IWSG Annual Conference booklet

International Wader Study Group

2020 Virtual Conference

International Wader Study Group

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1970 2020

International Wader Study Group

2020 Virtual Conference

Program

This year we celebrate our 50th anniversary. Here you see the delegates at the first **Annual Conference behind the Iron Curtain**, in Gdansk, Poland.For many waderologists this 1987 conference was the “best organized and most friendly” ever. Certainly it was a life changing experience, instigating a flood of long-term cooperative research, some of them ongoing!

Time zone: CEST	**IWSG Annual Conference 2020**

Saturday 10 October						
09.30-09.45	Opening of the conference				Yvonne Verkuil	

09.45-10.45	Session 1	**Breeding – predation**	09.45-10.00	Talk 1	**Leah Kelly**	Upland rush management increases predation of artificial wader nests
			10.00-10.15	Talk 2	**Triin Kaasiku**	Does a novel species in the predator guild affect wader nest survival?
			10.15-10.30	Talk 3	**Vojtech Kubelka**	Global patterns of chick survival in shorebirds
			10.30-10.45	Talk 4	**Kristal Kostoglou**	Embryonic vocalisations mediate parental defence in shorebirds
10.45-11.00				Break/Communication talk 1-4		

11.00-12.15	Session 2	**Breeding habitat, land use & productivity**	11.00-11.15	Talk 5	**Erik Kleyheeg**	Agri-environment measures in the Netherlands require improvement to enhance Northern Lapwing *Vanellus vanellus* reproduction
			11.15-11.30	Talk 6	**Maite Cerezo**	Investigating the link between adult density and breeding success in Icelandic whimbrels
			11.30-11.45	Talk 7	**Raphaël Leprince**	Influence of habitat quality and diversity on contracting dynamics of two populations of Eurasian Curlew *Numenius arquata* in western France
		Wader conservation	11.45-12.00	Talk 8	**Katharine Bowgen**	Curves for Curlew: Novel method to identify breeding stage from GPS tracking data
			12.00-12.15	Talk 9	**Peadar O'Connell**	Identifying important areas for breeding waders in Great Britain: Towards targeting conservation management, guiding forest expansion and other land-use changes
12.15-12.30				Break/Communication talk 5-9		

12.30-13.30	"Lunch" break					
13.30-14.30	Session 3	**Migration**	13.30-13.45	Talk 10	**Joshua Nightingale**	Using network analysis to understand estuary-scale patterns of individual wader movements
			13.45-14.00	Talk 11	**Philipp Schwemmer**	Migrating curlews on schedule: departure and arrival patterns depend on time rather than on wind conditions
			14.00-14.15	Talk 12	**Anton Ivanov**	Morphometry of the Great Knot *Calidris tenuirostris*: sex and age differences
			14.15-14.30	Talk 13	**Batbayar Galtbalt**	Shorebirds like to stay low - wind support appears secondary factor in migratory flight altitude
14.30-14.45				Break/Communication talk 10-13		
14.45-16.00	**Annual General Meeting** *Open to all members attending the conference*				**Important documents:**	Go to: https://www.waderstudygroup.org/agm-minutes-reports/
16.00-16:15	Break					
16.15-17.30	Session 4	**Migration**	16.15-16.30	Talk 14	**Rebecca Pederson**	Temporal and spatial migration patterns of Eurasian Curlews (*Numenius arquata*) in the NE Atlantic region assessed with GPS-dataloggers
			16.30-16.45	Talk 15	**Theunis Piersma**	Tracking Red Knots in the East Asian-Australasian Flyway
			16.45-17.00	Talk 16	**Afonso Rocha**	Migratory routes of Kentish Plovers revealed by geolocators
			17.00-17.15	Talk 17	**Eunbi Kwon**	Tracking the annual migration of Long-billed Dowitchers using the ARGOS satellite transmitters
	Introducing the new Chair		17.15-17.30		**Jennifer Smart**	
17.30-17.45				Break/Communication talk 14-17		

17.45-19.15	Session 5	**Wintering ecology**	17.45-18.00	Talk 18	**Sriman Delip Kumar Das**	Site use by non-breeding Black-tailed Godwits at Nijhum Dweep National Park and Char Birbira, Bangladesh
			18.00-18.15	Talk 19	**Ana Coelho**	How traditional shellfish harvesting may benefit shorebirds wintering in the Bijagós?
			18.15-18.30	Talk 20	**Joanna Castillo**	Available macrobenthic invertebrate as prey for shorebirs, Patagonia Argentina
			18.30-18.45	Talk 21	**Rebeca Linhart**	Movement, habitat use, body condition and migration of Semipalmated Sandpipers (*Calidris pusilla*) wintering at the Bancos dos Cajuais (Ceará, Brazil)
		Wader conservation	18.45-19.00	Talk 22	**Andrew Allen**	The demographic causes of population decline vary across four decades in a long-lived shorebird
			19.00-19.15	Talk 23	**Selena Flores**	Think like a (shore)bird: Deterrence techniques for shorebird protection during mouse eradication on Midway Atoll
19.15-19.30				Break/Communication talk 18-23		

19.30 "Dinner" break

20.30-21.45	Session 6	**Population structuring**	20.30-20.45	Talk 24	**Roeland Bom**	Bar-tailed godwits breeding in western Siberia: separated in space but converging in time!
		Assessment of demographic values	20.45-21.00	Talk 25	**Rachel Taylor**	When theory meets reality: making the best use of field surveys for monitoring breeding Curlew
			21.00-21.15	Talk 26	**Willow English**	Can feather corticosterone be used to assess carry-over effects in Arctic-breeding shorebirds?
			21.15-21.30	Talk 27	**Rachel Taylor**	Separating first-winter Icelandic and British Redshank highlights differential productivity dynamics in a mixed wintering population
		Space use	21.30-21.45	Talk 28	**Lena Ware**	Space use and habitat selection decisions of black oystercatchers across tidal, diel and annual cycles
21.45-22.00				Communication talk 24-28		

Sunday 11 October **continued: IWSG Annual Conference 2020** **Time zone: CEST**

09.30-10.30	Session 7	**Dispersal**	09.30-09.45	Talk 29	**Luke Eberhart-Phillips**	Individual variation in dispersal and migration strategies of Snowy Plovers
		Disturbance	09.45-10.00	Talk 30	**Selena Flores**	Sharing The Shores: measuring & mitigating disturbance to breeding White-fronted Plovers
			10.00-10.15	Talk 31	**Hendrik van der Kolk**	Modelling population impacts of disturbance on wintering oystercatchers
		Physiology	10.15-10.30	Talk 32	**Magali Frauendorf**	Quantifying body condition in ecology using structural equation modelling (SEM)
10.30-10.45				Break/Communication talk 29-32		

10.45-12.15	Session 8	**Population size assessment**	10.45-11.00	Talk 33	**Ellen Claire Martin**	Shorebird abundance estimates in Interior Alaska
			11.00-11.15	Talk 34	**Colin McShane**	A simple, effective method to census Jack Snipe in winter using thermal imagery
		Staging site ecology	11.15-11.30	Talk 35	**Micha Jackson**	Pervasive use of artificial habitats by shorebirds in the Asia-Pacific requires new conservation measures
		Food and feeding	11.30-11.45	Talk 36	**Mohamed Henriques**	What fuels shorebird food webs in a pristine mangrove-bordered West African intertidal ecosystem?
			11.45-12.00	Talk 37	**Wesley Payne**	Windchill effects on the foraging rates of estuary overwintering waders
12.00-12.15				Break/Communication talk 33-37		

12.15-13.30 "Lunch" break

13.30-15.30	Workshop	**Daniel Brown**	Eurasian Curlew migration studies
15.30-15.40	Break		
15.40-16.30	Sponsor workshop		Wildlife Acoustics
16.30-16.45	Break		

16.45-18.00	Session 9	**Mating systems**	16.45-17.00	Talk 38	**Edward H. Miller**	Evolutionary change and conservatism in breeding vocalizations within a sandpiper clade: Great Knot, Red Knot, and Surfbird
			17.00-17.15	Talk 39	**Hanna Algora**	Nest distribution in relation to male leks in ruffs (*Calidris pugnax*)
			17.15-17.30	Talk 40	**Johannes Krietsch**	Extra-pair paternity in a sequentially polyandrous shorebird: Not just sperm-storage from the previous mate
			17.30-17.45	Talk 41	**Lina M. Giraldo-Deck**	Consequences of a chromosomal inversion on reproductive output of Ruff females
			17.45-18.00	Talk 42	**Lourenço Falcao Rodrigues**	Polyandry and senescence shape egg size variation in a precocial bird
18.00-18.15				Break/Communication talk 38-42		

18.15-19.00	Session 10	**Food and feeding**	18.15-18.30	Talk 43	**Carmem Fedrizzi**	Diet of Red Knots *Calidris canutus rufa* at Lagoa do Peixe National Park, south Brazil
			18.30-18.45	Talk 44	**Liliana V. Vassileva**	Waders (Aves: Charadriiformes) along the Black Sea/Mediterranean Flyway: their time budget and trophic relations on a sand shore on the Bulgarian Black Sea coast
			18.45-19.00	Talk 45	**Rebeca Linhart**	Stopover Ecology of adult and juvenile Semipalmated Sandpipers (*Calidris pusilla*) using the Bay of Fundy and other coastal sites
19.00-19.15				Break/Communication talk 43-45		
19.15-19.30	Closing of the conference				**Jennifer Smart**	

2020 Virtual Conference

Abstracts

This year we celebrate our 50th anniversary. Here you see the batches of the delegates at the first annual conference behind the Iron Curtain, in 1987 in Gdansk, Poland.

This conference was organized by Jaga Gromadzka and her team, They hand-drew all 103 name badges, featuring the appropriate study species.

Nest distribution in relation to male leks in Ruffs (*Calidris pugnax*)

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Ruffs (*Calidris pugnax*) provide a textbook example for intensive sexual selection and lekking. Ornamental males compete vigorously in mating arenas (leks) to attract visiting females (reeves). Previous studies investigated the origin and maintenance of lekking including the importance of female choice and male-male competition as drivers of lek evolution. One remaining question is whether lekking evolved because males favour aggregating around other males with high reproductive value (hotshot hypothesis), or male aggregations arise in areas of high female density (hotspot hypothesis)? Here we investigate the latter, predicting that leks are positioned in places most preferred by females. In our analysis we use spatial information on Ruff leks and nests from a large breeding population at Liminganlahti, Finland, monitored over four field seasons. In Ruffs, the females provide all parental care, and choice of nest location is crucial for reproductive success and survival. Appropriate nesting location needs to be safe from flooding, provide adequate food sources and protection from predators and male harassment for females and their offspring.

Specifically, we test whether Ruff nests are uniformly distributed or whether they clump around certain areas such as leks. Furthermore, we investigate how nesting success differs across the breeding area depending on location.

This analysis will shed light on the potential importance of female habitat choice, for the evolution of male mating aggregations.

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The demographic causes of population decline vary across four decades in a long-lived shorebird

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We investigate how the demography of a declining long-lived shorebird (the Eurasian Oystercatcher *Haematopus ostralegus*) has changed in the past four decades. Vital rates are not homogenous among individuals and incorporating individual heterogeneity in population models is particularly important when individuals respond differently to environmental change. We therefore built and analysed Integral Projection Models separately for the 1980s, 1990s, 2000s and 2010s, with no less than three state variables: age, breeding status and lay date. Reproduction was the most important phase, especially nest success and to a lesser degree hatchling survival. All else being equal, restoring nest success to the levels of the 1980s would have stabilised population growth in the 2010s. Adult survival declined in recent years, but the effects on population growth appear to be offset by higher than average sub-adult survival and breeding probabilities. Lay date explained significant levels of variation in reproduction, with a general parabolic relationship of maximal productivity near the average lay date. However, this relationship has changed in the last decade with earlier nesting birds not only have higher productivity but also higher survival. If the mean lay date of the population were to advance by two days, population size would also have stabilized in recent years. Whilst it may be unfeasible to implement interventions that advance the lay date of oystercatchers, our analysis points towards something in the environment that has changed, such as predation or food availability, that is reducing the success of the average bird in the population.

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Bar-tailed godwits breeding in western Siberia: separated in space but converging in time!

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We studied the migration ecology of two groups of Bar-tailed Godwit *Limosa lapponica*, both currently considered the subspecies *taymyrensis*. The first group winters in the Middle East and breeds at Yamal (Russia). The second group winters in West Africa and breeds at Taimyr (Russia), and 'leap-frogs' the first group when migrating to and from their breeding areas. Satellite-tracking showed that individuals of either group may make stops at the same Arctic sites. Despite being indistinguishable in neutral genetic markers, the two groups are morphologically distinct. The groups further differ in their timing of migration, with the birds in Yamal breeding about a week earlier than those in Taimyr. This is correlated with differences in the date of snowmelt at the respective breeding areas. Besides spatial segregation, differences in timing likely contribute to reproductively isolating the two groups, but analyses of satellite imagery indicate that the two tundra areas are on different climate trajectories. Between 1995 and 2020, snowmelt has been advancing ca. half a day per year at Taimyr, whereas there has been almost no advancement at Yamal. As the Taimyr godwits have advanced their arrival time in the breeding areas by about a week over the last 20 years. If the Yamal birds indeed did not advance arrival phenology, there would be increasing temporal overlap. Whether the two groups will be able to maintain their geographic and morphological differences is an open question. Homogenization of previously isolated populations could be a new potential consequence of climate change.

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Curves for Curlew: Novel method to identify breeding stage from GPS tracking data

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It has proved near impossible to be able to identify breeding stage timings of cryptic species like Curlews without intense or expensive monitoring. Intensive monitoring comes with disturbance risks and so many projects now rely on tagging of individuals to provide remote information on movements. Given the importance of understanding these stages to target conservation practices and management new methods are needed. This study has found that it is possible to identify breeding stages of Eurasian Curlew (*Numenius arquata*) from GPS tag movement patterns using the recurse package which provides coordinates for important areas based on revisits and that pattern of the frequency plots from these data can be related to breeding stages. We can now identify pre-breeding, incubation attempts, chick-guarding, failure and post-breeding within several hours of the event. The Eurasian Curlew is a declining wader species that recent studies suggest is being affected most at the breeding stages rather than impacts on the survival of full grown adults. The acquisition of more knowledge on the behaviours at each stage allows the opportunity to provide more targeted conservation efforts and reduce the need for additional visits that may cause disturbance and thus risk failure to nesting pairs. This method can hopefully be applicable to a range of GPS tagged bird species.

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Available macrobenthic invertebrate as prey for shorebirds, Patagonia, Argentina

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The northern sector of the Golfo San Jorge at South America is an important non-breeding area for Nearctic shorebirds. Understanding dietary requirements in stopover and wintering sites is key to conservation of shorebirds and their habitats. In order to explore the availability of prey for shorebirds, we carry out samples of the benthic community during different dates of the year 2019 at Caleta Malaspina, Patagonia Argentina. Sediments were sampled using coring methods to identify benthic macroinvertebrate taxa and determine their abundances. We identified at least 30 species of polychaetes, crustaceans and clams. Also, we analysed the diet composition of the most common neartic species like the White Rumped Sandpiper (*Calidris fuscicollis*), Baird's Sandpiper (*Calidris bairdii*) and Sanderling (*Calidris alba*) through faecal analysis. Frequency of prey occurrence was calculated and compared. Despite the great diversity of prey available, only a few taxa comprised the main prey consumed by shorebirds. The White-rumped Sandpiper and the Baird's Sandpiper captured mostly polychaetes of Spionidae family, crustaceans, clams and insects. However, the main prey consumed by the Sanderling were polychaetes (mostly Onuphidae, Orbinidae and Nereididae families), crustaceans and clams.

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Investigating the link between adult density and breeding success in Icelandic Whimbrels

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Circumpolar Arctic regions support a unique composition of species threatened by climate change, habitat loss and degradation. In these regions, waders dominate the Arctic terrestrial bird guild, comprising 47% of the species in this group. With the majority of wader species with known population trends declining (48%), conservation action is urgent. Iceland, one of the 8 circumpolar regions, hosts important numbers of breeding waders and is responsible for the bulk of the population of several species like Golden Plover, Dunlin and Whimbrel. Iceland has undergone rapid changes in land use due to agricultural practices transforming important wader breeding habitats such as wetlands. These changes in habitat have the potential to greatly affect wader population sizes, and in order to mitigate such changes, a better understanding of the relationships between habitats and demography is essential at the relevant scales.

In this study, we explore the relationships between adult abundance over one generation (9 years) and productivity (7 years) in Whimbrels at large spatial scales. To do so, we surveyed the largest lowland basin in Iceland on a 200 km road transect from 2011 to 2019 censusing the adult population in June and the number of families in July. We then explored annual and spatial variation in productivity and looked for evidence of density dependence effects on productivity. The findings shed light on spatiotemporal variation in productivity at large spatial scales and on the mechanisms involved in driving the relationships between habitats and productivity.

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How might traditional shellfish harvesting benefit shorebirds wintering in the Bijagós?

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The Bijagós archipelago in West Africa holds large numbers of wintering shorebirds, with the maximum counts of 700,000 individuals representing about 10% of all shorebirds migrating along the East Atlantic Flyway. They are attracted by the extensive mudflats and dense mangrove that offer food and shelter. However, many of these populations are currently declining, particularly those foraging on benthos.
The archipelago is also home to the Bijagós people, known for their rich cultural heritage and animist believes which includes specific rules and determines sacred areas aimed at protecting the natural world. Although all Bijagós share the same cultural identity, people from some areas are gradually moving away from traditional practices looking for new opportunities, with new religions, tourism and social media likely propelling these changes.

Both shorebirds and the Bijagós people use shellfish, and although shorebirds tend to feed on smaller individuals than humans, over-exploitation of these resources could lead to reduced shellfish populations and in extreme cases to local depletion. As shorebird densities follow the abundance of their available prey, shellfish harvesting could potentially have great impact in shorebird distribution and abundance.

In order to better understand local shellfish collection patterns, its cultural and economic importance, and how local conservation actions may protect benthos, as a pilot we conducted interviews with shellfishers in an island with local management based upon cultural values, and in another island without such management. We then explore how these two approaches may benefit the Bijagós people and shorebirds, which share these same resources.

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Site use by non-breeding Black-tailed Godwits at Nijhum Dweep National Park and Char Birbira, Bangladesh

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Black-tailed Godwits *Limosa limosa* are globally a Near-Threatened species, but a common winter visitor to Bangladesh. Although the total wintering population size and trend are unknown, in view of habitat degradation a decline is suspected. Nijhum Dweep National Park is one of the most important sites for Black-tailed Godwit in Bangladesh. Here we report on the site use of Black-tailed Godwits in this national park and in adjacent Char Birbira. From the 2016-17 to the 2019-20 winter seasons (October-March) we made 17 counts. In these tidal areas, high tide roosts were counted from vantage points, whereas foraging activities were observed from boats during low tide. Black-tailed Godwits were always there, with the highest count of 8,269 birds in December 2017. The decrease from 2000 to 2020 in Nijhum Dweep and the stable (~1400) numbers in Char Birbira suggest a distributional shift towards the east, possibly due increased disturbance from fishing, agriculture, and livelihood activities in the Nijhum Dweep National Park. This calls for more effective conservation actions to help godwits and people to coexist. We suggest a monitoring and protection scheme with a focus on migratory waterbirds with restricted and regulated access to Damar Char West, East and Char Birbira. This should include attempts to create awareness among the main stakeholders, fishermen and crab hunters, to provide context and engage them in conservation action.

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Individual variation in dispersal and migration strategies of Snowy Plovers

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Differential strategies of dispersal and migration are common among conspecifics, such as sex-biased breeding and natal dispersal, or partial migration – whereby a subset of the population is resident and the remainder migrates. However, although the evolutionary mechanisms explaining dispersal and migration strategies are well established in theory, empirical evidence remains scarce due to the difficulty of following individual movements across vast landscapes over the full annual cycle. Furthermore, the exchange of individuals across time and space has important implications for endangered species conservation, such as population connectivity, source-sink dynamics, and the recognition of important wintering and breeding sites. Fortunately, recent advances in satellite-based tracking now offer biologists the enticing opportunity to explore previously uncharted aspects small-bodied animal movements. Here, I discuss our ongoing research combining state-of-the-art miniaturized GPS tags with detailed long-term demographic data to understand the feedbacks between individual variation in movement and spatially-structured population dynamics at an endangered breeding population of Snowy Plovers (*Charadrius nivosus*) in western Mexico. Snowy Plovers offer a highly tractable system to study movement ecology as they have an unusual life-history characterized by highly dispersive polyandry, male-biased uniparental care, and partial migration. I will present our latest GPS data and share our collaboration initiative to study the movement ecology of this enigmatic shorebird throughout its North American breeding range. The detailed information provided by this initiative will provide important information on population connectivity and seasonal movements relevant for conservation planning at the continental scale.

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Can feather corticosterone be used to assess carry-over effects in Arctic-breeding shorebirds?

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Carry-over effects occur when conditions in one part of the year affect an individual in subsequent seasons. Including carry-over effects in demographic studies or conservation planning can account for previously unexplained variation in survival or reproduction. While it remains challenging to obtain information about the same individual at multiple times of year to study carry-over effects, information about past conditions experienced by an individual can be obtained from intrinsic physiological markers. Feather corticosterone (fCORT) reflects stress levels experienced by a bird during feather growth and can be sampled at a later date. We analyzed levels of fCORT from ten species of shorebirds breeding at two sites in Alaska and one in Arctic Canada. We tested whether levels of winter stress, measured using fCORT, carried over to affect breeding metrics including nest initiation date and egg size. Levels of fCORT varied strongly between species: American Golden-Plovers and Western Sandpipers showed the highest levels, while White-rumped Sandpipers had considerably lower levels. A moderate negative relationship between fCORT and nest initiation date was found only at the Canadian site. The relationship between fCORT and nest initiation date also varied between species; some showed a positive relationship and some negative. The effect of winter fCORT on summer breeding success appears to be more complex in shorebirds than has been found in other species. More information on the timing of moult, and the mechanisms by which corticosterone is incorporated into feathers is necessary before fCORT can be reliably used to study carry-over effects in shorebirds.

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Diet of Red Knots *Calidris canutus rufa* at Lagoa do Peixe National Park, south Brazil

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We aimed to estimate the diet of Red Knots *Calidris canutus rufa* at the Lagoa do Peixe National Park, south Brazil, through analysis of droppings. Lagoa do Peixe (LP) is an important staging site for Red Knots during both the austral spring and autumn migrations; nevertheless, they are more abundant there during the latter period. We collected Red Knot droppings by following mono-specific foraging flocks on a stretch of oceanic beach within the Park in March and April 2006. Droppings were preserved in 70% ethanol individually and examined in the laboratory. We identified undigested prey parts from 71 droppings, 32 collected in March and 39 in April. Beetles were present in nearly all (FO = 95.7%) droppings. The other more frequent prey items were Mole Crabs *Emerita brasiliensis* (36.6%), Yellow Clams *Mesodesma mactroides* (33.8%), and Argentinean Wedge Clams *Donax hanleyanus* (19.3%). As expected, Red Knots at LP feed on abundant local benthic invertebrates. In January – April, small juveniles of *M. mactroides*, *D. hanleyanus*, and *E. brasiliensis* reach their highest numbers, a timing which coincides with the northward migration of Red Knots from Argentina. The high frequency of beetles in droppings was unexpected since nonbreeding Red Knots consume insects infrequently. Beetles are the dominant benthic organisms on the backshore of beaches in south Brazil. Perhaps, insects are trapped by the incoming tide, washed ashore, and captured by feeding birds on the shoreline.

Think like a (shore)bird: deterrence techniques for shorebird protection during mouse eradication on Midway Atoll

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Eradication of introduced rodents on islands benefit native species that rodents prey upon or compete with. While these conservation operations are critically necessary and often effective, there can be severely detrimental effects on non-target species (especially if exposed to bait) that require consideration and mitigation. The planned removal of invasive House Mice from Midway Atoll involves several non-target species needing protection and monitoring during the bait application and persistence period. In this case, migratory shorebirds that use the atoll as a stopover or over-summering site are a focal concern. Thus, several methods will be used to keep shorebirds away from the baiting areas as much as possible, including a variety of deterrence techniques, temporary flight restriction, and captive care. As this particular eradication plan involves unprecedented efforts to protect non-target species, it is hoped these methods will be effective and applicable to programmes with similar needs.

KEYWORDS: shorebirds, rodent eradication, conservation, methods, deterrence, hazing, disturbance, mitigation, islands

AUTHOR BIO: Selena Flores is a 2020 Directorate Fellow with the U.S. Fish & Wildlife Service, as part of the Midway Atoll Seabird Protection Project. Selena's research involves designing, implementing, and evaluating conservation interventions, ensuring measures remain effective. She also aspires to develop constructive communication between stakeholders, encouraging investment in protecting nature.

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Sharing The Shores: Measuring & Mitigating Disturbance to Breeding White-fronted Plovers

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In addition to larger concerns such as climate change and habitat encroachment from development, ground-nesting shorebirds are notably vulnerable to the cumulative impacts of smaller, everyday forms of disturbance, particularly the presence of beach visitors. Following global shorebird decline, the White-fronted Plover (*Charadrius marginatus*) has undergone considerable population reduction across the Western Cape of South Africa over the last three decades, largely due to anthropogenic pressure. This applied research aims to determine the impact of disturbance on shorebird breeding success of 236 nests, monitored over three breeding seasons in a popular area of South Africa's Garden Route. Multiple factors are synthesised to investigate how disturbance and ecological variables influence reproductive output. The disturbance gradient along the study site was mapped via observations of beach usage and human disturbance to nesting birds. Breeding attempts in areas of moderate disturbance were more successful in comparison to very high or very low levels, due to ineffective attendance and increased predation risk, respectively. Shorebird response to human presence was outlined through flight initiation distance experiments, indicating a 30m buffer zone being advisable. The outcome is to emphasise contemporary, on-the-ground application of conservation research, addressed by devising least-prohibitive management techniques, being nest signage and stewardship presence. Piloting implementation of such strategies showed an initial, promising increase in breeding success from 9.15% to 14.12%. Suggestions from a sound scientific standpoint will assist those driving this tourism-dependent region to make appropriate decisions, taking into consideration both economic development and environmental conservation.

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Quantifying body condition in ecology using structural equation modelling (SEM)

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Body condition is an important concept in behaviour, evolution and conservation as it is a key determinant of an individual's fitness. Consequently, body condition indices are increasingly used as a proxy for how individuals and populations are affected by environmental change (e.g. pollution, overharvesting, global warming). Although body condition is a broad and multivariate concept encompassing a wide range of morphological and physiological dimensions, in practice most studies operationalize the concept using a single (univariate) measure. One reason for ignoring other important axes of variation is that the multivariate description of body condition imposes statistical and analytical challenges.

We propose structural equation modelling (SEM) as a useful conceptual and flexible statistical tool to describe the multivariate nature of body condition. We discuss how different challenges (e.g. multivariate nature) in quantifying a body condition index can be overcome by using SEM and how they compare to more conventional approaches (multiple regression (MR), principal component analysis (PCA)) with the help of worked empirical examples on a shorebird species. Those examples not only highlight the flexibility of SEM, but also result in more biological insights: model performance is higher (reduced prediction error by 9.5% and doubled explained variation) when quantifying body condition with the help of SEM compared to analysing the same model with conventional MR and PCA. SEM is used in many fields to study questions relating to complex natural multivariate concepts, and SEM can be a powerful framework to flexibly describe the multivariate nature of the concept of body condition.

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Shorebirds like to stay low - wind support appears secondary factor in migratory flight altitude

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Understanding flight-altitude selection of migrants is of crucial importance in predicting the effects of climate change on migration and in mitigating bird strikes with aircrafts and man-made structures. We tracked the migration, including flight-altitude, in Far-eastern Curlew (*Numenius madagascariensis*) and Whimbrel (*Numenius phaeopus*). We uniquely revealed what drove their flight-altitude selection by testing the effects of wind, humidity, temperature, clouds, and altitude on flight-altitude using conditional logistic regression. We showed that in both species flight-altitude selection depends primarily on altitude itself, birds preferentially flying low and only next showing a preference for tailwind support. Our study confirms earlier hypotheses that birds select flight-altitudes with conditions that favourably impact their energy and water balance. However, contrary to common notion the bird's prioritisation seems to lay with flying low and limiting climbing costs and water loss rather than primarily flying at altitudes that yield most wind support.

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Consequences of a chromosomal inversion on reproductive output of Ruff females

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Chromosomal rearrangements such as inversions can profoundly alter mating behavior and reproductive fitness. However, studies relating inversion haplotypes with fitness consequences focused mainly on males and little is known about how they affect the reproductive output of females. In Ruffs, a large autosomal inversion is associated with three male mating morphs. 1) Independents have the ancestral chromosomal arrangement, whereas 2) Faeders and 3) Satellites who engage in alternative reproductive tactics carry distinct inversion haplotypes. We show that in captivity, Faeder females laid fewer eggs and that their offspring had a reduced hatching success compared to Independent or Satellite females. Faeder females laid smaller eggs with a higher concentration of the steroid hormone androstenedione compared to Independent or Satellite females. Yet, we argue that differences in hormone concentrations are unlikely to explain the observed differences in hatching success. Furthermore, egg size did not influence hatching success but affected chick survival: chicks hatched from larger eggs were more likely to survive until fledging than chicks hatched from smaller eggs. Our results suggest that if Faeder females do poorly, ironically Faeder males must have above par fitness. Further, they suggest that the inversion haplotype is more detrimental in Faeder than in Satellite females. Taken together, our results suggest that to understand the persistence of the inversion polymorphism in this species, it is important to study fitness consequences in both sexes.

What fuels shorebird food webs in a pristine mangrove-bordered West African intertidal ecosystem?

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Mangrove forests are productive habitats and major potential exporters of organic matter and nutrients for adjacent habitats, including to intertidal flats. Thus, mangrove productivity may be an important source of energy not only for primary and secondary consumers in these adjacent habitats, but also as a provider of photosynthetic substrate to other primary producers. The Bijagós archipelago, Guinea-Bissau, the second largest mangrove-covered area in Africa, is the third most important area for shorebirds of the EAF during the non-breeding season. There, these shorebirds feed on macrozoobenthos, which in turn, depend on the primary energy sources sustaining the entire food web. Yet, the role of mangrove carbon and other food sources in these shorebird food webs is still poorly understood. Here we use stable isotope analysis and dual stable isotope Bayesian mixing models to compare intertidal flats with and without adjacent mangrove forests in respect to the relative importance of potential primary food sources in sustaining macrozoobenthos. We found that mangrove had the lowest relative contribution to the diet of macrozoobenthos prey, while macroalgae, benthic microalgae and POM (mostly from sediment surface resuspension) were the most important. Our results suggest that these shorebird food webs may rely on a variety of locally produced and more nutritious carbon sources, as opposed to mangrove leaf litter, typically of little nutritional value. Nonetheless, this leaves open the possibility of mangrove forests acting as sources of inorganic dissolved carbon and processed nitrogen on which the algae may feed and subsequently fuel adjacent food webs.

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Morphometry of the Great Knot *Calidris tenuirostris*: sex and age differences

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Age and sex differences in morphometry of Great Knots and timing of migration were studied in 2016–2019 at a major stopover site at the western coast of Kamchatka, Russia. Over 900 Great Knots were caught and measured. Age was determined visually, using colouration and plumage characteristics. Sex was determined by molecular analysis of blood samples. On average, adult females had statistically significantly longer wings than males, and also juvenile females were longer winged than juvenile males. In juveniles, the lengths of the wing, tarsus, bill and head were somewhat shorter than in adult birds. At the same time, no statistically significant differences were found in the length of tarsus and bill both among adult males and females, and among juvenile males and females. There were also no statistically significant differences in head length in juvenile males and females; however, in adults, heads in females were significantly longer than in males. Generalized data on body weight showed that adult females are heavier than adult males, while adult birds are heavier than juveniles, and juvenile females are heavier than juvenile males. The timing of migration differed between the sex and age classes. The obtained results indicate earlier southward migration of adult females than of adult males. Juvenile birds migrate after the peak of the adults, and must still be growing during migration because they differ in size from adult birds. Undoubtedly, the differences in the morphology and migration timing of birds of different ages and sex should affect the characteristics of the ecology of this species.

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Pervasive use of artificial habitats by shorebirds in the Asia-Pacific requires new conservation measures

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Loss and degradation of wetlands has occurred worldwide and is a major cause of population declines in shorebirds that occur along the heavily developed coasts of the East Asian-Australasian Flyway (EAAF). Artificial (i.e. human-made) wetlands, sometimes called "working coastal wetlands" are widespread in the EAAF and known to be used by shorebirds as habitat in some cases. We collated data and expert knowledge to understand the extent and intensity of shorebird use of coastal artificial habitats in non-breeding areas of the EAAF. We found records of 83 species, including all regularly occurring coastal migratory shorebirds, across 176 artificial sites with eight different land uses. Thirty-six species including eleven threatened species occurred in internationally important numbers. However, threatened species were less likely to occur, and larger-bodied, migratory and coastal specialist species less likely to feed, at artificial sites. Abundance, species richness and density varied across artificial habitats, with for example high abundance and richness but low density on salt production sites; high abundance and density on port and power production sites; and, low abundance and richness on aquaculture and agriculture. While preserving and improving the condition of all remaining natural habitats remains a top priority for shorebird conservation in the EAAF, the widespread use of coastal artificial habitats warrants their further integration into conservation frameworks alongside natural wetlands. Salt production sites are cause for particular concern because they support large shorebird aggregations but are often at risk of production cessation and conversion to other land uses.

Does a novel species in the predator guild affect wader nest survival?

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High nest predation pressure by mammalian predators is one of the main direct causes behind current wader population declines in Europe. In recent years, a novel predator species, the Golden Jackal *Canis aureus*, has rapidly increased its range, reaching important wader breeding habitats in Estonia in 2011. An additional predator in the guild can influence existent trophic interactions and therefore affect prey populations, while the direction of such effect can be varied.

To ascertain the effect of the golden jackal on wader nests, we measured nest predation rates over three breeding seasons (2018-2020) in areas where the golden jackal has become common (western coast of mainland Estonia) and where the species has not reached yet (the island of Hiiumaa). Additionally, we used camera traps to identify predator species and to estimate predator densities.

We recorded high nest predation rates in both regions but found no differences in hatching success between areas with and without the Golden Jackal. Therefore, the Golden Jackal does not seem to add additional pressure on wader nests while also not alleviating it. Such results indicate that the Golden Jackal might be outcompeting local predators and occupying their niche.

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Upland rush management increases predation of artificial wader nests

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One frequently advocated strategy to facilitate population recovery of declining European waders is improving vegetation structure through agri-environment schemes (AES). A key example is cutting dense Rush *Juncus* to open the sward and improve foraging and nesting conditions. Empirical evidence for effects on breeding success are, however, unknown – generating a critical knowledge gap as high nest and chick predation rates are key drivers of declines. For waders that nest across a range of sward structures, e.g. Eurasian Curlew *Numenius arquata* and Common Snipe *Gallinago gallinago*, converting denser swards to more open ones may reduce opportunities for nest concealment and thus increase predation risk. Due to the difficulties of locating large numbers of wader nests, we assess rush management impacts on nest predation risk using artificial wader nests in two upland areas of England, using 21 treatment fields in which rush is managed and 22 un-managed control fields. Daily nest predation rates (DPRs) were twice as high in treatment (0.064 day-1) than control fields (0.027 day-1). Within treatment fields, DPRs were twice as high for nests in cut (0.108 day-1) than in uncut rush patches (0.055 day-1). Higher DPRs are driven by shorter and less dense vegetation in cut rush. Our results highlight the need to evaluate all pathways through which AES prescriptions can impact population trends. Studies using real wader nests should test whether AES rush management inadvertently creates an ecological trap by altering vegetation structure, and identify optimal sward structure and configuration of cut and uncut rush patches.

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Agri-environment measures in the Netherlands require improvement to enhance Northern Lapwing *Vanellus vanellus* reproduction

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Relative to other waders breeding in agricultural grasslands in the Netherlands, the population of Northern Lapwings *Vanellus vanellus* long persisted, but is now also showing a steady decline. The Dutch government prioritizes agri-environment schemes to halt the decline of meadow birds, despite limited success in the past decades. A new agri-environment scheme was put in place in 2016 after the reformation of the EU's Common Agricultural Policy. In forty agricultural collectives, which are responsible for agricultural nature management, farmers are implementing ambitious measures including pasture inundation and anti-predator fences to improve conditions for grassland-breeding waders. We set out in one of the richest meadow bird hotspots in the Netherlands to measure the effect of these measures on the reproductive success of Northern Lapwing. We used camera traps and temperature loggers to register daily nest survival and deployed radio transmitters to track chicks and determine their fate. Despite all efforts, we found that the current agri-environment measures fail to raise nest and chick survival of Northern Lapwings to a sustainable level. We hypothesize that the management of temporarily inundated pastures is often inadequate to achieve the desired effect on vegetation structure and found that a range of predators, including Red Fox *Vulpes vulpes*, were still active inside the fenced-off pastures. A thorough iterative process of improving and evaluating agri-environment measures is necessary to increase their effectiveness in halting the decline of grassland-breeding waders.

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Embryonic vocalisations mediate parental defence in shorebirds

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Avian embryos vocalise late in incubation and communicate with parents through the eggshell. Embryonic calling could conceivably evoke more intense parental defence, particularly when thermal conditions require rapid resumption of incubation, and/or render the eggs more vulnerable to detection by predators. Parental defence was experimentally induced by a standardised human (a predator analogue) approach in ground-nesting shorebirds (Red-capped Plovers *Charadrius ruficapillus* and Masked Lapwings *Vanellus miles*) for "vocalising" versus "not vocalising" clutches, accounting for air temperature, egg age and "predator latency" (investigator duration at the nest before departure). For clutches where embryonic vocalisations were present, Red-capped Plover parents were more likely to employ high-intensity displays (e.g. injury-feigning), with warmer temperatures facilitating both an increase in the display intensity and recruitment of both parents (joint defence). For masked lapwings, warmer temperatures were more likely to cause closer parental approaches to the investigator. As predator latency increased, red-capped plover parents were more likely to approach closer. Predator latency was shorter at nests in which defending masked lapwing adults approached more closely and called more frequently, suggesting that lapwings influence investigator behaviour. The presence of embryonic vocalisations, among other factors, may mediate individual components of shorebird defensive strategies in a species-specific fashion.

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Extra-pair paternity in a sequentially polyandrous shorebird: Not just sperm-storage from the previous mate

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In sequentially polyandrous bird species, where only males care for offspring, perform strong mate guarding and engage frequently in within-pair copulations, we expect low frequencies of extra-pair paternity. Second clutches of socially polyandrous females might nevertheless have higher rates of extra-pair paternity, due to stored sperm. We studied a population of Red Phalaropes (*Phalaropus fulicarius*), a non-territorial, sex-role reversed shorebird, with male-only care, in Utqiaġvik, Alaska. We found extra-pair paternity in 11% of 334 nests. We tested the sperm-storage hypothesis by comparing extra-pair paternity in first and second clutches of socially polyandrous females (N = 11). None of the first clutches contained extra-pair young, versus 27% of second clutches. The extra-pair father was the known first social mate of the female in two of three cases. Interestingly, males that re-nested with the same female never lost paternity. Socially polyandrous females often move large distances between breeding attempts. Thus, many clutches laid late in the season may be second clutches. Hence, we also tested the prediction that extra-pair paternity increased over the season, but found no support for such effect. Overall, our study shows that extra-pair paternity is relatively rare in this species and that it can be explained by different processes, including sperm storage from the first social mate.

Global patterns of chick survival in shorebirds

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Ongoing climate change is thought to disrupt trophic relationships, with consequences for complex interspecific interactions, yet the effects of climate change on species interactions are poorly understood. Using a global database of 38,191 nests from 237 populations and 111 species, we found that shorebirds have experienced a worldwide increase in nest predation over the past 70 years. Historically, there existed a latitudinal gradient in nest predation, with the highest rates in the tropics; however, this pattern has been recently reversed in the Northern Hemisphere, most notably in the Arctic. Furthermore, data on chick survival from 159 shorebird populations worldwide follows similar patterns demonstrating declining chick survival in recent decades. This reduced breeding productivity is consistent with ambient temperature alterations and climate-induced shifts in predator-prey relationships: (i) forecasting global consequences for population dynamics of birds and whole ecological communities; (ii) calling for the urgent international cooperation and targeted conservation actions.

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Tracking the annual migration of Long-billed Dowitchers using the ARGOS satellite transmitters

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Long-billed Dowitchers (*Limnodromus scolopaceus*; dowitchers) migrate relatively short distances from their wintering sites in Pacific and Gulf coasts to breeding sites along the NW coasts of Alaska. Because of their low breeding density and seemingly low site fidelity along with a short escape distance, dowitchers are relatively understudied. We deployed 2g Solar Argos PTT-100 satellite transmitters on 48 dowitchers (22 females and 26 males), captured on their nests (N = 27) during June-July of 2019 in Utqiaġvik, Alaska. Almost all tagged birds migrated South in a narrow corridor through the Northwest Territories in Canada and staged in Saskatchewan, Montana, and North Dakota on average for three months (August – October). Birds that reached their wintering ground (N = 39) utilized a relatively small area until they initiated the northward migration around mid-April. Of 29 birds that reached the breeding ground in 2020, five birds (17%) were detected again at the captured site, proving a higher return rate than what is known from field observations (< 1%). We compared the movement trajectories of 48 birds using the Dynamic Time Warping method and found no difference between males vs. females or failed vs. successful breeders. Our study describes the migration ecology of an underappreciated species and further proves that both the return rate and detection probability of the species is low in comparison to other sympatrically-breeding monogamous species.

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Influence of habitat quality and diversity on constrating dynamics of two populations of Eurasian Curlew *Numenius arquata* in western France

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The Eurasian Curlew *Numenius arquata* is largely impacted by agricultural intensification on its breeding grounds. In the department of Deux-Sèvres in western France, two breeding populations are characterized by contrasting dynamics. In the southern area, the number of breeding pairs slightly decreased while in the northern area, they increased continuously over years. Many wheat fields and some dry grasslands are found in the north whereas the landscape in the south is mainly composed of tillages, hay meadows and pastures. This study aims to highlight differences of food availability and quality within the two areas. Sample series of surface living and plant-living invertebrates were carried out during three key stages of the species' breeding cycle with pitfall traps and sweep-net. Dry grasslands in the north were the most favourable habitats in terms of prey availability for adults and overall for chicks during the brood rearing period. Pastures and particularly hay meadows of the south were likely to be favourable when mowing and grazing intensity remained low. Finally, tillages were less favourable because of their low food availability. Therefore, the farmlands of the northern site had higher abundances of invertebrates than the southern site habitats. These differences between both sites should lead to better adult breeding success as well as the best chick survival. However, strong variations within each habitat were observed. The increase of dry grasslands surface in the north and the establishment of adapted agricultural management in the south would be favourable for the conservation of local Curlew populations.

Movement, habitat use, body condition and migration of Semipalmated Sandpipers (*Calidris pusilla*) wintering at the Bancos dos Cajuais (Ceará, Brazil)

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Semipalmated Sandpipers are Arctic breeding shorebirds that migrate to South America during the non-breeding season. Little work has been done to understand body condition and daily movements of Semipalmated Sandpipers on nonbreeding grounds. Our work was conducted at the Bancos dos Cajuais Western Hemisphere Shorebird Reserve Network (WHSRN) site in Northeast Brazil. We captured sandpipers in February and March 2019 and 2020 and attached nanotags to monitor their daily movements using the Motus network. Blood samples were collected to measure plasma triglycerides (an index of fattening rate). We also conducted behavioural observations on foraging birds. We found birds spent similar amounts of time foraging on tidal flats and in salinas, though different foraging modes were used. Sandpipers appeared to have strong site fidelity and moved daily with the tidal cycle. At high tide many used salinas and empty shrimp farm basins, and at low tide used tidal flats. Others appeared to use daylight as an indicator for site use. Plasma triglyceride measures from 2019 show slow weight gain in both February and March, suggesting birds had not started preparing to migrate. We successfully tracked sandpipers to North America during spring migration 2020, detecting 7 on the East Coast of the United States. Many of these departed from our study site in early May and arrived in the United States in late May, suggesting they may have stopped elsewhere to fuel for migration. These data highlight the site's importance and provide insight into daily activities of sandpipers on non-breeding grounds.

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Stopover ecology of adult and juvenile Semipalmated Sandpipers (*Calidris pusilla*) using the Bay of Fundy and other coastal sites

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Semipalmated Sandpipers (*Calidris pusilla*) are Arctic-breeding shorebirds that use stopover sites in Atlantic Canada during their annual fall migration to South America. While activities of adult sandpipers in the Bay of Fundy are well studied, juvenile stopover and migration strategies remain unknown. Other coastal sites in Atlantic Canada have received comparatively little attention. To address this knowledge gap we are studying adult and juvenile Semipalmated Sandpipers in the Bay of Fundy and the Northumberland Strait. Using the Motus Wildlife Tracking System, we tracked adult and juvenile Semipalmated Sandpipers tagged within the Bay of Fundy and Northumberland Strait. We also collected blood samples for analysis of plasma triglyceride levels and diet. We found no difference in stopover duration between adult and juvenile sandpipers. However, there were differences among tagging sites. Birds tagged in the Bay of Fundy remained there, while birds tagged in the Northumberland Strait either remained on the coast or moved into the Bay. Stopover duration was shorter for birds using exclusively coastal sites compared to birds using Bay sites or transferring between them. Juveniles appear to exhibit broader habitat use when compared to adults. Prey availability differed between coastal and Bay sites, but both isotope signatures and plasma triglyceride levels (an index of fattening rate) were similar among tagging locations. These data suggest that Semipalmated Sandpipers show multiple different stopover strategies in Atlantic Canada, all of which allow for successful weight gain. Our results highlight the importance of implementing conservation measures for lesser-known stopover sites in Atlantic Canada.

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Shorebird abundance estimates in interior Alaska

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Interior Alaska, USA, is the least-studied region in Alaska for breeding shorebirds because of challenging accessibility and expectations of low densities and abundances. We estimated lowland and upland shorebird population sizes on 370,420 ha of military lands in interior Alaska boreal forest from May – July 2016 and 2017. We modified the Program for Regional and International Shorebird Monitoring (PRISM) protocol used elsewhere in Alaska and incorporated a probability-based sampling design and dependent double-observer methods. We pooled all lowland shorebird and all upland shorebird observations and estimated abundance using Huggins closed captures models in Program MARK. Estimated abundances of all lowland and upland shorebirds were 42,239 ± 13,431 (SE) and 3,523 ± 494, respectively. The survey area is important for shorebirds in Alaska. We estimate that military lands in interior Alaska support 45,762 ± 13,925 shorebirds, including 7 species of conservation concern. Higher abundance of lowland shorebirds was best explained by lower elevation, lower percent scrub canopy, and higher percent water on plots. Higher abundance of upland shorebirds was best explained by higher elevation and increased distance to wetland. Our modified Arctic PRISM protocol was effective for surveys in the boreal forest and we recommend continued use of method modifications for future shorebird surveys in boreal forests. Identifying baseline abundances of shorebirds using interior Alaska is an important step in monitoring distributional shifts and potential future population declines.

A simple, effective method to census Jack Snipe in winter using thermal imagery

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The UK winter population estimate for Jack Snipe (Lymnocryptes minimus) is almost certainly one of the least reliable figures quoted in ''Population estimates of birds in Great Britain and the United Kingdom'' by Musgrove et al (2013). Jack Snipe is a very difficult species to find and count. It is secretive, produces no sound, and is very well camouflaged in typical marshy vegetation. Over the last four winters (November 2016 to March 2020), we have successfully monitored the numbers of Jack Snipe 'day roosting' on a small patch of habitat –approximately 100m by 100m. We are using modern thermal imagers to find and count Jack Snipe with no need to flush them. Especially under dull conditions we find it very easy to find Jack Snipe and are confident that we are finding the vast majority (probably all) of the birds on site using this equipment. We have successfully tested this at other sites.

We have found that the numbers vary between years; and that numbers vary during the winter months following a reasonably predictable pattern. Maximum numbers at any one time were 41 Jack Snipe. We suggest a methodology to determine a much more meaningful winter population estimate using thermal imagery to derive a 'holding potential' for suitable habitats. We have also used the imager to help catch birds for ringing and this is helping to develop our knowledge of roosting and feeding behaviours

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Evolutionary change and conservatism in breeding vocalizations within a sandpiper clade: Great Knot, Red Knot, and Surfbird

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Nuptial signals of related species can diverge rapidly, but this is not always the case. For example, homologous nuptial displays are recognizable even in shorebird lineages that have been separated for millions of years. We investigated similarities and differences in two nuptial and one non-nuptial (parental "alarm trill", AT) sandpiper displays of breeding Great Knot (*Calidris tenuirostris*), Red Knot (*C. canutus*), and Surfbird (*C. virgata*). On molecular evidence, these species form a clade: (Great Knot (Red Knot + Surfbird)). Aerial displays by males feature two main kinds of call, one that is relatively simple and is repeated rhythmically in series ("rhythmically repeated call", RRC), and a more complex vocalization ("Song"). Parents of both sexes utter ATs, particularly late in incubation or with chicks. RRCs differ strikingly across species. In the Great Knot they are long and pulsed throughout (often >100 pulses per sec); RRCs of the Red Knot and Surfbird are briefer and are tonal, not pulsed, and show only moderate forms of frequency modulation. Song differs between but is most similar between the Great Knot and Surfbird, and comprises complex series of harsh-sounding broadband pulses; Red Knot Song is a simpler combination of tonal elements with varied kinds of frequency modulation. Finally, ATs are distinguishable among species but qualitatively similar across them. In summary, (1) differences in nuptial calls across species are far greater than in non-nuptial ATs, and (2) patterns of similarity are possibly connected with ecological conditions and do not reflect phylogenetic relationships..

TWITTER HANDLE: https://twitter.com/wadersounds

Using network analysis to understand estuary-scale patterns of individual wader movements

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Site connectivity is increasingly recognised as an important consideration for in-situ conservation of biodiversity. Many waders depend on a small number of distinct sites for foraging and roosting, and travel between them through tidal, diel and seasonal cycles. Using a long-term dataset of colour-ring observations of Black-tailed Godwits from the Tagus Estuary in Portugal, we identified and aggregated individuals' local movements, thus creating an estuary-scale network of site use. We then use this network to explore (a) individual consistency in space over time, (b) how network analysis can be used to quantify local and landscape-scale connectivity, and (c) the importance of spatial configuration in explaining site use by Black-tailed Godwits. Finally, we apply this network analysis to assess the potential impact of a proposed international airport in the Tagus Estuary, which is predicted to cause noise disturbance to a subset of the highly-used sites. By considering not only the area affected, but also the movement of individuals to and from that area, we highlight how conventional environmental impact assessment techniques risk drastically underestimating the proportion of the population affected by localised effects of development. While many studies of connectivity depend on recent tracking technology, we demonstrate that historical colour-ring observations can be used for robust analysis of animal movements through a network of sites. These results also show how network analysis can be a powerful tool to quantify connectivity, both for generating biological insights and for application to conservation issues.

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Identifying important areas for breeding waders in Great Britain: Towards targeting conservation management, guiding forest expansion and other land-use changes

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The UK hosts important concentrations of breeding waders, most of which are undergoing significant international declines. Due to the widespread distribution of many breeding waders in the UK, targeting conservation efforts to key areas is essential if they are to be effective. This project aims to develop a toolset that can guide conservation efforts to, and harmful activities away from, key wader hotspots. In particular, it aims to highlight where risks to breeding waders and their habitats are both higher and lower.

This will allow landuse changes such as forestry, to be more effectively planned and regulated to minimise any negative impacts on open habitat breeding waders. It will also enable better prioritisation of resources aimed at maintaining and enhancing wader populations at regional or national levels.
Using breeding wader data collected for the bird atlases in both 1988–91 and 2007–11, and incorporating relevant environmental variables, we have developed a model to predict the abundance of breeding wader species at the 1km square resolution across Britain. This allows us to create an interactive sensitivity 'heatmap' for breeding waders. The applications for the outputs of this project are broad. In this presentation we will look at the initial outputs, identify important landscapes and land uses and discuss their applications and limitations to inform land management and conservation.

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Windchill effects on the foraging rates of estuary overwintering waders

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Ambient temperature influences behaviour of overwintering waders; altering survival, escape flight distances and foraging behaviour. In the case of foraging, it is generally understood that under more adverse conditions, waders will increase their foraging rates to meet higher energetic demands. However, this has rarely been quantified across species within the same habitat.
This talk presents the findings of a quantitative study of diurnal foraging rates of three species of estuarine wader: Eurasian Curlew (*Numenius arquata*), Common Redshank (*Tringa totanus*) and Black-tailed Godwit (*Limosa limosa*). Video recordings of the behaviour of >15 individuals of each species were made on the Humber Estuary over two consecutive winters. The rates of pecks, probes and number of steps were taken from video footage and compared statistically. Results indicate that wader foraging rates differ significantly between sites, as well as with environmental conditions, namely windspeed, air temperature, and windchill. Further data collection will broaden the scope of this study and address remaining uncertainties about the impacts of weather conditions, as well as contrasting diurnal and nocturnal behaviour. This project has implications for conservation of waders at different sites on the Humber Estuary, and provides vital data about the potential future impacts of climate change.

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Temporal and Spatial Migration Patterns of Eurasian Curlews (*Numenius arquata*) in the NE Atlantic Region Assessed with GPS-dataloggers

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Eurasian Curlews (*Numenius arquata*) are migratory shorebirds that winter on the northeast Atlantic coast and breed from Spain and Ireland to the Ural Mountains and Arctic Polar Circle. Their four-stage annual cycle includes spring migration, breeding, autumn migration, and wintering. Due to the wide range of this species, this study compiles a large dataset across several countries to compare migration patterns in different sub-populations. We tagged 86 adult Curlews with GPS-dataloggers across six organizations in four countries (Germany, Poland, France, and Estonia) between 2013 and 2019. For a total of 177 migration tracks, we computed the distance flown, linear distance, duration, stopover number, total stopover duration and mean stopover duration. Curlews displayed chain migration because birds tagged further south did not travel as far north as birds tagged in the north. Furthermore, there was no difference in migration duration across the sub-populations. However, birds breeding further south started their spring migration earlier and spent more time in their breeding areas. The flown distance that was travelled by the birds did not deviate largely from the linear distance, indicating that Curlews selected a very straight route, independent of topography and weather conditions. There was no significant difference in duration or distance between autumn and spring migration. This suggests that Curlews tend to arrive early at their wintering site. Given the high level of site faithfulness in Curlews, this rapid autumn migration might enable birds to defend their foraging areas in their wintering sites where they actually spend most of their lifetime.

Tracking Red Knots in the East Asian-Australasian Flyway

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Red Knots *Calidris canutus* are a textbook example of a migratory species that makes long migrations with only a few stops. However, such behaviours are not necessarily species-specific and will be determined by ecological context. To fill a gap in the description of the migrations of different subspecies of Red Knots, we studied a relatively recently described subspecies (*piersmai*). Based on data from the tagging of Red Knots with 4.5 g and 2.5 g solar-powered Platform Terminal Transmitters (PTTs) and 1.0 g geolocators on the nonbreeding grounds in NW Australia, we obtained information on 17 tracks in 16 individuals, of which six tracks described complete return migrations. We confirm that *piersmai*-knots from NW Australia breed on the New Siberian Islands and that they stage along the coasts of eastern Asia, especially in China. Red Knots arrived on the tundra breeding grounds from 8 June. Southward departures mainly occurred in the last week of July and the first of August. We documented six non-stop flights of over ca. 5000 km (with a maximum of 6500 km, lasting 6.6 days). Nevertheless, rather than staging during migration at a single location for multiple weeks, *piersmai*-knots made several stops of up to a week. This was especially evident during northward migration, when birds often stopped along the way and 'hugged' the coast of China, resulting in detours of 1000-1500 km compared with a direct, great circle route, flight between NW Australia and the Yellow Sea. Staging longest along the shores of northern Bohai Bay and upper Liaoning Bay, coastal stopping sites in China were characterized by the presence of the bivalve *Potamocorbula laevis*, known as a particularly suitable food for Red Knots. This atypical pattern (among subspecies of Red Knot) of the use of multiple, probably food-rich, stopping sites during migration in *piersmai*, a subspecies in decline, indicates that the

apparent availability of multiple suitable staging areas did not prevent elevated mortality away from the NW Australian 'wintering' grounds over the past decade and a half.

TWITTER HANDLE: https://twitter.com/globalflyway

Migratory routes of Kentish Plovers revealed by geolocators

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Understanding the migratory movements and habitats used during the annual cycle of waders is essential to developing broad conservation strategies. In Europe, Kentish Plover (*Charadrius alexandrinus*) breeding populations have declined or disappeared in many coastal regions and little is known about the migratory ecology of this short-distance migrant. We used light-level geolocators to describe the first direct estimates of migration routes and wintering areas of Kentish Plovers breeding in coastal saltpans from south-west Portugal. During the breeding season of 2018, we deployed geolocators to 50 Kentish plovers and recovered eight during 2019 and six more in 2020. We present the first results on migratory strategies of 8 males and 6 females.

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Polyandry and senescence shape egg size variation in a precocial bird

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Identifying age-dependent trade-offs between reproductive effort and survival in wild organisms is central for understanding the evolutionary mechanisms of senescence. According to the disposable soma theory, early-life energy investments in reproduction compromise late-life investments in somatic maintenance – leading to senescence. However, some reproductive traits that are used to quantify senescence may also be shaped by other age-dependent processes such as mating tactics. For instance, polygamy, which is often positively associated with age, may lead to reduced gamete size due to trade-offs between gamete quantity and quality. Here we investigate how mating behaviour and senescence are associated with reproductive trade-offs of female Snowy Plovers (*Charadrius nivosus*). Snowy Plovers are long-lived shorebirds (longevity record: 19 years) that produce several nests each year, with females either being polyandrous and sequentially changing partners between breeding attempts or remaining monogamous between attempts. We examined how age, seasonality, and mating tactics affect within-female variation in egg volume using repeated measures collected over a 14-year period. Our results provide clear evidence for senescence in Snowy Plover females starting at three years of age. Furthermore, females laid smaller eggs in years when they were polyandrous compared to years when they were monogamous, with early- and late-season clutches having the smallest eggs. We suggest that individual female reproductive performance is regulated by flexible mating tactics and age- and season-dependent effects. Our findings highlight the existence of multiple trade-offs for female reproductive investments that likely shape individual variation in lifetime reproductive success.

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Migrating Curlews on schedule: Departure and arrival patterns depend on time rather than on wind conditions

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The right time to depart for spring migration is crucial for a subsequent successful breeding season. We investigated departure and arrival patterns in European Curlews (*Numenius arquata*) wintering in high numbers in the eastern Wadden Sea. We equipped 23 Curlews with GPS data loggers to record spatio-temporal patterns of their departure from and arrival at the Wadden Sea as well as migration across the Baltic Sea. In total, we received data on 41 Curlew migrations over a period of six years. Flight speeds of birds were highly correlated with tail wind component suggesting that birds time their migration according to favourable wind conditions.

Curlews left the Wadden Sea between early April and mid-May. While there was no difference among sexes in departure, males tended to return later from their breeding sites. Curlews breeding further away from the Wadden Sea departed significantly later than individuals breeding closer by. Curlews left the Wadden Sea during all kind of wind conditions and significant numbers also left during head wind conditions, contradicting the assumption of a wind-driven start of migration. However, during head wind conditions, Curlews tended to fly in altitudes of up to several kilometres while they migrated in very low altitudes during tail-wind conditions. Individual Curlews that were tagged over consecutive years showed a variation of only around 4 days in their departure dates. This suggests that start of Curlew migration depends on day of the year rather than on favourable wind conditions.

Separating first-winter Icelandic and British Redshank highlights differential productivity dynamics in a mixed wintering population

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Two races of Redshank winter in Britain; resident *Tringa totanus totanus* and Icelandic *T. t. robusta*. We investigated indices of body condition, population and productivity trends in the two races of Redshank, using long-term ringing data from cannon-net catches taken on Lavan Sands, North Wales between 1973 and 2015. Biometric data from birds measured in both their first winter and on recapture as adults was used to calculate a juvenile-adult wing length change factor. Using this correction, adult and first-winter Redshank were assigned to races using a discriminant function on corrected wing length, bill and tarsus-and-toe. Population productivity was calculated as the ratio of adult to first-winter birds of each race, and compared over time using Pearsons and Spearmans rank correlation.

More Icelandic than British Redshank winter on Lavan Sands, and the proportion of *T.t. robusta* has increased over time. During the 20-year period from 1980 to 2000, British adults declined and Icelandic first-winter birds increased. The ratio of the two races remained stable from 2001 to 2015. Productivity in the two races was more closely correlated (94%) between 2001 and 2015 than between 1980 and 2000 (60%). Body condition (transformed residual bodyweight) of British Redshank was negatively correlated with population productivity in the following year.

Correcting wing length for the difference between juvenile and adult remiges permits race identification in first-winter Redshank, with useful applications in understanding differential population dynamics in mixed wintering populations. We present some hypotheses for drivers of change in Iceland.

TWITTER HANDLE: https://twitter.com/fidhw

When theory meets reality: making the best use of field surveys for monitoring breeding Eurasian Curlew

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Demographic modelling is routinely used to provide estimates of minimum productivity required for population stability for many species, but what does this theoretical number mean in the real world? Recent demographic modelling work uses annual survival and lifespan measures from long-term ringing studies to calculate the number of chicks required per year to stabilise the adult populations, but these figures do not scale down to nest level because of a number of unknowns in breeding season monitoring data. We can define conservation challenges through matching demographic models to national trend indices, but associating these with field data provides better confidence in how individuals might be contributing to productivity.

For the rapidly declining Curlew population (European Curlew (*Numenius arquata*), many stakeholders are involved in breeding season monitoring, providing a range of metrics not directly interchangeable with a population productivity measure. We describe the demographic detail of a breeding Curlew population, and link field methods to demographic parameters to better understand both what we are confident we know but also what we might be able to measure better.

A better understanding of population breeding metrics could improve the targeting of field effort towards collecting critical field data for conservation monitoring; close critical gaps in our knowledge of productivity and better support higher level modelling. This presentation presents our planned approach alongside known gaps in both our understanding and in the data currently collected in the field.

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Modelling population impacts of disturbance on wintering oystercatchers

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Wildlife in natural areas is increasingly pressured by anthropogenic activities. Although it is often clear that wildlife responds to human presence (e.g. flight responses), it is challenging to quantify the impacts of disturbance at a population level. Over the last few years, we intensively studied disturbance frequencies and disturbance responses of wintering Eurasian Oystercatchers (*Haematopus ostralegus*) in the Dutch Wadden Sea. Oystercatchers are, however, long-lived, meaning that it is difficult to measure impacts of disturbance on survival in the field. We therefore now implement the frequencies and effects of disturbances in an individual based model, to determine whether disturbance affects oystercatchers at a population level. The model simulates a population of wintering oystercatchers over a complete winter season, and follows each individual in a landscape that consists of patches with food resources. The model is based on similar simulation models that were previously developed also for shorebirds: MORPH and WEBTICS. The food landscape is based on shellfish surveys and bathymetry. Time progresses in 30 minute time steps, during which realistic weather and tidal conditions are simulated. Foragers, representing wintering oystercatchers, have a unique set of individual characteristics, including age, sex and feeding efficiency. Oystercatchers in the model need to forage sufficiently to meet their energy requirements and survive. Three effects of disturbance are implemented: (1) Energetic costs due to flight, (2) reduced available foraging time and (3) reduced available area. Several disturbance scenarios are simulated (e.g. few large disturbances vs many small disturbances) to quantify their impact on oystercatcher winter survival.

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Waders (Aves: Charadriiformes) along the Black Sea/Mediterranean Flyway: their Time Budget and Trophic Relations on a Sand Shore on the Bulgarian Black Sea Coast

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In the last two decades Bulgarian ethological research is in continuous progress – in the field as well as in laboratory experiments. Waders are in local ornithologists' spotlight, but ecological publications are still scarce. With our work we would like to contribute to both Bulgarian behavioural ecology and shorebird science. As part of the Black Sea/Mediterranean Flyway, the Bulgarian coast shelters some 35+ species of waders in several stopover sites. We combine field behavioural research with potential food resources available on Pomorie Lake sand shoreline during migration. At this stage, we are looking for: 1) Wader species encountered on the habitat; 2) Their potential food resource; 3) Their time management during daylight; 4) Any regular patterns in their foraging, since there are no tides; 5) Exceptional events which can create foraging opportunism among these birds; 6) Seasonal variations in the species composition (waders and invertebrates respectively). To explore these questions, from March to April and August to October we collected macrozoobenthos and terrestrial invertebrate samples from the substrate. Our "stars" behaviour was video registered, to be analysed at a later stage. We expected eight species of waders on the territory, but encountered 10 so far: Little Ringed Plover *Charadrius dubius*, Kentish Plover *Ch. alexandrinus*, Sanderling *Calidris alba*, Dunlin *C. alpina*, Ruff *C. pugnax*, Ruddy Turnstone *Arenaria interpres*, Grey Plover *Pluvialis squatarola*, Eurasian Oystercatcher *Haematopus ostralegus*, Common Sandpiper *Actitis hypoleucos* and Whimbrel *Numenius phaeopus*. Here we share our first year experience (from 2019) and pose some methodological and research design questions.

Space use and habitat selection decisions of Black Oystercatchers across tidal, diel and annual cycles

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The Pacific coast of Canada is predicted to see a 7-fold increase of industrial marine traffic over the next decade that will pose a risk to coastal ecosystems and a diversity of wildlife. Effective planning to mitigate this risk requires baseline information on the habitat use of wildlife that occupy each coastal ecosystem. We investigated the space-use and dynamic habitat selection of the Black Oystercatcher, an intertidal obligate predator which is considered an indicator of rocky shoreline health. We asked how space-use varied across the year and whether the features driving habitat selection shifted over time using data from 20 adult oystercatchers equipped with solar satellite tags. Annual space-use varied enormously (5-1193 km^2) by individual but each utilized a small proportion of shoreline within this area (8-63%), such that individuals used a similar length of shoreline over a year (6-13 km). Population level shoreline selection changed across diel, tidal and seasonal cycles with covariates linked to predation risk (distance from treeline, islet size) driving selection at night and covariates linked to food availability (distance from stream outflow) driving movement decisions during the day at low tide. Individuals returned to particular sites far more than others indicating point locations were not independent and using the Recurse package in R allows the analysis of these complex spatio-temporal patterns inherent to habitat selection decisions. Using this technique, we explore how environmental variables influence the relative use of islets and estuaries by an individual over the course of a year.

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