

Annual Conference — Abstracts of talks

Covariation between long-term population variability, dynamic complexity and life-history traits in waders: a multi-species analysis

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Recent analyses of ecological time-series have emphasised the strong pattern of covariation between demography, life-history characteristics and population dynamical patterns among several vertebrate species. Indeed, current evolutionary theory identifies a “slow-fast” continuum in this covariation, where highly variable populations with a recruitment- and stochastic-driven demography lie at one extreme, with largely stable, density-regulated and survival-restricted species at the other.

This study is based on a literature search for time-series of population counts of waders spanning at least 15 years. For each of the 14 time-series that met this criterion, I measured the coefficient of variation of population size through time, the dominant period of fluctuation, the amount of environmental stochasticity impacting on the dynamics, and the Lyapunov exponent of a response-surface model fitted to the data. Additionally, data on the morphology and sexual dimorphism of each species were gathered from the literature. Results suggest a negative relationship between body weight of waders and both the degree of population variability and its dynamic instability (as measured by the Lyapunov exponent). Moreover, the more variable populations were the most affected by environmental stochasticity, while the magnitude of density-dependence affecting the dynamics was larger for the least variable populations.

I found that populations of sexually dimorphic species tended to be more variable from year to year and show no characteristic period of fluctuation relative to monomorphic waders. Interestingly, these results suggest, in contrast to previous findings, that the population dynamical characteristics of waders can be predicted from morphological and behavioural traits alone, even in the absence of demographic information. In this sense, populations of small-sized, sexually dimorphic waders, such as *Calidris alpina*, are very variable inter-annually, show a high degree of deterministic dynamic instability, and are severely affected by environmental stochasticity. In contrast, populations of large monomorphic waders, such as *Numenius arquata*, are more stable, less variable from year to year, and are mainly affected by negative feedbacks in density. In addressing the current world-wide decline of wader populations, these results can be used, for instance, to predict the relative extinction risk of different species and to choose between different management strategies for threatened populations.

Is timing that crucial?

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Arrival on a staging site may have large consequences in demographic terms. In this talk we present data from Delaware Bay on the east coast of the United States describing how turnover of Red Knot *Calidris canutus* occurred during the 2003 spring migration at Mispillion Harbor, one of the major staging areas in the bay. We then look to see if there is any evidence for changes in survival of Red Knot in relation to the predicted departure weight a bird could reach at the end of the spring staging period.

Growth rates of wader chicks: a comparison across the latitudes

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In the altricial–precocial spectrum of chick development wader chicks exhibit the precocial mode of development, meaning that they leave the nest soon after hatching. The chicks of most wader species are self-feeding but some, such as oystercatcher (Haematopodidae) and thick-knee (Burhinidae) chicks, are parentally fed. Energy expenditure of parent birds raising self-feeding young may be less than that of birds that feed their young but the burden of collecting food is shifted to the chick. This results in greater energetic demands on the chick due to greater activity and the requirement for thermoregulation. As a possible result of higher energetic requirements, self-feeding precocial chicks may grow more slowly than parent-fed precocials. The rate of chick growth has been determined for several species in arctic and temperate zones. In the arctic and some temperate areas, waders are time and energetically stressed compared to species breeding in subtropical regions. Subtropical waders have extended breeding seasons and longer reproductive time spans; they exhibit slower growth and longer fledging periods than arctic relatives. In addition, in subtropical regions wader chicks have reduced energetic demands compared to arctic or temperate species due to the warmer ambient temperatures. Peak daily energy requirements are known to scale not only with asymptotic body mass, but are also negatively related to the duration of the fledgling period. Growth rates of wader chicks across latitudes in relation to behaviour will be compared.



Seasonal variation in habitat use and daily energy intake of Kentish Plover *Charadrius alexandrinus*: energy demand or re-distribution hypothesis?

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Traditionally, the breeding season has been considered a period of high-energy demand and as a bottleneck in the life cycle of an individual. However, this general consideration does not always apply. Although there are in the literature studies that reveal the existence of an increase in the daily energy intake during reproduction (energy demand hypothesis), other authors have found that such energy intake during the breeding period is not higher than energy intake during winter (re-distribution hypothesis). Furthermore, it has been proposed that there exists a seasonal variation in energy use associated with gender and each sex should confront these energy requirements in distinct ways behaviourally and/or physiologically. The aims of this study were: (1) to determine whether a seasonal variation between winter and breeding period in the daily energy intake exists in the Kentish Plover, and (2) to establish the foraging pattern of males and females in both seasons.

The study was carried out in an industrial salina (saltpan) and in the adjacent intertidal mudflats, in the Bay of Cádiz, Spain. The percentage of foraging birds in each zone, time allocated to feeding and intake rate were calculated in order to obtain the daily energy intake in winter and the breeding season. Although it was found that there was a different foraging pattern between genders, no differences in daily energy intake were found between seasons. During winter, both males and females behaved in a similar way, regarding foraging activity, and obtained a similar amount of energy. Nonetheless, in the breeding season females fed two hours less than males during daylight, spending less time foraging on the intertidal mud. Despite this different foraging pattern in the breeding season, our results support the "re-distribution hypothesis" for Kentish Plover in the Bay of Cádiz.

Knowing wader feeding mechanisms better: a field-test analysis of Surface Tension Transport

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Margaret Rubega (*Auk* 110: 169–178) described a novel mechanism of prey transport employed by captive Red-necked Phalaropes *Phalaropus lobatus*: the surface tension of water. She showed that the same mechanism is also used by Wilson's Phalarope *P. tricolor* as well as two small sandpipers (Western Sandpiper *Calidris mauri* and Least Sandpiper *C. minutilla*). To date, however, there are no data on the use of Surface Tension Transport (STT) by birds in the field. In this study we carried out a field test to determine to what extent waders feeding on small prey use this mecha-

nism. We found that STT is commonly used by waders such as Black-winged Stilt *Himantopus himantopus*, Curlew Sandpiper *C. ferruginea*, Sanderling *C. alba* and Little Stint *C. minuta*.

The role of waders and other waterbirds in the dispersal of aquatic plants and invertebrates

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Although, almost two centuries ago, Darwin suggested that waterbirds are important to the dispersal of aquatic plants and invertebrates and despite the fact that bird-mediated transport is crucial to our understanding of the structure and composition of aquatic communities, little attention has been paid to this topic by waterbird researchers. This is especially true in the case of waders.

We review current evidence that waders and other waterbirds are responsible for transporting aquatic organisms attached externally to their bodies or inside their guts. Intact seeds are commonly reported in the pellets and droppings of waders. Eggs and seeds were found attached to the feathers and legs of a high proportion of waterbirds trapped in the Doñana area of Spain (35% to 100% depending of locality). These data therefore indicate that bird-mediated transport is frequent, at least at a local scale, such as within a wetland.

A comparison of the genetic structure of four species of North American invertebrates with waterfowl movements estimated from ring-recovery data gives further support to the crucial role of waterfowl in explaining the invertebrates' population structure at a continental scale. However, more information is needed on the impact of bird-mediated transport on the population structure of aquatic organisms and on the spread of alien species.

The importance of the Netherlands as a staging area for Icelandic Black-tailed Godwits *Limosa limosa islandica* during spring-migration in 2001 and 2002

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Until the early 1990s, the Icelandic Black-tailed Godwit was a scarce and not very well known subspecies in the Netherlands. An investigation during 1984–1992 showed an increase in numbers during spring with a maximum of 630 birds in 1992 (Scheepen & Oreel 1995). Of these, most (460) were using the mudflats of the Wadden Sea near Wieringen, Noord-Holland. Because we both noticed a strong increase of the numbers of Icelandic Black-tailed Godwit in our study areas (Wieringen and the river IJssel), in 2001 we organised five spring counts at the best-known Dutch spring staging sites (29). However, foot and mouth disease made it impossible to count some important areas in that year. Therefore a more complete census was organised in spring 2002, when



seven counts were carried out at 44 locations. In spring 2001, Icelandic Black-tailed Godwits were found at 72% of the sites during one or more counts. The maximum number of birds (3,015–3,556) was counted on 31 March/1 April. Regular counts at one of the key sites (Wadden Sea coast of Wieringen) showed that almost 50% of the birds had arrived by mid March. In March and April 2002, birds were seen at 98% of the counted spring migration sites, and again the maximum (6,758–9,811) occurred over 31 March/1 April. These totals show that at the peak of spring migration in 2002, 19–28% of the subspecies population used the Netherlands. This was a surprise that had not documented before. These figures show that in the last ten years the Netherlands has become a major staging area during spring migration. Most birds use coastal areas but large numbers also use flooded grasslands. Resightings of individually colour-marked birds allows estimation of residence time and site faithfulness. Along the river IJssel in spring, Icelandic Black-tailed Godwits stayed on average for 12 days with a maximum of 37 days. Inter-annual resightings of the same individuals were recorded both on Wieringen (up to seven subsequent years) and along the river IJssel (up to three years).

Non-breeding surveys of terrestrial waders – why and how?

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Autumn migration patterns and the winter distribution of open-habitat inland waders were identified as gaps in knowledge 16 years ago. I will discuss how these gaps remain for Eurasian Golden Plover and Northern Lapwing in north-west Europe. Particularly as, against a background of changing climate and modified farmland landscapes, shifts in distribution and habitat use may be evident in Britain and northern Europe. I suggest that there is a need for internationally-coordinated surveys and ecological studies of these species in autumn and winter to estimate abundance, identify key sites and migration routes and understand the timing of migration.

A stable isotopic search for the Slender-billed Curlew

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The Slender-billed Curlew *Numenius tenuirostris* is among the most endangered bird species on earth. The International and European Action Plans for the species agree that the primary requirement for its conservation is to locate the breeding grounds. The breeding range has never been mapped, and only one nest location has ever been described. The potential range – as suggested by experts – covers a vast area, and several biomes, from steppe to tundra. Ground-searches have hitherto failed to locate any Slender-billed Curlews, despite substantial cost. In a novel approach to the problem, we aim to narrow the search for the breeding and

moulting areas, and shed light on other aspects of the species' ecology, by using stable isotope analysis of museum skins. We describe the project's rationale and methods, and report some preliminary results from stable isotopic analyses of Slender-billed Curlew museum-skin feathers.

Where should Kentish Plover parents raise their young?

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Most waders are precocial, and thus they are expected to rear their young in a habitat that is safe from predators and/or provides resources for the developing offspring. If the costs and benefits of rearing the brood in a habitat change over time, then the parents are expected to move with their young between habitats. We investigated these propositions in the Kentish Plovers *Charadrius alexandrinus* that reared their broods in two habitats at our field site in southern Turkey: in saltmarsh and on a lakeshore. We present data on changes in the time spent in the two habitats as the season progressed and relate this to habitat-specific changes in food abundance and bird density with season. Our results are consistent with the notion that changes in the ecology of the brood-rearing habitat resulted in the movement of families between habitats, which in turn influenced the parental behaviour of the plovers.

The influence of rainfall on the behaviour of wintering Northern Lapwings and Eurasian Golden Plovers in southern Portugal

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Northern Lapwings *Vanellus vanellus* and Eurasian Golden Plovers *Pluvialis apricaria* are widely distributed in southern Portugal in the winter due to high availability of suitable habitat. In this study, we investigated patterns of habitat use, as well as the diet and the behaviour of these birds in varied farming systems and under different rainy conditions.

The percentage of land units used by the birds was greater in dry winters than in wet winters. Lapwings used more land units than Golden Plovers. Lapwings fed in a greater range of the available habitats than Golden Plovers, which preferred to feed in pastures. Lapwings seem better suited than Golden Plovers to spend the winter in southern Portugal due to their ability to use a wider range of habitats.

The Lapwings' diet is mainly earthworms, which are widespread and abundant and are consumed whenever they were available. In contrast, earthworms are less important in the diet of Golden Plovers, being replaced by arthropods and gastropods. Generally the ingestion of prey associated with damp habitats, like earthworms and dipteran larvae, is lower during dry winters. In both species, those prey are replaced by adult arthropods and gastropods. In wet winters, both species occur in similar numbers at coastal and inland sites. In these circumstances intra- and inter-specific compe-



tition is lower and the birds occur in larger flocks. On the other hand, in dry winters the birds tend to concentrate in the most favourable coastal areas. Prey shortage leads to more agonistic behaviour and flocks are smaller. In relation to feeding behaviour, we find two different scenarios: wet winters, with less time spent feeding, and dry winters, with more time spent feeding.

Large-scale intensification of agriculture and climate change are together having a major negative effect on Portuguese farmland as wildlife habitat. These changes could be responsible for a long-term decline in the capacity of the land to support Lapwing and Golden Plover populations. The wintering strategies of Golden Plovers are less dependent on wet soils than those of Lapwings, but much more dependent of a single habitat, pastures. In drier winters, Lapwings face food scarcity and greater competition. In these winters, smaller flocks, more time spent feeding and a greater incidence of night feeding suggest that Lapwings need to increase the intake rates. This may mean that in dry winters Lapwings have difficulty obtaining enough food to assure winter survival, to migrate and breed.

Algal mats and foraging wading birds: is foraging in a green environment profitable?

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In Western Europe, green macroalgal mats may develop in sheltered bays and estuaries during spring and reach high levels of cover and biomass during the summer before breaking down in autumn or early winter. A consequence of organic enrichment (eutrophication), algal mats are known to have profound effects on the underlying sediment chemistry with subsequent negative effects on benthic invertebrates. This paper presents the results of a three-year study at Clonakilty Bay, West Cork, Ireland (2000–2002).

The study aimed to examine the effects of algal mats upon wintering waders at two levels. The questions addressed were firstly, when present, did algal mats appear to exert any influence on the distribution of foraging waders? Secondly, following the algal mat breakdown, how successful or profitable could foraging be, within such previously impacted areas? Detailed foraging studies were carried out at six sites between August and February of the winters 2000/01 and 2001/02. Results are presented for Black-tailed Godwit *Limosa limosa* and Redshank *Tringa totanus*.

When a patchy algal mat coverage was present, foraging Black-tailed Godwits and Redshanks showed a distinct preference for clear patches of sediment. Black-tailed godwits took significantly more foraging actions within clear patches, although there was no significant difference in the number of steps, swallows or foraging success between patches with and without algal mat. In contrast, Redshanks swallowed more prey and achieved a greater foraging success within clear patches in comparison with algal-covered patches. Measured foraging parameters of Black-tailed Godwits and Redshanks exhibited both spatial and temporal variation but analysis revealed no significant negative relationships with either algal cover or algal biomass.

A major difference between Black-tailed Godwits and Redshanks was the difference in their foraging success and estimated prey biomass intake rates. Black-tailed Godwits achieved a prey intake rate comparable with other studies, whereas Redshanks foraging within algal mat areas were unlikely to meet daily energy demands. Biomass intake (mg ash-free dry weight) of both Black-tailed Godwits and Redshanks were positively correlated with the densities of *Hydrobia ulvae*. Increases in the densities of this mud snail and the amphipod *Corophium volutator* in the months following algal mat breakdown appeared important in partially offsetting the negative effects of algal mats.

Different breeding origin of migrating and wintering Dunlin *Calidris alpina* at Portuguese estuaries – evidence from morphology, ringing recoveries and mtDNA

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Migratory connectivity plays a major role in conservation of long-distance migrants. Here, we studied links between breeding and wintering areas of Dunlin *Calidris alpina* populations that use Portuguese estuaries during migration and winter. We combined three methods (ringing recoveries, morphometrics of genetically sexed birds, and mitochondrial DNA markers) for assessing breeding origins and migration routes, revealing different aspects of the migration pattern.

Recoveries show clear differences in migration routes of Portuguese Dunlin between seasons. In August and September, recoveries originate mainly from stopover sites in Great Britain, showing links to breeding areas in Iceland and Greenland. In October, and the winter months, a clear shift to more eastern migration routes occurs, with recoveries from stopover sites in the Baltic Sea and in the migratory direction of breeding populations from N Scandinavian and N Russia.

Consistent with the ringing recoveries, morphological data show significant differences between wintering populations and migrants. In autumn, shorter morphological measurements indicate birds of more western breeding origin, whereas larger birds during winter resemble eastern breeding populations in N Russia.

In addition, we used mitochondrial DNA haplotype frequencies to estimate the breeding origin of the populations. In breeding populations on the East Atlantic flyway, two mtDNA haplotypes occur (European and Siberian), and the frequency of the European haplotype decreases gradually with the longitude of the breeding zone. In Portugal, all spring and autumn migrants had European haplotype, corresponding to the subspecies *C. a. schinzii* and *C. a. arctica*, while the wintering population had 21% of Siberian haplotype, which is similar to N Russian populations of the nominate subspecies.



The effect of weather and tide on the intake rate of Eurasian Oystercatchers *Haematopus ostralegus*

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For the Eurasian Oystercatcher *Haematopus ostralegus*, a single low water period of normal duration is not sufficient to meet daily energy requirements (Zwarts *et al.* 1996). From experiments it is known that captive Oystercatchers are able to increase their intake rate when exposure times are reduced (Swennen *et al.* 1989). In this field study, we investigated the prediction that free-living Oystercatchers will increase their intake rate after a period of reduced feeding opportunities.

Behaviour observations were made of a population of colour-banded Oystercatchers, foraging in a bay on the Wadden Sea island of Texel during the winter. Variation in intake rate was analysed within individuals and exposure time was used as a measure for potential foraging time.

There was no significant effect of any of the temperature parameters on the intake rate, neither was there any detectable effect of the potential foraging time at the moment the observation was made. However, there was a significant positive relationship between the intake rate and the average length of the potential foraging time during the two days preceding the observation.

This leads to the conclusion that, after a period of reduced foraging time, Oystercatchers have a lower intake rate than after a period of good feeding opportunities. This is opposite to the expectation, and we present several possible explanations for this effect.

Waders in the new edition of the Red Data Book of Belarus: current numbers, trends and distribution.

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The Red Data Book is the legislative document for wildlife preservation in Belarus. New criteria for including different taxa of animals in the protection list were developed in the Institute of Zoology NAS in the course of preparing the new Red Data Book. Waders are among the more vulnerable groups of birds because their habitats are threatened as a result of human activities. In Belarus, 24 species of waders breed and half of them need protection. The new edition of the Red Data Book will include 15 wader species that are afforded different categories of protection. Great Snipe *Gallinago media*, Ruff *Philomachus pugnax* and Black-tailed Godwit *Limosa limosa* are new species included in the list of protected animals for the first time. Work carried out during preparation of the new Red Data Book included summarising and collating recent data on numbers, trends and distribution of waders in Belarus. Among the protected species, the populations of Whimbrel *Numenius phaeopus*, Curlew *Numenius arquata* and Greenshank *Tringa nebularia* have been stable over the last ten years. Eurasian Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula*,

Eurasian Golden Plover *Pluvialis apricaria*, Marsh Sandpiper *Tringa stagnatilis* and Terek Sandpiper *Xenus cinereus* have increasing numbers. However, the populations of Stone Curlew *Burhinus oedicephalus*, Great Snipe, Black-tailed Godwit and Ruff have declined considerably during the past 50–70 years. Jack Snipe *Lymnocyptes minimus* is a secretive species that probably breeds in Belarus only sporadically. There are single instances of breeding by Dunlin *Calidris alpina* and Black-winged Pratincole *Glareola nordmanni*.

The relation between body condition and intake rate in free-living Eurasian Oystercatchers *Haematopus ostralegus*

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Optimal foraging theory presumes that organisms are perfectly adapted to their environment and will forage in a way that maximizes their fitness. As fitness is hard to measure directly, a measurable currency that relates to fitness is used. Instantaneous intake rate is an important factor in maximizing foraging efficiency (Charnov 1976) and is used as such a currency. However, it is also difficult to relate intake rate directly to fitness. A possible solution for this problem is to relate intake rate to another indirect measure of fitness, body condition. Here we present the results of a field study on the relationship between instantaneous intake rate and body condition in Eurasian Oystercatchers *Haematopus ostralegus*.

During the winter of 2002/2003, free-living oystercatchers were captured at various sites in the Dutch Wadden Sea. The biometrics and blood composition (white and red blood cells) of the birds were measured in order to determine their body condition. After release, their foraging behaviour was studied in their natural environment. The relationship of body condition and intake rate was analysed for between sites and within sites.

A positive association was found between body condition and intake rates between sites (i.e. body condition was better on sites where intake rates were higher), but on an individual, within-site level this relationship was negative (i.e. body condition was better in birds with lower intake rates). This contradiction between the site and individual levels gives rise to an interesting insight in the spatial distribution of Oystercatchers on the mudflats in relation to condition, intake and survival.

Records of the Slender-billed Curlew *Numenius tenuirostris* in Bulgaria during the last ten years (1993–2002)

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Almost every year, the World-threatened Slender-billed Curlew visits Bulgaria, which offers favourable places for



resting and feeding during its migration between the unknown breeding grounds in Western Siberia and the distant wintering grounds in Morocco. During the last ten years the species has been recorded in Bulgaria 63 times with an aggregate total of 178 birds (though almost certainly not that number of individuals). Numbers appear to follow a 3–4 year cycle, as the birds were most numerous (33–72 birds) in 1993, 1996 and 1999. Most observations have been of single birds, but in the peak years mentioned there were flocks of 10, 9 and 15 individuals respectively. Lakes Atanasovsko and Pomoriisko are the most important sites having provided 74.2% and 14.6% of Slender-billed Curlew records for the country. The species is more regular and numerous (82.6% of birds recorded) during spring (March to May) than in autumn. It is more numerous and remains longer in Bulgaria during cool, rainy springs. The autumn migration is on a much smaller scale. Single birds have remained on some Bulgarian reservoirs in summer, as well as in autumn. Recent studies in Bulgaria, as well as in other countries, confirm our previous conclusions (Nankinov 1998) that, although there are fluctuations from year to year, the number of the Slender-billed Curlews is increasing slowly and hopefully its population will become stable.

**Breeding of African Black Oystercatchers
Haematopus moquini at Koeberg Nuclear Power
Station and Dyer Island: a comparison between a
mainland site and an island with no alien predators**

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During the 2002–03 nesting season, the breeding productivity of African Black Oystercatchers *Haematopus moquini* was monitored at two study sites. One of these, at the Koeberg Nuclear Power Station, 30 km north of Cape Town, had 37 breeding pairs of oystercatchers, which produced 10 fledglings (0.3 fledglings/pair). This site consists of a sandy shore and an artificial rocky shore inside a sheltered harbour which acts as the “settling pond” to the cooling water intake of the power station. Common predators here include Yellow Mongooses *Cynictis penicillata*, Pied Crows *Corvus albus*, Sacred Ibises *Threskiornis aethiopicus* and Kelp Gulls *Larus dominicanus*. At the other site, Dyer Island (55 km west of Cape Agulhas, area 20 ha, shoreline 2.5 km), 21 pairs of oystercatchers bred and produced 18 fledglings (0.9 fledglings/pair). The island’s shoreline consists of exposed rocky shore; there are no introduced mammalian predators on this island and Kelp Gulls are the only avian predator. Various aspects of breeding productivity are compared between these two sites.

**Spatial and temporal fluctuations in use by
shorebirds and in availability of chironomid prey
in the Odiel salt pans, southwest Spain**

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The Odiel Estuary in southwest Spain is protected as a Natural Park, Biosphere Reserve and Ramsar site and is one of the major sites on the East Atlantic flyway for shorebirds and other waterbirds. Tidal marshes (6,000 ha) and salinas (= salt-pans) (1,100 ha) are the major habitats used by shorebirds in the estuary. The importance of the salinas as feeding habitat increases during the spring and autumn migrations, when we have recorded up to 10,000 shorebirds using them at any one time. We present details of the variation in availability of chironomid larvae prey in the salinas according to season, situation and salinity during 2001. We show how this variation relates to differences in the importance of the salinas as feeding habitat for different shorebird species in the spring and autumn migration periods.

**Eggs in the fridge: nest site choice and nest
scrape design in tundra shorebirds**

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Living in the arctic entails high thermostatic costs and these extend to maintaining egg temperature during incubation. Energy expenditure of arctic-breeding shorebirds during incubation is about 50% higher than that of temperate-breeding birds, and approaches physiological limits to energy expenditure in small species (*Funct. Ecol.* 17: 356–362). Hence, arctic shorebirds, and especially small ones, may be expected to show behavioural adaptations that reduce the cooling rate of eggs. Recently, Reid *et al.* (*Funct. Ecol.* 16: 305–312) quantified the significance of several heat-conserving features of Pectoral Sandpiper *Calidris melanotos* nest scrapes.

We collected data on nest distribution, scrape dimensions and composition of nest lining material in six wader species breeding in NW Taimyr, Siberia (ordered by size these were: Little Stint *C. minuta*, Red Phalarope *Phalaropus fulicarius*, Dunlin *C. alpina*, Curlew Sandpiper *C. ferruginea*, Ruddy Turnstone *Arenaria interpres* and Pacific Golden Plover *Pluvialis fulva*). Nests were often located on south-facing slopes which have a favourable microclimate. There was a tendency for small shorebirds to make deeper scrapes than



the larger species and to apply them with a thicker layer of lining material. Little Stints deposit 1,000–2,000 willow leaves in their nest scrapes, by throwing them in one by one. At similar distances from the permafrost (no difference between species), thicker nest floor lining reduces clutch heat loss to the ground. Small species also tended to have a higher nest cup depth to diameter ratio, which results in a reduced sensitivity to the cooling effect of wind. Little Stints further used nest-lining material with better insulative properties than lining used by Turnstones and Golden Plovers, with medium-sized species selecting intermediate-quality materials. A quantitative integration of these differences indicates that heat loss from objects in nests increases with species body size in this shorebird assemblage, and thus supports the prediction that small shorebirds invest more than large species in their thermal incubation environment. Potential constraints and interactions due to species differences in habitat preference and parental care are discussed.

Wader nesting success and rodent abundance in the Arctic: testing prey-switching hypothesis at a super-regional scale

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In a number of studies, prey-switching by predators has been shown to be an important factor determining the nesting success of tundra birds, including waders. However, this relationship has never been analysed at a scale wider than a single region due to a lack of the data needed for formal quantitative processing. We used data for the 11 years, 1992–2002, accumulated in the framework of the Arctic Birds Breeding Conditions Survey (IWSG project) to study the temporal and spatial variability of the relationship between wader nesting success and rodent abundance as well as to interpolate nesting success information across the ranges of selected wader species. Missing data on rodent abundance were reconstructed for a proportion of samples based on the assumption that population peaks are very likely to be followed by population depression.

A general linear model linking rodent abundance and wader nesting success was established that took into account the variation in data quality. This showed a significant linear relationship between these parameters. This relationship was then used to predict wader nesting success for localities for which information was missing. Wader nesting success was interpolated for the whole circumpolar arctic region for each year from 1992 to 2002 based on the original and estimated data values. Comparison of nesting success across the ranges of some wader species and flyway populations with the proportions of juveniles on wintering grounds revealed significant correlations. This supports the validity of the methods chosen for modelling wader nesting success at a super-regional scale. However, these methods did not account for a substantial part of the environmental variation related to climatic conditions. Poor data coverage in some regions did not allow the making of any reliable interpolation. This shows the importance of expanding the information network further in order to raise the analysis to a global level.

Breeding systems of waders

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Waders exhibit some of the most diverse breeding systems among all birds. Immense variation exists both within and across species. I will overview recent phylogenetic comparative studies, and ask how ecology, life-history and developmental mode of the young have influenced their mating system and parental care. I will also investigate the determinants of sexual size dimorphism and plumage patterns. Finally, I will discuss some of the main unresolved questions where progress should be made. Taken together, waders are excellent model organisms for elucidating the evolution of avian breeding systems, and much remains to be learnt about their behaviour.

Interspecific variation in mercury contamination between Black-winged Stilt *Himantopus himantopus*, Kentish Plover *Charadrius alexandrinus* and Avocet *Recurvirostra avosetta* chicks in southwest Europe

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The main objective of this study was to investigate variation in mercury contamination in three wader species feeding on macroinvertebrate communities in saltpans. Chick feathers were collected from Black-winged Stilts *Himantopus himantopus*, Kentish Plovers *Charadrius alexandrinus* and Avocets *Recurvirostra avosetta* at Ria Formosa, the Guadiana estuary and Cadiz Bay. Samples were taken during the breeding seasons of 2000–2003. Mercury concentrations were determined by cold vapour atomic absorption spectroscopy.

Significant differences in total mercury concentration were observed between Kentish Plover and the other species. Moreover Kentish Plover showed the highest mean mercury concentration (e.g. Esperanza in Cadiz Bay: 3.64 ppm; Marim in the Guadiana estuary: 4.67 ppm; Tavira in Ria Formosa: 1.94 ppm). Interspecific variation in mean mercury levels was explained on the basis of differences in habitat use. Avocet and Black-winged Stilt chicks feed mainly on macroinvertebrates available in saltpan ponds. However, Kentish Plover chicks feed on both terrestrial and aquatic invertebrates from a large range of sites in and around the saltpans, including roads and pond walls. Therefore they can be contaminated by mercury from several different sources. Avocet chicks use only a small range of feeding habitats in the saltpans and this probably accounts for the fact they were found to have the lowest variation in mercury levels. Although Black-winged Stilt chicks feed mostly in water, they also take terrestrial food from the edges of the saltpans, particularly insects from among plants and wet soils. This probably explains the higher variation in mercury levels in Stilts compared with Avocets. Significant inter-site variation was



observed in mercury levels in all three species but no significant correlation was observed between species. This can also be explained on the basis of the species' different habitat usage.

Pipping at peak time: how well synchronised is hatching with food abundance in arctic chicks?

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The prime food resource for the chicks of arctic-breeding shorebirds is surface-active arthropods. The arctic summer is short and breeding must be well-timed to enable the young to grow fast enough and fledge before winter sets in. Thus, a close match between the growth period of the chicks and the seasonal pattern of abundance of the food supply is paramount for successful reproduction. This is particularly the case under arctic circumstances, much more so than at lower latitudes where food peaks are more spread. We evaluate the hypothesis that breeding is timed to allow the chicks to grow up during the peak period of the food supply. Our studies are based on data relating to the phenology of both surface-active arthropods and breeding shorebirds.

Concurrent with breeding bird studies, arthropod abundance was measured during three expeditions to the Taimyr peninsula in the Russian Arctic. Variation in seasonal patterns of abundance was large and can be attributed to weather and season-related variables. In two of the three years, the timing of the shorebird breeding season appeared to be late compared with the food peak: chicks hatched on the decreasing slope of the food abundance curve. However an earlier start of breeding in these years was impossible, because egg-laying took place almost immediately after snow had disappeared. On the basis of the close relationship between weather and season and arthropod abundance, we utilised our field data to model food abundance using a 30 year weather dataset for the same area. Over the 30-year period, peak abundance dates ranged from 10 July to 1 August, but in most years, occurred around 17 July. In our three-year study, all median hatching dates were before 23 July and, in most species, all nests hatched within a two-week period. This therefore contradicts the conclusion of our three-year study that chicks hatch too late. It appears that hatching is well synchronised with food availability when looking at the long-term average. However, the 30-year data does show a trend towards more variation in the timing of food abundance and a longer season. Possibly this has been induced by climatic change. Therefore the number of years in which hatching and food abundance are ill synchronised is likely to increase.

The p-value culture, and other statistical problems

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The way in which statisticians "do" statistics is moving away from a primary concern about formal statistical significance, a way of operating which is now known, disparagingly, as the "p-value culture". In its place is coming a paradigm which states that a result must not only be demonstrated to be statistically discernable, but must also be demonstrated to be biologically consequential. The talk will also consider other practical statistical issues, such as the importance of measuring variability, and will be illustrated by examples using waders and data collected on waders.

Choice of meadows for feeding in Ruffs, spring staging in The Netherlands: a pilot study

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From late February until early May ca. 50,000 Ruffs *Philomachus pugnax* stopover in the Province of Fryslân, in the north of the Netherlands, making it a major staging site in Western Europe. During their stopover, Ruffs refuel on a (presumed) diet of earthworms, leatherjackets and insects found in grassland meadows. At the same time, they moult into their wonderful breeding plumage. The much smaller females arrive later than the males and are relatively scarce compared with staging sites in Central and Eastern Europe. We studied choice of feeding sites (meadows) by Ruffs and Reeves and tried to relate meadow characteristics to use. We chose 125 meadows that varied in grassland type, agricultural use and landscape characteristics. In these meadows, Ruffs and Reeves were counted weekly between 1 April and 2 May 2003. The foraging behaviour of the birds, which fed either on buried prey or surface insects, was described by counting peck, probe, pace and intake rates. Whenever possible, a male and female feeding close to one another were observed sequentially and these observations were considered as paired.

Ruffs used about 50% of the meadows we studied. Sward height and distance to the nearest roost were the most important characteristics explaining variation in usage. Also important were vegetation type, fertilising intensity, and, to a lesser extent, openness of the landscape, drainage level and soil type. Water coverage, relief, presence of grazers and the fertilisation method were of no importance. In general, Ruffs



preferred to feed in meadows close to a roost, with low vegetation comprising grass mixed with herbs, either on a sandy or clayey soil, with an intermediate drainage level and in a more or less open landscape. Recently fertilised fields were highly attractive but scarce. The number of Ruffs feeding in meadows varied only with date (numbers decreased, as did overall numbers staging) and time of the day, as birds take siestas on roosts in Lake IJsselmeer. In the course of April, the proportion of birds feeding on insects increased. Females had lower prey intake rates than males, but higher pacing rates and equal pecking and probing rates. We suggest that aspects of feeding behaviour and feeding site choice can account for the rather different migration routes taken by each sex.

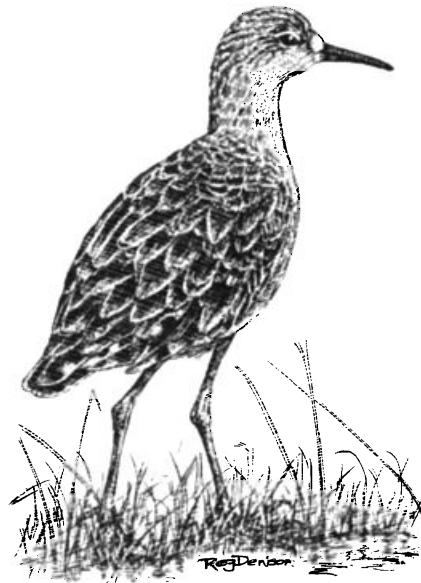
Breeding biology of the Stone-curlew in intensive agriculture habitat: a seven year study

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The Stone-curlew *Burhinus oedicanus* uses three habitats in France: steppe areas, vineyards/fruit plantations, and agricultural habitat. Very few data are available from this latter habitat, although most of the French population occurs in cultivated landscapes. Here we present results from a seven-year study (still ongoing) on a very large study site (340 km²)

in central western France. This study site still holds a high density of Stone-curlews (total population: about 300–400 pairs). We present data on habitat selection, spatial distribution of pairs, breeding biology, breeding success and population trends. We discuss these results with regard to trends currently affecting agricultural habitat in cereal plains in France (and Europe), and discuss some management and conservation issues for this species.



Annual Conference — Abstracts of posters

During the conference, Petra de Goeij organised the usual poster competition and participants voted for the one they preferred. The results were:

- ❑ **1st prize: Neap-tide roost selection by waders: maximizing feeding opportunities or reducing risks of predation?** by Susana M. Rosa, Ana Encarnação, José P. Granadeiro & Jorge Palmeirim
- ❑ **2nd prize: Assessing the use of mudflats by waders: bias due to the response of birds to the tidal cycle** by Maria P. Dias, Ricardo J. Martins, José P. Granadeiro & Jorge M. Palmeirim
- ❑ **3rd prize: Predation of horseshoe crab eggs by migratory shorebirds in Delaware Bay, USA** by S. Gillings, P. Atkinson, R. Robinson, R. Stillman, R. Weber & S. Love

Coping with heat-stress during incubation: the influence of water proximity on nest desertion by Kentish Plovers *Charadrius alexandrinus*

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Kentish Plovers *Charadrius alexandrinus* are small shorebirds that readily nest on exposed sited in hot environments, where air temperatures at ground level may be >45°C dur-

ing the hottest parts of the day. In these environments, leaving a nest unattended even for a short period may compromise nesting success. We examined whether the probability of nest desertion was affected by proximity to water. We found that this was the case. Nests located close to water were deserted less frequently (39.0% of 346) than nests located far from water (57.6% of 118). This was so in spite of the nests located close to water being more frequently placed in exposed sites (62.4% of 346) than were the nests in sites far from water (51.7% of 118). It seems likely that susceptibility to thermal stress changed in relation to proximity to water because in sites close to water it was possible to belly-soak, which would allow a more continuous nest attendance.

