MIGRATORY SHOREBIRD ASSESSMENT

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Prepared by:
Lindsay Tudor

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
WILDLIFE RESOURCE ASSESSMENT SECTION
BIRD GROUP

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continued)

Page

INTRODUCTION

Since 1968, the Maine Department of Inland Fisheries and Wildlife (MDIFW) has aggressively pursued development and refinement of wildlife species assessments and implementation of cost-effective comprehensive programs that support selected goals and objectives for the next 15 years. Assessments are based upon available information and the judgments of professional wildlife biologists responsible for individual species or groups of species. Precise data may not always be available or are too limited for meaningful statistical analysis; however, many trends and indications are sometimes clear and deserve management consideration.

The assessment has been organized to group information in a user-meaningful way. The Natural History section discusses biological characteristics of the species that are important to its management. The Management section contains history of regulations and regulatory authority, past management, past goals and objectives, and current management. The Habitat and Population sections address historic, current, and projected conditions for the species. The Use and Demand section addresses past, current, and projected use and demand of the species and its habitat. A Summary and Conclusions sections summarizes the major points of the assessment.

Shorebirds (*Order charadriiformes*) are represented in Maine by sandpipers, plovers, turnstones, godwits, curlews, dowitchers, and phalaropes. Thirty-six species of shorebirds have been reported along the Maine coast; most are long distance migrants stopping between their Canadian arctic breeding grounds and South American wintering areas to feed and rest (Table 1). Along with the Bay of Fundy, the Maine coast is

recognized as a critical staging area for migratory shorebirds. Many of these migrants depend on such staging areas to accumulate the fat necessary to make the nonstop, transoceanic flight (2000 - 3000 km) to their South American wintering areas (Morrison and Myers 1989).

Eight species of shorebirds nest in Maine (killdeer, American woodcock, common snipe, spotted sandpiper, piping plover, willet, upland sandpiper and American oystercatcher). Killdeer, spotted sandpiper, and common snipe are common and occur in both coastal and inland habitats. Two species, willet and American oystercatcher have recently expanded their breeding range to include southern and mid-coastal Maine. Individual assessments exist for American woodcock, piping plover, and red-necked phalarope. Staff from the Endangered and Threatened Species Group is currently drafting an assessment for upland sandpiper.

This assessment deals primarily with shorebird species that are long distance migrants dependent on Maine coastal staging areas. Shorebirds nesting in Maine, with the exception of American woodcock, upland sandpiper, and piping plover, are discussed.

Shorebirds are an important group for management consideration because large numbers of these birds concentrate in discrete areas of coastal habitat where they are highly susceptible to disturbance, development, and environmental contaminants.

Table 1. Abundance, Status and Distribution of Shorebirds in Maine[1]

Season and common name	Abundance[2]	Status[3]	Distribution[4]
Breeding Populations			
Piping plover	U	E	L
Spotted sandpiper	C	NL	S
American woodcock	C	NL	S
Common snipe	C	NL	S
Killdeer	C	NL	S
Willet	C	NL	R
Upland sandpiper	U	T	R
American oystercatcher	U	NL	L
Wintering Populations			
Purple sandpiper	C	NL	R
Migratory Populations			
Semipalmated plover	C	NL	R
Lesser golden plover	U	NL	R
Black-bellied plover	C	NL	R
Ruddy turnstone	C	NL	R
Whimbrel	C	SC	R
Solitary sandpiper	C	NL	S
Greater yellowlegs	C	NL	S
Lesser yellowlegs	C	NL	S
Red knot	C	NL	R
Least sandpiper	C	NL	R
White-rumped sandpiper	C	NL	R
Dunlin	C	NL	R
Migratory Populations (cont'd			
Pectoral sandpiper	C	NL	R
Short-billed dowitcher	C	NL	R
Stilt sandpiper	C	NL	L
Semipalmated sandpiper	C	NL	R
Hudsonian godwit	C	NL	R
Sanderling	C	NL	R
Red-necked phalarope	U	SC	L
Red phalarope	U	NL	L
Eskimo curlew	U	EX	R
Peripheral Populations			
Long-billed curlew	U	NL	R
Marbled godwit	U	NL	R
Baird's sandpiper	U	NL	R
Western sandpiper	U	NL	R
Buff-breasted sandpiper	U	NL	R
Ruff	U	NL	R
Long-billed dowitcher	U	NL	R
Wilson's phalarope	U	NL	L

1. Adamus (1985b), McCollough and May (1980), Vickery (1990), MDIFW data files.
2. Abundance codes:
   C=Common, populations secure and habitats are not severely threatened.
   U=Uncommon, species vulnerable because it exists in small numbers or is so restricted throughout its distribution that it may become endangered if its total population declines or if environmental conditions deteriorate.
3. Status codes:
   E=listed as Maine Endangered Species
   T=listed as Maine Threatened Species
   SC=listed as Maine Special Concern Species
   EX=listed as Maine Extirpated Species.
   NL=not listed
4. Distribution codes:
   S=Statewide, species found statewide.
   R=Regionally, species generally found in areas along the eastern coast (Frenchman's Bay east to Cobscook Bay) or in areas along the western coast (Penobscot Bay west to Kittery).
   L=Locally, species generally found only in a particular bay or watershed.

NATURAL HISTORY

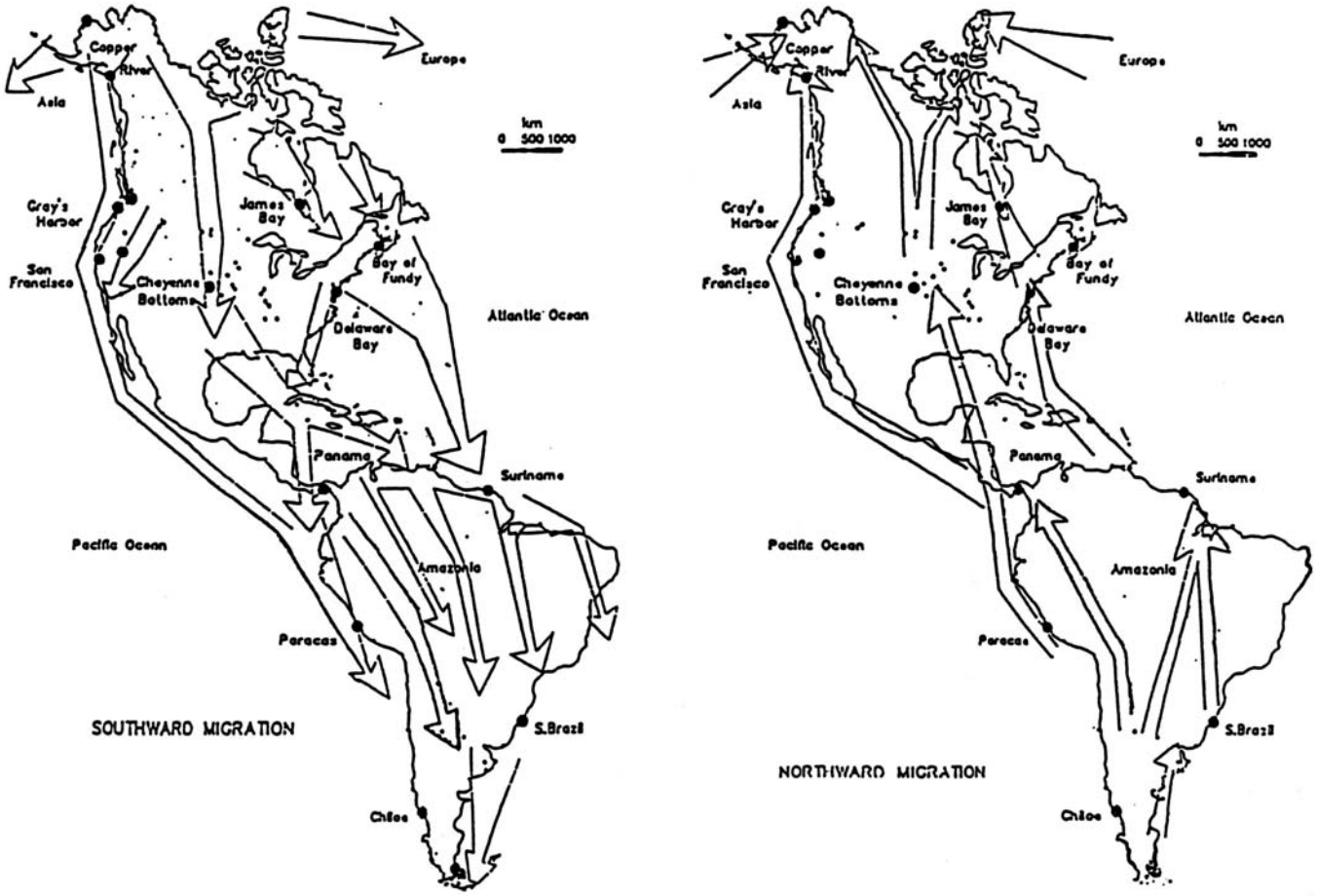
Description

Shorebirds are a large and diverse group of wading or swimming birds. Most are long-legged, white or gray and brown, with long pointed wings. Three families commonly occur in Maine. *Charadriidae* (plovers and turnstones) are small to medium sized birds, between 5 and 9 inches in length, with shorter bills and necks than most other shorebird species. *Scolopacidae* (sandpipers including woodcock) are a large and varied group ranging from 5 to 19 inches in length. Their legs and bills are generally long and slender. Plumage is mainly dull gray or brown, mottled or streaked. *Phalaropodidae* (phalaropes) are medium-sized birds 6 to 7 inches in length with lobed toes (Farrand, 1983).

Distribution

Shorebirds are found worldwide. According to Morrison and Myers (1989), there are three main migration systems in the western hemisphere. The first involves species that breed in the northeastern Canadian arctic and migrate to wintering areas on the European coast. The second includes species that breed in Alaska and migrate to wintering areas in Asia and the Pacific. The third group encompasses the majority of species, including those species that migrate through Maine. They breed across northern Canada and winter in North, Central, and South America (Figure 1).

Figure 1. Shorebird flyways (a) Southward migration; (b) Northward migration. Large circles represent sites supporting over 250,000 shorebirds or 30% of a species' flyway population. (Morrison and Myers 1989)



The greatest variety of shorebird species and numbers of shorebirds visit Maine during their southward migration (July - November). Feeding and roosting areas associated with staging areas occur along the entire Maine coast. Downeast Maine (Trenton Bay east to Perry) is probably the most important fall migratory stopover area in eastern U.S. for semipalmated sandpipers, semipalmated plovers, black-bellied plovers, ruddy turnstones and short-billed dowitchers (Famous and Ferris 1980). McCollough and May (1980) reported over 150,000 shorebirds feeding and roosting in Cobscook Bay between July and September 1979.

The relatively few shorebirds that migrate through Maine during their northward migration (April - June) primarily use staging areas in southern Maine, located in Kittery, Wells, and Biddeford, and along the coast to Phippsburg, Georgetown, and Boothbay Harbor (MDIFW file data).

Reproduction

Semipalmated sandpipers, sanderlings, red knots, ruddy turnstones, lesser golden plovers, black-bellied plovers, dunlins, and white-rumped sandpipers generally breed in the high Canadian arctic and sub arctic from Alaska east to Baffin Island (Paulson 1995, Parmelee 1992, Gratto-Trevor 1992, Farrand, 1983). Semipalmated plover (Farrand, 1983) and least sandpiper (Cooper, 1994) breeding areas extend from the Canadian sub arctic southeast around Hudson Bay and eastward to Newfoundland and Nova Scotia. Greater and lesser yellowlegs (Elphick and Tibbitts 1998, Tibbitts and Moskoff 1999), Hudsonian godwit, short-billed dowitcher, common snipe, and solitary sandpiper typically utilize breeding areas farther south than other shorebird species.

These shorebirds utilize muskeg habitats located across the Canadian prairie provinces eastward to James Bay in Ontario, Quebec, and Labrador (Farrand, 1983). Common snipe's breeding range extends farther south into New England. Marbled godwit's and upland sandpiper's breeding areas extend even farther south into Montana, South Dakota, Missouri, Minnesota and Ohio (Farrand, 1983). Upland sandpipers also breed in open grasslands in the northeast United States (Carter 1992). Willets commonly breed along the Atlantic coast from North Carolina to Maine (Farrand 1983, Finch 1971). Killdeer and spotted sandpipers breed throughout North America (Farrand 1983).

Upon arrival on the breeding areas, many species set up nesting territories. In the subarctic and low arctic nest initiation generally begins in late May and peaks by mid June (Gratto and Cooke 1987, Skeel and Mallory 1996, Paulson 1995, Cooper 1994). Although most shorebird species are monogamous, polyandry and polygyny occur in several species such as spotted sandpiper, white-rumped sandpiper, and phalaropes (Parmelee 1992, Oring et al. 1983). Studies by Gratto-Trevor (1992), suggest Semipalmated sandpipers are monogamous and once pair bond is formed, remains intact until shortly before or after hatching. If nest loss occurs early in the season, semipalmated sandpipers often renest, normally with their previous mate. Pairs that successfully nest one year often return the following year to the same territory and reunite (Gratto-Trevor 1992).

Shorebirds typically nest on the ground, making a shallow depression sometimes lined with leaves or grass, in open or semi-open herbaceous cover. Inland species generally nest within close proximity to wetlands often on freshwater islands. Species

that breed in the arctic typically nest on ice-free beaches. Shorebird clutches usually consist of four eggs. Eggs are cryptically colored for protective concealment (Bent 1929).

Incubation varies with species and ranges from 20 to 30+ days; often, both sexes incubate the eggs (Baker and Baker 1973). Eggs hatch within hours of each other. Precocial chicks are able to accompany their parents shortly after hatching. They immediately begin foraging on the abundant supply of invertebrates. The high invertebrate biomass available on arctic and subarctic breeding grounds is probably the ultimate explanation for migratory behavior in shorebird species (Baker and Baker 1973).

Survival

A review of shorebird studies by Evans and Pienkowski (1984) found that average annual adult survival ranged between 70 - 94%. Survival rate in young of the year is considerably less than in adults (20 - 30%). Baker and Baker (1973) compiled data from several studies on different shorebird species and repeatedly found estimates of a 40 - 50% fledging success. Oring et al. (1983) compared three studies of average longevity for spotted sandpipers, Temminck's stint, and dunlin, and found the average life span to be 3.5 years, 7 years, and 5.3 years, respectively, with maximum recorded life spans of 8, 9, and 10 years. The oldest known individual semipalmated sandpiper was 12-years-old (Holroyd and Brown 1970). A banded whimbrel observed in Churchill, Manitoba, was greater than 19 years (Skeel and Mallory 1996).

Feeding

Shorebirds are opportunistic foragers of terrestrial, aquatic, and marine invertebrates, which occur in abundance in feeding habitats. Species have different bill characteristics with accompanying feeding strategies which limit competition and increase foraging efficiency when food resources are limited, especially on the wintering grounds (Baker and Baker 1973). Semipalmated sandpipers and short-billed dowitchers, for example, locate prey almost exclusively by tactile probing of the substrate. Semipalmated plovers and black-bellied plovers locate prey visually and capture food by pecking at the substrate (McCollough 1981). Different bill lengths further increase feeding diversity by effecting the vertical range for capturing prey beneath the substrate surface.

Shorebird populations on the breeding grounds are widely dispersed. Emergence of adult tipulids and chironomids provide easy prey for precocial young and adults (Baker and Baker 1973). On migratory staging areas, the variety of shorebird feeding strategies allows large aggregate populations to congregate on relatively small but highly productive tidal flats.

On Maine coastal staging areas, McCollough (1981) observed shorebirds feeding on marine oligochaetes, polychaete worms, gastropods, isopods, and amphipods. On tidal flats in Chignecto Bay, within the Bay of Fundy, Peer et al. (1986) observed plovers and sandpipers feeding almost exclusively on a single species of amphipod, *Corophium volutator*. Individual birds ingested 9,600 - 23,000 corophium per bird per tidal cycle depending on tide height, the amount of foraging time available in daylight, and the amount of fat birds had already accumulated (Peer et al. 1986). Research in Maine

indicated that semipalmated sandpipers remained on staging areas for 10 to 20 days, during which time they nearly doubled their body weights (Dunn et al. 1988).

Phalaropes, on the other hand, are almost entirely pelagic, feeding on copepods brought to the surface by tidal upwellings (Brown and Gaskin 1986). Phalaropes are noted for spinning in circles while feeding and submerging their head and upending like a puddle duck to capture their prey.

Migration

The greatest numbers of shorebirds are found feeding and roosting along the Maine coast during their southward migration. Migration begins in July and continues through November, with most species arriving between July 15 and September 15.

For most shorebird species, the adults and juveniles migrate from the breeding grounds at different times. Adults generally leave before juveniles are capable of sustained flight. The females of several species migrate first, followed 2-3 weeks later by the males. Juveniles follow 3 to 4 weeks after the adults, creating three peaks in the numbers of migrants in Maine. The different timing in migration may be related to competition for resources (Morrison 1984). Exceptions to this are dunlin and purple sandpipers, which have a single peak in October or November (Famous and Ferris 1980).

Shorebirds generally stay 2 - 3 weeks at coastal staging areas, feeding and resting to accumulate fat reserves for the transoceanic flight to coastal and inland habitat in the Bahamas, Florida, Venezuela, Surinam, and Brazil. Some species, such as the red knot, continue on to Uruguay, Argentina, and Chile (Morrison and Myers

1989). Adult semipalmated sandpipers on staging areas in eastern Maine averaged a length of stay of 11.8 - 21.5 days at the start of migration (Dunn et al. 1988). Migration from staging areas may be timed in relation to decreased prey availability (Schneider and Harrington 1981). Weather conditions determine actual departure southward from fall staging areas. Flocks normally depart near high tide and when winds favor southeastern flight. Flocks usually migrate at night, but also diurnally during long nonstop flights (Lank 1989).

The northward migration period is much shorter than the southward migration. Most species migrate north through the interior of North America or along the Atlantic coast to Delaware Bay, and then north and west to the breeding grounds, bypassing Maine completely. Those birds that do utilize Maine staging areas (namely greater and lesser yellowlegs and black-bellied plovers) arrive between mid-April and early June. The greatest numbers are present in southern Maine between mid-May and the first week in June, and all species have only one peak (Famous and Ferris 1980).

Wintering

Purple sandpiper is the only species that commonly winters along the Maine coast. They generally winter in rocky intertidal areas along the mainland, offshore islands, and ledges, feeding on amphipods, mussels, and barnacles. Small groups of dunlin, sanderling, or ruddy turnstone may sometimes winter along the coast in southwestern Maine (Famous and Ferris 1980).

MANAGEMENT

Regulatory Authority

Shorebirds, and potentially shorebird habitat, are protected by a variety of Federal laws and international treaties. In 1900, the Lacey Act was passed and prevented interstate transport of birds. This law effectively stopped the exportation of shorebirds killed in Maine for markets in Boston. Passage of the Migratory Bird Treaty Act in 1918, gave the Federal government authority to regulate hunting of migratory game birds. The Bureau of Biological Survey, now the Department of Interior's U. S. Fish and Wildlife Service (USFWS), became responsible for establishing hunting regulations on migratory species.

In 1918, a ban on spring hunting and market hunting was enacted, and a shorebird hunting season with bag limits was set (Trefethen 1961). After 1927, all shorebirds, except American woodcock and common snipe, were no longer legally hunted (Senner and Howe 1984).

In 1972, two Federal laws were enacted that afforded some protection for shorebird habitat: the Clean Water Act, which empowered the Army Corps of Engineers (ACE) (in conjunction with the Environmental Protection Agency (EPA)) to regulate activities that modify wetland habitats, and the Coastal Zone Management Act, which established federal assistance to coastal states for coastal resource protection programs (Senner and Howe 1984).

In Maine, shorebird nesting, feeding, and staging habitat may be designated as Significant Wildlife Habitat under the Natural Resources Protection Act (NRPA) of 1988. This legislation recognizes Significant Wildlife Habitat as a state natural resource to be

protected. Maine Department of Inland Fisheries and Wildlife (MDIFW) is responsible for defining and mapping shorebird nesting, feeding, and staging areas for protection under this law.

Past Goals and Objectives

A goal and objectives for managing shorebirds in Maine through year 2000, were established by MDIFW on an interim basis until they could be established through the normal strategic planning process (MDIFW 1994).

Goal: Maintain or enhance the long-term presence and diversity of Migratory Shorebirds in Maine.

Objective 1: Maintain migratory shorebird habitat through year 2000.

Objective 2: Develop specific population goals and objectives for priority species and Maine breeding species by 2000.

Past and Current Management

Shorebird management consists primarily of gathering information on populations and their ecological requirements, and protecting shorebird populations and their habitat.

In Maine, feeding and roosting sites were initially surveyed along much of the coast by MDIFW, with funding and non funding support from USFWS, NOAA (through the Coastal Zone Management program), and various other state agencies, as part of Maine's Coastal Management Program. Regional inventories started in 1981 with the Casco Bay Coastal Resources Inventory and continued until the coastal inventory was completed in 1991. A combination of aerial and ground surveys were used to identify

shorebird feeding and roosting areas. This information, along with census data from the International Shorebird Survey and USFWS, have been collected, mapped, and entered into a MDIFW database.

To update and fill in gaps where information was lacking, regional surveys were initiated again in 1993 with support from the USFWS and Maine's Oil Spill Contingency Fund. Beginning with southern coastal areas, from Kittery to Phippsburg, MDIFW performed intensive ground surveys of shorebird areas mapped during the 1981 surveys, as well as additional areas previously not surveyed. Surveys continued annually, focusing on different coastal regions each year, completing the coast in 1999.

Data are entered into the Wildlife Resource Assessment Section (WRAS) Shorebird database to facilitate analyses used in defining Shorebird Areas of Management Concern as outlined by the Shorebird Management System (MDIFW 1998). These areas can be submitted as candidate shorebird feeding areas and staging areas for Significant Wildlife Habitat designation under NRPA. MDIFW has identified 496 shorebird staging areas of which 96 roosting areas and 120 feeding areas qualify as Shorebird Areas of Management Concern (MDIFW file data). All areas are mapped and entered in a GIS database by the WRAS Habitat Group.

A limited amount of shorebird research was completed in Maine between 1979-1981. Three publications resulted from this work: a study of migrating shorebirds in Cobscook Bay (McCollough and May 1980); a feeding ecology study of four common migrants in eastern Maine (McCollough 1981); and an energetics study of semipalmated sandpipers on eastern Maine staging areas (Dunn et al. 1988).

Presently, Maine is taking an active role in drafting the North Atlantic Regional Shorebird Plan, as part of the U.S. National Shorebird Conservation Plan (USNSCP). The goal and objectives outlined in the USNSCP are as follows:

Goal: to maintain, restore, and enhance migratory shorebird populations with multiple species habitat management throughout the United States.

Objectives:
a) develop a standardized, scientifically-sound system for monitoring and studying shorebird populations that will provide practical information to researchers and land managers for shorebird habitat conservation;
b) identify the principles and practices upon which local, regional, and national management plans can effectively integrate shorebird habitat conservation with multiple species strategies;
c) design an integrated strategy for increasing public awareness and information concerning wetlands and shorebirds.

The North Atlantic Regional Plan describes regional habitats and lists areas of significance to shorebirds within the region. Shorebird species occurrence and regional species priorities are described. Areas of Maine identified as Significant Areas for shorebirds within the North Atlantic Region are Downeast intertidal mudflats, Gulf of Maine coastal marshes, Atlantic coastal beaches and Moosehorn NWR (uplands). Regional high priority species are piping plover, Eskimo curlew, American oystercatcher, whimbrel, red knot, and American woodcock. The final draft of the North Atlantic Regional Plan will be submitted to the National Shorebird Plan for inclusion in mid-January 2000.

BREEDING SHOREBIRD HABITAT AND POPULATIONS ASSESSMENT

Killdeer

Killdeer are noisy and restless plovers, marked with two broad black bars on their chest, pale legs, and short, plover-like bill. Killdeer are arguably the most widely distributed and most common of all North American shorebirds. They breed across southern Canada, west to British Columbia, and south to South America. Nesting killdeer require open areas with a gravel component for cryptic concealment. They nest in heavily grazed meadows, edges of pasture ponds, and dry uplands, but they can also be found nesting on lawns, golf courses, cemeteries, driveways, parking lots, gravel pits, airports, and cultivated fields (DeGraaf and Rudis 1986). Killdeer feed on beetles, grasshoppers, caterpillars, ants, bugs, caddisflies, dragonflies, centipedes, spiders, earthworms, and various other invertebrates (Bent 1929).

Past killdeer habitat

The amount of nesting habitat available to killdeer before European settlement was most likely limited to natural forest openings, edges of inland ponds and lakes, and gravely areas along the coast. Breeding habitat in Maine increased in the 18th and 19th centuries as settlers cleared the forest for agriculture.

In Maine during 1880 - 1925, 1,280,000 acres were annually devoted to hay production to satisfy the lumber industry and hay markets in cities along the Atlantic coast. After 1910, with the development of motorized equipment, the hay market rapidly diminished. Only 750,000 acres were devoted to hay in 1940 (Day 1963).

Agriculture continued to rapidly decline in Maine because of increasing costs of farming and taxes; small farms were abandoned for jobs in the cites. Small family farms that raised hay and maintained pasture for sheep, beef, and dairy animals made way for large holdings of potatoes and poultry (Day 1963).

Killdeer adapted to the loss of pasture and hay fields by nesting around such manmade landscapes as lawns, cultivated fields, roadside areas, airports, gardens, and gravel pits.

Current killdeer habitat

Presently, killdeer breed in every county of Maine; the largest concentrations are in York, Cumberland, Androscoggin, Sagadahoc, Lincoln, Knox, Waldo, Hancock, and Penobscot counties. Killdeer are also common along the coast in Washington County, and in the agricultural areas in eastern Aroostook County (Adamus 1985b).

Projected killdeer habitat

Killdeer breeding habitat in Maine seems secure, because this shorebird has adapted to nesting in grassy, open fields and waste areas often associated with development.

Past killdeer population

Killdeer were common in New England until the late 1800's, when shooting reduced their numbers such that they were believed to have been nearly extirpated.

After 1920, with protection from the Migratory Bird Treaty Act, killdeer numbers gradually increased (Bent 1929).

Current killdeer population

According to the Breeding Bird Survey (BBS), the Maine killdeer population has remained stable with a trend estimate of 0.57 (p = 0.90) between 1980 to 1998, although a more recent period, 1990 to 1998, shows a significant decline of -7.54 (p= .06) (Sauer et al. 1999). In Maine, there is little information on breeding killdeer numbers, however, they are believed to be common and widespread throughout the state.

Projected killdeer population

Given their breeding habits and requirements, it is reasonable to assume killdeer numbers in Maine will remain stable. If the Breeding Bird Survey continues to indicate a declining trend for killdeer in Maine, further survey work may be warranted.

Common Snipe

Common snipe are a medium-sized shorebird with a large, white belly, a prominent, white, trailing edge to the wing, and a long bill. Common snipe are hunted and somewhat resemble Maine's more popular gamebird, American woodcock.

In North America, the breeding range of common snipe is restricted primarily to peatlands within the boreal forest biome, from Alaska across Canada and into Maine.

Isolated populations can be found breeding in bogs and marshes south of the Northern Forest Zone (Tuck 1965).

According to DeGraaf and Rudis (1986), in Maine breeding habitat consists of wet lowland areas with short scanty vegetation for nesting and brood cover, adjacent to large open areas used for courtship activities. Moist organic soils are needed to provide snipe broods with earthworms, crustacea, arachnids, and mollusks. Snipe can be found nesting in sedge meadows, willow and alder swamps, bogs, and saltwater and freshwater marshes (DeGraaf and Rudis 1986).

Gibbs and Melvin (1990) found snipe preferred wetlands larger than 25 ha. In their survey of 8 Maine peat lands, Stockwell and Hunter (1985) found snipe were abundant in the Fen vegetation type. Fens on their study area were described as a carpet of sphagnum and sedge species, interspersed with tamarack and red maple shrubs, surrounding shallow pools on the peat surface. Smaller shrubs of swamp rose, sweet gale, and buckbean were also present.

A study of nesting common snipe by Tuck (1965), reported a very interesting brood rearing strategy. According to Tuck (1965), the male common snipe arrives on its breeding area ten days to two weeks before the first females. Males establish a territory upon arrival. When the female arrives, she begins to explore potential nest sites, usually before pair formation. She may make several scrapes before selecting one. The scrape is usually located in a dry place where the female adds grasses and leaves for lining before the first egg is laid.

Similar to most shorebirds, the typical clutch size is four. The female incubates the eggs for about 18 - 20 days. After hatching, the precocial chicks are brooded at the

nest until dry. The oldest one or two chicks are called away from the nest by the male and are brooded and cared for entirely by the male; the female raises the remaining chicks entirely separate from the male and his brood. The divided, parental responsibility of the common snipe is unique among shorebirds.

Past common snipe habitat

Nesting habitat available to snipe during colonial times was limited to peatlands and sedge meadows in natural forest openings. Nesting areas in Maine likely increased somewhat during the 18th and 19th centuries with the establishment of pasture land in wet lowland areas. After 1920, Maine agriculture rapidly declined (Day 1963). Many earlier pastures reverted to willow and alder meadows, further improving nesting habitat. However, as plant succession continued and reforestation occurred, nesting habitat has again been limited to transitional zones surrounding natural peatlands and sedge meadows.

Current common snipe habitat

Common snipe nest in every county in Maine; the greatest number are in Washington, Penobscot, Kennebec, and Aroostook Counties (Adamus 1985). Peatlands in eastern and northern Maine, and wet meadows associated with the Penobscot and Kennebec River watersheds, provide large areas of nesting and brood habitat.

Projected common snipe habitat

Snipe habitat is potentially threatened by reforestation and development. Presently development on inland wetlands is regulated by the Maine Department of Environmental Protection (DEP). With strong wetland protection regulations, and the existing widespread habitat, it would seem that Snipe breeding habitat in Maine is relatively secure.

Past common snipe population

Common snipe populations did not suffer the over exploitation most other shorebird populations endured during the late 1800's. Since snipe do not exhibit the flocking behavior of most shorebirds, large numbers could not be killed at one time. The bogs and marshes where they feed were also not as accessible for hunting as were other shorebird habitats (Fogarty et al. 1977).

In the late 1930's, drought on the breeding range, and extended cold periods on the winter range, severely reduced the continental population (Fogarty et al. 1977). In response, the USFWS closed the hunting season on snipe from 1941 to 1953. Canada also afforded partial protection by reducing the daily bag limit. The population recovered enough to resume hunting in 1954. Since 1954, snipe hunting has not achieved its former popularity.

In Maine, Palmer (1949) described Snipe as common transients in fall and fairly common in spring, and, as a summer resident, "probably fairly common in eastern and northern counties." Unlike Fogarty, Palmer suggested Maine's population was affected by heavy gunning prior to 1941, although no harvest numbers were reported. With the

season closure, Palmer believed the species was increasing slightly in eastern Maine, but numbers were still low.

Current common snipe population

Fogarty et al. (1977) described snipe as common to abundant throughout its major ranges in North America. In the Breeding Bird Survey (BBS), snipe have shown a slight increasing trend in the northeast between 1960-1998 of 2.2% (p=0.14) based on 102 routes. In Maine the BBS shows a slight increasing trend of 2.7% (p=0.49) between 1990 - 1998, based on 29 routes (Sauer, J. L. et al. 1999). Annual harvests in the United States may approach 900,000 (Fogarty et al. 1977).

Information on the status of Maine's breeding snipe is deficient. Gibbs and Melvin (1990) found snipe present on 19 of 73 wetlands surveyed in southern, central, and eastern Maine. The Maine Breeding Bird Atlas reported snipe nesting in every county in Maine (Adamus 1985). Recent BBS data show snipe was reported on 35 out of a possible 56 routes in Maine (Sauer et al. 1999). Currently, snipe can be harvested in Maine during a 90-day season between Sept. 1 and Dec. 16, with an eight bird daily bag limit and 16 bird possession limit.

Presently, there are no annual records on the number of snipe harvested in Maine, although harvest data may soon be available from the Migratory Bird Harvest Information Program.

Projected common snipe population

Unless Maine suffers catastrophic drought for several breeding seasons, or snipe hunting greatly increases in popularity, Maine's breeding common snipe population should remain stable. No measurable changes are anticipated in the near future.

Spotted Sandpiper

This small shorebird is probably the most common shorebird in North America. Its small size, pale legs, and bold, thrush-like, spotted breast, along with the constant tail bobbing action, make this bird easy to identify. Spotted sandpipers (spotteds) nest from Newfoundland, west to Alaska, and south to South Carolina, Texas, and New Mexico. They breed throughout New England, usually in vicinity of fresh water, often along edges of ponds, rivers, islands, and lakes (DeGraaf and Rudis 1986). In Maine, spotteds commonly nest along coastal beaches, offshore islands, inland rivers, and lakes.

Nests are solitary or in loose colonies, often under shrubs, weeds, or tall grass up to 30 inches high. Females are polyandrous, and arrive on the breeding grounds before males to establish territories. They will mate with up to four males, laying as many clutches. Males are also territorial and will incubate and care for the young of a single nest (Lank et al. 1985). Spotted sandpipers feed on a wide variety of insects, beetles, caterpillars, grasshoppers, and crickets. They also prey on crustaceans, small fish, and fish fry (Bent 1929).

Past spotted sandpiper habitat

Spotted sandpiper nesting habitat along the rivers, lakes, coast, and offshore islands, probably has changed little since pre-colonial Maine. Whereas some natural nesting areas were lost to development in the 17th and 18th centuries, habitat was also created when forests around wetlands were cleared for agriculture.

Current spotted sandpiper habitat

Spotteds have been reported breeding in every county in Maine, most commonly along the coast, offshore islands, the Kennebec and Penobscot River waterways, and the ponds and lakes of northern Piscataquis County (Adamus 1985).

Gibbs et al. (1991) found spotted sandpipers on 40 of 87 wetlands surveyed in central and eastern Maine. Spotteds used wetlands that had extensive aquatic-bed and emergent vegetation, a large wetland area, and extensive shoreline development. Most wetlands used by spotteds in this study were greater than 1 ha. Wetlands of this nature are common throughout Maine.

Projected spotted sandpiper habitat

Given the existing widespread area of inland and coastal spotted habitat, and protective wetland legislation such as the Shoreland Zoning Act and NRPA, it would seem that spotted sandpiper breeding habitat is relatively secure.

Past spotted sandpiper population

Various sources from the early 1800's report that spotted sandpipers were very common and abundant in New England (Bent 1929). According to Palmer (1949), spotteds were less numerous along the coast and islands in the decades following 1900. Palmer had no information on the status of inland populations at that time. He believed that after 1940, the coastal breeding population increased.

Current spotted sandpiper population

Spotted sandpipers are common and widespread in New England (DeGraaf and Rudis 1986). According to the BBS, the spotted population has shown little significant change from 1966 through 1987 (Droege and Sauer 1987). Spotted sandpipers can be found nesting along the entire coast of Maine and seemingly on every coastal island. They are a common sight on inland rivers, ponds, and lakes.

Projected spotted sandpiper population

The spotted sandpiper breeding population in Maine should remain stable given current protective wetland legislation. No measurable changes are anticipated.

Willet

Willets are one of the larger species of shorebird, a heavy bird with medium-length bill, and long, thick, blue-gray legs. In flight, a brilliant white wingbar crosses the entire wing, contrasting with the black outer wing.

The eastern subspecies (semipalmatus) breeds along the Atlantic coast of North America. Localized populations occur on Prince Edward Island, Nova Scotia, eastern and southern Maine, and Massachusetts. Populations commonly occur from Long Island, New York, south to Florida (Hayman et al. 1986).

Willets typically nest in saltwater marshes, but they have been found in open fields and brushy pastures near salt marshes in Nova Scotia, and recently in a sphagnum bog in eastern Maine (Wells and Vickery 1990). Willets feed on aquatic insects, marine worms, small crabs, mollusks, fish fry, and fish (Bent 1929).

Past willet habitat

Prior to 1870, willets were described as occasional breeders within the limits of New England, preferring sandy islands, sand dunes, and salt marshes (Forbush and May 1955). After 1870, there were no records of nesting willets in Maine until 1971 (Adamus 1985b). Willets however, occurred regularly as fall migrants, utilizing the extensive salt marshes in the Scarborough region (Palmer 1949).

Current willet habitat

Willets were first confirmed breeding in Maine in 1971 (Adamus 1985). Since 1971, they are reported to nest on Petit Manan National Wildlife Refuge in Steuben, Corea Heath in Gouldsboro, Rachel Carson National Wildlife Refuge in Wells, Scarborough Marsh in Scarborough, Biddeford Pool in Biddeford, and areas located in Winter Harbor (Adamus 1985). In New Jersey, Burger and Shisler (1978) found willets typically selected nest sites on high ground in salt marsh dominated with *Spartina*

alterniflora and *Spartina patens*. In 1987, Jacobson et al. surveyed tidal marshes in Maine. A total of 3,071 discrete marshes were recorded constituting about 79 km^2. Sixty-eight percent of the total marsh area occurs in Wells embayment, Saco Bay, and the Kennebec River estuaries. These marshes are predominantly high salt marsh dominated by *S. patens* interspersed with lower zones of low grass, *S. alterniflora* (Jacobson et. al 1987). Wells and Vickery (1990) reported a small group of willets nesting in sphagnum bog, a habitat notably different from salt marsh normally utilized by willets. Sphagnum bogs are numerous in eastern Maine and may provide additional willet nesting areas. It would seem Maine habitat conditions can provide for a willet population that is increasing and expanding its breeding range.

Projected willet habitat

Willet nesting habitat may be threatened with human related disturbances from surrounding development. Most of Maine's salt marshes are located in the two fastest growing counties, York and Cumberland. Unless existing willet habitat receives protection from disturbance, carrying capacity may decrease in the future.

Past willet population

Willet was not a clearly documented breeding species in Maine before 1971 (Finch 1971). Willets were documented as regular fall migrants (Palmer 1949).

Current willet population

Willets were first reported breeding in Biddeford and Kennebunkport, Maine in 1971 (Finch 1971). Information on the number of breeding willets in Maine is deficient; however, in 1983, the Maine Breeding Bird Atlas confirmed willet nesting on salt marshes north to Scarborough (Adamus 1985). In 1987, 6 - 7 pairs were reported on Petit Manan (Widrig 1988), and 8 adult willets were found nesting in Corea, Hancock County (Wells and Vickery 1990).

In June 1997, over 300 willets were observed incidentally during sharp-tailed sparrow surveys on portions of Rachel Carson National Wildlife Refuge in southern Maine (MDIFW file data). It can be assumed that many of these individuals were nesting, as the sharp-tailed sparrow surveys coincide with the willet breeding season and field crews reported being mobbed by noisy groups of willets, a strategy willets use to protect nesting territories from intruders (Bent 1929).

Projected willet population

Although current information is extremely limited, it may be assumed that Maine's willet population is below carrying capacity. Given current habitat availability, and with protection from disturbance, Maine's willet population should remain stable or increase, filling in the gap between Long Island, N.Y. and Nova Scotia populations.

<u>American Oystercatcher</u>

American oystercatchers are recognized by their distinctive black and white pattern and bright orange bills. Juveniles have very brown dorsal plumage, gray legs,

and a bill that is pale orange with a dark tip. Second year birds have brownish-black rather than black dorsal plumage, orange bills, and light pink legs. Females are larger than males, with identical plummage (Bent 1929).

The range of the American oystercatcher extends from the Atlantic and Gulf coasts of the U.S. into Central and South America, the Pacific coast, and the Galapagos Islands (Bent, 1929). Oystercatchers typically nest on rocky or pebbly beaches, edges of exposed coral reefs, sand dunes, and on the wrack of salt marsh islands (Myers et al. 1998). The nests are merely scrapes in sand or similar substrates. The monogamous pair exhibits site fidelity to the breeding territory (Myers et al. 1998). Typically, one to four eggs are laid. Both sexes participate in incubation, which lasts 24 - 29 days (Humphrey 1990). Fledging occurs between 28 - 40 days. Juveniles remain with their family units after fledging and during southward migration (Myers et al. 1998). American oystercatchers feed on mollusks, marine worms, and echinoderms. They pry limpets from rocks by inserting their bill between shell and rock (Heppleston 1972).

Past American oystercatcher habitat

American oystercatchers are believed to have once nested along the entire Atlantic coast as far north as Labrador (Forbush and May 1955). By the turn of the century, American oystercatchers were considered rare or accidental north of Virginia, despite existing breeding habitats located from New Jersey to Nova Scotia (Humphrey 1990).

Current American oystercatcher habitat

Suitable nesting habitat for oystercatchers occurs in Maine coastwide, from sandy beaches in southern Maine to the many cobble and gravel shorelines in eastern Maine and offshore islands. Both documented pairs of oystercatchers nesting in Maine were on cobble shores of islands; non-breeding individuals were also observed foraging on the outer edge of islands. Oystercatchers have exhibited flexibility in nesting habitat selection in other parts of their range. In New York, New Jersey, and North Carolina, oystercatchers reportedly shifted from beaches to inland saltmarsh habitats, probably in response to human disturbance (Lauro and Burger 1989, Frohling 1965, Shields and Parnell 1990). In Florida, Toland (1992), observed oystercatchers successfully nesting on forested islands, with nest scrapes located in decaying pine humus 7 -10 meters within the forest. Use of atypical forested habitat was attributed to disturbance from intensive human recreational activities on Florida beaches.

Projected American oystercatcher habitat

Given American oystercatchers ability to nest in a wide range of habitats, Maine should be able to support a breeding population coast wide. However, competition with gulls and terns for nesting sites, coupled with gull predation of oystercatcher chicks, could seriously limit the functional carrying capacity for oystercatchers on the Maine Coast.

Past American oystercatcher population

As previously discussed, the American oystercatcher is believed to have nested along the entire Atlantic coast. However, in the 1800's, American oystercatchers were considered common only in Florida and Georgia (Bent 1929). They expanded their range to New Jersey in 1812. Few records exist prior to 1900 north of New Jersey (Bent 1929). Audubon recorded them as far north as Cape Whittle, Labrador in the 1830's, however, because of a later boundary change, the nest in Cape Whittle that Audubon observed, is now part of Quebec (Mawhinney et al. 1999). Forbush (1912) had information that oystercatchers were seen occasionally in Calais, Maine.

Unfortunately, market hunting caused a severe decline in the northern part of the American oystercatcher range, extirpating them from areas north of Virginia (Myers et al. 1998). After 1918, with the passage of the Migratory Bird Treaty Act, numbers gradually began to increase. Although, the population grew from Virginia southward, its range did not expand northward for 30 years after the act was passed. In the late 30's their breeding range expanded north into Maryland, to New Jersey by 1947, and New York by 1957 (Myers et al. 1998). By 1979, there were at least 18 pairs nesting in Massachusetts, which increased to 77 pairs by 1992 (Myers et al. 1998). Rhode Island estimated a breeding population of 48 in 1997 (Myers et al. 1998). Until 1994, there were no breeding records in Maine.

Current American oystercatcher breeding population

In 1994, the first American oystercatcher nest in Maine was found on Little Stratton Island, York County; unfortunately, this first attempt was washed away by high

tides. In 1995 and 1996, one pair of American oystercatchers nested successfully on Little Stratton, producing 2 fledglings each year. The pair nested again on Little Stratton in 1999, producing three eggs, two hatched but both chicks were depredated by gulls (MDIFW file data).

Another pair of American oystercatchers was observed all summer in 1997, on the Isle of Shoals; nesting was not documented. A third pair nested on Green Island, Washington County, in 1997, and fledged two chicks. In 1998, the Green Island pair nested again, but it was not determined if any young survived to fledge (MDIFW file data).

A pair of oystercatchers was observed off of Deer Isle in 1998, and on Ship Island in Penobscot Bay in 1999, nesting was not confirmed in either observation.

To our north, Canada's first pair was observed nesting on Cape Sable Island, Nova Scotia in 1997. Three chicks hatched on Cape Sable, but were believed to have been depredated by gulls (Mawhinney et al. 1999).

Projected American oystercatcher population

It is difficult to predict whether Maine will host a permanent breeding population of American oystercatchers, or if recent nesting records represent extralimital nesting. The history of this species demonstrates its ability to successfully expand its range northward. Maine offers a large expanse of suitable nesting habitat for American oystercatchers, but more research is required to evaluate limiting factors before potential for permanent expansion in Maine can be determined.

MIGRATORY SHOREBIRD HABITAT AND POPULATIONS ASSESSMENT

Coastal Migration Staging Areas and Winter Habitat

Habitats used by migrating and wintering shorebirds range from intertidal mudflats, to sandy beaches, to rocky intertidal areas. Food resources, consisting of intertidal invertebrates, and suitable roosting sites in close proximity to feeding areas, are the two most critical factors in determining shorebird distribution (Morrison and Harrington 1979).

Roosting areas provide migrating shorebirds time to sleep and preen during high water cycles (nonfeeding times), thus reducing energetic costs and maintaining a positive energy flow. This is critical if these migrants are to acquire the large fat reserves necessary to fuel their transoceanic migration to wintering areas (Myers 1983). Flocking behavior at roosting sites reduces the risk of predation, and may provide social stimulation within the flocks serving to synchronize migration (Handel and Gill 1992).

Banding studies have shown shorebirds exhibit strong site fidelity to staging and wintering areas having adequate feeding and roosting sites, and do not easily switch to alternative areas (Myers 1983). Smith and Stiles (1979) banded over 1500 individuals of 29 species at a staging area in Costa Rica, and found that not only did several species show strong site fidelity, but Western Sandpipers also demonstrated strong flock fidelity.

Past migration and wintering habitat

Maine has over 3500 miles of coastline with 78 miles of sandy beaches (Keeley 1988), which migrating shorebirds and wintering purple sandpipers have invariably depended on for feeding and roosting habitat. Total tidal wetlands in Maine is estimated to be 112,000 acres; this includes 19,840 acres of tidal marshes, 53,760 acres of tidal mudflats, and 38,400 acres of beach front (Krohn et al. 1998).

Approximately 90% of the tidal marshes that existed on the U.S. Atlantic coast prior to 1885, were drained by ditching by 1938 (Howe 1983). However, in Maine, land use on the coast (especially in eastern Maine) changed little during this period, thus allowing shorebird habitat to remain relatively secure (Anon. 1988). The heaviest losses of wetlands in the Northeast were caused by urbanization and occurred between the early 1950's and mid 1970's. Tidal mudflats changed little during this period, but an estimated 37,000 acres of emergent wetlands were drained for development in the northeast (Andrews 1987).

In Maine, during 1954-1964, the Coastal Wetlands Inventory showed a loss of only 50 acres of coastal wetland (USFWS 1965). Although few acres of wetland were lost in Maine directly to filling or dredging, wetland habitats suffered from secondary impacts associated with shoreline development, especially in York and Cumberland Counties. Degradation of water quality from sewage, chemical pollution, and agricultural pollution have decreased shorebird habitat. Excessive pollutant discharge into intertidal flats results in the closure of large areas along the coast to shellfish harvesting. Department of Marine Resources reported in 1974, that 21% (9,758 acres of 46,135 total acres) of clam flats in Maine were closed because of pollutant

contamination, and ranged from 8% in Washington County to 98% in York County (Widoff 1988).

Another secondary impact from development is the increase of disturbance to feeding and roosting shorebirds by human intrusion. However, there is no estimate of the amount of habitat affected in Maine by disturbance. With shorebird habitat shrinking all along the Atlantic coast, Maine's existing feeding and roosting sites have gained considerable importance.

Current migration and wintering habitat

Today, the Maine coast offers feeding and roosting habitat for southward migrating shorebirds as well as wintering purple sandpipers. Each species has preferred feeding and roosting habitats. Species requiring sand and gravel beaches and salt marsh (e.g.. yellowlegs, willet, sanderling, stilt sandpiper, and others) are more commonly found in Casco Bay, Saco Bay, and Penobscot Bay.

Eastern Maine offers highly productive intertidal mudflats attractive to semipalmated plovers, black-bellied plovers, semipalmated sandpipers, white-rumped sandpipers, whimbrels, dowitchers, red knots, and others.

Famous and Ferris (1980:14-34) identified the coastal zone from Trenton Bay east to Perry as "probably the most important fall migratory stopover area in the eastern U.S. for semipalmated sandpipers, semipalmated plovers, white-rumped sandpipers and whimbrels." The largest known semipalmated sandpiper and semipalmated plover roost in the eastern U.S. was located in Wards Cove, off of Ripley Neck, Harrington, which annually hosted more than 40,000 semipalmated sandpipers and 2,400

semipalmated plovers between July and October (Famous and Ferris 1980). The extensive flats along the Pleasant and Harrington Rivers, Flat Bay, Back Bay, and Narraguagus Bay are important feeding areas. Recent surveys suggest over 21,000 shorebirds continue to use the Harrington - Addison mudflats for feeding, and have established eight different roost sites in addition to Ripley Neck (MDIFW file data). This region qualifies as a potential Regional Shorebird Reserve within the Western Hemisphere Shorebird Network of Shorebird Staging Areas (Harrington and Perry 1995).

McCollough (1981) sampled invertebrate densities on nine areas in Cobscook and Machias Bays and found densities ranging from 2,600 to 83,000 invertebrates per m^2. This compared favorably with invertebrate densities of 2,000/m^2 to 52,744/m^2 sampled in the Bay of Fundy by Hicklin and Smith (1984). The Bay of Fundy annually supports 1.2 to 2.2 million shorebirds from late July to mid August, coinciding with the period of maximum invertebrate production (Hicklin 1987, Mawhinney et al. 1993).

Wilson (1990) investigated the relationship between prey (*Corophium volutator.* > 4 mm. long) abundance and foraging site selection by semipalmated sandpipers. He determined the threshold density, above which feeding rate is not constrained by prey abundance, falls between 625/m^2 and 2,000/m^2.

Concentrations of over 50,000 semipalmated sandpipers were observed in the late 1970's in Eastport, South Lubec, and Machias Bay (Famous and Ferris 1980). The Manomet Bird Observatory has listed Lubec flats and Ripley Neck in Harrington, on the twenty most important fall stopover sites in the U.S. (Harrington 1984).

Since 1984, however, recent surveys suggest the use of Lubec, Eastport, and Machias Bay mudflats by migrating shorebirds has declined (MDIFW file data).

Data collected by McCollough (1981) in Eastern Maine, suggested carrying capacity had not been reached . This was evident in two ways; 1) decline in invertebrate densities measured on these feeding areas during the southward migratory period was less than reported for major shorebird areas in the Upper Bay of Fundy and Massachusetts, and 2) Eastern Maine shorebird diets observed at that time overlapped broadly by prey taxa. When prey is limited, each species withdraws into its exclusive niche, foraging on a certain resource more efficiently, and thus decreasing diet overlap between species. Therefore, it appeared that invertebrate prey were in abundant supply throughout the migratory season.

The transient character of migrating shorebirds can prevent large-scale depletion of intertidal invertebrates in Eastern Maine (McCollough 1981). Studies in the Bay of Fundy have found migratory shorebirds may cause a temporary reduction in invertebrate densities, but by removing larger individuals (>4mm), the younger cohorts grow and multiply, free from competing adults. By late September, total densities of invertebrate prey are as high or higher than densities prior to migration in early July (Peer et al. 1986).

Survey data from 1991 - 1998 suggest the number of shorebirds utilizing staging areas in the Eastport/Lubec area has greatly declined (MDIFW file data). Information on carrying capacity of current staging areas in Maine is limited. There are no recent studies of invertebrate density on shorebird feeding flats.

Invertebrate density is no doubt a major factor affecting numbers and distribution of shorebirds. Adequate roosting sites, however, may be just as critical. Migrating shorebirds exhibit a strong degree of site tenacity within their respective staging areas (Myers 1983). Roosting habitats must have minimal human and animal disturbance, and remain above water during high tide. Large roosting areas are limited along Maine's coast and are extremely sensitive to disturbance (Famous 1987). Approximately half the roosting sites used during 1979-1980 in Cobscook Bay, are now abandoned (M. McCollough, MDIFW, pers. comm.).

Johnson Cove, Easport, is an example of a shorebird roost dramatically affected by disturbance. In 1980, over 5,000 shorebirds were recorded roosting on the beach in Johnson Cove (MDIFW file data). With the establishment of salmon pens in Johnson Cove, the numbers of roosting birds dropped dramatically to less than 1,000 in 1991; no shorebirds were observed at the roost site during 1997 and 1998 surveys. With employee parking on the beach, and support activities associated with transporting feed and personnel to the pens, it is assumed that the level of disturbance is more than the birds will tolerate. Shorebirds continue to use nearby feeding flats, but recent numbers of birds observed are only half of those observed in 1980 (MDIFW file data).

Shorebird abundance at Maine staging areas appear to be declining. More research is required to determine if this is a result of habitat degradation or from declines in hemispheric populations.

Phalaropes demonstrate an even more perplexing decline on their pelagic staging area in Maine. The tidal rips in the mouth of Passamaquoddy Bay traditionally supported 1/2 to 2 million red-necked phalaropes annually, which may have constituted

the largest concentration in the North Atlantic (Famous and Ferris 1980). Beginning in 1985, the number of phalaropes feeding in Passamaquoddy Bay began to decline. In 1985, flocks of 20,000 red-necked phalaropes were reported; in 1986, only 2,000 Phalaropes were seen; in 1987, 200 birds were reported, and, by 1989, there were none (C. D. Duncan, Inst. Field Ornithol., pers. commun. to A. E. Hutchinson, MDIFW). Whether this decline is a function of habitat or population trend is currently being studied by the Canadian Wildlife Service.

Winter shorebird habitat

The purple sandpiper is the only shorebird species that regularly winters along Maine's coastline. Flocks of ruddy turnstones, sanderlings, and dunlins have also been observed wintering in Maine. Wintering areas important to purple sandpipers are found along the mainland and offshore islands where they feed on small shrimp, crabs and mollusks amongst the rockweed (Bent 1929). Information on habitat requirements of wintering shorebird species in Maine is lacking, and should be investigated to determine carrying capacity and limiting factors.

Projected migration and wintering habitat

Rapid and unprecedented change is occurring along the Maine coast. Human populations in coastal communities have increased by as much as 40% since 1978 (Anon. 1988). Preferred resting habitats for larger (>1000) flocks of shorebirds are beaches and sand spits, but these areas are subject to high levels of human disturbance and habitat modification from development (Famous 1987).

Currently, shorebird feeding, nesting, and roosting sites in Maine are offered some protection through NRPA. Shorebird habitats face degradation from increasing development and other human-related disturbances. Aquaculture, which is NRPA exempt, is a recent and growing industry along the entire eastern U.S. coast. Aquaculture is one of Maine's fastest growing industries, increasing tenfold from 1985 - 1995 (Anon. 1998). The rapid expansion of this industry raises concerns such as the impact of waste discharges and related disturbances to wildlife habitats, including shorebird areas. Under such circumstances, functional shorebird habitat will diminish, lowering carrying capacity of existing sites and the shorebird resources that utilize them.

Past migratory and wintering populations

Historical records of shorebird populations before 1870 are deficient, however, several accounts indicate that shorebirds were once very abundant. Beginning in the 1860s, as waterfowl populations drastically declined, market hunters turned to shorebirds to satisfy the meat and millinery markets. Maine shorebirds were shipped by the barrel to Boston. By the 1890s, shorebirds were becoming scarce. The Journal of Maine Ornithological Society reported in 1900, " Where a few years ago our beaches and tide flats afforded thousands of the different species, ... flock after flock, each numbering hundreds could be seen running along the beach,... now there will be days and days that not a bird of this species will be seen." (Anon. 1900:54-55pp). In 1905, a 50 - 75% decrease in shorebird populations was estimated; also, up to a 95% decline in upland sandpipers, golden plovers, and the curlews was noted (Forbush 1905). After shorebirds received protection by the Migratory Bird Treaty Act, most species made

remarkable recoveries. However, they probably have not reached pre-1870 population levels (Famous and Ferris 1980).

Current migratory populations

There is a lack of information on population size and trends of North American shorebirds. Throughout the migratory period, shorebird numbers fluctuate as flocks depart for the next staging areas and new birds arrive, making exact counts impossible.

In 1972, Manomet Bird Observatory developed the International Shorebird Survey (ISS) to collect and compile census data of shorebird populations migrating along the Atlantic coast. The purpose of the ISS is to identify areas of major importance to migrating shorebirds. Howe et al. (1989), looked at ISS data for 12 species observed between 1972 and 1983, at ISS sites along the United States Atlantic coast, to derive population trend estimates. Actual numbers of individuals were impossible to estimate because of survey inconsistencies, nevertheless, they were able to conclude that populations of three species (whimbrel, short-billed dowitcher, and sanderling) showed significant declines. Black-bellied plover exhibited a nearly significant decline, and the remaining species showed no significant changes.

Analysis of data from the Maritimes Shorebird Survey by Morrison et al. (1994), indicated declines in a number of shorebird populations during the period 1974 - 1991. Significant declines were recorded for least sandpiper, semipalmated sandpiper, and short-billed dowitcher. Declines occurred during the latter part of the 1970s followed by increases during the first half of the 1980s, with less tendency towards declines in the

later years of the analysis. A series of cold summers on the breeding grounds during the 1970's may have led to the observed declines (Morrison et al. 1994).

Surveys of northbound migrant shorebirds at Delaware Bay, N.J., from 1986 through 1992, revealed significant declining trends in semipalmated sandpipers and sanderlings (Clark et al. 1993).

Various surveys have given estimates of populations passing through Maine. Twenty species commonly use staging areas in Maine, and six other species are considered infrequent or occasional visitors. According to Famous and Ferris (1980), coastal staging areas supported a transient population of over 300,000 semipalmated sandpipers in the 1970's. This was an estimated 6 -10% of the total population migrating along eastern North America (Spaans 1978). In 1980, McCollough (1981) estimated more than 96,000 semipalmated sandpipers roosting on sites in Cobscook and Machias Bays. More than 7,000 semipalmated plovers were also noted.

As previously discussed in the Current Habitat section of this assessment, it is unknown if numbers of shorebirds in Maine are currently below the carrying capacity of available staging area habitat. Maine shorebird population trends are unclear. Recent surveys (MDIFW file data) and personal observations have documented fluctuating shorebird numbers in eastern Maine over the last 10 years.

Of 9 feeding and roosting sites surveyed once a week in Washington County, during August 1980, 1991, and 1997, all but 1 exhibited dramatic declines in shorebird numbers (Table 2).

Table 2. Total number of shorebirds observed in 4 weekly surveys in August, Washington County.*

Site #	Location	Use type	1980	1991	1997
690	Lubec Flats, Lubec	Roosting area	3,732	521	1,880
691	Lubec Gravel Bar, Lubec	Feeding area	5,850	2,300	2,997
694	Lubec Town Roost, Lubec	Roosting area	5,684	258	40
696	Carrying Place Cove, Eastport	Feeding area	7,364	5,506	1,895
697	Broad Cove, Eastport	Feeding area	6,044	45	693
698	Johnson Cove, Eastport	Roosting area	4,980	2,006	0
687	Woodruff Cove, Machiasport	Feeding area	2,024	496	142
688	Looks Canning, Cutler	Feeding area	1,170	2,429	1,055
701	Half moon Cove, Perry	Feeding area	6,807	380	4

*MDIFW file data

Current wintering shorebird populations

Purple sandpiper is the only shorebird species that is a regular winter resident in Maine. Eastern Maine and New Brunswick support one of the largest known wintering purple sandpiper populations in North America. Flocks of less than 100 are common, but flocks of 500 to 1000 may occasionally be seen (Famous and Ferris 1980).

Presently, the only survey that even touches upon wintering purple sandpiper numbers is Audubon's Christmas Bird Count (CBC). An analysis of CBC data found the location of highest abundance was consistent over the years examined and distributed from Cape Cod to Nova Scotia, with the highest density along Maine's coast from Bath to Bar Harbor. Purple sandpiper observations in Maine recorded during the 1998 CBC totaled 670 (Root 1999). That same year, observers surveying Harlequin ducks (*Histrionicus histrionicus*) in outer Penobscot Bay, incidentally recorded more than 2,700 Purple Sandpipers (MDIFW file data). More comprehensive survey work is needed for an accurate population estimate and trend analysis.

Projected migratory and wintering populations

Howe et al. (1989) observed annual fluctuations of 5 to 13% for all shorebird species in his analysis. This reflects vulnerability of shorebird populations nesting in arctic or subarctic sites where severe spring weather in some years may inhibit reproduction. Such short-term declines, however, are offset by high survivorship of adults. One would expect, as long as shorebird survival remains high during migration and on their wintering grounds, that populations will remain stable.

Given that shorebirds exhibit a strong degree of site tenacity for migratory stopover areas, and cannot readily switch to other feeding or roosting areas, current staging areas in Maine must remain suitable to ensure the survival of local populations using them.

Inland Migration Habitats and Populations Assessment

The majority of shorebird species use staging areas in the coastal zone only. A few species, such as greater and lesser yellowlegs, least sandpiper, killdeer, pectoral sandpiper, solitary sandpiper, and white-rumped sandpiper, typically visit inland wetlands during migration. Many of these birds are feeding and resting while enroute to coastal staging areas.

Inland habitats for migrating shorebirds are primarily shallow wetlands. Water depths for foraging shorebirds range from dry mud to 7 in. Vegetation density ranges from no cover to more than 75% cover. The majority of use occurs at sites with less than 25% cover (Helmers 1992). Short vegetation is preferred, generally less than half the height of the bird. Some birds (eg. yellowlegs and snipe), however, will forage in

taller vegetation. A wide range of wetland types, such as vegetated mudflats along rivers and pond edges, moderately open shallow wetlands, flooded pastures, and agricultural fields, meet shorebird staging requirements (Helmers 1992).

Christina Reservoir, a fresh water source for potato processing in Fort Fairfield, Maine, is an example of a manmade impoundment, with seasonal drawdowns, that provides excellent habitat for large numbers of migrating shorebirds. Significant numbers have also been observed at Sebasticook Lake and Flagstaff Lake during fall drawdowns (Todd pers. communication).

Past inland migration shorebird habitat

There is little information on inland shorebird habitat trends in Maine. Losses of habitat to drainage, filling, or flooding have occurred but probably not to the extent experienced in other states.

Current inland migration shorebird habitat

Presently, there are no inland wetland surveys that accurately measure the amount of inland shorebird habitat in Maine. Data on the significance of such areas to migrating shorebird populations are largely deficient. Water level management may be influential. Seasonal drawdowns and flooding strategies can be adapted to create ideal foraging habitats for shorebirds on impoundments (Helmers 1992).

Projected inland migration shorebird habitat

Maine's wetland protection laws and regulations (the Natural Resources Protection Act (NRPA), the Shoreland Zoning Act, and the Land Use Regulation Commission (LURC) Zoning), as well as municipal zoning ordinances, have contributed to reduce land losses and should continue to offer protection to inland shorebird habitat. Water level management strategies could be employed on state owned impoundments to increase and enhance feeding areas for migrating shorebirds.

Past inland migratory population

There are no data on historic migratory shorebird numbers on inland staging areas.

Current inland migratory population

At this time, there are no surveys that adequately look at migratory shorebird numbers using inland staging areas.

Projected inland migratory population

Data do not exist to accurately project future numbers of migratory shorebirds on inland staging areas.

POPULATION LIMITING FACTORS

Breeding Populations

Breeding populations are also susceptible to disturbance. In Florida, Toland (1992) reported American oystercatchers switched from nesting on traditional open sand beaches, to nesting on islands covered with Australian Pine in response to human recreational activities along the beaches. Those pairs that nested in the forested habitat, free from disturbance, were 100% successful, whereas only 33% of the oystercatchers that continued nesting on the open beach sites were successful.

Disturbance to nesting shorebird species that cannot adapt, such as piping plover, can limit their populations. Populations of certain species, such as killdeer and spotted sandpiper, which have adapted to certain levels of disturbance, are less affected.

Depredation of eggs and chicks from black-backed gulls (*Larus marinus*) may have a significant impact on coastal breeding populations of willets, spotted sandpipers, and American oystercatchers.

In Maine, functional nesting habitat is potentially the most significant limiting factor for willets and American oystercatchers.

Migratory and Wintering Populations

Disturbance, habitat degradation, mortality on wintering areas (shorebirds are still hunted for food in many South American countries), and late winter storms on breeding areas, may all limit shorebird populations.

Human disturbance is probably the most important factor that could lead to a functional carrying capacity lower than habitat carrying capacity. Disturbance at feeding sites disrupts foraging time and causes birds to expend their energy reserves fleeing or traveling to other feeding sites. In Florida, wintering sanderlings ran or flew from beachgoers up to five times a minute. Foraging time per minute varied 26 - 60% as time devoted to alertness increased. Moreover, as the number of beachgoers increased, sanderlings concentrated on smaller, undisturbed feeding areas, consequently increasing time devoted to intraspecific aggression. To compensate for loss of foraging time, birds actually switched to feeding at night. Unfortunately, foraging time was still interrupted by joggers, who are more apt to be out in the evening enjoying cooler temperatures (Burger and Gochfeld 1991).

In one experiment, caged dunlins, acclimated to captivity, were exposed to low level human disturbance (5 minute disturbance on the hour during 10 hour diurnal interval). Birds reacted with alert behavior (standing, necks outstretched, alarm calls, and agitation such as preening and pacing). This resulted in a 8.3% decrease in gross energy intake (Morton 1991). Although wild shorebirds can move away from disturbances, locomotion behaviors, particularly flight, are energetically expensive. As disturbance levels increase, shorebirds may be unable to avoid human intrusions completely, resulting in reduced fitness.

Disturbance at roosting sites may be more detrimental. Availability of suitable roosting sites close to feeding areas is critical in determining shorebird distributions. Beaches and sandbars most commonly used for roosting sites, are uncommon in eastern Maine and are subject to high levels of human disturbance.

Disturbance interferes with daily activity patterns of the birds and exposes them to higher levels of predation at alternative sites. Predation on migrating and breeding birds by foxes, raccoons, skunks, and domestic cats and dogs can be especially limiting in areas of high development (Burger 1991).

Loss and degradation of habitat at migration and wintering areas certainly affect shorebird populations. Loss occurs mostly from urban development on coastal areas and from agricultural practices on interior areas.

Environmental contaminants, such as oil spills and agricultural pesticides, are capable of severely impacting shorebird populations. In 1990, 272 tankers used the Bay of Fundy approach to the Irving oil refinery in Saint John, New Brunswick (Love 1991). Oil traffic is as prevalent in Casco Bay and Penobscot Bay (Love 1991). Estimates ranging from 1,122,000 - 2,200,000 shorebirds, including 42 - 74% of the world population of semipalmated sandpipers, annually migrate through the Bay of Fundy (Hicklin 1987, Mawhinney et al. 1993). An oil spill in the Bay of Fundy, and consequently, contamination of feeding flats, would be disasterous. Agricultural pesticides are widely used throughout the Western Hemisphere, and shorebirds have been killed after application of pesticides on agricultural fields (Helmers 1992).

USE AND DEMAND ASSESSMENT

Historically, all shorebirds were considered game and were actively hunted for meat or sport. During the late 1800's, vast numbers were taken by market hunters, and some species, like the Eskimo curlew, were shot to extirpation. Shorebird eggs were also collected, marketed, and eaten.

Currently, the only shorebird species hunted in North America are American woodcock and common snipe. American woodcock is a popular gamebird in Maine, and common snipe are often taken incidentally.

Most shorebirds are now enjoyed by nonconsumptive users such as birdwatchers and photographers. The total number of individuals enjoying observations of shorebirds in Maine is unknown. However, Bolye et al. (1990) estimated that 90% of adult Maine residents enjoy nonconsumptive activities such as observing and feeding wildlife, and may collectively spend over $47 million per year to do so. As birdwatching gains in popularity, increasing numbers of birders will enjoy the challenge of finding and identifying all 36 species of Maine shorebirds. The National Audubon Society, The Nature Conservancy, and the Eagle Hill Center in Steuben all offer shorebird field trips and identification courses.

SUMMARY AND CONCLUSIONS

Breeding Shorebird Populations

Killdeer, spotted sandpiper, common snipe: Although little data exist on numbers of breeding killdeer, spotted sandpipers, and common snipe in Maine, indications are that all three species are abundant and widespread across the state.

Willet: Willets were first confirmed breeding in Maine in 1971. They are currently reported nesting on Petit Manan National Wildlife Refuge, Corea Heath, Winter Harbor, Scarborough Marsh, and other areas. Usually associated with high salt marsh communities, willets have recently been discovered nesting in sphagnum bog habitat. If this habitat proves to be suitable, it could greatly expand available habitat (Wells and Vickery 1990). Exact numbers of willets nesting in Maine cannot be determined without further survey work, however, it appears Maine can support a willet population that is increasing and expanding its range. Further research into nesting requirements and habitat quality is required to determine state carrying capacity. Maine's willet population is susceptible to such limiting factors as human disturbance, development, habitat contamination, and predation.

American oystercatcher : Since 1930, the American oystercatcher has steadily expanded its breeding range north from Virginia, reaching southern New England in the late 1970s, Maine in 1994, and Nova Scotia in 1997. Suitable nesting habitat for oystercatchers occurs in Maine coast wide. Possible limiting factors include human disturbance, development, competition with gulls and terns for nesting habitat,

and depredation of young by gulls. It is unknown if Maine will host a permanent breeding population or if recent nesting records represent extralimital nesting.

Migratory Shorebird Populations

Maine's coastal environment hosts 36 species of migrating shorebirds, thousands of which, after leaving their northern breeding grounds, funnel into staging areas from Kittery to Calais to accumulate vital fat reserves necessary to fuel a nonstop, transoceanic flight to their South American wintering grounds. The most productive staging areas in Maine are located in Hancock and Washington Counties. These Maine sites contribute to the Bay of Fundy shorebird habitats, which support more than 80% of certain shorebird populations during migration. Available data suggest that transient populations in Maine are potentially threatened with a declining functional carrying capacity of present staging areas.

Shorebird reproductive strategy is such that low recruitment rates are offset by high adult survival. Populations are, therefore, most sensitive to factors that decrease survival in areas other than the breeding grounds.

There are few locations along the southward migration path that provide adequate food resources, in conjunction with nearby suitable roosting sites at the appropriate time, to meet energetic requirements. Shorebirds seem to exhibit extreme fidelity to traditional staging areas. If habitats are degraded from development, pollution, or disturbance, birds do not readily relocate to new areas. If traditional staging areas become unsuitable, these transoceanic migrants cannot obtain the energy

reserves needed to complete their migration to the wintering grounds and survive to the following breeding season.

Existing stopover areas are critical to maintenance of shorebird populations. Without adequate protection, present habitat quality could deteriorate as a result of development, disturbance, or contamination.

Presently, the MDIFW shorebird database contains shorebird species and numbers surveyed at over 500 sites along the coast. Most of this information was gathered by MDIFW using combined aerial and/or ground surveys, starting in 1981 and continuing through 1999.

The MDIFW shorebird database lacks information regarding statewide population estimates. Although the International Shorebird Survey is performed annually in a few portions of Maine, it is not suitable for statewide trend analyses. Emphasis is placed on a few survey sites known to be traditionally important. Major portions of the coast are not surveyed, and a survey period may miss major flights taking place between consecutive sampling times.

Wintering Shorebird Populations

Purple sandpiper: The purple sandpiper is the only shorebird species that is a regular winter resident in Maine. Eastern Maine and New Brunswick support one of the largest known wintering purple sandpiper populations in North America. Most of the wintering areas important to purple sandpipers are found along the mainland as well as offshore islands and ledges. Flocks of less than 100 are common, but flocks of 500 to 1000 may occasionally be seen.

Presently, the only survey that touches upon wintering purple sandpiper numbers is Audubon's Christmas Bird Count. More comprehensive survey work is needed for population estimates and trend analyses. Information on habitat requirements of wintering sandpipers in Maine is lacking and is needed to determine carrying capacity and limiting factors.

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