SHOREBIRD

Management Manual

Douglas L. Helmers

THE WESTERN HEMISPHERE SHOREBIRD RESERVE NETWORK

North American Waterfowl Management Plan ©

WETLANDS FOR THE AMERICAS
HUMEDALES PARA LAS AMERICAS
P.O. Box 1770 • Manomet, MA 02345 U.S.A.
Phone (508) 224-6521 Fax (508) 224-9220

1992

Helmers, D. L. 1992. Shorebird Management Manual. Western Hemisphere Shorebird Reserve Network. Manomet, MA. 58pp.

Publication of the Western Hemisphere Shorebird Reserve Network, a program of Wetlands for the Americas (WA), P.O. Box 1770 Manomet, MA 02345. WA acknowledges the Manomet Observatory for its continued support.

Cover Photo: Marbled Godwit photographed by A. Morris/Vireo

Wetlands for the Americas Publication No. 3
ISBN: 1-883861-05-5

Fourth Printing - May 1999

Table of Contents

Foreword

Wildlife management is in a continuous process of evolution as it responds to society's needs. Traditionally, outdoor-minded people have enjoyed nature through consumptive activities, especially fishing and hunting. Not surprisingly, wildlife management was focused on enhancing habitats for game species. Rapidly changing demographics in the United States are responsible for a shift in interests. An increasing number of people are more and more inclined toward nonconsumptive activities, such as birdwatching, wildlife photography, et cetera. By the early 80s for example, a total of 135 million people enjoyed nonconsumptive activities, as opposed to 17 million who enjoyed hunting. There is therefore a clear need to develop management techniques aimed at enhancing habitats for both game and nongame species.

This manual was designed to provide wildlife managers with concise advice on how to manage habitats to benefit shorebirds. Although much has been written on the biology and ecology of shorebirds, very little information exists on shorebird management. Many of the techniques described in this manual are therefore new and have not been previously published in the technical literature. Moreover, given the preliminary nature of many of these techniques, this publication should be viewed as a working document which will be improved upon as more data and expertise become available. We invite the reader to send suggestions.

Recommendations provided in the manual are of a general nature, and we encourage wildlife managers to fine-tune them to accommodate their particular needs. We recognize that for any given location, the main experts are the local managers who deal with these issues on a day-to-day basis. In most cases, however, these techniques are compatible with current waterfowl management practices; small efforts in timing, according to shorebird migration chronologies, are sufficient. We encourage the use of this Manual in conjunction with the U.S. Fish and Wildlife Service's Waterfowl Management Handbook, which provides general techniques for managing waterfowl and wetlands.

Although significant information is given on systems with water manipulation capabilities, we do not advocate the alteration of natural systems to implement these activities. After all, we need to keep in mind that as a result of natural selection wildlife life histories correspond to natural fluctuations in the environment and that the need to manage natural habitats is a desperate response to the rapid disappearance and alteration of the natural world.

Although a relatively new concept, we view this manual as a small step in the right direction. Waterfowl plus shorebirds does not equal biodiversity! We recognize the need to develop management techniques that accommodate the needs of all species — systems that closely resemble natural ecosystems. If we can stimulate researchers and wildlife managers to concentrate their efforts in developing these techniques, then this effort will have been worthwhile.

Gonzalo Castro, Executive Director
Western Hemisphere Shorebird Reserve Network

Preface

Who among outdoor aficionados does not feel great emotional reward when a rich diversity of birds, flowers, and other critters are seen, heard, or smelled as we move through a marsh or wooded swamp or walk along an isolated beach? None, I dare say, and this is true even for the casual visitor who might wander for awhile out of a concrete canyon. We all are moved by encounters with large concentrations and varieties of life forms sharing this planet.

In truth, we have relatively few places where we can experience natural diversity. Today, the majority of natural systems within the United States have been physically altered and are unable to meet the requirements needed to sustain a natural array of species. Public and private natural resource organizations are protecting existing remnants of natural systems and restoring other disturbed systems. Management to enhance still additional habitat is an equally important part of the equation needed to support continental population of migratory birds and resident species with similar habitat requirements. Therefore, whenever wildlife managers manipulate altered systems to increase the productivity of an area, it should be done with an informed intent to benefit as many groups of species as is feasible given the resources available.

The partners producing this Shorebird Management Manual are intent on providing wildlife managers with current knowledge of principles and existing techniques to benefit multiple groups of species. Armed with such, these managers can expand the benefits of their tinkering to an even greater number of species. Although aimed at shorebirds and pyramided on existing waterfowl management capabilities, the target of this effort is by nature even broader. By simulating the natural timing of food resources for an array of species, altered systems management moves one step closer toward providing the natural diversity that has been lost in other places on the landscape.

We offer our appreciation to the author and the many partners that promoted, revised, and funded this effort. We endorse this handbook knowing that revisions and improvements are possible but that any great effort at this time would be of limited value in the face of the habitat shortages faced by shorebirds. We encourage improvements in the manual as time goes on, but actions by managers now.

Robert G. Streeter, Executive Director
North American Waterfowl and Wetlands Office

Acknowledgments

The development of this Manual would not have been possible without the technical expertise and dedication of numerous individuals. The ideas presented here were initially developed and discussed at a technical panel workshop, which included the participation of ten experts: Phil Covington, Missouri Dept. of Conservation; Thomas Edwards, Jr., Utah Cooperative Fish and Wildlife Research Unit; Jan Eldridge, USFWS; R. Michael Erwin, USFWS; Douglas Helmers, WHSRN; Peter Hicklin, Canadian Wildlife Service; Gary Page, Point Reyes Bird Observatory; Mark Ryan, University of Missouri; Susan Skagen, USFWS; and Lou Weber, South Carolina Cooperative Research Unit. In addition, the panel participants reviewed several versions of the draft and made important contributions.

Many other individuals provided advice and comments, including: Gonzalo Castro, H. Loney Dickson, George Finney, Curtis Freese, Leigh Fredrickson, Brian Harrington, R. I. G. Morrison, Murray Laubon, J. P. Myers, Stanley Senner, Kenneth Rosenberg, Suzanne Fellows, Michael Tome, and John Trapp.

Bob Joyner (South Carolina Wildlife and Marine Resources Dept.), Karen Smith, (USFWS), and Phil Covington (Missouri Dept. of Conservation) deserve special credit for providing information used in the case study sections. Special recognition is given to Brian Harrington for access to International Shorebird Survey data, and to Gary Page for Pacific Shorebird Survey data. Thomas Dwyer, Marshall Howe, and Robert Streeter provided significant guidance and insight during the development of this manual.

Nancy Ludlow provided assistance in line editing and desktop production. Dave Twichell authorized the use of his photographs. Special assistance was also provided by the WHSRN staff: Gonzalo Castro, Heidi Luquer, James Lyons, and Julie Sibbing.

This Manual was developed with funding provided primarily by the U.S. Fish and Wildlife Service, and by the David and Lucile Packard Foundation. Additional funding was provided by the National Fish and Wildlife Foundation, the W. Alton Jones Foundation, the Dorr Foundation, and the Western Hemisphere Shorebird Reserve Network.

Douglas L. Helmers, Technical Coordinator
Western Hemisphere Shorebird Reserve Network

Chapter 1 — Manual Overview

THE cumulative loss of wetland habitats across the United States and Canada since colonial times has forced public agencies to intensively manage or protect inland and coastal habitats for some time. Wetland management has developed steadily over the years to meet the resource needs of waterfowl. Early nongame management, however, has focused on the protection of endangered species and their habitats. Today this focus is changing. Increased public appreciation for the value of nongame wildlife and the need for biodiversity has highlighted the need to enhance management for nongame wildlife. Public agencies and international multiorganizational programs, such as the North American Waterfowl Management Plan, have responded by incorporating nongame resource needs into management strategies.

Wetland management must meet the needs of shorebirds.

Loss and degradation of habitat may determine the future of shorebirds.

To accomplish this, management plans for shorebirds must use information on migration chronology and habitat use for species groups and preserve and manipulate habitats to enhance food supplies and decrease disturbance. Managers of wildlife refuges can easily incorporate shorebird management strategies into the strategies that they now use for waterfowl. With minor changes in wetland regimes, they can adapt habitats for migrating shorebirds without compromising waterfowl habitats, especially in the spring. This manual is a reference for actively managing wetland habitats within four major geographic regions of North America: the Interior, the Atlantic, the Pacific, and the Gulf of Mexico (Figure 1.1). The management techniques offered are not well known among wetland managers since much of the information is relatively new and not yet available in the technical literature.

Historical Accounts and Today's Threats

Historical accounts of shorebird numbers, similar to those of waterfowl and other flocking species, noted populations in "huge numbers" and described occasions when "birds darkened the sky." During the late 1800s and early 1900s, shorebirds were extensively hunted for sport and food and suffered major population declines similar to those of waterfowl. The Eskimo Curlew, currently listed as an endangered species, is one species that may have been harvested beyond recovery. Other species, such as the Golden Plover and the Hudsonian Godwit, have also declined dramatically due to excessive harvesting. For example, in 1821 about 200 gunners in the New Orleans area harvested 48,000 Golden Plovers in one day. Since 1916, hunting has been illegal for all but two migratory shorebirds, the Common Snipe and the American Woodcock in North America. Although hunting of other shorebird populations does not occur now in North America, some species are hunted for food in northern South America. Sport hunting of shorebirds (mainly of Pectoral Sandpipers and Lesser Yellowlegs) continues at private "shooting swamps" in Barbados.

Loss and degradation of habitat at migration and wintering areas may determine the future well-being of migratory shorebirds. Wetlands in the United States decreased from an original estimated 77 to 90 million hectares (about 200 million acres) to approximately 42 million hectares (about 100 million acres) by the 1980s. This loss stems mostly from urban development in coastal areas and from agricultural practices in interior areas. For example, in California, more than 70 percent of the coastal intertidal wetlands have been altered by urban development; more than 90 percent of the seasonally flooded wetlands of the Central Valley have been converted to agriculture. The Piping Plover is one example of a shorebird being listed as a threatened

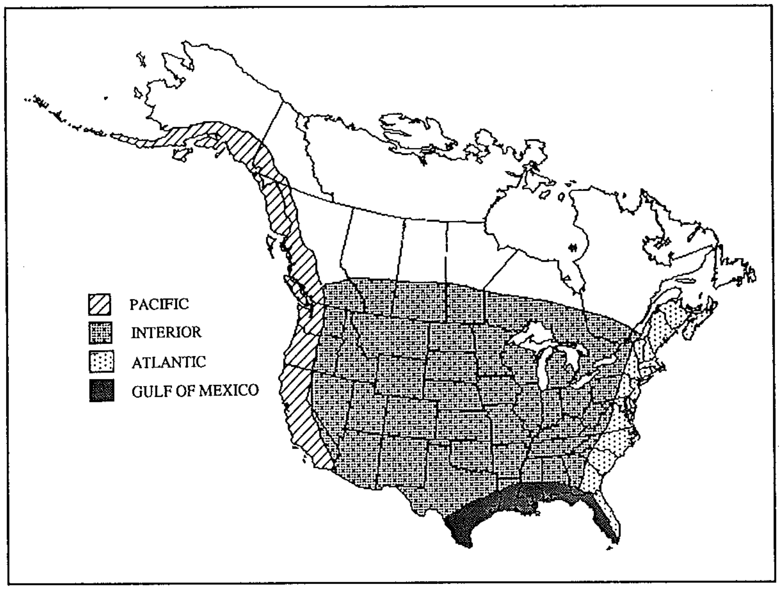


Figure 1.1 Major geographic regions within North America for shorebird management.

and endangered species due to habitat loss and modification. Other species, such as the Snowy Plover and the Mountain Plover, are currently under review for listing as endangered species.

Wintering habitats in Central and South America are also undergoing pressures resulting from increased human development. Traditional wintering areas, such as the Pampas regions of Argentina, have largely been converted to agriculture or are heavily grazed.

Migratory shorebirds need staging areas to refuel and complete their migration. Disturbance of shorebirds at feeding, roosting, and nesting sites can also have potentially serious effects on populations. When disturbance causes unnecessary flights, shorebirds attempt to meet their increased energy demands by increasing foraging time. As food resources become limited, shorebirds must increase length of stay or depart with less than optimal body masses. Disturbances resulting from human recreation or agricultural practices to nesting shorebirds can cause nest desertion and/or decrease nest success.

Migratory shorebirds need staging areas to refuel.

Environmental contaminants, such as oil spills and agricultural pesticides, are another potentially serious problem for shorebirds. Oil spills occurring in areas during peak migration periods could seriously impact significant portions of certain populations. For example, approximately 80 percent of the Red Knot population in the Western Hemisphere stops over at Delaware Bay, New Jersey, the second largest oil port in the eastern United States. A major spill in this area could seriously affect these birds and their food supply. Agricultural pesticides (mainly organophosphates) are widely used throughout North America. DDT, which was banned in the United States in 1972, is widely used throughout Central and South America where many shorebirds winter. Shorebirds have been killed after application of pesticides on agricultural fields.

Shorebird Ecology

Shorebirds (Aves: Charadriiformes) are a morphologically diverse group of birds that migrate, breed, and winter throughout the world. Shorebirds range in size from 20 grams (Least Sandpiper) to more than 500 grams (Long-billed Curlew) and exhibit a wide diversity of bill lengths, bill structures, and leg lengths. During the year almost 50 species of shorebirds, including plovers, sandpipers, avocets, and phalaropes, occur in North America (Table 1.1). Shorebirds travel great distances, with many species traveling up to 12,000 kilometers from breeding to wintering grounds.

Migration

Many shorebirds migrate long distances from breeding grounds in the Arctic to wintering areas in Central and South America (Figure1.2). In most species, the adults leave breeding areas before juveniles have fledged. The staggered flights of adults and juveniles extend the migration period in the postbreeding season.

Shorebirds have narrow habitat requirements.

During spring, summer, and fall, large numbers of shorebirds concentrate at coastal and inland staging areas. Shorebirds differ from many other Neotropical migrants (songbirds) in that they have narrow habitat requirements that limit them to relatively few, highly productive stopover sites. Shorebirds use the same coastal staging areas year after year, probably because the areas provide more highly productive, predictable feeding and roosting areas than other sites along the migratory route.

Before departing, many shorebirds increase body mass up to 100 percent at these staging areas. Most of this increased mass is the fat required to fuel their long-distance migration. Because shorebirds have higher metabolic rates than other nonpasserines of similar size, they must spend much of their day, during staging periods, foraging for maintenance and fat storage. The disappearance or degradation of spring stopover habitats may therefore be detrimental to entire populations.

Breeding

Shorebirds return each year to historical breeding sites to nest and rear their young. Many factors, however, determine their success in maintaining populations. Clutch sizes, for example, consist of only four eggs. Almost all are ground nesters and so are susceptible to predation. Although most shorebirds nest in the Arctic or subarctic where disturbance is low, they can have low reproductive success nonetheless. Because climatic conditions here are highly variable, the breeding season is short

Table 1.1 Foraging guilds of shorebirds in North America

Shorebird Group	Common Name	Scientific Name	Foraging Guild
Plover	Black-bellied Plover	*Pluvialis squatarola*	terrestrial/aquatic gleaner
	Lesser Golden Plover	*Pluvialis dominica*	
	Snowy Plover	*Charadrius alexandrinus*	
	Wilson's Plover	*Charadrius wilsonia*	
	Semipalmated Plover	*Charadrius semipalmatus*	
	Piping Plover	*Charadrius melodus*	
	Killdeer	*Charadrius vociferus*	
	Mountain Plover	*Charadrius montanus*	
Curlew	Eskimo Curlew	*Numenius borealis*	terrestrial/aquatic gleaner/prober
	Whimbrel	*Numenius phaeopus*	
	Long-billed Curlew	*Numenius americanus*	
Small Sandpiper	Sanderling	*Calidris alba*	aquatic prober/gleaner
	Semipalmated Sandpiper	*Calidris pusilla*	
	Western Sandpiper	*Calidris mauri*	
	Least Sandpiper	*Calidris minutilla*	
	White-rumped Sandpiper	*Calidris fuscicollis*	
	Baird's Sandpiper	*Calidris bairdii*	
Medium Sandpiper	Red Knot	*Calidris cantus*	aquatic prober/gleaner
	Pectoral Sandpiper	*Calidris melanotos*	
	Stilt Sandpiper	*Calidris himantopus*	
	Dunlin	*Calidris alpina*	
	Short-billed Dowitcher	*Limondromus griseus*	
	Long-billed Dowitcher	*Limondromus scolopaceus*	
	Common Snipe	*Gallinago gallinago*	
	Buff-breasted Sandpiper	*Tryngites subruficollis*	aquatic/terrestrial gleaner
	Upland Sandpiper	*Bartramia longicauda*	
Godwit	Hudsonian Godwit	*Limosa haemastica*	aquatic prober
	Marbled Godwit	*Limosa fedoa*	
Yellowlegs	Greater Yellowlegs	*Tringa melanoleuca*	aquatic gleaner
	Lesser Yellowlegs	*Tringa flavipes*	
	Solitary Sandpiper	*Tringa solitaria*	
	Willet	*Catoptrophorus semipalmatus*	
Turnstone	Ruddy Turnstone	*Arenaria interpres*	terrestrial/aquatic gleaner/prober
	Black Turnstone	*Arenaria melanocephala*	
	Surfbird	*Aphriza virgata*	
	Wandering Tattler	*Heteroscelus incanus*	
	Spotted Sandpiper	*Actites macularia*	
	Purple Sandpiper	*Calidris maritima*	
	Rock Sandpiper	*Calidris ptilocnemis*	
Avocet/Stilt	Black-necked Stilt	*Himantopus himantopus*	aquatic gleaner/sweeper
	American Avocet	*Recurvirostra americana*	
Phalarope	Wilson's Phalarope	*Phalaropus tricolor*	aquatic/pelagic gleaner
	Northern Phalarope	*Phalaropus lobatus*	
	Red Phalarope	*Phalaropus fulicarius*	
Oystercatcher	American Oystercatcher	*Haematopus palliatus*	aquatic prober/prier
	Black Oystercatcher	*Haematopus bachmani*	

and many raise only one brood. Sixteen species breed in the north temperate region, mainly in coastal areas or on the prairies. Disturbance and alteration of habitat can seriously

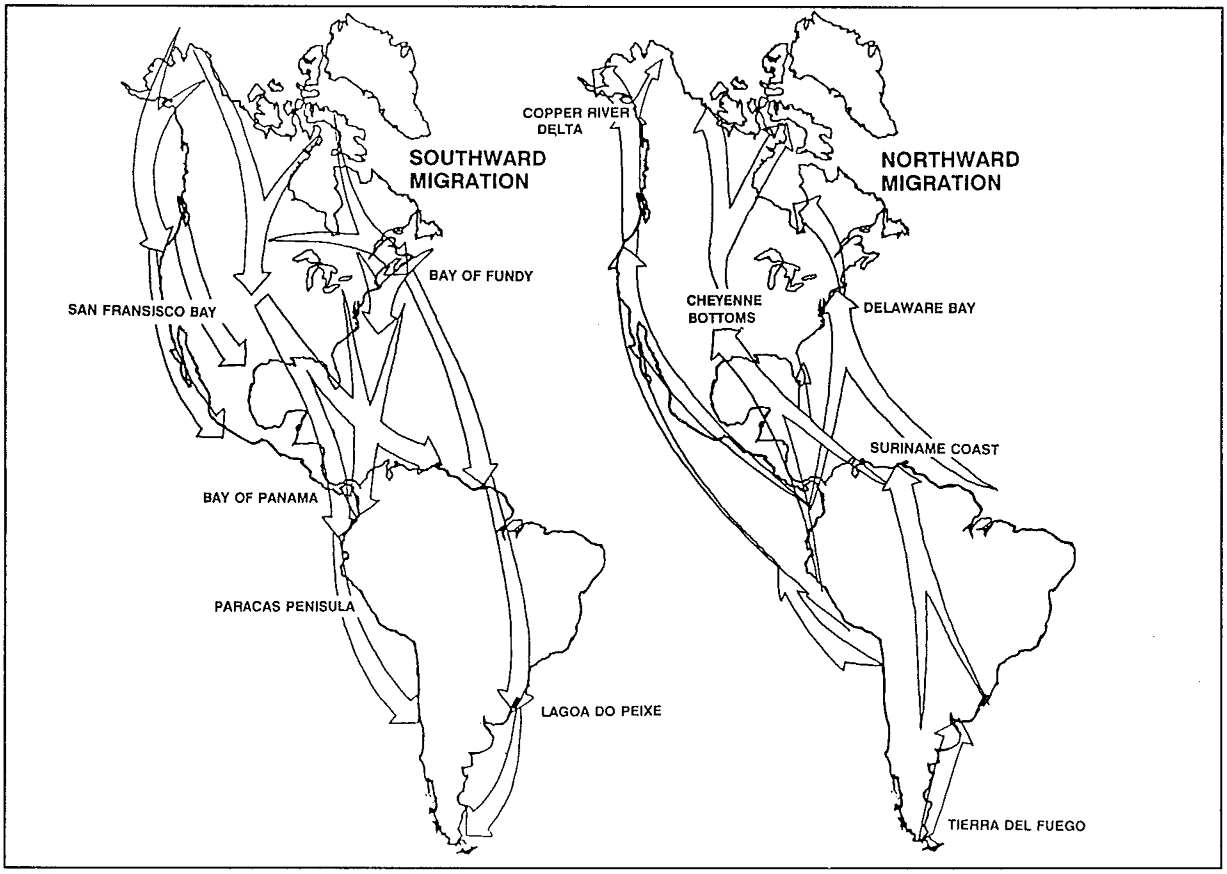


Figure 1.2 *Major migration routes for shorebirds in the Western Hemisphere.*

impact these shorebird populations. Increased availability of required habitats at summer and fall migratory stopover sites should increase survivorship of fledged young and therefore benefit total populations.

Shorebirds use productive and predictable feeding areas.

Wintering

Shorebirds spend as many as 9–10 months on wintering areas. During this period they must survive, molt, and build fat reserves before their northward spring migration. Although the majority of shorebirds winter in Central and South America, many winter in coastal and interior areas of the United States and northern Mexico.

Habitat Use

Shorebirds exploit various habitat types within coastal and interior wetlands and upland habitats. During migration, shorebirds occur primarily in shallowly flooded coastal or freshwater wetlands (with water depths of <10 centimeters) or on intertidal mud flats. Habitat types include sandy coastal beaches, shallowly flooded agricultural fields, and dry grasslands. Roosting habitats include sandbars, spits, or flats above the high tide line

Table 1.2 Shorebird foraging guilds and habitat types

			Habitat Type	
			Vegetation Structure	
Shorebird Group [a]	Foraging Guild [b]	Substrate	Height	Density
Plover	terr/aqua gleaners	dry/saturated	none/short	sparse
Curlew	terr/aqua gleaners/probers	dry/saturated	short/medium	moderate/dense
Sandpiper [c]	aqua/terr gleaners/probers	flooded/saturated	none/short	sparse
Godwit	aqua probers	flooded	short/medium	sparse/moderate
Yellowlegs	aqua gleaners	flooded	short/medium	sparse/moderate
Turnstone	terr/aqua gleaners/probers	rocky intertidal	none/short	sparse
Avocet/Stilt	aqua gleaners/sweepers	flooded	none/short	sparse
Phalarope	aqua/pelagic gleaners	flooded	none/short	sparse/moderate
Oystercatcher	aqua probers/priers	flooded/saturated/ intertidal	none/short	sparse

[a] Species for each shorebird group appear in Table 1.1.
[b] terr = terrestrial; aqua = aquatic; gleaners = birds that pick or glean for food from surface (visual); probers = birds that probe for food from substrate (tactile); sweepers = birds that sweep for food in the water column; priers = birds that use bill to pry open molluscs.
[c] small and medium

at coastal areas and shallowly flooded areas or islands free of vegetation at noncoastal sites.

Invertebrates are a key resource.

Foraging

Shorebirds have a wide range of foraging techniques, both across and within species depending on the habitat and foods available. These techniques range from picking terrestrial insects from dry mud flats (plovers) to probing for molluscs in tidal mud flats (oystercatchers). Differences in body size and bill length allow shorebirds to partition habitats. For management purposes the shorebird community has been described in terms of foraging guilds along two axes: foraging and habitat (Table 1.2).

Macroinvertebrates are a key resource for shorebirds. The migratory shorebird community at coastal sites exploits a benthic invertebrate fauna dominated by polychaetes, crustaceans, molluscs, or insects within shallowly flooded mud flat habitats. In interior areas, diptera (fly larvae) are an important invertebrate prey consumed by shorebirds during migration and breeding.

Habitat

Wetlands

In this manual, wetlands are defined as lands transitional between terrestrial and deep water aquatic systems where the water table is at or near the water surface or where the land is covered by

Invertebrate food supplies can be enhanced.

shallow water. Wetlands which are used by migrating shorebirds can be grouped into two major types: natural and altered.

Natural wetlands range from temporary and permanent freshwater marshes of the prairie pothole region to coastal tidal flats; they have had little or no human-caused changes in hydrology. Natural wetlands cycle through long-term, annual, or daily fluctuations in water levels that are usually driven by fluctuations in precipitation or tides. The hydrology of coastal wetlands is typically influenced by tides. The hydrological regime, that is the timing, duration, and extent of flooding within a wetland, controls the productivity of natural wetlands and influences invertebrate proliferation and vegetation composition, structure, and distribution.

Altered wetlands have been changed hydrologically by impoundment or changes in watersheds, such as through the use of levees along rivers and streams. Examples of altered wetlands are impounded salt marshes or freshwater marshes that are seasonally flooded. Many of these altered wetlands have been managed to enhance their values for wildlife.

Traditionally, managers of seasonally flooded marsh impoundments use drawdowns and reflooding to mimic hydrological conditions that produce food and cover for waterfowl. Until recently, seed production of migratory habitats has been the primary focus in waterfowl management; invertebrate availability has been a secondary consideration.

Chemical and physical fluctuations of the water and composition and structure of hydrophytes influence availability and abundance of invertebrates in wetlands. Effective wetland management requires that drawdown and reflooding cycles emulate natural wetland cycles. Poorly designed levees and water control structures or the lack of available water can hinder the ability to draw down or flood units. With improved design of structures and better management of water resources, the availability of invertebrate food supplies can be enhanced.

Uplands

Management of upland areas in association with many interior wetlands has primarily been directed toward dense nesting cover (DNC) for many species of waterfowl. Areas with short, sparse vegetation, preferred by Northern Pintails, are also exploited by several species of nesting shorebirds. Managing upland habitats to create short sparse vegetation for nesting and foraging shorebirds is an important consideration for the shorebird community.

Shorebird Management

Two major techniques can be identified as potential strategies for shorebird habitat management. *First*, we can protect and preserve important breeding, migrating, and wintering areas within relatively undisturbed habitats (such as the Copper River Delta in Alaska or the Bay of Fundy in Canada). The recent purchase of lands at Delaware Bay, New Jersey, part of the North American Waterfowl Management Plan, for example, will protect and preserve important staging areas for several species of migratory shorebirds.

Second, we can manipulate habitats to (a) reduce disturbance to shorebirds at feeding, roosting, and nesting sites and (b) increase food availability. Reducing disturbance to shorebirds from human recreational activities can be accomplished by temporarily limiting or prohibiting access to nesting areas. At a number of national parks and wildlife refuges, for example, nesting or roosting areas have been fenced off at critical times of the season.

Food availability is an important factor in the timing of shorebird migration and in the number of shorebirds that an area will support at coastal and interior sites. Managing wetlands for invertebrate availability benefits waterfowl, shorebirds, and other wetland-associated species.

Shorebird management can tie in with waterfowl management strategies.

Conclusion

Management of coastal or interior marshes and seasonally flooded wetlands for migratory shorebirds can be easily incorporated into current waterfowl management strategies. Minor changes in the timing, depth, and duration of drawdowns or reflooding within a wetland complex can provide habitats for shorebirds without affecting the potential to provide habitat for other avian groups.

This manual presents a series of management strategies to preserve and manipulate habitats for shorebirds within North America. Although this manual focuses on shorebird management, these recommendations should enhance conditions for other wetland-dependent species as well by increasing the productivity and availability of habitats.

Suggested Readings

Baker, M. C., and E. A. M. Baker.1973. Niche relationships among six species of shorebirds on their wintering and breeding grounds. Ecol. Mono. 43:193–212.

Dahl, T. E. 1990. Wetlands losses in the United States 1780's to 1980's. U. S. Fish and Wildl. Serv., Washington, D. C. 21pp.

Fredrickson. L. H., and F. A. Reid. 1986. Wetlands and riparian habitats: a nongame management overview. Pages 59–96 *in* J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the Midwest: a developing art. Proc. Symp. 47th Midwest Fish and Wildl. Conf.

Gerstenberg, R. H. 1979. Habitat utilization by wintering and migrating shorebirds on Humbolt Bay, California. Pages 33–40 *in* F. A. Pitelka, ed. Shorebirds in marine environments. Studies in Avian Biology Monograph Series, no. 2. Allen Press, Lawrence, Kans. 261pp.

Goss-Custard, J. D. 1977. The ecology of the Wash. III. Density related behaviour and the possible effects of a loss of feeding grounds on wading birds *(Charadrii)*. J. Appl. Ecol. 14:721–739.

Hayman, P., J. Marchant, and T. Prater. 1986. Shorebirds: an identification guide to the waders of the world. Houghton Mifflin Co., Boston, Mass. 412pp.

Johnsgard, P. A.1981. The plovers, sandpipers and snipes of the world. University of Nebraska Press, Lincoln. 493pp.

Morrison, R. I. G. 1984. Migration systems of some new world shorebirds. Pages 125–202 *in* J. Burger and B. L. Olla, eds. Shorebirds: migration and foraging behavior. Plenum Press, New York, N. Y.

Myers, J. P., R. I. G. Morrison, P. T. Z. Antas, B. A. Harrington, T. E. Lovejoy, M. Sallaberry, S. E. Senner, and A. Tarak. 1987. Conservation strategy for migratory species. Am. Sci. 75:18–26.

Chapter 2 — Interior Region

NEARLY forty species of shorebirds migrate through the interior region of North America (Figure 2.1) and thirteen species breed in this region (Table 2.1). This chapter concentrates on the management of these species. Since the early times of colonial settlement, over 40 percent of our emergent wetlands and many associated uplands have been lost to development, especially to agriculture. Many of the remaining wetlands, however, have been altered hydrologically to enhance their value to wildlife. We recommend these strategies be adopted as part of an integrated approach to wetland management.

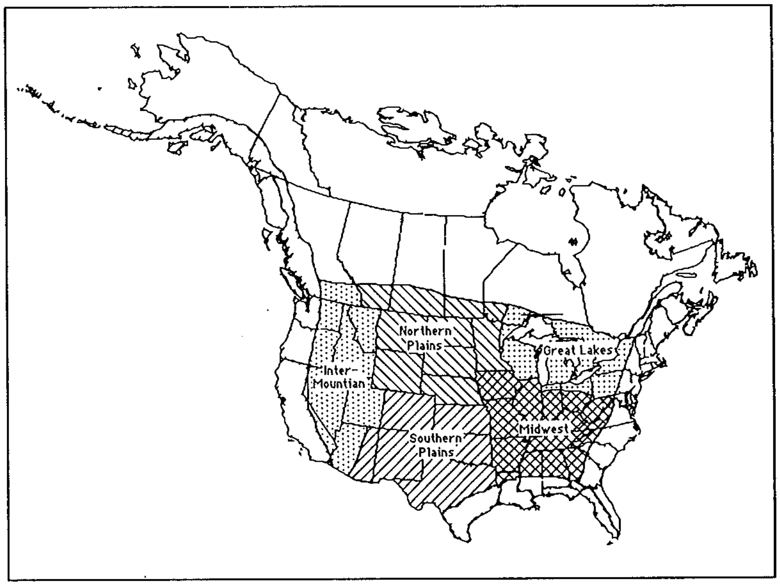
Many wetlands have already been altered to enhance their value to wildlife.

Shorebird Ecology

Migration

The majority of shorebirds occur in the interior regions during migration. However, the timing of their peak migration differs within specific interior areas (Figure 2.2). Shorebird species

Figure 2.1 *Major geographic areas for the interior region of North America.*



Most interior-nesting shorebirds occur in wetland habitats.

of similar size that belong to the same foraging guild and that exploit similar habitats tend to migrate at different times. For example, during their spring migration, three small shorebird species (Baird's, Semipalmated, and White-rumped Sandpipers) exploit similar habitats at Cheyenne Bottoms, Kansas. Even though the range of migration dates between species overlaps considerably, the dates of peak migration for each species show a temporal separation (Figure 2.3). With several shorebird species, the timing of summer/fall (southbound) migration between adults and juveniles differs. For example, the peak migration of small juvenile sandpipers occurs 3–4 weeks after that of the adults. Composition of species in stopover areas can also differ during each migration since some species, such as the White-rumped Sandpiper, migrate through the interior during spring (northbound) and along the Atlantic Coast during summer/fall.

Figure 2.2 Occurrence chronologies of shorebirds for areas in the interior region of North America. Boxes represent peak periods and lines represent the ranges of occurrence.

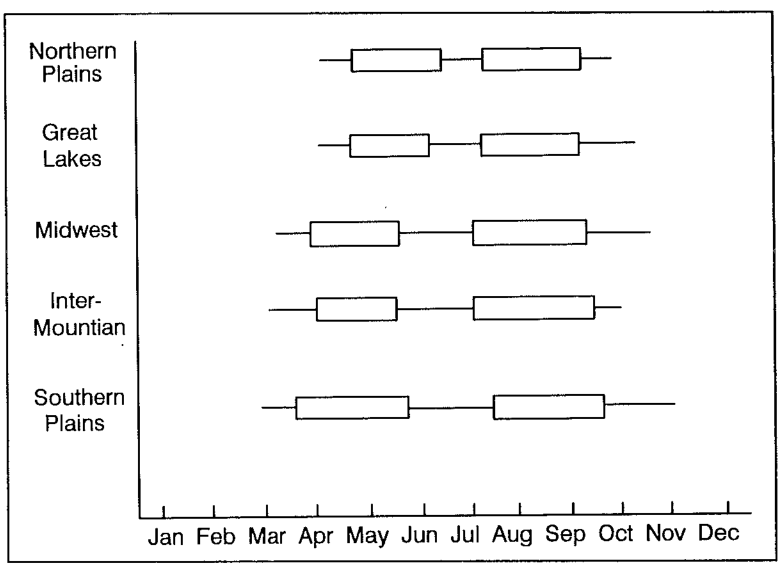


Table 2.1 Shorebird presence in the Interior region of North America

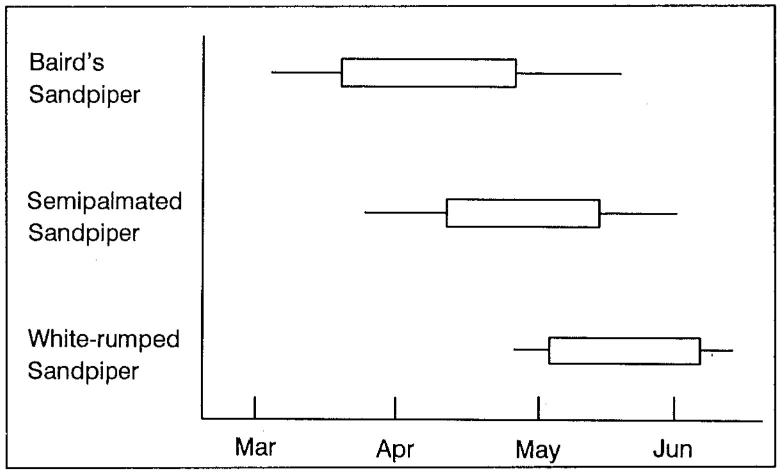
		Area[a]				
Shorebird Group	**Common Name**	**Midwest**	**Great Lakes**	**Southern Plains**	**Northern Plains**	**Inter-Mountain**
Plover	Black-bellied Plover	S[b]	S	N	N	N
	Lesser Golden Plover	N,S	S	N	N	
	Snowy Plover			N,S,B		N,S,B
	Semipalmated Plover	N,S	N,S	N,S	N,S	
	Piping Plover				N,S,B	
	Killdeer	N,S,W,B	N,S,W,B	N,S,W,B	N,S,B	N,S,B
	Mountain Plover			N,S		N,S,B
Curlew	Whimbrel		N			
	Long-billed Curlew				N,S,B	N,S,B
Small Sandpiper	Sanderling		S	S	N,S	
	Semipalmated Sandpiper	N,S	N,S	N,S	N,S	
	Western Sandpiper			S	S	N,S
	Least Sandpiper	N,S	N,S	N,S	N,S	N,S
	White-rumped Sandpiper	N	N	N	N,S	
	Baird's Sandpiper			N,S	N,S	S
Medium Sandpiper	Red Knot				N	
	Pectoral Sandpiper	N,S	N,S	N,S	N,S	S
	Stilt Sandpiper	S	S	N,S	N,S	
	Dunlin	N,S	N,S	N,S	N,S	N
	Short-billed Dowitcher	N,S	N,S	N,S	N,S	N,S
	Long-billed Dowitcher			N,S	N,S	N,S
	Common Snipe	N,S	N,S,B	N,S	N,S,B	
	Buff-breasted Sandpiper	S		N,S	N,S	
	Upland Sandpiper	N,S,B	N,S,B	N,S,B	N,S,B	
Godwit	Hudsonian Godwit			N	N	
	Marbled Godwit			N,S	N,S,B	N,S
Yellowlegs	Greater Yellowlegs	N,S	N,S	N,S	N,S	N,S
	Lesser Yellowlegs	N,S	N,S	N,S	N,S	N,S
	Solitary Sandpiper	N,S	N,S			
	Willet			N,S	N,S,B	N,S
Turnstone	Ruddy Turnstone				N	S
	Spotted Sandpiper	N,S,B	N,S,B	N,S,B	N,S,B	
Avocet/Stilt	Black-necked Stilt			N,S,B		N,S,B
	American Avocet			N,S,B	N,S,B	N,S,B
Phalarope	Wilson's Phalarope			N,S	N,S,B	N,S,B
	Northern Phalarope				N,S	N,S

[a] Map Figure 2.1
[b] N = northward migration, S = southward migration, W = wintering, B = breeding

Breeding

Thirteen species of shorebirds breed in temperate interior regions of North America. The nest sites of these birds range from sand or gravel substrate with no vegetation to midgrass prairie (Table 2.2). Most interior-nesting shorebirds occur in association with wetland habitats. Their successful nesting may be a function of hydrological conditions during the breeding season.

Figure 2.3 Spring migration chronologies for three sandpipers at Cheyenne Bottoms, Kansas. Boxes represent peak periods and lines represent the ranges of occurrence.



Foraging preferences of shorebirds differ.

Habitat Use

Migratory shorebirds within the same foraging guild use habitats of different water depth and vegetation height and density. Water depths for foraging shorebirds range from 0 cm (dry mud) to 18 cm (Figure 2.4). Vegetation density ranges from no cover to more than 75 percent cover. The majority of use, however, occurs at sites with less than 25 percent cover. Shorebirds prefer short vegetation, generally less than half the height of the bird, although some species, such as snipes and yellowlegs, will forage in taller vegetation. A range of wetland habitat conditions — from sparsely vegetated mud flats to moderately vegetated open shallows — provides these shorebirds with required habitats throughout their migratory and breeding periods. In the interior regions, shorebirds also exploit upland habitats associated with wetlands by foraging in shallowly flooded pastures or agricultural fields with short, sparse vegetation maintained by mowing, grazing, or fire.

Figure 2.4 Water depth (cm) and substrate preferences of shorebird foraging guilds.

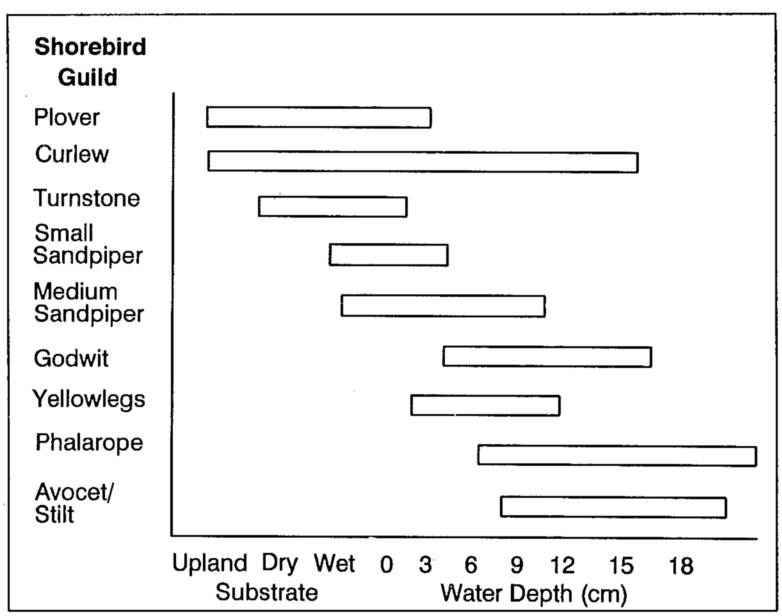


Table 2.2 Nest sites and habitat characteristics of interior nesting shorebirds

Species	Nest Sites	Substrate	Wetland Type	Vegetation Structure Height	Vegetation Structure Density	Nesting Behavior
American Avocet	beach/peninsula	open/exposed soil	alkaline/saline/ freshwater	short	sparse	semicolonial
Willet	upland/prairie	open/vegetated	freshwater/saline	medium	moderate	solitary
Marbled Godwit	upland	open/vegetated	freshwater/saline	medium	moderate	solitary
Black-necked Stilt	beach/peninsula	open/exposed soil	freshwater/saline	short	sparse	semicolonial
Wilson's Phalarope	upland/wet meadow	closed/vegetated	freshwater	medium	moderate	solitary
Spotted Sandpiper	beach	open/sand/rocky	freshwater	none	sparse	solitary
Killdeer	upland/beach	open/exposed soil/rocky	freshwater/saline	none	sparse	solitary
Piping Plover	beach/peninsula	open/salt flats/ gravel	alkaline/saline	none	sparse	semicolonial
Snowy Plover	beach/upland	open/salt flats/ gravel	alkaline/saline	none	sparse	semicolonial
Upland Sandpiper	upland/prairie	closed/vegetated	none	medium/tall	dense	semicolonial
Long-billed Curlew	upland/pasture	open/vegetated	freshwater	short	moderate	solitary
Common Snipe	upland/wet meadow	closed/vegetated	freshwater	medium	dense	solitary
Mountain Plover	pasture/prairie	open/vegetated	none	short	sparse	semicolonial

Invertebrates

Migratory shorebirds consume large numbers of invertebrates. Invertebrate availability in wetlands is a function of the hydrologic regime. In newly flooded habitats, recolonization rates of invertebrates can be variable and unpredictable. To survive the dynamic fluctuations in water levels of wetlands, many invertebrates have adapted to the timing, depth, and duration of flooding. Four major life-history strategies of invertebrates can be identified. The first group, invertebrates that are passively dispersed, cannot leave the wetland basin. They survive drying and freezing conditions with elaborate adaptations: they have drought-resistant eggs, build cocoons, or burrow into the substrate and emerge shortly after flooding occurs. Pond snails and freshwater shrimp are examples of this first group. The second group (e.g., midges and blackflies) needs standing water to lay eggs. This group will emerge and lay eggs in the same wetland or fly to recently flooded wetlands to colonize new habitats. The third group (e.g., mosquitoes and dragonflies) lays eggs on mud flats or moist substrate during drawdowns; the eggs hatch once reflooding occurs. The fourth group (e.g., water boatmen and diving beetles) cannot survive drought conditions and must move to other water bodies when wetlands become dry.

Invertebrate availability in wetlands is a function of flooding.

Many shorebirds feed predominantly on chironomid larvae (blood worms), members of the second invertebrate group described above. Chironomid larvae are benthic invertebrates and may occur in open shallow habitats with a silt substrate relatively free of vegetation. They feed by collecting algae in the water column or by grazing on periphyton, or algae, that thrive on living or decaying plants. Adult chironomids (midges) lay eggs in water and many species produce several generations per year under optimal conditions. Thus, the presence of water is an essential ingredient for the completion of their life cycle.

Detritus, or organic litter, within wetlands plays a major role in providing invertebrates their food base — plankton, algae, bacteria, or fungi. When detritus is flooded, it releases nutrients for plankton, algae, bacteria, and fungi in the water column. Flooded detritus also provides a substrate on which these microorganisms grow.

Wetland Management

Use of wetlands among different shorebirds and other waterbirds (i.e., waterfowl, herons, and rails) overlaps considerably both temporally and spatially. Wetland managers should consider times of peak abundance of shorebirds and should allow for continuous availability of the appropriate food resources and habitats throughout spring and summer/fall migratory periods. Maintaining a diversity of habitats throughout the annual cycle will provide food resources for many wetland-associated organisms. The distribution and structure of major vegetational zones are critical to the availability of habitats for waterbird guilds. Vegetation types within wetlands are a function of climate, hydrology, soil, water chemistry, management, and time since disturbance of vegetation. Wetland complexes allow managers the opportunity to develop strategies that will continuously create new habitats for many different shorebird guilds.

Management plans should focus on developing a continuous food base.

Managing for Shorebirds

To provide quality habitat for migratory shorebirds, managers must identify what foods exist at the sites they manage, what foods are needed by likely shorebird species, and when migratory flocks will appear. Although shorebird habitat may seem extensive, food may not be readily available to shorebirds in the wetland. Management plans for migratory shorebirds should focus on developing a food base that will be continuously available over time.

Migration

Spring — Units suitable for spring shorebird management require fall flooding approximately 1 month before the first heavy freeze and the continued maintenance of flooded conditions to enable chironomids and other invertebrates to lay eggs and to assure survival of larvae over winter. During the spring migratory period, units should have extensive areas of open water or areas only partially covered with emergent vegetation (less than 50 percent). Units should be drawn down slowly (2–3 cm per week) to make invertebrates continuously available to shorebirds foraging in open, shallow water and mud flats. If more than one unit is being drawn down for shorebirds, manipulations should be staggered to extend the availability of habitat.

To indicate the potential for providing resources through time, a hypothetical wetland has been divided into five elevational zones based on flooding gradient. In this example, water depths in Zone 1 were 45 cm on April 1 and 25 cm on May 1 following a gradual drawdown. As water depths in the pool changed, the foraging areas shifted to new elevational zones and untapped food resources became available (Figure 2.5). The size of each foraging area varied greatly with elevation and water depth.

As water depths change, food resources become available.

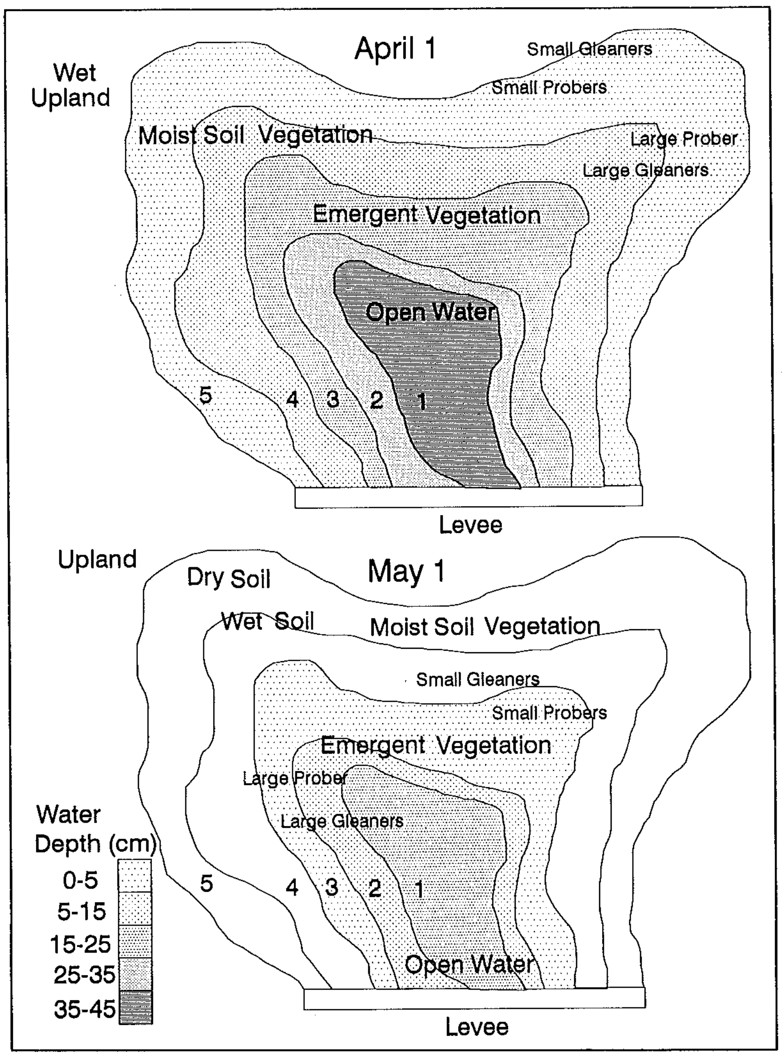


Figure 2.5 *Water depths, habitat types, and shorebird guild use within five elevational zones for one managed wetland unit. April 1 indicates initial flooding depths within zones (45-cm gauge depth) and May 1 indicates flooding depths after gradual drawdown (25-cm gauge depth). Water depths are measured at lowest elevation of pools.*

Summer/Fall— Units suitable for summer/fall shorebird management require two different strategies. First, to make invertebrates available, units that remained flooded through spring and early summer should be drawn down slowly or natural evaporation should be allowed to occur.

Second, units that remained dry should be shallowly flooded 2–3 weeks before summer/fall migration begins. This will allow time for invertebrates to repopulate the newly created habitat. Also, the vegetation often needs to be manipulated by disking to assure shorebird response. The type of disking is critical. Disking converts plant biomass to a detrital base attractive to invertebrates. Shallow disking, which only partially buries plant biomass, is more desirable than deep disking which completely buries it. In other words, shallow disking acts as human-induced senescence and provides excellent substrates for invertebrates, whereas deep disking reduces the invertebrate food base.

Breeding

The size of upland habitats and their proximity to wetlands are key.

Although many shorebirds breed in natural wetland areas (e.g., the prairie pothole region), other wetlands and the adjacent uplands can be altered for nesting shorebirds to mimic natural cycles. Managing upland habitats in association with wetlands is an important consideration for the breeding shorebird community.

In the temperate interior regions, breeding shorebirds nest between mid-March and late July. Manipulations such as burning, mowing, or intensive grazing of vegetation can be used. Since these manipulations have the potential for destroying nests, however, they should not be conducted during the breeding season.

Several species of nesting shorebirds use beaches, sparsely or unvegetated islands, or dry mud or salt flats. Mechanical treatments or grazing should not be used on beaches or salt flats because tracks or hooves leave depressions that may cause vegetation encroachment later. In certain cases, islands can be created and covered with fine gravel to discourage vegetation growth.

The size of upland, or grassland, habitats and their proximity to wetlands are two important issues for interior-nesting shorebirds. Willets in North Dakota, for example, have a home range of 44 hectares (109 acres) and Marbled Godwits, a range of 90 hectares (222 acres). Species such as Marbled Godwits and Willets require a mosaic of wetland types from ephemeral to semipermanent, interspersed with short-to-moderate-height grasslands for nesting and brood rearing.

Fragmentation and loss of adjacent uplands have provided predators with travel corridors where predation of ground-nesting birds can be high. Therefore, preserving nesting uplands is important in reducing nest loss. The use of predator barriers, such as electric fences, has also been successful in increasing shorebird recruitment, such as the endangered Piping Plover, in North Dakota.

Integrating Strategies

Managing a wetland complex to create different habitat types by drawdowns and flooding increases the diversity of foods available to migrating and resident waterbirds. When this food diversity occurs within a wetland, several waterbird guilds will use the pool simultaneously.

The most effective management plans consider potential species present, geographic location, and water availability. The recommendations given here must be finely tuned for each interior site. Since each management area has specific limitations and a unique potential, each site must be considered on a unit-by-unit basis.

Shorebird habitat is closely associated with the needs of pintails, teal, and geese. Increasing the availability of invertebrates in marshes and seasonally flooded impoundments is essential. Moving water between units during drawdowns and flooding ensures an "invertebrate soup" that increases the rate of invertebrate colonization. To allow for the rapid recolonization of chironomids, for example, management plans should provide newly flooded habitats close to originating colonies, that is, to "seed sources."

When food diversity occurs, waterbird guilds will feed simultaneously.

Problematic factors such as undesirable vegetation (e.g., cattails), poor water quality (e.g., increased salinity), or avian disease (e.g., botulism) must be addressed aggressively to protect and enhance wetland production for wildlife. Disturbance of vegetation through use of fire, prolonged drawdown, or mechanical treatments may be needed to control undesirable vegetation.

Drawdown management of wetlands for shorebirds may have associated conflicts or problems. Timing of drawdowns may increase undesirable vegetation such as purple loosestrife or cocklebur. Caution should be taken conducting early drawdowns, for example, in wetlands susceptible to invasion by purple loosestrife. Late drawdowns may allow soils to dry too quickly, which can promote cocklebur, and preferred plants may not become established. Drawdown rate should be slow, especially during periods of high temperatures, to maintain soil moisture if salinity is not a problem.

Wetlands in arid regions can have several problems associated with drawdowns. Availability of water for flooding after drawdowns is a concern in many areas. If so, partial drawdowns can be effective in providing foraging opportunities. Also, some conditions can cause high soil salinities within wetlands. During drawdowns with periods of high temperatures, salts may concentrate in the lowest areas and thus may alter the vegetative community. Wetlands with these conditions should be managed to enable continuous and complete draining and/or periodic flushing with fresh water in order to remove salts when it becomes necessary.

Many interior wetlands have traditionally been susceptible to outbreaks of avian botulism, which generally occurs between July and September. Conditions that contribute to avian botulism outbreaks are fluctuating water levels during periods of high temperatures, an abundance of flies, and animal carcasses. Therefore, providing shallow water for shorebirds during late summer and fall may provide conditions promoting avian botulism. Units planned for shallow flooding during this period should have the potential to be drained completely if outbreaks occur. Although other diseases such as avian cholera do not affect large numbers of shorebirds, shallowly flooded wetlands can concentrate bacteria and affect other waterbirds such as waterfowl. If outbreaks occur, draining or flooding a unit deeply should help reduce the spread of the disease.

Several independently controlled units can provide resources continuously within a complex.

Water level management to provide foraging opportunities for waterbirds should also consider local nesting species. Increasing water levels or dewatering units during the nesting season can be deleterious by flooding nests or removing foraging habitats later needed by broods. Therefore, it is important to know the potential species breeding in the area and their seasonal requirements.

Managed Wetlands

Managed wetlands with water control structures are regularly used to grow natural and row-crop foods for waterfowl. The timing, depth, and duration of drawdowns and flooding are important in creating habitats for all waterbirds. Water sources and movement capabilities for drawing down and flooding impoundments are important when considering management strategies.

For demonstration purposes, a drawdown and flooding schedule was developed to manage a wetland over a two-year period (Figure 2.6). Table 2.3 demonstrates how new resources in a single pool become continuously available for different waterbirds during two annual cycles.

Management areas with several independently controlled units can provide resources continuously within a complex. A staggered, or differential, drawdown and flooding regime will produce a diversity of vegetation types and water depths needed by different waterbirds. A hypothetical drawdown and flooding schedule for five pools over two years was developed to show how (Figure 2.7). Table 2.4 demonstrates how

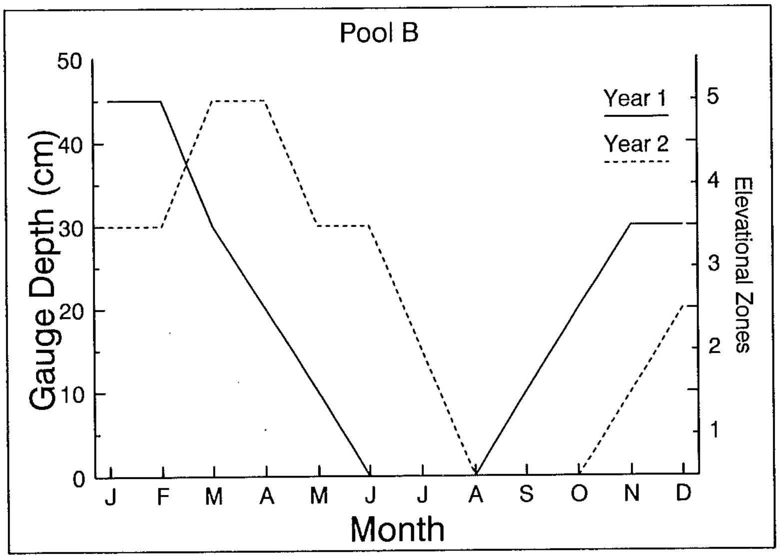


Figure 2.6 Hypothetical drawdown and flooding schedule for a pool over a two-year period. Water depths are measured at lowest elevation of pools. (Potential waterbird response to manipulations appears in Table 2.3.)

drawdown and flooding manipulations such as these within a complex of units can benefit all shorebird guilds during their annual cycle.

Natural Wetlands

Ephemeral to permanent wetlands also provide foraging sites for migrating and breeding shorebirds and other waterbirds. Basins with short sparse vegetation that are shallowly flooded during early spring from precipitation or snow melt can provide wet-meadow foraging zones. Drawdowns from natural evaporation of flooded areas during summer/fall also create shallow basins for southbound migrants. During periods of natural drawdown in winter or early spring, dense emergent vegetation can be reduced by burning or mowing edges. During winter, mowing of vegetation over ice can reduce dense emergent vegetation and

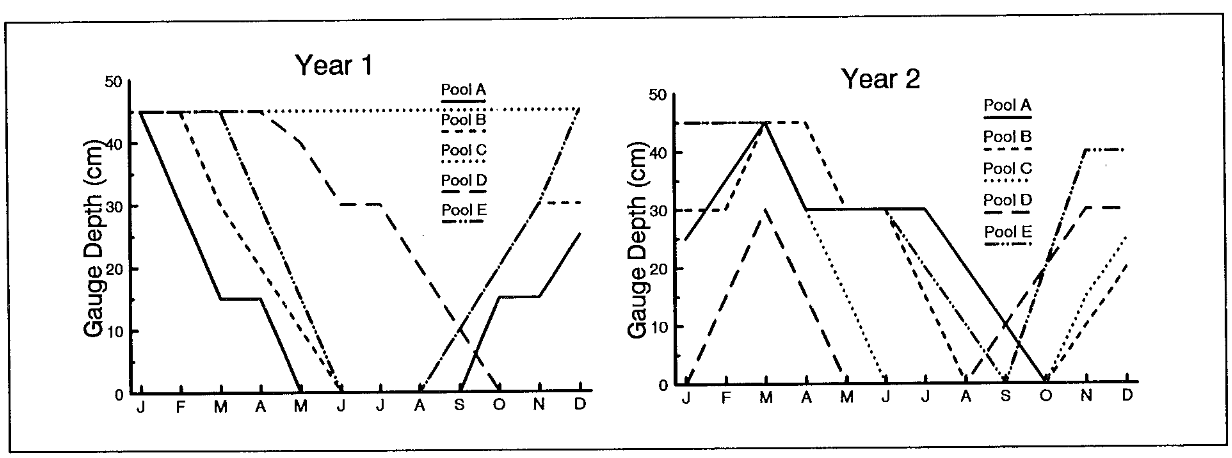


Figure 2.7 Hypothetical drawdown and flooding schedule for five pools over a two-year period. Water depths are measured at lowest elevation of pools. (Potential shorebird response to manipulations appears in Table 2.4.)

Table 2.3 Variations within elevational zones in water depth, waterbird use, vegetation, and invertebrate availability in one pool that is drawdown and flooded during two annual cycles

YEAR 1	**Jan–Feb**	**Mar–Apr**	**May–Jun**	**Jul–Aug**	**Sep–Oct**	**Nov–Dec**
Zone 1						
Depth[a]	35–45	20–30	0	0	10–20	20–30
Guilds[b]	dive	dive/dabb/her	spb/sgl		lpb/lgl/dabb	dive/dabb
Vegetation[c]	per/seed/tub	per/seed/tub	per/ms	per/ms	seed/tub	seed/tub
Invertebrates[d]	medium	medium	medium	terr	medium	high
Zone 2						
Depth	25–35	10–20	0	0	0–10	10–20
Guilds	dive	dabb/lpb/lgl	sgl	shore/dabb	dabb/gees/cran	
Vegetation	per/seed/tub	per/seed/tub	per/ms	per/ms	seed/tub	seed/tub/brow
Invertebrates	high	high	low	terr	low	medium
Zone 3						
Depth	15–25	0–10	0	0	0	0–10
Guilds	dabb	dabb/shore			sgl	dabb/gees/cran
Vegetation	ms/per/seed/tub	ms/per/seed/tub	ms	ms	ms/seed/tub	ms/seed/tub/brow
Invertebrates	high	high	terr	terr	low	low
Zone 4						
Depth	5–15	0	0	0	0	0
Guilds	dabb/gees/cran	sgl/spb				gees/cran
Vegetation	ms/seed/tub	ms/seed/tub	ms	ms	ms/seed/tub	ms/seed/tub/brow
Invertebrates	high	low	terr	terr	terr	
Zone 5						
Depth	0–5	0	0	0	0	0
Guilds	dabb/gees/cran	sgl				gees/cran
Vegetation	ms/seed/tub/brow	ms	ms	ms	ms/seed	ms/seed/tub/brow
Invertebrates	medium	low	terr	terr	terr	
YEAR 2	**Jan–Feb**	**Mar–Apr**	**May–Jun**	**Jul–Aug**	**Sep–Oct**	**Nov–Dec**
Zone 1						
Depth	20–30	35–45	20–30	0	0	10–20
Guilds	dive	dive	her/bro	spb/sgl	sgl/spb/dabb	dive/dabb
Vegetation	per/seed/tub	per/seed/tub	per	per/ms	seed/tub	seed/tub
Invertebrates	high	medium	medium	medium	low	medium
Zone 2						
Depth	10–20	25–35	10–20	0	0	0–10
Guilds	dabb/dive	dive	her/bro/lpb/lgl	sgl		dabb/gees/cran
Vegetation	per/seed/tub	per/seed/tub	per	per/ms	seed/tub/brow	seed/tub/brow
Invertebrates	high	high	high	low	terr	low
Zone 3						
Depth	0–10	15–25	0–10	0	0	0
Guilds	dabb/gees/cran	dabb/dive	shore			gees/cran
Vegetation	seed/tub/brow	ms/seed/tub	ms/per	ms/per	seed/tub/brow	seed/tub/brow
Invertebrates	high	high	high	terr	terr	
Zone 4						
Depth	0	5–10	0	0	0	0
Guilds	gees/cran	lgl/lpb/dabb	spb/sgl	gees/cran		
Vegetation	ms/seed/tub/brow	ms/seed/tub/brow	ms	ms	ms/seed/tub/brow	ms/seed/tub/brow
Invertebrates		medium	low	terr	terr	
Zone 5						
Depth	0	0–5	0	0	0	0
Guilds	gees/cran	sgl/spb/dabb				gees/cran
Vegetation	ms/seed/tub/brow	ms/seed/tub/brow	ms	ms	ms/seed/tub/brow	ms/seed/tub/brow
Invertebrates		low	terr	terr	terr	

[a] All water depths given are in cm

[b] Waterbird foraging guilds: dive = diving ducks, dabb = dabbling ducks, broo = duck broods, gees = geese, cran = cranes, her = herons, shore = all shorebirds, lpb = large prober shorebird, lgl = large gleaner shorebird, spb = small prober shorebird, sgl = small gleaner shorebird

[c] Vegetation types and foods available: per = emergent perennial, ms = moist soil (annuals), seed = seeds, tub = tubers, brow = browse

[d] Invertebrate availability based qualitatively on water depth (cm) and flooding duration. Aquatic invertebrates = high, medium, and low; terr = terrestrial invertebrates

Table 2.4 Potential scenario of drawdown and flooding manipulations and shorebird use during migration for a complex of five pools during two annual cycles

	Spring		Fall	
YEAR 1	**Manipulation**	**Shorebird Use**	**Manipulation**	**Shorebird Use**
Pool A	early drawdown	moderate	late reflooding	low
Pool B	late drawdown	high	early flooding	moderate
Pool C	maintained flooding	low	maintained flooding	low
Pool D	partial late drawdown	moderate	early drawdown	high
Pool E	late drawdown	high	early flooding	moderate
YEAR 2				
Pool A	partial early drawdown	moderate	early drawdown	high
Pool B	partial late drawdown	moderate	early drawdown	high
Pool C	late drawdown	high	late flooding	low
Pool D	early drawdown	moderate	early flooding	low
Pool E	partial early drawdown	moderate	early drawdown	high

This hypothetical scenario was established for a typical area in the central Great Plains. Manipulations must be adjusted for migration chronologies of different geographic regions. Manipulation timing: Spring early = February–April, Spring late = May–June, Fall early = July–August, Fall late = September–October. For detailed information on use by waterfowl and other waterbird guilds for Pool B see Table 2.3.

litter will provide a substrate for invertebrates the following spring.

Although many areas have little potential for managing habitats, unaltered natural wetland and upland habitats should have high priority for protection. Natural wetlands are dynamic and provide resources for a range of species during their hydrologic cycle. Although a single wetland cannot provide resources for all species during a single year, a complex of natural wetlands, each in a different phase of its hydrologic cycle, may provide a diversity of habitats for all waterbird species within a localized area.

Case Histories

Ted Shanks Wildlife Management Area

For several years, management personnel at Ted Shanks Wildlife Management Area (WMA) in northeastern Missouri have been managing for migrating shorebirds. Ted Shanks is a 2687-hectare (6636-acre) wetland complex with nineteen units managed for agriculture, moist soil, semipermanent marsh, and green-tree reservoirs.

At Ted Shanks, managers have been managing for shorebirds for several years.

The manager uses a series of differential drawdowns and flooding to attract shorebirds and to increase the complexity of vegetation for waterfowl and other waterbirds. During early spring (mid-March–mid-April), units to be planted with corn are drawn down slowly to concentrate and/or increase the availability of invertebrates for ducks and early migrating shorebirds. Between mid-April and mid-May, units scheduled for soybean planting are drawn down for late migrating ducks and shorebirds. Units scheduled for moist-soil management are drawn down between mid-May through early July for shorebirds, herons, and rails. Semipermanent marshes are partially drawn down or allowed to evaporate naturally between mid-July and October for summer/fall shorebirds, herons, and rails. Fall flooding of selected moist-soil units begins during mid-August for some shorebirds and rails. Units that have undesirable vegetation are shallowly disked in summer and shallowly flooded between August and September for shorebirds.

Seasonal drawdowns and flooding of impoundments create ideal foraging habitats for shorebirds and increase vegetation diversity for waterbirds. Strategies such as these developed at Ted Shanks WMA can be successfully adapted for other locations as well.

Lostwood National Wildlife Refuge

In the early 1920s, the area known today as Lostwood National Wildlife Refuge (U. S. Fish and Wildlife Service) in northeastern North Dakota had high numbers of Northern Pintail, Mallard, Northern Shoveler, and Blue-winged Teal. Also abundant were Baird's Sparrow, Sprague's Pipit, Chestnut-collared Longspur, and a grassland raptor community consisting of Swainson's Hawk, Ferruginous Hawk, and Northern Harrier. An added bonus in this grassland community was nesting shorebirds — Marbled Godwit, Upland Sandpiper, Willet, Wilson's Phalarope, Spotted Sandpiper, Piping Plover, and American Avocet.

Managers are restoring prairie communities.

From the 1935 purchase date to the early 1970s, Lostwood personnel managed the property with either a year of light grazing from spring through fall or with no grazing. About 20 years ago, management personnel discovered that species diversity and abundance were declining in the 109-km^2 refuge. They also recognized that if high diversity and abundance of grassland species could occur 100 years ago, "historical management" might restore these habitats and its former wildlife.

Lostwood's northern mixed-grass prairies with diverse wetlands had evolved with lightning-induced fire and bison-grazing patterns. These patterns created conditions conducive to dynamic flora communities that in turn created conditions conducive to diverse fauna communities. Current management is using historical management as much as possible to restore these communities. Lostwood personnel began by burning the woody-dominated prairie every 2–3 years (for a total of 3–4 times) to return it to grass, remove excess litter in wetlands, and stimulate nutrient cycles. Next came the phases when planned grazing, prescribed burning, and intermittent rest periods (years between grazing and burning) were used to continue renovation and will be used ultimately to maintain the grassland diversity.

Marbled Godwit, Upland Sandpiper, and Willet, all upland-nesting shorebirds, are responding positively to properly timed burning. Piping Plovers and American Avocets are also responding well as personnel remove shoreline vegetation by burning and as they create a peripheral view the birds seem to prefer. Other grassland species, such as Baird's Sparrow and Sprague's Pipit, have increased significantly. Waterfowl response has yet to be measured. The drought during the 1980s has adversely affected waterfowl numbers throughout the northern mixed-grass prairie.

Refuge areas that are grazed for short periods, burned, and rested — a mosaic pattern that once occurred naturally at Lostwood — will ultimately provide habitat diversity for species diversity. This includes unique nesting shorebirds such as Marbled Godwit, Upland Sandpiper, and Willet.

To maximize habitats for migrant shorebirds, develop a food base.

Conclusion

In summary, management recommendations to maximize habitats for migrating shorebirds are based on developing and allowing for the continuous availability of a food base within a wetland complex. Incorporating management strategies for shorebirds into those for waterfowl and other waterbirds can be easily achieved. Effective management requires knowledge about migration and breeding chronologies, habitat use, food requirements, and foraging modes for different waterbird guilds within a specific region.

Suggested Readings

Baldassarre, G. A., and D. H. Fisher. 1984. Food habits of fall migrant shorebirds on the Texas high plains. J. Field Ornithol. 55:220–229.

Bradstreet, M. S. W., G. W. Page, and W. G. Johnson. 1977. Shorebirds at Long Point, Lake Erie, 1966–1971: seasonal occurrence, habitat, preference, and variation in abundance. Can. Field-Nat. 91:225–236.

Colwell, M. A., S. D. Fellows, and L. W. Oring. 1988. Chronology of shorebird migration at Last Mountain Lake National Wildlife Area, Saskatchewan, Canada. Wader Study Group Bull. 52:18–22.

Colwell, M. A., and L. W. Oring. 1988. Habitat use by breeding and migrating shorebirds in southcentral Saskatchewan. Wilson Bull. 100(4):554–566.

Dahl, T. E. 1990. Wetland losses in the United States 1780's to 1980's. U.S. Fish and Wildl. Serv., Washington, D.C. 21pp.

Eldridge, J. L. 1990. Management for migrating shorebirds on national wildlife refuges in the midwest. Bell Museum of Natural History, Univ. of Minnesota, Minneapolis. 17pp.

Euliss, N. H., Jr., and G. Grodhaus. 1987. Management of midges and other invertebrates for waterfowl wintering in California. Calif. Fish and Game. 73(4):238–243.

Fredrickson, L. H., and T. S. Taylor. 1982. Management of seasonally flooded

impoundments for wildlife. U.S. Fish and Wildl. Serv. Resour. Publ. 148. 29pp.
Fredrickson, L. H. 1991. Strategies for water manipulations in moist-soil systems. U.S. Fish and Wildl. Serv. Leafl. 13.2.1. 8pp.
Fredrickson, L. H., and F. A. Reid. 1988. Invertebrate response to wetland management. U.S. Fish and Wildl. Serv. Leafl. 13.3.1. 6pp.
Hands, H. M., M. R. Ryan, and J. W. Smith. 1991.Migrant shorebird use of marsh, moist-soil, and flooded agricultural habitats. Wildl. Soc. Bull. 19:457–464.
Helmers, D. L. 1991. Habitat use by migrant shorebirds and invertebrate availability in a managed wetland complex. M. S. Thesis, Univ. of Missouri-Columbia. 135pp.
Locke, L. N. and M. Friend. 1989. Avian botulism: geographic expansion of a historic disease. U.S. Fish and Wildl. Serv. Leafl. 13.2.4. 6pp.
Mayer, P. M., and M. R. Ryan. 1991. Electric fences reduce mammalian predation on Piping Plover nests and chicks. Wildl. Soc. Bull. 19:59–63.
Moore, J. W. 1980. Factors influencing the composition, structure and density of a population of benthic invertebrates. Arch. Hydrobiol. 88:202–218.
Morrison, R. I. G. 1984. Migration systems of some new world shorebirds. Pages 125–202 *in* J. Burger and B. L. Olla, eds. Shorebirds: migration and foraging behavior. Plenum Press, New York, N. Y.
Prindiville Gains, E., and M. R. Ryan. 1988. Piping Plover habitat use and reproductive success in North Dakota. J. Wildl. Manage. 52:266–273.
Reid, F. A. 1985. Wetland invertebrates in relation to hydrology and water chemistry. Pages 72–79 *in* M. D. Knighton, ed. Water impoundments for wildlife: a habitat management workshop. U.S. For. Serv., St. Paul, Minn. 136pp.
Rundle, W. D., and L. H. Fredrickson. 1981. Managing seasonally flooded impoundments for migrant rails and shorebirds. Wild. Soc. Bull. 9:80–87.
Ryan, M. R., and R. B. Renken. 1987. Habitat use by breeding Willets in the northern Great Plains. Wilson Bull. 99(2):175–189.
Ryan, M. R., R. B. Renken, and J. J. Dinsmore. 1984. Marbled Godwit habitat selection in the northern prairie region. J. Wildl. Manage. 48(4):1206–1218.
Thompson, D. Q. 1989. Control of Purple Loosestrife. U.S. Fish and Wildl. Serv. Leafl. 13.4.11. 6pp.

Chapter 3 — Atlantic Region

THIS chapter concentrates on management techniques for shorebirds along the Atlantic Coast of North America (Figure 3.1). Its purpose is to provide appropriate management techniques to enhance habitats and to reduce disturbance for breeding, migrating, and wintering shorebirds.

Forty species of shorebirds occur in this region during their annual cycle, in both marine and freshwater habitats (Table 3.1). These wetland habitats can be placed in two broad categories: inland wetlands (e.g., freshwater lagoons, ponds, and impoundments) and coastal wetlands (e.g., salt marshes and beaches) influenced by tidal effects of brackish or saline water (Figure 3.2).

Loss and degradation of these habitats is a serious threat to the survival of most shorebird species. Over 50 percent of the coastal wetlands in the United States has been lost since the early 1900s, with some of the heaviest losses occurring along

Loss of wetlands is a serious threat.

Table 3.1 Shorebird presence in the Atlantic region of North America

Shorebird Group	Common Name	Area: North Atlantic	Mid-Atlantic	South Atlantic
Plover	Black-bellied Plover	N,S	N,S,W	N,S
	Lesser Golden Plover	S	S	N,S
	Snowy Plover			N,S,W,B
	Wilson's Plover		B	N,S,B
	Semipalmated Plover	S	N,S	N,S
	Piping Plover	N,S,B	N,S,B	N,S
	Killdeer	N,S,B	N,S,W,B	N,S,W,B
Curlew	Whimbrel	S	N,S	
	Long-billed Curlew		S	
Small Sandpiper	Sanderling	N,S	N,S,W	N,S,W
	Semipalmated Sandpiper	N,S	N,S	N
	Western Sandpiper		S,W	S,W
	Least Sandpiper	N,S	N,S	N,S
	White-rumped Sandpiper	S	N	N
	Baird's Sandpiper			
Medium Sandpiper	Red Knot	S	N,S	N,S
	Pectoral Sandpiper	N,S	N,S	N,S
	Stilt Sandpiper		N,S	
	Dunlin	N,S	N,S,W	N,S,W
	Short-billed Dowitcher	N,S	N,S,W	N,S,W
	Long-billed Dowitcher		N,S,W	
	Common Snipe	N,B	W	
	Buff-breasted Sandpiper		S	
	Upland Sandpiper	B		
Godwit	Hudsonian Godwit	S	S	
	Marbled Godwit		W	W
Yellowlegs	Greater Yellowlegs	N,S	N,S,W	N,S,W
	Lesser Yellowlegs	S	N,S,W	N,S,W
	Solitary Sandpiper		N	
	Willet	B	N,S,W,B	N,S,W,B
Turnstone	Ruddy Turnstone	N,S	N,S	N,S
	Spotted Sandpiper	B	N,S,B	
	Purple Sandpiper	W	W	
Avocet/Stilt	Black-necked Stilt		B	N,S,B
	American Avocet		N,S,W	N,S,W
Phalarope	Wilson's Phalarope			
	Northern Phalarope	S		
	Red Phalarope	S		
Oystercatcher	American Oystercatcher	N,S,B	N,S,W,B	N,S,W,B

N = northward migration, S = southward migration, W = wintering, B = breeding.
North Atlantic = Nova Scotia and New Brunswick (Canada) and Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut (U.S.). Mid-Atlantic = New York, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina.
South Atlantic = Georgia, Florida.

the Atlantic Coast in New Jersey, North Carolina, and Florida. Ditching, which was done in mosquito-control programs before 1938, affected nearly 90 percent of all salt marshes between Maine and Virginia. Increased urban and industrial development

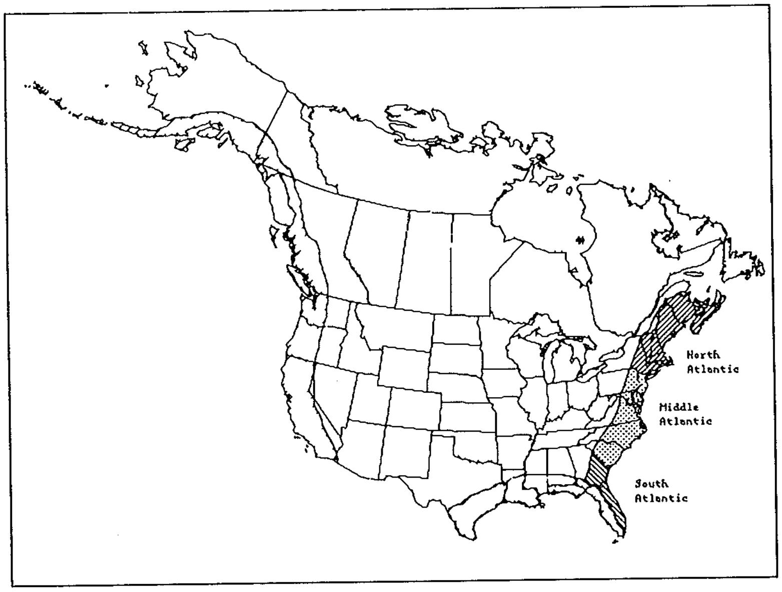


Figure 3.1 Major geographic areas for the Atlantic region of North America.

and recreational use in coastal areas have seriously affected the few wetlands that remain. The cumulative loss and degradation of habitat have had a tremendous impact on shorebird populations in the Atlantic region.

Shorebird Ecology

Migration

Although the great majority of shorebirds occur in the Atlantic coastal regions during migration, significant numbers remain here during breeding and wintering periods, especially south of New Jersey during the later period. Both timing of peak migration and species composition differ along a latitudinal gradient (Figure 3.3). The total number of shorebirds present also varies along a latitudinal gradient, depending on the time of year. For example, southern latitudes have a higher concentration of spring migrants and wintering birds, while northern latitudes

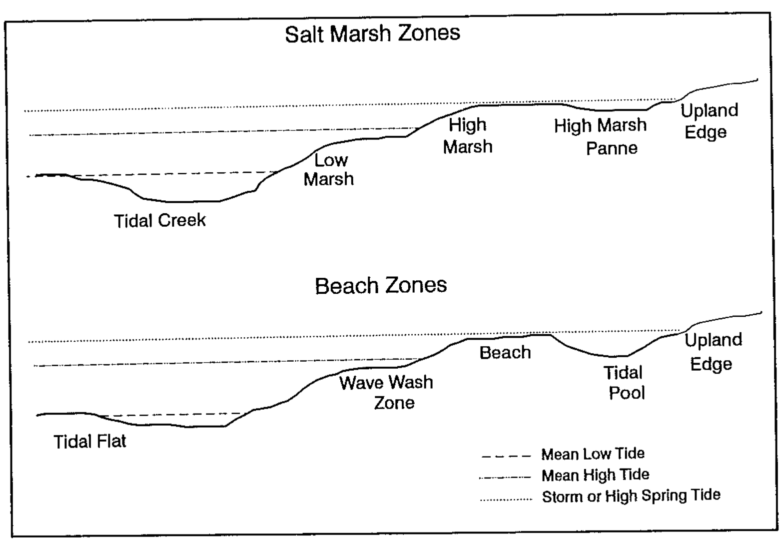
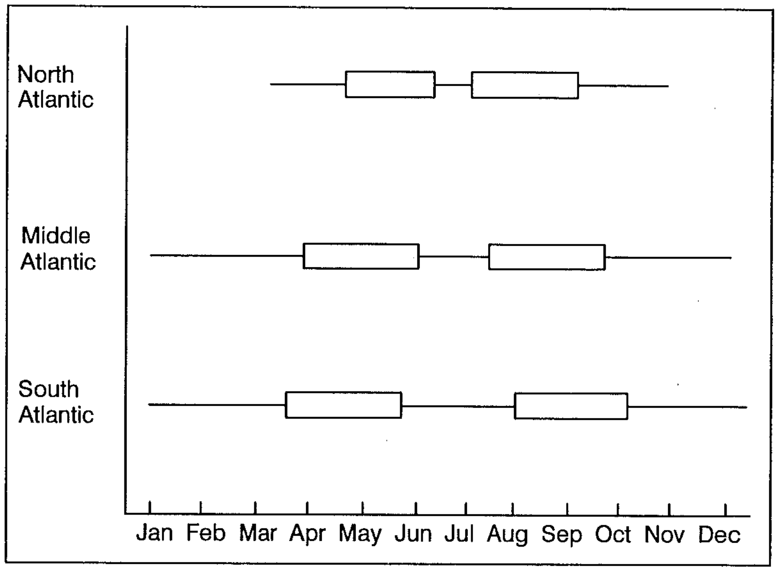


Figure 3.2 Habitat types and tidal zones of a generalized coastal beach and saltmarsh.

Figure 3.3 Occurrence chronologies of shorebirds for areas in the Atlantic region of North America. Boxes represent peak periods and lines represent the ranges of occurrence.



have a higher concentration of summer/fall migrants. Similarly sized shorebirds that share habitat and foraging preferences migrate at different times during both spring and summer/fall, although some migrations overlap. In addition, for many species, the adults and juveniles exhibit "differential migration," that is, they migrate at different times during the year.

Breeding

Endangered Piping Plovers nest along the Atlantic Coast.

Most shorebird species nesting in the Atlantic region use coastal wetland habitats. The composition of species within the geographic region varies with latitude (Table 3.1). Ten species of shorebirds, including the endangered Piping Plover, nest along the Atlantic Coast of the United States and southern Canada. Nest site selection of these species ranges from unvegetated sand or gravel substrate to vegetated high salt marsh (Table 3.2). The juxtaposition and diversity of habitats associated with salt-marsh wetlands are important for foraging and brood rearing for several nesting shorebirds. Willets, for example, require a mosaic of habitat types, including tidal creeks and open beaches for foraging, dense sedges (*Spartina* spp.) for nesting, and high marsh pannes for brood rearing.

Habitat Use

Habitat use along coastal and inland areas differs both within and between guilds and occurs in relation to water depth, substrate characteristics, and vegetation structure and distribution. Habitats used by migrating and wintering shorebirds range from muddy intertidal flats to sandy beaches. Throughout migratory periods, several species of shorebirds require a range of habitat conditions, from unvegetated mud flats to moderately vegetated open shallows. When a range of habitats is available,

Table 3.2 Nest sites and habitat characteristics of coastal nesting shorebirds

Species	Nest Sites	Substrate	Vegetation Structure Height	Vegetation Structure Density	Nesting Behavior
Willet	upland/saltmarsh	open/vegetated	medium	short	solitary
American Oystercatcher	beach/saltmarsh	open/sand/exposed soil	none	sparse	semicolonial
Black-necked Stilt	island/open flats/ salt marsh	open/exposed soil	short	sparse	semicolonial
Spotted Sandpiper	beach/upland	open/sand/rocky	none	sparse	solitary
Killdeer	upland/beach	open/exposed soil/rocky	short	sparse	solitary
Piping Plover	beach/barrier island	open/sand	none	sparse	semicolonial
Snowy Plover	beach/upland	open/sand/exposed soil	none	sparse	semicolonial
Wilson's Plover	beach/salt marsh	open/sand/exposed flats	short	sparse	solitary
Upland Sandpiper	upland/prairie	closed/vegetated	tall	dense	solitary
Common Snipe	upland/wet meadow	closed/vegetated	medium	dense	solitary

some shorebirds will be distributed across environmental gradients and make exclusive use of a specific macrohabitat. Two examples are the Purple Sandpiper in rocky intertidal areas and the Sanderling on sandy beaches.

Shorebirds will forage on beach habitats along the "wave wash" zone. Larger species, such as the Willet, feed in relatively deep water and smaller plovers feed on dry ground. The ecology of shorebirds foraging coastally on tidal flats and salt marshes (relative to water depth and vegetation structure) is similar to the ecology of shorebirds foraging in interior areas (which was discussed in Chapter 2).

Shorebirds also exploit upland habitats associated with coastal wetlands. Habitats with shallow flooding or terrestrial habitats with short, sparse vegetation (e.g., high salt marshes) provide alternative feeding habitats for several species when traditional habitats are lost or unavailable because of high tide or disturbance.

Shorebirds along coastal habitats shift between foraging and roosting sites according to the tide. Roosting shorebirds gather in flocks ranging from a few birds to several thousand. These flocks, either single- or multiple-species aggregations, usually occur above mean-high-tide areas. Shorebirds utilize roosting periods during the day or night for rest and maintenance. Flocks may also roost to avoid predators.

Shorebirds frequently roost on the tips of barrier islands, sandy beaches, salt marshes, or managed wetlands, often at night or during high tide when feeding areas are unavailable. Few specifics about roost site selection are known. Shorebirds probably select open sites with little or no vegetation where predators are visible and escape is possible.

Shorebirds along coastal habitats shift between foraging and roosting sites.

Shorebird habitats are being lost to coastal development.

Invertebrates

Migratory shorebirds consume large numbers of marine invertebrates, especially polychaetes, molluscs, and crustaceans. Invertebrate density and the tide affect the availability of shorebird food supplies in marine habitats. Shorebirds that exploit marine invertebrates are highly opportunistic and will take what is available within a particular geographic region. For example, in the mid-Atlantic region, the eggs of the Horseshoe Crab are heavily exploited by several species during spring migration, while in the Bay of Fundy shorebirds feed on very high densities of amphipods during July and August. Environmental degradation caused by human disturbance or pollution (e.g., oil spills) can decrease invertebrate densities and/or diversity.

Wetland Management

Management of wetlands in the Atlantic region has focused, to a large extent, on recreational issues (beach access), public health (mosquito control), and recent coastal development (at the federal and state level). Waterfowl management has also been intensive, especially within important migratory and wintering areas like Chesapeake Bay. Few programs, however, have been directly involved in the management of shorebirds, although there are some notable exceptions on Delaware Bay where habitats have been purchased for shorebirds.

Managing for Shorebirds

While the habitat required by foraging shorebirds may be extensive, the space available for their resting without disturbance may be limited, especially near urban areas. To maximize habitat availability for foraging and roosting shorebirds, management techniques must control human recreational use in marine areas and manage water levels in coastal wetlands. These techniques can be easily incorporated into management strategies on wildlife refuges. Shorebird management in the Atlantic region must have three main objectives: (1) to preserve and protect natural foraging and roosting habitats, (2) to reduce disturbance, and (3) to enhance foraging and roosting sites through habitat manipulation.

Preserving and Protecting Habitats

Coastal wetland habitats along the Atlantic Coast comprise a small percent of the remaining wetlands in the United States. Traditional habitats used by migratory shorebirds have been lost or degraded mainly because of heavy coastal development. The few remaining areas with high densities of shorebirds during migratory and wintering periods need to be protected from further development by land purchases or easements. The coastal marshes and tidal flats of Delaware Bay, for example, support very high proportions of four species of shorebirds during spring migration (50–85 percent of the hemispheric populations of Red Knot, Ruddy Turnstone, Sanderling, and Semipalmated Sandpiper). Continued development and disturbance in this region could have serious effects on these species.

Remaining areas need to be protected by land purchase or easements.

Reducing Disturbance

Migratory shorebirds require substantial energy in the form of fat reserves to fuel their migration. Disturbance to migrating shorebirds can be energetically expensive as they increase escape attempts. Limiting access to areas with high concentrations of migratory shorebirds will decrease these unnecessary flights induced by beachcombers, off-road vehicles, dogs, cats, and so forth.

The effects of disturbance vary depending on the species, type of disturbance (Table 3.3), time of year, and the tidal cycle. Many shorebirds in coastal areas, for example, forage on large expanses of intertidal flats exposed during low tide. Fortunately, little recreational use is made of these tidal-flat habitats, except by those collecting shellfish or digging worms for bait. During high tide, however, narrow stretches of habitat limit shorebird foraging or roosting. This is when shorebirds are exceptionally vulnerable to disturbance.

Areas with large numbers of roosting or foraging shorebirds and with little available habitat should be restricted or totally closed to avoid disturbance from recreational use. For example, areas known to be roost sites (such as beaches, tips of barrier islands, or portions of salt marsh) should be posted. Buffer zones that are a minimum of 50 meters from the mean high-tide mark should be created.

Buffer zones should be created.

Agencies such as the National Park Service, which administers highly used recreational areas, should develop signs, posters, and leaflets as part of their public education

Table 3.3 Types of disturbance to breeding, foraging, and nesting shorebirds

Human Recreational	*Vehicle*	*Natural*
Walking	Recreational vehicles	Weather (storms)
Jogging	Boating	Predators
Birdwatching	Farm machinery	
Hunting	Commerical dredging	
Bait harvesting		
Shell fishing		

Strategies to enhance coastal sites are not currently developed.

programs. The information can explain why certain areas are restricted or closed and what effect disturbance has on shorebirds.

Enhancing Habitats

Natural wetlands — Management strategies to enhance foraging and roosting sites for shorebirds at coastal beaches and tidal flats are not currently developed. Most management strategies focus on reducing disturbance. When available, high marsh zones of the salt marsh (Figure 3.2) provide foraging and sometimes roosting sites for migrating and wintering shorebirds. Within these zones are shallowly flooded pannes (natural intertidal depressions in the marsh that retain water even during low tide) with short, sparse, or no vegetation. When these high-marsh pannes are irregularly flooded from precipitation or extreme high tides, drawdowns from natural evaporation provide habitats for southbound migrants. During these periods of natural drawdown, dense emergent or woody vegetation can be reduced by the burning or mowing of edges. In extreme cases, applying herbicide to reeds (e.g., to *Phragmites australis*) may be necessary. Then, when pannes are naturally reflooded, shallowly flooded wetland edges are again available as habitats.

To control mosquitoes, many salt marshes have been parallel- or grid-ditched. These measures have subsequently drained numerous natural pannes. Modification of these ditches by plugging or filling ditches to reduce the drainage of high marsh zones will increase the number of natural pannes needed by shorebirds and other waterbirds as foraging sites.

Open Marsh Water Management (OMWM) is another widely used management technique for salt-marsh mosquito control along the Atlantic Coast. OMWM uses physical and biological methods to control mosquitoes. A series of shallow ponds with radiating ditches are developed to allow refuge for fish and to reduce oviposition sites for mosquitoes in salt marshes. Pond sizes are generally less than 0.25 ha and average approximately 30 cm deep to facilitate growth of submerged aquatic vegetation. Deeper water areas within a pond provide a reservoir for fishes during drought or between tides. Many of the radial ditches are connected to tidal creeks which allows for the exchange of water and small fish to the ponds during higher tides, such as spring or storm tides. Although water levels cannot be manipulated for shorebirds, the design and configuration of the ponds can be constructed to benefit shorebirds. Ponds constructed with gradually sloping sides provide different foraging zones for shorebirds and other waterbirds. Islands constructed within ponds provide nesting habitat for shorebirds and waterfowl and reduce the amount of dredge material on the surrounding marsh.

Managed wetlands — Most habitat-use data relate to tidal habitats. This information is therefore of limited use to managers of impounded wetlands where water levels remain constant for longer periods of time and where substrates are more homogeneous.

Chapter 2 introduced strategies to enhance availability of managed freshwater wetland habitats for migrating shorebirds and other waterbirds. Wetland management techniques along the Atlantic Coast build on these strategies, although the timing of manipulations must allow for differences in latitude and species composition. Making habitats available to wintering shorebirds, for example, can be accomplished within certain management scenarios.

Managed wetlands serve shorebirds and waterfowl.

Shorebird management of managed wetlands within coastal regions centers around three issues: (1) waterfowl management, (2) mosquito control, and (3) agricultural production.

First, brackish or saline managed wetlands can be managed to serve migrating and wintering shorebirds along with waterfowl. At present many impoundments are managed for widgeon grass, a preferred waterfowl food. Impoundments are drawn down in the spring to firm the substrate and initiate germination of plants. Once the plants have germinated, impoundments are irrigated (by approximately 10 cm per month) to allow plant growth. By modifying the timing of drawdowns and reflooding, these impoundments can benefit shorebirds as well. Staggering the initiation of drawdowns between several units and dewatering slowly (2–3 cm per week) will make new foraging habitat available continuously for spring migrating shorebirds and will concentrate invertebrates for late-spring waterfowl migrants (Figure 3.4, Table 3.4). Also, by slightly staggering germination dates, widgeon grass will mature at different times during the fall and thereby create new habitats continuously for migratory waterfowl.

Many managed wetlands are reconditioned every few years to discourage undesirable vegetation (such as *Spartina* species).

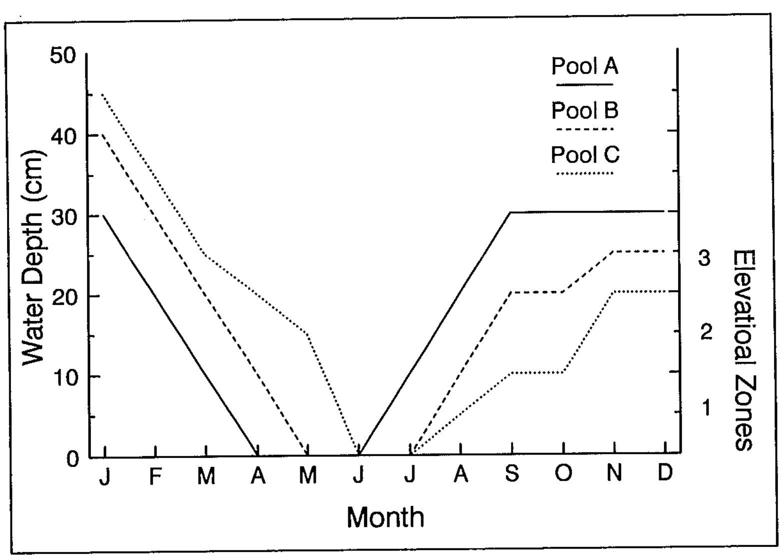


Figure 3.4 *Hypothetical drawdown and flooding schedule for three pools primarily managed for widgeon grass. Water depths are measured at lowest elevation of pools.*

Table 3.4 Variations within elevational zones in water depth, waterbird use, vegetation, and invertebrate availability in three brackish pools drawn down and flooded during an annual cycle

Pool A	Jan–Feb	Mar–Apr	May–Jun	Jul–Aug	Sep–Oct	Nov–Dec
Zone 1 [a]						
Depth [b]	10–20	0	0	10–20	20–30	20–30
Guilds [c]	div/dab/her	dab/shor	sgl	lpb/lgl/her/broo	dab/div/her	div/dab/her
Vegetation [d]	seed/tub	seed/tub/bro	per/ms	per/ms	seed/tub	seed/tub
Invertebrates [e]	high	medium	terr	low	medium	high
Zone 2						
Depth	0–10	0	0	0–10	10–20	10–20
Guilds	dab/gee/shor	spb/sgl		sgl/spb/broo	lgl/lpb/her/dab	dab/gee/her/lpb/lgl
Vegetation	seed/tub/bro	ms/per	ms/per	ms/per	seed/tub	seed/tub
Invertebrates	high	low	terr	low	medium	high
Zone 3						
Depth	0	0	0	0	0–10	0–10
Guilds	gee/dab/shor	sgl			dab/spb/sgl	dab/gee/spb/sgl
Vegetation	tub/bro	ms/per	ms/per	ms/per	tub/bro/seed	seed/tub/bro
Invertebrates	medium	terr	terr	low	medium	high
Pool B	**Jan–Feb**	**Mar–Apr**	**May–Jun**	**Jul–Aug**	**Sep–Oct**	**Nov–Dec**
Zone 1						
Depth	20–30	0–10	0	0–10	10–20	15–25
Guilds	div/dab/her	dab/shor	sgl	sgl/spb/broo	dab/her/lpb/lgl	dab/div/her
Vegetation	seed/tub	per	ms/per	ms/per	tub/seed	seed/tub
Invertebrates	high	high	terr	low	medium	high
Zone 2						
Depth	10–20	0	0	0	0–10	5–15
Guilds	dab/her/lpb/lgl	spb/sgl		sgl	dab/sgl/spb	dab/gee/her/shor
Vegetation	seed/tub	per/ms	ms/per	ms/per	tub/seed	seed/tub/bro
Invertebrates	high	medium	terr	terr	low	medium
Zone 3						
Depth	0–10	0	0	0	0	0–5
Guilds	dab/gee/shor	sgl				gee/dab/spb/sgl
Vegetation	seed/tub/bro	ms/per	ms/per	ms/per	ms/per	bro/seed/tub
Invertebrates	medium	terr	terr	terr	terr	low
Pool C	**Jan–Feb**	**Mar–Apr**	**May–Jun**	**Jul–Aug**	**Sep–Oct**	**Nov–Dec**
Zone 1						
Depth	25–35	10–20	0	0–5	0–10	10–20
Guilds	div/her/dab	dab/lpb/lgl/her	spb/sgl	sgl/spb/broo	shor/dab	dab/gee/her/lpb/lgl
Vegetation	seed/tub	seed/tub	ms/per	per/ms	tub/seed	seed/tub/bro
Invertebrates	high	high	low	low	medium	high
Zone 2						
Depth	15–25	0–10	0	0	0	0–10
Guilds	div/her/dab	dab/shor	sgl		sgl	dabb/gee/her/spb/
sgl						
Vegetation	seed/tub	seed/tub/bro	ms/per	ms/per	ms/per	bro/seed/tub
Invertebrates	high	medium	terr	terr	terr	low
Zone 3						
Depth	5–15	0	0	0	0	0
Guilds	dab/gee/lpb/lgl	spb/sgl				gee/sgl
Vegetation	seed/tub/bro	ms/per	ms/per	ms/per	ms/per	bro/tub/seed
Inverte brates	high	low	terr	terr	terr	

[a] Elevational zones. Generalized 10-cm gradients (contours) within a managed wetland. These hypothetical wetlands have a 30-cm difference in elevation between the lowest and high points.
[b] Water depth (cm)
[c] Waterbird guilds: div = diving ducks, dab = dabbling ducks, broo = duck broods, gee = geese, her = herons, shor = all shorebirds, lpb = large prober shorebird, lgl = large gleaner shorebird, spb = small prober shorebird, sgl = small gleaner shorebird
[d] Vegetation types and foods available during drawdowns or floodin. Per = emergent perennial, ms = moist soil (annuals), seed = seeds, tub = tubers, bro = browse
[e] Invertebrate availability based qualitatively on water depth and flooding duration. Aquatic invertebrates = high, medium, and low; terr = terrestrial invertebrates

A common practice is to flood units from 1–3 years to remove any unwanted vegetation. Conditions can be made more favorable for both wintering shorebirds and wintering waterfowl by slowly decreasing water depths from the beginning of the nongrowing season to the end of the season and then by reflooding before the growing season begins in the spring. This technique will provide a continuous invertebrate food base for shorebirds, waterfowl, and other waterbirds during the nongrowing season.

Many impoundments in the Atlantic region are used for mosquito control, the second issue. Salt-marsh habitats are continuously flooded during the summer months to preclude mosquito egg laying and production. Providing resources for shorebirds during the summer/fall migration can easily be incorporated into this control technique. The water depths between impoundment units within a complex should be staggered, as mosquito control practices allow. For example, units flooded to 15–25 cm will provide resources for herons and larger shorebirds (e.g., Black-necked Stilts and Willets). Units flooded to 5–15 cm will be available for rails and medium-sized shorebirds (e.g., dowitchers and yellowlegs). Shallow units flooded to 1–5 cm will serve small shorebirds (e.g., small sandpipers and plovers). When units are dewatered during the fall or winter, slow drawdowns will concentrate prey for late migrating shorebirds and other waterbirds.

The third issue, agricultural production, and the management of agricultural fields for shorebirds, will be discussed in Chapter 4.

Nesting areas should be posted or fenced.

Nesting Areas

Five species of shorebirds nest on coastal beaches that are particularly preferred for human recreational use. This use can disturb nesting shorebirds, reduce their productivity, and artificially increase the number of predators, such as gulls and crows. Shorebird-nesting areas should be posted or fenced to reduce disturbance and predation. Buffer zones need to range from a minimum of 35 meters for Snowy Plovers to 75 meters for American Oystercatchers. Prime nesting and roosting habitats, such as the tips of barrier islands, should be fenced and totally closed to prevent recreational use during nesting and migration periods.

Nest and chick predation along coastal areas can be high. Predators can be managed by removing fox dens from coastal beaches or large barrier islands. Fencing, especially in urban areas, helps reduce predation by domestic animals and "urban" wildlife such as skunks, opossums, and so forth.

Maintaining high-quality habitats for nesting shorebirds can be accomplished by reducing dense or woody vegetation with fire, mowing, or, in extreme cases, the application of herbicides. If possible, maintaining several unvegetated or sparsely vegetated islands in high salt marshes or within impoundments will provide ideal nesting and roosting areas for several species, such as the Black-necked Stilt. Once again, variety is the key to success.

Case History

An integrated approach benefits all waterbirds.

Management personnel at the Tom Yawkey Wildlife Center have been using waterfowl management strategies highly beneficial to nongame species without compromising waterfowl use. This wildlife center is located in coastal South Carolina, near Georgetown. Covering an area of approximately 8100 hectares (20,000 acres), it includes two natural barrier islands and surrounding tidal marshes. Major habitat types include 19 km (12 miles) of coastal beach, tidal marshes, maritime and pine forest, and over 1200 hectares (3000 acres) of managed wetlands. Although management personnel at Tom Yawkey Wildlife Center primarily manage their twenty wetland impoundments for the production of waterfowl foods, their integrated approach benefits all waterbirds, especially spring migrating and wintering shorebirds.

Many of the wetlands are managed for sea purslane and widgeon grass. Each plant species requires different conditions to flourish.

Units planned for sea purslane are drawn down gradually throughout the winter until early March and maintained in damp condition through early April to provide germination of plants. This slow drawdown concentrates invertebrates for wintering and late-spring migrating waterfowl as well as wintering and early-spring migrating shorebirds, such as yellowlegs and dowitchers. Gradual reflooding of units in July to 20–25 cm by September provides resources for waterfowl, herons, and egrets.

Units planned for widgeon grass are drawn down in early April; drawdowns continue through early June, allowing a continuous sheet flow of water and a mud flat for germination. This provides continuously available habitats for the spring migrant shorebird community and concentrates prey for herons. After plants germinate in June, units are gradually reflooded to a depth of 35–45 cm to allow for plant growth. During the late fall and winter, water depths are gradually decreased, approximately 10 cm per month. This reduction in water depth provides foods for wintering shorebirds, wintering waterfowl, and herons.

Annual drawdown of units does not always occur. Several units may be flooded continuously from 1–3 years to control undesirable vegetation or may be partially drawn down to provide brood habitat for introduced Mottled Ducks. These managed wetlands provide summer habitats for herons, rails, and especially American Alligators.

In 1984 a study was conducted at Tom Yawkey Wildlife Center to document waterbird use of managed versus unmanaged wetlands. Waterbird use was greater in the managed wetlands for all seasons except summer. Results showed that the percent of annual use-days in managed wetlands was 52 percent for shorebirds, 27 percent for waterfowl, and 14 percent for herons. The center's results demonstrate how modified waterfowl management strategies within brackish wetlands can enhance the availability of foods for various species and thus benefit several waterbird guilds.

Conclusion

In summary, management plans for shorebirds in the Atlantic region should focus on protecting natural coastal habitats, reducing disturbance (especially for roosting and nesting shorebirds), and developing a food base that will be continuously available over time. Management strategies for waterbirds need to identify how species' needs fit together, how much time is required to meet these needs, and what required foods are available.

Modified waterfowl strategies benefit other waterbirds.

Suggested Readings

Bergstrom, P. W. 1988. Breeding biology of Wilson's Plovers. Wilson Bull. 100(1):25–35.

Brush, T., R. A. Lent, T. Hruby, B. A. Harrington, R. M. Marshall, and W. G. Montgomery. 1986. Habitat use by salt-marsh birds and response to open marsh water management. Colonial Waterbirds 9(2):189–195.

Burger, J. 1986. The effect of human activity on shorebirds at two coastal bays in northeastern United States. Environ. Conserv. 13(2):123–130.

Burger, J., and J. Shisler. 1978. Nest-site selection of Willets in a New Jersey salt marsh. Wilson Bull. 90:599–607.

Burger, J., M. A. Howe, D. C. Hahn, and J. Chase. 1977. Effects of tidal cycles on habitat selection and habitat partitioning by migrant shorebirds. Auk 94:743–758.

Buckley, P. A., and F. G. Buckley. 1976. Guidelines for the protection and management of colonial nesting waterbirds. National Park Serv., North Atlantic Regional Office, Boston, Mass. 52pp.

Cairns, W. E. 1982. Biology and breeding behavior of breeding Piping Plovers. Wilson Bull. 94:531–545.

Carlson, D. B., and J. D. Carroll, Jr. 1985. Developing and implementing impoundment management methods benefiting mosquito control, fish and wildlife: a two-year progress report about the Technical Subcommittee on Mosquito Impoundments. J. Fla. Anti-Mosq. Control Assoc. 56:24–32.

Cross, D. H. and K. L. Flemming. 1989. Control of Phragmites or Common Reed.

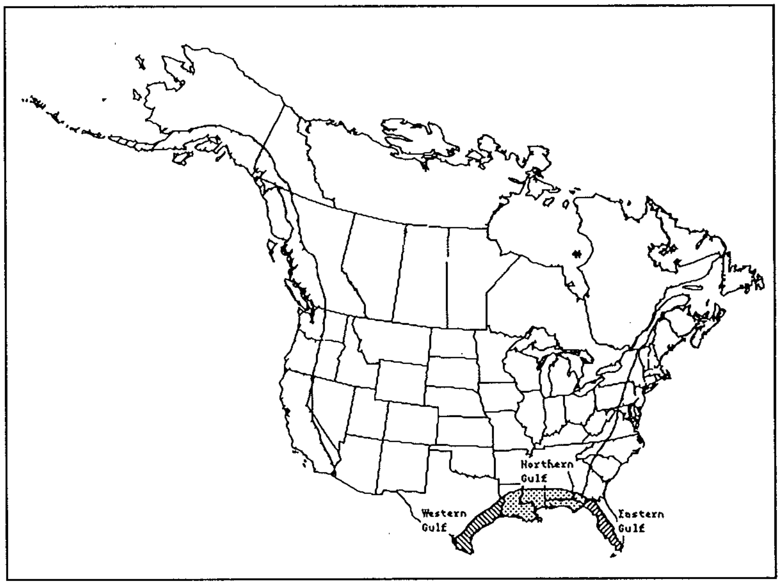


Figure 4.1 Major geographic areas for the Gulf of Mexico region of North America.

Urban expansion and agriculture threaten the habitats and shorebirds here.

nearly 40 percent of the area of coastal wetlands in the United States. At present, urban expansion (resort and condominium construction) and agriculture in Louisiana threaten the wetland habitats and the shorebirds here. Furthermore, oil development and refinement are a major industry in Louisiana as well as in Texas. Houston, Texas, especially endures as the largest oil port in the conterminous United States. The possibility of a disastrous oil spill taking place during migration is very real. In Florida, coastal housing developments and channelization have left their mark; foraging and nesting habitats have been reduced. Agricultural development has drained wetlands extensively, converted them to row crops, and degraded associated natural wetland habitats as well.

Management recommendations that include protecting habitats, reducing disturbance, and enhancing wetland habitats have been addressed in previous chapters. Management strategies for the Gulf region need only be adjusted for the presence of shorebirds. A few unique areas in the Gulf region needing special attention will be covered here.

Shorebird Ecology

Migration

The majority of shorebirds occur in the Gulf of Mexico region during migration (Figure 4.2), although several species remain during breeding and wintering periods. Several species, such as the Western Sandpiper, Long- and Short-billed Dowitchers, and Dunlin, winter here and may reach highest numbers then. In relation to other areas along the Gulf, south Florida has the highest concentration at interior sites during the summer/fall migration and at coastal sites during the winter.

Table 4.1 Shorebird presence in the Gulf region of North America

Shorebird Group	Common Name	Area: Eastern Gulf	Northern Gulf	Western Gulf
Plover	Black-bellied Plover	N,S,W	N,S,W	N,S,W
	Lesser Golden Plover	N,S	N	N
	Snowy Plover	N,S,W,B	N,S,W,B	N,S,W,B
	Wilson's Plover	N,S,B	B	N,S,B
	Semipalmated Plover	N,S	N,S	N,S
	Piping Plover	N,S,W	N,S,W	N,S,W
	Killdeer	N,S,W,B	N,S,W,B	N,S,W,B
Curlew	Eskimo Curlew			
	Whimbrel		N,S	N,S
	Long-billed Curlew		N,S,W	N,S,W
Small Sandpiper	Sanderling	N,S,W	N,S,W	N,S,W
	Semipalmated Sandpiper	N,S	N,S	N,S
	Western Sandpiper	S,W	N,S,W	N,S,W
	Least Sandpiper	N,S	N,S,W	N,S,W
	White-rumped Sandpiper		N	N
	Baird's Sandpiper		N,S	N,S
Medium Sandpiper	Red Knot	N,S,W	N,S	N,S
	Pectoral Sandpiper	N,S	N,S	N,S
	Stilt Sandpiper		N,S,W	N,S,W
	Dunlin	N,S,W	N,S,W	N,S,W
	Short-billed Dowitcher	N,S,W	N,S,W	N,S,W
	Long-billed Dowitcher		N,S,W	N,S,W
	Common Snipe	N,B,W	N,S,W	N,S,W
	Buff-breasted Sandpiper		N,S	N,S
	Upland Sandpiper		N,S	N,S
Godwit	Hudsonian Godwit		N	N
	Marbled Godwit	W	N,S,W	N,S,W
Yellowlegs	Greater Yellowlegs	N,S,W	N,S,W	N,S,W
	Lesser Yellowlegs	N,S,W	N,S,W	N,S,W
	Solitary Sandpiper		N,S	N,S
	Willet	N,S,W,B	N,S,W,B	N,S,W,B
Turnstone	Ruddy Turnstone	N,S	N,S	N,S
	Spotted Sandpiper		N,S	N,S
Avocet/Stilt	Black-necked Stilt	N,S,W,B	N,S,W,B	N,S,W,B
	American Avocet		N,S,W	N,S,W
Phalarope	Wilson's Phalarope		N,S	
Oystercatcher	American Oystercatcher	N,S,W,B	N,S,W,B	N,S,W,

N = northward migration, S = southward migration, W = wintering, B = breeding
Eastern Gulf = Florida, excluding Panhandle; Northern Gulf = Florida Panhandle, Louisiana, Mississippi, Alabama; Western Gulf = Texas.

Breeding

American Oystercatcher, Snowy Plover, Wilson's Plover, Willet, Killdeer, and Black-necked Stilt nest in the Gulf of Mexico region, primarily between mid-March and August. All are coastal breeders with the exception of the Killdeer and Black-necked Stilt which nest in both coastal and inland habitats. Major nesting habitats are barrier island beaches, salt marshes, and dredge-spoil islands. (See Chapter 3 for nest site selection and manage-

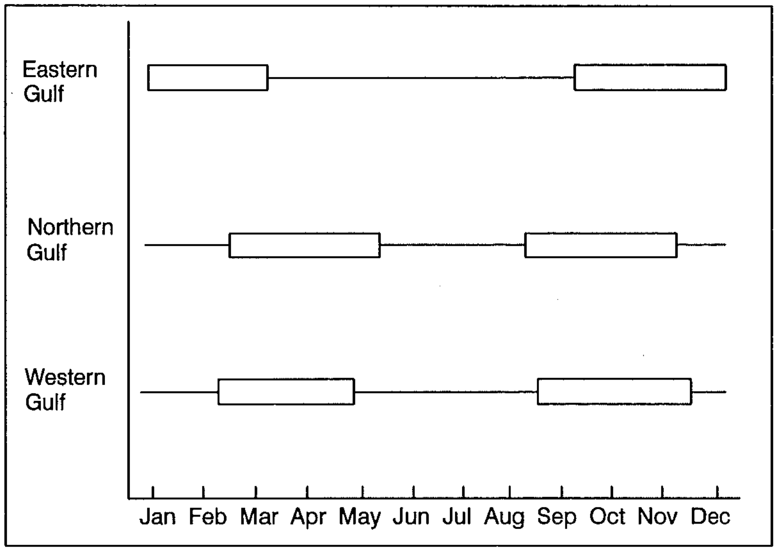


Figure 4.2 *Occurrence chronologies of shorebirds for areas in the Gulf of Mexico region of North America. Boxes represent peak periods and lines represent the ranges of occurrence.*

The milder climate of the Gulf region enables invertebrate production for a greater part of the year.

ment techniques to reduce disturbance and predation and to enhance shorebird habitats.) Snowy Plovers, possibly the most threatened breeding species in this region, are solitary nesters restricted to barrier island beaches.

Habitat Use

Shorebirds in this region exploit hypersaline lagoons, freshwater marshes, coastal beaches, and deltas. Shorebirds also exploit two additional habitats in this region: shallowly flooded agricultural fields and hypersaline tidal flats. Both of these major habitats support large numbers of migrating and wintering shorebirds. Habitat use by shorebirds here (in relation to vegetation distribution and foraging depth) is no different from that in other regions; habitat conditions range from unvegetated mud flats to moderately vegetated open shallows (< 15 cm).

Invertebrates

As in other coastal areas, the invertebrates used by shorebirds in the Gulf region are benthic marine polychaetes, molluscs, and crustaceans. In hypersaline habitats, however, brine shrimp and/or fly larvae in algal mats are important food sources. Invertebrates exploited by shorebirds in managed freshwater wetlands and agricultural fields in the Gulf region are similar to those alluded to in Chapter 2. The milder climate of the Gulf region, however, enables invertebrate production for a greater part of the year.

Wetland Management

Managing for Shorebirds

Managing for shorebirds in the Gulf region should focus on (1) protecting natural habitats used by migrating and breeding shorebirds, (2) reducing disturbance, and (3) enhancing habitats in managed wetlands.

Protecting Habitats

Southern Texas has large expanses of tidal flats, such as the Laguna Madre, found between the barrier islands and the mainland. These tidal flats, which are covered with algal mats, are extremely productive areas for migrating and wintering shorebirds. They are also economically valuable; they provide important brood-rearing areas for shellfish and other commercial fish. Therefore, protecting areas with high shorebird concentrations from further development or degradation caused by the dredging of tidal flats will not only benefit shorebirds but also sustain commercially important fisheries.

Reducing Disturbance

Reducing disturbance to breeding, migrating, and wintering shorebirds is especially important in areas of high recreational use such as barrier islands and coastal beaches. (See Chapter 3 for techniques to reduce disturbance to roosting and nesting shorebirds.) Areas of particular concern include the barrier islands of the Texas coast, where recreational vehicle use is prevalent, and the south Florida coast where public beaches are found. Boat landings on spoil or natural islands also disturb roosting or nesting shorebirds. The access of recreational vehicles to any areas used heavily by either nesting or roosting shorebirds should be carefully managed to reduce disturbance.

Protecting areas with high shorebird concentrations will also sustain commercially important fisheries.

When disturbance causes unnecessary flights, roosting or foraging shorebirds must meet their increased energy demands by increasing foraging time. Strategies to reduce disturbance may be especially important to wintering shorebirds because of their increased energy demands that already result from molting, shortened day length for foraging, reduced food supplies, and lower air temperatures.

Enhancing Habitats

Management practices for enhancing shorebird habitats in freshwater and brackish wetlands, salt marshes, and mosquito-control impoundments have been explained in previous chapters. Wetland management techniques in the Gulf region build on these strategies, although the timing of manipulations must allow for differences in latitude and species composition. For example, many herons and ibisis are permanent residents, whereas most waterfowl rely on this region from December through February. Additional areas of attention for enhancing shorebird habitats are spoil islands and agricultural fields.

Dredge Material Islands — The placement and management of dredge material islands from dredging projects may benefit nesting and roosting habitats. The construction and management

Managed agricultural fields can be effective shorebird habitats.

of dredge material islands have been well summarized by the U.S. Army Corps of Engineers.

Three basic concepts are important in the development of islands for waterbird use: site location, timing of development, and physical design. First, islands should be located in areas isolated from predators and human disturbance and established in the best location for optimal wildlife use. For example, nesting islands should be in close proximity to foraging sites and in open areas that will provide a high field of view. Second, islands should be developed for nesting during the fall, prior to the spring nesting season, to allow for the initial sorting of dredge material by wind and rain.

Finally, the physical design of islands can by placed into four categories: island size, configuration, substrate, and elevation. The Army Corps of Engineers recommends that islands be between 2-20 ha (5-50 ac), although smaller islands can be attractive as nesting islands for shorebirds, especially in managed wetlands. Steep banks on islands should be avoided; a slope of approximately 1 m per 30 m linear from the waters edge is recommended to reduce erosion and provide foraging sites for breeding birds and chicks. Substrate preferences of nesting species will depend on the target species and are quite variable. Generally, material such as sand and gravel makes better substrate than clays or silt because clays and silt are more susceptible to erosion by wind, rain, and tides. Islands should be constructed high enough to prevent flooding of areas that could be used for nesting. Elevations 1-3 m above the mean high water mark are recommended. Vegetation control on islands should also be dictated by the target species using the islands. Vegetation management should not be conducted during the nesting season.

Agricultural Fields — Agricultural development has had a major impact on wetlands in the United States and has caused nearly 90 percent of their loss. In particular, wetlands and associated uplands (used by foraging and nesting shorebirds) have been drained and converted to row crops. Nevertheless, agricultural lands in the Gulf region are used to benefit waterfowl and may have the potential to provide resources for shorebirds. Although shorebirds seem to prefer freshwater wetlands in other regions (e.g., the Midwest), they use flooded agricultural units heavily in the Gulf region. Managed agricultural fields can be highly effective in providing shorebird habitat, especially in areas where managed wetlands are unavailable or natural wetlands have been lost or degraded.

Integrating Strategies

Rice Fields

Rice farming is extensive in the Gulf coastal plain region because of long growing seasons and a plentiful water supply.

Management of rice fields is used by the U.S. Fish and Wildlife Services Refuge in the Mini Refuge System to provide undisturbed migrating and wintering habitats for waterfowl such as Mallards, Northern Pintails, teal, and geese. If optimal water depths are available, shorebird use of rice fields can be extensive, especially during spring and winter. The long growing season, different farming practices, and different drawdown and flooding schedules in these regions allow several options for enhancing agricultural fields for shorebirds (Figure 4.3, Table 4.2).

Summer/Fall — Rice fields are harvested from July to November depending on the number of crops, the planting date, and the variety of rice (90- or 120-day). Between late July and September, several shallowly flooded fields (from 1–15 cm) will provide foraging opportunities for southbound shorebirds (e.g., Semipalmated and Pectoral Sandpipers), as well as early waterfowl migrants (e.g., Blue-winged Teal).

Many rice fields have contour levees used to regulate water depths during the growing season. After harvest, rice fields can be rolled with a water-filled drum or shallow disk to remove stubble and create open areas preferred by shorebirds. The use of staggered water depths within a contoured field creates feed-

After harvest, rice fields can be managed to remove stubble and create open areas preferred by shorebirds.

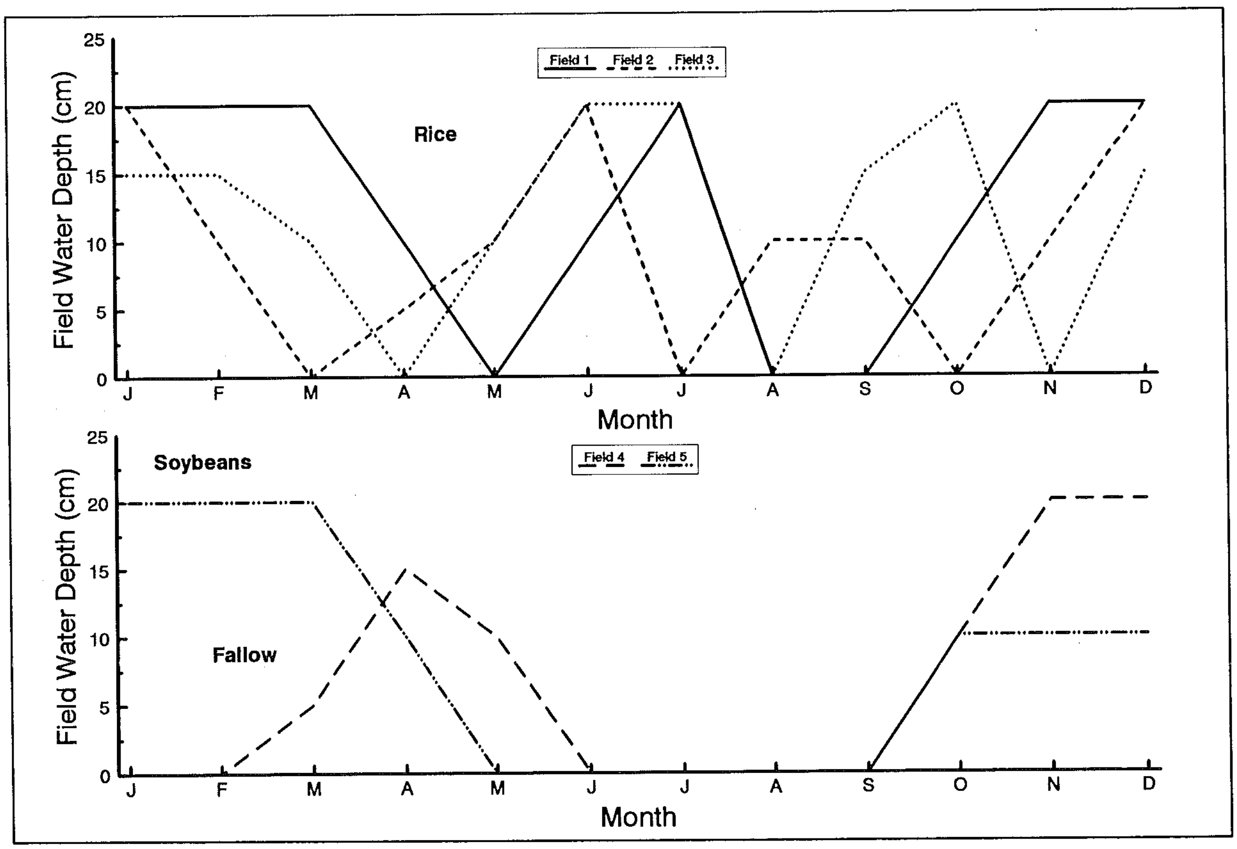


Figure 4.3 *Hypothetical drawdown and flooding schedule for five agricultural fields managed to provide habitats for migrating waterbirds. Water depths are measured at lowest elevation of field. (For potential waterbird response to manipulations, see Table 4.2.)*

Table 4.2 Variations within agricultural fields in water depth, waterbird use, vegetation, and invertebrate availability in five fields that are drawn down and flooded during an annual cycle.

	Jan–Feb	Mar–Apr	May–Jun	Jul–Aug	Sep–Oct	Nov–Dec
Field 1 Rice						
Manipulation[a]	maintain	drawdown	plant/irr	crop/harvest	flood	maintain
Depth[b]	20	20–0	0–20	20–0	10–20	20
Guilds[c]	div/dab/her	dab/shor/her	shor	her	dab/her/lpb/lgl	dab/her
Vegetation[d]	seed	seed	rice	rice	seed	seed
Invertebrates[e]	high	high	low	terr	low	medium
Field 2 Rice						
Manipulation	drawdown	plant/irr	irr	harvest/flood	drawdown	flood
Depth	20–0	0–5	5–20	0–10	10–0	10–20
Guilds	dab/gee/shor	shor	her	shor	gl/lpb/her/dab	dab/gee/her/lpb/lgl
Vegetation	seed	rice	rice	ms	ms/seed/tub	seed/tub/bro
Invertebrates	high	low	low	medium	high	medium
Field 3 Rice						
Manipulation	maintain	drawdown/plant	irr	harvest/plant	irr	harvest/flood
Depth	15	15–0	0–20	20–0	0–20	0–15
Guilds	dab/her	dab/shor	shor/her	her	dab/her/lpb/lgl	dab/shor/her
Vegetation	seed	seed	rice	rice	rice	seed
Invertebrates	high	high	low	low	low	low
Field 4 Fallow						
Manipulation	maintain	flood	drawdown	maintain	flood	flood
Depth	0	0–15	15–0	0	0–10	10–20
Guilds	gee	dab/shor/her	shor/her	dab/her/shor	dab/her/lpb/lgl	dab/gee/spb/sgl
Vegetation	seed/bro	seed/bro	fallow	fallow	tub/bro/seed	seed/tub/bro
Invertebrates		low	medium	terr	medium	high
Field 5 Soybeans						
Manipulation	maintain	drawdown	plant	maintain	harvest/flood	maintain
Depth	20	20–0	0	0	0–10	10
Guilds	dab/her	shor/dab/her	sgl		dab/sgl/spb	dab/gee/her/shor
Vegetation	seed	seed	soybeans	soybeans	seed	seed
Invertebrates	high	high	terr	terr	low	medium

[a] Type of manipulation within crop field. Maintain = maintain water level, drawdown = dewatering of fields, plant = field preparation and planting, irr = irrigation of rice, harvest = harvesting crops, flood = flooding fields
[b] Water depth (cm)
[c] Waterbird guilds: dab = dabbling ducks, gee = geese, her = herons and ibis, shor = all shorebirds, lpb = large prober shorebird, lgl = large gleaner shorebird, spb = small prober shorebird, sgl = small gleaner shorebird
[d] Type of foods available during drawdowns or flooding and type of crop in cultivation. Ms = moist soil (annuals), seed = annual plant seeds or crop seeds, tub = tubers, bro = browse, rice, soybeans, and fallow (not planted)
[e] Invertebrate availability based qualitatively from water depth and flooding duration. Aquatic invertebrates = high, medium, and low; terr = terrestrial invertebrates.

ing opportunities also (Figure 4.4). Level fields without contours should have several fields flooded at different depths (e.g., 3 cm, 10 cm, 15 cm) to provide foraging opportunities for different waterbird guilds .

During the summer, flooding fields at staggered times and water depths can have a dual benefit. First, the fields continuously provide new foraging habitat for migrating shorebirds, herons, and ibises. Second, fields that are flooded early and later drawn down from evaporation stimulate the germination of annual plants and, in turn, provide browse for wintering geese and possible seeds for dabbling ducks.

Winter— Between November and February, when the majority of waterfowl are found here, rice fields managed for water-

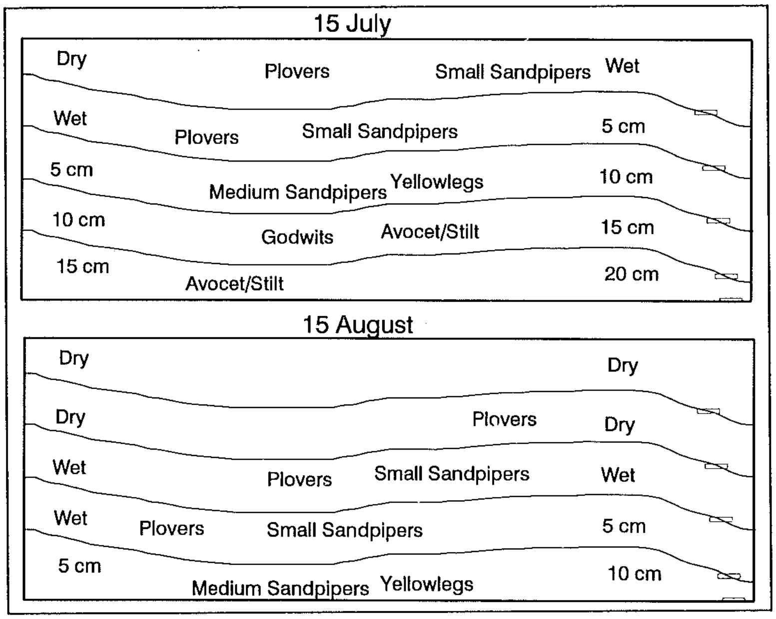


Figure 4.4 Water depth and shorebird guild use between levees within a rice field during the summer. July 15 indicates initial flooding depths within levees and August 15 indicates flooding depths after natural drawdown. Rectangles on levees represent water control gates.

fowl are typically flooded to approximately 20 cm, which is too deep for most shorebirds. Staggered water depths within and between fields during this period will provide foraging opportunities for geese in dry areas or mud flats and for Northern Pintails and teal in shallow open water. Wintering shorebirds such as Long-billed Dowitchers, Dunlin, and Western Sandpipers will also use areas of 10 cm or less. Fields not flooded by irrigation can have levees pulled up, or gates put in, for the gradual flooding from winter rains. This maneuver will benefit several waterbird groups.

Spring — Rice fields flooded for waterfowl or crawfish over winter are generally drawn down quickly in March to prepare for planting if two crops are planned within a single growing season. Alternatively, these fields can be drawn down slowly beginning in late February so that early migrating shorebirds, ibises, and late waterfowl migrants can be provided with invertebrates. Fields planned for a single crop can be drawn down slowly in late March or early April to provide habitats for later migrating shorebirds and herons. Rice fields irrigated after planting also provide foraging opportunities for shorebirds, until vegetation is too tall and dense for their use. Staggering planting dates between fields will provide new habitats continuously for spring migrants.

Rice fields irrigated after planting also provide foraging opportunities for shorebirds.

Other Agricultural Fields

Many other agricultural practices occur on a rotational basis with rice (e.g., soybeans, grass cover crop, or fallow fields). Techniques similar to those depicted above can be used in these fields for creating shorebird habitats in summer, fall, and winter. During the spring, fields purposefully left fallow and flooded for winter waterfowl should not be drawn down completely until late

May to ensure that habitat remains for late migrating shorebirds. Water should also be held as long as possible before preparing fields for later crops such as soybeans and cover crops.

Crawfish Ponds

Crawfish aquiculture is practiced widely on the Gulf coastal plain and can provide shorebird habitat during summer/fall migrations. Crawfish ponds are generally drawn down in July and reflooded in October to produce harvests throughout the winter. Initial drawdown dates can be staggered between mid-July and mid-September to make habitat available for southbound migrating shorebirds.

Conclusion

Shorebird management in the Gulf of Mexico region should be part of a strategy that protects and enhances habitat not only for shorebirds but also for all wetland-associated organisms. Large numbers of several shorebird species winter in this region; some of the less common species are endangered species or species of special concern. Management plans should especially focus on providing habitats for these wintering shorebirds.

Suggested Readings

Below, T. H. 1985. Shorebirds in south-west Florida. Wader Study Group Bull. 44:40–41.

Carlson, D. B., P. D. O'Brian, and J. R. Rey. 1991. Multipurpose management of Florida's mosquito control impoundments. Pages 163–171 *in* D. Jenings, compiler. Proceed. of the Coastal Nongame Workshop. U.S. Fish and Wildl. Serv., Region 4, and Florida Game Fresh Water Fish Commission, Gainsville, Fla.

Chapman, B. R. 1984. Seasonal abundance and habitat-use patterns of coastal bird populations on Padre and Mustang Island barrier beaches [following the Ixtoc I oil spill]. U.S. Fish and Wildl. Serv. FWS/OBS–83/31. 73pp.

Landin, M. C. 1991. Needs, construction, and management of dredge material islands for wildlife. Pages 99–117 *in* D. Jenings, compiler. Proceed. of the Coastal Nongame Workshop. U.S. Fish and Wildl. Serv., Region 4, and Florida Game Fresh Water Fish Commission, Gainsville, Fla.

Pashley, D. 1991. Shorebirds, gulls, and terns: Louisiana, Mississippi, Alabama. Pages 79–83 *in* D. Jenings, compiler. Proceed. of the Coastal Nongame Workshop. U.S. Fish and Wildl. Serv., Region 4, and Florida Game Fresh Water Fish Commission, Gainsville, Fla.

Soots, F. R., Jr., and M. C. Landin. 1978. Development and management of avian habitat on dredged material islands. Tech. Report DS-78-18. U.S. Army Waterways Experiment Station, Vicksburg, Miss.

Sykes, P. W., Jr., and G. S. Hunter. 1978. Bird use of flooded agricultural fields during summer and early fall and some recommendations for management. Fla. Field Nat. 6:36–43.

Tiner, R. W., Jr. 1984. Wetlands of the United States: current status and recent trends. U.S. Fish and Wildl. Serv., Washington, D.C. 59pp.

Chapter 5 — Pacific Region

THIS chapter concentrates on management techniques appropriate for shorebirds present in the Pacific region of the United States and Canada (Figure 5.1). Its purpose is to provide appropriate management techniques for enhancing habitats, including the reduction of disturbance for migrating, breeding, and wintering shorebirds.

Almost 35 species of shorebirds occur in this region.

Temperate Region

During their annual cycle, almost thirty-five species of shorebirds occur in this region in both marine and freshwater habitats (Table 5.1). These wetland habitats can be placed in three broad categories: (1) coastal wetlands influenced by tidal effects, (2) freshwater lakes and seasonally flooded wetlands, and (3) saline-alkaline lakes. Loss and degradation of these habitats

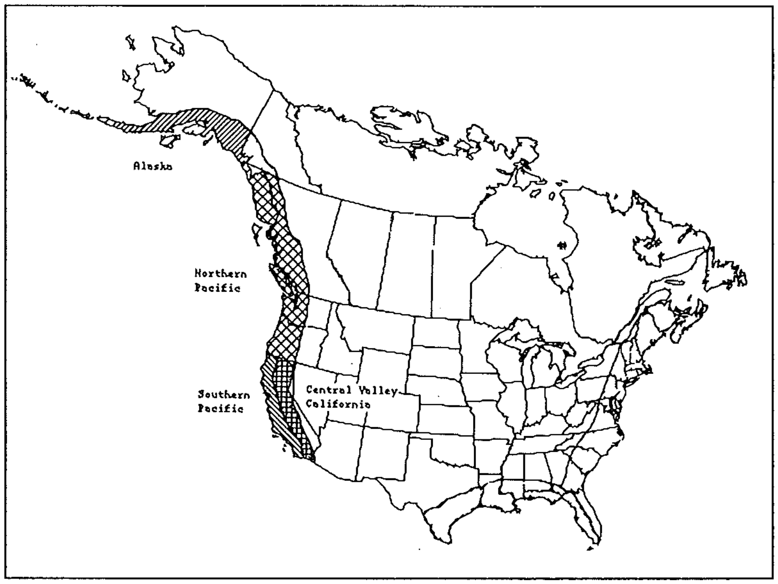


Figure 5.1 *Major geographic areas for the Pacific region of North America.*

Only 30 percent of the original coastal wetlands remain in the Pacific region.

seriously threaten the well-being of most shorebird species.

Only 30 percent of the original coastal wetlands remain in the Pacific region. California alone has lost more than 90 percent of the 2,020,000 hectares (5 million acres) of wetlands it once had. As coastal areas are increasingly used for recreation and urban, industrial, and harbor development, remaining wetlands are increasingly destroyed. In interior wetlands, such as those in the Central Valley of California, extensive areas have been lost to agriculture when converted to row crops or orchards; some associated wetland habitats have been contaminated by the use of agricultural pesticides.

The availability of fresh water in the Pacific region is a serious problem, especially in California, as human populations increase and agriculture expands. Water diversion projects brought on by increased agricultural activity have reduced wetland water supplies, affected the flow of natural streams, and reduced water tables. Decreased water flow through wetlands increases water salinity and concentrations of contaminants. One especially vexing problem is the increase of selenium concentrations in agricultural drain water flowing into wetlands. High selenium concentrations are known to cause deformities in nesting waterbirds. Shorebirds at Kesterson National Wildlife Refuge in central California have suffered losses from selenium poisoning. Clearly, the cumulative loss and degradation of habitat have substantially affected shorebird and waterfowl habitats throughout the Pacific region.

Management recommendations that include protecting habitat, reducing disturbance, and enhancing wetland habitats have been addressed in previous chapters. Wetland management techniques in the Pacific region build on these strategies although the timing of manipulations must allow for differences in latitude.

Table 5.1 Shorebird presence in the Pacific region of North America, excluding Alaska

		Area		
Shorebird Group	**Common Name**	**Central Valley California**	**Southern Coastal**	**Northern Coastal**
Plover	Black-bellied Plover	N,S,W	N,S,W	N,S,W
	Snowy Plover	N,S,B	N,S,W,B	B,W
	Semipalmated Plover	N,S	N,S,W	N,S
	Killdeer	N,S,W,B	N,S,W,B	B
	Mountain Plover	N,S,W		
Curlew	Whimbrel	N	N,S,W	N,S
	Long-billed Curlew	N,S,W	N,S,W	
Small Sandpiper	Sanderling		N,S,W	N,S,W
	Western Sandpiper	N,S,W	N,S,W	N,S,W
	Least Sandpiper	N,S,W	N,S,W	N
	Baird's Sandpiper	S	S	S
Medium Sandpiper	Red Knot		N,S,W	N
	Pectoral Sandpiper	S	S	S
	Dunlin	N,W	N,S,W	N,S,W
	Short-billed Dowitcher		N,S,W	N,S
	Long-billed Dowitcher	N,S,W	N,S,W	N,S,W
	Common Snipe	N,S,W	N,S	N,S,B
Godwit	Marbled Godwit		N,S,W	
Yellowlegs	Greater Yellowlegs	N,S,W	N,S,W	N
	Lesser Yellowlegs	N,S	N,S	S
	Willet		N,S,W	
Turnstone	Ruddy Turnstone		N,S,W	N,S,W
	Black Turnstone		N,S,W	N,S,W
	Surfbird		N,S,W	N,S,W
	Wandering Tattler		N,S,W	N,S,W
	Spotted Sandpiper		N,S,W,B	N,S,W,B
	Rock Sandpiper		W	N,S,W
Avocet/Stilt	Black-necked Stilt	N,S,W,B	N,S,W,B	
	American Avocet	N,S,W,B	N,S,W,B	
Phalarope	Wilson's Phalarope	S	N,S	
	Northern Phalarope	S	N,S	
	Red Phalarope			
Oystercatcher	Black Oystercatcher		N,S,W,B	N,S,W,B

N = northward migration, S = southward migration, W = wintering, B = breeding
Southern Coastal = California
Northern Coastal = Oregon and Washington (U.S.) and British Columbia (Canada)

Alaska

The coastal and interior wetlands in Alaska are more extensive than any wetlands in the United States. During migration, concentrations of migrating shorebirds are greater here than anywhere in the world. Nearly forty species of shorebirds breed in Alaska. Although some of Alaska's local problems resemble those of other regions (e.g., loss of habitat, disturbance, etc.),

Concentrations are greater here than anywhere in the world.

Production and transportation of oil may threaten shorebird habitats in Alaska.

the overall scale of the landscape makes wetland management difficult. Therefore, a detailed description of wetland management in Alaska is not included in this manual.

One of Alaska's potential local problems, however, needs attention here. Of major concern, both production and transportation of oil potentially threaten shorebird habitats in Alaska, either through loss of habitat or pollution from spills. The Exxon Valdez oil spill in 1989 took place within 120 kilometers (75 miles) of the Copper and Bering River Deltas, the largest spring stopover areas on the Pacific Coast. It was a "near miss" in several respects; time of year and location were the key factors. The possibility of an oil spill taking place during migration, of course, is very real. Long-term planning to reduce this possibility and monitoring the effects on waterbirds of oil production and transportation should be a high priority in Alaska. Lessening the risk of habitat loss or pollution should protect critical breeding and migratory stopover areas.

Shorebird Ecology

Migration

Most shorebirds in the Pacific region occur during migration, although significant numbers remain (from southern British Columbia and points south) during the breeding and wintering seasons. The timing of peak migration differs along a latitudinal gradient (Figure 5.2). Total numbers vary according to the time of year. Wetlands in the southern portions of the Central Valley of California, for example, have higher numbers during winter and spring than during summer or fall. Unlike shorebirds in other regions (e.g., several species in eastern North America which make elliptical migrations in more than one corridor), shorebirds in the Pacific flyway tend to use the same north-south flyway

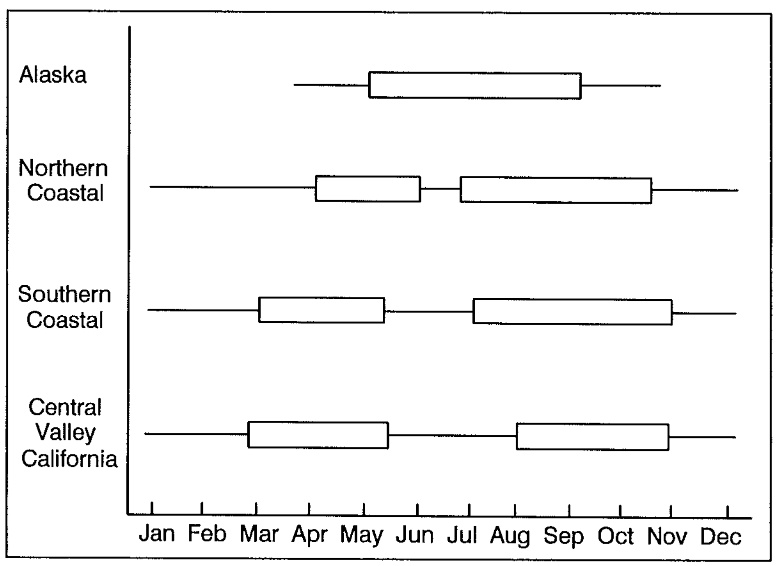


Figure 5.2 Occurrence chronologies of shorebirds for areas in the Pacific region of North America. Boxes represent peak periods and lines represent the ranges of occurrence.

corridor. Some Pacific flyway shorebirds may make regional movements, however, from coastal areas in the fall to interior wetlands in the winter and spring. Several species in the Pacific region regularly occur in large numbers during the winter. Dunlin and Marbled Godwit, for example, may reach maximum numbers during winter.

Shorebirds in the Pacific flyway tend to use the same north-south flyway corridor.

Breeding

Seven species of shorebirds nest in temperate areas of the Pacific region. Within each area, the composition of species varies with latitude (Figure 5.1, Table 5.1). Principal nesting season ranges from mid-March to August.

Major habitat types used for nesting are beaches, rocky shorelines, saline-alkaline flats, and islands. Most species — Snowy Plover, Killdeer, Spotted Sandpiper, American Avocet, and Black-necked Stilt — breed in either saline or freshwater habitats. The Black Oystercatcher nests only in rocky coastal habitats, and the Common Snipe nests only in inland freshwater areas. (See Chapters 2 and 3 for more on nest site selection and management techniques.)

Habitat Use

Most data on shorebird habitat use in the Pacific region have been collected in coastal and estuarine areas where daily tidal cycles control habitat availability. Coastal habitats used by migrating and wintering shorebirds in the Pacific region range from muddy intertidal flats to sandy beaches. Interior habitats range from permanent or seasonally flooded freshwater areas to the alkaline flats of saline lakes.

Upland habitats associated with coastal wetlands are also used by shorebirds in the Pacific region. Short, sparse grassland habitats flooded shallowly by spring tides or precipitation provide feeding and roosting grounds for several species during high tide.

As expected, habitat use differs along coastal and inland areas (both within and between guilds) with varying water depths, substrate characteristics, and vegetation structure and distribution. (See Chapters 2 and 3 for coastal and interior habitat use for different foraging guilds.)

Invertebrates

As in other coastal areas, marine invertebrates used by migrating and wintering shorebirds in the Pacific region include benthic polychaetes, molluscs, and crustaceans. Freshwater invertebrates in permanent or seasonally flooded wetlands and agricultural fields are similar to those discussed in Chapter 2. In interior saline-alkaline lakes, brine fly larvae and brine shrimp are important food resources.

Wetland habitats in California, Oregon, and Washington make up only 3 % of the remaining wetlands in the United States.

Wetland Management

Management of coastal wetlands in the Pacific region has focused, to a large extent, on recreational issues (beach access and harbor use). Additionally, waterfowl management in inland and coastal wetlands has been intensive, especially within important migratory and wintering areas like the Central Valley of California. Few management programs have been directly involved with nongame waterbirds, with the notable exception of the endangered Clapper Rail in San Francisco Bay, California.

Managing for Shorebirds

Management of recreational activities in coastal areas needs to maximize the temporal and spatial availability of habitats for foraging and roosting shorebirds. Wetland management strategies for nongame waterbirds should be incorporated into existing management strategies used at wildlife refuges. Shorebird management in the Pacific region must have four main objectives: (1) to preserve and protect natural foraging and roosting habitats, (2) to reduce disturbance, (3) to enhance foraging and roosting grounds through habitat manipulation, and (4) to restore habitats.

Preserving and Protecting Habitats

Wetland habitats in California, Oregon, and Washington make up only 3 percent of the remaining wetlands in the United States. Most of this habitat has been lost or degraded because of heavy coastal development or agriculture. Preserving and protecting remaining habitats from further development or degradation should be given high priority: sites that host high densities of shorebirds during migration or wintering periods can be purchased or leased.

San Francisco Bay, once the largest single wetland system on the Pacific Coast, is a classic candidate for preservation and protection. This critical area has lost approximately 80 percent of the original 80,940 hectares (200,000 acres) of tidal marshes because of the creation of salt evaporation ponds and development. Even though coastal marshes and tidal flats of San Francisco Bay now support up to one million shorebirds during their annual cycle, continued development and disturbance could seriously harm entire populations. This is a prime example of an area where conservation efforts to purchase land, obtain easements, and reduce the risk of pollution make good sense.

Reducing Disturbance

Reducing disturbance for migrating, breeding, and wintering shorebirds is especially important in areas of high recreational use such as urban wetlands and coastal beaches. (Chapter 3 discusses techniques to reduce disturbance to shorebirds.)

Enhancing Habitats

Management strategies at coastal beaches to enhance foraging sites for shorebirds have not been developed. Most management has been limited to disturbance reduction. Techniques for enhancing habitats for migrating and wintering shorebirds in fresh water, brackish wetlands, salt marshes, mosquito-control impoundments, and agricultural fields have been addressed in previous chapters.

As in previous cases, strategies for shorebirds and other waterbirds can be integrated with strategies used in wetlands managed for waterfowl simply by adjusting timing of water level manipulations.

Restoring Habitats

Extreme loss of coastal and interior wetlands in the Pacific region should make restoration, or creation of wetlands, a high priority. Tidal flats have been successfully restored to create foraging habitats for shorebirds and waterfowl. During 1982, 16.5 hectares (40 acres) of intertidal flats were restored at the Upper Newport Bay Ecological Reserve in California. Shorebird use increased during 3 years of monitoring but unfortunately did not match densities within natural intertidal flats within the reserve. Shorebird use was greater for the entire reserve, however, after the restoration project.

The specifics of wetland restoration and creation, not within the scope of this chapter, have been summarized in various sources (see suggested readings). Managers involved in mitigation projects should consider the habitat requirements of shorebirds in the design and construction of restored, or created, wetlands.

Tidal flats have been successfully restored to create foraging habitats for shorebirds and waterfowl.

Conclusion

Shorebird management in the Pacific region should be part of a strategy that protects and enhances habitat for all wetland associated organisms. These plans should focus on protecting and restoring coastal habitats, reducing disturbance (especially for roosting and nesting shorebirds), and developing a food base that will be continuously available through time. Large numbers of different shorebird species winter in this region. Therefore, management schemes here should put additional focus on providing habitats during the wintering period. Management strategies in refuges should aim to identify waterbird species, determine their required needs, and develop plans that will make resources available to them continuously.

Suggested Readings

Davison, N. C., and P. R. Evans. 1987. Habitat restoration and creation: its role and potential in the conservation of waders. Wader Study Group Bull. 49 Suppl./IWRB Special Publ. 7:139–145.

Gill, R. E., Jr., and C. M. Handel. 1990. The importance of subarctic intertidal habitats to shorebirds: a study of the central Yukon-Kuskokwim Delta, Alaska. Condor 92:709–725.

Goss-Custard, J. D. 1979. Effects of habitat loss on the numbers of overwintering shorebirds. Pages 167–178 *in* F. A. Pitelka, ed. Shorebirds in marine environments. Studies in Avian Biology Monograph Series, no. 2. Allen Press, Lawrence, Kans. 261pp.

Kusler, J. A., and M. E. Kentula, eds. 1990. Wetland creation and restoration: the status of the science. Island Press, Washington D.C. and Covelo, Calif. 591pp.

Myers, J. P. 1984. Spacing behavior of nonbreeding shorebirds. Pages 271–322 *in* J. Burger and B. L. Olla, eds. Shorebirds: migration and foraging behavior. Plenum Press, New York, N.Y.

Page, G. W., L. E. Stenzel, and C. A. Ribic. 1985. Nest site selection and clutch predation in the Snowy Plover. Auk 102:347–353.

Page, G. W., L. E. Stenzel, and C. M. Wolfe. 1979. Aspects of the occurrence of shorebirds on a central California estuary. Pages 15–32 *in* F. A. Pitelka, ed. Shorebirds in marine environments. Studies in Avian Biology Monograph Series, no. 2. Allen Press, Lawrence, Kans. 261pp.

Pitelka, F. A. 1979. The Pacific coast shorebird scene. Pages 1–12 *in* F. A. Pitelka, ed. Shorebirds in marine environments. Studies in Avian Biology Monograph Series, no. 2. Allen Press, Lawrence, Kans. 261pp.

Senner, S. E. 1979. An evaluation of the Copper River Delta as a critical habitat for migrating shorebirds. Pages 131–146 *in* F. A. Pitelka, ed. Shorebirds in marine environments. Studies in Avian Biology Monograph Series, no. 2. Allen Press, Lawrence, Kans. 261pp.

Wilcox, C. G. 1986. Comparison of shorebird and waterfowl densities on restored and natural intertidal mudflats at upper Newport Bay, California. Colonial Waterbirds 9(2):218–226.