecker species: Three-toed, White-backed, Grey-headed, Black, Great Spotted, Lesser Spotted. The sound analysis by software resulted the mean of 2,03 woodpecker species per study point, expert analysis was 1.38 time more, traditional census – 1,34 times less efficient. For monitoring schemes (detection probability 0.5) the recording period for Three-toed Woodpecker should last 3-5 days (recording start during 20.03-1.05), 6-8 days (10.03-19.03; 02.05-05.05). For White-backed Woodpecker recording period should last 3-4 days (20.02-17.04), 5-8 days (18.04-09.05), 9-14 days (10.05-22.05). Black Woodpecker monitoring should last 3 days (20.03-18.04), 4 days (29.02-19.03; 19.04-28.04), 5-7 days (20.02-28.02; 29.04-07.05). The recording for Great Spotted Woodpecker for population monitoring should last 1-2 days (15.03-15.05), 3-6 days (05.03-14.03). For scientific studies or evaluation of individual occurrence (detection probability 0.7) of Three-toed Woodpecker recording should last 6-9 days (recording start 23.03-22.04). For White-backed Woodpecker recording period should last 7-9 days (20.02-26.04), 10-14 days (07.04-26.04). Black Woodpecker recording should last 6-7 days (02.03-17.03), 8-9 days (20.02-01.03 and 18.04-24.04). Finally, the Great Spotted Woodpecker recording should last 1-3 days (25.03-01.05), 4-6 days (16.03-24.03).

PP-19

Influence of predators for breeding success of ground-nesting birds in Lithuania

Kastytis Šimkevičius, Gediminas Brazaitis, Loreta Bisikirskienė, Dalia Kančauskaitė, Renata Špinkytė-Bačkaitienė

Vytautas Magnus University, Kaunas, Lithuania

Predators are the key-factor for ground-nesting birds breeding success. It is often the main cause of the loss of clutches. The aim of our study was to evaluate the influence of predators on the ground-nesting birds breeding success. The study was conducted in two phases – 2012-2013 yrs. and 2018-2020 yrs. for comparison the effect of the wild boar *Sus scrofa* population significant decline due to the African swine fever virus expansion between study periods. During every breeding season, 30 units of artificial clutches with chicken eggs were placed each year. Totally, 150 artificial clutches were evaluated. Video cameras with motion detector were used to monitor nearest surroundings. We found 67.8 % of all artificial clutches were destroyed, 1.7% artificial clutches were partially destroyed, 22 % of artificial clutches had high potential risk to be destroyed and only 8.5 % had no risk to be destroyed. The most of all artificial clutch were destroyed by the Marten (*Martes* sp.), and Wild boar. Also, lots of artificial clutch were destroyed by the European badger *Meles meles* as well as Corvids (Corvidae). The average duration of artificial clutches destruction was 8 days. Artificial clutches destroying by predators were mostly at the morning (7AM). Our study concluded, the decline in the Wild boar population almost removed the Boar from the list of animals destroyed the artificial clutches. 2012-2013 Wild boars destroyed 23% of the nests, and during 2018 – 2020 only 2%. However, the overall risk of destruction has changed insignificantly, the risk of predation remained on similar level.

PP-20

Landscape effect on urban bird communities

Loreta Bisikirkienė, Gediminas Brazaitis, Kastytis Šimkevičius, Jolanta Stankevičiūtė

Vytautas Magnus University, Kaunas, Lithuania

Birds are an important part of biodiversity. Community structure, diversity of species and abundance can help assess habitat quality and dynamics. Ornithological research in cities provides information on sustainability of a city as an ecosystem, addresses important issues in urban areas such as rapid expantion of urbanization into natural habitats, impact of urbanization on biodiversity and provides insights how urban bird populations will change in the future. We compared bird communities in three types of urbanized landscapes: a large city, small regional centres surrounded by forests and agro-landscapes. The study of bird communities performed by a fixed - radius point count method in more than 600 points. During the study we assessed species diversity and

abundance of nesting and wintering birds, distribution of bird communities in different landscape areas. We investigated relationships between landscape elements and bird communities, identified impact of the level of urbanization on bird communities. We found that large cities were characterized by Great Tit *Parus major*, Eurasian Tree Sparrow *Passer montanus*, Common Starling *Sturnus vulgaris*. Urbanized areas surrounded by forest landscapes showed higher abundance of Great Tit, Common Chaffinch *Fringilla coelebs* as well as agro landscapes characterized by Common Starling, House Sparrow *Passer domesticus* and is distinguished by Common Linnet *Linaria cannabina* species abundance, also registered White Stork *Ciconia ciconia* nests.

PP-21

Long-term trends in the number of some species of birds of the Tula Zaseki forest

Oksana Brigadirova[1], Anna Bakulina[2]

[1]Scientific center RANS "Biodiversity protection", Moscow, Russian Federation. [2]Russian Bird Conservation Union, Tula, Russian Federation

Among the broad-leaved watershed forests of Tula Region, only the lands of Tula Zaseki have never been used as arable land. The territory is represented by lime-oak and lime-maple forests, 60 km long, with an area of 44 thousand hectares. From 1935 till 1951, there was a reserve "Tula Zaseki" (7 thousand hectares) on the part of the forest area. Ornithological studies at this time were conducted by G.N. Likhachev. This allows us to compare the number of some birds of that time with the modern one. After the closure of the reserve, the territory was subjected to anthropogenic impact. Oaks older than 70 years were cut down. The decline in the number of birds of prey is caused by a reduction in the number of high-stemmed trees suitable for reliable nest construction and anxiety during the nesting period. Over the past 60-70 years, the population density of *Milvus migrans* has decreased from 59 to 6 pairs/100 sq.km. The number of *Buteo buteo* decreased by 4 times; of *Hieraaetus pennatus* and *Aquila pomarina* by 2-3 times. Currently, the number of *Milvus migrans* and *Buteo buteo* is stable and amounts to 80 and 250 pairs, respectively. The number of *Aquila pomarina* is no more than 10 pairs. *Hieraaetus pennatus*, for which there has been a tendency to increase the number in recent years, reaches 40 pairs. Over the past 10-15 years, there has been a decrease in the number of *Falco tinnunculus, Phoenicurus phoenicurus* and *Turdus iliacus.*

PP-22

Ornithologists urge wide sample reuse and introduce the AviSample Network metadata repository

Vojtěch Brlík[1,2], Pavel Pipek[2,3], Kate Brandis[4], Nikita Chernetsov[5], Fábio J. V. Costa[6], Luis G. Herrera M.[7], Yosef Kiat[8], Richard B. Lanctot[9], Peter P. Marra[10], D. Ryan Norris[11], Chima J.

Nwaogu[12,13], Petra Quillfeldt[14], Sarah T. Saalfeld[9], Craig A. Stricker[15], Robert L. Thomson[13], Tianhao Zhao[16], Petr Procházka[1]

[1]Czech Academy of Sciences, Institute of Vertebrate Biology, Brno, Czech Republic. [2]Department of Ecology, Faculty of Science, Charles University, Prague, Czech Republic. [3]Czech Academy of Sciences, Institute of Botany, Prague, Czech Republic. [4]Centre for Ecosystem Science, School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, Australia. [5]Ornithology Lab, Zoological Institute of Russian Academy of Sciences, Saint Peterburg, Russian Federation. [6]Instituto Nacional de Criminalística, Polícia Federal, Brasília, Brazil. [7]Estación de Biología Chamela, Instituto de Biología, Universidad Nacional Autónoma de México, San Patricio Jalisco, Mexico. [8]Israeli Bird Ringing Center, Israel Ornithological Center, Society for the Protection of Nature in Israel, Tel-Aviv, Israel. [9]U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, USA. [10]Department of Biology and the McCourt School of Public Policy, Georgetown University, Washington, USA. [11]Department of Integrative Biology, University of Guelph, Guelph, Canada. [12]A.P. Leventis Ornithological Research Institute, University of Jos Biological Conservatory, Jos, Nigeria. [13]FitzPatrick Institute of African Ornithology, DSI-NRF Centre of Excellence, University of Cape Town, Cape Town, South Africa. [14]Department of Animal Ecology & Systematics, Justus Liebig University Giessen, Giessen, Germany. [15]U.S. Geological Survey, Fort Collins Science Center, Denver, USA. [16]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands

Avian tissue samples are frequently collected to study various aspects of avian biology but, in many cases, these samples are not used in their entirety. The already-collected samples provide a largely overlooked opportunity because they can be used by different researchers in different biological fields. Broad reuse of samples could result in multispecies or large-scale studies, interdisciplinary collaborations, and the generation of new ideas, thereby increasing the quality and impact of research. Besides, the reuse of already collected samples could save finances and human resources needed for sampling, or help studies on endangered species. Sample reuse has the potential to boost scientific research with manifold benefits for sample owners and researchers reusing these samples. However, broad sample reuse is largely limited at present as locating the sample of interest would be challenging. Therefore, we call for wide reuse of avian tissue samples and highlight its advantages. To facilitate the reuse of avian samples worldwide and across research fields, we introduce the first and completely free-to-use metadata repository – the AviSample Network (available at: https://avisample.net/). The main aims of this metadata repository are to collate and help provide access to descriptions of available avian tissue samples. We contend that the creation of the AviSample Network metadata repository will provide an excellent opportunity for new collaborations and studies, help create research connections between ornithologists worldwide and encourage sample reuse in other fields.

PP-23

A fear response is linked to stopover length but not flight behaviour in two species of songbirds during spring migration

Vera Brust, Ommo Hüppop

Institute of Avian Research, Wilhelmshaven, Germany

Migratory behaviour of birds is well known to be linked to external factors like resource availability or the prevailing weather conditions, often investigated on the level of species or populations. More recently, technological advancements, like miniaturized tagging devices, enable more detailed investigations down to the level of single individuals. With these detailed data we are now able to study also internal effects like physiological shape or animal personality, which are likely to add up on the external factors influencing an individual bird's migratory behaviour. In this study we investigated the fear response of 46 Blackcaps *Silvia atricapilla* and 51 Garden Warblers *Silvia borin* caught at coastal stopover sites at the German North Sea coast during spring migration. Birds were radio-tagged, tested and immediately released. Subsequently we tracked the lengths of their stopover and flights taken in the German Bight area. Tonic immobility values were linked to stopover lengths in both species, indicating that more fearful birds stayed longer at the stopover site. Once the birds resumed migration no linkage between their fear response and choice of the taken route or covered track distance became apparent. More fearful individuals might have difficulties to discover and exploit food sources at unknown sites or elongate stays to wait for more ideal weather conditions to fly. However, such linkages are speculative so far and need to be further investigated in future studies.

PP-24

Predator pressure as a factor limiting nocturnal singing in diurnal active birds

Kinga Buda, Michał Budka

Adam Mickiewicz University, Poznan, Poland

The highest vocal activity of birds occurs in the morning and evening hours. However, it is known, that typical diurnal active birds sing also at night, but this behavior is regulated by many stimulating and limiting factors. The aim of the experiment was to test whether the diurnal birds react to the playback of a foreign male of the same species at night. The response of the tested birds (Yellowhammer *Emberiza citrinella* and Common Chaffinch *Fringilla coelebs*) was recorded with the use of camera traps and sound recorders in 3-time intervals: 20 minutes before the experiment, 20 minutes during the experiment, and 20 minutes after the experiment. The treatments were conducted in Bialoweza Glade (eastern Poland) in April and May 2021. Despite earlier observations of nocturnal singing in both tested bird species, no vocal activity was recorded at

night. During the nocturnal experimental treatments, camera traps registered a higher number of flights of Yellowhammer near loudspeakers during the experiment than before its start. What is more, camera traps recorded predators attracted by playback, such as the Tawny Owl and the Pine Marten. In the case of the Common Chaffinch, the predator appeared on 23% of the experimental points. A possible explanation, why no vocal activity was recorded, is that nocturnal predators rely mainly on hearing to track their prey, so birds exposed to attack must behave silently. The phenomenon of nocturnal singing of diurnal bird species still requires a deeper understanding.

PP-25

Vital sources during the non-breeding period for Barn Owls *Tyto alba*

Roman Bühler, Bettina Almasi

Swiss Ornithological Institute, Sempach, Switzerland

Natural selection acts on individuals throughout their annual and full life cycle. A good understanding of the drivers of natural selection is crucial for a better understanding of population dynamics and conservation actions. Sedentary animals inhabiting temperate zones are prone to be confronted to low temperatures and low food availability during the non-breeding phase. Such harsh phases can not only severely affect an individual's fate within one life-cycle phase but also interact with events in the subsequent phase by e.g. delaying the onset of breeding which can have negative consequences for breeding success. Further harsh environmental conditions can also act on whole populations, by resulting in a tremendous increase in mortality rates. In a full annual cycle approach, we studied the habitat use and requirements of Barn Owls with the aim to identify its vital sources during the non-breeding phase. The combination of GPS data with habitat compositions and a year-round, long-term small-mammal monitoring, showed that home-range size during the non-breeding phase decreased when hedges with a high small-mammal abundance are present. Such structures could not only be interesting for barn owls to hunt because of prey availability and accessibility, but also for providing perching opportunities in an otherwise rather homogenous landscape. This indicates that even though such structures which are not very abundant in intensive agricultural landscapes, might play an important role on the survival perspectives of Barn Owls. Identifying and promoting such habitat types and structures could finally change the fate and development of whole populations.

PP-26

More grazing, more damage? Grassland damage relates non-linearly to goose grazing pressure in Friesland, the Netherlands

Nelleke Buitendijk[1], Monique de Jager[1], Menno Hornman[2], Helmut Kruckenberg[3], Andrea Kölzsch[4], Sander Moonen[5], Bart Nolet[1,6]

[1]Netherlands Institute for Ecological Research (NIOO-KNAW), Wageningen, Netherlands. [2]Dutch Centre for Field Ornithology (SOVON), Nijmegen, Netherlands. [3]Institute for wetlands and waterbird research e.V (IWWR), Verden, Germany. [4]Max Planck Institute of Animal Behavior, Radolfzell, Germany. [5]Wageningen University and Research (WUR), Wageningen, Netherlands. [6]Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, Amsterdam, Netherlands

Geese foraging on agricultural grassland can cause large economic damages for farmers. To manage this conflict, it is important to understand how agricultural damage relates to goose density. We have looked at how damage per goose-day changes, depending on grazing pressure, timing of grazing, and interactions between different goose species. For this purpose, we have combined data from geese carrying GPS transmitters, monthly goose counts and damage reports. Furthermore, we have done a field study using exclosures, which were placed either at the start of the winter, before geese arrived, or in early spring. This allowed us to see the effect of a release of grazing pressure in early spring. Furthermore, variation in grazing pressures between fields let us further analyse the change in damage per goose-day with increasing grazing pressure at different moments in time. The results indicate that for barnacle geese, there is a positive relationship between grazing pressure and grassland damage, but with a decreasing rate of change as grazing pressure increases.

PP-27

Effect of moulting pattern on the elimination of Hg in seabird's feathers: implications for Hg biomonitoring

Paco Bustamante, Jérôme Fort, Alice Carravieri, Céline Albert, Fanny Cusset, Yves Cherel

La Rochelle University, La Rochelle, France

Seabirds integrate bioaccumulative contaminants mainly via food intake. Because of their generally high position in food webs, they are considered as relevant bioindicators of biomagnifying contaminants such as mercury (Hg). As feathers can be non-lethally sampled during the reproduction period, they constitute an interesting tissue to implement Hg biomonitoring programs at large spatial and temporal scales. Mercury is excreted in growing feathers during moulting owing to its strong affinity for keratins. Its elimination occurs differently depending on the moulting pattern of the considered species/groups, from a synchronous whole moult in penguins only, whole asynchronous moult in most species, both whole and nuptial moults in alcids and larids, up to the continuous moult in some species like albatrosses. Therefore, Hg concentrations in feathers represent different periods of integration: 1) on the long-term (1 year) for the synchronous moults, 2) on the medium term (several months), i.e. the winter and summer periods for the alcids and larids, 3) on the short-term (a few weeks) for the continuous moulting birds. Thus, the collection and analysis of body feathers whose moulting periods are known provides information on the integrated contamination of the species during different periods and areas. It is therefore

necessary to know precisely the biology of species (moulting patterns) and their ecology (distribution range, migration patterns) to use seabird feathers in the biomonitoring of Hg and to determine areas where birds are exposed to this toxic. Taking concrete cases, we will show the power and limitations of using seabird feathers for Hg large-scale biomonitoring.

PP-28

Transposable elements mark a repeat-rich region associated with migratory phenotypes of Willow Warblers *Phylloscopus trochilus*

Violeta Caballero-Lopez, Max Lundberg, Kristaps Sokolovskis, Staffan Bensch

Lund University, Lund, Sweden

Two Willow Warbler subspecies (*Phylloscopus trochilus trochilus* and *Phylloscopus trochilus acredula*) follow different migratory routes to wintering grounds in Africa. Their breeding territories overlap in a "migratory divide" across central Scandinavia and eastern Poland. Earlier analyses demonstrate that the few genetic differences between these two migratory phenotypes cluster in chromosomes 1 and 5. In addition, an AFLP-derived biallelic marker (known as WW2) presents steep clines across both migratory divides but failed to be mapped in the genome. Here, we characterize the WW2 marker and describe its two variants (WW2 ancestral and WW2 derived) as portions of Long Terminal Repeat (LTR) retrotransposons originating from an ancient infection by an endogenous retrovirus (ERV). We used qPCR techniques to quantify copy numbers of the WW2 derived variant across the two subspecies and their hybrids. This, together with genome analyses revealed that WW2 derived variants experienced a recent expansion, they are much more abundant in *P. t. acredula* and appear embedded in a large repeat-rich scaffold (>12 Mbp) which has not been mapped yet. Furthermore, this scaffold is not associated with the divergent regions of chromosomes 1 or 5, but might interact with genetic elements controlling migration direction given its strong linkage to the migratory phenotype. Testing this hypothesis further will require knowing the exact location of this region, e.g. by obtaining more complete genome assemblies preferably in combination with techniques such as FISH applied to a Willow Warbler karyotype, and finally to investigate the copy number of this marker in hybrids with known migratory tracks.

PP-29

Red-legged Partridge abundance and population dynamics are influenced by land use and agricultural practices

Xabier Cabodevilla[1,2], Alba Estrada[2,3], François Mougeot[2], José Jimenez[2], Beatriz Arroyo[2]

[1]University of the Basque Country (UPV/EHU), Vitoria-Gasteiz, Spain. [2]Instituto de Investigación en Recursos Cinegéticos (IREC) (CSIC-UCLM-JCCM), Ciudad Real, Spain. [3]University of Málaga, Málaga, Spain

Red-legged Partridge (RLP) populations are thought to have declined sharply since the mid-20th century associated with farmland changes. However, no large-scale studies have tested whether abundance or trends of RLP are related to farmland composition or management. We used hierarchical distance sampling models to estimate RLP abundance in 2010 in central Spain (Castilla-La Mancha), a main population stronghold of this species. We studied associations between RLP density and land-uses (including variation in management). We also assessed regional abundance variation over seven years (2010-2017) and its relationship with changes in land-use. Our results show that RLP abundance increased with the availability of natural vegetation and traditional rain-fed vineyards, but decreased with increasing proportions of tree crops and irrigated vineyards; the latter association was less pronounced in areas sensitive to nitrate contamination in water, where the amount of fertilizers applied in farmland and use of certain farming practices is more strictly regulated. These results support the idea that increases in intensive vineyards are detrimental to the RLP. We also report a strong population decline of RLP in the region, with a 51% abundance reduction in seven years. This decline was steeper in areas where more natural vegetation had been lost and where ecological tree crops had increased. Overall, our results indicate that changes in land-use (crop type, or the destruction of natural vegetation in farmland) and farming practices (e.g. use of irrigation in certain crops, use of nitrates) have important impacts on this farmland bird, affecting both spatial distribution and population dynamics.

PP-30

Modelling the distribution of the Pygmy Owl *Glaucidium passerinum* in the western Italian Alps

Filippo Cravero[1], Luca Anselmo[2], Mara Calvini[3], Radames Bionda[4], Veronica Nanni[1], Massimo Pettavino[5], Enrico Caprio[1]

[1]University of Turin, Torino, Italy. [2]Ente di Gestione dei Parchi Alpi Cozie, Salbertrand, Italy. [3]Independent Researcher, Sanremo, Italy. [4]Ente di Gestione Aree Protette dell'Ossola., Varzo, Italy. [5]Independent Researcher, Peveragno, Italy

The Pygmy Owl *Glaucidium passerinum* is the European smallest Strigidae found in the Alps as a glacial relict. This research aims to study the potential distribution of Pygmy Owls in the western Italian Alps. The distribution maps were created with MaxEnt combining presence data with topographic and land use variables, along with climate variables of the study area. According to the AUC, the best model was projected for the two decades 2041-2060 following the climate change forecasts provided by the CHELSA database. A cut-off value was calculated using the True Skill Statistic (TSS) to compare the suitability of the maps obtained from the models. This study

allowed us to evaluate territory suitable for the Pygmy Owls in an area of 2000 km^2 in the western Italian Alps, suggesting a recent spread of the species, of which 60% is covered with coniferous forests and 30% is included in protected areas. The possible climate change scenarios suggest that the Pygmy Owl will be forced to higher altitudes, progressively losing the cryophilic vegetation provided by conifers as it is replaced by broadleaf forests. In the two decades 2041-2060 only 35% of climatically suitable territory will consist of coniferous forests. Responsible management of the coniferous alpine forest is therefore necessary for the conservation of this species; large scale deforestation should be avoided to preserve senescent trees used for nesting and food storage.

PP-31

Population connectivity in two high-elevation specialist birds

Francesco Ceresa[1], Mattia Brambilla[1], Laura Kvist[2], Severino Vitulano[3], Michele Pes[1,4], Laura Tomasi[1], Paolo Pedrini[4], Matteo Anderle[5], Andreas Hilpold[5], Petra Kranebitter[1]

[1]Museum of Nature South Tyrol, Bolzano, Italy. [2]University of Oulu, Oulu, Finland. [3]Studio Pteryx di Calvi e Vitulano, Basiano, Italy. [4]Museo delle Scienze, Trento, Italy. [5]Eurac Research, Bolzano, Italy

Birds living in high-elevation mountain areas are currently threatened by climate change and human-induced habitat modifications. Predictive models based on future climatic scenarios indicate that such species will suffer a severe breeding range reduction and fragmentation. In this unfavourable context, high dispersal ability is crucial to allow the interchange of individuals among increasingly isolated breeding areas, and therefore sufficient gene flow. However, the current knowledge about the dispersal ability of high-altitude birds is very scarce, and this limits our ability to predict the consequences of future distribution changes. We aimed to investigate population connectivity in two high-elevation specialists, the Water Pipit *Anthus spinoletta* and the White-winged Snowfinch *Montifringilla nivalis*, across a wide area in the central-eastern European Alps showing a north-south gradient in the fragmentation of suitable environments. We first developed species distribution models, based on occurrence data and land use, climatic and topographic data. The resulting environmental suitability was then used to elaborate resistance surfaces and model connectivity, adopting a circuit theory approach. Connectivity models showed null or low connectivity across the largest valley floors, and suggested that current breeding areas in the most peripheral zones of the mountain chain are relatively isolated. These patterns were especially pronounced in the White-winged Snowfinch. Using genomic information from local breeding individuals, the obtained landscape resistance surfaces will be used to test alternative hypotheses about population connectivity in the study species: isolation by resistance (landscape effect on dispersal), isolation by distance (distance effect on dispersal), or lack of limitations in gene flow.

PP-32

Effects of local climate on the abundance of mountain birds are largely mediated by vegetation

Francesco Ceresa[1], Petra Kranebitter[1], Juan Monrós[2], Franco Rizzolli[1], Mattia Brambilla[1]

[1]Museum of Nature South Tyrol, Bolzano, Italy. [2]University of Valencia, Paterna, Spain

Both climatic and land cover factors are often used to describe bird distribution/abundance, but their interrelations have been scarcely investigated. Climatic factors may indeed affect species both directly and indirectly, e.g. by influencing vegetation structure and composition. The aim of our study was to disentangle the direct and indirect effects (via vegetation) of local climate on bird abundance across a wide elevational gradient in the European Alps, including montane forests, the transitional belt and high-elevation open areas. We surveyed birds by means of point counts and collected fine-scale land cover and temperature data from 109 sampling points. We collected enough data for 15 species, representing a broad variety of different ecological requirements. Using structural equation modelling, for all species we found a significant indirect effect of local temperatures via vegetation on bird abundance. Direct effects of temperature were less common and occurred in seven woodland/shrubland species, including only mountain generalists. In these cases, local temperatures showed a positive effect, suggesting that on average our study area is probably colder than the thermal optimum of those species. The generalized occurrence of indirect temperature effects within our species set demonstrates the importance of taking into account both climate and land cover changes to obtain more reliable predictions of future species distribution/abundance. In fact, many species may be largely tracking suitable habitat rather than thermal niches, especially among endotherm organisms like birds.

PP-33

Metal pollution in the urban mosaic: its effects on bird populations

Marion Chatelain

University of Innsbruck, Innsbruck, Austria

Metallic trace elements (MTEs) are divided into essential and non-essential (i.e. toxic) metals. For instance, while zinc is beneficial for all aspects of immunity, lead is responsible for cognitive disorders in humans. Despite anthropogenic activities being responsible for a significant increase in MTE concentrations in the environment, especially in cities, we know little about animal exposure to MTE at a finer environmental scale (i.e. within the urban mosaic) and few studies investigated its effects on wild animal populations; even fewer in the context of urbanisation. The reasons might be two fold: first, correlative studies carried out in urban vs. rural environments often fail to disentangle the effects of inter-correlated environmental factors (e.g. chemical pollution,

light pollution, human disturbance); second, experimental studies hardly expose individuals to ecologically relevant metal concentrations. To fill in this gap, I investigated 1) Great and Blue Tit exposure to MTE within 8 cities in Poland and 2) fitness proxies in Feral Pigeons chronically exposed to lead and/or zinc, and in wild Great and Blue Tit populations nesting along a gradient of urbanisation in Warsaw. I will highlight the effects of MTE exposure on bird reproductive success, its proximate causes and its implication for population evolution within the urban mosaic.

PP-34

Seasonal variation in the choice of landscape urbanization level by a migratory waterbird

Amelia Chyb[1], Jan Jedlikowski[2], Radosław Włodarczyk[1], Piotr Minias[1]

[1]Department of Biodiversity Studies and Bioeducation, Faculty of Biology and Environmental Protection, University of Łódź, Łódź, Poland. [2]Faculty of Biology, Biological and Chemical Research Centre, University of Warsaw, Warsaw, Poland

A growing number of migratory bird species use constantly expanding urban areas during both breeding and non-breeding season. We used a long-term monitoring of habitat preferences in Eurasian Coot *Fulica atra* to test the hypothesis about individual consistency in the choice of landscape urbanization level across the annual cycle. Our analyses showed that coots from urban breeding populations selected more anthropogenically altered wintering sites than non-urban individuals. Also, urban breeding individuals selected more urbanized areas during non-breeding season than expected from random availability. We also found seasonal variation in habitat preferences of coots from both urban and non-urban breeding populations, shifting towards more human-dominated areas as the non-breeding season progressed. Our study shows that birds remain consistent in habitat preferences in respect to urbanization level over relatively long periods of time. These results stay in line with the personality-matching habitat choice hypothesis, although the consistency in habitat selection may also have genetic basis or be a result of natal habitat preference induction (NHPI).

PP-35

Novel migration routes and wintering sites in northernmost Kentish Plovers as revealed by miniaturised GPS tags

Dominic V. Cimiotti[1], Clemens Küpper[2], Heiko Schmaljohann[3,4]

[1]Michael-Otto-Institut im NABU, Bergenhusen, Germany. [2]Max Planck Institute for Ornithology, Seewiesen, Germany. [3]University of Oldenburg, Oldenburg, Germany. [4]Institute of Avian Research, Wilhelmshaven, Germany

The northernmost European breeding areas of the Kentish Plover *Charadrius alexandrinus* lie in the Wadden Sea. Since this population is critically endangered, we have started a full annual-cycle approach to study the poorly known migration routes, the location of important sites, and the threats that these plovers experience during the non-breeding period. We tagged 33 adult Kentish Plovers with light-weighted archival GPS tags in the German Wadden Sea during the breeding seasons 2019 and 2020. Of those, 21 individuals returned in the subsequent year. In total, we captured six individual migratory trajectories. After breeding, nearly all birds moulted at the same site in the German Wadden Sea and staged around the Coto de Doñana in Spain during autumn or spring migration. Two plovers wintered at the southern limit of the known wintering range near Lisbon and Seville. The other four migrated to wetlands in West Africa (from Senegal to Guinea). Hitherto, it was unknown that the Wadden Sea population winters that far south. Furthermore, our GPS data revealed different threats that our population faces in the non-breeding season, such as infrastructure projects, water extraction and climate change. Taken together, our results demonstrate that the Iberian Peninsula and, novelly, West Africa harbour the main wintering sites of this northernmost European Kentish Plover population, and that all stages of the annual cycle are affected by human influence. We tagged further plovers to complete our ecological knowledge about the Kentish Plover and to develop conservation approaches together with local experts and international organisations.

PP-36

Preventing rubbish accumulation in the street and monitoring roof-nesting pairs of Yellow-legged Gulls *Larus michahellis* in the historic centre of Venice (Italy): a mid-term perspective for management implications

Francesca Coccon[1], Lorenzo Vanni[2], Shira Fano[3], Pierpaolo Campostrini[1], Dimitri Giunchi[2]

[1]CORILA, Consorzio per il Coordinamento delle Ricerche inerenti al sistema Lagunare di Venezia, Palazzo X Savi, S. Polo 19 30125, Venice, Italy. [2]Dipartimento di Biologia, Università di Pisa, Via Volta 6, 56126, Pisa, Italy. [3]Fondazione Nord Est, Via Torino 151/c, 30172, Venice, Italy

The Yellow-legged Gull *Larus michahellis* has undergone widespread colonization of the urban environment in the recent past. In 2005 Venice hosted 24 roof-nesting pairs, but this number markedly increased over the last decade leading to several problems of coexistence with humans. Starting from 2016, a new door-to-door garbage collection system was established in the city to prevent the accumulation of rubbish in the streets and limit the trophic sources available for the species. In 2017, we started a monitoring program of the urban population of Yellow-legged Gulls to investigate the initial effects of the new policy on the population. We integrated data collected by walking along previously selected itineraries through the city, with point counts data that were used for estimating the population by means of distance sampling. Our results indicated a statistically significant effect of the new policy in lowering both urban waste and gulls foraging in the streets. However, we found an increase of the population in June 2021, this although the limited food availability following the garbage collection change and the COVID-19 pandemic that has

emptied the city from tourists and daily visitors, thus significantly lowered the presence of street waste. Our data suggest that limiting food, in the case of Venice by preventing the rubbish accumulation in the street, is not effective in controlling the urban gull population in the medium run. Integrated management actions based on updated monitoring data, associated with educational and informative campaigns are crucial elements to lower the problems with this pest species.

PP-37

Extreme ambient temperatures reduce survival and impair growth of nestling Lesser Kestrels *Falco naumanni*

Alejandro Corregidor-Castro[1], Jennier Morinay[2], Michelangelo Morganti[3], Giacomo Assandri[4], Samuele Ramellini[5], Enrico De Capua[6], Jacopo Cecere[4], Andrea Pilastro[1], Diego Rubolini[5]

[1]Università degli Studi di Padova, Padova, Italy. [2]Norwegian University of Technology and Science, Trondheim, Norway. [3]National Research Council - Water Research Institute (CNR-IRSA), Brugherio, Italy. [4]Institute for Environmental Protection and Research (ISPRA), Ozzano Emilia, Italy. [5]Università degli Studi di Milano, Milano, Italy. [6]Provincia di Matera – Parco della Murgia Materana, Matera, Italy

Future climatic scenarios for the Mediterranean forecast increments in average temperatures and in both frequency and magnitude of heatwaves. The Western Mediterranean Lesser Kestrel *Falco naumanni* population has a reduced breeding range and is considered highly vulnerable to extreme climatic events during reproduction. Its dependency on old buildings for nesting has led to a loss of natural nesting sites, which has been mitigated by the provisioning of artificial nests sites by conservation efforts. Nestboxes offer the opportunity to investigate the effect of extreme temperatures on nestling growth and survival under controlled conditions. We performed a temperature manipulation experiment to investigate the effect of nestbox temperature on Lesser Kestrel nestling survival and morphological development. At hatching, we randomly assigned one of two nearby nestboxes placed on rooftops to one of two treatments: shaded, to reduce direct sunlight, and unmanipulated (control). Maximum temperatures inside the nestboxes were warmer than ambient temperature, but more so in the control ones (shaded: +3.9 ± 1.6 °C; control: +8.1 ± 2.3 °C). During a heatwave, when maximum ambient temperature exceeded 38° C, we observed a strong reduction in nestling survival (shaded 85%, control 20%), body mass (-12%) and tarsus length (-3%) in control nestboxes as compared to shadowed ones. Our results demonstrate that the effect of heatwave events on nest microclimate have a strong negative impact on nestling condition and survival, and suggest that projected future increases of summer temperatures in the Mediterranean basin may pose a significant threat to the persistence of Lesser Kestrel populations.

PP-38

Total white blood cell counts but not HL ratio changes in the transition from post-juvenile moult to autumn migration in the first-year Eurasian Blackcap *Sylvia atricapilla*

Irina Demina, Arseny Tsvey

Biological Station Rybachy of the Zoological Institute of RAS, Rybachy, Kaliningrad Reg., Russian Federation

Theoretically, seasonal changes in immune functioning in animals are shaped by the trade-off between a probability of encountering pathogens and availability of resources. We used leukocyte profile (absolute and relative leukocyte counts) as a simple measure of immune system condition to study how it changes during the transition from post-juvenile moult to autumn migration in a free-living migratory songbird, the Eurasian Blackcap *Sylvia atricapilla*. We observed the higher white blood cells (WBC) and lymphocyte counts in moulting birds compared to migrating individuals, but we did not find differences in heterophils and HL ratio. We suppose that the high number of WBC in moulting Blackcaps could reflect the heightened ability of their immune system to resists infections. The decrease in WBC counts during migration was mostly due to reduced lymphocyte numbers, thus representing in a downregulation of specific immunity. An absence in heterophil dynamics between moult and migration might indicate that various components of immunity can change relatively independently (or at different pace). Fat scores had no effect on WBC counts and HL ratio, possibly because resources were not restricted. Therefore, we found no strong evidence for a resource – immune functionality trade-off during transition from post-juvenile moult to autumn migration in immature Eurasian Blackcap. This study is an important step in understanding how immune system in general and leukocyte profile in particular changes in transition between life-history stages in migratory songbirds.

PP-39

Bioacoustic versus mist-net data: insights from autumn bird migration at an inland bird ringing station in NE Poland

Krzysztof Deoniziak[1], Oliwier Myka[1], Marta Drobińska[1], Tomasz Tumiel[2]

[1]Faculty of Biology, University of Białystok, Białystok, Poland. [2]Dubelt Natural Society, Juszkowy Gród, Poland

Acoustic monitoring is emerging as an efficient tool for the studies of bird migration timing and magnitude, providing valuable information for effective bird conservation at a local and global scale, especially given ongoing climate change and increasing anthropogenic pressure on wildlife. However, there are still few studies evaluating bird migration dynamics acquired from acoustic monitoring in comparison with other migration monitoring methods. In this study we compare

bioacoustic data with mist-net data from an inland bird ringing station in NE Poland over two autumn migration seasons. Apart from defining species composition, timing and magnitude of birds' nocturnal migration, we compared data from five most numerous nocturnal passerine migrants with the number of individuals caught in mist-nets. The majority of recorded nocturnal flight calls belonged to only a few species. We found considerable discrepancies in nocturnal versus diurnal migration dynamics in three species and significant correlation between bioacoustic and mist-net data in two other. These differences may originate from differing migration strategies, visible even among closely related species. Placement of the recorder was found to play an important role in bioacoustic data acquisition. Bioacoustic data showed a stronger correlation with ringing data for newly ringed birds, rather than for the total number of captured birds. Finally, little differences were found while comparing data obtained for civil versus nautical dusk and dawn. Our results indicate that acoustic monitoring provides valuable information about birds' nocturnal migration and provides a different perspective on the phenomenon of bird migration as compared to mist-netting.

PP-40

Changes in spring arrival phenology of Common Starling *Sturnus vulgaris* in Northeastern Europe from 1922 to 2017

Ivo Dinsbergs[1], Oskars Keiss[1], Martins Briedis[2]

[1]Laboratory of Ornithology, University of Latvia, Institute of Biology, Riga, Latvia. [2]Department of Bird Migration, Swiss Ornithological Institute, Sempach, Switzerland

Climate change poses significant impacts on most migratory bird species altering their wintering distribution, migration distance and phenology. In this study we describe changes in spring arrival phenology of a short-distance migrant, the Common Starling *Sturnus vulgaris*, in Northeastern Europe and their relation to changes in the onset of meteorological spring during the last century. Phenological data were obtained from an open access database Chronicles of Nature Calendar that holds over 4500 records of the 1st spring observation of Starlings from 196 observation sites between 1922 and 2017. Air temperature data was downloaded from European Climate Assessment and Dataset database. We found that, spring arrival time of Starlings was positively correlated with the onset of spring on a local and broad scale. During the 96-year long period, Starlings on average advanced their spring arrival time by 12 days at a rate of 0.13 days/year. However, changes in the onset of spring occurred even more rapidly with an average rate of change of 0.29 days/year over the study period. These findings imply broad-scale adjustments in migratory patterns of a short-distance migrant that result from climate change induced shifts in spring phenology. However, adaptations in bird migration phenology are not occurring fast enough to track and compensate for the rapid increase in air temperature and consequently, the advancement in the onset of spring across Northeastern Europe.

PP-41

Exploration speed in captivity predicts foraging tactics and diet in free-living Red Knots

Selin Ersoy

Netherlands Institute for Sea Research (NIOZ), Texel, Netherlands

Variation in foraging tactics and diet are usually attributed to differences in morphology, experience, and prey availability. Recently, consistent individual differences in behaviour (personality) have been shown to be associated with foraging strategies. Bolder or more exploratory individuals are predicted to have a faster pace-of-life and offset the costs of moving more or in risky areas, with higher energetic gains by encountering profitable foraging opportunities and prey. However, the relationship between personality, foraging, and diet is poorly understood. We investigated how exploratory behaviour in Red Knots is associated with foraging tactics and diet by combining laboratory experiments, field observations, and stable isotope analysis. We found that tactile foraging Red Knots mainly caught hard-shelled preys that are buried in the sediment, whereas visual foraging Knots only captured soft preys located close to or on the surface. We also found that faster explorers showed a higher percentage of visual foraging than slower explorers. In these analyses, we tested for potential effects of morphology (bill length and gizzard size) on foraging tactics, but they had no effect. Diet analysis based on stable isotope values confirmed our field observations with slower explorers mainly consumed hard-shelled prey while faster explorers consumed more soft than hard-shelled prey. Our results show that foraging tactics and diet are associated with a personality trait, independent of morphological differences. We discuss how consistent behaviour might develop early in life through positive feedbacks between foraging tactics, prey type, and foraging efficiency.

PP-42

Light-mediated foraging tactics of a crepuscular insectivore

Ruben Evens[1], Michiel Lathouwers[2], Jean-Nicolas Pradervand[3], Bart Kempenaers[4]

[1]University of Antwerp, Wilrijk, Belgium. [2]Hasselt University, Diepenbeek, Belgium. [3]Swiss Ornithological Institute, Sierre, Switzerland. [4]Max Planck Institute for Ornithology, Seewiesen, Germany

Astronomical light pollution is one of the most pervasive, rapidly-expanding pollutants causing a broad-scale illumination of the nocturnal sky. It infiltrates far into natural areas and fundamentally changes the natural night-time environment which has been consistent in evolutionary history and tightly controls animals' circadian rhythms. Artificial skyglow may affect crepuscular and nocturnal light conditions, e.g. mimic a full-moon night in terms of sky brightness, especially during overcast nights, when the sky should be naturally-dark. In this study, we investigated the

light-mediated foraging behaviour of European Nightjars *Caprimulgus europaeus* (hereafter Nightjar). Similar to most members of the *Caprimulgidae*, Nightjars are crepuscular insectivores which visually detect the silhouettes of flying insects against the illuminated sky. Assuming that variation in sky brightness affects prey detectability rather than prey availability, we hypothesised that a full moon and artificial skyglow both improve prey detectability and allow individuals to increase nocturnal foraging activity. We quantified individuals' (66 individuals, 258 nights) nocturnal flycatching activity in breeding and foraging habitat using a combination of GPS-loggers and tri-axi accelerometers. Our data show that nightjars' nocturnal foraging activity increases, as expected, when nocturnal moonlight increases, but also when measured sky brightness increased (i.e. accounting for possible artificial skyglow). In sites subjected to higher levels of artificial skyglow, nocturnal foraging activity was increased, with indications that skyglow may weakened lunar-mediated responses in nocturnal foraging activity.

PP-43

Isolated population of tits in the Hyrcanian forest (Northern Iran and Azerbaijan). Taxonomical status and differences from Caucasian, Kopet Dag and European populations

Grigory Evtukh[1], Yaroslav Red'kin[2]

[1]Lomonosov Moscow State University, Biological faculty, Vertebrate Zoology dep., Moscow, Russian Federation. [2]Zoological Museum of Moscow State University, Moscow, Russian Federation

The ancient Caspian Hyrcanian forest is located in Northern Iran and Azerbaijan. It is an isolated region near the southern coast of the Caspian Sea, bordered by the Alborz mountain ridge and Kopet Dag mountains. The relict Tertiary plants still inhabit Hyrcanian forest as well as many endemic forms of vertebrates. Birds of Hyrcanian forest are studied poorly. Even the taxonomic status of some local forms still remains controversial. Tits of the Paridae family are among the most interesting Hyrcannian birds from evolutionary point of view. In this regions isolated forms of several species have been described as well as the only endemic species Caspian Tit *Poecile hyrcanus*. In average Hyrcanian forms of tits had smaller average size and darker plumage coloration compared to Caucasian and European populations. However, the level of genetic isolation between them is still unclear. We compared morphology, song and genetics of four tit species from different geographical populations: Great Tit *Parus major*, Blue Tit *Cyanistes caeruleus*, Coal Tit *Periparus ater* and Caspian Tit. Using the original species and subspecies descriptions as well as new data we were able to clarify the taxonomic status of Hyrcanian tits and make some conclusions on the evolution of isolated bird populations.

PP-44

Local- and landscape-scale management to boost a threatened breeding wader population

Harry Ewing[1], Samantha Franks[2], Jennifer Smart[3], Niall Burton[2], Jennifer Gill[1]

[1]University of East Anglia, Norwich, United Kingdom. [2]British Trust of Ornithology, Thetford, United Kingdom. [3]Centre for Conservation Science, Royal Society for the Protection of Birds, Edinburgh, United Kingdom

In recent decades, many wader species have declined in range and abundance across Western Europe. Population declines have been broadly attributed to changes in landscape composition, land management practices and quality of breeding habitat, which have made nests and chicks more susceptible to failure. As a result, breeding productivity of many wader populations has reached unsustainably low levels. To restore wader populations in Western Europe, considerable effort has been made to boost breeding productivity, primarily through deploying tools to directly and indirectly protect nests against predation and mechanised practices. In many cases, this has resulted in increased hatching success but increases in fledging success have been more challenging to achieve. This study aims to explore the potential of targeted habitat management to boost fledging success. We use daily observations of Eurasian Curlew broods, a species of major conservation concern across Europe, to quantify chick habitat use and survival in relation to spatial and temporal variation in vegetation structure, at a local- and landscape-scale.

PP-45

Inter and intra-population variability of migratory behaviour of a Mediterranean short distance migrant: the Eurasian Stone-curlew *Burhinus oedicnemus*

Valentina Falchi[1], Andrea Barbon[2], Carlo Catoni[3], Giulia Cerritelli[1], Alice Cutroneo[1], Giacomo Dell'Omo[3], Marco Dragonetti[4], Pietro Giovacchini[5], Angelo Meschini[6], Lucio Panzarin[2], Angela Picciau[4], Dimitri Giunchi[1]

[1]Ethology Unit, Department of Biology, University of Pisa, Via Volta 6, 56126, Pisa, Italy. [2]Osservatorio Ornitologico Medio Piave, Via XX settembre 13, 31020, Villorba (TV), Italy. [3]Ornis italica, Piazza Crati 15, 00199, Rome, Italy. [4]Gruppo Ornitologico Maremmano, c/o Museo di Storia Naturale di Grosseto, Strada Corsini 5, 58100, Grosseto, Italy. [5]Regione Toscana - Settore Tutela della Natura e del Mare, Strada Cavour 16, 58100, Grosseto, Italy. [6]Stazione Romana Osservazione e Protezione Uccelli, Piazza Margana 40, 00186, Rome, Italy

Short-distance migrants are more flexible in changing their migration schedule than long-distance ones and thus represent good models for investigating the factors affecting the variability of migratory behaviour. In this study we investigated the migratory strategy of the Eurasian Stone-curlew *Burhinus oedicnemus* using data collected on 40 individuals, tagged with geolocators and

GPS-GSM, belonging to two Continental and two Mediterranean populations of the Italian peninsula. The proportion of migrants, estimated using both geolocators and GPS data, differed significantly between different regions, but we observed a significant variability also between Mediterranean populations. GPS-tagged migrants covered rather short distances (<1000 km) and their wintering areas, which were quite diverse also within populations, were all located in the Mediterranean basin. Continental Stone-curlews departed earlier in autumn, later in spring and travelled greater distances than Mediterranean ones. While individuals from Continental populations did not change their speed between seasons, Mediterranean individuals tended to migrate faster in spring. The likelihood of departure for autumn migration of GPS-tagged birds was not affected by the breeding region while it increased on cold days and with tailwind conditions. On the contrary, in spring the likelihood of departure was higher for Mediterranean birds and tended to be significantly affected by northern winds and by an increase of daily minimum temperature. The results suggest that inter and intra-population variability of the migratory behaviour of the Stone-curlew could be at least partially related to the effect of environmental conditions, especially in autumn.

PP-46

Swimming asleep: characterization of sleep during paddling in Canada Geese *Branta canadensis*

Andrea Ferretti[1], Paul-Antoine Libourel[2], Niels C. Rattenborg[1]

[1]Max Planck Institute for Ornithology, Avian Sleep Group, Seewiesen, Germany. [2]CRNL, SLEEP Team, UMR 5292 CNRS/U1028 INSERM, Université Claude Bernard Lyon 1, Bron, France

Sleep is a behavioral state that is an important part of the biology of all organisms investigated so far, though our understanding of its function remains limited. Even though several species show drastic cognitive and physiological impairments subsequent to periods of extended sleep deprivation, in some life-history stages the need for sleep seems to be deleterious for the fitness of the individual, which would benefit from an extreme extension of the waking phase. This is the case of many bird species during migration or reproduction, as well as during challenging foraging situations. Although little is known about if and how they obtain sleep in such ecological contexts, previous studies have suggested several possibilities. For example, several birds show a drastic reduction in sleep during migration and non-stop foraging flights, as shown in great frigatebirds. Interestingly, this species is also able to sleep on the wing. Despite being able to sleep while soaring and gliding, frigatebirds never slept while flapping their wings, raising the question of whether sleep during active locomotion is even possible in birds. By using a combination of behavioral and accelerometer data, in this study we aim to determine, for the first time, whether sleep is compatible with stereotyped movements in birds by investigating sleep during active paddling in Canada Geese *Branta canadensis*.

PP-47

Possible *Salmonella* spp. infections originating from synanthropic Egyptian Goose *Alopochen aegyptiaca* in Germany: a One Health perspective

Ella Fischer[1,2], Romy Müller[2], Matthias Todte[2], Anja Taubert[1], Carlos Hermosilla[1]

[1]Institute of Parasitology Justus Liebig University Giessen, Giessen, Germany. [2]Avicare+, Köthen, Germany

Salmonellosis is worldwide one of the most common bacterial enteric diseases of humans and still representing a relevant disease for young, old and immunosuppressed patients. Anseriformes can become infected with *Salmonella* spp. and thus potentially acting as natural reservoir hosts within their habitats. The Egyptian Goose *Alopochen aegyptiaca* represents nowadays a spreading neozoan bird species within Europe. As synanthropic goose species, they prefer urban/periurban habitats such as city parks and public swimming pools, and thus being in frequent contact to humans and domestic pets. So far, no investigations are available in literature on the role of synanthropic Egyptian Geese in the transmission of *Salmonella* infections to humans. The aim of this study was to address this issue focusing on salmonellosis. During the year 2020, a total of 83 scat samples originating from 179 Egyptian Geese living in rural/periurban and urban habitats, i.e. 30 boot sock samples of 14 different public swimming pools as well as 25 freshly collected caecal samples from carcasses, were examined for the presence of *Salmonella* spp. Collected samples were obtained from six different Federal States of Germany as well as from Luxembourg. Neither collected individual scat samples, sock samples nor the caeca samples collected from deceased animals, were positive for *Salmonella* infections. The present findings collectively constitute baseline data for further monitoring of not only wildlife-derived anthropozoonotic bacteria but also parasites and call for future research on the health and ecological impact of this neozoan species closely linked to humans, domestic and wild animals.

PP-48

The influence of global teleconnections atmospheric patterns on the Mallard population during the breeding season

Sofiya Peshkova[1], Ivan Frolov[2,1], Marina Selivanova[2], Ekaterina Kharitonenko[1]

[1]Novosibirsk State University, Novosibirsk, Russian Federation. [2]Institute of Systematics and Ecology of Animals, Novosibirsk, Russian Federation

The Mallard *Anas platyrhynchos* population, as well as other animals, can be affected by global climate change. The best indicators of all fluctuations in atmospheric pressure, temperature, precipitation are the teleconnection patterns like North Atlantic Oscillation. The goal of the research is to figure out how different atmospheric teleconnection patterns of the Northern

Hemisphere affect the abundance of the Mallard during reproduction. To perform the analysis we selected six indices of atmospheric teleconnection patterns that have a significant impact on Eurasia and North America (including the North Atlantic Oscillation, the East Atlantic / Western Russia index, the Scandinavian index, and others). Each pattern is represented by 12 values of the monthly average index for each year. To track the interannual population dynamics we used data from open sources on the abundance of the Mallard population in the breeding season in the Russian Federation, Europe, and North America. Altogether we analyzed 46 time series lasting for 10 – 48 years. To match the abundance data from different locations, we normalized values to 0 – 100. To figure out the relationship between indices of atmospheric teleconnection patterns and the Mallard abundance, we created families of generalized linear models using the GLMulti package in the R environment. As a result, several maps have been created illustrating the connection between the Mallard abundance and atmospheric teleconnection patterns. Generalized linear models that we received can be used in the prediction of the Mallard population for the future seasons.

PP-49

The adaptation of three duck species to the global climate change: the flexibility of the species

Ivan Frolov[1,2], Marina Selivanova[1]

[1]Institute of Systematics and Ecology of Animals, Novosibirsk, Russian Federation. [2]Novosibirsk State University, Novosibirsk, Russian Federation

The Mallard, the Common Pochard, and the Tufted Duck are the three most abundant duck species on Lake Krotovo, southern Western Siberia. We performed the retrospective analysis of reproduction data collected in 1970 - 2018. Using Generalized Linear Models we created sets of models describing the connection between the reproduction timings and the local weather parameters together with global teleconnections atmospheric patterns (e.g. North Atlantic Oscillation, Scandinavian, and others). We found a significant shift in reproduction timings since the 1980s together with the global climate change. These species seem to be able to adapt to the warmer springs: when spring temperature goes above zero ducks may wait for more than average to initiate egg-laying. This mechanism may protect the population from unexpected night frosts. The analysis of nest survival data allowed us to define the most optimal period for the reproduction of these duck species. Thus, these ducks balance between two limiting factors: the frost risk period at the end of April and the land and air predators actively reproducing at the beginning of June. In this research we will explain how these duck species are adapting to global climate change and what can possibly happen in the future with the population and distribution. Also, there can be some differences in the ecology among these species.

PP-50

The impact of weather conditions on Low Pathogenic Avian Influenza Virus infection rate in dabbling ducks migrating through the south of Western Siberia

Olga Druziaka[1,2,3], Ivan Frolov[1,2], Alexey Druzyaka[1,2], Kirill Sharshov[3], Alexandr Shestopalov[3]

[1]Institute of Systematics and Ecology of Animals, Novosibirsk, Russian Federation. [2]Novosibirsk State University, Novosibirsk, Russian Federation. [3]Eurasian Institute of Zoonotic Infections FRC FTM, Novosibirsk, Russian Federation

Wild waterfowl including dabbling ducks are the main host of Low Pathogenic Avian Influenza Virus (LPAIV). Both ecological and demographic characteristics of the avian host together with weather and climate conditions can determine the infestation level. In this research we focus on the probable influence of the local summer weather conditions preceding the autumn migration period on the change of infestation level. We sampled cloacal swabs for LPAIV from more than 800 individuals of dabbling ducks during autumn migration in 2015 – 2021 in the Novosibirsk region, the south of Western Siberia, Russian Federation. We used Generalized Linear Models to find the connection between the infestation rate and weather conditions. During multi-model inference we selected the most accurate models using Akaike Information Criterion and found the most important weather factors influencing the infestation level. Air temperature and air humidity (as a relative characteristic of precipitation) prior 41 – 50 days before sampling in September showed a high connection with the infestation level. We suggest that warm and wet weather at the beginning of August may play a crucial role in the LPAIV dispersion in September significantly increasing the infestation level. Additionally, obtained models can help in forecasting virus outbreaks in the autumn season since the models are based on summer weather data. This research was supported by the RFBR (project No. 19-54-55004) and the IAEA (contract No. 22563).

PP-51

The Mallard population survival rate variation in response to the global climate change

Ekaterina Kharitonenko[1], Ivan Frolov[1,2], Marina Selivanova[2], Sofiya Peshkova[1]

[1]Novosibirsk State University, Novosibirsk, Russian Federation. [2]Institute of Systematics and Ecology of Animals, Novosibirsk, Russian Federation

We performed a retrospective analysis of the breeding biology of the Mallard *Anas platyrhynchos*. Nest survival data was collected in 1970 - 2018 at Lake Krotovo in the south of Western Siberia. This region is affected by the global climate change with the significant changes across local spring weather conditions from 1980s. This climate change may influence the clutch initiation dates and the overall timings of the breeding season. In this research we try to find out how the global climate change influences the time when the Mallard prefer to initiate and finish the reproduction season

together with the survival probability. The key question of this research is how the survival rate changes in response to the climate change. We evaluated the survival probability of the Mallard nests using the Nest Survival module of the MARK 7.1 program. Each nest has the final fate of being successfully hatched, abandoned, or depredated. The reproduction period of the Mallard may start on 14th of April or on the 13th of May. This observation illustrates that this species remains flexible in response to the variable spring weather conditions.

PP-52

Individual variation of movement patterns in the Lesser Kestrel and Common Kestrel during the annual cycle

Daniel García Silveira[1], Lina Lopez Ricaurte[1], Jesús Hernández Pliego[2], Willem Bouten[3], Javier Bustamante Díaz[1]

[1]Doñana Biological Station - Spanish National Research Council (CSIC), Seville, Spain. [2]Independent Researcher, Seville, Spain. [3]Institute for Biodiversity and Ecosystem Dynamics - University of Amsterdam, Amsterdam, Netherlands

From 2018 to 2021, 39 Common Kestrels (21 females and 18 males) and 39 Lesser Kestrels (22 females and 17 males) have been tagged with GPS data loggers (mean tracking period = 208 ± 30 days, range = 1-1137) in southwestern Spain, where both species breed sympatrically. Although morphologically similar, these small falcons are unlike in terms of prey selection, habitat selection, or breeding behaviour: the Lesser Kestrel is considered a specialist and colonial breeder, whereas the Common Kestrel a generalist and solitary breeder. We hypothesize that the ecological specialization of the Lesser Kestrel will be reflected in its movement ecology, and thus the variation in movement patterns (e.g., home range size, cumulative distance, maximum distance travelled per day, roosting behaviour, etc.) among individuals of the Lesser Kestrel will be smaller than among individuals of the Common Kestrel. These movement patterns will be estimated at daily scale during the annual cycle (i.e., breeding and non-breeding season).

PP-53

Lower error rate in much less time: video analysis of nest boxes of Great Tit *Parus major* with Motion Birdy

Uta Gerz, Max Pfister

Justus-Liebig-Universität, Giessen, Germany

Observations are a basic element of many ecological behavioral studies. They are often made with low-invasive video recordings to allow comparability and evaluation by multiple evaluators.

However, the time required and the possibility of errors due to fatigue pose major problems with the considerable amounts of data. Therefore, we developed and evaluated the program Motion Birdy to facilitate a faster analysis of video data. Motion Birdy detects movement events in videos and creates event videos and an event table from them. We used videos from the JLU Giessen nest box project and found that Motion Birdy resulted in a ~70% reduction in evaluation work time and a low error rate (~0.35%). Motion Birdy was found to perform very well and offers adaptability for broader uses until future machine learning applications become feasible.

PP-54

Effects of West African protected areas on Afro-Palearctic migrants

Sandra Goded[1], Nathaniel Annorbah[2], Samuel Boakye[3], Nico Arcilla[4]

[1]International Bird Conservation Partnership, Palas de Rei, Spain. [2]University of Environment and Sustainable Development, Kumasi, Ghana. [3]University for Development Studies, Tamale, Ghana. [4]International Bird Conservation Partnership, Stockholm, Sweden

Many bird species that nest in Europe and winter in Africa have exhibited population declines, but in many cases the drivers of these declines are not well understood. Most research on these species has focused on their breeding grounds, while their ecology and conservation on their stopover and wintering grounds remain poorly known. Therefore, we present highlights from two years of fieldwork performed on Afro-Palearctic migrants wintering in and outside Ghana's Mole National Park. We performed 16 1-km transects within and outside the protected area during February-March 2019 and 2020, in which we identified species, abundance and use of habitat. We obtained data from 111 individuals of 22 Afro-Palearctic migrant species, and compared bird species richness and abundance in and outside the park. Species richness was nearly double, and bird abundance over three times higher inside the protected area. In addition, inside the protected area 62% of all raptors, 74% of all insectivorous songbirds, and 94% of all waterbirds were detected. These findings contribute to our knowledge of the winter ecology of Afro-Palearctic migratory birds and demonstrate the importance of protected areas in their conservation. In addition, we will also show how to empower young West Africans in advancing bird conservation and research. These include mentoring students in field methods, data analysis, and scientific publishing, and supporting collaborators' postgraduate education.

PP-55

Breeding success and causes of chick mortality of Common Buzzards *Buteo buteo* in Northern Germany - a detective story with the help of video cameras

Thomas Grünkorn, Jorg Welcker

BioConsult SH, Husum, Germany

Since the beginning of the last century, the breeding population of the Common Buzzard *Buteo buteo* suffered a severe decline in the northern Germany of around 75 %. The breeding success was likewise significantly lower in recent years compared to a study carried out in the same area between 1967 and 1976 (78 % in the 1970s versus 57 % since 1998). The scope of our study was to measure and analyse egg or chick loss as a possible reason for the breeding population decline. Our study documented the hatching success and different causes of chick loss at ten common buzzard nests using one video camera per from 2015 and 2020. Continuous monitoring of nests, eggs and chicks with video cameras (one method) enabled us to define six possible hypotheses explaining the decreased breeding success. We documented the nestling phase of overall 61 breeding attempts. 168 chicks hatched of 177 eggs, 117 chicks fully fledged and 51 chicks died before fledging due to different reasons. We identified three major causes of chick fatalities with 39 of 51 cases (76 %). 1. malnutrition due to low numbers or accessibility of voles due to the recent intensification of agriculture (e. g. production of corn for biogas plants). 2. predation by Eagle Owls *Bubo bubo* and extreme weather conditions. Whether we identified the comparatively lower breeding success as the true reason for the stock decline is still open for discussion, as several further data (particularly adult survival) to be included in population modelling are still uncertain.

PP-56

Impacts of plant invasions on birds in heterogeneous landscapes

Emilia Grzędzicka[1], Jan Hanzelka[2], Jiří Reif[2,3]

[1]Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland. [2]Institute for Environmental Studies, Faculty of Science, Charles University, Prague, Czech Republic. [3]Department of Zoology and Laboratory of Ornithology, Faculty of Science, Palacky University in Olomouc, Olomouc, Czech Republic

Landscape heterogeneity increases the biodiversity and niche opportunities, although greater heterogeneity may contribute to the invasion spread. Our study aimed to assess the impact of plant invasion on bird assemblages in the context of landscape heterogeneity. We ask whether the Sosnowsky's hogweed *Heracleum sosnowskyi* and the giant hogweed *H. mantegazzianum* – invaders originating from the Caucasus region and spreading in Europe – can be tolerated by birds provided that sufficient availability of their optimal habitats are maintained. The research was conducted in south-eastern Poland in 2020 on 64 research sites, half of which were located near the Caucasian hogweeds' invasion, and the rest were control. The birds were counted from points within 100 m, while habitats and landscape heterogeneity were measured within 100 and 500 m. The impact of the invasion area was negative for the number of all bird species and the abundance of ground/herb dwellers whose numbers abruptly dropped with small increases of the invasion area. Ecotone birds benefited from small areas of invasion, although were negatively affected by the occurrence of large invasion areas. Habitat homogenization by the invader similar

to shrubs was favoured by bush foragers. The negative effect of patches' number (a measure of habitat heterogeneity) on bird abundance found in this study was supported by the increasing invasion area and is opposite to the widely known positive effect of heterogeneity on biodiversity. Our novel finding is the role of plant invasion area decreasing the availability of native habitats and supporting the negative effect of landscape heterogeneity.

PP-57

Effects of targeted repelling measures on GPS-tracked Barnacle Geese during stopover

Wieland Heim[1], Antti Piironen[1], Jukka Forsman[2], Ramona Julia Heim[1], Toni Laaksonen[1]

[1]Turku University, Turku, Finland. [2]Natural Resources Institute Finland, Oulu, Finland

Increasing populations of geese have led to conflicts with farmers and landowners throughout north-western Europe. The population of the Barnacle Goose *Branta leucopsis* has multiplied in the past 20 years, and up to 1 million individuals now regularly occur in eastern Finland during stopover. Farmers use different methods to repel geese, such as shooting in the air, laser pointers, and by directly approaching the flock. To alleviate the conflict, "goose fields" were established, where the birds could refuel without being repelled. We used solar-powered GPS-GSM/GPRS transmitters to investigate the response of free-flying geese to targeted repelling measures. In a quasi-experimental setup, tagged individuals were repelled with each of the three methods mentioned above. Here we present data on behavioural responses of Barnacle Geese after the repelling experiments. We further analysed the time spent on goose fields, and whether repelling measures would affect the use of space in the stopover area.

PP-58

Song and calls in the contact zones of subspecies and vocal dialects of the Chaffinch in southwestern and northwestern Russia

Vladimir Ivanitskii, Irina Syomina, Irina Iliyna, Irina Marova

Lomonosov Moscow State University, Moscow, Russian Federation

We investigate the diversity of song types and frequency-time parameters of rain calls in the contact zone between the Caucasian and Crimean subspecies of Chaffinches in the northwestern Caucasus, between the nominal and Caucasian subspecies in the northern Ciscaucasia (southern Russia) as well as between two rain call dialects in the north-eastern Russia. In total, the songs and rain call of more than 500 males have been recorded in 15 different locations. The song repertoires of Chaffinches in the Crimea and on the Abrau Peninsula (Black Sea basin) are very different with a distance between them of less than 100 km. In contrast, the repertoire of the Abrau population has

much in common with much more remote (270-300 km) populations of the Caucasus and Ciscaucasia. Zones of secondary contact between Chaffinch subspecies looks like a kind of filter that make it difficult to spread vocal patterns from the range of one subspecies to the range of another. In Karelia, we found significant differences in the distribution of rain calls dialects along the northern coast of Ladoga Lake compared to studies carried out in the 90s (Korbut 1996; Sorjonen 2001). Currently, the entire area is dominated by the south-eastern dialect ("rülsch"group), while only a few individuals performed the whistling north-western dialect ("hüit" group). It is possible that a large-scale advance of the south-eastern dialect and retreat of the north-western dialect occurred in response to climate warming. The study was supported by the Russian foundation for basic research (grant no. 20-04-00341).

PP-59

The importance of university campuses for maintaining urban bird biodiversity

Lucía Izquierdo[1], Rocío Ríos-Guisado[1], José Luis Molina-Pardo[2], Juan Diego Ibáñez-Álamo[1]

[1]University of Granada, Granada, Spain. [2]Centro de Investigación de Colecciones Científicas (CECOUAL), Almería, Spain

Nowadays there is a growing concern on how to design more sustainable cities. Previous studies have focused on the effect of specific urban areas (e.g. graveyards, parks) on biodiversity, but little attention has been paid to university campuses. Campuses are characterized by a higher number of habitat types and usually larger and less fragmented green areas than other typical urban areas, which can retain more birds in their communities. To our knowledge, there are no studies on the relative importance of university campuses on biodiversity and which landscape traits allow them to hold potential higher levels of diversity. We have explored these research questions regarding bird communities. We carried out bird censuses (point counts) during the breeding season of 2021 in 15 university campuses and paired urban patches outside those campuses from 12 cities in Spain. Additionally, we obtained several local and landscape traits to identify which environmental variables could determine the particularity of campuses in terms of biodiversity. We performed GLMs and found that university campuses are related with higher levels of taxonomic diversity (i.e. bird species richness). At the local level, this diversity pattern could be explained with differences in vegetation and buildings (between university and non-university urban areas), with campuses clearly showing higher levels of vegetation. These results indicate that university campuses are important to reduce the loss of bird species due to urbanization and that these urban areas could become urbanization models useful to create more biodiversity-friendly cities in the future.

PP-60

How Common Ravens *Corvus corax* exploit anthropogenic food sources through time and space in a semi-transformed, alpine environment

Varalika Jain[1,2], Petra Sumasgutner[2], Thomas Bugnyar[2], Matthias Claudio Loretto[3]

[1]University of Cape Town, Cape Town, South Africa. [2]University of Vienna, Vienna, Austria. [3]Max Planck Institute of Animal Behavior, Radolfzell, Germany

The behaviourally flexible and adaptable Common Raven *Corvus corax* has thrived by exploiting anthropogenic food sources (AFSs), which are often more spatially concentrated, accessible, abundant and stable than natural ones. Consequently, raven population numbers have grown across their range, raising conservation concerns including increased predation on threatened species and human-wildlife conflict. Using long-term GPS tracking data, we investigated which AFSs were most extensively used by non-breeding Ravens in the Upper Austrian Alps, and which factors predicted individual variation in their usage of AFSs. Individuals exhibited great variation in their movement patterns and AFS-use varied based on traits (i.e., age, origin and ranging behaviour), season and the type of AFS. Juveniles, captive-bred-released and local birds visited fewer AFSs than adults, wild-caught and vagrant birds, but did not have a higher probability of being at one specific resource, suggesting experience affects AFS-use. In winter, individuals visited the most sites, but also had the lowest probability of being at a specific site, indicative of high foraging competition under harsh environmental conditions. In spring, individuals visited many AFSs and had a high probability of being present at a specific site, perhaps due to decreased competition and increased food availability. From 44 AFSs, Ravens had a higher probability of being present at game parks and refuse sites than huts, likely due to differences in resource quality, quantity and replenishing rate. Strategies to manage Ravens should consider these differences, and focus on controlling food supply at sites on a regional scale.

PP-61

Morphological adaptation and sexual dimorphism of feather mites in birds with unique flight

Lucía Jiménez-Gallardo[1], José María Fernández-Calero[2], Javier Pérez-Tris[1]

[1]Evolution and Conservation Biology research group; department of Biodiversity, Ecology and Evolution (BEE). Biology Faculty, Complutense University of Madrid (UCM), C/ José Antonio Novais, 12 Ciudad Universitaria 28040, Madrid, Spain. [2]Freshwater Ecology, Hydrology and Management (FEHM), Department of Evolutionary Biology, Ecology and Environmental Sciences. Section of Ecology, Biology Faculty, Institut de Recerca de la Biodiversitat (IRBio). University of Barcelona (UB), Diagonal 643, 08028., Barcelona, Spain

The diversity of birds creates opportunities and constraints for obligate symbionts such as vane-dwelling feather mites. Feather mites are sexually dimorphic, with females showing larger size than males consistent with fecundity selection. However, mite mating systems may be altered in birds where an extravagant flight style constrains mating opportunities. We tested whether feather mites specific of swifts and hummingbirds, two closely related groups with unique flight styles, have unique morphology and sexual dimorphism. Using geometric morphometrics, we measured body size and size of the idiosome (a proxy of individual fertility) and posterior lobes (which males use to hold females during mating) of 269 feather mite genera. We tested whether these traits and their sexual dimorphism follow unique trajectories in swifts and hummingbirds compared to other bird lineages. Swift and hummingbird mites showed sexual dimorphism patterns that are common to all feather mites, such as females being larger than males. However, contrary to other mite groups (including hummingbird mites), female swift mites showed smaller idiosomes than males, suggestive of stronger fertility selection on males. Another general pattern of feather mite sexual dimorphism, that males have larger posterior lobes than females, was exaggerated in swift mites but lost in hummingbird mites, suggesting divergent mating systems for mites of these closely related birds. Our results show that the diversity of avian hosts may alter the social environment of these obligate ectosymbionts resulting in different mating systems.

PP-62

Greenery loss and congeneric relations cause the serious decline of the urban population of Syrian Woodpecker in Poland

Łukasz Kajtoch, Bartłomiej Kusal

Institute of Systematics and Evolution of Animals Polish Academy of Sciences, Krakow, Poland

Syrian woodpecker had been among avian winners in Europe thanks to its expansion in the XX century from the Middle East to SE and central Europe. However, a recent strong decline of its rural populations at the edge of expansion suggested reverse trends. Comparison of Syrian Woodpecker territories distribution in the last decade in the Krakow agglomeration (S Poland) showed a serious decline of 48%, which makes this bird among one of the most threatened at least in parts of its range. Analyses of changes in the environment pointed that urban greenery removal, which is associated with acceleration of urbanization, was the main reason for Syrian Woodpecker loss (approx. 30% of territories vanished in areas with greenery loss). Simultaneously, intense expansion of Great-spotted Woodpeckers to urban greenery was observed (an increase of 53%), which resulted in the shift (30%) or replacement (17%) of some of the former Syrian Woodpecker sites and an increasing number of sympatric territories (a 3-fold increase of Syrian Woodpecker pairs sharing territories with Great-spotted Woodpeckers). The latter probably accelerated the rate of hybridization as currently 25% of Syrian territories are constituted by at least one hybrid mate (9% if considering both Syrian and Great-spotted Woodpecker sites). In 2021 for the first time, a pair formed by two hybrids was detected, which successfully produced four offspring. That decline of abundance, probable competition for space and resources with Great-spotted Woodpeckers and

accelerating hybridization could be a serious threat to the persistence of urban populations of Syrian Woodpeckers.

PP-63

Seasonal sex allocation strategies in Tawny Owls are colour morph-specific and associated with differential fitness prospects of sons and daughters

Patrik Karell[1,2], Amandine Tooth[2], Chiara Morosinotto[1,2]

[1]Novia University of Applied Sciences, Raseborg, Finland. [2]Lund University, Lund, Sweden

Sex allocation theory predicts that parents should adjust their brood sex ratio to maximize fitness, based on different costs of raising sons and daughters. Melanin-based colour polymorphism is predicted to evolve and be maintained through differential fitness in different environments, as well as to covary with life history strategies. Sex allocation decisions are thus expected to be morph-specific. Tawny Owls *Strix aluco* display a grey and a brown morph which vary in life history strategies, physiology, and behavior: brown parents are indeed known to produce heavier offspring. Here we studied the interactive effect of parental colour morph and timing of breeding on offspring sex ratios and sex-specific offspring condition in Finland during 2009-2019. We predicted that (larger) daughters would be more common in early broods, particularly in those born to brown mothers, and that fledgling mass of daughters would be higher in offspring of brown mothers. Brood sex ratio varied across the season depending on parental colour morph: late broods of brown mothers were more strongly male-biased than those of grey mothers. Offspring of early broods and of brown mothers were heavier than those of late broods or grey mothers. Higher mass at fledging increases the probability of recruitment, and brown daughters appear to benefit most from being born under good food conditions (early broods). Under poor food conditions (late broods), brown mothers produce more (smaller) cheap sons, while grey mothers face fewer challenges and favor daughters. These findings provide evidence of morph-specific sex ratio adjustment in Tawny Owls.

PP-64

Asynchrony or synchrony? Consequences of hatching strategy on parental effort, condition and telomere length in the Pied Flycatcher

Tiia Kärkkäinen[1], Pauliina Teerikorpi[1], Wiebke Schuett[2], Antoine Stier[1,3], Toni Laaksonen[1]

[1]University of Turku, Turku, Finland. [2]University of Sussex, Brighton, United Kingdom. [3]Université Claude Bernard Lyon, Villeurbanne, France

In many birds, chicks hatch asynchronously. Hatching asynchrony occurs when a female starts incubation before completing her clutch. Many hypotheses have been suggested to explain this

behavior, from adaptive brood reduction to diversification of offspring phenotypes. One branch of theories hypothesizes hatching asynchrony to be energetically efficient for the parents, as not all their offspring will have their peak of energy demand simultaneously. We set out to examine this hypothesis by controlling the start of incubation to create both asynchronous and synchronous broods in wild Pied Flycatchers *Ficedula hypoleuca*. We followed parental provisioning rates from chick hatching to fledging by fitting parent birds with individual PIT tags that record the times the bird moves through the nest box entrance. We recorded the wing and tarsus length, and body mass of female parents twice during the breeding period, once during incubation and once at the end of chick rearing. Males were measured only at the end of the chick rearing period. Every time a parent was caught, a blood sample was taken for telomere length assessment. Telomeres, the ends of chromosomes, are increasingly used as an indicator of stress and future survival. We use provisioning rates, telomere length, change in body mass index, and fledging success to investigate the potential differences in parental effort and subsequent condition after the chick rearing period between parent birds caring for asynchronous or synchronous broods.

PP-65

Secrets of The European Robin *Erithacus rubecula* in the primeval Białowieża Forest

Oliwia Karpińska[1], Katarzyna Kamionka-Kanclerska[1], Grzegorz Neubauer[2], Robert Rutkowski[3], Aleksandra Gwiazdowska[4], Dorota Czeszczewik[1], Patryk Rowiński[5]

[1]Siedlce University of Natural Sciences and Humanities, Siedlce, Poland. [2]Wrocław University, Wrocław, Poland. [3]Museum and Institute of Zoology PAS, Warszawa, Poland. [4]Museum and Institute of Zoology PAS, Waszawa, Poland. [5]Warsaw University of Life Sciences, Warszawa, Poland

European Robin is a widespread and one of the most numerous birds in European forests. Its breeding biology is quite well understood, but most of the data comes from managed forests and other man-made habitats, while almost no information from natural forests. Here, we want to show some unknown aspects of breeding biology of the European Robin nesting in primeval deciduous stands of the Białowieża National Park (BNP), E Poland. Direct observation, camera traps, ringing and molecular methods were used. Robins in the BNP are true hole-nesters - 72 % of its nest were located in tree cavities. Predation was the most important cause of breeding losses of this species (98% of all brood failures). Extra-pair paternity was found in only 5 % of families, thus Robin seems to be socially and genetically, monogamous species. Furthermore, the commencement of eggs lying was significantly earlier in ash alder compared to lime-oak-hornbeam stands, and the difference increased when spring was colder. Site fidelity of this species are rarely noted in literature, whereas in BNP we observed 10% of individuals returning from winter grounds in exactly the same breeding place. The European Robin behaviour under primeval conditions of the BNP differs from that obtained in simplified man-transformed habitats. This is due to both – a much complicated forest structure and higher biodiversity, including numerous groups of predators

in the BNP. Such research allows us to better understand how the evolution of individual species proceeded.

PP-66

Do ixodid ticks affect body condition of migratory birds?

Elza Zacmane, Oskars Keišs

Laboratory of Ornithology, Institute of Biology, University of Latvia, LV-1586 Riga, Latvia

Birds are well known as hosts of parasitic Ixodid ticks. The main focus of research of Ixodid ticks on birds have been spreading of infectious disease, because in addition to their main host species – small ammals, they can take blood meals from migratory birds, and therefore might spread the infected tick population further to new territories across geographical barriers. Here, we investigate if ticks have any effect on body condition of a bird during autumn migration. For this purpose, we compared individuals with identical wing length and capture date with and without ticks. The birds were captured, and ticks collected at Pape Ornithological station at the Baltic Sea, Latvia. We investigated only five bird species since only for those five species datapoints were sufficient for statistical analyses. Birds without ticks were significantly heavier in Reed Warbler *Acrocephalus scirpaceus*: n=36; p=0.0005; Marsh Warbler *Acrocephalus palustris*: n=48; p=0.039 and European Robin *Erithacus rubecula*: n=226; p=0.00003. Two other species – Song Thrush *Turdus philomelos*: n=30; p=0.236 and Blackbird *Turdus merula*: n=60; p=0.081 did not showed statistical difference in weight. So – birds with ticks have less weight, the question is – do the ticks affect bird's condition or ticks easier infest birds with poor body condition caused by other factors?

PP-67

Where do they move next year? Migratory movements of Red-throated Divers *Gavia stellata* reveal low connectivity but high repeatability

Birgit Kleinschmidt[1], Claudia Burger[2], Monika Dorsch[2], Stefan Heinänen[3], Julius Morkūnas[4], Georg Nehls[2], Ramūnas Žydelis[5]

[1]University of Giessen, Giessen, Germany. [2]BioConsult SH, Husum, Germany. [3]Novia University of Applied Sciences, Ekenäs, Finland. [4]Marine Research Institute, Klaipėda, Lithuania. [5]Ornitela UAB, Vilnius, Lithuania

The Red-throated Diver *Gavia stellata* a strictly protected species, winters in temperate coastal waters and migrates to circumpolar arctic breeding areas. In Europe, the eastern German Bight is known to be an important wintering and spring staging area for this species but is affected by increasing anthropogenic pressures and recently strong displacement effects from offshore wind

farms have been documented. Annual movements of individuals using this area are still unclear. A better understanding of space utilisation in terms of migratory connectivity, site fidelity and timing of movements is highly needed to better assess displacement effects on population level. We successfully tracked 31 Red-throated Divers, equipped with satellite transmitters in the eastern German Bight between 2015 and 2017, throughout their annual cycle. Individuals from one breeding region displayed a diffuse migratory connectivity but a faithful site utilisation during breeding and stationary non-breeding periods. Timing and migratory movements were correlated with breeding location and staging behaviour, showing 40 days later arrival at easternmost breeding sites, probably adapted to the phenological gradient along the migration route. We conclude that the weak connectivity distributes disturbance effects in one site to only a portion of individuals from several breeding regions and thus causes resilience whereas high site fidelity indicates individually low adaptability to changed habitats or inflexibility to explore new habitats when displaced. In addition, we found staging sites along the migration route to northern Russia consistently used in spring and autumn, highlighting the importance of these sites for future conservation measures and spatial planning.

PP-68

The time budget of the Eurasian Crane during the spring, summer and autumn periods in the center of the European part of Russia

Kristina Kondrakova

A.N. Severtsov's Institute of Ecology and Evolution RAS, Moscow, Russian Federation

The time budget of the Eurasian Crane was defined at congregations from 29 July to 26 September 2020 and from 4 April to 8 June 2021 in the Ryazan Region, the center of the European part of Russia. Crane behavior activities were separated into the following categories: "feeding without moving" (a bird feeds at one point), "feeding during moving" (a bird feeds and goes), "vigilance", "aggression", "rest", "other actions" (preening, walking, dancing, running, short flights). 2407.45 minutes of observations of 241 individuals were processed. Time of observation was separated into spring (April-May), summer (June, July, August), early September (1–15 September), late September (15–26 September). Families with chicks started to visit the staging area in mid-August. "Feeding without moving": in spring – 21.6%, in summer – 3%, in early September – 66.3%, and in late September – 34.5%. This category of activity occupied a longer period of time in the morning (25.9%) than during the day (11.5%) and the evening (14.3%). The category of "feeding while moving": in spring – 32.1%, in summer – 31%, in early September – 3.2%, in late September – 1.9%. Cranes spent less time in this category when flock sizes increased. "Vigilance": in spring was – 13.4%, in summer – 8%, in early September – 8.6%, and in late September – 9.1%. Juveniles for this category – 9.9%, adults – 11%. More time was spent for "vigilance" when flock sizes increased. "Aggression": in the morning - 0.2%, during the day – 11.5%, the evening – 14.3%. "Rest" was only in the morning - 0.6%. The other actions were not significantly different.

PP-69

High individual repeatability of the migratory behaviour of a long-distance migratory seabird

Nathalie Kürten[1,2], Heiko Schmaljohann[1,2], Coraline Bichet[1,3], Birgen Haest[4], Oscar Vedder[1], Jacob González-Solís[5], Sandra Bouwhuis[1]

[1]Institute of Avian Research, Wilhelmshaven, Germany. [2]University of Oldenburg, Oldenburg, Germany. [3]University of La Rochelle, Villiers-en-Bois, France. [4]Swiss Ornithological Institute, Sempach, Switzerland. [5]University of Barcelona, Barcelona, Spain

Environmental change has been associated with population declines of many migratory species, long-distance migratory birds in particular. Current knowledge, however, is primarily based on population-level analyses at breeding sites. To understand whether and how long-distance migratory birds may adjust and adapt to change, we need additional knowledge on migratory behaviour, and on the degree to which its spatial and temporal components vary within and among individuals. We tracked 138 migratory journeys undertaken by 64 Common Terns *Sterna hirundo* from a German breeding colony to identify their annual spatiotemporal distribution and evaluate the individual repeatability of several traits describing their migratory behaviour. Birds left the breeding colony early September, then moved south along the East Atlantic flyway. Wintering areas were reached mid-September and located at (i) the west coast of West Africa, (ii) the south coast of West Africa, and (iii) the coast of Namibia and South Africa. Birds left their wintering areas late March and reached the breeding colony mid-April. The timing, duration and distance of migration, as well as wintering areas, were moderately to highly repeatable (repeatability indexes: 0.36 – 0.75, 0.65 – 0.66, 0.93 – 0.94 and 0.98 – 1.00, respectively). Common Terns thus show large between-individual variation in their annual spatiotemporal distribution and strong individual repeatability of several aspects of their migratory behaviour.

PP-70

Rush or relax: migration tactics of a nocturnal insectivore in response to ecological barriers

Michiel Lathouwers[1,2], Ruben Evens[3], Tom Artois[1], Nicolas Dendoncker[2], Natalie Beenaerts[1]

[1]UHasselt, Hasselt, Belgium. [2]UNamur, Namur, Belgium. [3]UAntwerpen, Antwerpen, Belgium

In order to balance travel with refuelling opportunities, flight tactics of avian migrants can be determined by local habitat conditions. We hypothesise that European Nightjars spend less time on migratory flight in global biomes which may provide daily foraging opportunities. Conversely, we expect the probability of migratory flight to be higher in global biomes without such foraging opportunities. We tracked the autumn migration of 24 European Nightjars from breeding populations in Mongolia, Belgium and UK, using GPS-loggers and multi-sensor data loggers to

quantify crepuscular and nocturnal migration and foraging probabilities, as well as daily travel speed and flight altitude in response to global biomes. Nightjars were observed to employ a "rushed" migration strategy, reflected in a high daily travel speed and high nocturnal and crepuscular migration probabilities, while crossing ecological barriers. Hospitable biomes were traversed with a "relaxed" migration strategy, characterised by high foraging probability at dusk, lower travel speed and lower nocturnal and crepuscular migration probabilities, suggesting that Nightjars may alternate between feeding and short migratory flight bouts within the same night. The rushed migration tactic adopted when traversing ecological barrier seems to indicate that nightjars attempt to minimize the time spent in these unfavourable areas, while Nightjars seem to opportunistically feed during the crepuscular hours when they encounter hospitable biomes. How this may truly affect individuals' fuel stores and whether different biomes actually provide refueling opportunities *en route* remains to be investigated, in particular to understand how future land-use change may affect migration patterns and survival probabilities.

PP-71

Extreme hot weather has stronger impacts on avian reproduction in forests than in cities

Ivett Pipoly[1,2], Bálint Preiszner[3], Krisztina Sándor[4,2], Csenge Sinkovics[2], Gábor Seress[1], Ernő Vincze[5,1], Veronika Bókony[6], András Liker[1,2]

[1]MTA-PE Evolutionary Ecology Research Group, University of Pannonia, Veszprém, Hungary. [2]Behavioral Ecology Research Group, Center for Natural Science, Faculty of Engineering, University of Pannonia, Veszprém, Hungary. [3]Fish and Conservation Ecology Research Group, Balaton Limnological Research Institute, Eötvös Loránd Research Network, Tihany, Hungary. [4]MTA-ELTE Comparative Ethology Research Grou, Budapest, Hungary. [5]Theoretical Population Ecology and Evolution Group, Department of Biology, Lund University, Lund, Sweden. [6]Lendület Evolutionary Ecology Research Group, Plant Protection Institute, Centre for Agricultural Research, Eötvös Loránd Research Network, Budapest, Hungary

Climate change and urbanization are among the most salient human-induced changes affecting Earth's biota. Extreme weather events can have high biological impacts and are becoming more frequent recently. In cities, the urban heat island can amplify the intensity and frequency of hot weather events. However, the joint effects of heat events and urban microclimate on wildlife are unclear, as urban populations may either suffer more from increased heat stress or become adapted to warmer temperatures. Here we test whether the effects of hot weather on reproductive success of Great Tits *Parus major* are exacerbated or dampened in urban environments compared to forest habitats. By studying two urban and two forest populations over six years, we show that 14-16 days-old nestlings have smaller body mass and tarsus length, and suffer increased mortality when they experience a higher number of hot days during the nestling period. The negative effects of hot weather on body mass and survival are significantly stronger in forests than in urban areas, where these effects are dampened or even reversed. These results suggest that urban birds are less vulnerable to extreme hot weather conditions than their non-urban conspecifics, possibly by

adaptively evolving or flexibly adjusting nestling physiology to tolerate heat stress, and/or by adjusting parental behavior in response to heat. This finding highlights that birds may be able to adapt to heat stress, which may help their populations cope with the joint challenges of climate change and urbanization.

PP-72

The growth rate and quality of feathers: the effects of avian malaria in three migratory bird species

Sergio Magallanes Argany[1,2], Carlos Mora-Rubio[1], Alfonso Marzal Reynolds[1], Florentino de Lope Rebollo[1], Martina Ferraguti[3]

[1]Departamento de Anatomía Biología Celular y Zoología, Universidad de Extremadura, Badajoz, Spain. [2]Estación Biológica de Doñana (EBD-CSIC), Sevilla, Spain. [3]Academic (Theoretical and Computational Ecology (IBED, FNWI)), Amsterdam, Netherlands

During moult, stressors such as malaria and related haemosporidian parasites (e.g. Plasmodium, Haemoproteus and Leucocytozoon) could affect the growth rate and quality of feathers, which in turn may compromise future reproduction and survival. However, there are few studies of the consequences of infections on the moult of migratory birds. Here, we analyse the quality and the growth rate of tail feathers moulted in the African winter quarters in parallel with the infection status of blood in three migratory bird species (*Delichon urbica*, *Hirundo rustica* and *Riparia riparia*). We explore if different genus of avian malaria parasite could affect differently to these species, in your reproduction places.

PP-73

A process-driven approach to identify causes of population changes

Katarzyna Malinowska, Katarzyna Markowska, Lechosław Kuczyński

Population Ecology Lab, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland

Process-based (or mechanistic) models provide a high degree of realism of the modelled biological systems. In contrast to static models, a mechanistic approach allows to incorporate processes affecting species range dynamics, such as inter- and intraspecific interactions, population dynamics or environmental change. In order to diagnose the causes of bird population changes, we propose a mechanistic approach that explicitly include spatiotemporal variation (in both bird numbers and environmental factors), density-dependent regulation, biotic interactions, and the observer effect. Furthermore, we compare the proposed approach with three typically used methods, differing in their complexity. A long-term (20 years) and large-scale (>300 000 sq. km) population data for

selected bird species were obtained from the Common Breeding Bird Survey. A wide range of environmental predictors, such as land cover type, weather and topography, were obtained from open access databases. Models were fitted with Generalized Additive Mixed Models (GAMMs) in R using mgcv library. Results were compared between models and evaluated in the context of biological knowledge. The process-based model showed higher explanatory power in identifying causes of population changes. As the high quality metapopulation and spatiotemporal environmental data become increasingly available, a process-based approach should be routinely used when assessing causes of population changes. The study was supported by the National Science Centre, Poland (grant no. 2018/29/B/NZ8/00066).

PP-74

Studies of the Common Swift *Apus apus* Colony in Jerago con Orago, Italy: phenology and reproductive success

Milo Manica[1,2], Daniela Casola[2], Alessandra Stocchetti[2], Manuela Bazzarelli[3], Davide Biganzoli[4], Michelangelo Morganti[5]

[1]LIPU BirdLife Italy, Parma (PR), Italy. [2]Gruppo Insubrico di Ornitologia, Clivio (VA), Italy. [3]independent, Besozzo (VA), Italy. [4]Comune di Jerago con Orago, Jerago con Orago (VA), Italy. [5]CNR-IRSA, Brugherio (MB), Italy

The reproductive biology of the Common Swift *Apus apus* is widely studied, however the studies based on pluriannual data collected on an individual basis remain scarce. Since 2017, LIPU and the Municipality of Jerago con Orago, Italy, have been collaborating in the monitoring and conservation of the Common Swift colony present in the town hall building, which has a swift-tower with 105 cells. The study undertaken since the 2018 breeding season allowed to assess colony consistency (31 couples in 2018, 32 in 2019, 36 in 2020 and 38 in 2021), phenology (the first individual arrived on 12th April 2018 and 9th April 2019, 2020 undefined because of the pandemic lockdown and 19th April 2021) and reproductive success. The monitoring project was supported by a ringing project, thanks to which 469 individuals (148 adults and 323 pullets) were ringed from 2018 to 2021. Reproductive success was estimated by the ratio between the total number of fledged chicks and the total number of laid eggs, obtaining the following values: 2018 = 61.47%, 2019 = 59.48%, 2020 = 54.97%, 2021 = 61.74%. The four-year monitoring allowed to establish an inter-annual recapture rate, which is an approximation of survival. The comparison of four-year data also shows a strong fidelity to the reproduction cell by each couple. The continuation of the ringing project in the following years will allow to estimate with more accuracy these and other parameters and to relate them to the reproductive outcome of the previous years.

PP-75

Do tropical trees suffer of increased herbivory inside predator exclosures?

Elina Mäntylä[1,2], Katerina Sam[1,2], Simon Segar[3], Martin Volf[1], Alexander Weinhold[4], Juha-Pekka Salminen[5], Jan Frouz[6], Heveakore Maraia[1,2], Gibson Sosanika[7], Grace Luke[7], Mentap Sisol[7], Austin Sau[7], Vojtech Novotny[1,2]

[1]Biology Centre of the Czech Academy of Sciences, Ceske Budejovice, Czech Republic. [2]University of South Bohemia, Ceske Budejovice, Czech Republic. [3]Harper Adams University, Shropshire, United Kingdom. [4]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, Germany. [5]University of Turku, Turku, Finland. [6]Charles University, Prague, Czech Republic. [7]The New Guinea Binatang Research Center, Madang, Papua New Guinea

The tritrophic interactions between plants, herbivores and insectivorous predators, such as birds, can be prone to trophic cascades. Then the predators can help plants by removing the herbivorous arthropods. This has been shown to happen in several experiments where plant condition was compared between plants growing inside predator exclosures and plants openly available for predators. We did larger experiments where one part of the treatments were net exclosure cages covering some trees. We did these experiments with 11 understory tree species in lowland tropical forests in Papua New Guinea. Most of the trees were of genus *Ficus*. Trees were organized as pairs of which always one was inside the exclosure and one was in open. Other treatments and characteristics were similar for each pair. The exclosures blocked the access of birds, bats, and ants. We did three experiments in three different forests during 2018-2020. Each experiment lasted for 6 months. We measured the trees and collected samples before and after the experiment. The preliminary results of the differences between the caged and freely growing trees are very variable. In general, the trees inside exclosures grew less in both height and stem diameter than trees in open, but this difference was not statistically significant. Changes and differences in the missing leaf area were even more variable. It may be that birds and other predators cannot cause obvious trophic cascades and thus help the smaller understory trees in the complex and species-rich tropical forests.

PP-76

From the Bosporus to Kopet Dagh: variation in the Chiffchaff in Turkey, the Caucasus and western Turkmenistan

Irina Marova1[1], Irina Ilyina[1], Vladimir Ivanitskii[1], Vassiliy Grabovsky[2], Pavel Kvartalnov[3], Eugenia Solovyova[4], Maryana Belokon[5]

[1]Lomonosov Moscow State University, Moscow, Russian Federation. [2]Center for Forest Ecology and Productivity; Russian Academy of Science, Moscow, Russian Federation. [3]Lomonosov Moscow State University, Moscow, Russian Federation. [4]Zoological Museum of Lomonosov

Moscow State University, Moscow, Russian Federation. [5]Vavilov Institute of General Genetics; Russian Academy of Science, Moscow, Russian Federation

The Chiffchaff superspecies complex occupies almost the entire Palearctic and includes many taxa of different ranks. It is traditionally considered to be one of the most complex problems in the taxonomy of Palearctic birds. We present new data on the genetics, morphology and bioacoustics of the Chiffchaff taxa found in Turkey, the Caucasus, Transcaucasia and Kopet Dagh: 'greenish' *brevirostris, caucasicus, menzbieri* and 'brownish' *lorenzii*. In southern Turkey, two Chiffchaffs were identified which carried a novel haplotype, recently discovered in Northern Israel. Both individuals from Turkey looked somewhat brighter and more yellowish than typical *brevirostris*, but their song clearly corresponded to the *brevirostris* dialect. The form *brevirostris*, inhabiting the western and central regions of Northern Turkey, was found to be the most distinct among all 'greenish' taxa, due to its small body size, wing formula and distinct vocal dialect. Paradoxically, the mitochondrial DNA of *brevirostris* is almost identical with *caucasicus*, whereas, in this respect, *menzbieri* is different from both. We believe that this paradox can be explained if we suppose that *caucasicus* originated during the ancient hybridization of *brevirostris* and *menzbieri*. The relationships between *brevirostris* and *lorenzii*, in the mountainous regions of eastern Turkey, show the mismatch between phenotypic and genotypic traits in some individuals that could also be a result of hybridization.

PP-77

Implications of landfills in the ontogeny of foraging processes of a generalist bird species (*Ciconia ciconia*)

Bruno Herlander Martins[1,2,3,4], Andrea Soriano-Redondo[1,2,3], Aldina M. A. Franco[4], Inês Catry[1,2,3]

[1]CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Campus de Vairão, Universidade do Porto, Vairão, Portugal. [2]CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Instituto Superior de Agronomia, Universidade de Lisboa, Lisboa, Portugal. [3]BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, Vairão, Portugal. [4]School of Environmental Sciences, University of East Anglia, UK

Human waste, mostly on landfills, provides wildlife with valuable food subsidies worldwide. The concentrated nature of these resources attracts a large number of individuals to small areas, where food accessibility may vary based on individual ability and skills to compete for space and needs. Using daily GPS fixes from 68 adult and 67 juvenile White Storks, tagged in southern Portugal between 2018 and 2020, we assess if breeding adults and fledgling juveniles differ in frequency of use of landfill resources and in competitive skills to access the area where waste is deposited. We then used landfill visual counts and video analysis of 165 adults and 124 juveniles, to investigate the effect of age on (i) relative foraging time, (ii) feeding success and (iii) aggressiveness of individuals exploring areas with high, medium and low waste availability. We

found that age is decisive in determining landfill use and access to waste, with juvenile storks being spatially segregated from adults. Adult birds regularly feed on landfills and spend proportionally more time in areas with higher waste availability, while juveniles spend more time alert and restless in areas with low waste availability. Moreover, adults have higher feeding success and show higher levels of aggressiveness. Overall, juveniles are outcompeted in access to resources at landfill sites suggesting that the use of this new food source may be mediated by age-related ability and competitive skills. Thus, landfills could be acting as ecological traps for juvenile birds, by promoting changes in food competition processes and affecting population dynamics.

PP-78

Diversity and host assemblage of avian haemosporidians in five terrestrial ecoregions of Peru

Alfonso Marzal[1], Luz Garcia-Longoria[1], Jaime Muriel[2], Sergio Magallanes[1], Zaira Hellen Villa-Galarce[3,4], Leonila Ricopa[4], Wilson GiancarloI Inga-Díaz[5], Esteban Fong[6,7], Daniel Vecco[8,9], Cesar Guerra-Saldaña[8], Teresa Salas-Rengifo[10], Wendy Carol Flores-Saavedra[11], Kathya Espinoza[12], Carlos Mendoza[13], Blanca Saldaña[13], Manuel González-Blázquez[1], Henry Gonzales-Pinedo[14], Charlene Lujan-Vega[15], Carlos Alberto Del Aguila[16], Yessica Vilca-Herrera[17], Carlos A. Pineda[18], Carmen Reategui[4], Jorge Manuel Cárdenas-Callirgos[19], Jose Alberto Iannacone[20,21], Jorge Luis Mendoza[20], Ravinder NM Sehgal[22]

[1]University of Extremadura, Badajoz, Spain. [2]Pyrenean Institute of Ecology (CSIC), Jaca, Spain. [3]DIRESA, Dirección Regional de Salud, Loreto, Peru. [4]Universidad Nacional de la Amazonia Peruana, Iquitos, Peru. [5]Universidad alas Peruanas, Lima, Peru. [6]EverGreen Institute, Loreto, Peru. [7]Observatorio de Aves Loreto (LBO), Iquitos, Peru. [8]Centro Urku de Estudios Amazónicos, Tarapoto, Peru. [9]Universidad Nacional de San Martin, Tarapoto, Peru. [10]Servicio Nacional de Áreas Naturales Protegidas por el Estado, Lima, Peru. [11]Universidad Nacional Agraria La Molina, Lima, Peru. [12]Universidad Científica del Sur, Lima, Peru. [13]Laboratorio de Análisis Clínico Moraleslab, Morales, Peru. [14]Asociacion Ecosistemas Andinos (ECOAN), Cuzco, Peru. [15]University of California, Davis, USA. [16]Global Health Initiative, Wabash College, Crawfordsville, USA. [17]Universidad Nacional Mayor de San Marcos, Lima, Peru. [18]Universidad Nacional Hermilio Valdizan, Huánuco, Peru. [19]Asociación Peruana de Helmintología e Invertebrados Afines, Lima, Peru. [20]Universidad Nacional Federico Villarreal, Lima, Peru. [21]Universidad Ricardo Palma, Lima, Peru. [22]San Francisco State University, San Francisco, USA

Characterizing the diversity and structure of host-parasite communities is essential to understanding their eco-evolutionary dynamics. Malaria and related haemosporidian parasites are responsible for fitness loss and mortality in many bird species worlwide. Although the Neotropical region exhibits the greatest ornithological biodiversity, our knowledge of diversity on bird haemosporidians from Neotropical regions is still limited. Here, we present a molecular-based study to explore the infection by haemosporidian parasites and characterize host-parasite assemblages in more than 1300 birds belonging to 206 bird species from five Peruvian ecoregions. We detected 70 different haemosporidian lineages infecting 74 bird species. We showed that 35%

of the parasite haplotypes had not been previously recorded. Moreover, we also identified 81 new host – parasite interactions representing new host records for these haemosporidian parasites. Our outcomes revealed that the effective diversity (as well as the richness, abundance, and Shannon-Weaver index) for both birds and parasite lineages was higher in Amazon basin ecoregions (Iquitos várzea, Southwest Amazon moist forests and Ucayali moist forests) than in other ecoregions (Sechura desert and Peruvian Yungas). Furthermore, we also showed that ecoregions with greater diversity of bird species also had high parasite richness, hence suggesting that host community is crucial in explaining parasite richness. These outcomes reveal that Neotropical region is a major reservoir of unidentified haemosporidian lineages. Further studies analysing host distribution and specificity of these parasites in the tropics will provide important knowledge about phylogenetic relationships, phylogeography, and patterns of evolution and distribution of haemosporidian parasites.

PP-79

Using machine learning to classify behaviour and annual time budgets of Common Woodpigeon *Columba palumbus*

Juan F. Masello[1], Wanja Rast[2], Yvonne Schumm[1], Benjamin Metzger[3], Josef Kühling[4], Petra Quillfeldt[1]

[1]Department of Animal Ecology & Systematics, Justus Liebig University, Giessen, Germany. [2]Department of Evolutionary Ecology, Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany. [3]26/1 Immaculate Conception Street, Gzira, Malta. [4]Department of Veterinary Clinical Sciences, Clinic for Swine, Justus Liebig University Giessen, Giessen, Germany

Accelerometers have been increasingly being used to infer animal behaviour and energy expenditure. This method allows to collect large quantities of fine-scale information, recorded at high frequency, and capturing rapid changes in acceleration during animal motion. These data, coupled with recent advances in machine learning algorithms and presently available light-weight tags, enable the inference of broad animal behaviour categories such as eating, flying and resting, over long periods of time. Such information is very valuable to investigate a broad spectrum of ecological questions. In the framework of the monitoring project through networked sensors Natur 4.0 (www.natur40.org), we deployed solar powered GPS-GSM/GPRS trackers with tri-axial gravity acceleration sensors on 18 Common Woodpigeons (*Columba palumbus*) from Hesse, Germany (forest and urban birds), and seven from Lisboa, Portugal (urban). These birds provided a large number of GPS positions and tri-axial gravity acceleration data during June 2019 to June 2021. Training three machine learning algorithms, Random Forest, Support Vector Machine and Extreme Gradient Boosting, we classified the main behaviours of the deployed Common Woodpigeons, namely foraging, flying and resting and calculated time budgets over the breeding and non-breeding seasons. We here present the results of our research and discuss possible uses for investigating time budget, the energetics of habitat use and migration.

PP-80

Linking landscape-scale conservation to regional and continental outcomes for a migratory species

Brady J. Mattsson[1], James H. Devries[2], James A. Dubovsky[3], Darius Semmens[4], Wayne E. Thogmartin[5]

[1]Institute of Wildlife Biology and Game Management, University of Natural Resources and Life Sciences, Vienna, Austria. [2]Ducks Unlimited Canada, Stonewall, Manitoba, Canada. [3]Division of Migratory Bird Management, U.S. Fish and Wildlife Service (retired), Lakewood, Colorado, USA. [4]Geosciences and Environmental Change Science Center, U.S. Geological Survey, Denver, Colorado, USA. [5]Upper Midwest Environmental Sciences Center, U.S. Geological Survey, La Crosse, Wisconsin, USA

Land-use intensification on arable land is expanding and posing a threat to biodiversity and ecosystem services worldwide. We predicted population trajectories of a migratory bird species at a continental scale under varying levels of landscape-scale conservation investments within a core breeding region while accounting for hunting regulation across all regions. In particular, we developed methods to link funding for avian breeding habitat conservation and management at landscape scales to equilibrium abundance of a migratory species at the continental scale. Our methods combined a landscape habitat model, fecundity model, harvest model and a full-annual-cycle population-projection model. We applied this novel approach to a species valued by birders and hunters in North America, the Northern Pintail duck *Anas acuta*, a species well below its population goal. Based on empirical observations from 2007-2016, habitat conservation investments for waterfowl cost $313M (2016 USD) and affected <2% of the pintail's primary breeding area in the Prairie Pothole Region of Canada. Realistic scenarios for harvest and habitat conservation costing an estimated $588M led to predicted pintail population sizes < 3M when assuming average parameter values. Given competing needs for remaining lands and fiscal limitations on conservation funding, our models suggest that achieving the continental population goal of 4M individuals under the current harvest policy is unlikely. Using our work as a starting point, we propose continued development of modeling approaches that link conservation funding, habitat delivery, and population response to better integrate conservation efforts and harvest management of economically important migratory species.

PP-81

Demographic consequences of management actions for the successful reintroduction of White Storks in the UK

Mayall Elouise[1], Lucy Groves[2], Rosalind Kennerley[2], Mike Hudson[2], Tim Mackrill[3], Aldina Franco[1]

[1]University of East Anglia, Norwich, United Kingdom. [2]Durrell Wildlife Conservation Trust, Bath, United Kingdom. [3]Roy Dennis Wildlife Foundation, Forres, United Kingdom

For reintroduction projects to be successful, it is important to identify the conditions required for the establishment of viable populations. We developed a demographic model using Vortex10 to assess the long-term implications of different management strategies on the success of the recent reintroduction of White Storks *Ciconia ciconia* to the UK. Demographic data obtained from this population was supplemented with parameter information from western European populations to build the models. The impact of incorporating different management actions on the stochastic population growth rate was assessed. Survival rates differ depending on the individual's migratory strategy, hence we also tested the impact of having different proportions of the population as resident or migratory. If the British stork population adopts a fully migratory strategy, with its associated higher mortality rates, increasing the supplementation rate of juvenile birds alone would not lead to a positive population growth rate. However, including further management actions which increase the number of fledglings per nest can generate a slight positive growth rate and, when different management options were combined, the growth rate increases further ($r = 0.0104 \pm 0.0005$ SE). Alternatively, if a minimum of 9% of individuals remained as residents in Britain, which is likely based on observations and tracking data, additional management would not be required due to associated lower mortality rates. We conclude that the British White Stork population will likely be viable long-term, but these models and projections should be updated as more demographic and stochastic data on this novel population becomes available.

PP-82

Selection at the avian MHC class I is consistent across both peptide-binding domains

Piotr Minias[1], Ke He[2], Peter Dunn[3]

[1]University of Lodz, Lodz, Poland. [2]Zhejiang Agriculture and Forestry University, Hangzhou, China. [3]University of Wisconsin-Milwaukee, Milwaukee, USA

The Major Histocompatibility Complex (MHC) genes code for the key immune proteins responsible for pathogen recognition in vertebrates. Foreign antigens are recognized via their compatibility to hyper-variable region of the peptide-binding groove. MHC class I (MHC-I) proteins are primarily responsible for recognition of intra-cellular pathogens and they have two peptide-binding domains encoded by exon 2 (α1) and exon 3 (α2) of a single gene. So far, most research on MHC-I in birds has focused exclusively on exon 3 and it remains to be established whether both domains are subject to similar selective pressure. In this study, we took advantage of publicly available genomic resources (120 species from nearly 50 families) to test for the differences in selection patterns between both peptide-binding domains of avian MHC-I. Our analyses provided strong evidence for highly consistent levels of selection at α1 and α2 domains, as we found strong positive correlations in all selection measures between both exons. We conclude

that the strength of selection at exon 3 is a reliable proxy for selection at the entire peptide-binding groove of avian MHC-I molecule.

PP-83

Migration routes and wintering grounds of Russian Greater Spotted Eagles: news obtained with telemetry

Alexander Mischenko[1], Alexander Sharikov[2], Dmitry Karvovsky[3]

[1]Severtsov Institute of Ecology and Evolution, Moscow, Russian Federation. [2]Moscow Pedagogical State University, Moscow, Russian Federation. [3]National Research University MPEI, Moscow, Russian Federation

For five young Greater Spotted Eagles *Clanga clanga* from the European Russia, were traced autumn and spring migration routes and wintering grounds, summer movements, and stopoverss during migration and vagrancy, with the use of GPS-GSM trackers in 2019-2021. In contrast to birds from more western populations, some of which winter in Southern Europe, all studied eagles migrated to wintering grounds located in the Middle East and North Africa in 2019. One of the birds spent the winter 2020/2021 in the North Caucasus successfully, despite the severe weather conditions. It is new phenomenon for this species which is long-distant migrant. It was found that the migration paths of two birds was circular: the autumn route 2019 passed along the eastern coast of the Black Sea, and the spring route 2020 – through the Bosphorus and Dardanelles Straits, and then to the west of the Black Sea coast. Long stopovers during the autumn migration are mainly determined by the presence of places with an abundance of potential prey in the migration path, which was found by only two birds. The long stopovers of the two birds during their summer migrations were located in the areas occupied by extensive used agricultural lands (not often found in the forest zone of Russia nowadays), which is probably due to the easy availability of prey during prolonged period of haymaking. The death of two birds in the Middle East in the first and second year of life indicates unfavorable conditions in the region.

PP-84

Diversity of migration in European Blackcaps *Sylvia atricapilla*

Lucy Mitchell[1], Chris Hewson[2]

[1]University of Hull, Hull, United Kingdom. [2]British Trust for Ornithology, Thetford, United Kingdom

Bird migration is changing, in response to climate and habitat change. Altered migratory routes may cause populations to experience changing demographics and new phenotypes to establish.

However, particularly for small passerines, understanding changes in migration is challenging, because of a lack of appropriate technology. The European Blackcap *Sylvia atricapilla*, which typically overwinters in the southern Mediterranean or north Africa, has started to regularly overwinter in the United Kingdom. These birds come from breeding populations across Europe and identified through ringing recoveries and, more recently, geolocators. For the blackcap, small sample sizes mean we lack information on the different migratory phenotypes and their relative abundance. We will present results from a pilot project carried out in Autumn 2021, using miniature VHF tags, deployed onto migrating Blackcaps at bird observatories on the east coast of the UK. Tags will be deployed at automated VHF receiver ('Motus') locations to detect migration departure directions. These data will identify the direction of travel of the individual from the location, inferring the bird's phenotype. We are also collecting feather samples to analyse stable isotopic signatures and morphological measurements to look at physical and genetic differences between phenotypes. Identifying the variety of Blackcap migratory routes converging in the UK will increase our understanding of the evolution of new routes within a species. These results are important for understanding how species generally can produce short term responses to environmental change.

PP-85

Foraging specialisation in a changing world - a multi-year study in adult Lesser Black-backed Gulls

Mélibée Morel[1,2,3], Eric Stienen[4], Luc Lens[2], Wendt Müller[5]

[1]University of Anwerp, Antwerp, Belgium. [2]University of Ghent, Ghent, Belgium. [3]INBO, Bruxelles, Belgium. [4]INBO, Research Institute for Nature and Forest, Bruxelles, Belgium. [5]University of Antwerp, Antwerp, Belgium

Lesser Black-backed Gulls are considered as a generalist species, of which individuals can forage in terrestrial, marine and/or urban habitats. Yet at the individual level, they show a high consistency in their foraging strategies, among others in what resources they use when and where, but also in how flexible they are. However, individual variation in foraging specialisation is typically studied over relatively short periods of time, so we lack a proper understanding of its long-term consistency as well as with the factors that could contribute to it. Here I hence study whether foraging specialisation is consistent over years using Lesser Black-backed Gulls as a model species. My study is based on 39 individuals, carrying GPS tags as part of ongoing research projects in three breeding colonies at the south-western belt of the North Sea. I specifically focus on the incubation period to standardize the context, and on birds that have been recorded in at least three years between 2014 and 2019. I expect that foraging specialisations are consistent across years. However, there might be changes in environmental conditions, that will alter the birds' favoured habitats or the availability of their favoured resources. Thus, individuals might have to switch to a different strategy. This might come at a cost as they will have less knowledge and be less skilled for finding

and exploiting resources they are not specialised on. I expect that the higher foraging effort will among other be reflected in higher foraging duration and greater foraging distances.

PP-86

Movements during the breeding season of European Turtle Doves *Streptopelia turtur* in Spain

Lara Moreno-Zárate[1], Cécile Joly[2], Beatriz Arroyo[1], Miguel Delibes-Mateos[3], Mario Fernández-Tizón[1], Juan Lorente Rejano[1], Helena Navalpotro[4], François Mougeot[1], Carlos Santisteban[4], Francesc Sardà-Palomera[4], Gerard Bota[4]

[1]Instituto de Investigación en Recursos Cinegéticos, Ciudad Real, Spain. [2]Trinity College Dublin, Dublin, United Kingdom. [3]Instituto de Estudios Sociales Avanzados, Córdoba, Spain. [4]Centre de Ciència i Tecnologia Forestal de Catalunya, Solsona, Spain

Assessing home range size is critical to understand resource use and requirements, and this information is particularly important for declining species for which conservation management is needed. The European Turtle Dove *Streptopelia turtur* is considered "Vulnerable" due to marked population declines in recent decades in Europe. Based on >30 birds marked with GPS tags in 2020-2021, we assessed movements during the breeding season and home range size variation in four study areas with different habitats (from farmland-dominated to woodland-dominated) in two regions of Spain. Home range size during each breeding attempt (Kernel analyses on positions outside the nest between laying date and end of reproductive event, i.e. fledgling or failure date) was relatively large (in 2020: 18.79 ± 24.20 km^2, Kernel 95 or 3.21 ± 5.05 km^2, Kernel 50). There were large differences among individuals and breeding attempts, but no significant differences among study areas, despite variation in habitat and provision of supplementary food, nor in relation to laying date or nesting success. Mean distance to the nest of GPS locations while breeding in 2020 was 1.1 km ± 1.9 km (range 8-15480 m). Mean distance between nests from consecutive breeding attempts of the same individual in each season was 263 ± 430 m (range 13-3188 m). Movement distances increased largely after the last breeding attempt and before migration, where we observed round-trip movements of up to 330 km in various individuals in all study areas. We discuss implications for conservation and hunting management of the species at a local scale.

PP-87

Western Greenish Warbler *Phylloscopus trochiloides viridanus* and Green Warbler *Ph. (t.) nitidus* show different ways of increase in song complexity

Anton Morkovin[1], Marova Irina[2], Vladimir Ivanitskii[2]

[1]Zoological Museum of M.V. Lomonosov Moscow State University, Moscow, Russian Federation. [2]Faculty of Biology of M.V. Lomonosov Moscow State University, Moscow, Russian Federation

We made a comparative analysis of male singing in Western Greenish Warbler *Phylloscopus trochiloides viridanus* and Green Warbler *Ph.* (*t.*) *nitidus*. The Green Warbler has an isolated breeding range in Caucasus, Transcaucasia and Asia Minor; we recorded its vocalization in Krasnodar region in 2018–2019. The other subspecies is spread from C Asia to W Siberia, E and N Europe; we made records in Moscow and Kaluga regions in 2017–2019. All forms of the Greenish Warbler complex have a discrete manner of singing. Its structural unit is a stable sequence of elements that we call vocal unit, and a series of merged units called vocal composition. We described song structure, population and individual repertoires and spectra-temporal characteristics of singing. There were 13 types of vocal units in the population repertoire of form *viridanus* and over 40 in *nitidus.* Their upper frequencies were similar, but lower ones were higher in *nitidus*. The latter had significantly shorter units: however, the median number of unique notes per unit did not differ, because singing of *viridanus* often contained repeated elements. In both forms, most elements were specific to a unit type. The order of vocal units in compositions was rather strict in Western Greenish Warbler and flexible in Green Warbler, so the males of the latter form had a greater variety of vocal compositions, even with a similar median value of vocal unit repertoire. Both forms rarely repeated same vocal unit in a composition, and we found no differences in median duration of vocal compositions.

PP-88

Unexpected role of Great Cormorants in a coastal food web of the Baltic Sea

Rasa Morkūnė[1], Julius Morkūnas[1,2]

[1]Klaipėda University, Klaipeda, Lithuania. [2]Lithuanian Ornithological Society, Vilnius, Lithuania

The role of the Great Cormorant Phalacrocorax carbo from a newly established colony to a coastal food web on the Baltic Sea coast was unknown. We used traditional and innovative methods to investigate foraging behavior, diet, and the role of breeding cormorants in the trophic food web. Results, based on satellite telemetry data, stable carbon, nitrogen, and sulfur isotope analysis, pellet analysis, scientific fishery data, and constructed food web model, showed that newcomers forage only in the marine environment and almost exclusively choose invasive Round Goby Neogobius melanostomus within breeding and post breeding seasons. As Round Goby was demonstrated to have negative impacts in many recipient ecosystems in Europe and North America, cormorants became important for effective control of invaders and sustaining a good status of the marine environment.

PP-89

Social behaviour of White-winged Snowfinches in winter

Anne-Cathérine Gutzwiller[1,2], Fränzi Korner-Nievergelt[1], Valentin Amrhein[2,1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]Department of Environmental Sciences, Zoology, University of Basel, Basel, Switzerland

In winter in the mountains, foraging is challenging due to low availability of food, even for species adapted to cold environments. Forming social groups can then improve foraging efficiency but may also increase intraspecific competition. How individuals living in extreme habitats behave within the social context may therefore determine how well they have access to food and how well they survive. Dominant individuals benefit, for example, through better access to food resources that the group has discovered. White-winged Snowfinches *Montifringilla nivalis*, mountain specialists, can often be seen in winter exploring anthropogenic feeding sites or snow-free patches in groups. However, we know hardly anything about snowfinch groups and their social behaviour. We thus investigated how competition is expressed in Snowfinch winter flocks. Further, we examined individual differences in social behaviour and how these correlate with characteristics such as sex or beak colour. We analysed observations of Snowfinches foraging at anthropogenic feeding sites in the Swiss Alps in winter 2021. Video recordings allowed us to monitor how Snowfinches were distributed between two alternative experimental feeders and when agonistic interactions occurred. With focal observations of colour-ringed birds, we were able to collect individual behavioural and morphological data. Our first results suggest that Snowfinches are attracted to the feeder at which other individuals are already present, rather than choosing the less occupied feeder to avoid competition. We found evidence that not all individuals have equal access to food. Beak colour could be a characteristic reflecting individual differences in social behaviour or access to resources.

PP-90

Nest site choice at high elevation – the importance of snow, structures and exposition for an alpine bird

Carole Niffenegger[1,2], Christian Schano[1], Raphaël Arlettaz[2], Fränzi Korner-Nievergelt[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]Division of Conservation Biology, Institute of Ecology and Evolution, University of Bern, Switzerland

Selecting the right place and time for reproduction is crucial for many animals living in spatio-temporally variable habitats. Temperate mountain ecosystems are characterised by a strong seasonality where snowmelt is one of the main factors shaping the conditions during the reproductive period. Changing snow conditions or altered microclimate caused by climate change might profoundly affect the fined-tuned behavioural and physiological adaptations of alpine

species. We studied the nest site choice of White-winged Snowfinch *Montifringilla nivalis*, an alpine passerine with declining population trends. We used a combination of habitat mapping in the field and satellite remote sensing to compare nest sites to randomly selected locations at small- and broad-spatial scales. We show that Snowfinch nest sites are distributed patchily and their availability might locally limit the breeding distribution of the species. Snowfinch selected nest sites in proximity to snow and show a preference for morning sun exposed nest cavities early during the breeding season. Our results suggest that highly specialized birds such as Snowfinch might face big challenges to find suitable nest sites as mean air temperature increases and with altered snowmelt patterns under climate change. Understanding the species-specific needs can help to develop targeted conservation actions such as nest boxes providing improved microclimate and can help to delineate priority areas for such interventions.

PP-91

Extrinsic and intrinsic factors in the settlement decisions of a partially-migrating raptor

Florian Orgeret, Patrick Scherler, Stephanie Witczak, Benedetta Catitti, Valentijn van Bergen, Lara Groß, Martin U. Grüebler, Urs G. Kormann

Swiss Ornithological Institute, Sempach, Switzerland

Natal dispersal is critically important for many ecological and evolutionary processes, but our mechanistic understanding of where and when individuals settle at new sites is still limited. This is probably due to the fact only few studies can investigate the complete dispersal trajectories. To explain settlement decision-making, three hypotheses are commonly used. The “habitat quality hypothesis” states that high quality habitats encountered en route should be associated with shorter prospecting phases and ultimately a higher probability of settlement. The “conspecific density hypothesis” states that settlement probability should increase from low conspecifics to medium density but decrease at high densities (density dependence). Finally, the "habitat imprinting hypothesis" states that the probability of settling should increase in habitats similar to the natal habitat. We tested these hypotheses in a growing population of a partially-migratory raptor, the Red Kite *Milvus milvus*, located in Switzerland. Using GPS-GSM loggers, we tracked the dispersal movement of 92 juveniles from their first departure to their first settlement (up to 5 years of data per individual). We used a combination of clustering algorithms and step selection functions to investigate the relative influences of natal habitats (encountered early in life), habitat quality and conspecifics densities (both encountered during prospecting phases) on settlement site selection. Our results demonstrate the role of both intrinsic and extrinsic factors in the decision to settle. Altogether, our results also underscore the potential of combining long-term GPS-tracking and remote sensing technologies to understand the drivers of natal dispersal in wild avian populations.

PP-92

60 leagues over the sea: species-specific departure and routing decisions in long-distance migratory songbirds passing the south-eastern North Sea during autumn

Florian Packmor, Vera Brust, Ommo Hüppop

Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany

Most long-distance migratory songbirds need to negotiate large bodies of water (i.e., the sea and large lakes) at some point along their migration route. For landbirds, these offer no opportunity to shelter, rest or feed and are, thus, considered as ecological barriers. When confronted with an ecological barrier, the individual bird's departure and routing decisions for the upcoming migratory flight are crucial and can hardly be altered once taken. In long-distance migratory songbirds such decisions are generally assumed to follow a time-minimising strategy to meet the time constraints of their seasonal schedule. Therefore, they should favour timely departures and direct routes, whenever possible. The potential costs and benefits of these, however, may vary strongly between species when individuals face an ecological barrier like the sea due to differences in both morphology and ecology. Apart from that, migratory songbirds need to consider the current weather conditions in their individual departure and routing decisions before crossing the sea to avoid lethal consequences for the individual. We radio-tagged long-distance migratory songbirds of three species during three consecutive autumn migration seasons and tracked their migratory departures and approximate flight routes by means of the MOTUS radio-telemetry network installed along the southern North Sea coast. We tested whether the species would differ in their departure and routing decisions depending on morphological and ecological differences and whether the individuals' decisions would be affected by weather, with favourable conditions (e.g. weak and/or tailwinds and clear skies) promoting early departures and direct routes across the sea.

PP-93

Active use of camouflage and behavioural responses to biotic stressors in Tawny Owls *Strix aluco*

Charlotte Perrault[1,2], Chiara Morosinotto[1,3], Jon Brommer[2], Patrik Karell[1,3]

[1]Novia University of Applied Sciences, Tammisaari, Finland. [2]University of Turku, Turku, Finland. [3]Lund University, Lund, Sweden

Global warming and environmental changes have major impacts on wildlife. For instance, colouration in animals is used to camouflage into the specific environmental type, which gives them a fitness advantage. Our study species, the Tawny Owl *Strix aluco*, shows a melanin-based polymorphism with two colour morphs: brown and grey. This species is ideal to study changing camouflage effects due to environmental variation since the reddish-brown morph has lower survival and is more conspicuous in snowy (light) conditions compared to the paler grey morph.

We ran a series of behavioural experiments in captivity to disentangle if the morphs differently choose to perch in a matching background, if they use space differently and if their response to predator and mobber cues depend on their perception of conspicuousness during roosting. We found that grey Tawny Owls are more prone to use open space for perching compared to the brown. However, neither of the morphs chose the camouflage background associated with their colour morph to perch. Mobbing and predator cues triggered a behavioural alertness response similarly in both colour morphs. Our results suggest that the morphs use space differently, which may affect detectability by mobbers and predators, but that the morphs do not choose roosting site according to a matching background colour.

PP-94

Foraging strategies of a small seabird across an oceanic landscape

Kristin Piening[1,2], Teresa Militão[2], Marta Cruz-Flores[2,3], Andreia Leal[4], Isabel Rodrigues[5], Diana Matos[6], Mariona Sardà-Serra[2], Herculano Andrade Dinis[4], Marcos Hernández-Montero[7], Heiko Schmaljohann[8,9], Vitor Hugo Paiva[6], Jacob González-Solís[2]

[1]Carl von Ossietzky University of Oldenburg, 26111 Oldenburg, Germany. [2]Institut de Recerca de la Biodiversitat (IRBio) i Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals, Universitat de Barcelona, Av. Diagonal 643, Barcelona 08028, Spain. [3]Littoral, Environnement et Sociétés (LIENSs), UMR 7266 CNRS-La Rochelle Université, 2 Rue Olympe de Gouges, FR-17000 La Rochelle, France. [4]Projecto Vitó, São Filipe, Fogo, Cape Verde. [5]Biosfera, Mindelo, São Vicente, Cape Verde. [6]University of Coimbra, MARE - Marine and Environmental Sciences Centre, Department of Life Sciences, 3004-517 Coimbra, Portugal. [7]Associação Projeto Biodiversidade, Santa Maria, Sal, Cape Verde. [8]Institute for Biology and Environmental Sciences (IBU), Carl von Ossietzky University of Oldenburg, Carl-von-Ossietzky-Straße 9-11, 26129 Oldenburg, Germany. [9]Institute of Avian Research, An der Vogelwarte 21, 26386 Wilhelmshaven, Germany

Understanding how birds change their foraging strategies in relation to intrinsic and extrinsic factors is crucial not only for a better comprehension of its ecology but also for its conservation. The recent decrease in the size of tracking devices has enabled their deployment in small seabird species, as the Bulwer's Petrel *Bulweria bulwerii* (~100g). Here, we aim to assess the variability in their foraging strategies among colonies, breeding stages, and sexes. For that, from 2017 to 2021, we recovered 499 GPS devices (~3g) from Bulwer's Petrels breeding in four different colonies (Canary Islands and Cabo Verde). Bulwer's Petrels from all colonies foraged almost exclusively on oceanic waters but their foraging strategies differed between archipelagos. Birds from Cabo Verde remained in waters around this archipelago, while showing some spatial segregation among colonies. In contrast, those breeding in Canary Islands engaged in much larger and longer foraging trips, often reaching the Azores archipelago at ~1400 km lineal distance and travelling maximum 300 hours per trip. The trip duration and distance from the colony were longer during the incubation than during the chick-rearing period due to the need to feed the chick regularly. Foraging strategies

between sexes were similar probably because they share the parental duties. Our results show the importance of multi-colony tracking studies to accurately identify the marine important areas used by different populations as well as in different periods of the breeding cycle. Further analyses should focus on understanding the drivers shaping foraging strategies at intra-specific levels.

PP-95

Breeding time changes of the Pied Flycatcher in Latvia since 1950s

Ance Priedniece

Institute of Biology of the University of Latvia, Riga, Latvia

The research paper analyses breeding time changes of the Pied Flycatcher since 1950s. Data about breeding of the Pied Flycatcher in nest box plots near Garkalne were collected from 2019 to 2021 and compared to the data from 1950s (the same region). The aim of the scientific paper – to find out, what changes can be seen in breeding time of the Pied Flycatcher. The results – during the time period from 1948 till 1959 the average laying date of the first egg varies within 10 days – from May 23 till June 1. In 2019 the average laying date was May 21 – it is significantly earlier than in 9 analysed years of 1950s out of 12. In 2020 the average laying date was May 20 – it is significantly earlier than in 12 analysed years of 1950s out of 12. In 2021 the average laying date was May 21 – it is significantly earlier than in 9 analysed years of 1950s out of 12. The main conclusions of the research – in 2019 the average laying date of the first egg is significantly earlier than in the middle of 20th century. Reasons of these changes are not fully understood. It would be important to collect more data in the following years to avoid the impact of weather conditions of one particular year and to make conclusions about changes in the breeding time of the Pied Flycatcher and its reasons.

PP-96

Variability in time in the shape of Eurasian Coot eggs in the local conditions of Campenesti wetlands (NW Romania)

Liviu Razvan Pripon[1], Valentin Adrian Kiss[2], Judit Veres-Szászka[3]

[1]Independent researcher, Cluj-Napoca, Romania. [2]Romanian Institute of Science and Technology, Cluj-Napoca, Romania. [3]Romanian Ornithological Society/BirdLife Romania, Cluj-Napoca, Romania

In this study, we aim to analyze the shape of the Eurasian Coot *Fulica atra* eggs in the local conditions of Campenesti wetlands and compare it with the past recorded data from Romania, in order to find possible differences. For this purpose, we measured 60 eggs during 2018 and

calculated the egg shape index. Comparing our results with the ones in the literature, we found that the length of the egg is significantly smaller in our study (mean = 50.92 mm, stdev = 2.368, N = 58) than the mean value (57.41 mm, N = 100) given by Lintia in 1955. The width also shows a significant difference between our data and the one before 1955. The mean egg shape Index is 68.00 for eggs measured at Campenesti while the value is 61.19 calculated based on the data before 1955. We found that the length and width of the eggs are not proportional values. We also noted a strong negative correlation (R2 = -0.81) between the length of the eggs and the egg shape index and a lack of correlation between the width of the eggs and the egg shape index. In conclusion, we can state that the egg shape index is higher in the local condition of Campenesti, meaning that the eggs tend to be rounder as well as smaller.

PP-97

Repeatability of migration and wintering range movements in a long-distance migrant

Sara Raj Pant[1], Ulrik Lötberg[2], Patrick Byholm[3], Susanne Åkesson[1]

[1]Lund University, Lund, Sweden. [2]BirdLife Sweden, Mörbylånga, Sweden. [3]University of Helsinki, Helsinki, Finland

Migration has evolved in numerous taxa, enabling the access to resources that vary with global seasonality. Interestingly, migratory behaviour can vary considerably on many levels, i.e. between species, populations and individuals, and even within individuals across years. Few studies to date, however, have addressed the amount of variation in migratory strategies within individuals. Moreover, little attention has been paid to individual movements within wintering ranges, even though carry-over effects from the wintering to the breeding season can affect the fitness of migratory animals. Here, we will investigate the repeatability in the migration and wintering-range movements of Caspian Terns *Hydroprogne caspia* breeding in the Baltic Sea. We will analyse repeated tracks of individuals during the full annual cycle across multiple years and assess the level of consistency vs flexibility in migratory behaviours, including wintering range movements, in relation to local environmental conditions. Moreover, we will address the fitness consequences of consistency vs flexibility in migratory strategies. This should increase knowledge on the relative influence of endogenous programs vs environmental effects on animal movements, and shed light on whether consistency in migratory behaviours is adaptive.

PP-98

Overview of key ecological traits of Tawny Owl *Strix aluco* in Europe for their use in contaminant monitoring

Urška Ratajc[1,2], Rui Lourenço[3], Al Vrezec[1,4,2], Silvia Espín[5], Pablo Sánchez-Virosta[5], Simon Birrer[6], Dani Studler[7], Chris Wernham[8]

[1]Department of Organisms and Ecosystems Research, National Institute of Biology, Ljubljana, Slovenia. [2]Jožef Stefan International Postgraduate School, Ljubljana, Slovenia. [3]MED – Mediterranean Institute for Agriculture, Environment and Development, LabOr – Laboratory of Ornithology, Instituto de Investigação e Formação Avançada, Universidade de Évora, Évora, Portugal. [4]Slovenian Museum of Natural History, Ljubljana, Slovenia. [5]Area of Toxicology, Faculty of Veterinary Medicine, University of Murcia, Murcia, Spain. [6]Swiss Ornithological Institute, Sempach, Switzerland. [7]Blumenhaldenstrasse 9, Arbon, Switzerland. [8]British Trust for Ornithology (Scotland), Unit 15 Beta Centre, Stirling University, Innovation Park, Stirling, United Kingdom

Top predators are often used as sentinel species in contaminant monitoring due to their exposure and vulnerability to persistent, bioaccumulative and, in some cases, biomagnificable contaminants. The COST Action European Raptor Biomonitoring Facility has identified Tawny Owl as one of the most suitable species candidates for pan-European biomonitoring. Some of its ecological traits are known to influence individual contamination levels and should therefore be used as contextual data for a correct interpretation of large-scale contaminant spatial patterns. These traits can explain spatiotemporal variation in contaminant exposure (e.g., diet, dispersal) or contaminant impacts (e.g., population size, clutch size). The aim of our research was to review the spatial variation in selected contextual parameters in Tawny Owl based on available published and unpublished data. We found great variation in availability of contextual data across Europe, with diet being the most extensively studied. In general, the most important contamination exposure pathway was through small mammal intake. Herbivore small mammals were of greater importance towards the north and omnivore small mammals towards southern parts of Europe. The overall dispersal distance in Europe was 18.2 km (± 36.3 SD). Clutch size was the most extensively studied parameter of breeding productivity and it was increasing significantly with increasing longitude. Highest population densities were recorded in parts of W Europe (Belgium) and W Balkan. No specific patterns in population trends were found. We have shown that Tawny Owl is a suitable bioindicator on a local scale, however taking spatial variation in other contextual data into account is necessary.

PP-99

Intensively used cropland – ecological trap for insectivorous farmland birds?

Adriana Hološková[1], Tomáš Kadlec[2], Jiří Reif[3]

[1]Department of Ecology, Faculty of Science, Charles University, Prague, Czech Republic. [2]Department of Ecology, Faculty of Environmental Sciences, University of Life Sciences, Prague, Czech Republic. [3]Institute for Environmental Studies, Faculty of Science, Charles University, Prague, Czech Republic

Farmland birds show continent-wide population declines but the proximate underlying mechanisms are still poorly understood. Limited food supply due to increasing pesticide

application may be one of the possible drivers. To investigate this possibility, we performed a simultaneous sampling of farmland bird breeding abundance (represented by yellow wagtail and skylark, open habitat specialists), invertebrate food supply for birds and habitat characteristics in fields covered by various crop types in an intensively cultivated agricultural region in south-western Slovakia (Eastern Europe). Although we found a strong link between the pesticide application and invertebrate abundance or diversity, the relationships between invertebrate food supply for birds and farmland bird abundance were weak. Specifically, Yellow Wagtail abundance was higher on the plots with a more diverse food supply only at the start of the breeding season in April, whereas Skylark abundance was best predicted by habitats surrounding the surveyed fields and sward height, and was unrelated to invertebrate food supply at all. Based on these results, we suggest that farmland birds assess their breeding sites based on the habitat characteristics that were once related to the invertebrate food supply developing during later phases of the breeding season. However, such links are disrupted by the pesticide application. Therefore, the habitat cues used by birds for breeding site selection are no longer related to abundance or diversity of the insects. As a consequence, birds may occupy suboptimal sites that can serve as ecological traps underlying the widespread farmland bird population declines.

PP-100

Disentangling the effects of management, field structure of fallows and surrounding landscape composition to promote steppe bird species conservation

Natalia Revilla-Martín, David Giralt, Gerard Bota, Ana Sanz-Pérez, Francesc Sardà-Palomera

Centre Tecnològic Forestal de Catalunya, Solsona, Spain

In a context of agricultural intensification, fallow lands provide crucial habitats for steppe birds. In north-eastern Spain, a regional conservation measure promotes the management of more than 3000 ha of fallow land, especially focusing on the requirements of steppe bird species. This Targeted Fallow Management (TFM) has been proven to improve steppe bird populations by increasing the abundance of its target species and other farmland bird species, in contrast with less tailored fallow promoting measures like Agri-Environment Schemes (AES) or Ecological Focus Areas. Despite TFM has proved generally successful, its positive effects are variable within the steppe bird community. In this study we explore which are the characteristics that make these fallow fields successful. We aim to separate the effects of management (e.g. vegetation height or fallow age), intrinsic field structure (e.g. field size) and landscape composition (e.g. amount of farmland area) on the presence and abundance of target species and on community richness. Depending on the species either management and field structure or landscape composition are more relevant for the species abundance. Our results point out that these three dimensions are important when managing fallow fields for steppe bird conservation and highlights the importance of objective driven management. Knowing the keys of successful management at the field level would facilitate the improvement of targeted conservation measures, as well as help improving future AES scheme designs.

PP-101

Transcriptional consequences of avian malaria infections in the early life of a common bird of prey (*Buteo buteo*)

Tony Rinaud, Meinolf Ottensmann, Hugo Eira Pereira, Oliver Krüger, Nayden Chakarov, Kai-Philipp Gladow

Bielefeld university, Bielefeld, Germany

Parasites stimulate and reinforce diverse defence mechanisms in their hosts, both at the individual and at the population level. In evolutionary terms, the recurring interactions and their fitness effects amount to an arm-race between host defences and parasite ability to overcome them. A particularly challenging task of genomics is to identify pathways and genes involved in this arm-race. Defence components may contribute to resistance, i.e. the suppression of parasites, and to tolerance i.e. the capacity to limit the costs caused by parasites. We approached the potential effects of resistance and tolerance through a field experiment in a wild population of Common Buzzard *Buteo buteo*, a long-lived bird of prey. A large part of the nestlings in our study population is infected by *Leucocytozoon*, a blood parasite that can cause malaria-like conditions. Upregulation of immune pathways is expected in individuals where parasitemia is increasing or high in contrast to chicks with decreasing and low parasitemia and uninfected ones. Upregulation of maintenance genes may be suggestive of tolerance. We used differential gene expression analysis to find signatures of resistance and tolerance among nestlings of varying infection trends. Preliminary results show that resistance as well as maintenance genes are overexpressed in nestlings to cope with acute infections. These results suggest that Buzzard chicks are resistance to a certain point to their main blood parasite but do not mount particularly costly immune responses against them. Nestlings may therefore be an overall tolerant developmental stage, thus enabling transmission and defusing the resistance-virulence arms-race.

PP-102

Identifying stepping-stones for dispersal in spatially structured populations

Hugo Robles[1], Carlos Ciudad[2], Alessia Uboldi[3]

[1]University of Antwerp, Wilrijk, Belgium. [2]TRAGSATEC, Madrid, Spain. [3]Associazione CRAS Vanzago, Milano, Italy

Natal dispersal critically influences the persistence of spatially structured populations – i.e. those resulting after habitat subdivision and isolation. In particular, immigration through interpatch dispersal may buffer the extinction risk of spatially structured populations by (i) replacing the

breeders that disappear from small local subpopulations, and (ii) (re)colonizing habitat patches that balance local extinctions. Interpatch dispersal is often achieved by 'stepping stones' that connect local subpopulations, but what makes a patch to be a stepping stone for dispersal remain poorly understood. Using movements of radio-tracked juveniles and banded floating adults during dispersal (2003-2021), we identified some characteristics associated with the use of patches as stepping stones in a spatially structured population of Middle Spotted Woodpeckers. After controlling by patch isolation, stepping stones were smaller and had lower density of large oaks (lower habitat quality) than patches where the juveniles were born. Likewise, stepping stones used by floating adults were smaller and had lower quality than patches occupied by territorial woodpeckers. Therefore, conservation actions should consider protecting not only large and high quality patches used by territorial breeders, but also smaller and lower quality patches that can serve as stepping stones for dispersal. Moreover, because stepping stones were significantly larger than non-used patches, the enlargement of non-used habitat patches can improve their potential use as stepping stones. Finally, floating adults, but not juveniles, preferred using high quality patches as stepping stones, which may arise if adults and juveniles show different motivations and/or skills during dispersal.

PP-103

Migratory behaviour and survival of Great Egrets *Adrea alba* after range expansion in Central Europe

Radoslaw Wlodarczyk[1], Daria Szafara[2], Tomasz Janiszewski[1], Piotr Minias[1]

[1]Department of Biodiversity Studies and Bioeducation, Faculty of Biology and Environmental Protection, University of Łódź, Łódź, Poland. [2]Student's Ornithological Section, University of Łódź, Łódź, Poland

Great Egret *Ardea alba* is one of the few Western Palearctic species that underwent a rapid range expansion in the recent years. Originally breeding in central and eastern Europe, the species has spread in northern and western directions. In consequence, it established viable breeding populations throughout almost entire continent. We monitored one of the first Great Egrets colonies established in Poland to study migratory patterns and survival rates directly after range expansion. For this purpose, we gathered resightings from over 200 Great Egret chicks marked between 2002-2017 in central Poland. During autumn migration, birds moved almost exclusively in the western direction. Wintering grounds were located mainly in the western Europe (Germany to France) within distance of 800-950 km from the breeding colony. Moreover, first-year birds spend winter farther from breeding colony than adults. Capture-recapture models, used for survival rate estimation, suggested age-related variation in survival. The annual survival rate of adults was nearly twice as high as the estimate for first-year birds ($\phi_{ad} = 0.85 \pm 0.05$ vs. $\phi_{fy} = 0.48 \pm 0.15$). We did not find support for the effect of hatching date on survival of first-year birds and for inter-annual variation in survival rates.

PP-104

Nest protection fences increase hatching success of Lapwing and Black-tailed Godwit clutches

Volker Salewski[1], Oliver Granke[2], Luis Schmidt[1]

[1]Michael-Otto-Institut im NABU, Bergenhusen, Germany. [2]Stiftung Naturschutz Schleswig-Holstein, Molfsee, Germany

Many species of meadow birds are declining in northwestern Europe. Examples are Northern Lapwing *Vanellus vanellus* and Black-tailed Godwit *Limosa limosa* in northern Germany, where the demographic driver of declines is low breeding success. Eggs and chicks used to suffer high mortality due to direct and indirect effects of changes to land use such as intensification of agriculture, but in recent years, predation became an additional problem. Our study sites in Schleswig-Holstein, northern Germany, are managed for meadow birds so losses due to agricultural activities are reduced to a minimum. Nevertheless, breeding success of Northern Lapwing and Black-tailed Godwit remains too low to maintain the population. The application of trail-cameras has shown that, in the case of the Black-tailed Godwit, predation by a few nocturnal mammals is the main reason for low hatching success. We installed electric fences surrounding between four and 22 ha in different breeding areas to exclude nest predators. Using nest survival models implemented in the programme MARK, we found that hatching success in fenced areas was up to four times higher in Northern Lapwing, and more than 500 times higher in Black-tailed Godwit, compared to adjacent unfenced areas. Furthermore, in the years prior to fencing, hatching success was similar in areas never fenced and those subsequently fenced, indicating that the fences were not installed in areas with a per se higher hatching success. Hence, electrical fences are an appropriate measure to increase hatching success in meadow birds.

PP-105

Flight height distributions of five European raptor species based on GPS tracking and their implications for wind turbine design

Tonio Schaub[1,2,3,4], Raymond Klaassen[3,4], Caroline De Zutter[2], Alexandre Millon[1]

[1]Aix Marseille University, Avignon University, CNRS, IRD, IMBE, Aix-en-Provence, France. [2]ENGIE Lab Crigen, Stains, France. [3]Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands. [4]Dutch Montagu's Harrier Foundation, Scheemda, Netherlands

Wind energy development is key for the reduction of carbon emissions, however it leads to conflicts with bird conservation through collisions with wind turbines. Detailed knowledge on species-specific flight height is crucial to inform the design of future wind turbines for minimising

collision risk. We used high-accuracy altitude data from GPS tracking (high-resolution 3D GPS data and barometric altimetry) to study flight height in five European raptor species (Montagu's, Hen and Marsh Harrier, Common Buzzard, Red Kite; $N > 100$ adults tagged across > 10 sites), a bird family particularly vulnerable to collisions with wind turbines. We derived species-specific flight height distributions and assessed theoretical collision risk in relation to wind turbine dimensions. Preliminary results indicated a peak of flight activity at heights below 30 m above ground level in all species. The proportion of time spent at 40-200 m, where most wind turbine rotors are situated, ranged from 7% in Marsh Harrier to 45% in Red Kite. With decreased rotor ground clearance, time spent at risk height – and hence collision risk – exponentially increased in all species. An increased rotor diameter would again lead to a higher risk, but this could be partially offset by the increased power capacity allowing for a reduction in the number of turbines. Our results suggest that applying wind turbines with larger rotor ground clearance could be a way of meeting renewable energy production targets while minimising the impacts on raptors. To corroborate this conclusion, data collection will be continued until the end of 2022.

PP-106

Long-range dispersal of Pink-footed Geese to cope with climate change in the Arctic

Kees Schreven[1], Jesper Madsen[2], Bart Nolet[1,3]

[1]Dept. Animal Ecology, Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, Netherlands. [2]Dept. Ecoscience, Aarhus University, Aarhus, Denmark. [3]Dept. Theoretical and Computational Ecology, IBED, University of Amsterdam, Amsterdam, Netherlands

The Arctic is a highly seasonal environment currently experiencing the highest rate of global warming, to which Arctic species have to adapt, either in timing or range. On the other hand, by global warming, new areas become snow-free early enough in the year to serve as breeding habitat. We show by GPS-tracking that Pink-footed Geese *Anser brachyrhynchus*, which traditionally breed on Svalbard, have colonized Novaya Zemlya as breeding site, almost 1000 km from Svalbard. This development occurred rapidly, over the last 10-20 years and the new subpopulation now consists of c. 4000 individuals. Snowmelt on Novaya Zemlya occurs later than on Svalbard, but has advanced in both areas in the past decades and, on Novaya Zemlya, is nowadays similar to that on Svalbard 40 years ago. In the new breeding sites on Novaya Zemlya, geese are therefore expected to be better matched in timing with local food abundance and quality after arrival, than on Svalbard. We tested this prediction by combining GPS-tracking and remote sensing data of temperature, snow and vegetation greenness (NDVI).

PP-107

A study into the influence of parental behaviour and habitat quality on Great Tit chick behaviour

Eva Serrano Davies[1], Kees van Oers[1,2]

[1]Netherlands Institute of Ecology (NIOO/KNAW), Wageningen, Netherlands. [2]Wageningen University and Research (WUR), Wageningen, Netherlands

Early rearing conditions have a big impact on animal behavioural development. However, it is largely unknown which are the major drivers of behavioural development, and how they shape behaviour in an early life stage has rarely been investigated. The aim of this study was to investigate how habitat quality, parental provisioning and exploration behaviour relate to chicks behaviour in the Great Tit *Parus major*. We measured three different behaviours, namely breath rate, docility and handling aggression, as a reaction to handling stress in the field when the chicks were fourteen days old. The frequency of parental provisioning and diet was videotaped, and a proportional similarity index (PSi) score was used as a measure of how specialised the provisioned diet was. Also, we carried out a novel environment test out to measure the exploration behaviour of the parents. Habitat quality was assessed by tree and vegetation composition and coverage of each breeding territory. Our results show that breath rate of the chicks was positively related to provisioning of both parents. When analysing the docility behaviour of the chicks, maternal provisioning was negatively related to the number of struggles of the chicks. And last, handling aggression did show a negative relation to a habitat structure of lower quality. These findings show that provisioning and, to a lesser extent habitat quality, can be seen as important factors in the expression of stress related behaviour in Great Tit chicks.

PP-108

Effects of spring weather on laying dates, clutch size and nest survival of ground-nesting passerines in abandoned fields in the north of European Russia

Viktoria Grudinskaya[1,2], Tatiana Makarova[1], Dmitry Shitikov[1]

[1]Moscow Pedagogical State Univercity, Moscow, Russian Federation. [2]Zoological Museum of Moscow State University, Moscow, Russian Federation

We examined the effects of spring weather on first egg laying dates, clutch size and nest survival of Booted Warbler *Iduna caligata* and Whinchat *Saxicola rubetra* breeding in abandoned agricultural fields in the north of European Russia in 2005-2019. Our results demonstrated that variability of May precipitation and averaged daily temperature are important drivers of first egg dates, clutch size and nest survival in both species. The first egg dates of Booted Warbler and Whinchat were determined primarily by the May temperature: the warmer the weather in May, the

earlier the laying dates. Taking into account the effect of first egg date, the clutch size of Booted Warbler strongly depended on the May averaged daily temperatures May, whereas the clutch size of Whinchat was weakly affected by May precipitation. The spring weather had a strong impact on Booted Warbler and Whinchat nest survival, probably by influencing the activity of nest predators and determining the vegetation development rate. We suggest that years with coincidence of low spring precipitation and temperature are the "bad" years for reproduction of grassland birds.

PP-109

Automatic scale system with RFID sheds light on body mass development throughout Barn Owl annual cycle

Nicolas Sironi, Bettina Almasi

Swiss Ornithological Institute, Sempach, Switzerland

Studies investigating the full annual cycle of an animal are still rare but crucial to understand seasonal interactions and their fitness consequences. However, many species are difficult to access outside the reproductive season. New advances in bio-logging and telemetry technologies have opened a large field of research to gather information about animal movements and physiological conditions with least disturbance and low impact on behaviour. Among the different technologies, radio frequency identification (RFID) has emerged as a useful tool for monitoring animal activities at specific locations throughout the annual life cycle. We developed a RFID-system with an integrated scale to gather data about presence at nest-sites along with body mass data. The system is mounted at the entrance of Barn Owl *Tyto alba* nest boxes and owls wear a plastic ring with an integrated RFID-tag. 40 systems were mounted for two years and tracked 916 individuals, with adults being measured up to 10,000 times revealing interesting sex-specific differences in body mass maintenance through the annual cycle. Body mass was highest in winter for males and substantially lower during the breeding season, while females showed the highest body mass during egg laying and incubation while body mass was substantially lower during the pre-breeding and nestling rearing period. In the present poster we discuss the methods and the potential of this low maintenance data gathering system, that will deepen our knowledge about behaviour, life history traits, and phenology of this species, and that could be used in many other wildlife research projects.

PP-110

Spatial and typological structure of the ornithocomplexes of the forest-steppe of Western Siberia

Sergej A. Soloviev

Institute of Systematics and Ecology of Animals of Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russian Federation

The spatial and typological structure of the ornithocomplexes is understood by us as the general character of the territorial heterogeneity, the basic directions in the changes of communities in factorial space. In the first halt of summer (15.05 - 15.07) on the level of subtype is presented as three condensations of communities connected among themselves: natural landscapes on the ground; rivers and lakes, cities and settlements. The basic tendencies of territorial changes is the time are defined by forests, characteristies of lakes and rivers, and also human buildings and the presence landfills. The subtypes ot the ornithocomplexes presented in the scheme in the second half of summer (16.07 - 31.08) are more ordered, than in the first, in connection with leveling of influence of after-nesting migration of birds. According to the classification of the ornithocomplexes for the summer time for individual estimation of communication the six factors of environment were selected, basically determining the territorial variability of ornithocomplexes. The most significant was antropogenous influence, including the settlements and land cultivation.The influence of the latter significantly decreases in the second half of summer. The force of the influence of feeding on city dumps is lower. Level of moisture and landscape are less significant. Level moisturing grows in the second half of summer, which connected with the concentration of waterbirds and waterfowl on the significantly big areas of mashes and lakes while in forests and fields the drying of small reservoirs took place and they lost appeal to birds due to openness and availability.

PP-111

LIFE Perdix - Reintroducing the Italian Grey Partridge *Perdix perdix italica* into the wild

Alberto Sorace[1], Claudia Greco[1], Paolo Montanaro[1], Nadia Mucci[1], Cristiano Tabarroni[1], Daniel Tramontana[2], Valter Trocchi[2]

[1]ISPRA, Roma, Italy. [2]FIdC, Roma, Italy

The Italian Grey Partridge started its decline around the middle of the last century due to several factors: abandonment of the inland agricultural areas; intensive farming; unsustainable hunting; introduction of allochthones grey partridges that caused genetic pollution and diffusion of diseases. It is currently considered extinct in the wild. The LIFE Perdix Project aims to recover and conserve *Perdix perdix italica* by genetic selection, captive breeding and then reintroduction of a viable population within the Valle Mezzano (Ferrara), a Special Protection Area (SPA IT4060008) in the Po delta that until the mid-1980s housed a large Grey Partridge Population estimated at over 12.000 individuals. In 2019, starting from a stock of specimens still breeding in captivity presenting haplotypes detected in wild Italian museum specimens, genetic selection of breeders for the reintroduction of Italian Grey Partridge was carried out. From 3 August to 21 September 2021, after checking their sanitary status, the first 4500 individuals were introduced in eight acclimatization aviaries and then released in the wild. Fifty partridges were equipped with radio

collars. First environmental improvement and risk mitigation measures (e.g. to reduce the impact of poaching and predators) were undertaken. Local relevant stakeholders and people were actively involved to ensure that each planned conservation action has a positive outcome. In the following two years is foreseen the monitoring of released individuals (i.e. play-back, field survey) and the introduction of other 18.000 individuals.

PP-112

The wintering and migration ecology of the Common Whitethroat *Curruca communis*

Claudia Tapia-Harris[1,2], Will Cresswell[1,2]

[1]University of St Andrews, St Andrews, United Kingdom. [2]A.P. Leventis Ornithological Research Institute, Jos, Nigeria

The non-breeding period represents a significant part of an Afro-Palearctic migratory bird's annual cycle. Both fine- and large-scale information regarding spatial and temporal use is crucial for understanding a species' overall habitat availability and the degree of resilience populations may exhibit in the face of future habitat changes. Here we show in-depth non-breeding ecology of Common Whitethroats *Curruca communis* during three seasons in Nigeria (2017 – 2020), as well as the complete annual cycle of five individuals fitted with geolocators in 2019. Site persistence varied across individuals, ranging from one to 165 days. Many individuals established small home ranges (3405 ± 435 m^2) with little significant variation through time, age, sex, and residency, despite habitat changing through winter. On average, 19% of individuals returned to the study site the following year, shifting, on average, 300 m. Breeding sites in Eastern Europe spanned an area of 355,000 km^2, indicating a somewhat high migratory spread defined by a north-eastern flight pattern. Spring migration was similar to autumn migration but birds undertook a loop migration and stopped at a first non-breeding site in the Sahel region before arriving in Nigeria. Shorter residencies suggest the use of more than one stationary non-breeding site, rather than low winter survival. We suggest that wintering habitat is not limiting for Whitethroats so long as shrubs are present. The study highlights the importance of conserving suitable habitat for Common Whitethroats over a very large area in both the breeding and non-breeding grounds, particularly the Sahel region.

PP-113

The role of new anthropogenic environments as stopover sites for migratory birds. The case of juvenile White Storks

Marcin Tobółka[1,2], Andrea Flack[3], Artur Siekiera[4], Joachim Siekiera[4], Joanna Białas[5], Łukasz Dylewski[5], Zuzanna Jagiełło[5]

[1]Department of Zoology, Poznań University of Life Sciences, Poznan, Poland. [2]Konrad Lorenz Institute of Ethology, University of Veterinary Medicine Vienna, Vienna, Austria. [3]Department of Migration, Max Planck Institute of Animal Behavior, Konstanz, Germany. [4]Chespa, Krapkowice, Poland. [5]Department of Zoology, Poznań University of Life Sciences, Poznań, Poland

Anthropogenic land changes are generally adverse for birds. Many birds use agricultural lands as stopover sites, and while these environments cover almost half of the global land surface, they seem to play an important role for migratory birds. The increase of the human population causes an increase in food demand and new lands for agriculture. The increase in consumption also causes higher waste production and the need for their management, often just the storage on landfills. As an effect, new ecosystems (habitats) are being created, accessible for migratory birds. The migration time is crucial for migratory soaring birds like the White Stork due to limited optimal air conditions for soaring, i.e. thermal uplifts in the late summer. Therefore departures from the breeding grounds are highly synchronised. Migrating after the preferred period might be more costly and risky. However, new foraging grounds may act as attractive stopover sites for migrants. This work aimed to explore how the new environments (artificial irrigated crop fields and landfills) along the migratory routes are used by migratory juvenile White Storks. Based on GPS-GSM tracking of 181 juvenile White Storks from Poland, we tested whether the new anthropogenic environments are a chance for later breeders or ecological traps. We tested whether they are preferred above other land-use categories, how was the duration of foraging there, and whether individual traits (body condition, hatching date, migratory speed) were significant predictors for the probability of using these environments by storks.

PP-114

Reduced habitat quality increases intrinsic but not ecological costs of reproduction

Matthias Tschumi[1], Vanja Michel[1,2], Beat Naef-Daenzer[1], Herbert Keil[3], Martin U. Grüebler[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]University of Zurich, Zürich, Switzerland. [3]Forschungsgemeinschaft zur Erhaltung einheimischer Eulen e.V., Oberriexingen, Germany

The cost of reproduction is fundamental to the evolution of reproductive strategies and life-histories and sets the basis for one of the most important life-history trade-offs faced by living organisms: the trade-off between current and future reproduction. However, although the costs of reproduction are predicted to vary with the quality of the breeding habitat, empirical evidence for this pattern remains sparse and equivocal. Costs of reproduction can operate through immediate ecological mechanisms or through delayed intrinsic mechanisms. Ignoring these separate pathways might hinder the identification of costs and the understanding of its consequences. We investigated the survival costs of reproduction for adult Little Owls *Athene noctua* using an experimental release of parents from provisioning care by supplementing food to nestlings within a gradient of habitat quality. Food supplementation increased adult survival not only during the breeding season but also during the rest of the year, suggesting both, strong ecological and strong intrinsic costs.

However, while immediate costs resulting from ecological mechanisms occurred also in high quality habitats, intrinsic costs carrying over to the post-breeding period occurred only in low quality habitats. The results suggest that differential effects of habitat quality on the two mechanisms can mask the increase of costs of reproduction in low quality breeding habitats. Intrinsic costs may represent an underrated mechanism of habitat quality affecting adult survival rate thereby considerably accelerating population decline in degrading habitats.

PP-115

The state of the populations of Rustic Bunting on the eastern edge of Asia according to long-term data of standardized catches

Olga Valchuk

Ministry of Science and Higher Education of the Russian Federation Federal Scientific Center of the East Asia Terrestrial Biodiversity Far Eastern Branch of the Russian Academy of Sciences, Vladivostok, Russian Federation

Despite its VU status in the IUCN Red List, Rustic Bunting is one of the most numerous migrants in the Amur basin and Southern Primorye and a numerous nesting species in Kamchatka and in North-Eastern Siberia. Decline in the number of this species during migration has been observed in Japan since the 1990s. According to data from 60 banding stations (>100,000 birds annually), Rustic Bunting's share in the total number of migrating birds was the highest in 1980 (27.8%), then it gradually decreased and varied within 3-5% since 2007 (minimum 1.9% in 2011). Catches at the Fuchu Monitoring Station (Japan) decreased from 1,500 birds/year (early 2000s) to 12-5 birds in 2016-2018. However, Rustic Bunting regularly ranks among the five most abundant species in Japan's catches. Standardized catches at the Primabirds banding station (Primorye, Russia) in 1998-2019 showed significant (U=190, UT=212, p=0,045) interannual fluctuations in the number of birds and a negative trend over 22 years (32,6%, rs=0,653, p=0,001). Peak years and low years at different banding stations (Primabirds, Lazovsky Reserve and Fuchu) do not always coincide, which confirms that migration routes of the species are inconsistent. The species does not stick to permanent stopover sites either, as evidenced by almost no repeated off-season catches. In this case using standardized catches as a monitoring method cannot explain the abrupt changes in population dynamics. A correct state assessment of Rustic Bunting is possible with the correlation analysis of data from standardized catches, counts at nesting sites and during migration and wintering.

PP-116

Migration distance affects how closely Eurasian Wigeons follow spring phenology during migration

Mariëlle van Toor[1], Sergey Kharitonov[2], Saulius Švažas[3], Mindaugas Dagys[3], Erik Kleyheeg[4], Gerard Müskens[5], Ulf Ottosson[1], Ramunas Žydelis[6], Jonas Waldenström[1]

[1]Linnaeus University, Kalmar, Sweden. [2]Bird Ringing Centre of Russia, A. N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russian Federation. [3]Nature Research Centre, Vilnius, Lithuania. [4]SOVON Dutch Centre for Field Ornithology, Nijmegen, Netherlands. [5]Müskens Fauna, Groesbeek, Netherlands. [6]Ornitela UAB, Vilnius, Lithuania

The timing of migration for herbivorous migratory birds is thought to coincide with spring phenology as emerging vegetation supplies them with the resources to fuel migration. Individuals with very long migration distances might have to trade off between utilising optimal conditions en route and reaching the breeding grounds early, and thus might have to overtake spring on the way. We investigated whether migration distance affects how closely individually tracked Eurasian Wigeons follow spring phenology during spring migration. We tracked Eurasian Wigeons caught in the Netherlands and Lithuania throughout spring migration to identify staging sites and timing of arrival. Using temperature-derived indicators of spring phenology, we investigated how maximum longitude reached and migration distance affected how closely Wigeons followed spring. We further estimated the impact of tagging on Wigeon migration by comparing spring migratory timing between tracked individuals and ring recovery data sets. We found that Wigeons reaching higher longitudes followed spring more closely, and increasingly so the greater distance they had covered during migration. Yet we also found that despite tags weighing only around 2% of individual's body weight, individuals were on average 11-12 days slower than ring-marked individuals from the same general population. Overall, our results suggest that migratory strategy can vary dependent on migration distance within species, and even within the same migratory corridor. Individual decisions thus depend not only on environmental cues, but potentially also trade-offs made during later life-history stages.

PP-117

Colony-dependent assortative mating in a long-lived seabird, the Scopoli's Shearwater *Calonectris Diomedea*

Francesca Visalli[1], Federico De Pascalis[2], Jennifer Morinay[3], Andrea Benvenuti[4], Simona Imperio[3], Ivan Maggini[5,6], Carlo Catoni[4], Giorgia Gaibani[6], Dan Chamberlain[1], Diego Rubolini[2], Jacopo Cecere[3]

[1]Department of Life Science and System Biology, University of Turin, Turin, Italy. [2]Department of Environmental Science and Policy, University of Milan, Milan, Italy. [3]Area Avifauna Migratrice, Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Bologna, Italy. [4]Ornis Italica, Roma, Italy. [5]Konrad-Lorenz Institute of Ethology, University of Veterinary Medicine, Vienna, Austria. [6]Conservation Department, LIPU-BirdLife Italy, Parma, Italy

To optimize reproduction, animals should find the ideal life partner. Generally, mate choice is guided by genetic, phenotypic and/or behavioral features of potential partners. For example, positive assortative mating occurs when there is a defined mating strategy, with selection for specific functional traits (e.g., size, age) that is positive if mates are more similar, and negative if they are less similar, than expected by chance. Specific phenotypic features may reflect individual foraging abilities and therefore could be a good indicators of partner suitability. We investigated mating strategies of a long-lived seabird, Scopoli's Shearwater *Calonectris diomedea* by testing for assortative mating according to body size (using tarsus length as a proxy), with a multi-colony approach focused on three Mediterranean colonies of differing density (i.e. different numbers of potential partners). We found a positive correlation between tarsus length and foraging trip duration. Furthermore, we found positive assortative mating, where individuals selected potential partners of similar size, in the large colony of Linosa but not in the medium size colony of Tremiti and La Maddalena Archipelago. Positive assortative mating may reflect how partners of similar size can better coordinate incubation shifts, when one is out at sea foraging for long periods (>10 days), and the other is fasting on the nest. Careful modulation of partner choice is important for fitness in the light of the potential evolutionary processes shaping sexual selection in such a long-lived species with long term pair bonds.

PP-118

Relationship between leukocyte profile and energetic condition, hematocrit and blood metabolites in Great Tit *Parus major*

Anastasiia Volkova[1], Maria Berezantseva[2], Kirill Afonov[3], Diana Polikarpova[2], Artem Spiridonov[2], Ekaterina Zhukova[4], Irina Demina[1], Arseny Tsvey[1]

[1]Biological Station Rybachy, Zoological Institute of Russian Academy of Sciences, Rybachy, Russian Federation. [2]Herzen State Pedagogical University of Russia, Saint-Petersburg, Russian Federation. [3]Saint-Petersburg State University of Veterinary Medicine, Saint-Petersburg, Russian Federation. [4]Department "Summer Garden, Mikhailovsky Garden and green areas of the Museum", State Russian Museum, Saint-Petersburg, Russian Federation

The state of animal populations can reflect ongoing changes in their environment. Various physiological parameters can be used to assess individual and population conditions. These parameters may be related or independent, allowing organisms to respond to environmental changes flexibly. We investigated dynamics of leukocyte profile (total numbers and relative proportions of various types of leukocytes) and its relation to energetic condition, hematocrit, and

the levels of blood metabolites (glucose, β-hydroxybutyrate) in an urban population of Great Tits *Parus major* during two stages of the annual cycle: autumn migration and wintering. We found that the total numbers of leukocytes and the numbers of lymphocytes were higher during autumn migration compared to wintering. We argue that such pattern indicates the more active state of immune system in Great Tits during migration. The ratio of heterophils to lymphocytes (H:L ratio, a measure of long-term physiological stress) was higher in winter than during autumn migration. We suppose that this may be caused by low temperatures and increased competition for food in wintering birds. The total number of leukocytes was positively correlated with energy reserves and negatively correlated with blood glucose level, which might indicate a coordinated response of these physiological parameters to environmental cues. The H:L ratio was not correlated to other physiological parameters. The ecological explanations of the found relationships are discussed.

PP-119

Where do birds fly and how do they survive in the non-breeding area?

Saskia Schirmer[1,2], Fränzi Korner-Nievergelt[1], Jan von Rönn[1], Volkmar Liebscher[2]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]Department of Mathematics and Computer Science, University of Greifswald, Greifswald, Germany

Spatial variation in survival has individual fitness consequences and influences population dynamics. It impacts use of space including migratory connectivity. Therefore, knowing spatial patterns of survival is crucial to understand demography of migrating animals. Extracting information on survival and space use from observation data, in particular dead recovery data, requires explicitly identifying the observation process. We build a fully stochastic model for dead recovery data in spatially discrete nonbreeding areas. It acts on the population level and includes parameters for use of space, survival and recovery probability. The model is based on the division coefficient and the multinomial reencounter model. We apply the model to real-world data of European Robins ringed at a stopover site. We can reproduce already known patterns of use of space for this species with our method. Additionally, we estimate survival in different spatially discrete non-breeding areas.

PP-120

The co-occurrence of European Blind Snakes *Xerotyphlops vermicularis* with nesting Eurasian Scops Owls *Otus scops* in Turkey

Elif Göçer[1], Al Vrezec[2,3], David H. Johnson[4], C. Can Bilgin[5]

[1]Department of Biology, Faculty of Natural Sciences and Mathematics, University of Maribor, Maribor, Slovenia. [2]National Institute of Biology, Ljubljana, Slovenia. [3]Slovenian Museum of Natural History, Ljubljana, Slovenia. [4]Global Owl Project, Alexandria, USA. [5]Middle East Technical University, Department of Biology, Ankara, Turkey

Nests of hole nesting birds can be a shelter also for other organisms. Between 2017-2021 we monitored 68-72 nest-boxes annually aimed for breeding of Eurasian Scops Owl *Otus scops* in two study areas located near Ankara, Turkey. On average, the nest-boxes were occupied annually by breeding Scops Owls (27%), Great Tits *Parus major (*27%), Hoopoes *Upupa epops* (2%) and Eurasian Tree Sparrows *Passer montanus* (4%). Only in boxes used by Scops Owl did we find live European Blind Snakes *Xerotyphlops vermicularis*. Of the 68 total successful Scops Owl nests, 44 nests (65%) contained 1-4 European Blind Snakes (average 1.7 snakes per nest). Blind snakes are ground dwelling animals and are not known to climb the trees, therefore we suggest that the owls brought them to their nests. While all nest-boxes were cleaned at the end of each breeding season, snakes were again found within the same nest-boxes in subsequent years, indicating owls repeatedly brought snakes to the nest-boxes during each breeding season. Blind snakes are insectivorous and might act as nest cleaners, but we did not find a significant difference in owl brood sizes or fledging rates in the nests with and without snakes. No such potentially mutualistic relationship with reptiles has been found in other parts of the Scops Owl breeding range; a similar relationship was found between the Eastern Screech Owl *Megascops asio* and blind snakes in southern USA.

PP-121

Large fire initially reduces bird diversity in Poland's largest wetland biodiversity hotspot

Michał Walesiak[1], Grzegorz Mikusiński[2,3], Zbigniew Borowski[4], Michał Żmihorski[1]

[1]Mammal Research Institytute, Polish Academy of Sciences, Białowieża, Poland. [2]School for Forest Management, Swedish University of Agricultural Sciences (SLU), Skinnskatteberg, Sweden. [3]Grimsö Wildlife Research Station, Department of Ecology, Swedish University of Agricultural Sciences (SLU), Riddarhyttan, Sweden. [4]Forest Research Institute, Sękocin Stary, Poland

Freshwater wetlands are widely recognized as biodiversity hotspots for many organisms, including birds. Climate change and the projected increased risk of wetland fires may pose a major threat to wetland biodiversity in the future. However, the impact of fire on avian biodiversity in the context of wetlands is still poorly understood. We analyzed the impact of a large (5500 ha) spring wildfire on the community of breeding marshland birds in the best-preserved Polish wetland hotspot: Biebrza Valley. We compared the avian community structure and abundance of certain species before and shortly after the fire on the 18 permanent transects located in both burned and unburned habitats. Fire significantly reduced pooled abundance and species richness of the whole bird community. Three bird species of special conservation concern (including aquatic warbler)

disappeared from burned areas, and the numbers of 11 other species declined. In contrary, only 3 species benefited from the fire, none of which depended on marshes as their primary habitat. Although the reported strong initial fire effect is likely to fade off in subsequent years, its immediate detrimental effects on marshland birds should not be underestimated. We conclude it is essential to temporarily provide the unburned adjacent refuge areas with additional protection and bird-friendly management and to focus on preventing further degradation of marshes to increase their resilience to fire.

PP-122

Flying across the sea – what does weather radar data tell us about bird migration over the Baltic Sea?

Arndt H.J. Wellbrock, Natalie A. Kelsey, Ommo Hüppop

Institute of Avian Research "Vogelwarte Helgoland", Wilhelmshaven, Germany

The Baltic Sea represents an ecological barrier for millions of landbirds migrating between Fennoscandia/Siberia and Central Europe within the East-Atlantic flyway system. To mitigate human impacts on migrating birds (e.g., by offshore wind farms), it is necessary to identify the main migration routes across the different parts of the Baltic Sea. For this large-scale purpose, operational weather radar provides the only method to scan the airspace in a high spatial and temporal resolution, especially for nocturnal migration of passerines invisible to the eye. Using weather radar data from countries neighbouring the Baltic Sea and providing data to the Operational Programme for the Exchange of Weather Radar Information (OPERA), we investigate the spatial-temporal patterns of bird migration across the Baltic Sea. We will present first results on the main offshore and coastal migration areas. For the peak of migration, we will show bird densities and migration traffic rates exemplarily for selected areas in order to detect main hotspots of migration under risk of human impacts. This will help to focus future observation studies and environmental management on areas which were out of one’s radar so far.

PP-123

Food availability drives migratory decisions in a partial migrant

Stephanie Witczak[1,2], Urs Kormann[1], Michael Schaub[1], Martin U. Grüebler[1]

[1]Swiss Ornithological Institute, Sempach, Switzerland. [2]University of Zurich, Zurich, Switzerland

Changes to migratory behaviour in recent decades indicate the strong effect that climate change and human activity can have on wildlife. Many populations exhibit changes in migratory phenology or change their tendency to migrate altogether. Partial migration, where only part of a population

migrates while the rest remains in the breeding area, provides an exciting opportunity to study drivers of the condition-dependent decision to migrate or remain resident. Nevertheless, few studies have experimentally investigated how environmental factors interact with individual characteristics to shape that decision. We conducted a three-year feeding experiment, providing supplementary food to territorial, GPS-tagged Red Kites *Milvus milvus* during the non-breeding period in a population with a growing resident proportion. Using a Bayesian logistic regression with a state-space likelihood, we show that supplementarily fed birds were less likely to migrate than controls. Furthermore, this was modulated by sex, such that control females were more likely to migrate than other individuals. These results suggest that food availability is an important driver of resident and migrant frequencies in partially migrant populations. Two mechanisms may contribute to an increase in food availability in the study area: 1) milder winters due to climate change lead to increased food availability, and 2) increasing human activity leads to higher frequency of both intentional and unintentional anthropogenic food sources. Such changes to food availability have the potential to alter the seasonal distribution of migration-flexible bird species, changing local competition and predation pressures, large-scale energy fluxes, and parasite transmission between breeding and non-breeding areas.

PP-124

The post fledging period in Barn Owls *Tyto alba*: timing, body mass development and survival

Franziska Wolf[1,2], Bettina Almasi[1]

[1]Vogelwarte, Sempach, Switzerland. [2]University of Zurich, Zürich, Switzerland

Fledging is the first step to independence for young birds and the first weeks post-fledging are characterized by a high mortality in many species. Starting in good body condition into this phase might be of crucial importance. Among others, competition within the nest and environmental conditions during the nestling period can affect an individual's growth rate and body condition, which in turn affects timing of fledging. Furthermore, environmental conditions during and after fledging also affect post-fledging behaviour and survival. And the effects of these two processes are not isolated but often interact with individual performance in subsequent periods generating carry-over effects. Body condition may be a key parameter shaping timing and behaviour during the post-fledging period. However, body mass development during the post-fledging period is virtually a black box since birds are often no longer accessible for research. The aim of this study is to learn how environmental and rearing conditions affect body mass development, timing of fledging, post-fledging behaviour and survival of juvenile Barn Owls. We follow the juveniles with VHF-transmitters to determine the age individuals fledge and track them during the dependent post-fledging period and natal dispersal. To get information on body mass development during the first days post-fledging, an automatic scale system, which registers the bird's identity together with its mass, is installed at each nest box entrance. We then investigate how the natal habitat configuration and food availability together with weather data shape post-fledging body mass development, timing of fledging, natal dispersal behaviour and survival.

PP-125

Forest characteristics and history influence Crested Tit distribution at its south-eastern range border

Yehor Yatsiuk

Department of Zoology, Institute of Ecology and Earth Sciences, University of Tartu, Tartu, Estonia

Crested Tit is a sedentary species associated mainly with coniferous forests. In Eastern part of Ukraine it was previously known from a few pine forests on sandy river terraces; this species was presumed to be associated with old forests of natural origin. The current study analyzed the species' distribution in the region in order to find stand characteristics of predictive value. I analyzed available records of Crested Tits in the region and made playback counts in 254 point stations. Stand characteristics were taken either from forest survey databases or assessed on site. An isolated population was found up to 300 km from the border of the main range; it had a clear core area with higher density and more patchy distribution in the periphery. In the core area, the birds occupied a wider range of forest conditions in the pine stands, showing a positive relationship with mean tree diameter and a negative relationship with tree density. In the periphery, the birds occupied relatively older forests and showed a tendency of aggregated distribution; not all potential habitats were occupied. There was no current preference for stands of natural origin, but the core area was located in relatively better-connected forests that suffered less area shrinkage in the previous centuries.

PP-126

Foraging ranges of inland breeding Common Terns

Ramūnas Žydelis[1], Julius Morkūnas[1], Vytautas Eigirdas[1], Renatas Jakaitis[2], Armandas Naudžius[1], Liutauras Raudonikis[1]

[1]Lithuanian Ornithological Society, Vilnius, Lithuania. [2]Nemunas loops regional park, Birštonas, Lithuania

Common Terns are often restricted by the availability of suitable sites for breeding. Colonies of this species establish on exposed islands on lakes, rivers, fish ponds and flooded peat-lands. Consequently, conservation effort is usually focused on management and protection of such islands, sometimes including the waterbody surrounding them. The objective of our study was to find out how far common terns travel from their colonies for feeding during the breeding period. Such knowledge might have important species conservation implications. We used GPS telemetry and successfully tracked 58 Common Tern individuals from 6 colonies located in different parts of Lithuania. The results showed high individual variation in terms of foraging flight direction,

waterbody targeted and distance flown. Despite high variability between individuals, there was high consistency in foraging habits at individual level. Only few birds consistently foraged in close proximity to the colony, while majority regularly endured on longer foraging trips up to 20 km away from the colony to different waterbodies. In several cases Common Terns traveled as far as 50 km and even farther with repeated flights to the same waterbodies. We conclude that majority of the inland breeding Common Terns regularly use a variety of waterbodies within 20 km radius around their colonies.

PP-127

Non-contact method for sexing the Takahe *Porphyrio hochstetteri* (Rallidae, Gruiformes) by the beak outlines: graphic and statistical techniques

Andrei Zinoviev, Andrei Vinogradov

Tver State University, Tver, Russian Federation

Graphic and statistical techniques of the analysis point to the main difference in the beak outlines of males and females of the Takahe. This difference is the relative height of the mandible. “Male-type of the beak” is characterized by the more convex culmen, especially in the proximal third of the beak. The frontal shield is more pronounced extending further to the forehead; its proximal extremity may go beyond the level of the posterior edge of the eye. The mandible is noticeably higher than that of the female, often forming a pronounced convex arch in the chin region. “Female-type of the beak” is characterized by a more evenly curved culmen along its entire length. The frontal shield is less pronounced and never extends beyond the level of the posterior edge of the eye. The mandible does not form a pronounced convex arch in the chin region; the border of its lower margin is almost straight, slightly convex, or even somewhat concave in the apical third. Several statistical methods support the validity of the mentioned graphic features.

PP-128

Trade-off between song complexity and colorfulness in parid birds

Veronika Samotskaya[1], Antje Hahn[2], Ulf S. Johansson[3], Dieter Thomas Tietze[2]

[1]Lomonosov Moscow State University, Moscow, Russian Federation. [2]Universität Hamburg, Hamburg, Germany. [3]Swedish Museum of Natural History, Stockholm, Sweden

Complex singing as well as plumage coloration of male birds are honest signals for potential partners and provide information about the males' quality. To function as honest signals, both traits must be costly for the males. Due to limited resources, we expect a trade-off between the expression of both traits. This study researches the relation between song complexity and plumage coloration

in tits (Paridae). These belong to the songbirds (Oscines) and show great variability in song and plumage coloration across species. For statistical analysis we implemented a phylogenetically generalized model of least squares containing potential explanatory variables. In the best model, body size besides colorfulness had a negative impact on song complexity: Large colorful tits sing less complex and vice versa. This result supports the hypothesis of a trade-off between costly traits and their likely intense signal function. This study contributes to the better understanding of how sexual selection influences diversification of traits.

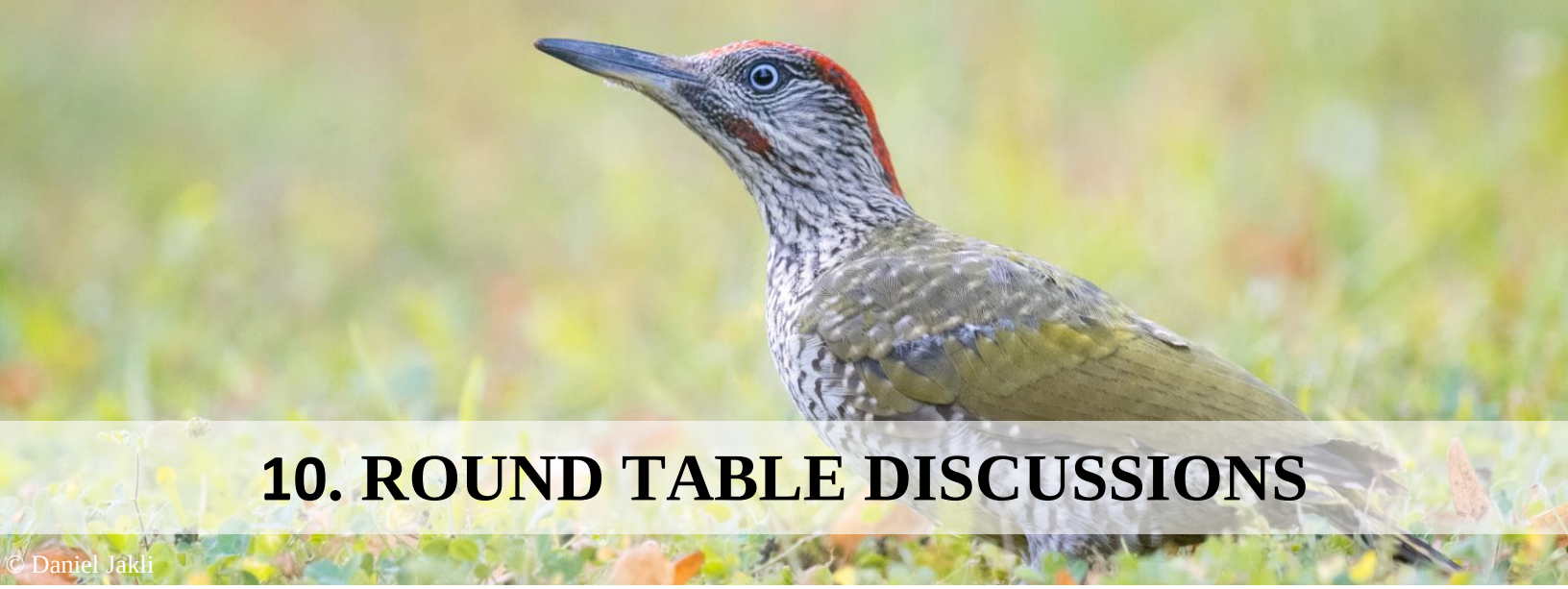
PP-129

Cis-Caucasia steppes as the area of the secondary contact zone of two species of Nightingales

Maria Mikhaylova[1], Vladimir Ivanitskii[1], Irina Marova[1], Mariana Belokon[2]

[1]Deptartment of vertebrate zoology, Faculty of biology, Lomonosov Moscow State University, Moscow, Russian Federation. [2]Vavilov Institute of General Genetics, Russian Academy of Sciences, Moscow, Russian Federation

Cis-Caucasia steppes of Southern Russia were actively afforested throughout the 20th century. The result of such a deep anthropogenic change is the emergences of a unique zone within the conditions contribute to resettlement of different taxa of birds towards each other from the European deciduous forest and the Caucasus forests to the north and south respectively. Our study focuses on the abundance, distribution and interaction between two closely related species of nightingales, the Common Nightingale *Luscinia megarhynchos* and the Thrush Nightingale *Luscinia luscinia* in Cis-Caucasia steppes of Southern Russia. Analysed data were gathered during 2017, 2019 and 2021 in Cis-Caucasia steppes. The songs of males were recorded, ecologically important traits were measured and a blood sample was collected for genetic analysis. The zone of secondary contact of nightingales in the Cis-Caucasia steppes was located in the north-eastern part of the Krasnodar region and in the western part of the Republic of Kalmykia according to study of this region conducted 40 years ago. At present, mixed populations have been found only in the Kalmykia. In the investigated areas of the Krasnodar region, the Common Nightingale was not found in the survey, although it was common in this area. The number of the Thrush Nightingale, on the contrary, has increased and the obtained data shows spreading the species to the south. These results characterize the Cis-Caucasia zone of repeated contact of nightingales as a sufficiently dynamic area, the reason of which is probably the fact that the origin is relatively young and anthropogenic.



10. ROUND TABLE DISCUSSIONS

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RTD-1

Urban Bird Consortium (URBICON): next steps in building a global platform

Organizers: Juan Diego Ibáñez-Álamo[1], Petra Sumasgutner[2], Pablo Capilla-Lasheras[3], S. James Reynolds[4], Mark Mainwaring[5], Davide Dominoni[3]

[1]University of Granada, Spain. [2]University of Vienna, Austria. [3]University of Glasgow, UK. [4]Centre for Ornithology, University of Birmingham, UK. [5]Bangor University, UK

Urbanization, one of the most important human-induced landscape changes, is consid-ered a major global threat to biodiversity. The Urban Bird Consortium (URBICON) launched in Vancouver at the IOC2018 brings together ornithologists interested in ex-panding our knowledge about urban bird ecology and behaviour. This Round Table Discussion (RTD) will provide a rare opportunity to plan the next steps in developing this global platform from which to launch exciting initiatives. It will be organized into three sections: (1) a short (10 min.) presentation on the current status of URBICON including preliminary findings from an online and ongoing survey of the major research areas in urban ornithology; (2) four 5-min. talks on potential research areas as foci for working groups (Dan Chamberlain: Socioeconomic aspects of urban ornithology, Pablo Capilla-Lasheras: Causes and consequences of variation in avian microbiomes in cities, S. James Reynolds: Coordinating citizen science urban bird projects, Petra Sumasgutner and Mark Mainwaring: Interactive effects of urbanization and climate change); and, finally, (3) a general discussion on the future of the initiative (e.g., funding, potential expansion to include other stakeholders such as NGOs, city administrations and city planners). We expect an enriching and interesting discussion about many topics that will provide an excellent opportunity to build a strong European platform for the Urban Bird Consortium that can then be expanded globally to include previously under-represented global areas in avian urban ecology and behaviour.

RTD-2

Motus – opportunities for automated VHF telemetry in Europe

Organizers: Lucy Mitchell[1], Vera Brust[2], Florian Packmor[2]

[1]University of the Highlands and Islands, UK. [2]Institute for Avian Research (IAR), Wilhelmshaven, Germany

Motus, an automated VHF telemetry system used around the world, has changed the way we track small flying animals, over a large spatial scale, without the need for recapture. The system revolves around static telemetry receivers and miniature coded radio tags which can be detected an average of 10km away from any one receiver. We can now view movement data such as flight direction, speed, departure and arrival times of all but the smallest passerines (as well as bats and insects), allowing us to document parts of their migration including movements across ecological barriers. Even though Motus has been used here in Europe for several years, and that it works best as a collaborative system whereby we work together to share ideas and data, there are still issues relating to the frequency on which all countries work and there are swathes of Europe that do not have a single receiver, leading to significant gaps in research. It has been 6 years since the last meeting of the European Motus 'community' in Lund, Sweden. Now, in an ever-changing world where joined up thinking and collaborative working are vital, we wish to invite participants to join us to discuss how we can use the system best, including where it would be most pertinent to site receivers, which topics would be best explored using Motus and what types of data it can provide. We invite those who both use and do not use the system and will introduce the topic with brief (~5 minute) presentations on the background of Motus and where it is currently used across Europe, as well as our aspirations for the system. We hope to promote discussions around new collaborations, innovative technologies and of course, funding opportunities for the future where we can expand Motus in Europe.

RTD-3

Overcoming challenges for transboundary conservation of migratory birds under global change: from human-wildlife conflicts to climate change

Organizer: Brady J. Mattsson

Institute of Wildlife Biology and Game Management, University of Natural Resources and Life Sciences, Vienna (BOKU), Austria

Calls for urgent action to conserve biodiversity under global change are increasing, and conservation of migratory species in this context poses special challenges. The Convention on the Conservation of Migratory Species of Wild Animals (CMS) and the EU Birds Directive have provided a framework for several subsidiary instruments including action plans for migratory bird species in Europe, but the effectiveness and transferability of these plans remain unclear. Such laws and policies have been credited with positive outcomes for the conservation of migratory species, but lack of international coordination and on-ground monitoring of the implementation pose major challenges. While research on the full annual cycle of migratory populations has received growing attention, considerably less emphasis has been given to integrating ecological information throughout the annual cycle for examining international strategies to conserve migratory species in the face of global change. In a fast-changing environment, climate change and human-wildlife conflicts (HWC) arise as major threats for species conservation, not only individually but also in combination. In this context, the roundtable here proposed aims to address the research question: *How can a migratory species be recovered and maintained across its range in the face of increasing HWCs and climate change?*

To address this question we use three representative species from the African-Eurasian flyway representing diversity in geographies, migratory strategies, diet, types of human-wildlife conflict (HWC), and degree of transboundary coordination in their conservation, i.e. Pink-footed Goose, Red Kite and European Turtle Dove. We begin with four 5-minute introductions by experts on the ecology and conservation of each focal species, with particular emphasis on the level of transboundary coordination in conservation actions along with the role of (1) human-wildlife conflicts and (2) climate change. The roundtable proceeds with breakout rooms to compare the three case studies regarding (1) and (2) above, and to (3) identify advantages and disadvantages regarding transboundary approaches to address shared conservation threats among countries. A spokesperson from each breakout session gives a 5-minute presentation summarizing their group's findings. The roundtable concludes with a synthesis of the discussion and outlook for developing the roundtable findings into a scientific manuscript. The roundtable also provides a basis for improving conservation regulations (e.g. through the EU REFIT scheme) and updating action plans for these and other migratory species in the face of global change. These plans should account for new information on the species distribution, demographics, and ways of overcoming challenges presented and discussed in the roundtable.