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Piping Plover Ecology, Management, and Research Needs

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ABSTRACT

The Atlantic coast piping plover (*Charadrius melodus*) population was listed as threatened under the Endangered Species Act in January 1986 due to declining populations. Part of the decline is attributed to habitat loss from beach development and dune reclamation. Where plovers continue to nest, productivity is often low. Nest predation appears to be the most immediate threat to piping plovers in many areas. Although unrestricted recreational activity may be highly detrimental, nesting plovers can apparently habituate to some degree of human activity on beaches. Factors affecting chick mortality are not fully understood. We believe that foraging habitats have a major influence on the distribution and reproductive success of piping plovers on barrier islands. However, these hypotheses need to be tested.

Key words: barrier islands, *Charadrius melodus,* endangered species, foraging habitat, nesting habitat, piping plover, reproductive success.

INTRODUCTION

The piping plover is a migratory shorebird which breeds in the Great Lakes watershed, on the northern Great Plains of the United States and Canada, and along the Atlantic coast from Newfoundland to South Carolina (Federal Register, 1985). As a result of declining populations, plovers nesting in the Great Lakes watershed were listed as endangered and the remaining populations were listed as threatened under the Endangered Species Act in January, 1986 (Federal Register, 1985). Threats to this species include habitat loss, predation, and disturbance by humans (U.S. Fish and Wildlife Service, 1988).

Virginia and Maryland supported 16% of the known breeding population on the Atlantic Coast in 1987 (Piping Plover Recovery Team, unpubl. data). Barrier islands support 95% of the known breeding population in Virginia and the entire Maryland population (K. Terwilliger, pers. comm., Patterson, 1988). Successful piping plover management in these states requires a detailed understanding of factors affecting plover population dynamics on these islands. The following paper summarizes what is currently known about these issues, discusses management strategies, and identifies research needs.

BREEDING BIOLOGY

Piping plovers return in mid-March to Virginia and Maryland breeding grounds from wintering sites along the southern Atlantic Coast (Patterson, 1988, Haig and Oring, 1988). Courtship displays begin in March and nests may be initiated as early as mid-April (Patterson, 1988). Piping plovers almost always lay

clutches of 3 to 4 eggs (Bent, 1929; Wilcox, 1959; Cairns, 1977). Eggs are laid every other day (Wilcox, 1959; Cairns, 1982). Both male and female incubate, probably for approximately equal periods of time (Wilcox, 1959; Cairns, 1982). Incubation lasts 25 to 31 days (Wilcox, 1959; Cairns, 1982; Whyte, 1985; Haig, 1987). Although piping plovers raise only one brood per season, they have been observed renesting up to five times if nests are destroyed prior to hatch (MacIvor, 1990).

Plover chicks are precocial and young usually leave the nest within a few hours after hatch (Bent, 1929; Wilcox, 1959). Broods remain together until the chicks are able to fly, although it is not unusual for one of the adults to desert the brood within 7 to 10 days of hatch (Cairns, 1977; Whyte, 1985; Haig, 1987). Chicks grow rapidly and have been observed flying short distances 20 days after hatch (Whyte, 1985; Patterson, 1988).

Fledglings may remain on the breeding grounds longer than adults, and family groups probably do not stay together during migration (Cairns, 1977; Whyte, 1985). On Assateague Island, family groups began leaving feeding territories as early as mid-July, although one brood with 34-day old chicks was still on its feeding territory during the last week of August (Patterson, 1988).

NESTING HABITAT

Nests are shallow scrapes in the sand, usually placed well above the high tide line (Burger, 1987; Patterson, 1988). Nesting habitat is typically described as wide, sparsely vegetated beaches (Bent, 1929; Wilcox, 1959; Haig and Oring, 1987). Few studies have quantitatively analyzed vegetative cover at nest sites. As a result, it is not possible to identify the point at which vegetation cover becomes too dense for nesting. Niemi and Davis (1979) found that most plover nests occurred in areas with an average vegetative cover of 5%, but one of the ten nests they studied was placed in an area with 42% vegetative cover. On Assateague Island, most nests were located in sparsely vegetated areas, but 2 (2%) were found in areas with more than 50% vegetative cover (Patterson, 1988). Additionally, plovers on this island continue to nest on the Wild Beach in Virginia which has a narrow beach and a well established dune line. In 1987, 23 nests were located in this area.

FORAGING HABITAT

Little is known about plover foraging ecology or the role of foraging habitat in breeding site selection (U.S. Fish and Wildlife Service, 1988). On Assateague Island, piping plovers have nested in only a few specific areas for at least three years (1985-1987) (Ailes, 1985; Hoffman, 1985; Patterson, 1988). While these nesting areas were not readily distinguished by nesting habitat characteristics or human use characteristics, they did appear to be related to the location of foraging habitats (Patterson, 1988). These foraging habitats included bayside mud and sand flats, saltwater pools formed by storm tides, and a drawn-down waterfowl impoundment.

These types of foraging habitats appear to be important on other barrier islands as well. During recent surveys of barrier islands in Virginia, broods were more frequently observed on mudflats than on the high-energy beach (K. Terwilliger, pers. comm.). Fussell (1986) reported that some piping plover territories at Kathryn Jane Inlet, Cape Lookout National Seashore appeared to be closely associated with saltwater pools formed by a hurricane. Most of the other nesting pairs in this area were found on overwash or inlet flats that provided unvegetated access to the bay.

Areas that provided suitable nesting habitat, but were separated from the bay by zones of grass or shrub thickets were not utilized.

Preliminary analysis of data from Assateague Island suggests that chick survival was related to the type of foraging habitat used. On Assateague, broods foraging on bayside mud and sand flats had a higher survival rate than broods that utilized the high-energy beach. Possible explanations for this include greater prey abundance and/or quality on bayside mud and sand flats, greater human disturbance on beaches, or different predation rates.

POPULATION STATUS

Piping plover populations may have been declining since the 1930's (Arbib, 1979). The Atlantic coast population was estimated to be 910 pairs in 1979 (Cairns and McLaren, 1980). A more intensive survey was conducted along the Atlantic coast from Newfoundland to Virginia in 1987 yielding a population estimate of 745 pairs (Piping Plover Recovery Team, unpubl. data). North and South Carolina were surveyed in 1986 and had a combined total of 33 pairs (Piping Plover Recovery Team, unpubl. data). The population estimate for Virginia in 1987 was 100 pairs, and Maryland had an estimated population of 23 pairs. Plover populations on the Virginia barrier islands have been censused since 1975. The data from these surveys do not follow the national trend. Although there have been population shifts among islands, the overall population has not exhibited a decline (Williams *et al.*, 1987).

FACTORS CAUSING THE PLOVER DECLINE

Habitat loss resulting from human development of beaches is thought to be a major factor contributing to the recent population decline (Federal Register, 1985). However, little quantitative historical information summarizing actual loss of nesting habitat has been published. Wilcox (1959) described loss of former nesting areas in New York due to the construction of summer homes. Raithel (1983) suggested that the increase in summer home construction since the 1950's has reduced the amount of available plover nesting habitat in Rhode Island, and has been partially responsible for the population decline observed in the state. Increased construction has been suggested as a possible cause for the recent population decline observed on Cedar Island, Virginia (Williams *et al.*, 1987).

Dune stabilization efforts are thought to be responsible for reducing the amount of available nesting habitat by encouraging vegetation growth (Federal Register, 1985). Wilcox (1959) observed that plovers deserted one nesting area several years after dunes were rebuilt, and attributed this to the growth of vegetation. Raithel (1983) noted that plovers increase in areas which are flattened and devegetated by hurricanes and continue to increase until beaches are revegetated or dunes are rebuilt. He felt that part of the decline in suitable nesting habitat in Rhode Island is due to the lack of a destructive hurricane since 1954. Another way that dune reclamation may degrade breeding habitat is by decreasing the accessibility or availability of bayside mudflats and tidal pools.

Recreational use also may be responsible for a reduction in available breeding habitat. In Rhode Island, plovers failed to nest on Maschaug Beach for several years after ORV access was improved (C. Raithel, pers. comm.). In 1987, ORV use was no longer possible on a portion of South Beach Island, Massachusetts. During this season, several plover pairs nested in habitat which had been unavailable during

previous years due to the presence of ORV's (MacIvor, 1990). E. Strauss (pers. comm.) believed that several plover territories on Barnstable Beach, Massachusetts were abandoned prior to nest establishment due to the presence of recreationists.

However, in other areas, plovers have continued to nest despite the presence of vehicles and pedestrians. Plovers returned to Maschaug Beach five years after ORV access had been improved despite the presence of ORV's (C. Raithel, pers. comm.). Niemi and Davis (1979) found plovers nesting successfully within 10 m of frequently used roads. Strauss (pers. comm.) reported that one of the most consistently used plover territories over a five year period was exposed to heavy pedestrian and vehicular traffic. Piping plovers have been nesting on Toms Cove Hook at Chincoteague National Wildlife Refuge (Assateague Island) since at least 1978 despite heavy recreational use (Britton, 1982; Ailes, 1985; Patterson, 1988).

In Rhode Island, apparently suitable nesting habitat in the vicinity of large gull colonies is not used (Raithel, 1983). The establishment of a gull colony may be responsible for the disappearance of nesting plovers from one island in that state. Similarly, on Metompkin Island, Virginia, plovers apparently avoid a section of beach used by an expanding gull colony (Williams *et al.*, 1987).

On beaches where plovers continue to nest, productivity is often low. Cairns (1977) estimated that piping plovers on Nova Scotia beaches fledged 0-2.1 chicks/pair. Plovers on the U. S. coast in 1987 fledged 0.19-1.75 chicks/pair (Piping Plover Recovery Team, unpubl. data). Predation and recreational disturbance are usually identified as the two major factors responsible for this low reproductive success (Federal Register, 1985).

Nest predation is a problem in many areas and was the leading cause of nest loss on Assateague Island; Coast Guard Beach, Massachusetts; and Long Island, New York in 1987 (Patterson, 1988, MacIvor, 1990, D. MacLean, pers. comm.). Red foxes (*Vulpes vulpes*) were the primary predators on Coast Guard Beach and foxes and raccoons (*Procyon lotor*) were the primary predators on Assateague Island (MacIvor, 1990; Patterson, 1988). Other potential predators include opossums (*Didelphis virginiana*), skunks (*Mephitis mephitis*), domestic pets, grackles (*Quiscalus*), gulls (*Larus* spp.) and fish crows (*Corvus ossifragus*) (U.S. Fish and Wildlife Service, 1988; Patterson, 1988). The role of predation in chick mortality has not been evaluated.

Comparison of present and historic predation rates is available in only one area. During a 20-year study on Long Island, Wilcox (1959) reported that 91% of the eggs in 174 nests hatched. D. MacLean (pers. comm.) reported that at least 27% of the nests on Long Island in 1987 were lost to predators. An issue which has not been addressed is why predation appears to have increased to the point that it may be a major factor in the current population decline. It has been suggested that human activities have increased predation pressure by attracting predators to plover habitat (Federal Register, 1985; E. Strauss, pers. comm.). Also, the loss of prime nesting habitat may force plovers to nest in areas which would otherwise be avoided due to high predation pressure. Finally, the red fox may not be a natural component of some beach communities. European red foxes were introduced into New York, Maryland, and Virginia between 1650 and 1750 by fox hunters (Gilmore, 1946; Churcher, 1959). The native red fox may have been limited to northern boreal forests or the northwestern portion of the continent, and the present population in

the middle eastern U.S. may be descended from European introductions (Rhoads, 1903; Gilmore, 1946; Churcher 1959).

Human activities may reduce plover productivity directly through nest and chick destruction or indirectly by preventing birds from incubating eggs, reducing the amount of time chicks spend feeding, or attracting predators to plover nesting habitat. Many observations linking human disturbance to increased nest and chick mortality involve direct mortality: nests or chicks being crushed by cars or stepped on by people (U.S. Fish and Wildlife Service, 1988).

The indirect effects of human activities on productivity are not well understood. Although incubating plovers on isolated beaches may flush from nests when people are more than 80 m away, they can apparently become habituated to human activity nearer the nest. Cairns (1977 and Cairns and McLaren, 1980) found that some plovers on heavily used recreational beaches allowed humans to approach as close as 3 m before flushing. On a heavily used beach in Massachusetts, plovers allowed people to approach within 20 m before flushing (E. Strauss, pers. comm.). Flemming (1984) found no difference in nest success when comparing areas with different levels of recreational activity.

Cairns' (1977) study is frequently cited to indicate the adverse impacts recreational activity may have on piping plover reproductive success. She observed a fledging rate of 1.3 to 2.1 chicks/pair at Cadden Beach, Nova Scotia, while eight smaller beaches had a combined fledging rate of 0.7 to 1.1 young/pair. Cairns noted that the eight smaller beaches had much greater recreational activity than Cadden and speculated that this might be related to the difference in plover productivity. A weakness with this hypothesis is that at least two (possibly three) of the eight high human-use beaches had a fledging rate in the same range as that observed at Cadden beach. Other factors which could have contributed to the difference in productivity such as differences in predation rates or habitat quality were not evaluated. Since Cairns' study, plover nesting success at Cadden beach has plummeted, largely due to predation. In 1983, two of the eight high use beaches had a fledging rate higher than that observed on Cadden beach in 1976. One beach again had a lower fledging rate, while data for the five remaining beaches were incomplete (Flemming, 1984).

A second study from Nova Scotia is also commonly used to demonstrate the adverse impacts of recreational activity. Flemming *et al.* (1988) found that broods in areas receiving 20 or fewer recreational visits per week had higher fledging rates than broods in areas with 24 or more human visits per week. Furthermore, they reported that broods appeared to react to humans approaching within 160 m. During the first three minutes of this type of disturbance, chicks spent more time sitting and being vigilant and less time feeding and brooding than when undisturbed. ORV's did not appear to cause a major disturbance; chicks ignored or passively avoided moving vehicles.

MANAGEMENT STRATEGIES AND RESEARCH NEEDS

The national population decline and low productivity indicate that protective measures are needed now. Successful management of this species depends on application of management strategies based on the current level of knowledge combined with research designed to resolve unanswered questions.

Although a variety of factors may influence piping plover productivity, the most immediate threat in many of the existing breeding areas appears to be predation. The two primary methods to control predation are predator removal and predator exclosures. Unfocused trapping will probably not be effective. Trapping efforts should be concentrated on specific individuals immediately prior to the breeding season.

Electric fences have been used to reduce fox activity in other shorebird nesting areas (Forster, 1975; Patterson, 1977). In North Dakota, electric fences were used to protect nesting beaches adjacent to lakes (P. Mayer and M. Ryan, pers. comm.). Nest success increased, but chick survival was similar in fenced and unfenced areas. Electric fencing appeared to reduce fox predation on shorebird nests at Chincoteague National Wildlife Refuge in 1979, but was not effective during the following two years (Britton, 1982). Predator exclosures constructed around individual nests are another alternative. Experiments with killdeers (*Charadrius vociferus*) and piping plovers indicate that these birds continue to attend nests that are protected by these exclosures (Nol and Brooks, 1979; MacIvor, 1990). The exclosures around killdeer nests effectively reduced avian predation, but due to the small size, raccoons were able to reach the eggs (Nol and Brooks, 1979). Larger exclosures were used around plover nests, and preliminary experiments suggest that they may effectively reduce mammalian predation (MacIvor, 1990).

Our results from 1986 and 1987 indicate that some subpopulations experience much lower predation than others (Patterson, 1988). Studies examining predator foraging patterns are needed to determine why this is the case. It has been suggested that human presence on the beach attracts predators and increases predation rates. Although this is a plausible hypothesis, these claims are poorly documented. A specific goal of predation studies should be to determine the extent to which humans influence the activities of predators.

Very little is known about predators' contribution to chick mortality or factors which influence chick predation rates. These issues need to be addressed in greater detail.

The sensitivity of breeding plovers to human activities is an unresolved issue which warrants further investigation. On beaches where pedestrians and cars utilize the same areas as nesting plovers, recreational use clearly is a problem. However, it appears that plovers are capable of habituating to some degree of recreational activity. For example, Cairns felt that the mere presence of people probably does not affect reproductive success (Cairns and McLaren, 1980). Restricting recreational use to narrow zones immediately adjacent to the high-energy beach using symbolic fencing may effectively eliminate significant disturbance to plovers nesting on some wide beaches. During a four year study at Chincoteague National Wildlife Refuge, none of the shorebird nests protected by symbolic fencing were lost to direct human disturbance (Britton, 1982). In 1987, the only nest loss on the refuge attributed directly to human destruction occurred outside of the symbolic fence (Patterson, 1988).

A major unanswered question is how recreational activity influences chick survival. The answer may differ among beaches depending on the location of brood foraging areas. Broods feeding on the high-energy beach may be highly sensitive to recreational use, while broods foraging on bayside flats may not be significantly

disturbed or may be adequately protected by the same fencing used to prevent destruction of nests.

A large gap in our understanding of piping plover ecology is the absence of data about diet and foraging habits. We believe that foraging habitat is important in nest site selection on barrier islands and that it is a major factor in chick survival. Additionally, because foraging habitat seems to regulate nest placement, it may also influence predation rates. However, these hypotheses have not been tested. These issues need to be addressed to refine the ability to identify potential breeding habitat, to enhance efforts to improve existing habitat, and to improve efforts to create additional habitat.

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