Impacts of livestock on shorebirds: a review and application to shorebirds of the western Great Basin

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Livestock impacts environments and wildlife that shares the habitat. Shorebird survival and reproductive success may be affected directly by contact with livestock or indirectly through influences on habitat features. Direct effects include disturbance to individuals and trampling of nests or chicks. Potential indirect effects include changes in vegetation, changes in shorebird prey biomass or accessibility, changes in predator pressure, and changes in competitive outcomes. Livestock management in the west has been a massive uncontrolled experiment at landscape and regional levels. A few studies of grazing impacts on shorebirds breeding in the Great Basin have been conducted. Studies aimed at determining impacts of grazing in this arid environment are necessary. A large proportion of the Great Basin desert that contains water is privately owned. As landowners are not likely to sacrifice economic endeavors strictly to benefit shorebirds, it is imperative that conflicts between livestock and waterbirds be fully understood and compatibility be explored. The development of management strategies that exploit compatibility will help promote cooperation between landowners, public land managers, and policy makers. Here we review the limited information on livestock impacts on shorebirds in the Great Basin and summarize studies in diverse habitats, such as the American Great Plains and European meadows. We attempt to provide understanding of potential effects of livestock on Great Basin shorebirds and their habitats.

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Introduction

Impacts of livestock on ecosystems are receiving increasing attention (*e.g.*, Kauffman *et al.* 1985; Kovalchik & Elmore 1992; Noss 1994; Brussard *et al.* 1994). Livestock may be keystone species (Paine 1969), exerting dramatic influences on habitats in which they graze (Bock *et al.* 1993; Fleischner 1994). In the ongoing debate over the legitimacy of grazing livestock over vast areas of land, it has been argued that some environments, such as the grassland savannas of Africa (McNaughton 1986) and the American Great Plains (Mack & Thompson 1982), evolved with

waterbirds, it is imperative that conflicts between shorebirds and livestock be fully understood and possible management strategies that promote any potential compatibilities be explored and developed (Payne & Wentz 1992).

The purpose of this paper is to review current information and results of studies on shorebird habitat use and grazing impacts that may be applicable to shorebird species using the western Great Basin. We begin by discussing general information and studies on livestock grazing and shorebird interactions from other regions, and follow with more specific discussion on key shorebirds that breed or migrate through the western Great Basin. It is not our intention to advocate the continuation or the cessation of grazing, but to evaluate knowledge on interactions of domestic grazers with shorebirds and to suggest areas for future research.

General requirements of shorebirds and potential effects of grazing

Habitat requirements of breeding shorebirds include: 1) sites for courtship, nesting, and roosting, 2) foraging areas with adequate prey bases to support reproduction, 3) brood-rearing habitat, and 4) sites for refuge from predators and environmental stress. Although breeding shorebirds are influenced strongly by proximity of nesting sites to wetland foraging areas, specific habitat elements and characteristics important in habitat selection vary significantly among species (Colwell & Oring 1988, 1990). Shorebirds vary in their use of areas of different vegetation heights and densities, and in the degree of importance of bare ground and habitat heterogeneity. The extent and depth of water used by different shorebird species varies along a gradient (Colwell & Oring 1988). The variation in habitat use observed for a subset of shorebirds breeding in or migrating through the Great Basin is shown in Table 1. We point out the lack of available information specific to shorebirds in the Great Basin. Some of the studies represented in Table 1 are from habitats, such as the American Great Plains and European peat bogs, that differ from those found in the Great Basin desert. Habitat requirements of species may differ between these ecosystems. Generally, plovers tend to use short, sparse vegetation and nest near conspicuous objects, such as old manure piles (Mace 1971; Paton & Bachman, this volume). Other shorebird species, such as Common Snipe *Gallinago gallinago* and Wilson's Phalarope *Phalaropus tricolor* use taller or denser structure (Mason & MacDonald 1976, Colwell & Oring 1990). Snipe and phalarope tend to use wetter zones (Beintema 1986), while Long-billed Curlew use drier areas (Paton & Dalton 1994). Some species, such as American Avocet *Recurvirostra americana* and Black-necked Stilt *Himantopus mexicanus* use islands and hummocks for nesting and loafing habitat (Alberico 1993). Generally, water depth appropriate for feeding appears to correspond to culmen and tarsus length. Small sandpipers and plovers forage primarily along the shoreline and on mudflats, while longer-legged avocets and stilts forage while wading in deeper water. Some shorebirds, such as curlews and Willets *Catoptrophorus semipalmatus* feed in uplands as well.

Given the gradient of habitat used by shorebirds, conditions favoring one species of shorebird may not benefit another. As shorebird habitat use varies by species along several continua, livestock grazing can have multiple direct and indirect effects on birds, their habitat, and interrelationships with other species and taxa across each continuum. To assess the potential outcomes of grazers on shorebird habitat, it is important to consider bird species individually and to use caution when applying generalities obtained from studies in diverse locations.

Direct Effects

Shorebird species differ in sensitivity to the presence of large herbivores in their midst. Individuals of some species attempt to actively defend or distract livestock approaching nests (*e.g.*, Mountain Plover *Charadrius montanus* Graul 1975, Lapwing *Vanellus vanellus* and Oystercatcher *Haematopus ostralegus* Beintema & Muskens 1987) while others flush from nests and display little or no defense (Black-tailed Godwit *Limosa limosa* and Redshank *Tringa totanus* Beintema & Muskens 1987). Due to increased expenditure of time and energy, these reactions may result in decreased adult body condition that may affect survival or reproductive output, although no data exist on this hypothesis. Decreased incubation time and increased exposure of nests to predation while adults are away can result in lower hatching success. Ground-nesting shorebirds vary in susceptibility of nests to trampling and in response of breeding pairs to partial or total destruction of nests. Guldemond *et al.* (1993) reported a 10% nest loss in Redshanks *Tringa totanus* due to trampling by cattle and sheep even when protective structures were placed over nests. In the same study, no Ruff *Philomachus pugnax* nests were trampled. In a study of pastured lands in the Netherlands, four species of meadow-birds deserted nests after the damage of one egg, with 22.7-51.6% of nest loss attributed to trampling by cattle (Beintema & Muskens 1987). The amount and timing of egg damage affect abandonment rates in other shorebirds as well (Delehanty & Oring 1993).

Direct effects of livestock on shorebirds also vary with species of grazing animal and with livestock management practices. In a comparison of impacts of different grazing animals on the survival rate for nests of meadow-birds on Dutch agricultural grasslands, yearling cattle were the most destructive, followed by dairy cows, with sheep the least detrimental per individual animal (Beintema & Muskens 1987). On Dutch dairy farms with overall stocking rates of 3-4 head / ha, a rotational grazing system was employed that actually resulted in densities of several dozens of grazing animals / ha for short periods of time. Under this scheme, the probability of meadow-bird nest survival was found to be close to zero (Beintema 1986; but see Koerth *et al.* 1983). The potential outcome of the effects of disturbance and trampling on reproductive success is further complicated by interspecific differences in the tendencies of shorebirds to renest after initial failure and by differences in success rates of earlier versus later nests (Beintema & Muskens 1987; Redmond & Jenni 1986).

Indirect Effects

Livestock can affect shorebirds indirectly by altering the quantity or quality of habitat features. Dramatic changes in vegetative composition and structure have been attributed to grazing livestock (see Fleischner 1994 for review; Brandt & Rickard 1994). Vegetation structure is altered through herbivory or trampling (Holmgren & Hutchings 1972; Thompson *et al.* 1995). Changes in vegetation composition occur through selective foraging by grazers and the introduction of exotic plant species, either inadvertently through supplemental feed or invasion, or directly through plantings for range forage improvement (Laycock 1967; Reynolds & Trost 1980; National Research Council 1982;, Medin 1986). Livestock additionally alter habitat heterogeneity through soil compaction or disturbance, formation of trails, altered percentage of bare ground and

field drainage and by subsequent increased cattle grazing pressure on pastures. It was suggested that high rates of nest predation resulted from reduced nesting cover and contributed to snipe population decline. Bowen & Kruse (1993), studying Upland Sandpiper *Bartramia longicauda* in North Dakota, reported lower sandpiper nesting densities and reproductive success in fields where cattle grazing altered vegetation structure to <50 cm. However, the authors suggest that in areas where vegetative growth tends to become much taller and denser, grazing may produce suitable sandpiper habitat of moderate vegetation height and density.

Shorebird habitat must provide an adequate, accessible prey base for breeding and migratory birds. Livestock and related land management practices may have indirect impacts on shorebirds by affecting foraging habitat and/or prey availability. Some examples of potential positive effects of livestock on shorebird foraging opportunities have been reported. In Spain, wintering snipe were more numerous on grazed meadows that supported greater earthworm abundances than did ungrazed plots (Granval *et al.* 1993). Grazing animals can increase abundance of excrement-associated invertebrates or make them more active and accessible to foraging shorebirds (Thompson *et al.* 1982; Barnard & Thompson 1985). Lapwing chicks were found to forage on fauna living in cow dung (Beintema *et al.* 1991). In Britain, Lapwing prey biomass was found to be greater on permanent pasture than on rough grazing areas, such as unimproved marginal upland grasslands, and this resulted in better female body condition, larger eggs, and larger chicks (Galbraith 1987).

Other studies point to potential negative effects of livestock on shorebird foraging habitat and prey. Excessive grazing has been reported to increase erosion, potentially destroying shallow water habitat (Kadlec & Smith 1989). Grazing on marsh edges can result in a decrease in emergent vegetation (Wagner 1977), which is important for larval and pupal attachment of aquatic invertebrate prey species (Mono Basin Ecosystem Study Committee 1987, Reid *et al.*, this volume). Drainage of land to permit earlier introduction of livestock on floodplains in Britain has had adverse effects on shorebirds by reducing foraging habitat (Green & Robins 1993). Feeding conditions, while adequate at the initiation of the breeding season, often were not sufficient to support completion of incubation and brood-rearing. In the Netherlands, intense grazing corresponded with a temporary decrease in arthropod abundance in late spring (Beintema *et al.* 1991). Smith (1940) reported changes in invertebrate abundances and assemblages due to livestock grazing. Indirect effects of livestock and management practices on shorebird foraging opportunities can conceivably have great impacts on shorebird survival and reproduction.

Shorebirds incur varying degrees of predation on eggs, chicks and adults. Bowen & Kruse (1993) and Kirsch & Higgins (1976) found higher predation of Upland Sandpiper nests on grazed lands compared to ungrazed sites. Management of grazing livestock may affect habitat, type, abundance, and efficiency of predator species, and also may affect alternative prey communities (*e.g.*, Page *et al.* 1978; Crouch 1982; O'Connor & Shrubb 1986; Bowen & Kruse 1993).

1980). However, most of these observations were not the result of controlled experiments (*cf.* Elphick, this volume).

Other Species

A number of other shorebird species breed in Great Basin desert wetlands and are potentially impacted by livestock grazing practices. Studies pertaining to effects of livestock grazing on these species are lacking for the Great Basin. The western subspecies of the Snowy Plover *Charadrius alexandrinus tenuirostris* is another USFS Species of Concern (Finch 1992) that is a breeder and migrant in the Great Basin (Oring & Reed, this volume). Snowy Plover numbers have apparently declined in Nevada (Bradley *et al.* 1991, 1994; Page & Gill 1994) due to loss of habitat, disturbance, and destruction of nests (Ehrlich *et al.* 1992). As cited in the section on indirect effects of grazing, European studies suggest that some livestock grazing may provide suitable habitat for nesting plovers by reducing dense shoreline vegetation (Kohler & Rauer 1991). Other shorebirds that commonly breed in desert wetlands are Killdeer, Black-necked Stilt, American Avocet, Willet, Spotted Sandpiper, Common Snipe, and Wilson's Phalarope. Many populations of these species have experienced declines in recent decades due primarily to habitat loss and degradation (Littlefield 1990; Page & Gill 1994).

Based on what is known about the habitat-use by these shorebird species, predictions can be made concerning the impacts of grazing cattle or sheep on shorebird breeding grounds and migration stop-over sites in the Great Basin. Several authors have offered predictions concerning grazing effects. The Mono Basin Ecosystem Study Committee (1987) predicted no response to increased grazing in the Mono Basin for plovers, stilts, avocets, curlews, and phalaropes. However, they also state that grazing already has exacted significant impacts on the vegetation, including decreased shrubs, increased alien annuals, and close cropping of herbaceous growth. Bock *et al.* (1993) speculated that curlew would respond negatively to cattle grazing during the breeding season in shrubsteppe habitat of the Intermountain West. Presumably, the prediction is based on potential direct effects of disturbance and trampling of nests.

Any livestock grazing and intrusive management activities occurring on or very near nesting areas during the shorebird breeding period may result in negative direct effects due to trampling of nests or chicks and disturbance of breeding adults. Based on observed habitat-use patterns for shorebirds in the Great Basin, non-breeding season grazing might benefit some shorebird species by maintaining suitable habitat characteristics, including short, sparse vegetation, patches of barren ground, and manure piles. Shorebirds using sparsely vegetated areas, such as the Snowy Plover, Killdeer, and Long-billed Curlew, may benefit from heavier grazing by cattle or sheep that greatly reduces vegetation stature. Species, like the Black-necked Stilt and Willet, that use more vegetated areas for nesting or for brood-rearing, may profit from moderate grazing but suffer negative impacts from heavy grazing if vegetation of nest sites or nursery areas is reduced below a critical level. Common Snipe and Wilson's Phalarope might benefit from pasture development and management that produces taller, dense growth, and may tolerate lower levels of sheep or cattle grazing, but may respond negatively to more intense grazing that substantially reduces the height and density of the vegetation. As species vary in their tendencies to use wetland edge or

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Table 1. Variation in habitat use of breeding shorebirds in the western Great Basin.

Species	Vegetation density	Vegetation height	Citations
Snowy Plover	None to sparse	None to short	concluded from Mono Basin Ecosystem Study Committee (1987), Colwell & Oring (1990)
Killdeer	None to sparse	None to short	Colwell & Oring (1990), pers. obs.
Black-necked Stilt	Sparse to moderate	Short to tall	concluded from Hamilton 1975), Richards (1988), pers. obs.
American Avocet	None to sparse	None to short	(Colwell & Oring 1990), pers. obs.
Willet	Sparse to moderate	Short to moderate	concluded from Burger & Shisler (1978), Howe (1982), Ryan & Renken (1987), Colwell & Oring (1990)
Spotted Sandpiper	Sparse to dense	Short to moderate	concluded from Miller & Miller (1948), Kings River Conservation District (1985), L. W. Oring, pers. comm.
Long-billed Curlew	Sparse	Short	concluded from Allen (1980)
Common Snipe	Dense	Moderate to tall	concluded from Tuck (1972), Mason & MacDonald (1976)
Wilson's Phalarope	Dense	Short to tall	Colwell & Oring 1990, L. W. Oring, pers. comm.