

Current ornithological research in Ireland: seventh Ornithological Research Conference, UCC, November 2017

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Introduction

This is the seventh conference on Irish ornithology to be held at University College Cork, since the first in 1985. All researchers working on Irish ornithology have been invited to submit a brief abstract of their current work for each conference, and the number submitted has ranged from 98 in 1985 to 159 in 1997 (Figure 1). The focus of the research topics has evolved over the years and this year there is a particular concentration of effort on waterbirds, seabirds, farmland birds, birds of prey and owls.

During the period that this conference has been held the projects presented have showcased both the basic and applied research that is being undertaken on avian biology, with a wide range of funding sources (volunteer and self-funded, non-government organisations, state agencies,

university or industry). The research knowledge shared during these events is derived from work that has been carried out by volunteers, members of conservation organisations or groups of people with a deep interest in understanding our bird populations and by researchers who are funded by agencies and bodies such as the European Research Council, Science Foundation Ireland, National Parks and Wildlife Service, Department of Agriculture, Food and the Marine or the Irish Research Council. Over the years we have seen a welcome and increasing trend in collaborations occurring both between Irish ornithologists and with researchers from other countries. As wildlife (birds in particular) is not bounded by political territories but often transcend the borders of many countries and open seas this is an important development.

It is important that the results of scientific enquiry are utilised and made available through appropriate channels, such as peer-reviewed journals and institutional reports, whenever possible. Thus we examined the number of abstracts submitted for the previous conference in this series (2013) to see what proportion had led to peer-reviewed publications in scientific journal or reports. We determined that as many as 35% of submissions have led to at least one publication, although in some cases the particular project described led to multiple publications. This publication rate should be viewed against the backdrop that many projects reported at that conference are part of long-term monitoring programmes, which do not lend themselves to rapid publication. However, this long-term work is particularly valuable as these studies provide key insights into environmental change, species ecology, biodiversity conservation and natural resource management.

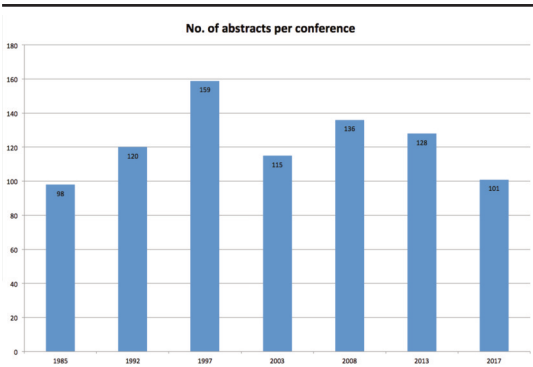


Figure 1. Number of abstracts submitted for each conference, 1985-2017.

A number of ongoing projects have now been running for twenty years or more (e.g. Irish Wetland Bird Survey (I-WeBS), Countryside Bird Survey (CBS)) and are building data sets that will continue to gain considerably in scientific value over time. Projects on terns (Sternidae), Kittiwakes *Rissa tridactyla*, Great Cormorants *Phalacrocorax carbo*, Fulmars *Fulmarus glacialis*, Black Guillemots *Cepphus grylle*, Whooper Swans *Cygnus cygnus*, Greenland White-fronted Geese *Anser albifrons flavirostris*, Barnacle Geese *Branta leucopsis*, Brent Geese *Branta bernicla brota* and Dippers *Cinclus cinclus* (among others) have been ongoing for many decades, some even since the early 1960s. These projects are typically run by dedicated individuals or small teams working for conservation organisations, government agencies and universities, but with some working privately and unsupported. An increasing number of organisations are also embracing networked science, where field teams are comprised of volunteers or 'citizen scientists'. The increasing importance of citizen science in gathering data for projects such as I-WeBS and CBS (BirdWatch Ireland & National Parks and Wildlife Service) and in submitting records to websites (e.g. National Biodiversity Data Centre) should not be underestimated.

In the same way, the many birdwatchers submitting records of rare birds at coastal headlands and at bird observatories and especially sea-watchers and those who go to sea to record and study birds, are adding new knowledge on species distributions and on likely new colonists. As changes in climate or environmental disturbance cause shifts in species distributions, these records provide key data which allow us to understand how biodiversity is responding to human-driven changes at a local and global scale. Along with conferences held by the British Trust for Ornithology, the Irish and Northern Ireland Raptor Study Groups, and BirdWatch Ireland and Royal Society for the Protection of Birds (Northern Ireland), the UCC ornithological research conferences have been an important showcase for Irish ornithology, and have led to a valuable published record of ongoing research and lasting networks and collaborations. We look forward to supporting this into the future.

The use of beached bird surveys for marine plastic litter monitoring in Ireland

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Seabirds are highly susceptible to entanglement and ingestion of litter at sea. Governments all around the world are being urged to monitor litter sources and inputs, and to mitigate

the impacts of marine litter, which is primarily composed of plastics. The aim of this research is to investigate the feasibility of using Northern Fulmars *Fulmarus glacialis* and/or other potentially useful species of seabirds as indicators for floating marine debris in Ireland. From the inception of the project to date (45 months), 226 birds comprising 20 different species have been collected and subsequently investigated. The research has evolved from relying on beached birds to investigating availability of birds at seabird colonies during the breeding season. As a result, of the 226 individuals examined, 157 were beached and 69 were collected at colonies during fieldwork, or by wardens. In total, 19% ($n = 43$) of 14 different species were found to have ingested litter, mainly plastics. Ninety-three percent ($n = 16$) of Northern Fulmars sampled had ingested litter. When comparing beached versus colony collected birds; for beached birds (19 species, 157 individuals) 22.9% ($n = 36$) had ingested plastic litter. The average mass was 0.1944 g and the average number of plastic pieces was 6.4. In birds collected at breeding colonies (11 species, 69 individuals) 10.1% ($n = 7$) had ingested plastic litter. The average mass was 0.004 g and the average number of plastic pieces was 1.04. These preliminary results show that multispecies of seabirds in Ireland are ingesting marine litter, mainly plastics, as in many other countries in the world. Monitoring seabird litter ingestion has the potential to form part of a wider marine litter monitoring programme that can help to inform mitigation and management measures for marine litter.

(*Marine Environmental Research* 120: 122-129; *Marine Pollution Bulletin* 117: 512-514, 120: 171-174)

Quantifying the effects of human disturbance on breeding Northern Gannets *Morus bassanus* in the presence and absence of regulatory signs

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Anthropogenic disturbance to wildlife is on the rise. With clear evidence this can be detrimental, it is imperative to identify effects and impacts over the short- and long-term. Nesting birds can be particularly vulnerable when located at sites experiencing heavy tourist footfall, and impacts including increased egg predation, increased chick mortality, reduced nestling feeding rates, site abandonment, and complete failure to breed, have been shown to result. The focal species here is a colonial, cliff-nesting bird, the Northern Gannet *Morus bassanus* in an Irish island colony. Visitor behaviour was monitored throughout the 2017 breeding season in relation

to displacement of breeding and prospecting birds within the colony. Interpretation, in the form of an advisory sign, was erected to establish effectiveness at modifying visitor behaviour and reducing disturbance effects. Numbers of birds displaced per sample period was correlated negatively with minimum approach distance, and significantly higher numbers were displaced on advancement closer than a metre. With a sign in place, visitor proximity to the colony decreased significantly. This in turn resulted in fewer birds being displaced, and the effect was significant for breeders. Different sections of the sample group, and a second, undisturbed control group, were also monitored for nest predation and eventual nest success. The mean number of chicks fledged per nest was significantly higher at the back of the sample group (further away from disturbance), and also in the control as compared with the sample. This evidence strongly suggests that humans can have a profound impact on seabird colonies and, with many species in decline, it is vital that measures are put in place to prevent active disturbance. This study shows that simple management techniques can be hugely beneficial, and that interpretation at Great Saltee (Wexford) could practically eliminate the flushing of breeding birds from nests by over-eager visitors.

Passive acoustic monitoring of burrow-nesting seabirds: a quick fix for unknown burrow occupancy

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Monitoring burrow-nesting seabirds is a major challenge compared to many other seabird species. Current methods use tape-playback at burrows to determine occupancy, but this is a laborious process. Consequently, these populations are poorly quantified and no definitive monitoring strategy has been proposed for many of them. Several previous studies have used passive acoustic monitoring to determine presence or absence, or to quantify burrow-nesting populations in remote areas and following predator eradications. We compared passive acoustic monitoring methods with tape playback methods to determine the validity of using passive acoustics as a census method for Manx Shearwater *Puffinus puffinus* monitoring, a nocturnal, burrow-nesting species breeding on the west coast of Ireland. Twelve study plots were established on High Island off the west coast of Ireland (Galway), and variation in vocalisation rates was examined in relation to time of day, breeding stage, wind speed, wind direction, moon illumination and precipitation. Wind speed and moon illumination had the most significant effect on acoustic activity, with a negative relationship associated with

each. However, we found that although study plots differed in known density from the playback surveys, there was no relationship between vocalisation rates and the density of breeding birds in the plot. Comparison of acoustic detections and concurrent telemetry data highlighted a positive correlation ($\rho = 0.4895$, $P = 0.109$) between acoustic activity and the number of times GPS tracks intersected the acoustic study plots. This suggests that in-colony flight is the driving factor of the acoustic soundscape, not the density of breeding birds in an area, and thus acoustic monitoring is not an effective census method for this species.

Waterfowl numbers, usage and distribution on the River Shannon and River Fergus estuaries

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As part of the Strategic Integrated Framework Plan (SIFP) for the Shannon Estuary, McCarthy Keville O'Sullivan have been contracted to carry out a bird usage survey of the River Shannon and River Fergus estuaries Special Protection Area (SPA). The gathering of such data contributes to the establishment of 'an evidence-based approach to identifying areas for future development, to ensure proposals will work in harmony with the designated Natura 2000 sites', which is one of the stated objectives of the plan. This is a complete survey of the waterbirds of the estuaries, the most important coastal wetland habitat in the country, regularly supporting in excess of 50,000 waterfowl. Eleven counts of the estuary are being undertaken over a 12-month period with each of these counts utilising 15 surveyors and taking place over a two-day period. Surveys commenced in May 2017 and will be complete in April 2018. As well as giving total numbers of each species occurring within the SPA, data is analysed to show how waterbirds are distributed across the estuaries and areas that are important for roosting and foraging are identified for each species with broad habitat types being mapped alongside sub-site boundaries. The relative density of waterfowl on intertidal habitat is calculated per km². Dot density maps are used to represent the distribution of species across the Shannon-Fergus estuary area and across four main tidal habitat types. Flock mapping is analysed to determine the location and behaviour of large flocks of species of interest throughout the estuary. This is provided on GIS maps to determine the relative importance of sections of the estuary for each species. This is an ongoing project and we look forward to sharing early findings and discussing methodology, aims and the practicalities of such a large-scale survey.

Farming for Hen Harriers *Circus cyaneus* in the south west of Ireland

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IRD Duhallow's RaptorLIFE is an EU funded Life+ project whose main objective is to help restore the population of Hen Harrier *Circus cyaneus* in the south west of Ireland. Much of the project area is designated as part of the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle Special Protection Area (SPA) under the EU Birds Directive. This SPA is one of the most important Hen Harrier SPAs in Ireland and at the time of designation held 29% of the national population. However, the population within this SPA has declined by 38% since 2005, over twice the average national rate of decline. Hen Harriers are largely dependent on the type of habitat created through traditional farming practises in upland areas. RaptorLIFE are implementing a range of conservation actions to improve nesting and foraging habitat within the SPA. The bulk of the actions are undertaken on six pilot farms that collectively cover an area of 300 hectares. The habitats include cutover blanket bog, dry and wet heath, rough grassland with >50% rush cover, dry calcareous and neutral grassland, mosaic grassland, improved grassland, and conifer plantation. The conservation actions include heather regeneration through controlled burning and mowing, rush control, improvement of existing hedgerows, removal of wilding conifers, and the control of invasive plant species. Small mammal trapping and farm bird surveys undertaken throughout the project will provide quantifiable data on the densities of potential prey items pre- and post-treatment. Outside the pilot farms, RaptorLIFE are working with Coillte and the Forest Service to create a riparian foraging corridor, free of conifers, which will connect the SPA with the River Blackwater (Cork/Waterford) SAC at the Source of the Blackwater. The lessons learnt from these initiatives will be incorporated into a conservation action plan for the SPA, to be written in collaboration with statutory authorities and interested parties.

The first GPS tracking of Atlantic Puffins *Fratercula arctica* in Ireland reveals a novel form of foraging

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Under optimal foraging theory, an animal aims to gain the most benefit (energy) for the lowest cost. In marine systems,

where prey distribution is patchy, seabirds often travel large distances between prey patches. Previous seabird tracking studies have found that Lévy walks can optimize search efficiencies interspersing short and longer steps, reducing the energetic cost of foraging. Here we present preliminary results from the first GPS tracking of Puffins *Fratercula arctica* in Ireland, suggesting an alternative foraging strategy consistent with optimal foraging theory. Nine breeding Puffins were tracked using a combination of GPS and dive loggers from Little Saltee, County Wexford during May and June 2017. Puffins travelled an average of 16.6 \pm 7.1 km to foraging grounds south of the breeding colony at an average speed of 20.8 km per hour. Upon arrival at foraging grounds, birds significantly decreased speed and undertook straight-line travel in either easterly or westerly directions. These slow speeds were considered too slow (mean 2.6 km per hour) for powered flight in a seabird with particularly high wing-loading, but were consistent with drifting on tidal currents. Directed linear travel periods lasted for an average of five hours and fifty-two minutes, equivalent to half a tidal cycle, and abrupt changes in direction correlated with slack tide where flow direction reverses. Concurrently deployed dive loggers showed regular foraging dives throughout the drift period to an average dive depth of 16.2 \pm 3.5 m (maximum dive depth of 23.37 m). We hypothesize that drifting with tidal currents maximises prey encounter rates by moving birds across patchily distributed prey, while removing energy expenditure for travel. This novel use of tidal flows is previously unreported in Puffins and seabirds in general, and represents an interesting behavioural adaptation conforming to optimal foraging theory.

Repeatable measures of oxidative balance affect survival but not reproduction in a long-distance migrant

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Physiological processes, including those that disrupt oxidative balance, have been proposed as key to an understanding of fundamental life history trade-offs. However, analyses in wild systems are still relatively sparse, yet this natural context is crucial for determining the importance of these interactions. In particular, it is essential to establish the repeatability of measures of oxidative balance within individuals across time and space – including major life history challenges – and to relate these measures to important fitness consequences. Here we examine the repeatability of commonly used measures of oxidative balance within a large cohort of a long-

distance migrant, the Brent Goose *Branta bernicla brota*. We then examine the consequences of these physiological measures for both survival and reproductive success. We find high repeatability in measures of lipid peroxidation (damage) and circulating non-enzymatic antioxidants, demonstrating that single measures of oxidative balance can be informative in a long-distance migratory organism. Higher levels of damage and lower levels of antioxidants predicted survival of individuals, but no measured metric of oxidative balance was associated with reproductive success. Our finding of an important negative relationship between oxidative damage and survival suggests a potential oxidative cost to migration, and highlights the need to investigate such relationships in other species undergoing similar challenging lifecycles.

The Dublin Bay Birds Project (DBBP)

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Dublin Bay is one of the top ten most important sites for wintering waterbirds in Ireland since national-scale monitoring of waterbirds began in the 1970s. Its location – adjacent to the capital city of Ireland – means it is subject to human-related pressures. In order to adequately assess potential impacts, up-to-date information on how birds use the bay is vital. Since its initiation in 2013, the Dublin Bay Birds Project (DBBP) has gathered detailed information about how waterbirds use Dublin Bay for roosting and foraging, at all tidal states, both diurnally and nocturnally. The project has also carried out a programme of monitoring of the breeding tern colonies within the Dublin Port area. The programme of work carried out by the DBBP has thus far included (with selected results from 2013–2016 in parentheses): (1) year-round waterbird counts – one low-tide and one rising-tide per month (totals of ~40,000 at low-tide; <30,000 at rising-tide); (2) annual dusk gull roost surveys (peak of 29,564 gulls, 2014); (3) all-day focussed observations of waterbirds in the Dublin Port area; (4) monitoring of Common Tern *Sterna hirundo* and Arctic Tern *Sterna paradisaea* colonies in Dublin Port (peak count of 548 nests, 2015); (5) ringing of Common and Arctic Tern chicks in Dublin Port (1,364 terns metal-ringed, 380 colour-ringed); (6) surveys of post-breeding tern aggregations (peak of 17,440 in 2016); (7) a programme of wintering wader ringing (over 2,200 birds of 13 species metal-ringed; colour-rings fitted to 376 Oystercatcher *Haematopus ostralegus*, 99 Bar-tailed Godwit *Limosa lapponica*, 41 Redshank *Tringa totanus*); (8) post-breeding tern ringing (232 metal-ringed; 173 colour-ringed); (9) radio-tracking (Oystercatcher, Bar-tailed Godwit, Redshank) and GPS-tracking (Oystercatcher, Redshank, Curlew *Numenius*

arquata). The DBBP also facilitated the initiation of a Ph.D. at University College Cork which was designed to examine how waterbirds use Dublin Bay, and the effects on waterbirds of human-related activities.

Irish Wetland Bird Survey 1994/95–2014/15

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The Irish Wetland Bird Survey (I-WeBS) is the national scheme for monitoring wintering waterbird populations and their wetland sites over time. It is a joint project of BirdWatch Ireland and the National Parks and Wildlife Service. It has been running since 1994/95 and follows on from two earlier wetland surveys (1971–74 and 1984–86). Each year, in excess of 250 wetland sites are surveyed nationwide between September and March by survey participants. The survey facilitates several key functions, including an assessment of wetland site status, providing the justification for the designation of more than 90 wetlands as Special Protection Areas for wintering waterbirds. It also delivers the ongoing status of 43 waterbird species in Ireland, and the production of population estimates on a regular basis which are used to evaluate the importance of sites nationally and internationally. Based on the most recent five-season period (2010/11–2014/15), a total of 33 internationally important and 93 nationally important wetland sites were identified. The trends of 43 species were measured for the period 1994/95 to 2014/15 and ten species showed increasing trends with greatest increases seen in Little Egret *Egretta garzetta*, Barnacle Goose *Branta leucopsis*, Sanderling *Calidris alba*, Great Northern Diver *Gavia immer* and Light-bellied Brent Goose *Branta bernicla brota*. Declines of 2% or more per year were recorded for eleven species, and were greatest for Bewick's Swan *Cygnus columbianus bewickii*, Scaup *Anas marila*, Pochard *Aythya farina*, Lapwing *Vanellus vanellus*, Dunlin *Calidria alpina*, Golden Plover *Charadrius apricaria* and Grey Plover *Pluvialis squatarola*. An assessment of short-term trends for the period 2009/10 to 2014/15 showed greatest increases in Red-throated Diver *Gavia stellata*, Greenshank *Tringa nebularia* and Bar-tailed Godwit *Limosa lapponica*, while the greatest short-term declines occurred in Pochard, Scaup and Coot *Fulica atra*.

Preliminary assessment of the scope and scale of illegal killing and taking of birds in Europe: the Irish case

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The illegal killing and taking of wild birds remains a major threat on a global scale. However, there are few quantitative data on the species affected and countries involved. The scale and scope of this issue was quantified in European countries and territories between 2014 and 2017, using a diverse range of data sources and incorporating expert knowledge. The issue was reported to be widespread across the region and affects almost all countries and territories assessed. In total, 7-17 million birds per year may be killed and taken illegally in Europe, of which 100-6,300 birds relate to Ireland. Estimates for Ireland were based on informed expert opinion and some quantitative data for raptor species. The mean estimate of birds illegally killed and taken per year per km² in Ireland (0.04) was lower than for most countries and territories assessed. All 44 countries assessed are parties to the Bern Convention and 28 are EU Member States. There are specific initiatives under both these policy instruments to tackle this threat, yet the data showed that illegal killing and taking of birds is still occurring throughout Europe. Markedly increased effort is therefore required to ensure that existing legislation is adequately implemented and enforced. The legislation in Ireland is robust, however enforcement remains an issue. This study also highlighted the paucity of data on illegal killing and taking of birds, including in Ireland, affecting the quality of estimates. It is therefore a priority to implement systematic monitoring of illegal killing and taking and to collate robust data, allowing stakeholders to set priorities, track trends and monitor the effectiveness of responses. In Ireland, collection of systematic data for all bird species (not only raptors) should increase robustness of estimates and allow measure of trends in illegal activities, and better law enforcement should help to underpin efforts to tackle this issue.

Illegal killing and taking of birds in Europe: assessing the scope and scale of a complex issue

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The illegal killing and taking of wild birds remains a major threat on a global scale. However, there are few quantitative data on the species affected and countries involved. We quantified the scale and scope of this issue in Northern and Central Europe and the Caucasus, using a diverse range of data sources and incorporating expert knowledge. The issue was reported to be widespread across the region and affects almost all countries and/or territories assessed. We estimated that 0.4-2.1 million birds per year may be killed or taken illegally in the region. This result is largely driven by a high estimate in Azerbaijan (0.2-1.0 million birds per year). Out of the 20 worst locations identified, 13 were in the Caucasus. In Ireland, 100-6,300 birds were estimated to be killed or taken illegally each year based on informed expert opinion and some quantitative data for raptor species (RAPTOR reports). The mean estimate of birds killed or taken illegally per year per km² in Ireland (0.04) was lower than for most countries assessed. Lack of evidence and recording of the scale of illegal killing affects the quality of estimates, and the trend in scale of killing or taking illegally in Ireland is unknown. All 29 countries and/or territories assessed are parties to the Bern Convention and 19 are EU Member States. There are specific initiatives under both these policy instruments to tackle this threat, yet our data showed that illegal killing and taking is still occurring throughout Europe. Markedly increased effort is required to ensure that existing legislation is adequately implemented and enforced. Our study also highlighted the paucity of data on illegal killing and taking of birds, including in Ireland. It is a priority to implement systematic monitoring of illegal killing and taking and to collate robust data, allowing stakeholders to set priorities, track trends and monitor the effectiveness of responses.

Survival and causes of mortality among radio-tracked Lapwing *Vanellus vanellus* chicks

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Over a period of two years, 2014-2015, a radio-tracking study was undertaken to analyse the distances Lapwing *Vanellus vanellus* chicks moved; what habitat/s they selected for foraging, the estimation of chick survival among the

population and the relative importance of starvation and predation as causes of chick mortality. A total of 41 broods were identified. One chick was randomly selected from each brood and fitted with a radio-tag shortly after hatching. A 0.4 g, 30-day life, transmitter was attached to each chick. Thereafter, the tagged chick in each brood was radio-tracked-untill fledging or tag recovery. The probability of daily survival of the tagged chicks was calculated using the Kaplan-Meier estimator incorporating Pollack's staggered entry design. This enabled for the tagging of chicks over a period of several days rather than all chicks having to be tagged on a single occasion. Twenty of the 41 tagged chicks (49%) survived until fledging age. Eighteen tagged chicks were predated (46%) and one chick died of disease (5%). Of the chicks predated, Foxes *Vulpes vulpes* accounted for 47%, avian predators 32%, and unknown predators 16%. Overall, the average number of chicks fledged per pair was 0.86. There was no evidence that chick mortality was influenced by the size of the range used by the radio-tracked broods and chick survival to fledging was independent of the habitat type. To our knowledge the fledging rate in this study significantly exceeded the estimated fledging rates of other Irish populations and exceeded the breeding productivity of waders at sites in the United Kingdom where mammalian predators are excluded by electric fences. There has been little research to date on wader chick survival in Ireland, but understanding how to increase brood survival may be crucially important for the long-term maintenance and recovery of breeding waders.

The conservation of the Hen Harrier *Circus cyaneus* in Ireland: opportunities in another landscape

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Over a period of twenty years (1996-2016) National Parks and Wildlife Service has been engaged in creating habitats for the conservation of the Grey Partridge *Perdix perdix* in an area of 4 km² in Boora, Cutaway Bog, Co. Offaly. Within this managed area, encounters with Hen Harriers *Circus cyaneus* exploiting the ensuing abundant prey bio-mass were logged on a granularity of days over the 20-year period. The potential effects of several variables, including weather conditions and the creation of habitats targeted for Grey Partridge conservation were modelled. The aim of the modelling was to combine observations in predicting which of these variables had a statistically significant impact in terms of increasing the frequency in the rate of encounters. The effect of each variable on the number of Hen Harriers encountered is quantified by

employing a Poisson generalised linear model. The yearly rate parameter is itself modelled using the observed weather, habitat management variables and whether persecutions were occurring. To investigate seasonal patterns the proportion of yearly counts observed per quarter were computed. These data showed a distinct preference for the first and last yearly quartile. Our model also showed a corresponding increase in encounters with Hen Harriers when the volume of Grey Partridge nesting and brood-rearing habitats increased. However, a drop in the frequency of encounters is apparent from 2001 until 2007. Corroborating evidence suggests that this may have been influenced by purposeful persecution as a result of widespread discontent with the prospect of Special Protection Area (SPA) designations for Hen Harriers during that period. SPA designations and their effect on Hen Harriers were accounted for in the modelling by a factor adjusting for that time period. The results of this study demonstrate the conservation potential that exists if Ireland's cutaway peatlands were managed for the conservation of the Hen Harrier.

Assessment of numbers and distribution of post-breeding terns at a selection of east and south coast wetlands in August and September 2016

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In autumn 2016, 20 sites along the east and south coasts of Ireland (Cruisetown, Louth to Cork Harbour) were surveyed for aggregations of post-breeding terns under the auspices of the Irish Wetland Bird Survey (I-WeBS) to examine the importance of key wetland sites for post-breeding terns. I-WeBS counters and others were asked to undertake two or more visits to known and suspected tern sites between mid-August and early September, when numbers of migrating terns were expected to be at their peaks. Where the importance of a site was unknown, counters were asked to undertake at least one count at dusk on a rising to high tide, when the terns are pushed into a smaller area and are generally closer to the observer and are easier to count. Additional records of post-breeding terns were sourced online. Sandwich Terns *Sterna sandvicensis* were recorded at 19 of 20 sites, Common Terns *Sterna hirundo* at 15, and Roseate Terns *Sterna dougallii* and Arctic Terns *Sterna paradisaea* at 11 sites each. Common Terns were the most numerous species recorded overall. South Dublin Bay held by far the largest numbers of terns with a peak count of 17,440

(all species combined) and with other counts ranging from 990–11,890. Counts of >1,000 terns were also recorded at Crossfintan Point (Wexford), Wexford Harbour and Barnageeragh (Dublin). There were peak counts of 500–1,000 terns at six sites, 100–500 terns at six sites and eight sites with <100 terns. Repeated counts found varying numbers of terns, individual species, different age-classes and different marked birds, all of which highlight the movement of terns between sites during the post-breeding season. Thus, even the largest counts at most sites are likely to represent a small fraction of the individual birds that use the site during the post-breeding period. This survey adds to the known value of the sites as important roosting and staging sites for tern species listed in Annex I of the EU Birds Directive. The survey was repeated in 2017, including the full extent of the Irish coast. (*Irish Birds* 10: 339–344)

Nestboxes benefit seabird breeding performance in a high density colony

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The provision of artificial nest structures is used in the conservation of a broad range of bird groups including raptors, owls, ducks, passerines and seabirds. Artificial nest boxes have been provided to increase the density and breeding success of Roseate Tern *Sterna dougallii* pairs at colonies in north-west Europe, the Azores and the United States of America, with differing levels of success. Nest box occupancy has been high at north-west European colonies, but the breeding performance of Roseate Terns in nest boxes compared to traditional nest sites has yet to be critically evaluated in this part of their range. In this study we compare the breeding performance of Roseate Tern pairs utilising artificial nest boxes with those nesting at natural sites, on Rockabill Island, County Dublin, to evaluate the effectiveness of nest box installation as a conservation measure. Nest data from 1997 to 2016 was used based on twice-daily nest monitoring visits to study plots around the island. Nest box occupancy was high (mean 75%) throughout the study period. Nest boxes were used ahead of traditional sites early in the season. Hatching success, fledging success and overall productivity were higher for pairs in nest boxes compared to those in natural nest sites. Earlier clutches were more successful than later ones, independent of the effects of nest site type. The degree of cover surrounding natural nest sites was measured in 2016 but had no significant effect on hatching or fledging success. The

results of this study show that Roseate Terns nesting in nest boxes perform better than those using natural nest sites at their largest European colony. We recommend the continued and increased use of nest boxes on Rockabill and other colonies in north-west Europe, to help maximise the densities and breeding performance of this amber-listed, Annex I (EU Birds Directive) species.

Population dynamics of the Cormorant *Phalacrocorax carbo* on Little Saltee, Co. Wexford

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This study commenced in 1960 when the first detailed annual census of the breeding Cormorant *Phalacrocorax carbo* population (number of breeding pairs, and clutch size – based on eggs and chicks per nest) was carried out. Since then, all available pulli (totalling 12,931) have been ringed each year from 1960 to 2017 inclusive, the longest ringing project for Cormorants in Ireland or Britain. Investigations into diet (regurgitated food brought to the colony during the breeding season) have been completed. Pesticide levels in eggs have been monitored over several years. In the early years of the study, Cormorants nested on top of old stone walls, traversing the 100 acre island. The introduction of cattle, sheep and deer to the island caused the Cormorants to vacate the stone wall nesting habit and move, first to headlands, and presently to the base of cliffs. During the 57 year study, the colony has fluctuated between 136 and 408 breeding pairs, showing a significant increase in numbers from 1987 onwards, a delayed response to the Cormorant's protected status under the Wildlife Act, 1976. An analysis of 9,006 pulli ringed showed there have been 1,167 recoveries or 13.3% of those ringed, to 1 April 1997, one of the highest recovery rates amongst Irish birds. Most (38.8%) were shot; 36.8% found dead; 16.7% trapped or caught in nets; 3.7% unknown causes; 2.4% sick-injured; 0.6% oiled and 1.5% miscellaneous. During their first year of life birds suffered two to three times higher reported mortality than older birds from being shot or tapped in nets. Little Saltee Cormorants exhibited more positive migratory movements than birds ringed in other colonies. Reported recoveries of all aged birds from France have been 21.6%; Spain (7.7%) and Portugal (2.1%). The project is ongoing, making it one of the longest continuous studies of the species in Western Europe. Students from the School of Biological, Earth and Environmental Science, University College Cork have assisted the project.

(*Irish Naturalists' Journal* 34: 89–94)

Population dynamics of the Fulmar *Fulmarus glacialis* on Little Saltee, Co. Wexford

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The study commenced in 1960 when Fulmars *Fulmarus glacialis* were prospecting the island. First breeding occurred in 1962 (5 pairs) and peaked in 2004 (260 pairs), followed by a gradual decline to 120 pairs in 2017, in line with some other colonies. Intensive ringing of adults and pulli commenced in 1974. Morphometric measurements (breeding adults) and egg measurements and weights are now taken. Totals of 1,230 adults and 749 pulli have been ringed to 2017, inclusive. A total of 1,834 adults, mostly incubating birds, have been re-trapped. In 2017 some 80% of the breeding birds were carrying rings, previously ringed on the island, a remarkably high proportion. Controls have come from Fair Isle (1984), Gairsay, Orkney (1972), Puffin Island, Co. Kerry (1972 – two pulli), Yell Sound, Shetland (1981), North Rona (1984) and Bardsey (1986). Despite large numbers ringed on nearby Great Saltee, only four adults have been recaptured breeding on Little Saltee. These records demonstrate strong site fidelity. Recovery of Little Saltee ringed birds have been from Cork (1), Wales (1), Cumbria (1), Lancashire (1), Scilly Islands (2), Finestere (3), Norfolk (1), Netherlands (1) and Sweden (1). Annual productivity (well grown chick per breeding pair) showed a mean of 0.51 (range 0.34-0.82; sd 0.13) for the period 1976-1986, compared with 0.16-0.52 recorded from the long term study at Eynhallow, Orkney, Scotland. Based on an estimated annual survival rate of 88-92% (calculated from the Eynhallow study) and mean productivity from Little Saltee, 27 young will survive from 100 pairs to be recruited into the breeding population each year. A database containing some 4,000 records of birds ringed, re-trapped, controlled and recovered has been established. Students from the School of Biological, Earth and Environmental Science, University College Cork have assisted the project.

(*Ibis* 157: 631-636)

Population dynamics of Barnacle Geese *Branta leucopsis* wintering on the Inishkea Islands, Co. Mayo

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Approximately 2,500 Barnacle Geese *Branta leucopsis* winter (mid-October to late-April) on the Inishkea Islands, Co. Mayo, where they have been studied since 1961. Numbers have

remained more or less constant while the overall Greenland population has increased from some 8,000 to 82,000 over the same period, suggesting a limited carrying capacity of the islands. Over 1,200 geese have been ringed, each with alphabetically coded and colour rings for individual recognition. GPS trackers have been used in recent years to study migration behaviour. Basic population data is collected annually on the islands – population censuses, proportion of first-winter birds in the flocks and mean brood size. As the geese are generally site faithful, individually marked geese are followed each winter to provide life-time data with over 19,000 visual recoveries. Observations of marked geese are also made principally in Co. Sligo by Martin Enright and in Scotland, mainly on Islay where Steve Percival is working on a similar project. Recently, Susan Doyle (a Ph.D. student at University College, Dublin) has started research on what determines fitness of individual geese for successful breeding. Only a small proportion (7-15%) of the population breeds successfully. Goose management strategies (agricultural conflicts and conservation issues) and the possible role of climate change require to be better understood. Three expeditions have been made to North East Greenland to study Barnacle Goose breeding biology, which included the ringing of large numbers of geese.

Quantifying habitat associations and factors affecting the breeding success of Hen Harriers *Circus cyaneus* in Ireland

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The Hen Harrier *Circus cyaneus* is a medium-sized bird of prey breeding in open areas across northern Eurasia. It is listed in Annex I of the EU Birds Directive and, therefore, is a species of conservation concern among EU Member States. As a result, six Special Protection Areas (SPAs) were designated in Ireland, in 2007, with the goal of maintaining suitable habitat for the species. In contrast to Hen Harriers elsewhere which prefer heather moorlands and scrub habitat, Irish Hen Harriers are frequently and atypically associated with pre-thicket and second rotation forest. Though widely distributed, and despite the continued existence of SPAs, Hen Harriers are declining in Ireland with only an estimated 108-157 pairs recorded during the National Hen Harrier Survey 2015, 33.5% down on estimates from 1998-2000. It is important that factors affecting Hen Harrier breeding success in Ireland are understood if effective management and conservation processes are to be developed. We used archival Hen Harrier breeding data to investigate the effect of bioclimatic

(e.g. landclass, temperature, rainfall) and topographic (e.g. hilliness, slope) variables on breeding success (i.e. success or failure). We also present Species Distribution Models, comparing maps of suitable and unsuitable breeding habitat for the species in Ireland. This study is part of the Supporting Hen Harriers in Novel Environments (SHINE) project, currently ongoing at University College, Cork. We discuss our findings in the context of Hen Harrier conservation, future analytical refinements and the wider context of the SHINE project.

Halting the decline of Curlew *Numenius arquata* in Northern Ireland

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Curlew *Numenius arquata* are in decline throughout much of their range and the rate of decline in the island of Ireland is especially acute. In Northern Ireland the species breeding range has shown a marked contraction and the number of breeding pairs has declined by >80% between 1987 and 2013. RSPB Northern Ireland is engaged in a number of initiatives aimed at reversing these declines. Through advisory work and management interventions on and off reserve, numbers in lowland wet grassland sites or upland farmland are stable or increasing with some encouraging signs of improved productivity. A trial management project is investigating the responses of breeding birds to habitat management and predator control in control and treatment plots in upland Co. Antrim.

Foraging behaviour of nesting Swifts *Apus apus* tracked using miniature GPS tags

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Common Swifts *Apus apus* are a widespread breeding migrant familiar to residents predominantly of towns, cities and villages throughout the European and Asian breeding ranges. Declines in range and abundance highlighted through the recent *Bird Atlas 2007-11* and annual breeding bird surveys may be driven, in part, by continued loss of nesting sites. In common with other long-distance afro-palearctic migrants, threats on migration and in the winter range may also play a part in the decline. Recent advances in the miniaturisation of tracking devices have meant that for the first time researchers have been able to fit data-logging GPS devices to <50 g birds. Our study is investigating (a) the short-term foraging behaviour of provisioning adult Swifts, comparing the

behaviour of birds in urban and rural settings in Northern Ireland over < 1 week time periods in the mid to late breeding period, and (b) the long-distance migration of nesting Swifts between the breeding and wintering ranges. Here we report on the initial findings of our foraging study describing spatio-temporal use of foraging areas over two breeding seasons.

Migration patterns of Icelandic Whooper Swans *Cygnus cygnus* revealed using satellite telemetry

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Ireland holds two-thirds (67%) of the Icelandic flyway population of Whooper Swans *Cygnus cygnus* and, as a consequence, in numerical terms they are one of our most important wintering species. Our understanding of patterns of movements within and between winters has been largely based on intensive re-sightings of colour leg-banded birds up to around 2001. In this paper we describe general movement patterns based on coloured leg band observations and the application of satellite telemetry to improve our understanding of site use (wintering, pre-migration and pre-nesting) and broad-scale migration patterns, tracking birds from Iceland and from Northern Ireland.

Utilisation of the Canadian Arctic breeding range by Irish Light-bellied Brent Geese *Branta bernicla hrota*

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Holding almost the entire flyway population of Light-bellied Brent Geese *Branta bernicla hrota*, Ireland has a special responsibility for the conservation of the species for more than half of the year. For a species undertaking such a long distance migration it is critical to understand basic ecological processes and pressures at all stages of the annual cycle. Despite several decades of research on the species via a long-term study little is known about the spatio-temporal use of the breeding range in the Canadian Arctic between June and September. The link with Ireland was established as recently as the mid-1970s and as few as 15 nest records were documented up to 1998. Here, using a combination of historical records, field studies and telemetry we describe the current state of knowledge of the breeding ecology of this flyway population, highlighting the major information gaps

that remain and review the potential direct and indirect impacts of climate change on the breeding grounds.

The Countryside Bird Survey, 1998-2016 **D. Coombes, O. Crowe, D. Tierney, A. Walsh** **and J. O'Halloran**

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The Countryside Bird Survey (CBS) has been in operation since 1998. Its primary aim is to monitor breeding bird populations in the Republic of Ireland and the survey is undertaken by a combination of BirdWatch Ireland volunteers and professional staff of the National Parks and Wildlife Service and BirdWatch Ireland. A random sample of 10 km squares was selected, and within each, the most south-westerly 1 km square is surveyed twice during each breeding season. Bird numbers are counted along two roughly parallel 1 km transects in each square. The 2017 CBS report summarises the results for the 19-year period between 1998 and 2016. Some 401 squares were surveyed in two or more seasons and were included in trend analyses. Some 53 species occurred in 30 or more squares and these are eligible for meaningful trend analyses. Wren *Troglodytes troglodytes*, Robin *Erithacus rubecula*, Blackbird *Turdus merula* and Chaffinch *Fringilla coelebs* were the most widespread species, being found in 90% or more of squares, while Rook *Corvus frugilegus*, Starling *Sturnus vulgaris*, and Wren were the most abundant. Overall, 26 species showed increasing trends, 12 species declined, while the remaining 15 species remained relatively stable. Greatest increases occurred in Blackcap *Sylvia atricapilla* and Goldfinch *Carduelis carduelis* while greatest declines were in Greenfinch *Chloris chloris*, Stock Dove *Columba oenas* and Swift *Apus apus*. The species affected by the cold winters between 2009/10 and 2011/12, namely Skylark *Alauda arvensis*, Meadow Pipit *Anthus pratensis*, Grey Wagtail *Motacilla cinerea* and Stonechat *Saxicola rubicola*, while still in decline, are all showing some level of recovery.

Migration phenology of Jack Snipe ***Lymnocyptes minimus* at an Irish** **coastal wetland**

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Although Jack Snipe *Lymnocyptes minimus* are annual winter visitors to Ireland, there is no reliable data on the timing of their biannual migrations. This lack of data is, however, understandable as Jack Snipe are a difficult species to detect and monitor owing to their crepuscular or nocturnal

activities, secretive nature and reluctance to take to the wing when disturbed. What little is known about their movements in Ireland is largely based on records supplied by hunting organisations and random observations by birdwatchers. To test the feasibility of recording baseline data on their migration phenology, systematic monitoring was carried out at North Bull Island in Dublin Bay in autumn 2011 and spring 2012. Because the results were promising the survey work has been carried out annually since then. The presence or absence of birds was recorded during two, three and occasionally four site visits each week from August to October and again from February to May. The specific habitat surveyed was a small Mediterranean salt meadow known to the author as a regular site for this species during migration times. Field recording of migration times of Jack Snipe is considered feasible but can be very time consuming as multiple visits over long periods are required before the first and last migrant birds are recorded. Preliminary results to date suggest that the average arrival times in autumn, departure times in spring and duration of stay in winter at North Bull Island are comparable to published data for Britain.

Non breeding waders in summer at a **wetland on the east coast of Ireland**

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The main objective of this work was to document the occurrence of fifteen non-breeding wader species at North Bull Island in Dublin Bay between spring and autumn. The presence or absence of each species was recorded during weekly visits from May to mid-July 2012 to 2015 and in 2017. Weekly counts were also carried out in 2017 to assess the size of their respective populations in summer. Species diversity was highest during the migration periods in May and late-June/July and lowest in mid-June. During the ten-week survey period five species were present continuously, seven more were only absent occasionally or for short periods while the remaining three species occurred either sporadically or rarely. Although wader numbers in 2017 were lowest in mid-June, in excess of 450 birds were recorded during all June counts. The most numerous species in mid-June were Curlew *Numenius arquata* and Oystercatcher *Haematopus ostralegus* representing 80% to 90% of all birds present. Although weekly counts were only carried out in 2017, it is noteworthy that six species occurred in concentrations in excess of their respective thresholds for national importance. The results show that North Bull Island is an important site in summer for a diverse range of wader species some of which occur in large numbers. For many wader species there were no clear cut-off points between the departure of wintering birds, the spring movement of passage migrants and the arrival of

summering bird. This has obvious implications for phenologists investigating potential changes in the duration of stay of 'winter visitors'.

Variation in the breeding bird community at Cabragh Wetlands from Constant Effort Site ringing data

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Constant Effort Site (CES) mist netting has been undertaken at the Cabragh Wetlands, near Thurles in Co. Tipperary, since 2006. The CES methodology standardises ringing between sites and years to allow comparisons to be made. Briefly, it requires that the same nets be operated in the same locations for the same time in each year. A total of 12 visits are undertaken each year between early May and late August. There is typically a ten-day window within which a visit can take place, and visits have to be spaced a minimum of six days apart (for full detail of the CES methods, see <http://bit.ly/2wOKu3i>). The Cabragh Wetlands is a Natura 2000 site, forming part of the Lower River Suir SAC. Habitats vary with amenity grassland, scrub and trees on the drier parts of the site, the wetland area comprising extensive *Phragmites* reedbed, swamp and wet grassland habitats. The bird community at the site reflects this diversity of habitat, with a total of 43 species captured to date and a total of 3,877 individuals. Of these, Sedge Warbler *Acrocephalus schoenobaenus* is the commonest species caught, with 1,051 individuals captured since 2006, followed by 360 Reed Buntings *Emberiza schoeniclus*, 359 Wrens *Troglodytes troglodytes*, 214 Blue Tits *Cyanistes caeruleus*, 193 Robins *Erithacus rubecula*, 191 Blackbirds *Turdus merula* and 171 Willow Warblers *Phylloscopus trochilus*. The standardised nature of the methodology allows comparisons for a range of population metrics for common species, such as over-winter survival (the number of adult birds present on the site in the first six visits) and breeding performance (by looking at the ratio of adults to juveniles in a given year). A full analysis of these data is currently in progress.

Aspects of the ecology of Dippers *Cinclus cinclus* in the Slieve Blooms

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Dippers *Cinclus cinclus* have been studied in a number of catchments in the Slieve Blooms since 2004. Since 2011, research has focused on two river catchments: the River Little Brosna and the upper River Nore. Study sites in both catchments are typically at road bridges, although other sites

(e.g. stone walls or natural nest sites) are included. The total number of sites visited annually is approximately 180 (92 in the Little Brosna catchment and 88 in the upper River Nore). Nesting boxes have been provided in the River Little Brosna catchment since 2011, with the number of nesting boxes increasing annually to the current total of 52. In the upper River Nore catchment, nesting boxes were first erected in the autumn of 2016, and a total of 30 boxes were present in the 2017 nesting season. During the winter season, sites are checked for roosting birds, which are caught and ringed (approximately 100 birds are caught annually between the two catchments). Birds identified as adults (i.e. birds that did not hatch in the current calendar year) are also colour-ringed. Colour-ringing started in the Little Brosna catchment in winter of 2014/15 and in the River Nore catchment in the winter of 2016/17. In the nesting season, breeding occupancy at nesting sites is recorded, along with nest record data (first egg dates, clutch size, brood size, etc.), and pulli are ringed. Adults are also checked for colour rings as part of a Retrapping Adults for Survival (RAS) study. Approximately 45 pairs are recorded annually in the River Little Brosna catchment, with 24 nests recorded in the River Nore catchment in 2017. One feature of this ongoing research is high nesting box uptake (just over 75% occupancy) suggesting that natural nest sites may be limited.

Late nesting birds in Ireland: gathering data to inform policy

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Knowledge of bird nesting seasons in Ireland is essential. Nest record data is vital to answer fundamental questions about, for example, the demography of species in decline, inform dedicated species research projects (e.g. those where distributional shifts driven by climate change are apparent) and help protect other species whose habitats are vulnerable (e.g. upland species and late-nesting hedgerow species that would be affected by the proposed Heritage Bill). Gathering nest record data that will significantly benefit the interpretation of population trends (e.g. Countryside Bird Survey), support species research programs and will identify future management needs of several of Ireland's common bird species. Overall, this work aims to develop the necessary infrastructure for gathering records (in an online platform) that will be used for the ongoing collation of nest records for all birds into the future. Launched in summer 2017, with funding from the Heritage Council, a call went out via national media, and through BirdWatch Ireland branches in Kildare,

Meath and Tipperary for records of late-nesting birds, particularly Yellowhammer *Emberiza citrinella*. At the same time, the National Biodiversity Data Centre developed and hosted an online recording form for Yellowhammer, Blackbird *Turdus merula*, Greenfinch *Chloris chloris* and Goldfinch *Carduelis carduelis*. Cognisant of the requirements of the Wildlife Act in respect of inspecting actual nests, participants were asked to record out-of-the-nest breeding evidence (singing males, pairs seen together, adults carrying food and recently fledged young), and enter this information together with location. To date, just over 450 records have been submitted from 18 counties for nest records in August and September 2017. Of these, 383 records were for Yellowhammer which, as a hedgerow nesting species, may be affected by August hedge cutting, if permitted. It is hoped that future work will continue to explore nesting data for other species throughout the breeding season.

Monitoring of a winter roost in east Kerry and its importance for Hen Harrier *Circus cyaneus* conservation

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The Hen Harrier *Circus cyaneus* is an Annex 1 species of the EU Birds Directive and is of conservation concern in Ireland. Winter roost monitoring by IRD Duhallow's RaptorLIFE project revealed that a known site in East Kerry is one of the most important winter roosts in Ireland. Thirty-five evening counts conducted during the winters of 2015/16 and 2016/17 revealed that this site regularly contains higher numbers of roosting birds than has been previously reported anywhere else in Ireland. According to available published data, the previous record for the number of Hen Harriers observed at a communal roost was ten. Over a two-year period, there were nine occasions when a count of ten birds or higher was recorded, including one occasion where 14 birds were observed. The highest count in both winters occurred in January. The mean number of birds recorded was high ($M = 7.4$, $SD = 3.4$), with the majority being grey males ($M = 5$, $SD = 2.6$) compared to a lower number of ringtails ($M = 2.4$, $SD = 1.8$). European law stipulates that the identification and delimitation of Special Protection Areas (SPAs) must be based on scientific criteria such as '1% of the population of listed vulnerable species'. The presence of up to 14 Hen Harriers during the winter period far exceeds the Irish 1% threshold. Furthermore, monitoring during the breeding season has shown that up to two pairs of Hen Harriers have nested in the vicinity of this roost in recent years. The fact that this roost

has no specific conservation measures for Hen Harriers is of concern. There is currently an application to develop the site that if approved will result in significant disturbance. For this reason, RaptorLIFE have prepared a document requesting the site be designated as a SPA for Hen Harriers.

Predicting changes in Irish bird communities in response to projected afforestation

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Understanding the way in which species assemblages respond to habitat change is a key aim of ecological research. Although most of the focus internationally has been on the effects of deforestation on biodiversity, afforestation as a land-use change also influences species populations and ranges. Moreover, it is widely predicted that far greater changes due to afforestation are yet to occur, particularly in light of recent climate change agreements. The aim of this study was to forecast how bird communities, as well as the abundance of a number of selected species, may respond to current afforestation policies in Ireland. Detailed distribution and abundance data was used to model how current communities and populations distribute across the country according to current climate and land use. These models were then used to forecast predicted changes under four realistic afforestation scenarios. A new method for community modelling was used (Latent Dirichlet Allocation model), and detailed projections of population change were developed. The findings reveal a clear shift in community composition when afforestation exceeds 35% of the landscape. Results using both national abundance data and habitat-specific densities predict future declines in response to increasing afforestation for a number of birds of conservation concern as well as for some common species. Two of the six birds of conservation concern investigated (Starling *Sturnus vulgaris* and House Sparrow *Passer domesticus*) are predicted to decline under all four afforestation scenarios tested. Only Robin *Erithacus rubecula* populations and numbers were predicted to increase under all four afforestation scenarios. The magnitude of the predicted population changes ranged from <0.5% (Barn Swallow *Hirundo rustica*, Coal Tit *Periparus ater*, Goldfinch *Carduelis carduelis*, Jackdaw *Corvus monedula*, Rook *Corvus frugilegus*) up to 28% (Meadow Pipit *Anthus pratensis*). On the basis of these results, it is advised that afforestation policies should be balanced with policies aimed at preserving open habitats, both natural (e.g. peatland) and man-made (e.g. grassland).

All wrapped up: plumage as a buffer against varied ambient conditions

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Plumage is the most complex integumentary structure on vertebrates and is characteristic of birds. Warmed air is trapped by down and overlying pennaceous feathers and, in effect, a thermal buffer is created between the bird and its surroundings. Therefore, plumage is thought to play a key role in bird-mediated ectozoochorous dispersal. In particular, evidence suggests that the moisture content (humidity) found within plumage can influence the success of an ectozoochorous event. Knowledge of temperature and humidity regimes within the plumage microclimate, combined with known dispersal unit tolerances, will allow dispersal kernel modellers to accurately assess dispersal distance and propagule survival. Building on our examination of the within-plumage microclimatic regimes of Mallard *Anas platyrhynchos*, we examined the prevailing humidity and thermal regimes within the plumage of Homing Pigeons *Columba livia domestica* under various ambient temperature and humidity combinations. Plumage temperatures and humidity regimes were found to increase with increasing ambient temperature and humidity. However, within-plumage temperatures remained in excess of 30°C despite exposure of birds to cooler ambient temperatures (20 and 27°C). Although plumage may not provide for complete insulation, it is an effective buffer to varied ambient conditions in the case of resting birds. The present study suggests that the plumage microclimate could facilitate the dispersal of enmeshed propagules via a reduced desiccation exposure rate.

Bird-mediated ectozoochorous dispersal of freshwater invaders: an overlooked vector in biological invasions?

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Vectors that underpin dispersal often remain poorly understood. In particular, mechanisms facilitating the natural dispersal of invasive alien species (IAS) are frequently unknown. Research suggests that birds can facilitate both short and long-distance dispersal of plants, animals, microbes and fungi. Therefore, it is hypothesised that bird-mediated ectozoochory (external dispersal) can play an important role

in biological invasions. Ectozoochory occurs when dispersal units stick to feathers, feet and bills, become enmeshed within plumage or encapsulated within mud coating the external surfaces of vector birds. To identify knowledge gaps, an extensive systematic search of the literature was conducted across multiple on-line scientific databases using various search terms and associated synonyms. Our review of the literature indicates that bird-mediated ectozoochory of aquatic dispersal units is a frequent process, at least at a local scale. However, the quantitative contribution of bird-mediated ectozoochory to overall dispersal remains unclear. Greater consideration of all prerequisites necessary for successful waterbird-mediated ectozoochorous dispersal is required (i.e. contact with vector, attachment, survival and retention of viability, detachment, colonisation and persistence). In particular, the impact of factors which influence attachment and detachment of dispersal units (e.g. dispersal unit densities, preening behaviour and the role of encapsulating mud) needs further examination. A better knowledge of these interactions between disperser and dispersal units will facilitate understanding of species mobility in the context of a changing world. Equally, bird ringers and field ornithologists regularly observe and often handle a variety of bird species, and it is not unlikely that instances of ectozoochory have been detected but remain undocumented. Citizen science initiatives to increase collection and cataloguing of such observations should be encouraged.

Divided but not disconnected: high frequencies of short-distance, bird-mediated ectozoochorous dispersal of aquatic macrophytes

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Freshwater systems can be viewed from a classical island biogeographic perspective as islands of freshwater in a 'sea' of terrestrial habitats. However, many invasive aquatic macrophytes have successfully colonised and re-colonised these isolated habitats. Moreover, despite the limited life span of lakes and wetlands on geological and evolutionary time scales, aquatic plants tend to have broader distributions than their terrestrial counterparts. Accordingly, it has been hypothesised that the successful colonisation and range expansion of many aquatic macrophytes is facilitated by more mobile animals. We have experimentally examined *in situ* and *ex situ* dispersal of selected aquatic macrophytes. A high frequency of native *Lemna minor* dispersal between garden bird water-baths was observed *in situ*, and was linked to bird-mediated ectozoochory (external dispersal). Similarly, in an *ex situ*

experiment, invasive *Lemna minuta* and *Azolla filiculoides* were found to be dispersed by Mallard *Anas platyrhynchos*. Overall, we conclude that short distance or 'stepping-stone' dispersal via bird-mediated ectozoochory can occur with high frequencies. Therefore, as highly mobile vectors, aquatic birds can play an important role in facilitating colonisation, range expansion and biological invasion of macrophytes. Accordingly, this triggers the question whether fragmented habitats are as isolated as previously thought.

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Predictive distribution mapping of seabirds at sea to inform marine spatial planning

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The conservation of seabirds depends strongly on the designation of Marine Protected Areas (MPAs) in order to capture important areas away from colonies. However, mapping seabird distributions using at-sea surveys or tracking studies can be costly and time-consuming work, particularly for far-ranging pelagic species. We report on the use of a foraging radius model to predict at-sea distributions for all seabird species in Britain and Ireland, identifying likely hotspots of highest density and species richness. We compared model outputs with GPS tracking and at-sea survey data to show that our model gives a reasonable picture of the reported at-sea distribution of many species. Strong correlations ($r > 0.5$) were found between predicted distributions and either tracking data or at-sea surveys for a number of species including Manx Shearwater *Puffinus puffinus* and Razorbill *Alca torda*. On a broad scale, hotspots with the highest density of birds also contain the highest species richness. However, predicted distributions highlight differences between hotspots for coastal versus pelagic species. We then calculated the estimated proportion of Ireland's seabird populations afforded protection by MPAs. On average, 33% of coastal seabirds and 13% of pelagic seabirds overlapped with protected areas, indicating that pelagic species, many of which are near threatened or endangered, have significantly less coverage from protected areas than coastal species. Future assessment for MPAs should account for the disparity between coastal and pelagic foraging species to ensure that wider-ranging seabirds are afforded sufficient levels of protection. More generally, we suggest that

a predictive approach allows for a practical and rapid method of assessing at-sea distributions and identifying potential MPAs, particularly in regions throughout the world with limited data and resources. An online GIS platform has been developed concurrently to display the predictive distributions. This will enable stakeholders, in both conservation and industry, to identify, manage and mitigate potential risks.

Assessing the movements and usage of a selection of seabirds nesting at Irish east coast breeding colonies

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This project, funded under the OEDU Prototype Fund of the Sustainable Energy Authority of Ireland, examined the deployment of tracking technology on seabirds and coastal waterbirds along the east coast of Ireland. The project aimed to assess the efficacy of this technology in delivering appropriate information for informing a Bird Sensitivity Map for Offshore Renewable Energy. It also aims to gather key supporting information on birds in the marine environment. In total, some 36 birds were caught and fitted with tracking devices under license, including 17 Shags *Phalacrocorax aristotelis*, ten Kittiwakes *Rissa tridactyla*, three Herring Gulls *Larus argentatus*, three Lesser Black-backed Gulls *Larus fuscus* and three Great Black-backed Gulls *Larus marinus*. The patterns of movements observed were widely variable. The larger gulls (Herring, Lesser Black-backed and Great Black-backed) showed the greatest diversity in habitat use, illustrating significant movements inland as well as within the inshore and offshore areas. The Shags and Kittiwakes were more marine in nature than the other species. The Shags made a small number of trips, usually one per day, and most lasting less than three hours. They showed movements predominantly in a southward direction. The diving activity showed that Shags made between 114 and 249 dives overall and mean depth ranged between 14.2 and 16.4 deci-bars and mean dive duration ranged between 54 and 63 seconds. The Kittiwakes made the longest trips, with two individuals undertaking trips that lasted almost two days, and both of these individuals headed in an eastwards direction from their colony. The information gathered during this study will contribute key information to an overall Bird Sensitivity Map for Marine Renewable Energy Development in Ireland.

Movements and usage of waders in Dublin Bay using tracking technology

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This project, funded under the OEDU Prototype Fund of the Sustainable Energy Authority of Ireland, examines the deployment of innovative tracking technology on wintering coastal waterbirds and breeding seabirds along the east coast of Ireland. The project aims to assess the efficacy of this technology in delivering appropriate information for informing a Bird Sensitivity Map for Offshore Renewable Energy. In November 2016, a total of 14 birds were caught and fitted with GPS tracking devices, including three Curlews *Numenius arquata*, five Redshanks *Tringa totanus* and six Oystercatchers *Haematopus ostralegus*. The devices licensed for use on wading birds are limited due to restrictions over the weight of tag to weight of species ratios. The data are downloaded using fixed/mobile base stations, so individuals must return to accessible roost/foraging locations to allow successful retrieval of data. The patterns of movements observed differed between species with summaries of the patterns for each individual detailed in the results section. Individual Oystercatcher (3A) exhibited the widest range of movements, utilising both intertidal and terrestrial habitats at feeding and roosting stages of the tidal cycle. Individuals typically made single daily movements from preferred core intertidal feeding and/or high tide roosting areas to nearby parks and playing fields to feed. The scope of this initial phase of the project is limited to the GPS fixes collected for 14 individuals ranging from periods of four days up to 105 days. In the longer-term targeting tagging work at additional nationally important sites along the west and south coasts would add considerably to current knowledge of how waterbirds utilise coastal wetlands in winter and how they move between these sites.

Usage of Sruwaddacon Bay, Co. Mayo, by waterbirds through the winter period

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Sruwaddacon Bay, in north Co. Mayo, forms part of a wider coastal wetland known as Blacksod Bay/Broadhaven Special

Protection Area (SPA). Few wetland sites in Ireland have been subject to such long-term intensive monitoring, which commenced in 2002 in connection with the Corrib Gas Project, initially as part of the Environmental Impact Assessment process, and latterly as part of the Project Environmental Management Plan's extensive ecological monitoring programme. Since 2008/09, almost weekly surveys of waterbird usage through winter and passage months have been carried out in the bay, culminating in a five-year dataset. Waterbird composition and abundance across the bay was examined using peak monthly low- and high-tide count data from six sub-sites. There were distinct spatial and temporal differences in how species used the site. The overall macro-invertebrate biomass of the bay is considered relatively low compared to similar estuaries. Some waterbirds had clear preferences for certain parts of the bay, likely related to availability of preferred foraging prey species at low tide and roosting sites at high tide. Species richness and abundance of waterbirds varied across the site and also with tide, with an obvious disparity in total numbers using the site between low tide and high tide counts indicating some species use the site more as a resource for foraging than roosting and vice versa.

Fluctuations in breeding activity of Sand Martins *Riparia riparia* at a coastal site in the west of Ireland

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This study of breeding activity of a local Sand Martin *Riparia riparia* population at Sruwaddacon Bay in Co. Mayo first commenced in 2002 with intensive monitoring being carried out in connection with the Corrib Gas Development's activities at Glengad between 2008 and 2014 (the period covered by this paper) which is continuing post-construction into the operations phase. During the monitoring period, which included construction of the offshore pipeline landfall and the Landfall Valve Installation (LVI) adjacent to the main Sand Martin colony at Glengad, this colony doubled in size reflecting positive national trends at that time with additional nesting cliffs colonised within a 3 km radius of the original colony at Glengad. Overall, construction activities were not considered to have had any long-term impact on the local breeding population. In 2013, colony sizes were smaller due most likely to the effects of weather locally (colder springs) and on overwintering grounds in the Sahel region of Africa which negatively influenced overall survival and breeding success with fewer nesting pairs and nesting attempts.

Surveys for breeding Curlew *Numenius arquata* in the border counties, 2011-2014, as part of the Halting Environmental Loss Project

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As part of the Halting Environmental Loss Project (HELP), baseline surveys for breeding Curlew *Numenius arquata* were carried out in the border counties of Donegal, Cavan, Leitrim and Monaghan between 2011 and 2014. Areas with records of breeding Curlew during the 1988-91 Breeding Atlas survey and the Countryside Bird Survey were resurveyed. Reports were also received as a result of publicity and each was followed up. In total, 106 tetrads were surveyed but only 13 had breeding Curlew with a total of 19 pairs found. The population is likely to have declined by more than half in the last 20 years. If representative of the national situation, there are likely to be less than 200 pairs left in Ireland. Most pairs were on rushy pastures or peat bogs. Pairs were more likely to be successful if they nested on bogs, but for pairs which nested on farmland, they were more likely to be successful if the land had been entered into the Curlew grant scheme. It is recommended that a national survey to establish a population estimate and allow for monitoring and targeted conservation effort be carried out as a matter of urgency. It is also recommended that in parallel, an agri-environment measure that invites applications from farmers who may have breeding Curlew on their land is implemented as soon as possible and that specialist advisors are deployed to verify the presence of birds and assist farmers with management measures. Without these measures, the Irish breeding Curlew population could be facing extinction within the next ten years.

Survival and productivity in Greenland Barnacle Geese *Branta leucopsis*: insights from a long-term dataset

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The Greenland Barnacle Goose *Branta leucopsis* is an Arctic visitor to Ireland. This population breeds in north-east Greenland and migrates, via Iceland, to winter in western Scotland and Ireland. Once a popular quarry species, the population fell to critically low levels in the 1950s until

protective legislation was introduced throughout Britain and Ireland. The rate of recovery was unprecedented: between 1959 and 2013 the population grew from 8,277 to 80,670 birds. During this period of growth, extensive data were collected on its population dynamics. A colour-ringing scheme commenced in 1960 to investigate trends in survival while data on productivity were collected from a subset of the population at an important wintering site on the Inishkea Islands, Co. Mayo. Here we present the apparent survival and productivity rates of the Greenland Barnacle Goose population over the past half century. Re-sighting data from 1,875 geese were used to estimate apparent survival using capture-mark-recapture analysis. Annual productivity was estimated from the proportion of juvenile birds in the population and mean brood size. Productivity has remained low but relatively stable over time. The average annual proportion of juveniles in the population is just 0.07 and average annual brood size is 1.8 young. Survival, however, shows much greater variability and often dramatic declines and recovery. Average survival over time is 0.86 in juveniles and 0.85 in adults, but apparent survival dropped as low as 0.46 and 0.51, respectively, in certain years. Exploration of environmental factors that influence productivity and, in particular, survival may elucidate the drivers of population growth in the Greenland Barnacle Goose.

A review of owl prey in Ireland

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Small mammals are crucial to ecosystems. For example as prey, and seed predators. Given the importance of small mammal species' functions within ecosystems, studies providing insight into species assemblage, diversity, and numbers are of high conservation value. Owls in Ireland feed predominantly on small mammals and, less frequently, on birds, and amphibians. When small mammals are controlled by rodenticide, these can enter the food chain and affect predators, such as owls. The Irish small mammal species assemblage is species poor. A maximum of six commonly occurring prey species are present in total, however, habitat where all species are found is rare due to range restrictions and competition. However, despite reduced prey species, the relationships between predator and prey species remain intricate and complex. For instance, Irish Barn Owls *Tyto alba* exhibit a more nocturnal hunting habit than those in Britain due to dependence for prey on the largely nocturnal Field Mouse *Apodemus sylvaticus* rather than the crepuscular Field Vole *Microtus agrestis*, a common prey species in Britain, but absent from Ireland. A result of dependence on small

mammals as a food source is that owl diet studies can be used as indicators of small mammal species population trends through time, range shift and as a method of detecting introduced species. There are 37 published papers and notes on Irish Barn Owl prey dating from the 19th century to 2015. Other owl species; Short-eared Owl *Asio flammeus* and Long-eared Owl *Asio otus* diet have been studied to a lesser extent. The frequency of all species found in the diet of each species of owl is reviewed. The year(s) the pellets were collected were used to determine small mammal distribution, dietary significance and abundance. We conclude by suggesting how prey will influence owl numbers in future, and appeal for people to watch for pellets, especially large quantities of Barn Owl pellets.

Another 'statutory maze'? Nesting bird protection in Ireland

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The Wildlife Act, 1976 (as amended) ('The Act') is the cornerstone of nature conservation law in Ireland, and is one of the primary laws providing protection for nesting birds. Despite repeated and significant amendments to the Act since 1985, a consolidated version (i.e. a version showing all insertions and deletions) was published only as recently as 2017 by the Irish Law Reform Commission — the independent body established by law, to keep Irish law under expert review, and make recommendations for law reform. By way of contrast, a consolidation of the United Kingdom Wildlife and Countryside Act, 1981 (as amended) ('the WACA'), whose scope and purpose largely mirrors that of the Irish Act, has been available online for many years. Moreover, the WACA consolidation was a more complex task given the jurisdictional differences between England, Wales, Scotland, and Northern Ireland. In Ireland, the repeated amendments, absence of a consolidation, and the wording of certain subsections has frustrated planners and ecologists in public and private sectors when interpreting, and promoting nesting bird protection under the Act. The author is drafting a paper for a legal journal to comment (with the input of a lawyer) on the interpretation of nesting bird protection under the Act. This paper will also identify numbers of Irish prosecutions for destruction of birds' nests, informed by recent Freedom of Information Requests to the Department of Culture, Heritage and the Gaeltacht. This paper will also attempt to analyse derogations for nest destruction under the Act, which may inadequately implement the far-reaching protections of the EU Birds

Directive (2009.147.EEC). A comprehensive review of wildlife legislation, including protection of nesting birds was completed by the UK Law Commission in 2016. Subject to the findings of ongoing analysis, a similar review may be needed in Ireland, to include the Wildlife Act.

Knowledge gaps in disturbance distances for breeding birds: a pesky but necessary business

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This study addresses knowledge gaps in disturbance distances for Irish breeding birds of conservation importance. Some authors consider it impossible to generate useful generic disturbance distances; for instance, citing varying disturbance tolerances of populations across sites and between years. However, human disturbance to nesting bird populations is a common threat from development projects, and rulings of the European and Irish courts require there to be a scientific basis underpinning ecological assessments. The courts have also emphasised the rigorousness of scientific methods required, which must constitute 'best scientific knowledge in the field'. This contribution, therefore, argues that however imperfect, ecological consultants and conservation managers require an evidence base (including margins of error) with which to predict the effect of human disturbance on nesting birds. Because it is rarely feasible (and clearly controversial) to collect empirical data on the actual effect of disturbance on birds, ecologists often rely on published a priori estimates of human disturbance. A Scottish study published in 2008 employed expert opinion to provide disturbance distances for 'priority' Scottish breeding bird species and these may be tentatively applied to Irish populations. This study did not assess breeding populations of 21 species for which Irish Special Protection Areas (SPA) have been designated. Moreover, National Parks and Wildlife Service have identified human disturbance as a threat to five of the 21 SPA species not covered by the 2008 study. A systematic review of the scientific literature is being conducted to reduce the disturbance distance knowledge gap, starting with the five species indicated above. A search of over 250 scientific papers has generated few reliable estimates of disturbance distance. In the absence of arguably unacceptable empirical studies on disturbance, it is likely expert opinion will be required to establish an evidence base.

Effects of water quality and land use on the breeding ecology of an aquatic passerine, the White-throated Dipper *Cinclus cinclus*

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Land use changes are one of the main drivers of global change. Riparian systems are particularly interesting, as they have the potential to reflect changes occurring across large areas of influence. As one of the few aquatic passerines, White-throated Dippers *Cinclus cinclus* are dependent on rivers for all aspects of their life history, and have the potential to integrate environmental changes in their territories, and also across the wider catchment. This provides a unique opportunity to assess how environmental factors and land use influence a key species within these ecosystems. We monitored Dipper nests at rivers in two areas (56 sites in Counties Laois and Offaly, 144 sites in County Cork) over three breeding seasons (2014-2016), recording data on a range of breeding parameters (lay date, brood size, chick biometrics and nest success). We also assessed baseline levels of corticosterone in nestling feathers. Corticosterone is the main hormone involved in the stress response, the behavioural and physiological changes that an organism undergoes to re-establish homeostasis after exposure to an acute (e.g. presence of a predator) or a prolonged (e.g. food limitation, adverse weather) stressful stimulus. Nest sites and territories were characterised by water chemistry and land use in surrounding areas. Our aim was to determine whether corticosterone levels can provide a useful indicator of environmental stress in Dippers. Results indicate that traditional breeding parameters reflect differences between sites in water chemistry, but not in land use. Corticosterone levels, however, reflected variation in both water chemistry parameters and in predominant land use surrounding each nest site. These findings suggest that corticosterone levels can provide a more direct measure of how an organism responds to environmental stress and habitat quality. Furthermore, they can be used to detect the indirect effects of factors (such as land use) which are not picked up by more traditional measures.

Results-based agri-environmental scheme approach to managing for breeding waders in the Shannon Callows

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In 2013, BirdWatch Ireland, under contract to National Parks and Wildlife Service, trialled a results-based agri-environment scheme targeting breeding wader populations in the Shannon Callows. The scheme's objective was to determine whether a results-based measure could deliver for the suite of endangered breeding waders present in the Callows, Lapwing *Vanellus vanellus*, Redshank *Tringa totanus*, Curlew *Numenius arquata* and Snipe *Gallinago gallinago*, and whether farmers would accept such an approach. This scheme ended in 2014 and was followed by the European Commission-funded Results-based Agri-environmental Pilot Scheme (RBAPS) project (2015-2019). In the RBAPS project, farmers were given information on scheme objectives (the output) and fields were scored against several habitat criteria (indicators) which reflected the suitability of habitat for breeding waders. Payments were dependent upon, and scaled with, this 'field score', with scores ranked from 1-10. The breeding wader measure is a hybrid scheme: prescriptive elements are contained in the scheme's terms and conditions to prevent damage to nests and chicks from tractor operations and overstocking; and a capital works programme is included to improve breeding habitat and reduce the risk of depredation. Since 2013, 15 farmers entered 128 ha in the NPWS and RBAPS measures. The results show that populations are recovering on land under agreement, while continuing to decline on land not under agreement. The results-based approach is considered a success for the conservation of breeding waders in lowland wet grasslands for the following reasons: total productivity was higher on RBAPS plots compared to control plots (0.8, 0.4); farmer training and specialist advisory support was embedded, helping to improve farmer buy-in and delivery; capital works were easily incorporated, resulting in improvements to habitat condition; results-based field scores provided an incentive for farmers to improve their management and habitat condition; and farmers found the payment mechanism fair and transparent, and liked the training and advisory elements.

Nocturnal roosting by waterbirds in Cork Harbour: implications for water-bird monitoring and conservation

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The Cork Harbour Special Protection Area (SPA) is designated for its populations of 23 species of waterbirds, while nationally important populations of several other species also occur. Standard waterbird monitoring data from high- and low-tide counts has been used to set conservation objectives for these species, but some important aspects of waterbird utilisation of the harbour are not captured by these methods. This paper reports some findings from studies of nocturnal waterbird roosts in Cork Harbour, and shows the contribution that information on the distribution and utilisation of such roosts can make towards monitoring and conserving waterbird populations in coastal SPAs. At least 20 species of waterbirds in Cork Harbour regularly occur in nocturnal communal roosts. Notably, these include Great Crested Grebe *Podiceps cristatus*, for which the existence of such roosting behaviour does not appear to have been recognised in the scientific literature. Nocturnal roost surveys in Cork Harbour show that I-WeBS counts routinely underestimate the populations of Cormorant *Phalacrocorax carbo* and Great Crested Grebe, and several important roosts for these species are not included within the SPA. Great Crested Grebe appear to be very sensitive to disturbance when roosting, while diel variation in the distribution of Red-breasted Merganser *Mergus serrator* in Cork Harbour may reflect their apparent high sensitivity to disturbance from marine traffic. In mid-winter, large numbers of several wader species feed on fields around Cork Harbour and return to the harbour to roost at night. Monitoring of these roosts provides information on the numbers of birds feeding on fields and the general areas used. For example, counts of Curlew *Numenius arquata* nocturnal roosts indicate that up to 50% of the mid-winter population may feed on fields, while observations of flightlines indicate that birds may travel up to 5 km between their roosts and field feeding sites.

Improving breeding conditions for a red-listed species of conservation concern: Whinchat *Saxicola rubetra* as a case study

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The Whinchat *Saxicola rubetra* is a long distance migrant passerine that breeds in Europe. A dramatic population

contraction has been observed since the 1980s across its European range. Like many ground nesting farmland birds, the causal factor is agricultural intensification. In Ireland, the mowing of grasslands during the avian breeding season has likely caused adult and juvenile mortalities and greatly reduced the availability of invertebrate prey. To half the decline of this vulnerable species, delayed mowing is urgently required throughout its breeding range. Using a look-see method, over two breeding seasons (2014 and 2016), 34 Whinchat broods were monitored until juveniles had fledged from the nest. A literature review was conducted to calculate the intrinsic population growth ($\lambda = PA + PJ\beta$). The date at which a stable percentage of Whinchat chicks had fledged from the nest could then be determined. The reviewed literature indicated that 75.1% of Whinchat broods must survive the breeding season if populations are to remain stable. This study provides options for targeted conservation that would maintain an unchanged population of Whinchats in the Shannon Callows. If 100% of broods are protected, 75.1% of these broods must produce fledglings before mowing commences, which, according to this study, is post 26 July. If 75.1% broods are protected, 100% of these broods must produce fledglings before mowing commences. Arguably, the most efficient method may be to combine these two options (e.g. protect 86.7% of broods until 86.7% of these broods have produced fledglings – $86.7\% \times 86.7\% = 75.1\%$). The benefit to cost ratio must be investigated to further the validity of the options presented. Improving conditions for Whinchats should enhance farmland habitats and its associated biodiversity.

Have warmer springs led to earlier breeding in Black Guillemots *Cepphus grylle* in Co. Down?

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The late Julian Greenwood studied Black Guillemots *Cepphus grylle* breeding at Bangor, Co. Down, from 1985 to 2016. In 2007 he showed that in the 1985-2006 data the median date of first egg-laying was correlated with spring seawater temperature, advancing by two to three days for every 1 °C rise in temperature. This does not, of course, mean that there was a causal connection because there was both an overall trend to earlier breeding and an overall trend of rising temperatures: the two trends could have been driven independently by long-term changes in the environment, the correlation between them being merely incidental. However, another ten years' data have allowed us to explore the correlation more

deeply because temperatures have not continued to increase in the later years. We conclude that the evidence for a direct causal connexion between laying date and seawater temperature is now stronger.

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White-tailed Eagle *Haliaeetus albicilla* nest site selection in Ireland, 2012-2017

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By the early 1900s White-tailed Eagles *Haliaeetus albicilla* were considered extinct in Ireland following a long history of human persecution. In 2007, a collaborative reintroduction programme between the Golden Eagle Trust and National Parks and Wildlife Service was initiated and 100 eagle chicks were brought to Ireland from Norway between 2007 and 2011. The first of the released birds bred successfully in 2013 when two chicks fledged in Co. Clare. To date, twenty-one Irish-bred chicks have fledged from nine pairs, spread over four counties. Between 2012 and 2017, twenty nests were built in thirteen White-tailed Eagle territories by fourteen pairs/trios. Nest site attributes and other factors potentially influencing nest site selection are examined, including tree type, aspect, altitude, habitat type and size, proximity to waterbodies, distance to nearest 'neighbouring' nests and levels of disturbance. In several cases birds changed nest site and the probability of this happening post-breeding (successful versus unsuccessful) was calculated. Productivity varies between pairs and the potential role of nest site selection in this process is discussed. Findings regarding nest site selection are largely in line with that known in other European countries, with birds using a variety of tree types which are, sheltered from prevailing winds, at low altitude (≤ 160 m), strongly associated with woodlands and large waterbodies and showing a preference for sites with little or no disturbance. Birds appear to be almost twice as likely to change nest site after an unsuccessful breeding attempt, than after a successful one. Productivity is higher for the two pairs nesting on Lough Derg (a large, productive, mesotrophic, inland lake) compared to the remaining pairs whose nests are more coastal and/ or located near oligotrophic lakes. Overall, distances between neighbouring nests are larger and productivity lower than in most other European countries, but this is not unexpected during this relatively early stage of the reintroduction programme.

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Linking seabird behaviour with their space use enhances marine conservation

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Seabirds are at direct risk from a range of human-related threats at sea, notably, from fisheries as well as the renewable energy and petroleum industries. But such risks are behaviour dependent. Whereas a transiting bird will not be affected by an oil spill, a resting bird will, and the opposite is true for wind turbine collisions. Thus, it is vital to combine the behavioural ecology of seabirds with their spatial ecology if we are to be effective in conserving them. By combining GPS tracks of seabirds with high resolution environmental data from their environment we can identify areas of behavioural space use, adding to previous work which identified space use alone, without differentiating behaviours. We achieve this by applying state space models to fine scale tracking data which allows us to tease apart three distinct behaviours, namely, resting, foraging and transiting. We then correlate these behaviours with relevant environmental data such as those areas with high primary productivity; indicative of suitable food patches for seabird species. What is more, we identify when these behaviours occur, adding a temporal dimension to our work. Here, we showcase some of our research by identifying behavioural space use of two far-ranging seabird species, the European Storm Petrel *Hydrobates pelagicus* and the Manx Shearwater *Puffinus puffinus*, encompassing populations of each species from Ireland and the United Kingdom over multiple breeding seasons. If we improve our understanding of seabird spatial ecology in marine systems by including a behavioural component then we are better placed to advise relevant industries as to the placement of their infrastructures, their shipping lanes and so on, an essential step in 21st century marine conservation.

The importance of grassland and bog habitats for birds in Ireland

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Declines of habitat specialist birds in Europe are largely associated with land-use change. A better understanding of the importance of specific habitats for birds in Europe is needed to inform appropriate conservation management. This study investigated bird communities in four open habitat

types in Ireland: improved and wet grasslands, and raised and blanket bogs. Bird and habitat surveys were conducted at 80 study sites using transects. Data from 142.2 km of transects, covering an area of 2844 hectares, was collected. The relative importance of each habitat for a number of bird groups was investigated using GLMMs on group species richness and density data. The bird groups used were: all birds; tree-, hedge- and scrub-associated birds; open-habitat specialist birds; red-listed birds and migrant birds. Total bird species richness and density and the species richness and density of tree-, hedge- and scrub-associated birds were highest in wet grassland. Raised bog supported the highest species richness and density of open-habitat specialist and red-listed birds. Red-listed bird species richness and density were significantly lower in improved grassland than in other habitat types. Migrant species richness was highest in wet grassland and migrant density was highest in raised bog. Migrant species richness and density were lowest in blanket bog. The vegetation and environmental features within each habitat were responsible for the variation in species density and richness between habitats. Higher species richness of tree-, hedge- and scrub-associated birds was found closer to plantation forest edges in all habitats, and higher densities of this group were found closer to plantation forest edges in all habitats except improved grassland. Lower densities of open-habitat specialist species occurred adjacent to plantation forest edges in raised and blanket bog. Findings from this study are important for the development of land and habitat management policy that can support the protection of birds of conservation concern.

A novel and highly targeted results-based agri-environment measure for the protection of ground-nesting meadow birds

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The design and implementation of agri-environment schemes needs to be greatly improved if schemes are to effectively deliver benefits to farmland biodiversity. The Results-based Agri-environmental Pilot Scheme (RBAPS) is trialling novel results-based measures in the Shannon Callows. In this scheme, farmers who produce higher quality biodiversity outputs (i.e. better 'results') receive a higher payment. A Species-rich Flood Meadow measure operated in the Shannon Callows in 2016-17, where participant farmers were paid according to the quality of meadow they produced, with quality determined primarily using botanical indicators. Some of these meadows hold breeding populations of Curlew

Numenius arquata and Whinchat *Saxicola rubetra*, two red-listed, ground-nesting species of conservation concern in Ireland. As mowing poses a significant threat to the successful breeding of these populations, farmers in the measure had a voluntary option to delay mowing on meadows where the birds were present in return for a higher payment rate. The aim of this option was to improve the breeding success of Curlew and Whinchat by reducing the negative impacts of mowing. For Whinchat, eight pairs were monitored in 2016 and nine in 2017. In both years, Whinchat breeding success and productivity was higher on RBAPS participant sites compared to control sites. Only three pairs of Curlew were recorded across 2016 and 2017 and none exhibited signs of successful breeding. Our results suggest that a highly targeted results-based approach can contribute to the conservation of ground-nesting birds, while also conserving and enhancing the habitats on which they rely. The results-based approach facilitates improved farmer participation and ensures that participants receive a higher financial reward for a greater biodiversity output. Additionally, this approach can improve scheme cost-effectiveness and provides some in-built scheme monitoring. We therefore recommend that future agri-environment measures explore the value of a similarly tiered and highly targeted results-based approach where possible.

Yellow-legged Gulls

***Larus michahellis* in Irish waters**

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Yellow legged Gull *Larus michahellis* is considered a scarce passage migrant and winter visitor to Ireland, originating from continental Europe where the species is undergoing a breeding range expansion which now includes several pairs nesting in Britain. This range expansion, coupled with improved observer awareness, has led to an increase in Yellow-legged Gull sightings in Ireland during recent years, typically in the south and east of the country along with two records of birds paired with Lesser Black-backed Gulls *Larus fuscus* at breeding colonies. Offshore surveys for seabirds in Irish waters during the late 1990s and early 2000s recorded Yellow-legged Gull as a rare visitor. More recent dedicated surveys for seabirds on RV *Celtic Explorer* and RV *Celtic Voyager* produced a total of twelve observations (numbering fifteen birds) of Yellow-legged Gull in Irish waters between March 2012 and October 2016. Most birds observed (11) were recorded in the Celtic Sea off Co. Cork and Co. Wexford during October. Further records included birds seen off the west coast of Ireland (Porcupine Seabight and Porcupine Bank region) in March (1), May (2) and July (1). The age profile was made up of five adults (33%), four third-year (26%), three

second-year (20%) and three first-year (20%) birds. Behavioural observations revealed strong associations with flocks of Lesser Black-backed Gulls and suggested that Yellow-legged Gulls preferentially forage in association with fishing vessels in Irish waters with >80% of birds observed noted as following fishing vessels. A single bird was observed associating with a group of three Fin Whales *Balaenoptera physalus* over the Porcupine Seabight and foraging for fish at the water's surface with Black-legged Kittiwakes *Rissa tridactyla*. These observations suggest that Yellow-legged Gull is now occurring more regularly in Irish waters than previously reported and is to be expected in the Celtic Sea during autumn.

Goaded by a gadfly: observations of endangered petrels in the northeast Atlantic

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We report on the observations of two species of endangered gadfly petrel recorded in the offshore waters west of Ireland during dedicated surveys for seabirds. A Bermuda Petrel *Pterodroma cabow* was seen on 19 May 2014 from RV *Celtic Voyager* while over the western slope of the Porcupine Bank approximately 170 nautical miles west-northwest of Slea Head, Co. Kerry, thus inside the Irish Economic Exclusive Zone (hereafter EEZ). A Zino's Petrel *Pterodroma madeira* was seen on 20 April 2017 from RV *Celtic Explorer* while over the Lorient Knoll area, approximately 410 nautical miles west of Slyne Head, Co. Galway, thus outside the Irish EEZ. Both birds were photographed and identification was verified by relevant seabird authorities. These records provide the first at-sea observation of Bermuda Petrel in the northeast Atlantic and the most northerly observation of Zino's Petrel to date. Tracking studies using geolocators fitted to birds at breeding sites have shown that both species range into Irish waters on foraging trips during spring and early summer (March to June) with non-breeding or failed breeding Bermuda Petrels and pre-egg laying Zino's Petrels likely to be involved. Both species are classified as 'endangered' on the IUCN Red List of Threatened Species due to their extremely small population size (120 breeding pairs of Bermuda Petrel and 45 breeding pairs of Zino's Petrel) and vulnerability of the breeding colonies. Despite a small sample size, these at sea observations not only confirm the presence of both species

utilising the waters west of Ireland as suggested by tracking studies, but also highlight the value of offshore seabird surveys in monitoring species of conservation concern as required under Article 12 of the EU Birds Directive. These data are essential for assessing risk and managing Ireland's offshore waters.

Colour ringing study of breeding urban and coastal gulls in Dublin

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The Herring Gull *Larus argentatus*, Lesser Black-backed Gull *Larus fuscus* and Great Black-backed Gull *Larus marinus* are the three most numerous large gull species in Ireland. All of these species are listed as being of high conservation concern due to significant and sustained declines in their breeding populations. In recent decades Herring Gulls and Lesser Black-backed Gulls have started to nest on rooftops in Dublin city and are now a common sight in the city centre. The relationship between man and breeding gulls in Dublin city is fraught. Breeding gulls will vigorously defend their young and may swoop at anyone who comes too close to a nest or chicks. Rogue individuals will brazenly steal sandwiches and snacks from unwary people as gulls have come to associate humans with food. In recent years this natural urge to protect and feed their young has resulted in ill-informed and disproportionate criticism of urban gulls, particularly during the breeding season. Very little study has been undertaken on breeding urban gulls in Ireland. The Irish Midlands Ringing Group (IMRG) commenced a colour ringing study of breeding urban and coastal large gulls in Dublin during summer 2017. IMRG placed uniquely numbered red leg rings on 90 urban gull pulli (primarily Herring Gull) on 13 rooftops in Dublin city centre and 135 coastal gull pulli on Ireland's Eye (Herring Gull 90 and Great Black-backed Gull 45). The red colour rings have a number sequence 000: D to 999: D which will allow birds to be identified as individuals. Twenty one (9%) of the 225 colour ringed birds have been re-sighted in the eight weeks since ringing. The longest recorded movement was 65 km from Ireland's Eye in Dublin to Arklow in Wicklow. Future sightings of colour ringed gulls will be used to look at the size of the urban breeding population, dispersal patterns, survival rates and longevity. In 2018 it is hoped to increase the number of urban gull pulli with colour rings, complete nest record cards and study the food sources used to feed chicks.

Annual survival, movement and site fidelity of a House Sparrow *Passer domesticus* population in Tipperary

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The Irish House Sparrow *Passer domesticus* population is stable, however, the species is amber listed due to moderate ongoing declines across Europe. It is not possible to age House Sparrows using plumage features after the end of October because all birds complete a full moult. House Sparrows are “net shy”, consequently, it is difficult to recapture birds to study annual survival rates. Birds that reach breeding age at one year old have a typical lifespan of three years. The House Sparrow population in Templemore, County Tipperary has been the subject of a targeted colour ringing and re-sighting study for the last five years. Over 1,400 birds have been coloured ringed at one site since February 2013. This project has been registered as a RAS project (Ringing Adults for Survival) with the British Trust for Ornithology, due to the high number of adult birds colour ringed. Ringed birds vary in age from 0–6 years with 70% of these ringed as recently fledged juveniles. Over 7,000 re-sightings of colour ringed birds have been generated by the author within two km of the ringing site. Re-sightings provide data on site fidelity, seasonal movement, longevity, annual survival and sex related survival rates. The annual RAS re-sighting period runs from April to August each year. In the 2016 RAS season, 127 birds born in previous years were re-sighted. Adult House Sparrows re-sighted in the 2015 RAS season had a minimum survival rate of 53% in 2016. Birds are sedentary with 77% of individuals re-sighted at the ringing site and 25% of birds only re-sighted at the ringing site during the 2016 RAS season. Eighty percent of birds re-sighted in 2016 had been ringed since 2014. Males appear to have a better survival rate than females with males accounting for 59% of birds re-sighted in the 2016 RAS season. Very little work has been performed on nesting ecology and breeding productivity because birds have made almost no use of nest boxes provided probably due to abundant natural nest sites. Future work will focus on continuing colour ringing, surveying the breeding population and using re-sightings to obtain a population estimate.

Habitat utilisation and behavioural ecology of wintering Mediterranean Gulls *Larus melanocephalus* in south County Dublin

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The Mediterranean Gull *Larus melanocephalus*, formerly a near-endemic of the Mediterranean-Black Sea region has accomplished a dramatic colonisation of Central and North Western Europe over the last fifty years. The wintering distribution of Mediterranean Gulls in Europe is being studied by a number of closely coordinated colour ringing schemes. A wintering population of Mediterranean Gulls has used Sandycove in south County Dublin as a day roost since 1999. Regular census and colour ring observations have been used to examine this flock's expansion, habitat utilisation, survival rate, site fidelity and migration pattern. Thirty four Mediterranean Gulls have been fitted with yellow rings at Sandycove since 2011. Over 2,400 sightings of 90 colour marked individuals ringed in Ireland, United Kingdom, France, Belgium, Netherlands, Denmark, Germany, Poland, Hungary and the Czech Republic have been recorded in south Dublin in that period. The oldest bird observed was over 14 years old. The maximum annual count of Mediterranean Gulls in south Dublin has increased by over 900% from 32 in 2003 to 293 in 2015. Colour and metal ring observations show that this expansion has been achieved solely through the recruitment of immature birds and a high survival rate of approximately 78%. Mediterranean Gulls have been recorded in all months at Sandycove. Breeding birds start to return in late June with numbers peaking between July and September. Two thirds of the flock depart by the end of October to winter in France and Portugal with most of the remaining birds leaving Sandycove to breed by mid-March. Dublin-based Mediterranean Gulls have been observed at breeding colonies in France, Netherlands, Germany and Poland. There is very little interaction between the Dublin flock and the other major Irish wintering flock at Whitegate in Cork. Lady's Island in Wexford holds the largest breeding colony of Mediterranean Gulls in Ireland with over 70 pairs in 2016. Only one of the 52 pulli ringed at Lady's Island between 2015 and 2017 has been recorded in Dublin. The south Dublin Mediterranean Gull flock behaves in a highly habitual daily manner. Birds arrive at dawn at the Cabinteely football fields to feed on invertebrates, lounge at Sandycove during the day and arrive at sunset on Booterstown Strand to roost on the sea. The highly clumped aggregation of Mediterranean Gulls in Dublin mirrors distribution patterns observed in continental Europe.

Intertidal habitat creation– Kilmacleague Compensatory Wetlands, Tramore, Co Waterford

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The Kilmacleague Compensatory Wetlands, owned by Waterford City and County Council, were created in the spring of 2013 as compensation for damage caused to Tramore Back Strand Special Protection Area and Special Area of Conservation. Intertidal habitat was created through breaching the seawall and allowing part of the Kilmacleague fields to be inundated with seawater. The benthic fauna of the intertidal habitat and its use by waterbirds was monitored during winter 2016-2017; the fourth winter since the seawall was breached. Survey work was funded by the Heritage Council (Waterford Heritage Plan Fund 2016-2017). A diversity of waterbirds was found to use the created intertidal habitat, including seven species listed for Tramore Back Strand SPA, however only two macroinvertebrate species were recorded: lugworm *Arenicola marina* and the amphipod *Corophium volutator*. Waterbird foraging activity appeared linked to this availability. Herbivorous Light-bellied Brent Goose *Branta bernicla hrota* and Wigeon *Anas penelope* foraged on green macroalgae, while Dunlin *Calidris alpina* and Redshank *Tringa totanus* likely fed on *Corophium volutator*, with Curlew *Numenius arquata* attracted to the available lugworms. Waterbird foraging is likely limited by the impoverished benthic fauna with birds that specialise upon bivalves or a wider range of polychaetes unlikely to utilise the created habitat. We found that the intertidal habitat does not drain fully at low water and fills slowly on a rising tide, not always completely filling at high water. While the results highlight that intertidal habitat creation is not necessarily straight-forward, with some remediation works needed at Kilmacleague, they do show that waterbirds will use created habitats. Kilmacleague is a good example of how ‘managed realignment’, an estuarine habitat management tool, whereby sections of flood defences are moved inland to create intertidal habitat, could be used as a ‘soft-engineering’ approach to combat the increasing risk of sea level rise and flooding.

Light-bellied Brent Goose *Branta bernicla hrota* at Sruwaddacon Bay, north-west Co. Mayo

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Sruwaddacon Bay, located on the north-eastern side of Broadhaven Bay in north-west Co. Mayo, is a constituent part of the wetland complex designated as the Blacksod Bay/Broadhaven Special Protection Area (SPA) under the EU Birds Directive. It and nearby inner parts of Broadhaven Bay have been monitored intensively since 2002 in connection with the Corrib Gas Development. Using these monitoring data, the importance of the study area for Light-bellied Brent Goose *Branta bernicla hrota*, in the context of the wider wetland complex was assessed. This revealed that the study area supports internationally important numbers on occasion, and that numbers have increased over time, in line with trends observed across the wider wetland complex and at national level. Of interest was the pattern for increasing numbers within the study area into March and April. Examination of data in light of theoretical definitions of staging and stopover sites suggests that the study area, comprising Sruwaddacon Bay and adjacent sections of Broadhaven Bay, may be a staging ground for a proportion of the wintering population of Light-bellied Brent Goose.

Using within-site level trends of non- breeding waterbirds as a monitoring tool: a case study using data from Sruwaddacon Bay, Co Mayo

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Wintering waterbirds of Sruwaddacon Bay, Co. Mayo, have been subject to intensive monitoring since 2002 in connection with the Corrib Gas Project. Sruwaddacon Bay is, in turn, part of the larger Blacksod Bay/Broadhaven site complex which is monitored each winter by the Irish Wetland Bird Survey. The combination of detailed site and site complex data enabled trends in waterbird numbers at these two scales to be compared and contrasted, while site trends for Sruwaddacon Bay were examined in light of national, all-Ireland and international level trends. The ‘site’ trends calculated for Sruwaddacon Bay were positive (increasing/stable numbers) for six of the nine selected study species, with declines noted for Ringed Plover *Charadrius hiaticula*, Dunlin *Calidris alpina* and Redshank *Tringa totanus*. The decline for Dunlin is consistent with the trend observed at site-complex and national level and it is likely therefore that the broad-scale declines are driving the decline at site level. However, the trends for Ringed Plover and Dunlin were driven by a low index in the final season; having been largely stable previously, so future monitoring will be important to track this further. We discuss the suitability and use of trend analyses for waterbirds at site level, as well as their ability to provide a

means of assessing population change over time and to determine conservation status. In addition, they may provide an important early-warning system to identify the start of potential longer-term declines; whilst overall being a useful tool in practical ecological monitoring and management programmes.

Waterbird populations on non-estuarine coasts in the Republic of Ireland: results of the 2015/16 Non-Estuarine Coastal Waterbird Survey (NEWS-III)

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A national survey of waterbirds on non-estuarine coasts was carried out in December 2015 and January/February 2016; organised under the auspices of WeBS and I-WeBS, the national waterbird monitoring schemes in Northern Ireland and the Republic of Ireland respectively. NEWS-III represents the third full national survey, undertaken nine years after the second in 2006/07 (NEWS-II). A total of 2,095 km of non-estuarine coastline was covered across Northern Ireland and the Republic of Ireland, representing 63% of available coastline. Observers recorded all waterbirds seen in three broad-scale habitats (sea, intertidal and land). A total of 110,061 birds of 72 species was recorded including 36 wildfowl species (and their allies), 22 wader species, 12 gull species, one tern species (Sandwich Tern *Sterna sandvicensis*) and Kingfisher *Alcedo atthis*. Waders were the most numerous group comprising 43% of the total waterbirds counted, with the majority recorded in the intertidal zone. The Herring Gull *Larus argentatus* was the most numerous species overall, with a total count of 19,681 birds. Oystercatcher *Haematopus ostralegus* was the most numerous wader and the most widespread species overall. Curlew *Numenius arquata*, Dunlin *Calidris alpina*, Lapwing *Vanellus vanellus* and Ringed Plover *Charadrius hiaticula* were also numerous among the waders. Cormorant *Phalacrocorax carbo* and Common Scoter *Melanitta nigra* were the most numerous wildfowl species. Highest densities of wildfowl were each recorded in the eastern region while wader densities were highest in the northeast. Densities ranged between 5.6 and 20.0 birds per km for wildfowl, and between 12.6 and 45.4 birds per km for waders. We are currently in the process of calculating population estimates and trends for the most

regularly-occurring species and from here will be able to assess the changes in estimates between NEWS-III and NEWS-II, and calculate the proportion of the overall national populations that occur along non-estuarine coasts

Black-tailed Godwits *Limosa limosa islandica* and Redshanks *Tringa totanus* respond differently to macroalgal mats in their foraging areas

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In Clonakilty Bay, southwest Ireland, we examined the effects of macroalgal mats on two shorebird species, Black-tailed Godwit *Limosa limosa islandica* and Redshank *Tringa totanus*, in the winters of 2000-2001 and 2001-2002. In both winters, coverage with macroalgae was variable and declined to zero by January. Godwit densities decreased over the course of each winter, while Redshank densities showed an increase. Godwits were more numerous in the second winter, while Redshanks were more numerous in the first winter. These opposite intra-seasonal and annual trends are not consistent with a general negative effect of algal mats on shorebirds. The potential effects of macroalgae were assessed through (1) association between site use (expressed in bird-days) and environmental parameters (macroalgal cover and biomass, prey densities, sediment silt content and organic matter), (2) individual habitat selection, and (3) foraging behaviour. Strong positive correlations between site use and prey densities were found for both shorebirds. Site use by Redshanks was negatively correlated with algal cover, but this was not the case for godwits. The foraging behaviour of both species was affected by algae, but in a different manner. Godwits made about 30% fewer foraging attempts in algal patches than in clear patches, but foraging success was similar in both. Redshanks attempted prey captures at similar rates in clear and algal patches but success was 50% lower in the latter. This suggests that Redshanks may be constrained in obtaining their required daily energy intake on algal covered mudflats in contrast to godwits. How much the observed increase in Redshank densities over the winter (when godwit densities decrease) is related to inter-specific interference or to the decline in algal cover remains an interesting research question.

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Breeding ecology and habitat selection of Merlin *Falco columbarius* in forested landscapes

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Breeding Merlin *Falco columbarius* have a widespread but sporadic distribution in upland habitats in Ireland. As Merlin use a variety of habitats in or adjacent to open country and specialise on open-country passerines, they may be especially susceptible to land use changes. In recent decades, the upland landscape within the breeding range of Irish Merlin has been significantly altered through the extensive afforestation of previously open habitats. We compiled data on Merlin to determine long-term trends in breeding performance and to examine habitat selection in a country with one of the fastest rates of afforestation in Europe. Merlin had a breeding success rate of 74% ($n = 300$), and productivity of 2.1 young per breeding attempt ($n = 265$) between 1982 and 2014. Breeding parameters remained constant over the 33-year study period, despite an increase of more than 75% in forest cover. Merlin showed positive selection for moors and heathland, peat bogs and natural grasslands, and breeding success was also positively influenced by the proportion of these land uses surrounding nests. The majority of Merlin nest sites ($n = 183$) were located in trees (99.5%), with a positive selection for conifer plantations. Moors and heathland were strongly selected as an adjacent land use to nest sites. Most nests were located within 10 m of the forest edge, and in forests aged between 31 to 40 years. Merlin breeding performance suggests no long-term effects of increased afforestation on the ability of the species to reproduce. Although Merlin predominantly nested in conifer plantations, the presence of suitable open habitats influenced nest site selection and breeding success. However, nesting preference of Merlin make them vulnerable to disturbance from forest operations, and this requires mitigation.

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Using top predators to assess impacts and changes in small mammal communities

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Introduced species can impact biodiversity through outcompeting native species and affecting ecosystem processes. Small mammal communities and distributions on the island of Ireland have and are continuing to change considerably due to the arrival and range expansion of introduced and invasive species (Bank Vole *Myodes glareolus* and Greater White-toothed Shrew *Corcidura russula*), with implications for small mammal populations and the wider ecosystem. We investigated the response of a small mammal specialist, the Barn Owl *Tyto alba*, to this change and used diet data to assess small mammal distribution and species diversity at a landscape and localised scale. Barn Owl diet was assessed at 115 nest and roost sites throughout Ireland via analysis of pellets collected between 2006 and 2016. A total of 17,627 prey items were identified, of which the majority (97%) were small mammal species ($n = 6$). Wood Mouse *Apodemus sylvaticus* ($n = 4,777$) was the most important prey item in terms of biomass (28.9%), followed by Bank Vole ($n = 4,410$; 25.4%) and Greater White-toothed Shrew ($n = 4,536$; 18%). Species composition varied spatially, Greater White-toothed Shrew was the most important prey item within their range (38.1%), as was Bank Vole (27.5%). Both species constituted >80% of Barn Owl diet at individual sites in their core range. Pygmy Shrew *Sorex minutus* was absent in pellets at all sites ($n = 31$) where Greater White-toothed Shrew exceeded 10% of the diet, and our data indicates further range reduction for this species with the expanding Greater White-toothed Shrew population. We showed that analysis of predator diet is a reliable, non-invasive method for determining small mammal distribution and species diversity, and confirmed a range expansion for Bank Vole and Greater White-toothed Shrew, including satellite populations of the latter in the mid-west.

Barn Owls *Tyto alba* and major roads: understanding individual behaviours and population responses to inform mitigation

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Due to their hunting behaviour, low flight and poor peripheral vision, Barn Owls *Tyto alba* are especially vulnerable to vehicle collision. Several studies to assess avian mortality on major roads in Europe and North America have recorded Barn Owl as the most affected raptor and/or species. How Barn Owls interact with major roads is poorly understood, which has compromised the development of appropriate mitigation solutions. We investigated Barn Owl mortality on major roads

in Ireland to determine the extent of road deaths and the factors which influence collision risk, and assessed individual and population responses to major roads. Preliminary results show road mortality is a major cause of death for Barn Owls in Ireland. Of 387 mortality incidents (2008-2017), 277 (71.5%) were attributed to vehicle collisions, of which the majority were on motorways (58.8%). A road casualty survey (ongoing) over 144 weeks on the Tralee By-pass (13.5 km) and 76 weeks on the M8 motorway (96 km), estimates a mortality rate of 75-100 Barn Owls per 100 km per year on these routes when the number of carcasses recovered are adjusted for search and removal bias. Analysis of mortality locations on the M8 show that collision does not occur at random, and is influenced by the width of grass verges. Juveniles are killed with greater frequency than adults, with peaks in mortality during the post-breeding dispersal period. A breeding density survey (2016-2017) in study areas encompassing the Tralee By-pass (195 km²) and M8 (800 km²) and control areas of the same dimension without major roads, suggest that Barn Owl breeding densities and distribution is not influenced by these routes. We used GPS data loggers on 13 breeding adults (2016-2017) to inform our understanding of Barn Owl foraging selection and movement patterns in relation to major roads, which should help inform mitigation.

How many Woodpigeons *Columba palumbus* in the urban environment? Some observations from Cork city

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The Woodpigeon *Columba palumbus*, an obligate herbivore, is well known to be a pest of cereal and horticultural crops. However, the species is also a hazard to aviation and considerable damage may follow its ingestion into a jet engine. A recent estimate puts the total number of Woodpigeons in Ireland at 2.3 million (upper bound 3.17 and lower bound 2.15 million) individuals – following a major increase that commenced in the 1990s (BTO data). Woodpigeons are known to occupy two major habitats in Ireland, namely urban and rural and that the former breed in the spring while the latter do so in the late summer and autumn. In Cork City, 2016 and 2017 springtime densities ranged from 1.5 (1.0-2.5) birds per ha in commercial areas to 5.6 (3.3-9.8) birds per ha in city parks. Specifically, Woodpigeons had the highest densities in city parks in the core of Cork city – 8.6 (3.5-21.4) birds per ha. The purpose of our study is to estimate the numerical abundance of Woodpigeons in Cork city based on surveys conducted during the winter, and during the spring and summer.

Assessing the suitability and presence of breeding Merlin *Falco columbarius* in the Duhallow region

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In Ireland, breeding Merlin *Falco columbarius* have a widespread but sporadic distribution across upland habitats, typically nesting in planted forest. Due to their nest site selection, low population densities and secretive breeding behaviour, it is accepted that Merlin are a difficult species to census. This is reflected in the few published studies on Merlin in Ireland. Monitoring of discrete populations has provided information on Merlin nesting ecology and short term regional trends, however information on the distribution, trends and conservation requirements for the Irish population is lacking. This is particularly the case in the south west, where there has been no targeted monitoring, and limited evidence of breeding Merlin recorded by multi species surveys, despite areas of apparently suitable habitat. We investigated occupancy of breeding Merlin in selected upland areas in Duhallow (north Cork and east Kerry) through collating available evidence and survey work. We collated 24 records of Merlin in Duhallow between 2007 and 2017, of which six records were in areas of suitable habitat during the breeding season. Nine distinct survey areas of 41 km² combined were selected on previous evidence of breeding Merlin and habitat suitability. These areas were extensively searched for Merlin using best practice survey techniques between May and July 2017. Survey work was carried out over 298 hours, which included 88 hours sign searching and 210 hours conducting vantage point watches. Despite this survey effort no Merlin were observed and no signs which could be attributed to the species were confirmed. This is the first study to focus on Merlin in the south west. Our results indicate that Duhallow can support breeding Merlin based on recent evidence in habitat considered to be suitable, however, the results of survey work indicate that densities are likely to be low, and occupancy in the area may be sporadic.

Breeding season and wintering diet of Hen Harriers *Circus cyaneus* in the south-west of Ireland

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The ongoing analysis of Hen Harrier *Circus cyaneus* pellets and prey remains is helping to shed light on the breeding and

wintering diet of this raptor across the south-west of Ireland. This work is funded through the EU Life+ RaptorLIFE project implemented by IRD Duhallow. To date, over 100 pellets and prey remains have been collected from 13 nests and one large communal winter roost. Preliminary results show a marked difference between breeding season and wintering diet. The breeding season diet of Hen Harriers is dominated by small passerines (71% of the diet by number of prey items) with small mammals, primarily Bank Vole *Myodes glareolus*, comprising 27% of the diet. The remaining 2% includes Rabbit *Oryctolagus cuniculus* and non-passerines such as Snipe *Gallinago gallinago*. Twelve species of small passerine, including Bullfinch *Pyrrhula pyrrhula*, Meadow Pipit *Anthus pratensis* and Wren *Troglodytes troglodytes* have been identified thus far. Though small passerines remain the most important prey group during the winter months (58%), small mammals comprise a significantly higher proportion of the wintering diet (42%) compared to the breeding season diet. The remains of beetles were also found within pellets during both seasons. However, it is unknown whether these were deliberately targeted by Hen Harriers, or whether they were secondary prey from the stomachs of prey species. Further work is necessary to identify prey remains to species level through the use of advanced methods such as genetic analysis. Furthermore, pellets and prey remains collected during the 2017 breeding season, including from nests within the Greater White-toothed Shrew *Crocidura russula* range, have yet to be analysed. These, together with future collections at the communal winter roost and nest sites, will enable a comprehensive assessment of Hen Harrier diet in this part of the species' range. This will help to inform management practices to benefit Hen Harrier prey at both the farm and landscape level.

Invading and expanding: range dynamics and ecological consequences of the Greater White-toothed Shrew *Crocidura russula* invasion in Ireland

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Establishing how invasive species impact upon pre-existing species is a fundamental question in ecology and conservation biology. The Greater White-toothed Shrew *Crocidura russula* is an invasive species in Ireland that was first recorded in 2007 and which, according to initial data, may be limiting the abundance and distribution of the Pygmy Shrew *Sorex minimus*, previously Ireland's only shrew species. Because of

these concerns, we undertook an intensive live-trapping survey and used other data from live-trapping, sightings and Barn Owl *Tyto alba* and Kestrel *Falco tinnunculus* pellets and prey remains, collected between 2006 and 2013 to model the distribution and expansion of the Greater White-toothed Shrew in Ireland and its impacts on Ireland's small mammal community. The main distribution range of the Greater White-toothed Shrew was found to be approximately 7,600 km² in 2013, with established outlier populations suggesting that the species is dispersing with human assistance within the island. The species is expanding rapidly for a small mammal, with a radial expansion rate of 5.5 km per year overall (2008-2013), and independent estimates from live-trapping in 2012-2013 showing rates of 2.4-14.1 km per year, 0.5-7.1 km per year and 0-5.6 km per year depending on the landscape features present. Pygmy Shrew is negatively associated with Greater White-toothed Shrew. Pygmy Shrew is completely absent at sites where Greater White-toothed Shrew is established and is only present at sites at the edge of and beyond the invasion range of Greater White-toothed Shrew. The speed of this invasion and the homogenous nature of the Irish landscape may mean that Pygmy Shrew has not had sufficient time to adapt to the sudden appearance of Greater White-toothed Shrew. This may mean the continued decline or disappearance of Pygmy Shrew as Greater White-toothed Shrew spreads throughout the island.

The breeding gulls of the Lough Mask Special Protection Area, County Mayo

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A census of breeding gulls has taken place annually between 2010 and 2017 within the Lough Mask Special Protection Area (SPA 004062) in County Mayo. This site contains a significant proportion of the inland-breeding population of Black-headed Gull *Chroicocephalus ridibundus*, Common Gull *Larus canus* and Lesser Black-backed Gull *Larus fuscus* in Ireland where they are considered to be species of conservation concern due to a contraction in both breeding range and population size. Between 2010 and 2017 the Black-headed Gull population has ranged between 1,091 and 189. Apparently Occupies Nests (AONs) with the low figures often corresponding with higher numbers breeding on the adjacent Lough Carra in years of high water levels. During the same time-frame the breeding population of Common Gull has decreased from 230 to 145 AONs, whilst there has been a significant increase in Lesser Black-backed Gull from 247 to 360 AONs. These fluctuations may be due to external causes as no significant habitat change or large scale predation events

were noted within the site during these census years. In tandem with this study a colour-ringing scheme targeting these three species was carried out between 2006 and 2015 in order to obtain information on dispersal patterns, survival rates, site fidelity and longevity. On Lough Mask a small number (three to five AONs) of Great Black-backed Gull *Larus marinus* also breed annually and breeding was also confirmed by single pairs of Mediterranean Gull *Larus melanocephalus* in both 2013 and 2017.

The breeding seabirds of Inishturk and outliers, County Mayo

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An annual census of breeding seabirds has been carried out since 2008 on Inishturk, an inhabited island located approximately 9 km off the south Mayo coast. Inishturk supports breeding populations of at least 13 seabird species with an additional two or three species occurring on adjacent outlying islands. These latter, uninhabited islands (Caher, Ballybeg, Inishdalla and Mweelaun) are difficult to access, and have only been surveyed intermittently. Northern Fulmar *Fulmarus glacialis*, Shag *Phalacrocorax aristotelis*, Black Guillemot *Cepphus grylle* and Great Black-backed Gull *Larus marinus* occur in nationally important numbers on Inishturk and the site now holds the second largest Irish breeding population of Northern Fulmar. Dramatic increases in Kittiwake *Rissa tridactyla*, Guillemot *Uria aalge* and Razorbill *Alca torda* populations have occurred since the Seabird 2000 census, followed by a decrease since 2015. It is hoped that a comprehensive survey of burrow-nesting species will take place in 2018. The accessibility of its seabird colonies, their high species diversity and its regular ferry service makes Inishturk an ideal location for long-term seabird monitoring studies on Ireland's west coast.

Bird sensitivity mapping for wind energy developments and associated infrastructures in the Republic of Ireland

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Wind energy, as part of a sustainable energy mix in Ireland, can help to reduce greenhouse gas emissions and so reduce climate impact. However, we also have obligations under European law to ensure that the expansion of wind energy

developments does not impact on protected habitats and species. The potential impact of wind energy developments on protected bird populations includes collision with turbines, loss of habitat, disturbance and obstruction of movements (i.e. barrier effects). This project gave a measured spatial indication of where protected birds are likely to be sensitive to wind energy developments. By assessing the characteristics of a selected number of the most-sensitive bird species, a simple mapping tool has been developed as a pre-planning tool for industry, government and conservation practitioners. For the 22 most sensitive species, expert opinion was combined with available data on 'risk' to give a "species sensitivity score" for these species. Then, using trusted distribution data for each species, a combined picture of bird sensitivity to wind energy was developed. A total of 25 participants from the energy sector and government departments and agencies contributed to the development of appropriate guidance and format, and in targeting user groups. The roll out of the mapping tool and guidance involved local authority, National Parks and Wildlife Service and consultant professionals. The map, at a 1 km² resolution for mainland Republic of Ireland, uses a graduated colour scheme based on species sensitivity and species richness. This is accompanied by introductory information on individual species' ecology and characteristics which increase their sensitivity to wind energy, and a full guidance document outlining the project justification, details on the mapping process and detailed species-level literature reviews. The tool and its associated guidance material are publicly accessible on the BirdWatch Ireland website and are integrated onto the majority of local authority planning maps.

Survey of breeding wader populations at machair and coastal wetland sites in north-west Ireland, 2017

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In Ireland, severe losses in population and range of breeding waders have been recorded. This study assessed seven breeding wader populations at 34 sites on machair and coastal wet grassland sites in north-western Ireland in 2017. Across 25 sites a total of 491 pairs was recorded; Tory Island and Inch, both being counted comprehensively for the first time, had 172 and 78 pairs respectively, whilst Rinmore, the third most important site, had 37 pairs. Almost half the sites had less than three pairs. Fifteen sites were surveyed in 1985, 1996, 2009 and 2017. A comparison of Lapwing *Vanellus vanellus* and Redshank *Tringa totanus* populations across these sites shows that overall the populations declined by 35% since

1985, but since 2009, have increased by 73%, mostly as a result of a 144% increase recorded at three sites protected by predator fences in 2012/13. Unfenced sites declined by 4% since 2009. For all species, declines of up to 48% in breeding density were recorded, together with a contraction in the overall range. The complete loss of breeding Dunlin *Calidris alpina* (21 pairs from 6 sites) recorded in 2009 was confirmed. However, six pairs were recorded on Tory Island. Lapwing productivity was also assessed; productivity was zero at several sites, including one fence site, Sheskinmore. Productivity was very low on Tory Island, indicating possible significant problems with avian predation of eggs and chicks. At only two sites, Bunduff and Inch, was productivity above the level required to maintain populations. These results demonstrate the continued severe plight of breeding waders in Ireland. However, it also shows how active management programs, such as predator exclusion fences, can allow local population recovery over short timescales, though long-term productivity, even at these sites, needs further action to bring about sustainable increases.

Population dynamics and nest site selection of Hen Harriers *Circus cyaneus* in the Mullaghareirk Mountains, south-west Ireland

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Hen Harriers *Circus cyaneus* in the Mullaghareirk Mountains (north Cork, east Kerry) were studied (EU funded RaptorLIFE project) to determine breeding success, population trends and to identify limiting factors for the population. Although national and regional population trends for Hen Harrier are largely negative, with the Stack’s to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle Special Protection Area (SPA 004161) population declining since 2005 (-37.7%), the study population has remained stable since 2015. Breeding pairs have been lost at three traditional sites in recent years, but there have been ‘gains’ at three other sites. However, monitoring was more intense in the current project and it is possible that some sites may have been missed in the national surveys. Breeding success (pairs fledging young) declined from 66.7% in 2016 to 36.4% in 2017. Productivity (young fledged per nesting pair) declined over the past three years (mean 1.8, 1.5, 1.3). Nest monitoring indicated that forestry and peat harvesting operations as well as predation negatively impacted potential nesting and/or breeding success. Despite the nesting association of Hen Harriers with pre-thicket conifer forest in Ireland, and the preponderance of afforested

habitats within this SPA (53%), most harriers in the study area nested in open, non-afforested habitats close to the forest edge. Study nests ($n = 19$) were primarily located in non-afforested habitats (77%). Within the ‘open’ nesting habitats, scrub (50%), in particular gorse scrub (36%), appears to be an important sub-habitat, possibly because the dense cover provides a barrier to potential ground predators. The recent nesting of harriers in non-afforested habitats in the Mullaghareirks may be a response to the decline in pre-thicket forest habitats since 2000 (59% to 25% in 2012) and may be an adaptive switch from sub-optimal or unusable forest habitat following canopy closure to traditional, open nest sites.

Reintroduction of the White-tailed Eagle *Haliaeetus albicilla* to the Republic of Ireland

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White-tailed Eagles *Haliaeetus albicilla* were extirpated as a breeding species in Ireland in the early 20th century. As part of a reintroduction programme for the species in Ireland young eagles were collected from nests in Norway and relocated to Killarney National Park, Co. Kerry. Between 2007 and 2011 one hundred eagles (51 males, 49 females) were released in Killarney. Birds were tagged for identification and tracked in the wild post-release to determine their movements and post-release survivorship. Pairing in the wild began as early as 2010 with the first eggs laid and young fledged in Co. Clare in 2012 and 2013 respectively. White-tailed Eagles now nest annually across four counties: Kerry, Clare, Cork, and Galway. Between 2013 and 2017 twenty-one young eagles fledged successfully from 37 nesting attempts. Breeding success (mean $0.46 \pm \text{SD } 0.28$) and productivity as measured by the number of young fledged per nesting pair (mean 0.50, range 0.14-0.78) and young per successful pair (mean 1.2, range 1.0-2.0) has tended to increase over time. Mortality, most due to illegal poisoning, was high in the first years of the reintroduction but has declined in recent years. To date, 35 White-tailed Eagles (20 males, 15 females), including two Irish bred juveniles, have been recovered dead. Illegal poisoning ($n = 14$) accounted for 40% of all mortalities but 58% of losses when eagles whose cause of death was undetermined ($n = 11$) were excluded. This is one of the highest attrition rates to poisoning in Europe. However, only one adult has been lost to poisoning in the last three years suggesting that increased awareness and cooperation with the farming community as well as the banning of most poisons in 2010 have had a beneficial effect. Other mortality factors

include wind turbine strikes (8.6%) and shooting (5.7%). Despite these losses the outlook for the species recovery and re-establishment is positive.
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Population trends and breeding success of Hen Harriers *Circus cyaneus* in the Ballyhoura Hills

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The Hen Harrier *Circus cyaneus* is listed under Annex 1 of the EU Birds Directive and is a species of conservation concern in Ireland. The Ballyhoura Hills, on the Cork and Limerick border, holds one of the most important harrier populations in the Republic of Ireland. The Ballyhoura population has been monitored by the Irish Raptor Study Group since the 1990s, was surveyed during national Hen Harrier survey years (1998-2000, 2005, 2010, 2015), as well as during an intensive research study by University College Cork (COFORD 2007-11). Monitoring has shown the Ballyhouras to consistently hold a significant proportion of the Irish Hen Harrier breeding population. The population increased from six to eight pairs in 1998-2000 to a peak of 17 to 19 pairs in 2005, declined to ten to fifteen pairs in 2010, ten to twelve pairs in 2015, eight pairs in 2016 and seven pairs in 2017. Thus, the Ballyhoura range held a significant proportion of the Irish breeding population in all years: 5.6-6.2% (1998-2000), 12.4-12.9% (2005), 7.8-8.7% (2010) and 7.6-9.3% (2015). Breeding success ranged from 33-75% tending to be highest in recent years: 60%, 75% and 71% in 2015, 2016 and 2017 respectively. Causes of nest failures included poor weather, predation, recreational and windfarm construction disturbance. Productivity ranged from 0.55-2.1 young fledged per nesting attempt and 1.6-3.0 per successful pair. Almost all harriers in the Ballyhouras now nest in second rotation pre-thicket forest with one to three pairs annually nesting in open, heath and bog habitats. One traditional heather nesting site has been deserted in recent years, likely due to increased recreational disturbance. Though population declines may be mainly related to changes in forest structure, factors such as increased recreational use, especially off-road vehicles, may place additional pressures on the population. Construction (2016-18) and operation of two windfarms (20 turbines) may also have additional impacts. Continued monitoring is planned to determine future trends.

Breeding Great Cormorant *Phalacrocorax carbo* in County Wexford

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Both the Saltee Islands and the Keeragh Islands are designated Special Protection Area's for Great Cormorants *Phalacrocorax carbo*. The first record of the Great Cormorant breeding in County Wexford dates from 1893 when "many" were recorded breeding on Makestone Rock, off Great Saltee Island. Breeding numbers then fluctuated on Great Saltee until the island was abandoned and the population moved to Little Saltee where the population has been censused annually since 1960. Great Saltee was recolonized in 2005 possibly by birds from the Little Saltee colony that had been under pressure from cattle, sheep and deer that had been introduced to the island. The Keeragh Islands were monitored from 1968 to 1991, and monitoring recommenced in 2008. Since 2008 all colonies have been monitored on an annual basis. In that period (2008-2017) the combined number of pairs has ranged between 418 and 587. The colony on Little Saltee has fluctuated from 140 pairs in 2012 to 297 pairs in both 2013 and 2014. Great Saltee has dropped from a peak of 187 pairs in 2009 to as few as 29 in 2014, although some recovery has taken place in recent years. The Keeragh Islands have also fluctuated between 131 pairs in 2008 to 242 pairs in 2009, and in those islands numbers have varied to all on Great Keeragh in 2016 to more on the Little Keeragh in 2017 than on the Great Keeragh.

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Post breeding dispersal of Sandwich Terns *Sterna sandvicensis* from Lady's Island Lake, Co. Wexford

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Lady's Island Lake, County Wexford, is one of Ireland's largest tern breeding colonies, and the site is designated as a Special Protection Area for, among others, Sandwich Tern *Sterna sandvicensis*. This species is the most abundant of the four breeding tern species at the site, with numbers ranging between 825 pairs (in 2002) and 1,958 pairs (in 2009) over the last 20 years. Despite the number of pairs it appears that as soon as juveniles fledge they leave the site and locality and by late July are generally quite scarce locally. With juveniles ringed at other colonies seen in Wexford at autumn aggregations it was decided to replicate a similar study at

Lady's Island Lake. Darvic ringing commenced in 2015 and a total of 209 pullus were ringed that year (from 1,799 pairs). In 2016, 226 pullus were ringed (from 1,682 pairs) and in 2017 236 pullus were ringed (from 1,674 pairs). Of the 2015 cohort, 17 juveniles were seen in that autumn (8.13 %), while in 2016, 43 juveniles were seen (19.03%). In 2017, 42 juveniles were seen (17.79%). All records of juveniles were in Britain and Ireland. While many others were seen in Namibia, South Africa and Guinea Bissau as first winters, they are not included in the above figures. Of the 102 juveniles seen in immediate post breeding dispersal, 92 were seen only at one specific location with ten juveniles seen at two or more localities, some diverse movements have been noted with one 2016 juvenile seen in Dublin and Connemara. The returns will continue to develop data on first-winter, first-summer, second-summer and adult movements.

The status of Mediterranean Gull *Larus melanocephalus* at Lady's Island Lake, Co. Wexford

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Mediterranean Gull *Larus melanocephalus* was first recorded nesting in the Republic of Ireland in 1996 when an adult was seen attending a near fledging chick at Lady's Island Lake, Co Wexford. For the next seven or eight years, breeding was usually confined to a single pair attempting to breed, occasionally successfully but quite often failing. The number of breeding pairs increased to five in both 2003 and 2008. Some pairs which bred contained one or both adults in their second-summer and this was attributed to explaining failures, as it was their first breeding attempt. The number of breeding pairs has steadily increased and reached double figures in 2010. In 2014, 23 pairs were noted, rising to 72 pairs in 2016. Monitoring of nests has shown productivity to be low, particularly in 2012 when the exceptionally wet summer resulted in most chicks dying. However, the good summers of 2013 and 2016 resulted in good productivity, and most of the breeding pairs were considered to have had chicks that fledged. In the spring of 2012 an adult Black-headed Gull *Chroicocephalus ridibundus* and an adult Mediterranean Gull were noted displaying, and that July two hybrid chicks were noted by birdwatchers. In 2013, an adult Mediterranean Gull was also seen attending two just fledged hybrid chicks at the colony. The hybrid nests have not been identified as it is likely they are counted to whichever species the eggs closest resemble during census work. Overall, 74 chicks have been colour ringed on the site, and some have been re-sighted in Madeira, Spain, Portugal, Morocco, France, the Netherlands

and in Britain, as well as back at Lady's Island Lake. In addition, birds ringed as chicks in Belgium, the Netherlands, France and Poland have been seen at and near Lady's Island Lake in south Wexford.

Ecology and conservation management of Lady's Island Lake Special Protection Area, Co. Wexford

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Lady's Island Lake Special Protection Area (SPA 4009) is designated for Black-headed Gull *Chroicocephalus ridibundus*, Sandwich Tern *Sterna sandvicensis*, Roseate Tern *Sterna dougallii*, Common Tern *Sterna hirundo*, Arctic Tern *Sterna paradisaea* and Gadwall *Anas strepera*. The management and protection of Ireland's largest tern colony at Lady's Island Lake by the National Parks and Wildlife Service (NPWS) has been ongoing for many years. Two islands within Lady's Island Lake support the qualifying interest breeding species and other regularly breeding birds such as Shelduck *Tadorna tadorna*, Mallard *Anas platyrhynchos*, Shoveler *Anas chapeata*, Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula* and Redshank *Tringa totanus*. All the breeding species benefit from the SPA conservation project which starts early in the year with predator management. Terrestrial mammalian and avian predators are controlled under licence and monitored throughout the breeding season. Liaison with lake users throughout the season has generated goodwill for the project and the terns suffer minimal human disturbance. NPWS has commissioned an appropriate assessment on water level management systems in place and also commissioned engineering solutions for alternative systems, and an appropriate assessment on preferred engineering solutions, as we strive for favourable water level management and conservation status of the Special Area of Conservation (SAC) and the SPA. Black-headed Gull numbers have increased in each of the last six years, exceeding 2,000 pairs in 2015, with 2,012 pairs and 2,606 pairs in 2017, the highest ever recorded since the project commenced in 1993. Sandwich Terns have remained stable over the last six years, with between 1,617 pairs and 1,799 pairs in the 2012-2017 period. Common and Arctic Terns have increased in recent years, despite a decrease in 2017 we still had 1,690 pairs. Roseate Terns numbers have also grown over the last 12 years, from a low of 46 pairs in 2001 to 143 pairs in 2013 and a record 219 pairs on 2017. Ring reading suggests that this increase is at least in part the result of previous good productivity years at the site.

Effects of operating wind turbines on foraging efficiency in Bar-tailed Godwit *Limosa lapponica*

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The foraging behaviour of Bar-tailed Godwit *Limosa lapponica* was studied at a sandy beach in south-east Ireland using focal sampling to examine for significant effects of nearby operating wind turbines on the foraging efficiency of the birds. Mean probing rate, prey intake rate and probing efficiency were all negatively correlated with distance from the nearest operating turbine, suggesting that disturbance from the moving rotors was not the main factor limiting foraging activity. The higher foraging success near the turbines was almost certainly due to the higher density of lugworms *Arenicola marina* in that part of the study beach. In these sandy shores, Bar-tailed Godwit showed no significant difference in their foraging efficiency between the windfarm and a control site. Habituation to the movement of the turbine rotors is suggested as the birds forage close to operating turbines in order to exploit the most profitable food resources.

Ecology and conservation of terns on Rockabill, County Dublin, 2013-2017

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Rockabill Island has maintained its status as the largest European colony of Roseate Terns *Sterna dougallii* over the last decade. A review of demographic factors and their importance in maintaining the European metapopulation is underway as part of an EU LIFE-funded project. Since 2013 Roseate Tern numbers have increased by 31% from 1,214 to 1,597 pairs in 2017. Productivity, number of young fledged per egg laying pair, has fluctuated between 0.66 and 1.12 with a mean of 0.92 although the longer term trend is negative in what appears to be a density dependent pattern. The island also supports a large colony of Common Terns *Sterna hirundo* which has remained fairly stable during 2013-2015, with a mean of 2,042 pairs. Their productivity is lower than that of Roseate Terns ranging between 0.26 and 0.81, mean 0.60 despite laying a larger mean clutch (typically 3 eggs). A small number (21-94 pairs) of Arctic Terns *Sterna paradisaea* attempt to nest on the most exposed outer parts of the colony but their productivity is close to zero most years with non-breeding Great Black-backed Gulls *Larus marinus* and

Herring Gulls *Larus argentatus* depredating most eggs soon after laying. Methods of reducing the negative impact of gulls are under review as they have now become a serious threat to 150-200 pairs of Kittiwakes *Rissa tridactyla* that also nest there. Prey delivered to young of Roseate Terns is also monitored. The population continues to depend on two key species groups: Sprat *Sprattus sprattus* and sandeels *Ammodytes* species. The proportion of each vary year to year, e.g. in 2014 and 2016 sandeels dominated early in the chick-rearing period to be replaced later on by Sprat whereas in 2015 the diet was dominated by Sprat throughout the season. We do not know whether this variation represents parental choice or stock availability.

Conservation of terns at Dalkey Island, County Dublin, 2013-2017

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Small numbers of Common Terns *Sterna hirundo* and Arctic Terns *Sterna paradisaea* have traditionally nested on the one of the smallest skerries (Maiden Rock) of the Dalkey archipelago. This and adjacent rocks and Lamb Island have also been used as a post-breeding and pre-migratory roost for an assemblage of terns that gather in Dublin Bay in late July to September. This feature resulted in the island being designated as a Special Protection Area. Roseate Terns *Sterna dougallii* were regularly present in the assemblage and since the early 1990s members of the South Dublin Branch of BirdWatch Ireland have provided Roseate Tern nestboxes and other social attractants to encourage some birds to nest. The project met with limited success and pairs nested from 2002 onwards, peaking in 2004 when at least 11 nested and a maximum of 15 young fledged. In the period 2013-2017 only one pair has nested most years and rarely reared young. The area used by terns on Maiden Rock is low-lying and vulnerable to overwash during easterly winds and thus efforts have been made to encourage terns to nest on Lamb Island which has higher relief and a vegetated upper plateau. In 2016 and 2017 between 90 and 110 pairs of Arctic Terns have nested here, making it the largest colony in Dublin. Breeding success has been poor with rat (*Rattus* species) depredation potentially a significant factor. The feasibility of rat eradication is being discussed with members of the Dalkey Island Conservation Plan steering committee and Dun Laoghaire Rathdown County Council Parks Department and will hopefully be a key action of the Roseate Tern LIFE Project (2015-2020). The proximity of these islands to the mainland (300-400 m) means that, even if eradication is successful, ongoing biosecurity measures will be necessary.

An aerial census of Irish Gannetries in 2013/2014

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Gannets *Morus bassanus* are censused at decadal intervals across British and Irish colonies. The most recent survey utilised systematic aerial photography taken in 2013 and 2014 to estimate the number of Apparently Occupied Sites (AOS) across Ireland's six gannetries. The previous census in 2004 estimated a total of 36,111 AOS in five colonies with one extremely large, Little Skellig at 29,683 AOS and one tiny, Clare Island at only three AOS. Since then, a new gannetry has appeared on the northern cliffs of Lambay Island in County Dublin and this held 728 in 2013 and was also censused from terrestrial vantage points in 2015 when 928 AOS were recorded. The 'proto-colony' on Clare Island, County Mayo had been stable over a 20+ year period at two or three AOS, but it has now 'taken off', in common with all other rapidly increasing colonies, and supports at least 267 AOS. Three colonies approximately doubled in size over the last ten years: Bull Rock (Cork), Great Saltee (Wexford) and Ireland's Eye (Dublin). The increase has not been so dramatic at Little Skellig (Kerry) but it still increased by 18% to 35,102 AOS. Overall the population has increased by approximately 11,600 AOS to a 2013/14 total of 47,754 AOS.

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Conservation of Little Terns *Sternula albifrons* at Baltray, County Louth, 2013-2017

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The conservation of Little Terns *Sternula albifrons* at Baltray has been a collaborative project between the Louth Nature Trust (LNT) and BirdWatch Ireland, largely funded by the Heritage Council, with National Parks and Wildlife Service providing additional resources and equipment. Between 2007 and 2012 LNT volunteers had successfully protected the colony and seen its tern population become established and regularly fledge young. With colony growth, local predator guilds become aware of the seasonal availability of food (eggs and chicks) on the beach and round the clock protection and on-site wardening become inevitable if the colony was to succeed. A project milestone was reached in 2013 with 102 pairs of Little Terns nesting (106 nest attempts) and high productivity estimated at 1.89 young fledged per laying pair.

Numbers increased again in 2014, to 111 pairs making 150 nest attempts but some predators, notably Red Foxes *Vulpes vulpes*, gained access to the electric-fenced enclosures and depredated eggs, then Kestrels *Falco tinnunculus* and a Sparrowhawk *Accipiter nisus* depredated a significant number of chicks which limited final productivity to 0.89. However, a colour-ringing scheme was implemented this year with 26 out of 91 fledged young receiving engraved green darvic rings. In 2015, only 25 pairs nested making 68 attempts, the poorest year since wardening and fencing was introduced in 2007. Most egg losses were attributed to crows (Corvidae). A total of 20 young fledged giving a productivity of 0.80. In the last two years Little Terns have failed to nest at Baltray, some pairs prospected early in 2016 but moved on and in 2017 very few were seen until late in the season when post-fledging family groups arrived in July. These had been colour-ringed at Kilcoole, demonstrating strong links between the two sites.

Conservation and breeding biology of Little Terns *Sternula albifrons* at Kilcoole, Co. Wicklow

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Between 2013 and 2017, BirdWatch Ireland successfully tendered for the National Parks and Wildlife Service contract to manage the Kilcoole, County Wicklow, Little Tern *Sternula albifrons* colony. This location is usually the premier site for the species on the Irish Sea coastline. The project comprises continuous day and night time wardening from the laying of the first eggs to the fledging of the majority of young; conservation actions include the erection and maintenance of electrified (terrestrial) predator-proof fencing around the colony on the shingle foreshore above high-water mark. In 2013 the site supported 45 pairs (54 nest attempts), a rather low total. Since then, numbers have ranged between 120-186 pairs (145-223 nest attempts) with mean clutch sizes ranging between 1.84 and 2.50. Between 2013 and 2016 the first eggs were laid between 21-25 May, but in 2017 was much earlier with eggs seen on 14 May. The incubation period ranges between 20.1 and 22.5 days. Egg and chick losses vary from year to year with overwash due to easterly backed spring tides and a variety of mammalian and avian predators the key factors. Red Foxes *Vulpes vulpes* are the most prevalent terrestrial carnivores and Hooded Crows *Corvus cornix*, Rooks *Corvus frugilegus* and Kestrels *Falco tinnunculus* the most frequent avian predators. Productivity (number of young fledged per egg-laying pair) was consistently high between 2013 and 2015 (1.66, 1.83 and 1.87 respectively) but was between 0.35 and 0.69 in 2016 due to starvation and intense

Fox activity. The majority of young are metal ringed and since 2014 have also been darvic colour-ringed. Ring reading has shown that Kilcoole-reared birds have dispersed to the key Welsh colony at Gronant and that there is considerable post-breeding movement between Irish Sea colonies (including Gronant and Baltray, Louth) prior to southward migration. Kilcoole birds have been recorded on migration in southern England, western France, Spain and Portugal.

Seabird productivity monitoring: Kittiwakes *Rissa tridactyla* and other cliff-nesters, 2013-2017

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The United Kingdom-Irish Seabird Monitoring Programme, Joint Nature Conservation Committee coordinated, is a long running project gathering demographic information on the seabirds of the British Isles. It is the main annual monitoring tool of a sample of sites, between the comprehensive censuses conducted every 15 years. Ireland has a good record of seabird colony counting but our understanding of breeding productivity and diet is very limited compared to British sites. Given recent declines in breeding numbers of some species, particularly Kittiwakes *Rissa tridactyla*, BirdWatch Ireland have monitored productivity at a sample of east and west coast colonies whenever opportunity arises. Two core sites, Downpatrick Head in County Mayo and Rockabill off County Dublin are monitored annually and in the last two years (2016-17) we have covered Ireland's Eye (also Dublin) and in 2017, the Cliffs of Moher (Clare). Kittiwake numbers at Downpatrick Head averaged 890 Apparently Occupied Nests (AONs) in the period 2008-2012 with productivity of 0.55 young fledged per AON. There was a pronounced population drop in 2013, to 439 AONs and the five-year mean up to 2017 has been similar at 551 AONs. However, mean productivity has been similar at 0.55 (2013-2017). On the east coast, Rockabill averaged 163 AONs (2008-2012) with a productivity of 0.81; 129 AONs (2013-2017), productivity of 1.01 in 2013-15 and 0.23 in 2016-17, with large gull depredation of eggs accounting for most losses in the latter period. At Ireland's Eye, a sample of 103 AONs had a productivity of 0.34 in 2016 with a larger sample of 187 AONs in 2017 having a productivity of 0.25. Population declines are national concerns whereas breeding performance seems much better on the Atlantic coast compared to the Irish Sea. Productivity of other cliff-nesting species in 2017 was Fulmar *Fulmarus glacialis*: east 0.42, west 0.67; Guillemot *Uria aalge*: east 0.62, west 0.43; Razorbill *Alca torda*: east 0.46, west 0.19.

Population recovery, bird hazards, threats and responses: the case of the Common Buzzard *Buteo buteo* in Ireland

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The Common Buzzard *Buteo buteo* became extinct in southern Ireland sometime during the late 19th century. Population recovery was underway by the mid-1980s, but early attempts were unsuccessful. Thereafter, from the late 1990s onwards, recolonization has been rapid and buzzards are now regular visitors to airfields along the east coast of Ireland. Recovery was followed by collisions with aircraft, some of which caused damage as a buzzard can weigh up to 1.37 kg. The elevated risk of collisions associated with population increases in large birds is addressed in Dolbeer and Eschenfelder (2003). This study describes the preliminary results of a trapping programme (licensed by National Parks and Wildlife Service) and translocation of captured individuals several hundred kilometres to the south. These birds were marked with wing tags and an important element of the study is to establish (a) whether or not they returned to the airfield following release, and (b) if there was a reduction in the number of buzzard sightings at the aerodrome? The results prove conclusively that the population is much larger than was initially thought as sustained trapping resulted in 34 birds being caught over the September 2014 to December 2016 period. In addition to an analysis of age structure of the captured sample, sex ratio and body masses, answers have also been sought in relation to the frequency of buzzard strikes as well as the number of observations and scaring actions following the capture - release programme. Initial results suggest that the use of the 'at-risk' airspace by buzzards has decreased following the large scale capture, removal and release of birds. To our knowledge this is the first study of its kind to have been undertaken in Ireland.

(Dolbeer, R.A. & Eschenfelder, P. 2003. Amplified bird strike risks related to population increases of large birds in North America. *Proceedings of the International Bird Strike Committee* 26: 49-67)

Competitively mediated selection in "great speciators"

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Feeding niches are defined by resources, but resource availability may depend on competition. Competition for

resources is most intense in closely-related species, which are likely to share similar niches. In competing species, traits which minimise resource competition are expected to experience positive selection. This process is known as ecological character displacement (ECD). ECD typically results in a greater difference in resource-exploiting traits. Conversely, if a competitor disappears from an ecosystem, the remaining species may experience character release. In bird species, bill length is a strong indicator of feeding niche. Here we demonstrate cases of competitively mediated selection in two “great speciator” lineages of south-east Sulawesi, Indonesia, the *Zosterops* white-eyes and *Todiramphus* kingfishers. “Great speciators” are known to evolve rapidly, making excellent subjects to study adaptive divergence. *Zosterops chloris* and *Zosterops consobrinorum* are closely related species which compete for similar resources. When these species were found in sympatry there was strict niche partitioning, with little overlap in bill lengths. However, at sites where only *Zosterops chloris* was present its bill length showed increased trait diversity, covering the full range of bill lengths shown by both *Zosterops* species when living in sympatry. This is clear evidence of character release, with *Zosterops chloris* expanding to fill the niche space split between the species in sympatry. Similarly, *Todiramphus chloris* and *Todiramphus sanctus* are close relatives with similar ecological requirements. On the mainland they strictly partition habitat, avoiding direct competition. However, on small islands this habitat partitioning does not occur. *Todiramphus chloris* shows an increase in bill and body size, allowing it to access larger prey than *Todiramphus sanctus*. This reduces direct competition, a clear example of ECD. These results provide rare empirical support for the theoretical framework of competitively mediated selection and illustrate the utility of using “great speciator” lineages for studying this phenomenon.

A picture tells a thousand birds: assessing the utility of UAVs to improve precision of breeding seabird colony counts

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In order to monitor seabird numbers and distribution, colony counts are conducted from land, boats or aircraft. Seabird colonies are often remote and inaccessible or with portions obscured from observers. We tested the use of an unmanned aerial vehicle (UAV, hereafter drone) to collect images from seabird colonies, and compared results to simultaneous ground and boat based counts. Under license from National

Parks and Wildlife Service, a drone was flown over three seabird colonies, Gannets *Morus bassanus* on Great Saltee, Co. Wexford, Cormorants *Phalacrocorax carbo* on Deer Island Co. Galway, and Fulmars *Fulmarus glacialis* and Kittiwakes *Rissa tridactyla* on Loop Head, Co Clare. Reactions of seabirds to the drone were assessed by flying at different heights and qualitatively from observations. No adverse reactions were observed during overflights of Cormorants at 100 m, of Gannets at decreasing altitudes of 100, 75, 50 and 40 m or of Kittiwakes and Fulmars. Estimates of precision of counts of nesting Gannets from Great Saltee were compared to conventional ground observer counts. Apparently Occupied Nests (AONs) are the preferred counting unit for all species counted in this study. Estimates of precision of Gannet counts from drone images were also compared to estimates of precision of counts from images obtained from aircraft. Drone footage permits the counting of AONs where Apparently Occupied Sites (AOSs) were the only metric possible from aircraft survey data provided. Counts of Cormorant AONs in Galway using drone footage were more precise than simultaneous boat based counts. An automated image analysis protocol for drone footage of Gannets from Great Saltee was compared with manual counts of the same footage. Automated counting of birds using image analysis had a comparable level of precision to manual counts. These findings suggest the use of UAVs for colony counts of nesting seabirds provides improved precision and consequently the ability to detect population changes.

Seabird eggs as a higher trophic level indicator of contaminants in Irish marine waters

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Contaminants such as persistent organic pollutants (POPs) are almost all exclusively synthesised chemicals that are highly resistant to natural degradation and are ubiquitous in marine environments. POPs have been shown to exhibit toxic properties causing endocrine dysfunction, mutagenesis, or reproductive and behavioural disturbances. Many of these contaminants bio-accumulate within organisms and bio-magnify within food webs with subsequent consequences for higher trophic level predators. Seabirds are integral, conspicuous and long-lived components of aquatic ecosystems and have been used to infer diverse aspects of the health of the marine environment. Seabird eggs have been reported as one of the most ideal matrices for contaminant

monitoring. Seabird life history strategies mean that the removal of eggs has very little impact on the breeding population. We describe a pilot study to assess the feasibility of using seabird eggs as a POP indicator for the Irish marine environment. Three species were selected for this study; Common Tern *Sterna hirundo*, Northern Gannet *Morus bassanus* and Common Guillemot *Uria aalge*. Common Tern eggs are widely utilised in monitoring programmes across Europe. The International Council for the Exploration of the Sea (ICES) recommends Common Guillemot as a species for the monitoring of contaminants in the marine environment. Northern Gannet was selected as they feed on larger prey items and can travel significant distances to forage for food, and their eggs may reflect the level of contaminants found offshore. Seabird eggs were collected in 2017 from three seabird colonies. Eggs will be tested for the presence of legacy and emergent POPs, heavy metals and mercury. As part of the pilot study the impact of sampling on the breeding success of sampled birds is a critical component of the research. As such, non-destructive sampling techniques such as analysis of feathers and preen oil from adult birds of each species is also being investigated.

Do releases of non-native gamebirds affect the distribution and abundance of generalist predators?

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The release of more than 45 million captive-bred Pheasants *Phasianus colchicus* and Red-legged Partridges *Alectoris rufa* in Britain annually may represent a potentially significant addition to the food available for predators and scavenger species. By sustaining predator populations, gamebird releases could indirectly affect the populations of other wild birds by increasing predation pressure on them. We used three extensive datasets to examine relationships between abundances of released gamebirds and those of generalist predators in lowland rural Britain, controlling for influences of land cover and habitat quality. We examined: spatial relationships between captive-reared gamebirds and abundance of free-roaming gamebirds and spatial and temporal correspondence between abundance of gamebirds and abundance of predators. We present strong evidence that the abundance of free-roaming gamebirds across Britain is affected by gamebird releases, over and above any effects of land use or habitat. We also found positive spatial and temporal associations between the abundances of predators and numbers of both reared and free-roaming gamebirds.

Although correlative in nature, this study indicates clearly that large-scale releases of gamebirds are typically associated with higher densities of generalist predators, with potential knock-on implications for other prey populations. Such effects would run counter to previously reported conclusions that game management has positive effects on wider biodiversity. This contrast may be due to the fact that previous studies have focused on single farms or small study areas, whereas this study considered national and landscape-scale patterns. Overall impacts of game management on wild bird populations are likely to be determined by complex interactions between its effects on habitat, food supply and competition, as well as predation. Determining the balance of these effects, as well as the approaches or policies likely to be most effective to mitigate the negative effects, requires more detailed investigation.

The breeding performance, movement and mortality of a Mute Swan *Cygnus olor* population in the east of Ireland

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The current Mute Swan *Cygnus olor* population in Dublin, north Wicklow and east Kildare has been the subject of investigation by members of the Irish Midlands Ringing Group for the past two years. A total of 390 birds have been colour ringed since September 2015, which represents approximately 75% of the total swan population in the study area. Ringed birds vary in age from 0–14 years with 97 of these ringed as cygnets while still in their family groups. Over 4,000 re-sightings have been reported which provides data on age related movement of birds seasonally and dispersal of juvenile birds from their natal area. Of the 390 swans colour ringed, 294 have been re-sighted within the study area since 1 April 2017 and 21 birds are known to have died. A number of birds have also dispersed outside the study area. Nesting parameters including nest site details, hatching success and fledging success of individually identifiable pairs have been recorded in the 2016 and 2017 breeding seasons. These are compared with published historical data gathered in the same study area in a previous study of the same population over two decades ago. The project has also been registered as a RAS project (Ringing Adults for Survival Project) with the British Trust for Ornithology, due to the high proportion of adult birds now colour ringed in the population. This allows comparison of adult survival of this Irish population with other swan populations in the United Kingdom.

Feasibility study of marine bird sensitivity mapping for offshore marine renewable energy developments in Ireland

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With advances in offshore wind, wave and tidal renewable energies, there is a need to provide adequate environmental assessments of potential impacts on fauna including seabirds and waterbirds. Impacts can include behavioural changes around devices, avoidance, displacement, collision risk and whether important areas for foraging birds offshore occur in areas which offer high potential for renewable energy technologies. Given seabirds are such long-lived species, the potential impacts of such developments may not be detected immediately, but are more likely to be manifested in terms of poorer breeding productivity and survival of seabirds, ultimately having a population-level impact. Significant data gaps exist and more information is needed on patterns of distribution and timing of movements of vulnerable bird species in the marine environment at key times of the year. In order to inform better planning and decision-making for marine renewable energy, addressing these ecological knowledge gaps is vital and will ensure better marine spatial planning and afford better environmental safeguards while delivering better outcomes in terms of meeting renewable energy targets and helping to address the national and international obligations with respect to climate change. A mapping tool is proposed that identifies the potential risks posed to birds through visually representing the offshore areas used by selected species and their respective sensitivities to wind, wave and tidal energy developments. Species sensitivity scores have been calculated separately for both collision risk and disturbance for offshore wind energy developments, sensitivity to tidal energy developments and vulnerability to wave energy developments, based on conservation scores and behavioural factors for each species. The next phase of this project will produce trial map layers for six species, representing different foraging guilds of birds in the marine and thereby including the likely range of interactions of birds with different marine renewable energy structures in the offshore.

Citizen Science utility in monitoring of raptors in Northern Ireland

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The Northern Ireland Raptor Study Group (NIRSG) is a voluntary organisation that monitors birds of prey in Northern

Ireland and along border counties with the Republic of Ireland. The NIRSG has a small network (about 150) of expert volunteers. Since around 2008 the group has been working in partnership with the Northern Ireland Environment Agency (NIEA) on the centralised co-ordination of monitoring, reporting and analysis of data. NIEA funding has facilitated an extensive programme of training for volunteers, workshops, conferences and reports annually. Up-skilling, resource provision and support of the specialist surveyors within the raptor network are important in maximising data collection and standardisation. The data generated by the network and centralised by co-ordinators has resulted in between 442 and 1,144 raptor breeding season sightings and 255 and 530 winter sightings recorded each year, along with 408 to 636 nest records being generated annually. More than 3,900 records have been collated across a range of species with most records aggregated for Peregrine *Falco peregrinus* (n = 1569; 2008-2017), Hen Harrier *Circus cyaneus* (n = 849; 2006-2017) and Buzzard *Buteo buteo* (n = 498; 2008-2017). Historical records (prior to 2008) have also been collated, with an additional 4,201 records added to the centralised raptor database. The utility of such data is high and centralised resources are able to carry out more formal analysis; e.g. for peer-reviewed publication, strategic and framework analysis such as management and action plans and directly inform conservation and management action such as nest protection and strategic spatial planning. The feedback and annual reporting to the raptor network is a key to encouraging the volunteer resources and adding value to nest monitoring, winter monitoring and sightings data to obtain scientifically robust information on distribution, occupancy, productivity and threats and provide direct conservation protection and analysis of raptor data. The key to this is citizen-science, with an expert raptor network, but it is essential to have a formal and centralised staff resource to maintain and support the scheme.

The 2015 national survey of breeding Hen Harriers *Circus cyaneus* in Ireland

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The Hen Harrier *Circus cyaneus* is a protected raptor, and is listed in Annex I of the EU Birds Directive. Member states are obligated to conserve the species. These obligations involve key actions to designate Special Protection Areas (SPAs) and to undertake monitoring of Hen Harrier populations. The fourth national survey of Hen Harriers in Ireland was undertaken in 2015 and was preceded by surveys in 2010,

2005 and 1998-2000. The survey aimed to quantify the size, distribution and trends in the breeding population. An estimated 108 to 157 breeding pairs of Hen Harrier were recorded in 2015. This is lower than population estimates in 2010 (128 to 172), but is similar to 2005 (132 to 153) and marginally higher than in 1998-2000 (102 to 129). The national population (confirmed and possible pairs) declined by 8.7% since 2010, whilst mid-point analysis indicated a national decline of 11.7%. Analysis of 139 10 km squares surveyed in both 2015 and 2010 estimated a population decline of 16.4%. Analysis of 78 squares covered in all four national surveys estimated an overall decline of 33.5% between 1998-2000 and 2015. The distribution of confirmed breeding pairs was similar to 2010 with 62 10 km squares occupied, however, overall breeding distribution (confirmed and possible pairs) increased by 22%. The SPAs held between 44% and 47% of the national population (51 to 69 pairs) with four SPAs recording a decline and two an increase since 2005. Overall, the population within the SPA network has declined by 26.6% since 2005. Breeding success was higher per confirmed breeding pair (45.4%) than recorded in other studies but productivity was low (0.94 young per confirmed breeding pair) compared to published studies. These results should inform management in order to optimise the environmental conditions for the breeding population of Hen Harriers in Ireland.

Protecting seabirds using chemosterilants to exterminate rats (*Rattus* species) from islands: the steps to be taken on Lambay Island, County Dublin

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In order to survive, certain seabirds need predators eliminated from their nesting habitat. Common predators are rats, both the Brown Rat *Rattus norvegicus* and the Ship Rat *Rattus rattus*. Unusually, both are found on Lambay Island, without mice. There is an urgent need to exterminate rats from islands off Ireland, as they predate nesting seabirds, and could also act as a prey for predators such as Mink *Neovison vison*. Considerable progress has been made in exterminating rats from islands, however, at some cost. The preferred rodenticides for such projects are second generation anticoagulant rodenticides (SGAR), which are toxic. They cause both a loss of 'natural' prey for predators, but also secondary poisoning. There was interest in chemosterilants for rats in 1970s, but these were never widely used. A new liquid product produced in the United States by Senstech prevents rats from

breeding. It has been deployed in areas of the United States, for example the New York subway. There would be four phases to the planned extermination process on Lambay Island. First, all buildings and boats would be rat-proofed. Then surveys would be done of rats, and of life on selected seashore sites. The latter is the primary rat foraging habitat. Phase three would involve delivery of baits over a two week period along with concurrent monitoring of the rats. During this phase a training course would be organised and digital mapping, climbing and rodent management skills would be taught. There would then be a fourth phase where rats would be trapped and their reproductive systems monitored long-term, on the island, by a small team. It is hoped that this would lead to extinction, and steps would be taken to ensure that if rats returned, for example from a ship wreck, a prompt response would ensure their elimination. Finally, there would be a re-survey of selected seashore sites one year after the extermination, and of burrow breeding seabirds.

Barn Owls *Tyto alba* attracted to motorway verge habitats due to increased abundance of small mammals?

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Due to their hunting behaviour, low flight and poor peripheral vision, Barn Owls *Tyto alba* are especially vulnerable to vehicle collision. Mortality on roads is the primary cause of death of Barn Owls recorded in Ireland. The factors which influence risk of collision and how Barn Owls interact with roads are poorly understood, and this limits the development of appropriate mitigation solutions. We investigated whether the verge habitats of motorways in an intensively managed landscape had a positive impact on small mammals – the main prey of Barn Owls. We compared small mammal communities in the verges of the M8 motorway in Co. Tipperary to field margins in adjacent agricultural land. A total of 1,406 individual small mammals were caught over 3,156 trap nights on motorway and non-motorway sites. Bank Vole *Myodes glareolus* was the most common species trapped on both motorway and non-motorway sites, followed by Greater White-toothed Shrew *Crocidura russula*, Wood Mouse *Apodemus sylvaticus* and House Mouse *Mus domesticus*. The number of Bank Vole and Greater White-toothed Shrew were comparable between the two treatments but the number of Wood Mouse was significantly higher on motorway verges ($n = 164$) than on non-motorways ($n = 87$). Despite higher

numbers of small mammal captures on motorways ($n = 817$) compared to non-motorways ($n = 757$), small mammal abundance was comparable between treatments with 0.49 individuals per trap night on motorways and 0.498 individuals per trap night on non-motorways. Biomass per trap night was also comparable between motorway (6.20 g) and non-motorway (6.23 g) sites. Our results suggest that motorway verge habitats in an intensively managed agricultural landscape do not provide a greater abundance of prey species for Barn Owls compared with field margins in the adjacent landscape, although there may be other factors which influence suitability of these habitats for Barn Owls.

The use of Citizen Science by BirdWatch Ireland to gather large datasets as an aid in species conservation in Ireland

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Volunteer effort has been a proven and effective method for monitoring species nationally and gathering large datasets over time. Volunteer “Citizen Science” effort has been shown to be effective in large scale, multi-species surveys such as Bird Atlas, Irish Wetland Bird Survey (I-WeBS) and Countryside Bird Survey (CBS). These surveys involve significant planning, some training of volunteers and large amounts of administration. In recent years BirdWatch Ireland has adopted a Citizen Science approach to collecting data on certain species. Volunteers are recruited to gather information on species that are easily identified and observed, which has aided monitoring of: roof-nesting gulls (*Laridae*), autumn tern roost numbers and locations, Swift *Apus apus* sightings and nest locations, Barn Owl *Tyto alba* and other raptor sightings and nest locations, late nesting species (e.g. Yellowhammer *Emberiza citrinella*) and river birds nesting in built structures. Additionally, projects rely on Citizen Scientists to submit sightings of colour-rings as part of; The Dublin Bay Birds Project (waders/terns), Greylag Goose *Anser anser* (collars) and Dipper *Cinclus cinclus* in the Slieve Blooms, and to submit information on Barn Owl road mortalities. Citizen Science has also been integral in delivering practical conservation, including implementing nestbox schemes for species such as Swift and Barn Owl led by local community groups and schools. Information on these projects is hosted on the BirdWatch Ireland webpages and the projects are promoted online through social media and available print and broadcast

media. Record entry is online and has evolved over time, first utilising free online platforms (Survey Monkey) but now utilising GIS mapping through ArcGIS Online and collaborations with the National Biodiversity Data Centre. Despite the data validation and administration requirements, this method of compiling data has been an effective tool for informing status, trends and ecology of Irish birds as well as identifying conservation priorities.

Interactions between Hen Harriers *Circus cyaneus* and wind turbines

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Hen Harriers *Circus cyaneus* are an Annex 1 species under the EU Birds Directive and a species of conservation concern in Ireland. As a species that breeds in upland habitats, encroachment, transformation and disturbance of these areas can represent a significant threat to Irish Hen Harrier populations. The increase of wind energy developments, preferentially sited in upland areas to optimise wind yield and minimise disturbance to human populations, has led to growing concerns over their potential effects on Hen Harrier populations. To address these concerns, we studied a broad range of aspects of the interactions between Hen Harriers and wind farm developments from 2012 to 2014. Assessment of nation-wide Hen Harrier population trends indicated a significant geographical and altitudinal overlap with areas with wind farm development, and a weak negative relationship between the change in number of pairs and wind farm presence. Studies of prey availability, which focussed on passerine bird communities, indicated that impacts from wind farm developments were mediated by habitat changes associated with wind farm construction. The particular species and extent of the impact were dependent on the pre-existing habitat and size of areas affected by construction. Hen Harrier breeding parameters were found to be lower for nests located within close proximity of wind turbines (<1000m). Collision risk analysis indicated that adult birds spent 12% of their flight time at turbine rotor sweep height, resulting in an overall low collision risk in comparison with other raptor species. Studies of foraging behaviour showed that Hen Harriers at wind farm sites spent less time foraging over young and open forested areas in comparison to control sites, probably as a consequence of the preferential siting of wind farms in forested environments. Our findings represent an important contribution to the body of knowledge on the interactions between Hen Harriers and wind farms in the Irish context.