Shorebird management during the non-breeding season – an overview of needs, opportunities, and management concepts

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In the United States, as in most other parts of the world, vast areas of wetlands have been lost and many shorebird species are in decline. I highlight opportunities to manage the wetlands that remain for shorebirds. In the US, many of these are already wildlife management areas. In marine wetlands, probably the greatest problem is chronic human disturbance and I suggest ways in which this might be mitigated. For nonmarine wetlands, I suggest a range of management prescriptions. The most important of these are those designed to increase the availability of invertebrate food supplies, such as managing water levels and increasing organic inputs.

INTRODUCTION

Wetlands are an important habitat for bird fauna in the United States. Although less than 5% of the land area of the Lower 48 US states is classified as wetland, almost a third of our bird species principally inhabit wetlands.

Although not well enumerated, there is no doubt that the cumulative loss of wetlands worldwide has been enormous during the last two centuries. In the Lower 48 United States, for example, it is estimated that more than 50% of the wetlands that existed in the 1700s are now gone. Of the 29 federally endangered and threatened bird species in the Lower 48 United States, 16 are principally wetland and coastal inhabitants.

According to Ramsar Convention resources (http://www.ramsar.org),

"Outside North America and a few European countries, very little effort has been made to document wetland loss on a systematic basis ... In a very generalized overview,

"Some estimates show that the world may have lost 50% of the wetlands that existed since 1900; whilst much of this occurred in the northern countries during the first 50 years of the century, increasing pressure for conversion to alternative land use has been put on tropical and sub-tropical wetlands since the 1950s.

"No figures are available for the extent of wetland loss worldwide, but drainage for agricultural production is the principal cause; by 1985 it was estimated that 56–65% of the available wetland had been drained for intensive agriculture in Europe and N America; the figures for tropical and sub-tropical regions were 27% for Asia, 6% for S America and 2% for Africa, making a total of 26% worldwide. Future predictions show the pressure to drain land for agriculture intensifying in these regions."

There are few data identifying loss rates of marine versus nonmarine wetlands. According to the National Marine Fisheries Service in the U.S. (http://www.nmfs.noaa.gov/habitat/habitatprotection/wetlands4.htm),

"Coastal wetlands currently make up about 30% of the wetlands in the lower 48 states, or approximately 27 million acres. Since the 1700s, more than half of all of the wetlands in the lower 48 states have been lost, and although there are no reliable statistics that deal solely with coastal wetlands, several factors point to the loss of coastal wetlands as being at least as severe as the loss of wetlands overall. A U.S. Fish and Wildlife Service report estimates that by the mid 1970s, over half of all saltmarshes and mangrove forests present in pre-colonial times had been destroyed. California, a large coastal state, has lost over 90% of its wetlands. Florida and Louisiana, two coastal states with the greatest acreage of wetlands, have lost about half of their original wetland area. Louisiana alone is losing between 16,000 and 25,000 acres of wetlands a year, which is the highest sustained wetland loss rate in the country. Most of that loss is occurring in coastal areas."

As wetland loss continues, population sizes of many shorebird species are declining (Morrison *et al.* 2000). There is little information to explain the cause(s) of these declines, but nonbreeding habitat loss is one likely factor.

The principal habitats used by most kinds of shorebird during nonbreeding seasons are marine (here defined as coastal wetlands with tidal connections to the sea) and nonmarine (all other) wetlands. This review focuses on opportunities for providing shorebird habitat in managed wildlife areas, one approach that is available to help offset habitat loss that has occurred in most regions of the world.

As human population grows, and wildlife habitat decreases worldwide, the importance of wildlife refuges and of wildlife management as a profession have rapidly grown. Traditional emphasis of the wildlife management profession has generally been on species most popular for fishing and hunting. Indeed, in the United States, most of the funds that have purchased lands for the national wildlife refuge system have come from levies for licences and hunting equipment. Most state wildlife areas have been purchased with similar sources of funding. In many parts of the world, and perhaps especially in the United States, there have been extensive

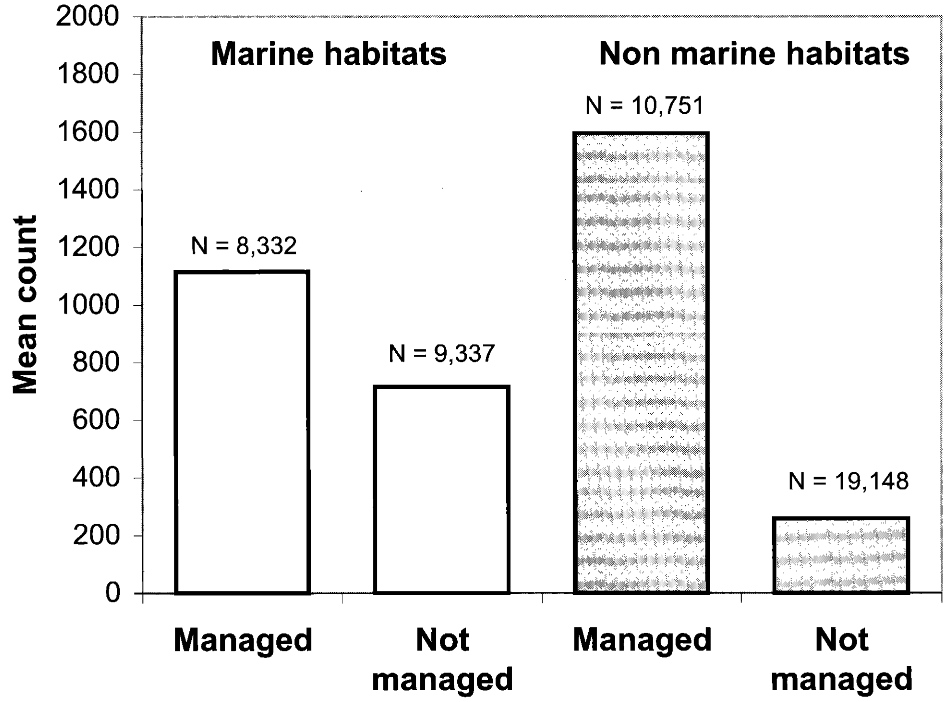

Fig. 1. Mean counts of shorebirds at US locations managed for wildlife versus locations not managed for wildlife. The data are from the International Shorebird Surveys (Manomet Center for Conservation Sciences, unpublished). Sample sizes (number of counts) are shown above the bars. In respect of both marine and nonmarine habitats, the difference between the mean counts in managed and unmanaged habitats is significant ($p<0.01$, Mann-Whitney U-tests).

programmes oriented to acquiring wetlands and managing them as wildlife reserves.

Because most shorebird species inhabit wetlands, they are one of the bird groups (besides waterfowl) that has benefited most from development of wildlife management areas. According to data from the International Shorebird Surveys (Manomet Center for Conservation Sciences, unpublished), mean counts of shorebirds at areas managed for wildlife are higher, on average, than counts from locations that are not managed for wildlife (Fig. 1). Although the difference between counts in managed and unmanaged areas is significant, it is unclear whether the cause or causes of the difference lie in the original selection of lands for wildlife management areas and/or from the management practices used in those areas. Nevertheless, it appears that roughly 70% of the shorebirds using stopover sites in the Lower 48 United States are at locations managed for wildlife.

In recent years there has been a rapid shift of popular wildlife-related activities from hunting and fishing to wildlife viewing, photography, or more general activities such as hiking, boating, and bicycling. Managers of public wildlife lands are being asked to respond. In the United States alone, more than 35 million people annually visit one or more of the national wildlife refuges; roughly a third of these visits are for hunting and fishing, and two-thirds are for "non-consumptive" uses such as bird watching.

Inasmuch as many kinds of shorebirds can be attracted to wetlands by relatively simple management techniques (Helmers 1992), there is a large potential for increasing amounts of important habitat during some of the most energy demanding phases (migration, breeding, and moulting periods) of shorebird life-cycles.

There has been a history and tradition of managing wetland reserves with habitat objectives focused on waterfowl – not surprising given that most of the funds have come from sportsmen. In the United States, there are roughly 538 national wildlife refuges comprising nearly 95 million acres (38 million ha). Although roughly 85% of this land is in Alaska, the remaining 15 million acres (6 million ha) in the "Lower Forty-eight" include some of the best remaining wildlife wetlands in a rapidly developing country.

Many of the federal and other wildlife refuges in the U.S. were established because of their wetland value to waterfowl. Often these are the same types of wetlands that shorebirds could potentially use as migration stopover areas, and indeed, as illustrated (Fig. 1), many already are using areas managed for wildlife. Notwithstanding their high level of use of refuges, there often is little management directed at shorebirds.

With slight modification of management practices, typically with little effect on traditional waterfowl objectives, there is a huge potential for practising shorebird management on refuge lands. To this end, a number of initiatives currently are underway. For example, various agencies in the United States have embarked on a shorebird management training programme (as reflected at http://www.manomet.org/WHSRN/shorebird%20management%20workshops.htm) that is focused on professional wildlife managers. To date more than 1,000 wildlife professionals have attended the 4-day workshops, and many of these people now include management objectives for shorebirds in their operations.

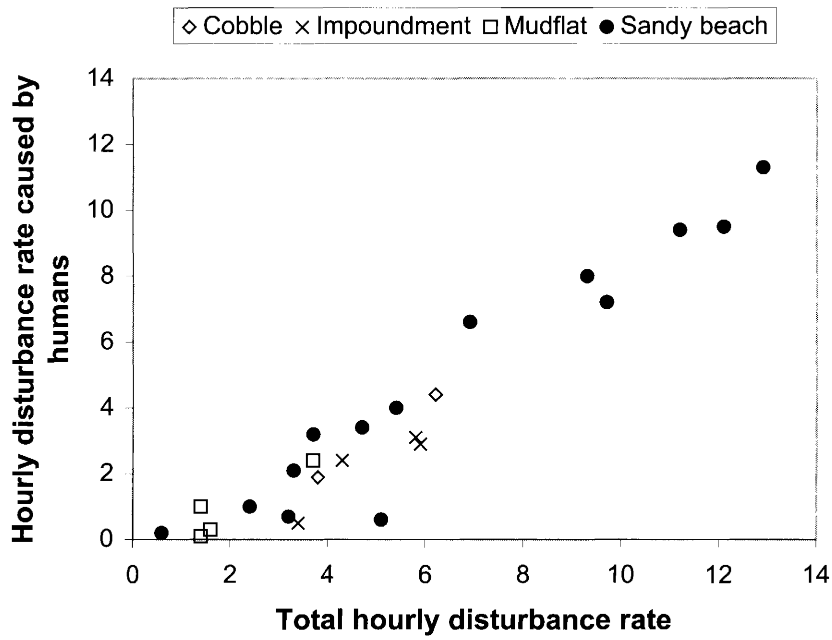

Fig. 2. Disturbance rate affecting shorebirds caused by human activities alone plotted against total disturbance rate. The data relate to different habitats of National Wildlife Refuges on the U.S. Atlantic coast during the summer of 1996 (Harrington & Drilling, unpublished).

MANAGEMENT METHODS TO BENEFIT SHOREBIRDS

The remainder of this commentary focuses on some of the methods that managers can use to benefit shorebirds in areas managed for wildlife, as well as in other areas. My focus is on shorebirds during nonbreeding seasons, and especially during migration.

In general, management needs for shorebirds will be different in marine and nonmarine habitats.

Marine locations

There are limited options for managing habitat and food production for wildlife at marine locations, but nevertheless there are important roles for wildlife managers, planners and conservationists to play. Specifically understanding and, where warranted, managing for chronic disturbance from human-related sources is a high priority. Reasons for this are outlined below, but here I first want to note that it is of relevance even in existing wildlife refuges. For example, Harrington & Drilling (*in litt.*, unpublished) found that there was frequent disturbance (defined as flushed into flight) of shorebirds in coastal refuges, and that most disturbance was caused by human versus natural activities (Fig. 2).

Growing evidence points to chronic disturbance being problem to shorebirds in a variety of situations (Davidson & Rothwell 1993). Understanding whether there is need to control disturbance, and how to best design controls where warranted, requires basic knowledge of the shorebirds and their habits.

Human disturbance at nonbreeding areas can affect shorebirds at marine sites in several ways, including:

- ❑ Causing reduced foraging time,
- ❑ Increasing daily energy expenditure from increased numbers of flush flights (take-offs),
- ❑ Loss of time for preening and resting,
- ❑ Lost use of habitats in heavily disturbed locations, and
- ❑ Probable indirect cause of mortality (through the combination of reduced foraging time and increased energy expenditure)

In some situations, shorebirds are disturbed so frequently that the amount of time they have available for foraging or resting is reduced to such a degree that it is likely to affect their well being (Burger 1997). For example, Goss-Custard & Verboven (1993) estimated that Eurasian Oystercatchers *Haematopus ostralegus* in chronically disturbed areas foraged for 30–50% less time than in other areas, or in some cases stopped using good foraging sites during times of heavy human use. Pfister *et al.* (1992) showed that human activities were the likely cause of reduced numbers of shorebirds at a migration staging-site on the Massachusetts coast, and Mitchell *et al.* (1989) found that declines of wintering shorebirds in the Dee Estuary (> 90% for some species) were likely caused by human disturbance. However, Gill *et al.* (2001a,b) found little evidence that human activities affected distribution or foraging habitat use by wintering godwits.

Resting and preening are important components of shorebirds' activity budgets at migration and wintering locations (Morrier & McNeil 1991, Evans & Harris 1994). At marine locations, shorebirds generally forage during low tide periods and roost/preen over high water. I have found no information on how deprivation of time for these activities affects shorebirds. However, Pfister *et al.* (1992) and Mitchell *et al.* (1989) found that shorebirds abandoned traditional roosting sites when disturbance levels increased.

Some, but apparently not all, shorebird species will accommodate to disturbance to some degree by developing a shorter "fright-flight" distance (Smit & Visser 1993, Goss-Custard & Verboven 1993). Whether disturbance affects shorebirds is likely to depend upon the nature and consistency of the disturbance, the activities of the birds (e.g. foraging, roosting), time available for acclimatisation, and habi-

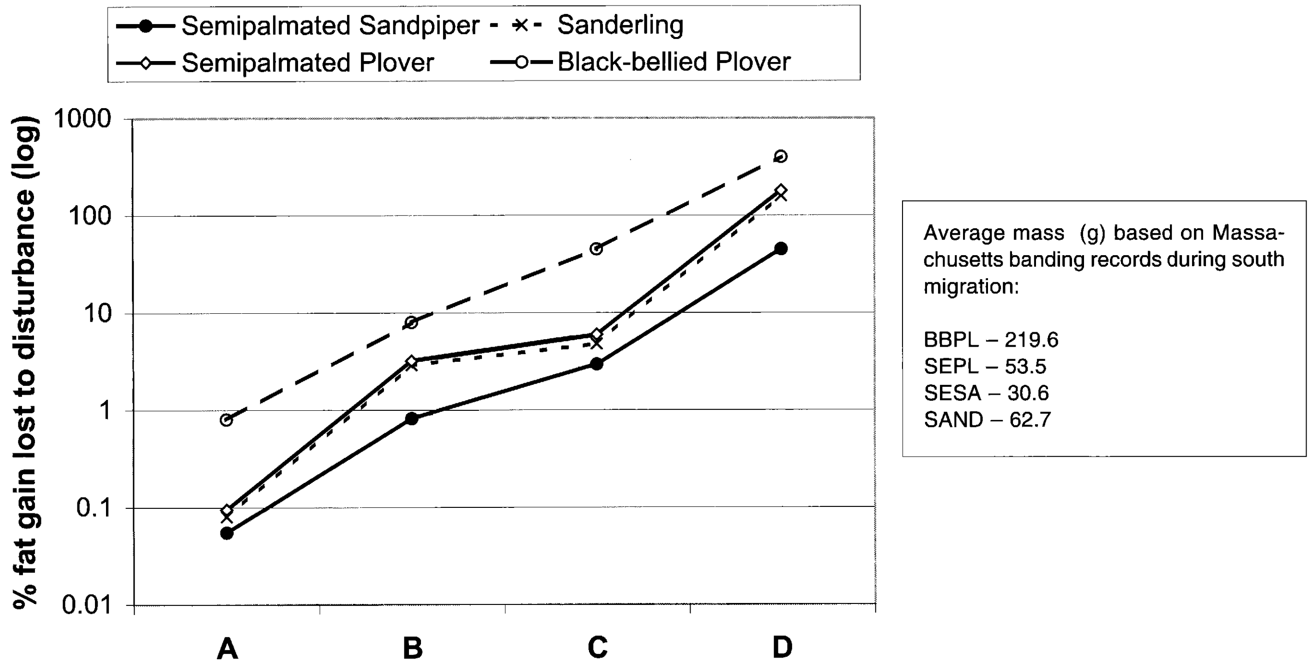

Fig. 3. Four scenarios modelling the energetic consequences of disturbance (see text) in four shorebird species at migration staging areas (Black-bellied Plover *Pluvialis squatarola* (BBPL), Semipalmated Plover *Charadrius semipalmatus* (SEPL), Semipalmated Sandpiper *C. pusilla* (SESA) Sanderling *Calidris alba* (SAND)). **Scenario A.** Sites with low disturbance frequencies and good feeding conditions where shorebirds can gain mass at high rates; less than 1% of daily fat gain may be spent in response to human disturbance. **Scenario D.** Sites with high disturbance frequencies and poor feeding conditions, shorebirds will gain mass at low rates; more than 100% of needed daily fat gain may be spent in avoiding human disturbance. Scenarios B and C represent intermediate conditions of disturbance and mass gain rates (based on Harrington and Drilling, *in litt.*).

tat conditions. Although no specific comparison of acclimatisation to disturbance by shorebirds has been made between migration staging and wintering areas, it is unlikely that there is sufficient time for shorebirds to acclimatise to human activities during brief migration visits.

Does chronic disturbance cause mortality? No conclusive information exists to answer this question for shorebirds. However, compelling circumstantial evidence suggests that mortality is a likely consequence at chronically disturbed migration stopover sites:

- Pfister *et al.* (1992) linked reduced shorebird use of resting areas at a migration staging site with increasing recreational activity
- Through modelling, Harrington & Drilling (unpubl., see Fig. 3) showed that it is likely that the energetic costs of disturbance impaired shorebirds' ability to gain weight, and
- Pfister *et al.* (1998) found evidence of reduced survivorship of sandpipers that do not achieve threshold weights at a migration stopover site.

Through measurements of "fright-flight" distances, and energetics modelling based on Pennycuick (1989), Harrington & Drilling (*in litt.*) showed that levels of shorebird response (fright-flight distance) to disturbance could impair shorebirds' ability to accumulate fat needed to prepare for migration (Fig. 3). Based on banding information, and information from literature, they determined the amount of mass shorebirds gain each day during migration stopovers at "good" (where mass is gained rapidly) and at "poor" (where mass is gained slowly, probably due to food constraints) locations. They then estimated what percentage of that mass gain would be consumed in response to disturbance under different scenarios, based on average "fright-flight distances" that they determined for common species. Simplified results of this work, summarized in Fig. 3, suggest chronic disturbance can cause reduced mass in shorebirds at migration staging sites, and that the effects are potentially most severe for larger species and species at staging areas where fattening rates are low. This information, in combination with information developed by Pfister *et al.* (1992, 1998), suggests that mortality may be a consequence of chronic disturbance to shorebirds at migration stopover sites.

Managing marine locations for shorebirds

It seems clear that reducing human disturbance where it is a problem can provide benefits for shorebirds. However, determining whether chronic disturbance is an existing or potential problem at a given location requires some basic information. Considerations include the frequencies of disturbance (Fig. 3), the type of disturbance, whether the area is a migration staging area or a wintering area, whether food resources are accessible and plentiful (allowing rapid fattening (Fig. 3)), size of the birds (energetic consequences of disturbance are greater to large than to small birds, Fig. 3), the habitat and configuration of the location (e.g. linear, sandy beaches tend to have higher disturbance than broad mudflats or impoundments (Fig. 2), and activities of the birds (e.g. foraging shorebirds tend to be more tolerant of human activities than resting shorebirds).

At many locations, especially in coastal situations, disturbance is most likely to be an issue at roost sites; this is because of simple spatial relationships; at lower tides there is

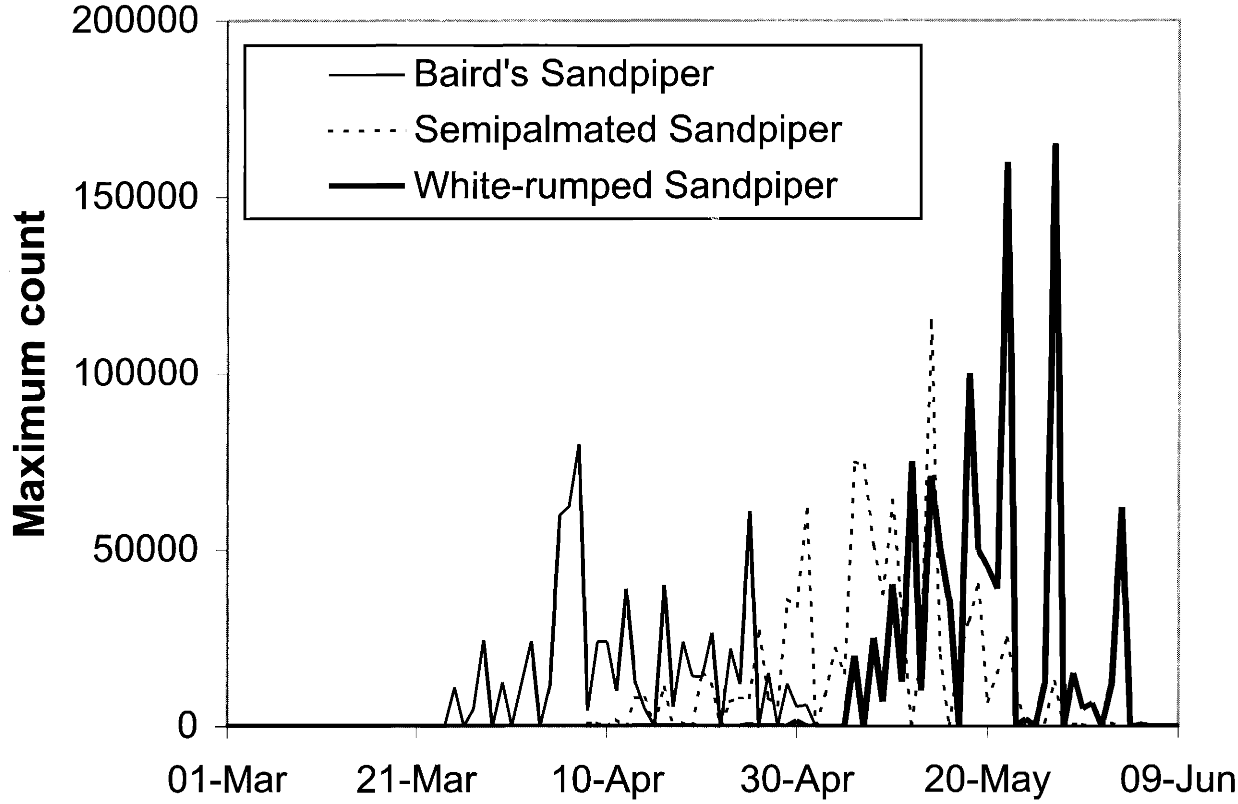

Fig. 4. Spring migration chronology of Bairds Sandpiper *Calidris bairdii*, Semipalmated Sandpiper *C. pusilla* and White-rumped sandpipers *C. fuscicollis* during spring (Mar 1–Jun 10) in Kansas (unpubl. data compiled for 10 years from the International Shorebird Surveys).

more coastal space for shorebirds to spread across than at high tides, although water sports, shellfishing and worm-digging can cause significant problems (Piersma & Koolhaas 1997, Shepherd & Boates 1999).

Management action can range from outright restriction of human activities to selected restrictions (e.g. pet restrictions or closures under certain tidal conditions), depending on the situation.

Nonmarine wetlands

In addition to the considerations outlined in the preceding section, at nonmarine wetlands habitat management can make a wildlife management area more useful to shorebirds. In this section I focus on unforested, nonmarine wetlands ranging from damp or shallowly flooded land (including permanently or temporarily flooded terrestrial areas), to deeper semi-permanent and permanent wetlands including ponds and lakes. Some of the most important characteristics of wetlands that directly affect foraging birds are the type of substrate, the water depth, the vegetative structure and its size (Brown & Dinsmore 1986, Helmers 1992).

Substrate

Although I will not dwell on this topic, it is important to note that substrate type (eg. mud, sand, and gravel) will affect the kinds of vegetation, the types and densities of invertebrate animals (Velásquez & Navarro 1993), and how birds can forage in it (Quammen 1982). Muddier substrates tend to have higher invertebrate animal populations, which in turn can attract greater bird use (Quammen 1982).

Substrates also affect foraging methods. Many species, especially shorebirds and some of the ibises, probe in the substrate; difficult to penetrate substrates are less useful to them (Quammen 1982). Other birds hunt visually for prey on the bottom surface and/or in the water column; for these, substrate conditions may be less critical.

Water depth

Many wetland birds prefer water less than 12 cm deep (Elphick & Oring 1998). For example, 72 of the 156 waterbird species common to the Lower 48 United States use water less than 12 cm deep (Harrington, unpublished); this includes all of the 48 species of sandpipers and plovers, 4 of the 5 kinds of rails, and 7 of the 11 kinds of dabbling ducks. Other groups, such as herons and ibises (16 species) prefer depths between 12 and 25 cm. A number of other types such as grebes (7 species), loons (3 species) and diving ducks (35 species) prefer deep water but sometimes will use the intermediate-depths of waters too (Elphick & Oring 1998). Some species may switch preferences seasonally.

Vegetation

Many kinds of wetland birds use different vegetation types during breeding and nonbreeding seasons. In the nonbreeding season most species, including most shorebirds, prefer habitats with less vegetative cover (Colwell & Dodd 1997), unless the vegetation is short and visibility of surrounding horizons is not obscured. Nevertheless, some species, such as the rails, require thickly vegetated wetlands.

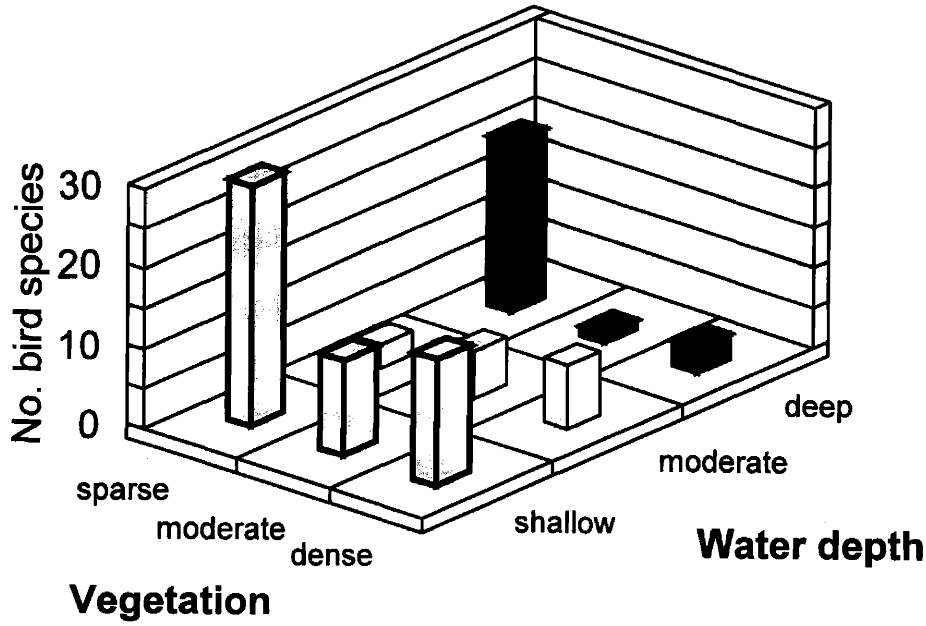

Fig. 5. Wetland bird diversity among 102 species during the nonbreeding season in relation to water depth and vegetation density (see text for further information).

Wetland size

The size of a wetland will also affect the variety of birds that use it (Brown & Dinsmore 1986). Some species, e.g. Solitary Sandpiper *Tringa solitaria*, favour small wetlands whereas others, e.g. Dunlin *Calidris alpina*, prefer large wetlands. Some species may prefer one type for breeding and another for wintering.

Managing nonmarine wetlands for shorebirds

A variety of considerations described by the *Shorebird Management Manual* (Helmers 1992) revolve around having appropriate information on the migration chronology of targeted species, managing for conditions that provide abundant food resources (invertebrate animals), managing vegetation structure appropriate for shorebirds, managing for water depths suitable for making food resources accessible to shorebirds, and timing management activities such as water draw-downs to coincide with the seasons when shallow water or mud flats are needed by shorebirds. Throughout the manual, Helmers stresses the importance of annual rotation of management activities in wetlands to avoid conditions that can cause vegetation problems, lead to introduction of exotic species, or create conditions that can cause problems of disease.

Chronology

It is perhaps obvious that management for shorebirds needs to take place at times when they are present. In cases where managers want to target activities for a particular species, routine census counts can provide information needed for selecting proper dates. Alternatively, a manager may elect to provide habitat for a particular guild of shorebird, for example small species that forage on mud. Fig. 4 illustrates these points; during spring there are three species of small calidrid sandpipers that are abundant migrants in mid-western states of the U.S., all of which use essentially similar wetland habitats (Skagen & Knopf 1994). But each kind has different but overlapping migration dates. Managing water levels in a wildlife area for all three of these species would require slow water draw-down lasting from about 1 March to 10 June (roughly 3 months). Managing for the last species to pass through the region would require a draw-down lasting from about 1 May to 10 June. At most managed wetlands it would be difficult to sustain a draw-down in a single unit for as long as three months, but at sites having multiple management units, this could be more easily achieved by staggering draw-downs between units.

In a similar vein, different species of shorebirds will have different foraging methods and water-depth preferences (see above). Locations having multiple management units can increase diversity of shorebird (and other) species by providing a variety of water depths in different units.

Food resources

Most species of shorebirds (and other birds) that use wetland habitats feed principally on invertebrate animals (Reid 1993). Managers have multiple options for creating conditions that encourage development of rich invertebrate animal populations (see Helmers, 1992 for details), all of which essentially depend on providing sufficient organic materials (and conditions for their decay) to sustain invertebrate animal populations. In impoundments where water levels can be managed, or in seasonal wetlands, creating good conditions for invertebrates frequently involves tilling (sometimes burning or mowing) vegetation into the substrate, and then flooding the area (Rundle & Frederickson 1981, Helmers 1992, Weber & Haig 1996). The management "art" comes in making the invertebrate animals available to shorebirds at the right time by slowly drawing down water levels so that muddy habitat is *gradually* exposed. Too rapid a draw-down will cause mud to become dry (resulting in emigration, death and/or aestivation of the invertebrates) before shorebirds have an opportunity to crop the food resources it contains.

On the other hand, if the water is too deep, it will prohibit access by most shorebirds.

Other opportunities for providing nonmarine foraging habitat exist in the management of sewage treatment areas (Fuller & Glue 1980), in wet meadows (Kohler & Rauer 1991), pastures (Colwell & Dodd 1997), agricultural areas (Rottenborn 1996, Elphick & Oring 1998, Huner *et al.* 2002), stock ponds (May *et al.* 2002), grasslands (Milsom *et al.* 1998), and grazed lands (Powers & Glimp 1997).

Vegetation structure

During migration and winter most species of shorebirds avoid wetlands and other habitats where vegetation structure will impair visibility of surrounding landscapes (Helmers 1992), evidently to avoid situations vulnerable to raptor predation (Cresswell 1994). In managing for shore (and many other) birds, this trait translates to limiting stands of tall vegetation so that open, muddy or shallow water habitat comprises roughly two-thirds or more of managed units (Helmers 1992, Vickery *et al.* 1996). As it happens, this need melds well with a need to provide organic materials for high invertebrate biomass; disking is a common practice for both reducing the vegetation structure and for providing organic materials to nurture abundant invertebrate animal populations.

To highlight the importance of varied depths and vegetation, from personal experience I characterized common wetland birds in the Lower 48 United States with respect to their preferences for shallow (less than about 5 cm), moderate (around 5–10 cm) and deeper (more than 10 cm) water, as well as for their preference for dense (>70%), moderate (30–70%) or sparse (<30%) vegetation. Fig. 5 charts how many species of birds prefer each of nine depth/vegetation categories during the nonbreeding season. The goal of this exercise was not to show which category is "best" (that will vary with numerous factors), but to emphasize how a greater diversity can be achieved by managing for varied water depths and/or vegetative conditions.

CONCLUSIONS

The habitats that shorebird species use during their migration and wintering periods are shallow tidal and nontidal wetlands ranging from estuarine mud flats to inland wetlands that ebb and flood on daily or seasonal scales. Wetlands are some of the most biologically productive areas on earth, attracting shorebirds because they can provide abundant and accessible food that shorebirds require for their "high energy" lifestyle. Unfortunately, wetlands have long been viewed by industrial societies as locations "ripe" for development, whether for coastal urban expansion or for large-scale agricultural operations. Though poorly documented, it is clear that the degree of world-wide wetland loss has been enormous. Too late, we now understand that wetlands, in a sense, are strong "biological engines" – engines that propel populations of creatures such as fishes and shorebirds through their life trajectories.

Today many shorebird populations are declining, some at rates as high as 10% a year; causes are largely unknown, so solutions are enigmatic. So what can be done?

Though clearly not a cure-all, habitat management for shorebirds may offer opportunities to help stem population declines of some species. This commentary has highlighted some of the prospects that exist to manage wetland habitat for shorebirds.

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