

Abstracts of wader theses

As a means of disseminating information about important new wader studies well in advance of formal publication, this series features abstracts from recent wader theses (bachelors, masters and doctoral). Thesis authors are invited to submit abstracts to the editor.

Population biology of Mountain Plovers in southern Phillips County, Montana

(2001, PhD thesis, Colorado State University, Colorado, United States)

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Effective conservation measures for rare or declining species cannot be implemented unless their biology and demography are well understood. The Mountain Plover (*Charadrius montanus*) is a local and declining species breeding on the western Great Plains of North America. Populations are thought to have declined drastically in the last several decades and the species has been proposed to be listed as Threatened. Their breeding biology has been extensively studied, especially in northeastern Colorado, although aspects of their life-history such as their demography have not been studied. During a 6-year study (1995–2000) I investigated their nesting biology, demography, and population trends in southern Phillips County, Montana.

I modelled the daily nest survival of Mountain Plovers as a function of the sex of the incubating adult, daily nest age, year, linear and quadratic time trends, and two weather covariates (maximum daily temperature and daily precipitation) using Program MARK. The sample of 432 nests included slightly more male-tended nests (55% of total). Observed (31 May for females and 2 June for males) and expected (27 May for females and 26 May for males) mean nest initiation dates did not differ between nests tended by female and male plovers. I found that daily nest survival was a function of the sex of the incubating adult, daily nest age, a quadratic time trend, and daily precipitation. I found no evidence of yearly differences or an effect of maximum daily temperature on nest survival. Nests tended by male plovers had higher daily survival rates than those tended by females. Daily nest age positively influenced survival with older nests having higher survival, although this effect may have been confounded with individual heterogeneity. Daily precipitation during the nesting season negatively influenced nest survival. Seasonally, the daily survival of Mountain Plover nests was high early in the nesting season, dipped to a low in mid-season, and then gradually rose to a peak at the end of the nesting season. Total nesting success was 0.35 for nests tended by females and 0.49 for nests tended by males.

I used the robust design in program MARK to estimate annual apparent survival (ϕ), conditional capture (p and r) and recapture (c) probabilities, and the annual population size (N) of Mountain Plovers in southern Phillips County, Montana in the presence of temporary emigration. I modelled annual survival rates as a function of two age-classes (adults and juveniles), body mass at capture (juveniles only), a radio transmitter effect in 1999, and annual area occupied

by prairie dogs within the study area. I modelled year-specific capture probabilities to include a resighting effect (r) for plovers that had been marked in a prior year. The results supported age-specific differences in annual survival that were also a function of juvenile body mass and area occupied by prairie dogs. Body mass had a positive effect on juvenile survival. The area occupied by prairie dogs appeared to have no effect on survival. Estimated annual apparent survival rates were 0.46 to 0.49 for juveniles and 0.68 for adult plovers. Using these estimates, I computed the mean life span of a Mountain Plover at banding as 1.92 years (SE = 0.17; 95% CI was 1.58, 2.26). There was strong evidence for a negative resighting effect on capture probabilities. The size of the adult Mountain Plover population in the study area was estimated at between 95–180 individuals annually. The population size closely tracked annual changes in the area occupied by black-tailed prairie dogs with both prairie dogs and plovers rapidly recovering from an outbreak of sylvatic plague in the mid-1990s.

Finally, I estimated the annual rate of population change (λ) and recruitment rate (f) using the Pradel models in Program MARK. I modelled λ as a constant across years, as a linear time trend, as year-specific, and as a function of the area occupied by prairie dogs. I modelled f only as a function of the area occupied by prairie dogs. The results indicated a strong negative effect of area occupied by prairie dogs on both λ and f . There was also good evidence for a negative time trend on λ ; this model had substantial weight ($w_i = 0.31$) compared to models without a time trend. Yearly estimates of λ were >1 in all years except 1999, indicating that the population increased beginning in 1995 and then stabilized in the last year of the study. There was weak evidence for year-specific estimates of λ ; the best model with year-specific estimates had a low weight ($w_i = 0.02$), although the pattern of yearly estimates of λ closely matched those estimated with a linear time trend. I found that the population trend of Mountain Plovers closely matched the trend in the area occupied by black-tailed prairie dogs. Black-tailed prairie dogs declined sharply in the mid-1990s in response to an outbreak of sylvatic plague, but their numbers steadily increased since 1996 with subsequent increases in plovers. This suggests that the conservation of Mountain Plovers in this region is closely linked to the available area occupied by prairie dogs. Threats to prairie dogs such as sylvatic plague and recreational shooting pose indirect threats to Mountain Plovers.

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Non-breeding shorebirds in a coastal agricultural landscape: winter habitat use and dietary sources

(2002, PhD thesis, Simon Fraser University, British Columbia, Canada)

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The Fraser Delta's intertidal mudflats currently support approximately 44,000 shorebirds during the winter. Adjacent agricultural fields also provide roosting and feeding habitat, but land-use changes are reducing the availability of open-soil farmland. A multi-faceted research program was designed to quantify farmland use by Dunlin (*Calidris alpina pacifica*), Black-bellied Plover (*Pluvialis squatarola*), and Killdeer (*Charadrius vociferus*) during three non-breeding seasons (October–April) from 1997 to 2000.

Habitat surveys and farmer interviews revealed disproportionately greater use of fields close to shore for Dunlin and Black-bellied Plover, and smaller fields for Killdeer. Dunlin made disproportionately greater use of bare, cover crop, winter vegetable, and grass fields; Black-bellied Plover mainly used bare and cover crop fields, and Killdeer used all crop types equally. Agricultural practices appearing to enhance field usage were multi-year applications of manure, inorganic fertilizer, laser levelling, and a longer time with the same crop. All species occurred more frequently in fields previously used by conspecifics and where other shorebird species were present.

The frequency of occurrence in fields was greater by night

for Dunlin and by day for Black-bellied Plover and Killdeer. Environmental predictors of field use differed between day and night, and among species. Shorebirds used fields less frequently during increased nocturnal moon illumination, consistent with the hypothesis that perceived predation risk is an important modulator of field use.

The proportional contribution of diet from terrestrial fields versus marine mudflats was quantified via stable isotope analysis (¹³C and ¹⁵N) of Dunlin blood samples. Isotopic turnover rates and tissue fractionation factors for these isotopes were also measured experimentally for Dunlin in captivity. Based on these results, mudflats were the main source of invertebrate prey for Dunlin, contributing approximately 70% of their diet. However, extreme inter-individual variation was found, with farmland dietary contribution ranging from 0–87%. Juveniles had consistently more terrestrial diets than adults in all years. The proportion of diet from fields varied with body shape, but not with overall skeletal size or sex. Culmen lengths were shorter relative to wing and tarsus lengths for Dunlin with more terrestrial-based diets. The results of this research will facilitate targeted conservation and management strategies for non-breeding shorebirds.

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Male territoriality and female brood desertion in Purple Sandpipers (*Calidris maritima*)

(2001, MSc thesis, University of Copenhagen, Denmark)

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Unlike most avian species, uniparental brood care is a prevalent phenomenon among shorebirds. Female Purple Sandpipers (*Calidris maritima*) desert the brood at hatching, leaving parental care to the males. Possible future benefits for the male might be the reason why males to stay in their territories long after hatching. These benefits might be greater for the male than they would be for the female, and may possibly include the assessment of potential future mates, and prevention of late-breeders from nesting nearby. Uniparental brood care may thus give males a higher net benefit than it would females (“the male territorial benefit theory”).

The focus of these studies was the breeding population of Purple Sandpipers at Adventdalen, Svalbard. During the three periods of the breeding season (pre-incubation, during incubation and brooding period) we tested whether males were territorial.

The study benefited from the ringing program of the breeding population carried out by Elin Pierce and the investigation centred on the time budgets of colour-ringed males. The time allocation of behaviours was compared.

All territorial behaviour was recorded. The amount of such behaviour declining markedly during incubation and very little territorial behaviour occurred during brood care.

The “male territorial benefit” theory did not find full support in this study. However, the fact that males stay in their territories for long periods after their broods have hatched suggests that there are benefits of staying. Nevertheless those benefits do not appear to be dependent upon territorial behaviour.

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The effects of human disturbance on the behavior of Sanderlings (*Calidris alba*) foraging at a migratory stopover

(2003, ALM thesis, Harvard University Extension School, United States)

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Human disturbance has caused significant alteration of natural landscapes, and many wildlife populations have declined as a consequence. Of particular concern are shorebirds, which are sensitive to encroachment because they migrate exceptionally long distances and have specific habitat and high-energy intake requirements (Brown, S. *et al.*, 2001). Besides habitat loss, human recreational activities are also thought to interfere with migrating shorebirds' ability to obtain fat reserves necessary for survival (Pfister *et al.*, 1998). For example, the effects of such numerous, but relatively small disturbances have been modelled in the Eurasian Oystercatcher *Haematopus ostralegus* and are thought to impact at the population level (West *et al.*, 2002). The study reported here tested the hypothesis that foraging by Sanderlings *Calidris alba* at a migratory staging area was negatively affected by disturbance from human recreational activities.

Data were collected in August 2001 at Plymouth Beach, Massachusetts, by the focal observation method and results confirmed the hypothesis. Sanderlings reacted to human disturbance by increasing their rates of alert ($X^2 = 32$, $P < 0.0001$) and running ($X^2 = 7$, $P = 0.0071$) behaviour and by increasing the % time spent running ($X^2 = 8$, $P = 0.0049$). Pecking rate was not significantly affected by human disturbance. Alertness rate ($X^2 = 42$, $P < 0.0001$) and % time running ($X^2 = 17$, $P = 0.0536$) were sensitive to the level of disturbance, but running rate was not significantly affected by disturbance level. Temporal and environmental factors were also found to influence foraging behaviours. Results of this study help us to understand the impact of human disturbance at the individual level, and could be used in establishing a model to measure its impact on the Sanderling population.

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Ecology of migratory timing by southbound male and female Western Sandpipers (*Calidris mauri*)

(2003 MSc thesis, Department of Biological Sciences, Simon Fraser University, Canada)

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Western Sandpipers (*Calidris mauri*) show the pattern typical of long-distance migrants of the family Scolopacidae, with male-biased parental care, female-first southward migration, and independent migration of age classes. I investigated the migratory timing of southbound Western Sandpipers, focusing on the period between departure from breeding sites and the first major stopover. A simulation model based on published breeding parameters predicted that females should precede males to post-breeding sites by 1.1–5.3 days, which agreed well with data (2.3–8.3 days). At the first major stopover, the mean difference was only 1.2 days, but varied over 14 years from –7.8 days (females-first) to +2.3 days (males-first). Juvenile females preceded males by on average 0.5 days (–5.1 to +1.1 days, $n=19$).

To examine this interannual variation, I compiled data on snowmelt, breeding phenology, and the migration of an im-

portant predator, the Peregrine Falcon (*Falco peregrinus*). Snowmelt and falcon migratory timing varied greatly year-to-year, and were strongly correlated. These events bracketed sandpiper breeding and migration, which in contrast varied relatively little. Sandpipers migrated later relative to falcons in years with early snowmelt, which I infer makes the journey more dangerous.

I compared predictions of five hypotheses about sandpiper migratory timing (Breeding Recovery, Migration Distance, Molt Deadline, Escape Performance, Territoriality) to data. I found strongest support for the hypothesis that migration timing results from a trade-off between benefits (more time for parental care or development) and costs (greater exposure to falcons) of delayed migration. Females weigh costs more heavily due to their poorer escape performance.

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Seasonal and age-related trends in the reproductive output of Western Sandpipers *Calidris mauri* at Kanaryaraq, Alaska

(2002, Masters thesis, Humboldt State University, United States)

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I studied seasonal and age-related effects on the reproductive output of Western Sandpipers (*Calidris mauri*) breeding at Kanaryaraq, Alaska, in 1999 and 2000. I examined variation in date of nest initiation, clutch-size, average egg volume per clutch, nest daily survival rate, fledging success, reproductive success, and parental brood attendance.

Nests initiated before mean initiation date hatched at higher rates than nests initiated after mean initiation date ($P < 0.001$ in 1999; not significant in 2000) and early breeders exhibited higher reproductive success than late breeders ($P < 0.01$ in 1999; not significant in 2000). Parental brood attendance by male and female Western Sandpipers declined



seasonally (males $P < 0.01$; females $P < 0.001$, years combined), but this decline was not related to fledging success, which remained constant across the seasons. Predation pressure increased seasonally in both 1999 and 2000 (not significant in 1999; $P < 0.05$ in 2000) and likely accounted for the seasonal decline in both hatching and reproductive success.

I utilized age-specific plumage characteristics to distinguish between second-year ("yearling") birds and after second-year ("adult") birds. I thus categorized breeding Western Sandpipers as yearlings (birds less than one year old, attempting their first breeding effort), new adults (birds more than one year old, attempting their first breeding effort), or old adults (birds more than one year old, attempting at least their second breeding effort). Effects of age and experience were more pronounced in females than males. In 1999, old females initiated nests on average eight days before new females and nine days before yearling females (not significant); in 2000, old adult females initiated nests an average of 10 days before new females and eight days before yearling females ($P < 0.01$). New females laid a significantly higher proportion of four-egg clutches (100%, $n=23$) in 1999 than yearling females (25%, $n=4$; $P < 0.0001$) or old females (80%, $n=10$; $P < 0.05$). Old adults and yearling females did not differ significantly in proportion of four-egg clutches. Yearling females laid significantly smaller eggs in 2000

($P < 0.05$) than either new or old females, who laid eggs of nearly equal volume (6.86 ml \pm 0.13 SE, 7.23 ml \pm 0.07 SE and 7.21 ml \pm 0.08 SE, respectively). Finally, new females exhibited higher reproductive success than either yearlings or old females in 1999 ($P < 0.01$), whereas reproductive output of old females was higher than both yearlings and new females in 2000 ($P < 0.05$), which did not differ from each other.

Male Western Sandpipers exhibited significant variation in date of nest initiation and duration of brood attendance. In 1999, old males initiated nests six days before new males ($P < 0.05$; no yearling males detected in 1999) and five days earlier than both new and yearling males in 2000 (not significant). New males attended broods longer than old males in 2000 only ($P < 0.05$).

Older, more experienced females exhibit increased reproductive output compared to younger, less experienced birds. This is a result of special conservation interest given the low annual survival rate of female Western Sandpipers at Kanaryaraq (0.40 \pm 0.06 SE) in contrast to males (0.67 \pm 0.05 SE). Strong seasonal and age-related trends are noteworthy in both years of study, and additional data over a longer study duration will serve to better determine lifetime reproductive success, which will in turn aid in estimating population demographic parameters.

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The effect of disturbance on the breeding biology of Hooded Plovers

(2000, PhD thesis, Department of Zoology, University of Melbourne, Australia)

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Disturbance of birds by humans is a growing problem. This thesis examines the mechanisms through which disturbance may reduce reproductive success in the Hooded Plover *Thinornis rubricollis*, a solitary-nesting shorebird for which disturbance is thought to constitute a conservation threat.

As a precursor to examining disturbance in Hooded Plovers, breeding biology, life history and parental care were investigated in a colour-banded population in coastal Victoria, Australia. Pairs bred in widely dispersed territories, and intact pairs bred in the same territories year after year. The breeding season was asynchronous and protracted, lasting up to eight months. Breeding success was low, but pairs re-nested frequently and rapidly after nest and brood failure, and sometimes after successfully fledging young. Survival of juveniles was similar to that reported for other plovers, and adult survival was high compared with other plovers. However, it was estimated that only 34% of adults were expected to live 11 years, the average period needed for a pair to replace itself (produce two young).

One unusual feature of the life cycle of Hooded Plovers was the complete temporal overlap of adult wing moult with breeding. Complete biparental care occurred throughout the breeding cycle. There is some evidence that males undertook more of the nocturnal incubation while females undertook more of the diurnal incubation but overall, pairs shared incubation equally. Levels of incubation were high and constant over the incubation period. Once chicks hatched, the proportion of time parents spent close to eggs and chicks and

the frequency of distraction displays increased. Additionally, adults fed less after their chicks hatched, and adult body mass decreased. Brooding decreased as chicks grew.

A number of mechanisms through which disturbance could reduce reproductive success were examined. Disturbance resulted in egg temperatures moving both above and below benchmark values, potentially leading to thermal stress in eggs. At least some recorded egg temperatures were potentially lethal. The proportion of abandoned eggs was highest in nests at the interface between the beach and dunes, followed by beach then dune nests. This pattern mirrored the pattern of disruption of incubation by humans between habitats, suggesting thermal stress due to disturbance caused egg mortality. Thermal stress could also kill chicks, and disturbance disrupted brooding. Failure of adults to defend eggs or chicks due to disturbance did not lead to nest or brood failure. Adults defended nests and broods, but predation events were only observed during undisturbed conditions. For broods, foraging time decreased and they foraged further from the sea with increasing levels of disturbance. Energetic stress is therefore another potential mechanism that could decrease chick survival. This study uncovered potential mechanisms through which disturbance could decrease hatching and fledging success in Hooded Plovers. Identification of the mechanisms through which disturbance acts, suggests that a management approach that emphasises managing the effect of disturbance rather than the response to it, will be a necessary component of the recovery of this species.

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