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Source: Waterbirds, 38(1):40-46.
Published By: The Waterbird Society
DOI: http://dx.doi.org/10.1675/063.038.0106
URL: http://www.bioone.org/doi/full/10.1675/063.038.0106

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Abstract.—Darkness comprises more than half of each 24-hr cycle during winter in California's Sacramento Valley, but no studies have assessed nocturnal habitat use by wintering shorebirds at this inland site. From February to May 2013, the day and night habitat associations of radio-tagged Dunlin (*Calidris alpina*) were compared between post-harvest flooded rice fields and managed freshwater wetlands in the Sacramento Valley. Dunlin had decreasing associations with rice during both day and night from February to April. Dunlin exclusively used rice at night until 25 March, when they shifted to wetlands. During the day, Dunlin were regularly associated with both rice and wetlands until 4 March, and they exclusively used wetlands beginning 25 March. Diel movements by individual Dunlin revealed that birds using rice during the day also used rice during the subsequent night. Our findings suggest that flooded rice, when available, may be more suitable as nocturnal habitat than managed wetlands, and the removal of water from rice fields in February and March causes Dunlin to either use wetlands exclusively or leave the area. Conservation of Dunlin, and likely other migratory shorebirds, may be enhanced by managing the agriculture-wetland mosaic in the Sacramento Valley to ensure that an adequate amount of shallow-water habitats remain during March and April, prior to spring migration. *Received 8 August 2014, accepted 6 October 2014.*

Key words.—*Calidris alpina*, diel shift, Dunlin, flooded rice fields, habitat association, night, radio telemetry, wintering shorebirds.

Waterbirds 38(1): 40-46, 2015

The composition and spatial configuration of habitat patches are important elements for wildlife that use landscape mosaics containing a mix of natural and agricultural areas (Bennett *et al.* 2006; Elphick 2008). This is true for migratory shorebirds that spend the non-breeding season in landscapes where they encounter a variety of potential habitat types (e.g., natural or semi-natural wetlands, tidal mudflats, flooded agriculture). Landscapes that are managed to offer a mosaic of habitat types have the potential to sustain a large number of migratory shorebirds during winter. For example, the Sacramento Valley in California is considered a site of international importance to shorebirds (Western Hemisphere Shorebird Reserve Network 1993) with over 100,000 shorebirds wintering in a mosaic of flooded rice fields and managed freshwater wetlands (Shuford *et al.* 1998; Central Valley Joint Venture 2006).

The post-harvest flooding of rice fields is an effective strategy to create alternative wetland habitat for shorebirds during migration and winter (Fasola and Ruiz 1996; Elphick and Oring 1998; Tourenq *et al.* 2001; Fujioka *et al.* 2010). In the Sacramento Valley, flooded rice fields provide functionally equivalent foraging habitat when compared to managed wetlands (Elphick 2000), and the effects of flooding rice fields on diurnal shorebird abundance are well documented (Shuford *et al.* 1998; Elphick and Oring 2003; Strum *et al.* 2013). During November and January when most rice is flooded in the Sacramento Valley, smaller shorebirds, such as Dunlin (*Calidris alpina*), are more abundant in rice fields than wetlands (Shuford *et al.* 1998). After water is removed from rice fields during February and March in preparation for planting, managed wetlands comprise most shorebird habitat available in the Sacramento Valley region (Elphick and Oring 1998; Central Valley Joint Venture 2006). The use of both rice fields and wetlands during distinct seasons or times of day may explain, in part, why the diurnal abundance of shorebirds in flooded rice fields has been positively correlated with the area of wildlife refuge wetlands nearby (Elphick 2008). However, little is known about the locations of shorebirds at night in the Sacramento Valley (Elphick 2008), even though darkness comprises ~12-16 hr each day during winter.

Habitat associations of shorebirds may differ between day and night (Beyer and Haufler 1994; Shepherd and Lank 2004;

Gillings *et al.* 2005). Daylight and tidal cycles govern the diel habitat use patterns by wintering shorebirds at Humboldt Bay on the northern California coast (Dodd and Colwell 1998; Conklin and Colwell 2007). At inland locations, daylight alone is likely the main driver of diel habitat use patterns because foraging areas are readily available regardless of time of day, but other factors, such as predation risk or disturbance, may cause a particular habitat type to be more suitable during the day or night. In the Sacramento Valley, recent observations during early winter of shorebird flocks flying away from rice fields at dusk and returning around dawn may indicate that shorebirds are seeking a particular habitat type or location at night (Elphick 2008; B. A. Barbaree, pers. obs.). More information about the diel patterns of habitat associations by wintering shorebirds in the Sacramento Valley is required for effective management of this agricultural-wetland mosaic and conservation of wetland-dependent birds.

In 2013, we studied the day and night habitat associations of radio-tagged Dunlin within a mosaic of post-harvest flooded rice fields and managed freshwater wetlands in the Sacramento Valley. Our objectives were to: 1) characterize the nocturnal habitat associations of wintering Dunlin; 2) quantify diel movements by individual Dunlin between or within rice fields and wetlands; and 3) assess changes in habitat associations during a period when water is being removed from flooded rice fields. Based on observations of shorebird flocks leaving rice fields at dusk, we hypothesized that shorebirds would be more strongly associated with wetlands than rice at night. We also hypothesized that the relative use of managed wetlands would increase during March and April because some managed wetlands would remain flooded after water was removed from rice fields.

METHODS

Study Area

We conducted fieldwork in the Sacramento Valley, California, at Colusa National Wildlife Refuge (NWR) and in rice fields directly to the west (Fig. 1). Colusa NWR (20.55 km^2), composed primarily of managed wetlands, is located 2 km southwest of Colusa and ~110 km north of Sacramento, California. Privately owned rice farms border the refuge to the west, providing a nearly contiguous area of agriculture lands and wetlands. We chose this area because it is characteristic of the agricultural-wetland mosaic that is a common feature of the Sacramento Valley.

Capture and Radio Telemetry

We used mist nets and leg-hold noose mats to capture and radio-tag 36 Dunlin at three locations in rice fields from 5 December 2013 to 4 January 2014 (Fig. 1). We attached a radio transmitter (1.0-1.5 g, coded nanotags; Lotek Wireless, Inc.) using a leg-loop harness (Sanzenbacher *et al.* 2000) to each bird as well as a uniquely coded U.S. Geological Survey aluminum band.

We conducted 13 ground-based telemetry surveys, one every 2-11 days (mean = 7 days) from 8 February to 1 May 2013, to monitor the presence and habitat associations of radio-tagged Dunlin during the day and the subsequent night. We used a handheld, 5-element Yagi antenna to search for radio-tagged Dunlin from survey stations on accessible roads (Fig. 1). We placed survey stations within Colusa NWR to ensure that we covered most wetland habitat within the refuge. Survey stations in rice farms covered as much rice habitat as possible given restricted access to some farms and roads. We defined a survey as monitoring each survey station once during the day and once during the subsequent night. Diurnal monitoring ceased at least 15 min prior to sunset and at least 60 min prior to official civil twilight (U.S. Naval Observatory 2013). Nocturnal monitoring occurred after the beginning of civil twilight and at least 75 min after diurnal monitoring had ceased to allow sufficient time for crepuscular movements by Dunlin.

For each radio-tagged Dunlin that we detected, we recorded time of day and habitat association after the location of the bird was confirmed by triangulation or by sight (i.e., a group of Dunlin was observed in vicinity of the signal), using a high-powered spotlight when necessary. If an individual was located near the border of rice and wetland habitat types, we determined its habitat association by pinpointing the signal on foot.

Habitat Associations

We quantified the total area surveyed in each habitat type by classifying all areas within 500 m of each survey station as rice, wetland, or other. Through a series of tests with a dummy radio-tag on dry and level ground, we determined that a radio-tag was consistently detected up to ~500 m from the observer (B. A. Barbaree, unpubl. data); however, the actual range of detection likely varied due to factors such as proximity to open water, air temperature, bird position, topography, and proximity to common causes of signal interference (e.g., power lines, natural gas wells). In total, we surveyed 19.94 km^2 of rice fields and 16.36 km^2 of wetlands during each survey. Because we know that the daily space use of a Dunlin can be greater than the area that

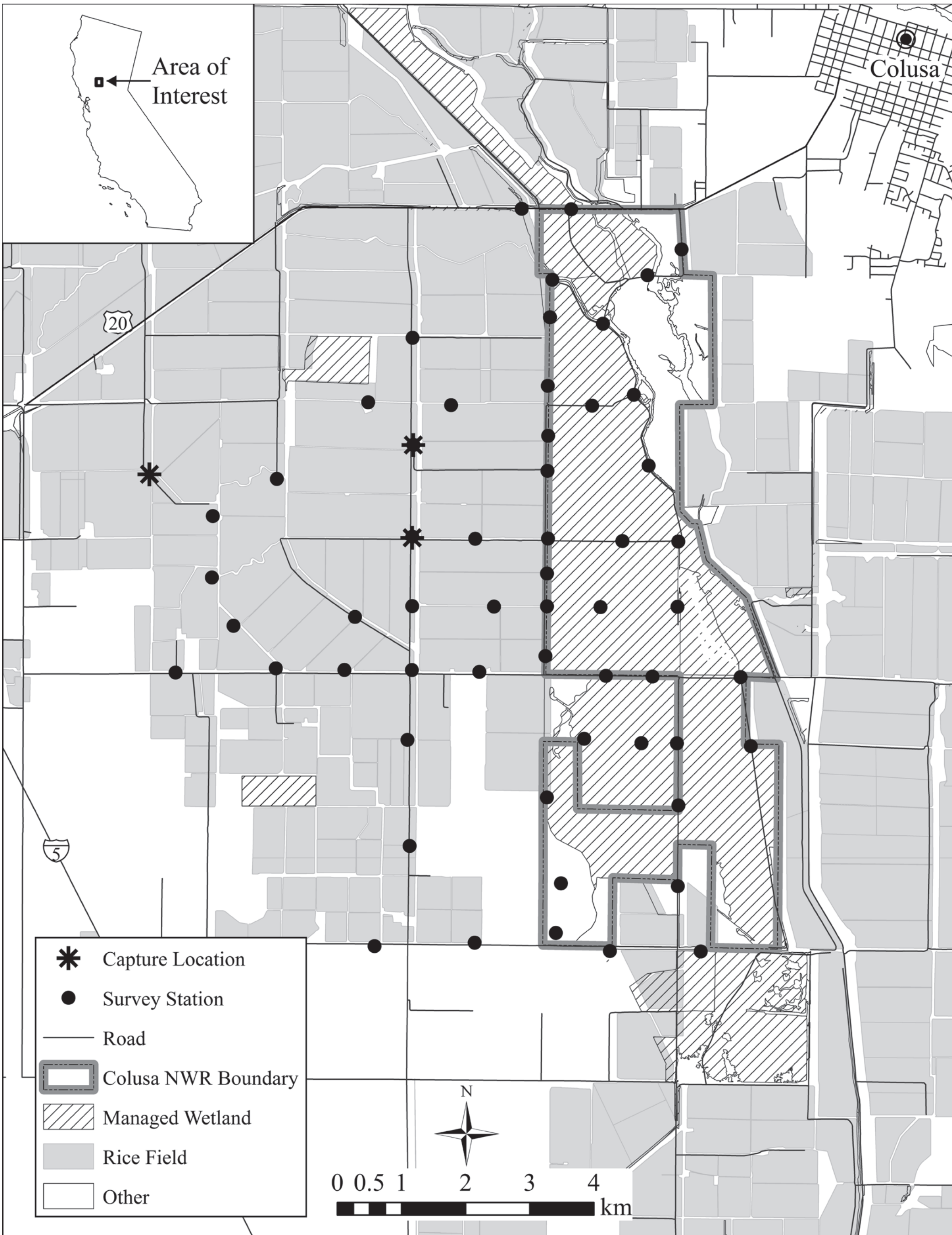

Figure 1. Study area in California's Sacramento Valley including potential Dunlin habitat in Colusa National Wildlife Refuge wetlands and nearby rice fields, and the locations of radio-telemetry survey stations.

we surveyed, and we did not have landscape data on habitat availability, our analyses do not represent habitat selection by Dunlin (Manly *et al.* 2002), but rather their habitat associations and relative use of rice fields and wetlands.

Statistical Analysis

We investigated the relative use of rice fields and wetlands during each survey by pooling detections into four categories by time of day and habitat type: 1) day:rice; 2) day:wetland; 3) night:rice; and 4) night:wetland. We then used separate Poisson regression models (Gelman and Hill 2007) for each of the four detection categories to determine relative use (i.e., average number of detections per km^2 surveyed) during each survey (intercept-only model) and test whether relative use was influenced by survey date (full model).

To determine whether the habitat associations of individual Dunlin change from day to night, we analyzed a subset of our data that only included diel movements by individual Dunlin (i.e., occasions when an individual was detected during both day and night portions of the same survey). We categorized diel movements by habitat association during the day (rice or wetland) and used separate mixed-effects logistic regressions (Gelman and Hill 2007) to calculate the conditional probability that, if a Dunlin was associated with rice or wetland during the day, it would be found in rice or wetland during the subsequent night. We included individual birds as a random effect in both models to reduce the potential bias caused by correlation of diel movements by the same individuals. Models resulted in conditional probability estimates for four diel movement types: 1) rice during both day and night (P_{RR}); 2) rice during the day and wetland at night (P_{RW}); 3) wetland during both day and night (P_{WW}); and 4) wetland during the day and rice at night (P_{WR}).

We used the Julian day of the survey date, divided by 100 to facilitate model convergence (Gelman and Hill 2007), as the survey date covariate in relative use models. We tested for significance by comparing the 95% confidence intervals (CI) for model-based estimates of relative use and conditional probability. We considered comparisons between estimates to be significant if their 95% CI did not overlap. We considered trend in relative use to be significant if the 95% CI of the survey date parameter did not overlap zero. We used the statistical program R for all analyses (R Development Core Team 2013).

Results

Radio Telemetry

We recorded 100 detections of radio-tagged Dunlin during the day and 86 detections at night, including 68 diel movements by individual Dunlin during a survey. We detected 69% (n = 36) of radio-tagged Dunlin at least once, and those birds were tracked for a mean (± SE) of 90 ± 6 days after capture (range = 38-139). We detected Dunlin during most surveys and 11% (n = 36) during at least 85% of our surveys (n = 13). Fewer individual Dunlin were detected during each consecutive month of survey effort (n = 24 in February, n = 14 in March, and n = 8 in April; Fig. 2); we did not detect any radio-tagged Dunlin or visually observe any flocks of Dunlin during our final survey on 1 May.

Habitat Associations

The habitat associations of radio-tagged Dunlin from February to May were characterized by decreasing associations with rice during both day and night and the exclusive use of rice at night until mid-March (Fig. 2). Overall, the average number of detections per km^2 surveyed was highest in rice (0.26; 95% CI: 0.20, 0.33) and wetlands (0.33; 95% CI: 0.26, 0.41) during the day; detections at night were lower in both rice (0.16; 95% CI: 0.11, 0.21) and wetlands (0.08; 95% CI: 0.05, 0.13), although the 95% CI for day and night detections in rice overlapped. Models that included survey date suggested a significant decline from February to April in the relative use of rice during the day (β = -7.03; 95% CI: -10.06, -4.64) and at night (β = -3.83; 95% CI: -5.22, -2.61). In wetlands, trend parameters suggested the relative use of wetlands during the day was fairly constant from February to April (β = -0.39; 95% CI: -1.28, 0.47), but a significant increase in the relative use

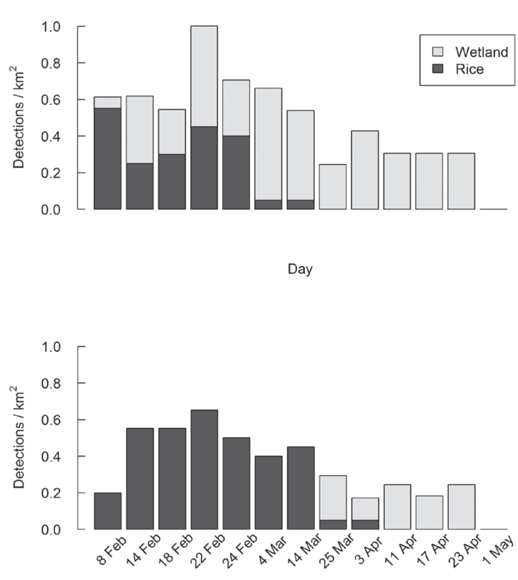

Figure 2. Relative use (detections per km^2 surveyed) of managed wetlands and flooded rice fields by radio-tagged Dunlin during the day (top) and at night (bottom).

of wetlands occurred at night over the study period (β = 3.60; 95% CI: 1.59, 6.02).

Diel movements revealed that individual Dunlin using rice during the day also used rice at night (P_{RR} = 1.0, P_{RW} = 0.0; Fig. 3). Dunlin that were associated with wetlands during the day had a significantly higher probability of being associated with rice at night (P_{WR} = 0.78; 95% CI: 0.54, 0.92) than wetlands at night (P_{WW} = 0.22; 95% CI: 0.05, 0.46; Fig. 3). Seasonal patterns were evident because no individual Dunlin were detected in rice during both day and night after 14 March, and the first date that an individual Dunlin was detected in wetlands during both day and night was 25 March. The last diel movement from wetland during the day to rice at night was on 3 April when a single radio-tagged Dunlin was found at night using a nearly dry rice field with only residual moisture and no standing water.

DISCUSSION

The habitat associations of wintering Dunlin in the Sacramento Valley were governed by time of day and season. Contrary to our prediction, Dunlin were associated with rice exclusively at night until 25 March, when rice fields were no longer flooded, leading to the exclusive use of wetlands at night by 11 April. Our results support findings by Elphick (2000) that rice and wetlands were functionally equivalent foraging habitats during the day, but our data suggest that rice fields, when flooded, may be more suitable than wetlands as nocturnal habitat.

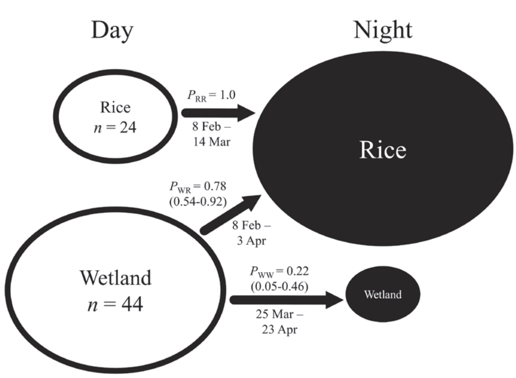

Figure 3. Diel movements of individual radio-tagged Dunlin located during both day and night portions of a survey. The size of each circle is scaled to represent the proportion of the sample size (*n* = 68) in rice and wetlands during the day and at night. P_{XX} represents the conditional probability of each movement type. Diel movements from rice during the day to wetland at night did not occur.

The strong association with rice fields at night instead of wetlands may be related to one or more factors, including predation risk (Rogers *et al.* 2006), disturbance (Peters and Otis 2006), or other environmental correlates such as air temperature or exposure to wind (Rehfisch *et al.* 2003). Elphick (2000) found that encounters with predators of shorebirds during the day were less frequent in rice fields than in wetlands and a similar pattern may occur at night. Disturbance related to both predators and humans may influence the habitat associations of Dunlin at night. Prior observations of shorebirds leaving rice fields at dusk in the Sacramento Valley may be partly explained by proximity of the observer to potential sources of disturbance, such as buildings, roads, and raptor perches. It is also possible that there was more available habitat in rice fields than in wetlands during February and the first half of March, causing Dunlin to use rice disproportionately at night. However, our data suggest that this was not a factor because Dunlin were often associated with wetlands during the day but never at night prior to 25 March. Additional work is needed on predator abundance and disturbance in relation to shorebird locations at night to better understand the factors influencing the nocturnal habitat associations of Dunlin.

Our study quantified changes in habitat associations by wintering Dunlin from February to April, a period of dynamic habitat availability for shorebirds in the Sacramento Valley (Central Valley Joint Venture 2006). Changes in patterns of habitat associations are likely a common occurrence for wintering Dunlin at inland sites where seasonal changes in weather patterns and water use by humans govern the availability of shallow-water habitat. For example, Dunlin wintering in the Willamette Valley in Oregon increased home range size on the landscape in response to reduced habitat availability caused by relatively dry weather conditions from February to April (Taft *et al.* 2008). In our study, changes in habitat associations by wintering Dunlin coincided with the drying of rice fields during February and March (Elphick and Oring 1998; Central Valley Joint Venture 2006). Specifically, diurnal associations with rice fields ended on 14 March and most nocturnal use of rice fields ended by 25 March. Although other factors, such as increasing availability of shallow-water habitat in wetlands, may have contributed to the declining associations with rice during our study, the removal of water from rice fields likely caused most Dunlin to either begin using wetlands exclusively or leave the area.

The declining use of rice fields was accompanied by fewer detections of individual Dunlin, suggesting that the probability of remaining in our study area declined simultaneously. Shuford *et al.* (1998) counted fewer Dunlin in the Sacramento Valley during April than in November or January, and our data reflect a similar decline in abundance from February to April. Even though most of the wintering Dunlin that we radio-tagged no longer used our study area by April, a portion (11%) remained resident from December until at least mid-April. Similar declines in local residency, which were also likely related to reduced habitat availability, have been documented for wintering Dunlin in coastal California (Warnock *et al.* 1995) and in the Willamette Valley in Oregon (Sanzenbacher and Haig 2002). The net loss of potential shorebird habitat caused by the removal of water from rice fields may cause substantial portions of wintering shorebird populations to leave the Sacramento Valley because rice fields account for considerably more land area than wetlands (Central Valley Joint Venture 2006). The onset of spring migration may also contribute to the declining local residency of Dunlin in our study area during March and April because some Dunlin likely begin northward migration as early as March.

Our study finds that post-harvest flooded rice fields provide both day and night habitat for Dunlin wintering in the agricultural-wetland mosaic of the Sacramento Valley. The post-harvest flooding of rice fields has become an integral part of shorebird conservation in the region (Elphick and Oring 2003; Stralberg *et al.* 2010), and the habitat associations of Dunlin in our study confirm the importance of this practice. Once water is removed from rice fields and rice fields are no longer available as habitat, managed wetlands account for most, if not all, shorebird habitat during late-March and April (Central Valley Joint Venture 2006). The exclusive use of wetlands by Dunlin during April reflects this circumstance and highlights the importance of these managed wetland refuges, which represent only a small fraction of the historic extent of wetlands in the region (Dahl 1990; Central Valley Joint Venture 2006). Effective conservation of migratory shorebirds in the Sacramento Valley requires an adequate amount of shallow-water habitat during March and April, a critical time period prior to migration and breeding. Maintaining water availability for wetlands and exploring opportunities to create additional habitat in both agricultural areas and wetlands should be high priorities.

Acknowledgments

Support for this study was provided by the S. D. Bechtel, Jr. Foundation in cooperation with the Migratory Bird Conservation Partnership, a partnership of Point Blue Conservation Science, The Nature Conservancy, and Audubon California. This manuscript benefited tremendously from reviews by T. Gardali and N. Seavy. We thank the U.S. Geological Survey Bird Banding Laboratory for their support; capture, banding, and radio-tagging were covered under U.S. Fish and Wildlife Service permit #09316. We thank M. Wolder, J. Isola, and M. Peters of the U.S. Fish and Wildlife Service for facilitating access to Colusa NWR for surveys. We especially want to acknowledge D. Bransford and M. Gallentine for providing access to their rice farms and facilitating access to nearby farms during both capture and survey efforts. We are also grateful to R. Barbaree, B. Campos, R. Cormier, C. Eyster, M. Gilbert, C. Gregory, D. Humple, M. Iglecia, N. Seavy, and K. Velas for assisting with capture efforts.

Literature Cited

Bennett, A. F., J. Q. Radford and A. Haslem. 2006. Properties of land mosaics: implications for nature conservation in agricultural environments. Biological Conservation 133: 250-264.

Beyer, D. E., Jr. and J. B. Haufler. 1994. Diurnal versus 24-hour sampling of habitat use. Journal of Wildlife Management 58: 178-180.

Central Valley Joint Venture. 2006. Central Valley Joint Venture implementation plan: conserving bird habitat. Unpublished report, U.S. Department of the Interior, Fish and Wildlife Service, Sacramento, California.

Dahl, T. E. 1990. Wetland losses in the United States 1780s to 1980s. Unpublished report, U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Dodd, S. L. and M. A. Colwell. 1998. Seasonal variation in diurnal and nocturnal distributions of nonbreeding shorebirds at North Humboldt Bay, California. Condor 98: 196-207.

Conklin, J. R. and M. A. Colwell. 2007. Diurnal and nocturnal roost site fidelity of Dunlin (*Calidris alpina pacifica*) at Humboldt Bay, California. Auk 124: 677-689.

Elphick, C. S. 2000. Functional equivalency between rice fields and seminatural wetland habitats. Conservation Biology 14: 181-191.

Elphick, C. S. 2008. Landscape effects on waterbird densities in California rice fields: taxonomic differences, scale-dependence, and conservation implications. Waterbirds 31: 62-69.

Elphick, C. S. and L. W. Oring. 1998. Winter management of California rice fields for waterbirds. Journal of Applied Ecology 35: 95-108.

Elphick, C. S. and L. W. Oring. 2003. Conservation implications of flooding rice fields on winter waterbird communities. Agriculture, Ecosystems, and Environment 94: 17-29.

Fasola, M. and X. Ruiz. 1996. The value of rice fields as substitutes for natural wetlands for waterbirds in the Mediterranean Region. Colonial Waterbirds 19 (Special Publication 1): 122-128.

Fujioka, M., S. D. Lee, M. Kurechi and H. Yoshida. 2010. Bird use of rice fields in Korea and Japan. Waterbirds 33: 8-29.

Gelman, A. and J. Hill. 2007. Data analysis using regression and multilevel/hierarchical models. Cambridge University Press, New York, New York.

Gillings, S., R. J. Fuller and W. S. Sunderland. 2005. Diurnal studies do not predict the nocturnal habitat choice and site selection of European Golden Plovers and Northern Lapwings. Auk 122: 1249-1260.

Manly, B. F. J., L. L. McDonald, D. L. Thomas, T. L. McDonald and W. P. Erickson. 2002. Resource selection by animals: statistical analysis and design for field studies, 2nd ed. Kluwer Academic Publishers, Boston, Massachusetts.

Peters, K. A. and D. L. Otis. 2006. Shorebird roost-site selection at two temporal scales: is human disturbance a factor? Journal of Applied Ecology 44: 196-209.

R Development Core Team. 2013. R: a language and environment for statistical computing v.3.1.0. R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org, accessed 30 April 2014.

Rehfisch, M. M., H. Insley and B. Swann. 2003. Fidelity of overwintering shorebirds to roosts on the Moray Basin, Scotland: implications for predicting impacts of habitat loss. Ardea 91: 53-70.

Rogers, D. I., P. F. Battley, T. Piersma, J. A. Van Gils and K. G. Rogers. 2006. High-tide habitat choice: insights from modelling roost selection by shorebirds around a tropical bay. Animal Behaviour 72: 563-575.

Sanzenbacher, P. M. and S. M. Haig. 2002. Residency and movement patterns of wintering Dunlin in the Willamette Valley of Oregon. Condor 104: 271-280.

Sanzenbacher, P. M., S. M. Haig and L. W. Oring. 2000. Application of a modified harness design for attachment of radio transmitters to shorebirds. Wader Study Group Bulletin 91: 16-20.

Shepherd, P. C. F. and D. B. Lank. 2004. Marine and agricultural habitat preferences of Dunlin wintering in British Columbia. Journal of Wildlife Management 68: 61-73.

Shuford, W. D., G. W. Page and J. E. Kjelmyr. 1998. Patterns and dynamics of shorebird use in California's Central Valley. Condor 100: 227-244.

Stralberg D., D. R. Cameron, M. D. Reynolds, C. M. Hickey, K. Klausmeyer, S. M. Busby, L. E. Stenzel, W. D. Shuford and G. W. Page. 2010. Identifying habitat conservation priorities and gaps for migratory shorebirds and waterfowl in California. Biological Conservation 20: 19-40.

Strum, K. M., M. E. Reiter, C. A. Hartman, M. N. Iglecia, T. R. Kelsey and C. M. Hickey. 2013. Winter management of California's rice fields to maximize waterbird habitat and minimize water use. Agriculture, Ecosystems, & Environment 179: 116-124.

Taft, O. W., P. M. Sanzenbacher and S. M. Haig. 2008. Movements of wintering Dunlin *Calidris alpina* and changing habitat availability in an agricultural wetland landscape. Ibis 150: 541-549.

Tourenq, C., R. E. Bennetts, H. Kowalski, E. Vialet, J. Lucchesi, Y. Kayser and P. Isenmann. 2001. Are rice fields a good alternative to natural marshes for waterbird communities in Camargue, southern France. Biological Conservation 100: 335-343.

U.S. Naval Observatory. 2013. U.S. Naval Observatory astronomical applications: data services. http://aa.usno.navy.mil/data/, accessed 4 February 2013.

Warnock, N., G. W. Page and L. E. Stenzel. 1995. Nonmigratory movements of Dunlins on their California wintering grounds. Wilson Bulletin 107: 131-139.

Western Hemisphere Shorebird Reserve Network. 1993. Western Hemisphere Shorebird Reserve Network site profiles. WA Publications No. 4, Wetlands for the Americas, Manomet, Massachusetts.