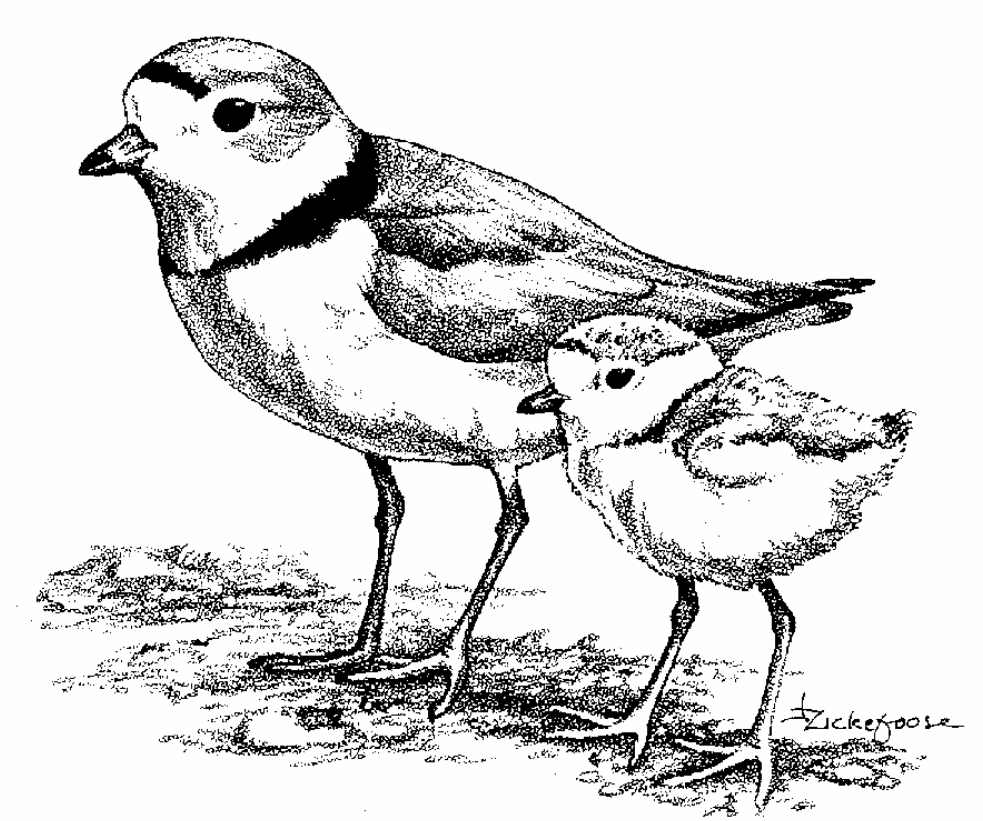
Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*)



September 2003

Department of the Interior
U.S. Fish and Wildlife Service
Great Lakes-Big Rivers Region

Recovery Plan for the Great Lakes Piping Plover

(Charadrius melodus)

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Region 3
U.S. Fish and Wildlife Service
Fort Snelling, Minnesota

Approved: Robyn Thorson
Regional Director, Region 3, U.S. Fish and Wildlife Service

Date: September 8, 2003

EXECUTIVE SUMMARY

Current Status: The Great Lakes population of piping plovers was listed as endangered under provisions of the U.S. Endangered Species Act on January 10, 1986. Critical habitat was designated on the Great Lakes breeding grounds on May 7, 2001 and for all populations of piping plovers on the wintering grounds on July 10, 2001. The Great Lakes population had declined from a historic size of several hundred breeding pairs to 17 at the time of listing. From 1986-2002, the population fluctuated between 12 and 51 breeding pairs, with breeding areas remaining largely confined to Michigan. The restricted breeding range of this population creates a gap in the distribution of piping plovers across North America, with the Great Lakes population isolated from the two other breeding populations (Atlantic and Northern Great Plains). The current size of the Great Lakes population makes it extremely vulnerable to chance demographic and environmental events that could extirpate the species from the Great Lakes region.

Habitat Requirements and Limiting Factors: In the Great Lakes region, piping plovers breed and raise young mainly on sparsely vegetated beaches, cobble pans, and sand spits of glacially-formed sand dune ecosystems along the Great Lakes shoreline. Wintering grounds range from North Carolina to Florida and along the Florida Gulf Coast to Texas, Mexico, and the Caribbean Islands. On the wintering grounds, piping plovers forage and roost along barrier and mainland beaches, sand, mud, and algal flats, washover passes, salt marshes, and coastal lagoons. Threats to populations and habitat are similar on the breeding and wintering ranges. Habitat destruction and degradation are pervasive and have reduced physically suitable habitat. Human disturbance and predators further reduce breeding and wintering habitat quality and affect survival. Contaminants, as well as genetic and geographic consequences of small population size, pose additional threats to piping plover survival and reproduction.

Recovery Objective: To restore and maintain a viable population (95% or greater chance of persisting 100 years) to the Great Lakes region and remove the Great Lakes population from the list of Threatened and Endangered Species by 2020.

Recovery Strategy: To increase average fecundity, protect essential breeding and wintering habitat, increase genetic diversity to levels needed to maintain population persistence, increase public education and outreach, and establish and maintain funding mechanisms and partnerships for long-term protection and management.

Recovery Criteria:

Reclassification from endangered to threatened when:

1. the population has increased to at least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states,
2. five-year average fecundity is within the range of 1.5-2.0 fledglings per pair, per year, across the breeding distribution, and ten-year population projections indicate the population is stable or continuing to grow above the recovery goal,
3. ensure protection and long-term maintenance of essential breeding and wintering

habitat, sufficient in quantity, quality, and distribution to support the recovery goal of 150 pairs (300 individuals), and

4. genetic diversity within the population is deemed adequate for population persistence and can be maintained over the long-term.

Delisting when the above criteria are met, plus:

5. agreements and funding mechanisms are in place for long-term protection and management activities in essential breeding and wintering habitat.

Actions Needed:

1. Protect the Great Lakes piping plover breeding population and manage breeding habitat to maximize survival and fecundity,
2. Protect wintering piping plovers and manage habitat to promote survival and recruitment,
3. Identify and protect migration habitat outside of wintering range,
4. Conduct scientific research to facilitate recovery efforts,
5. Develop and implement public education and outreach,
6. Develop partnerships and additional funding mechanisms,
7. Develop emergency methods to prevent extirpation, and
8. Review progress toward recovery and revise recovery tasks as appropriate.

Estimated cost of recovery for FY 2004-2008 (in $1000s): Details are found in the Implementation Schedule.

Fiscal Year	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	TOTAL
2004	450.5	122.5	15	203	33	6	40	3	**873**
2005	403.5	122.5	10	173	1	6	35	3	**754**
2006-08	1000.5	367.5	30	279	65	6	75	9	**1832**
TOTAL	**1854.5**	**612.5**	**55**	**655**	**99**	**18**	**150**	**15**	**3459**

Date of Recovery: Contingent on various factors and vigorous implementation of recovery actions, full recovery of this species could occur in 2020.

DISCLAIMER

Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. Plans published by the U.S. Fish and Wildlife Service (USFWS) are sometimes prepared with the assistance of recovery teams, contractors, state agencies, and other affected and interested parties. Recovery teams serve as independent advisors to the USFWS. Plans are reviewed by the public and submitted for additional peer review before they are adopted by the USFWS. Plan objectives and funds are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the USFWS. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

By approving this document, the Regional Director certifies that data used in its development represent the best scientific and commercial data available at the time of writing. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the East Lansing Field Office, Michigan.

Literature Citation:

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ACKNOWLEDGMENTS

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I. INTRODUCTION

The piping plover (*Charadrius melodus*) was listed on January 10, 1986, under provisions of the U.S. Endangered Species Act (ESA) of 1973, as amended (USFWS 1985). Piping plovers breed only in North America in three geographic regions: beaches of the Atlantic Coast, shorelines of the Great Lakes, and along alkali wetlands and major rivers of the Northern Great Plains (Figure 1). Though declining, the Northern Great Plains breeding population remains the largest, numbering 2,953 adults during a 2001 census (Ferland and Haig 2002). The same census effort in 2001 found the Atlantic Coast population consisted of 2,920 adults, a 78% increase from 1991. The Great Lakes population remains extremely imperiled. Only 72 adults were recorded during the 2001 census. While increasing from the 48 adults recorded during the 1996 census, the range of the Great Lakes population has not expanded to narrow the current gap among the three breeding populations that potentially inhibits inter-regional gene flow (Haig and Oring 1985; Plissner and Haig 1997). The three breeding populations are recognized and treated separately in the Final Rule (USFWS 1985) listing the piping plover across its range: the American Atlantic and Northern Great Plains populations are classified as threatened and the Great Lakes population as endangered. Piping plovers from the three breeding populations winter in coastal areas of the United States from North Carolina to Texas. They also winter along the coast of eastern Mexico and on Caribbean islands from Barbados to Cuba and the Bahamas (Haig 1992). Piping plovers on migration and in wintering areas are considered threatened under the ESA. Critical habitat was designated for the Great Lakes breeding population on May 7, 2001 (USFWS 2001a), and for all three populations of piping plovers on the wintering grounds on July 10, 2001 (USFWS 2001b). The Great Lakes piping plover population has been assigned a 2C (high degree of threat and recovery potential) recovery priority (USFWS 2002).

In 1986, recovery teams were appointed to develop recovery plans for the Atlantic Coast and the Great Lakes/Northern Great Plains breeding populations. These teams worked together with the two Canadian recovery teams to produce draft recovery plans for the Atlantic Coast and Great Lakes/Great Plains populations (USFWS 1988a, 1988b; Canadian Wildlife Service 1993). In 1994, the Great Lakes/Northern Great Plains team released a draft revised recovery plan for public comment. Subsequently, the Service decided the two inland populations would benefit from separate recovery plans. This recovery plan for the Great Lakes population reviews progress toward recovery and outlines a strategy to achieve full recovery.

A. Ecosystem Implications of Piping Plover Protection

The Great Lakes basin has been identified as a refuge for a diversity of globally rare species and ecosystems (TNC 1994).

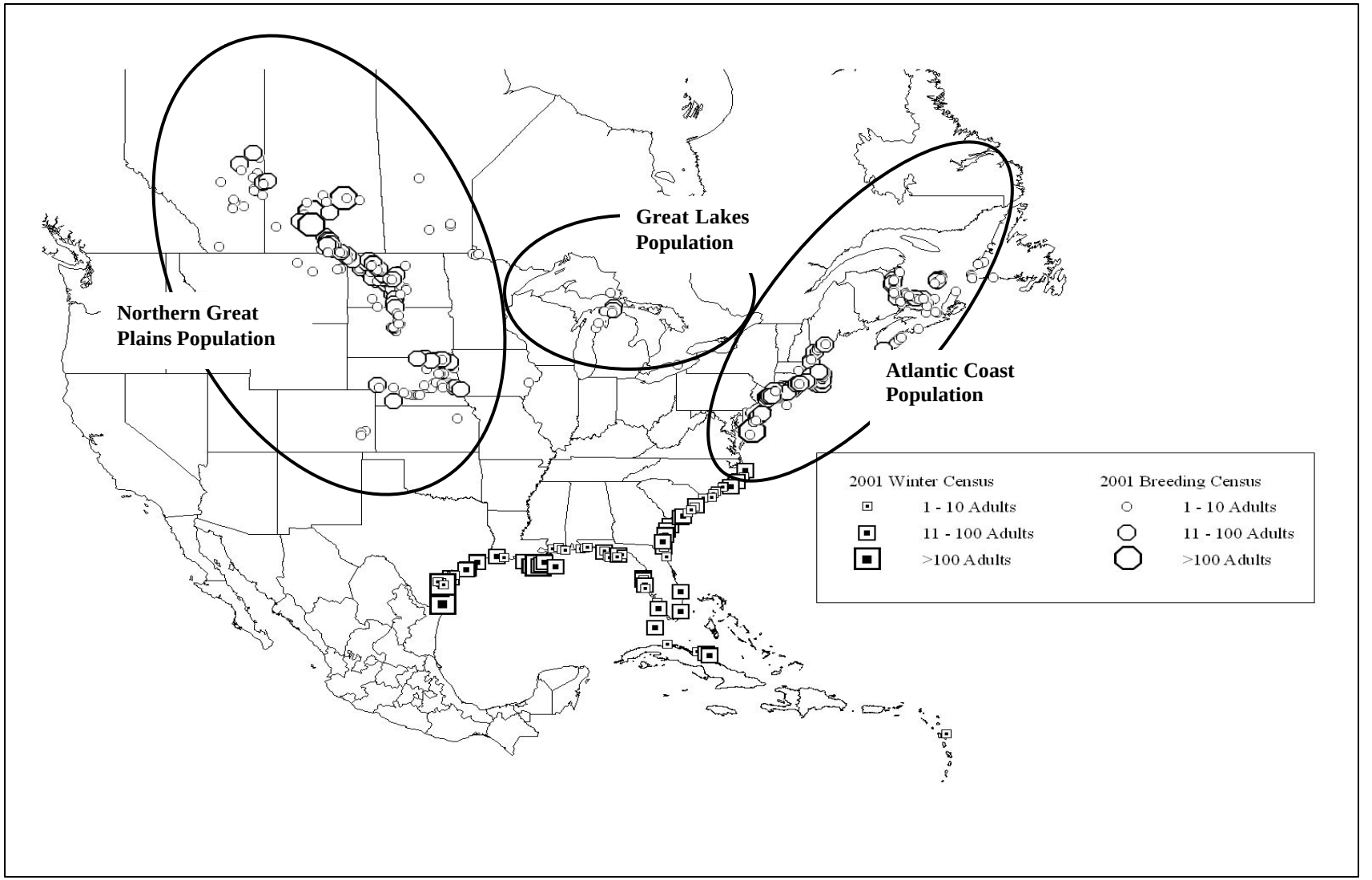

Figure 1. Piping plover breeding and wintering distribution (Ferland and Haig 2002).

Of the globally significant biodiversity elements that occur entirely or largely within the Great Lakes basin, nearly 30% are associated with coastal shore systems. Unique natural communities of the coastal shore region include dunes, interdunal wetlands, jack pine (*Pinus banksiana*) barrens and sand beaches. Many piping plover breeding beaches harbor rare dune features or provide habitat for other species of special status such as the federally listed Houghton's goldenrod (*Solidago houghtonii*), Pitcher's thistle (*Cirsium pitcheri*), and dwarf lake iris (*Iris lacustris*), as well as the state listed Lake Huron locust (*Trimerotropis huroniana*), among others. Adequately protecting Great Lakes piping plover breeding habitat may safeguard a significant proportion of shoreline biodiversity (Cuthbert et al. 1998). Similarly, wintering sites of the piping plover are located in sensitive coastal ecosystems that provide habitat for endangered or threatened plants and animals, such as seabeach amaranth (*Amaranthus pumilus*) and loggerhead sea turtles (*Caretta caretta*).

Habitat alterations such as marina construction, erosion control measures, and residential development affect the dynamic nature of the beach ecosystem by altering sediment patterns and hydrology, and inhibiting dune formation. These actions may degrade or destroy habitat for all the above species (USFWS 1996, 1997; Cuthbert et al. 1998). Off-road vehicles (ORVs) and high levels of foot traffic may erode dunes and result in direct mortality by trampling (Bowles et al. 1990; USFWS 1997). Other rare or sensitive species often benefit from piping plover protection efforts, at least for limited time periods while plovers are present. However, some piping plover management activities, such as re-routing of foot traffic around piping plover nest sites (and sometimes over sensitive dunes) or habitat enhancement through vegetation removal, may be detrimental to these species if these activities are not considered adequately during management planning. Given the imperiled nature of beach ecosystems, both within the Great Lakes region and along the Atlantic and Gulf coasts, an ecosystem approach to conservation will benefit both piping plovers and other inhabitants of coastal ecosystems.

B. Description and Taxonomy

The piping plover (Figure 2), named for its melodic call, is a small North American shorebird approximately 17 cm (6.7 in) in length (Palmer 1967) that weighs 40-65 g (1.4-2.3 oz) and has a wing span measuring about 38 cm (15 in) (Haig 1992). Light sand-colored upper plumage and white undersides blend in well with the piping plover's principal beach habitats. During the breeding season, the legs and bill are bright orange and the bill has a black tip. Other distinctive markings include a single black band across the upper breast and a smaller black band across the forehead. In adult females, the breast band is often thin or incomplete, and plumage is frequently duller than in adult males (Wilcox 1959; Haig 1992). During winter, the legs pale, the bill turns black, and darker markings are lost. Chicks have speckled gray, buff, brown, and white down. The coloration of fledged young resembles that of adults in winter. Juveniles acquire adult plumage the spring after they fledge (Prater et al. 1977).

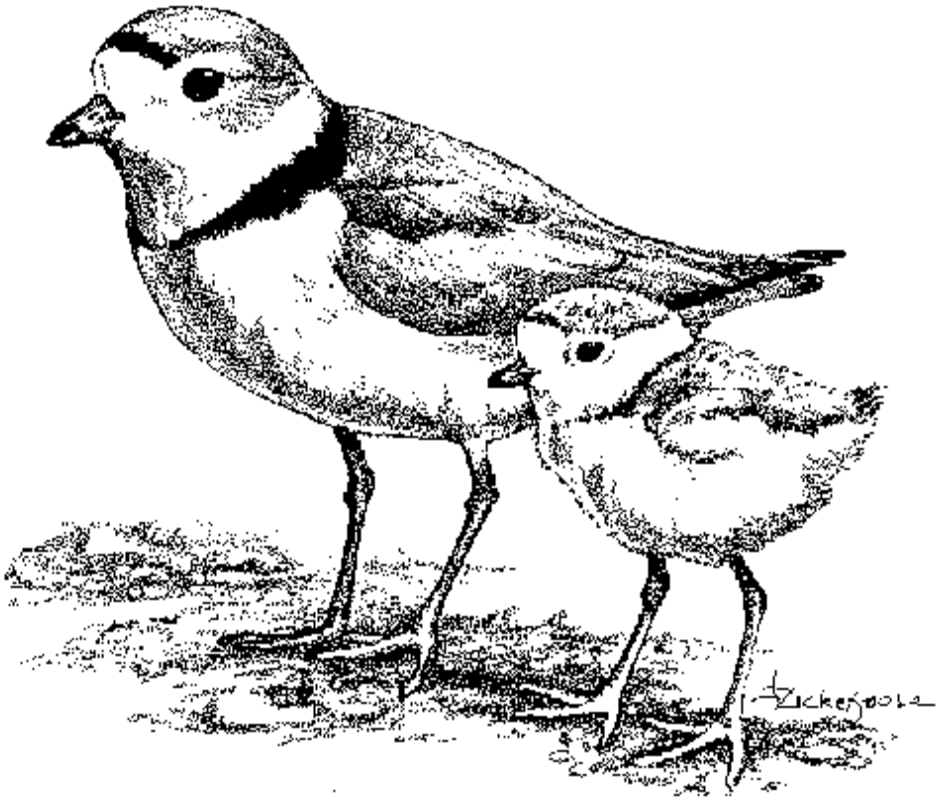

Figure 2. Piping plover adult and chick (drawing by Zickefoose)

Ornithologists have long debated the designation of two subspecies, *C. m. melodus* (Atlantic Coast) and *C. m. circumcinctus* (inland birds). Moser (1942) argued the distinction based on differences in the extent and brightness of the breast bands on inland and coastal birds, facilitating acceptance of two subspecies by the American Ornithologists' Union (AOU) (1945). Wilcox (1959) reported breast bands of variable extent in piping plovers on Long Island, New York, and did not find significant differences in morphological measurements of birds from different regions. Although electrophoretic analyses did not indicate genetic differences among populations in Saskatchewan, Manitoba, and New Brunswick as well as North Dakota and Minnesota (Haig and Oring 1988a), the AOU (1957, 1983) maintains the subspecies designations. Additional genetic studies of the populations are underway. Preliminary results suggest genetic differences may be present between the populations that were not revealed in the original studies.

C. Life History and Ecology

In the Great Lakes region, piping plovers breed and raise young on the shores of the Great Lakes. They migrate along an unknown flight path to the Atlantic and Gulf coasts of southern North America and Central America.

1. Breeding Chronology and Behavior

Piping plovers are migratory shorebirds that spend approximately 3-4 months a year on breeding grounds. In the Great Lakes region, birds begin arriving on breeding grounds in late April, and most nests are initiated by mid to late May (Pike 1985). Courtship behavior includes aerial displays, digging of several nest scrapes, and a ritualized stone-tossing display (Cairns 1977, 1982; Haig 1992). Finished nest cups are shallow depressions approximately 6 cm (2.3 in) in diameter and 2 cm (0.8 in) deep, usually lined with light-colored pebbles and shell fragments less than 1 cm (0.4 in) in diameter (Pike 1985; Perles 1995). Nest territories are actively defended by both adults. Females lay an egg approximately every other day; clutches are complete at three or four eggs. Both sexes share incubation duties that last 25-31 days (Wilcox 1959; Cairns 1977; Prindiville 1986; Wiens 1986; Haig and Oring 1988b). Adults may re-nest up to four times if nests are destroyed (USFWS 1988b), but in the Great Lakes region, they usually re-nest only once per breeding season (Wemmer 2000).

At Great Lakes nesting sites, eggs typically hatch from late May to late July (Lambert and Ratcliff 1981; Pike 1985). Precocial chicks usually hatch within one half to one day of each other and are able to feed themselves within a few hours. Brooding responsibilities are shared by both parents, although females may desert broods as soon as 1-2 weeks after eggs hatch (Haig 1992; Sharyn Howard, Michigan Department of Natural Resources, pers. comm., 1996). Adults and chicks rely on their cryptic coloration to avoid predators. Adults also use distraction displays (feigning injury, false brooding) to lure intruders away from their territories (Cairns 1977; Pike 1985). In Michigan, chicks fledge approximately 21-30 days after hatching (Wemmer 2000). Although piping plovers typically produce one brood per year, they have

produced two broods at some Atlantic Coast sites (Bottitta 1997) and in the Great Lakes (J. Stucker, Research Fellow, University of Minnesota, pers. comm., 2001). Breeding adults depart nesting grounds in the Great Lakes as early as mid-July, but the majority depart by mid-August (Wemmer 2000). Juveniles usually depart a few weeks later than adults, and most disperse by late August.

2. Foraging and Diet

Piping plovers feed primarily on exposed beach substrates by pecking for invertebrates one centimeter (0.4 in) or less below the surface (Cairns 1977; Whyte 1985). Diet generally consists of invertebrates, including insects, marine worms, crustaceans, and mollusks (Haig 1992). The endangered and threatened status of piping plover populations precludes collection of birds for gizzard/stomach content analyses. Opportunistic salvage of dead piping plovers and fecal analysis have provided information on diet preferences. Bent (1929) reported the eggs and larvae of flies (Diptera) and beetles (Coleoptera), as well as crustaceans (Crustacea), mollusks (Mollusca), and other small marine animals in the stomachs of four piping plovers from Alabama. Fecal analysis revealed that piping plovers in a marine environment prey predominantly on rove beetles (Staphylinidae), snout beetles (Curculionidae), and flies (Shaffer and Laporte 1994). Cuthbert et al. (1999) identified freshwater prey in gizzards of four dead piping plovers salvaged from a breeding area in Grand Marais, Michigan. These chicks consumed insects from 16 different families and 6 orders; the most common orders were wasps and bees (Hymenoptera), beetles, and flies.

Most foraging is diurnal, but piping plovers in New Jersey have been observed feeding at night with reduced intensity during the breeding season (Staine and Burger 1994). The time adults devote to foraging may increase during the incubation period and after chicks fledge; adults incubating or caring for chicks may spend less time foraging than birds that have lost their broods (Burger 1991). Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990a; K.L. Drake 1999; K.R. Drake 1999). Time spent foraging by piping plovers wintering in Alabama dominated diurnal activities during all months from September through April and was highest in December (Johnson and Baldassarre 1988).

Piping plovers use numerous areas within breeding and wintering habitats for foraging, including wet sand in the wash zone, intertidal ocean beach, wrack lines, washover passes, mud, sand and algal flats, and shorelines of streams, ephemeral ponds, lagoons, and salt marshes (Powell 1991; Hoopes et al. 1992; Loegering 1992; Zonick et al. 1998). Areas used by piping plovers for foraging depend on availability of habitat types, prey abundance, stage of breeding cycle, and human disturbance (Cross 1990; Burger 1991; Loegering and Fraser 1995; Zonick et al. 1998). Several studies on the Atlantic Coast indicate that foraging habitat and food resources ultimately affect piping plover survival. In Maryland, chick survival was related to brood access to quality foraging habitats (Loegering and Fraser 1995). Goldin and Regosin (1998) found that chicks foraging in Rhode Island mudflats were more likely to survive than

chicks foraging in other habitats. In New York, chicks preferred ephemeral pools, where arthropod abundance was greater than in other foraging habitats. Chick survival was also higher in areas containing ephemeral pools (Elias et al. 2000)

3. Breeding Distribution, Population Trends, and Reproductive Success

Piping plovers once nested on Great Lakes beaches in Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and Ontario, Canada (Figure 3). Russell (1983) reviewed historic records and estimated pre-settlement populations based on these accounts and his knowledge of historically suitable habitat. Russell's estimates may be high for some Great Lakes states (S. Matteson, biologist, Wisconsin Department of Natural Resources, Madison, pers. comm., 1988), but no other historic estimates are available for the Great Lakes population. Russell estimated a total population of 492-682 breeding pairs in the Great Lakes region in the late 1800s. Michigan may have had 215 pairs or more; Ontario and Illinois likely supported the next largest populations (152-162 and 125-130, respectively). Indiana, Ohio, and Wisconsin were estimated to have 100 or fewer breeding pairs each, and Minnesota, New York, and Pennsylvania fewer than 30.

Piping plovers were extirpated from Great Lakes beaches in Illinois, Indiana, New York, Ohio, Pennsylvania and Ontario by the late 1970s (Russell 1983), although occasional nesting has occurred since then. Few piping plovers nested in Wisconsin after the 1970s, and no nests were found in the state between 1983 and 1997 (S. Matteson, pers. comm., 1998). Similarly, the small number of pairs that nested in Duluth Harbor, Minnesota, had abandoned the area by 1986 (B. Eliason, biologist, Minnesota Department of Natural Resources, pers. comm., 1999). In 1977, the Great Lakes population was estimated at 31 nesting pairs (Lambert and Ratcliff 1979) but declined to approximately 17 pairs by 1985 (USFWS 1985). When the piping plover was listed as endangered in 1986, the Great Lakes population nested exclusively at a few sites on the northeastern shore of Lake Michigan and southeastern shore of Lake Superior in Michigan, the state with the most habitat remaining.

Between 1986 and 2002, nests were recorded at 34 breeding sites in 12 counties in Michigan and two counties in Wisconsin (Figure 4). A breeding site represents a contiguous area of shoreline habitat supporting a nesting location or collection of locations or "nest sites". During different stages of the breeding season, piping plovers use different zones of breeding areas for foraging, nesting, brood rearing, and pre-migratory flocking. In the Great Lakes region, breeding sites are located on bay beaches, sand spits or islands; sites are either discrete areas bounded by geomorphological or artificial features or areas located within continuous habitat.

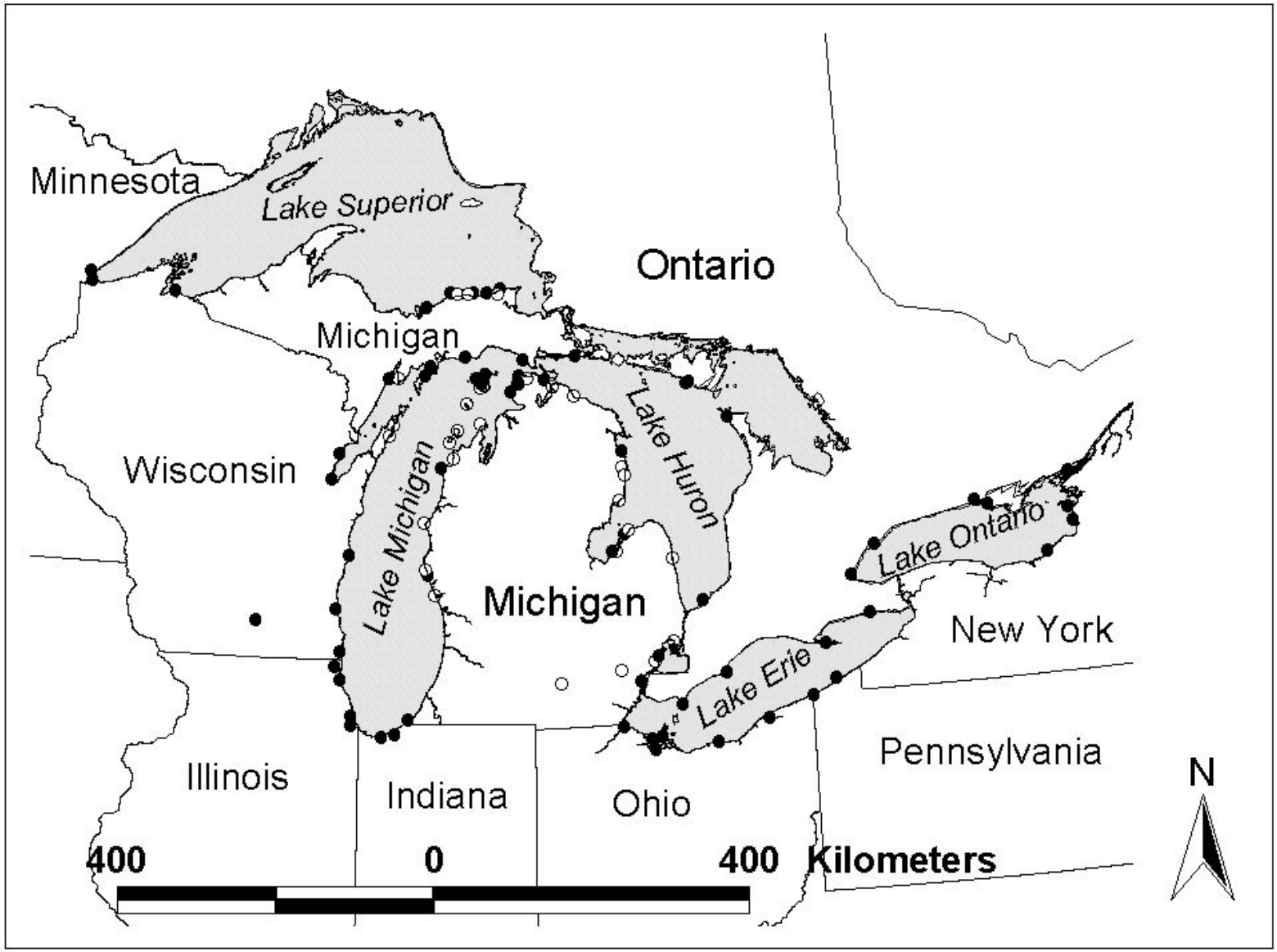

Figure 3. Piping plover historical breeding sites in the Great Lakes. Solid circles indicate nest records; open circles indicate sighting record. Locations for Michigan sites based on Cottrille (1957) and Lambert and Ratcliff (1979); sites in other states based on information in Russell (1983). Locations of some sites are not exact.

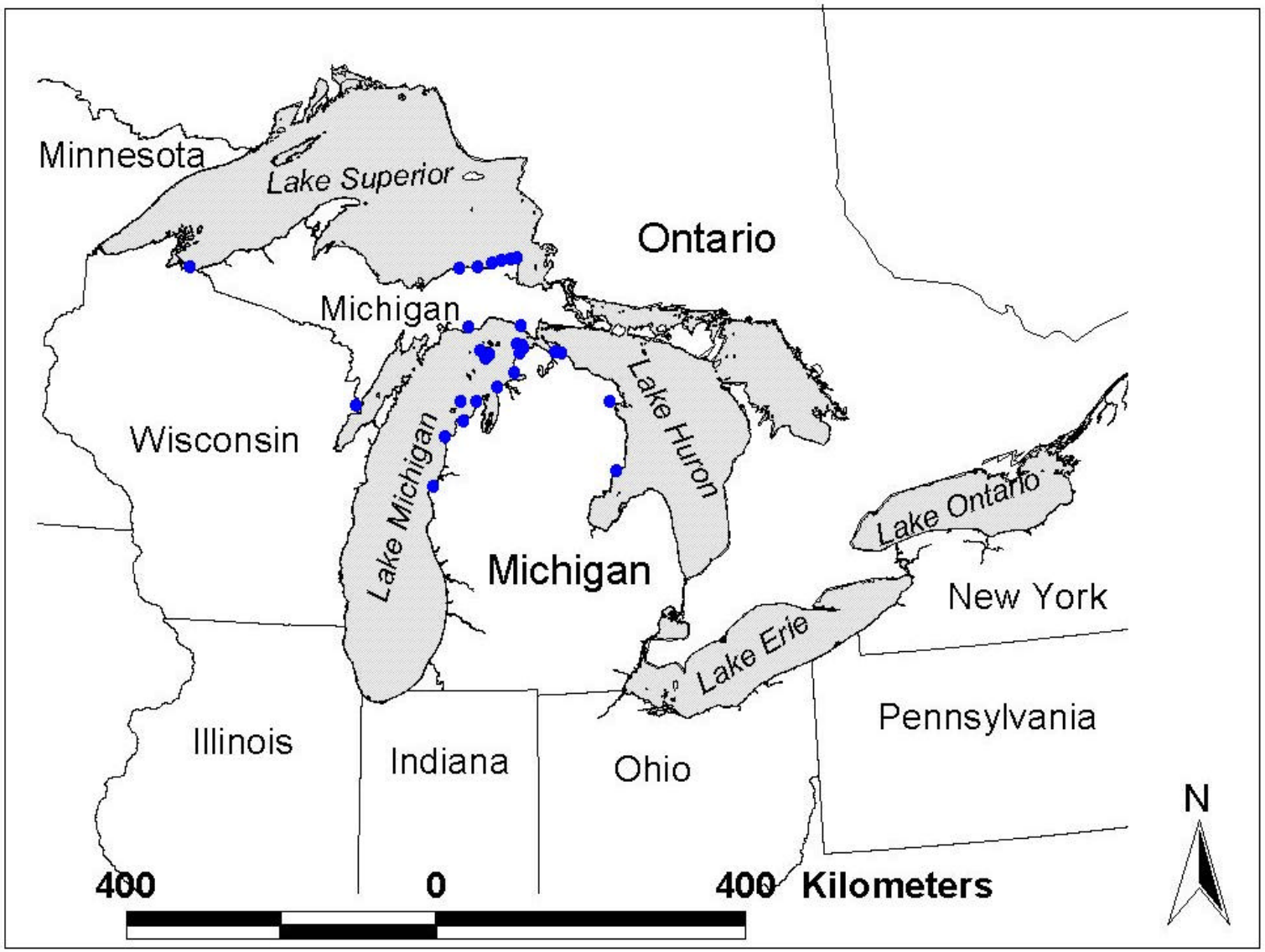

Figure 4. Piping plover breeding sites in the Great Lakes, 1986-2002.

From 1984 – 2001, the Great Lakes piping plover population ranged from 12 to 32 breeding pairs (Figure 5). In 2002, 51 pairs (50 pairs in Michigan, 1 pair in Wisconsin) were observed nesting in the Great Lakes (Figure 5). Although this is a substantial increase in population size compared to the previous years, the species remains critically endangered. Reproductive success has also fluctuated among years (Figure 6) and may be negatively correlated with increases in lake levels (Wemmer 2000). In recent years, the Great Lakes population has gradually increased and expanded to the south and east in Michigan and to the west with pairs breeding in Wisconsin. One quarter and one third of all breeding pairs nested in the Sleeping Bear Dunes area (Leelanau and Benzie Cos., Michigan) in 1997 and 1998, respectively (Wemmer et al. 1997; Stucker et al. 1998). By 2002, the Sleeping Bear Dunes area contained 25% of the breeding pairs in the Great Lakes. Additionally, two pairs nested at Chequamegon Point-Long Island, Ashland County, Wisconsin in 1998 and 1999 (Matteson and Manthey 1998; Stucker and Cuthbert 1999) and in Marinette County, Wisconsin in 2001.

4. Survival, Site Fidelity, and Dispersal

Prior to the 1990s, information on survival, fidelity to breeding areas, and dispersal was extremely limited for the Great Lakes population (Pike 1985). Recent data from piping plovers banded in Michigan suggest approximately a 70% adult survival rate, a similar level to that reported for other populations (Wemmer and Cuthbert 1999; Wemmer 2000). Survival of fledglings to first breeding (30%) falls between rates reported for populations in the Great Plains and Atlantic Coast (Table 1). Accurately measuring survivorship is hindered by small sample sizes, color band loss, dispersal outside monitored areas, and delay of breeding by some young adults for one or more years. Because survival estimates affect the accuracy of population viability models, it is important to continue to refine survival estimates through studies of banded individuals. These models are useful for setting recovery goals and examining the impact of alternative management strategies on population persistence.

Adult fidelity to breeding areas in other piping plover populations range from 24% to 69% (Haig and Oring 1988b). However, study areas and number of birds banded varied widely among studies summarized by Haig and Oring (1988b; 1988c). In Michigan, adults returned to beaches where they nested previously approximately 65% of the time. In Manitoba and Minnesota, site fidelity was apparently not related to sex or reproductive success (Haig and Oring 1988b; Wiens and Cuthbert 1988); however, in Michigan, site fidelity was correlated with previous reproductive success with males more faithful to breeding areas than females (Wemmer 2000). Distances between successive nests in Michigan have ranged from 0.2 - 180 km (0.1 - 111.8 mi) (Wemmer 2000). The longest distance between successive nests recorded for individuals from this population was 595 km (370 mi): an adult that nested on Long Point, Ontario (Lake Erie) was recaptured the following year breeding on Waugoshance Point, Michigan (Pike 1985). Most young return to nest at sites distant from natal areas.

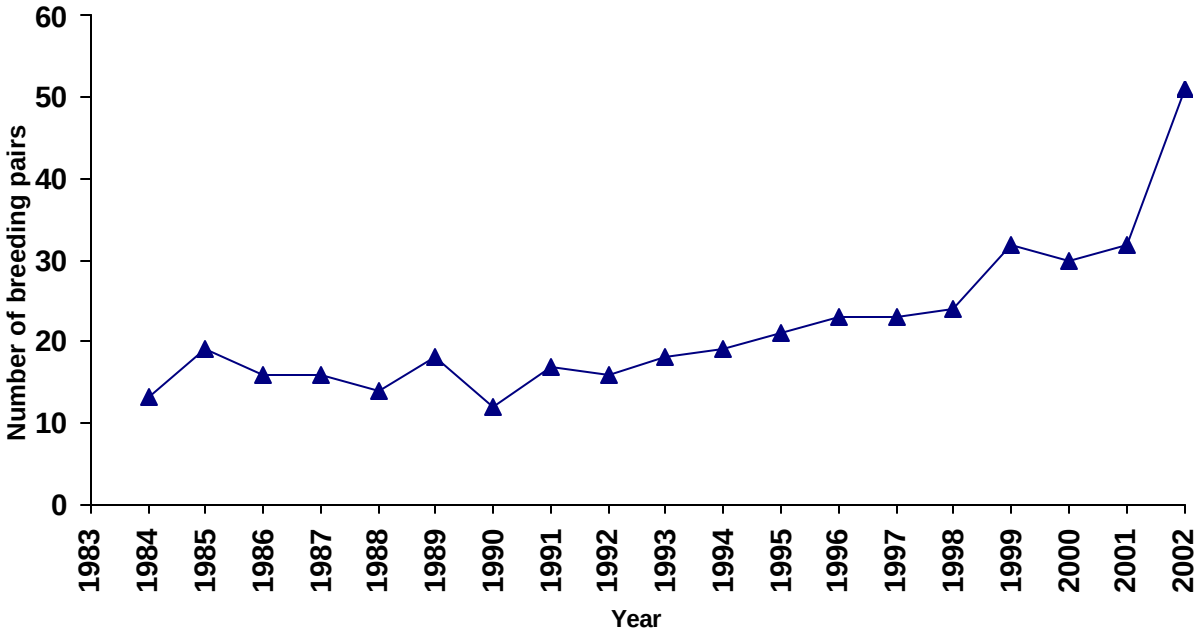

Figure 5. Breeding pair estimates for Great Lakes piping plover, 1984-2002.

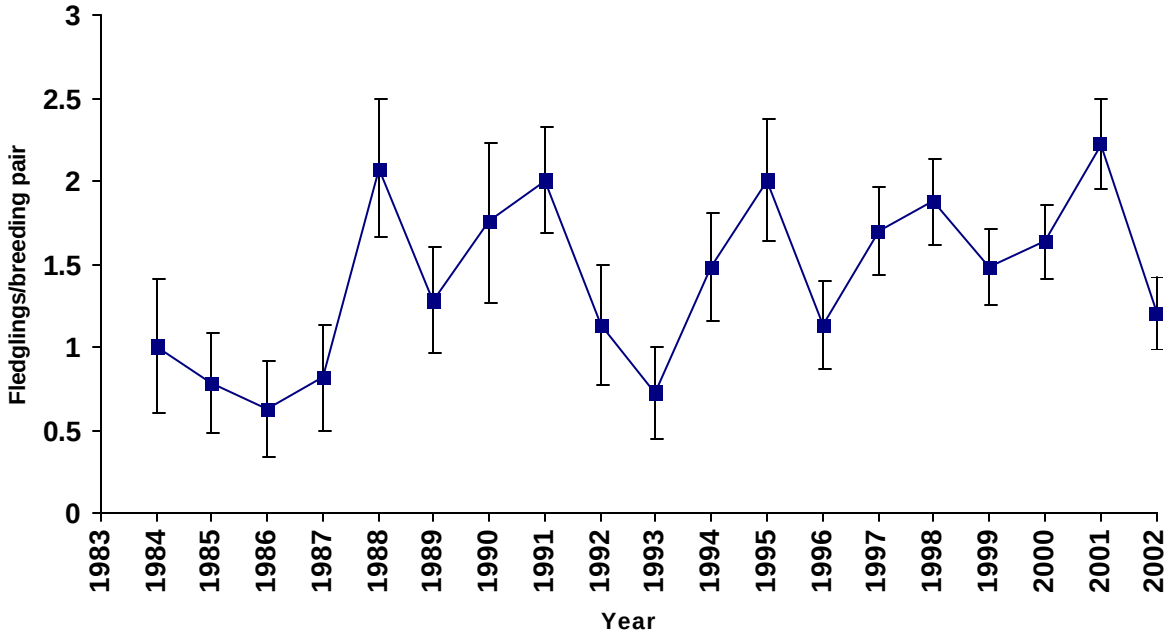

Figure 6. Reproductive success estimates for the Great Lakes piping plover, 1984-2002.

Table 1. Survival rates of piping plovers (Source: Wemmer 2000)

Adults*	Fledging to adult	Location	Source
0.47-0.97 (n=47)	0.11-0.35 (n=91)	Lake of the Woods, MN	Wiens 1986
0.56-0.93 (n=214)	0.14 (n=138)	North Dakota	Root et al. 1992
0.67-0.72 (n=53)	0.41 (n=29)	Assateaque Island, MD	Loegering 1992
0.74 (n=103)	0.48 (n=61)	Massachusetts	MacIvor (in USFWS 1996)
0.75-0.83	0.44	Virginia	Cross (in USFWS 1996)
0.73-0.83	0.28	Great Lakes	Wemmer 2000

*Population sizes in parentheses when available from source

The longest distance recorded between a natal site and first breeding site for this population is 360 km (224 mi), the approximate flight-line distance from Grand Marais, Michigan to Long Island Chequamegon Point, Wisconsin (Wemmer 2000). Because adults use numerous beaches throughout their lifetimes and many young breeders nest distant from natal areas, preservation of historic and less frequently used areas in addition to traditional breeding sites remains important for population persistence.

5. Nest Site Selection

Piping plovers select open, sparsely vegetated sandy habitats for nesting, foraging, and rearing young throughout their breeding range. On Lake Michigan, piping plover nest sites occur on sand spits or sand beaches associated with wide, unforested systems of dunes and swales or in the flat pans located behind the primary dune (Pike 1985; Powell and Cuthbert 1992). These sand dune systems are dynamic communities formed by glacial activity 2,500 – 4,500 years ago (TNC 1994). Dominant plant species include marram grass (*Ammophila breviligulata*), bearberry (*Arctostaphylos uva-ursi*), sand cherry (*Prunus pumila*), willow (*Salix* spp.), and creeping *(Juniperus horizontalis)* and common juniper (*J. communis)*. Michigan breeding areas on Lake Superior are generally simpler morphologically, consisting of a single, large dune dominated by marram grass associated with a beach more than 30 m (100 ft) wide. Nesting on both Great Lakes often occurs adjacent to rivers or ephemeral ponds (Pike 1985; Olivero 1994) that function as alternate feeding sites for chicks (Lambert and Ratcliff 1981; Wemmer, pers. obs.).

Beach width, the distance between the water's edge and dune or contrasting habitat edge when a dune is absent, has been shown to influence nest site selection on the Atlantic Coast and on inland lakes in North Dakota (Burger 1987; Prindiville Gaines and Ryan 1988). Similarly, piping plovers in Michigan construct nests in wide areas of beach (Wemmer 2000).

Studies of several nest sites in Michigan report mean beach widths greater than 30 m (100 ft) (Lambert and Ratcliff 1981; Powell and Cuthbert 1992; Allan 1993), but piping plover nest sites vary widely in their physical characteristics. Wemmer (2000) and Olivero (1994) measured characteristics of the majority of nests in Michigan from 1994–1997; beach width at the nest ranged from 7–89 m (23-620 ft; n=81). Sparse, low-lying vegetation and cobble[1] are also important to nest site selection by piping plovers because they provide cover from predators (Cairns 1977; Whyte 1985). The coloration of adult piping plovers and their eggs and chicks resembles the light coloration of sand and cobble and provides camouflage against predators. In North Dakota, Prindiville (1986) found that piping plover territories had significantly more cobble that was more uniformly distributed than unoccupied sites. Vegetation on the beach may function as additional escape cover from predators for piping plovers and may help conceal the location of nests. Prindiville Gaines and Ryan (1988) found that vegetation was more clumped within piping plover territories than in unoccupied areas. Furthermore, territories of plovers that successfully produced young had either less vegetation or more clumped vegetation than territories of plovers with unsuccessful nests. Faanes (1983) suggested that visibility around the nest influenced nest site selection on rivers in Nebraska.

In Michigan, nests were located 35 m (115 ft) or more from a forest edge. Vegetative cover around nests ranged from 0–50%, while gravel (stones with a diameter less than 0.5 cm or 0.2 in) or cobble around the nests ranged from 0–97%. Nests of piping plovers that successfully produced young were surrounded by significantly greater amounts of cobble and were located on beaches that had a greater overall percentage of vegetation than nests of unsuccessful plovers (Wemmer 2000). Nests have also been found in the following atypical situations: 1) under a willow shrub on the primary dune, 2) 5 m (16 ft) up the steep side of a dune blowout, 3) in narrow interdunal cobble pans more than 100 m (330 ft) from the lakeshore, and 4) in an active gravel pit 0.5 km (0.3 mi) from shoreline (Wemmer et al. 1993, 1994, 1996, 1997; F. Cuthbert, pers. obs.). Despite the variability in nest location and characteristics found in Michigan, piping plovers likely select optimal nesting sites that have unsaturated habitat at the current small population size and low nesting density. During population expansion, piping plovers will likely use areas now regarded as sub-optimal or marginal habitat.

While physical characteristics of nest microhabitats are well documented for the Great Lakes population, information on size and characteristics of nesting and brood rearing territories remains scarce. Brood home range is highly variable (Shutt 1996; Fadroski 1998) as observed elsewhere; broods on the Atlantic Coast have been observed utilizing habitat greater than 1000 m (3300 ft) from nest sites (USFWS 1996). Home range size may be influenced by a number of factors including age of chicks, physical dimensions and features of the habitat, foraging opportunities, presence of other territorial piping plovers, and human disturbance (Jones 1997).

[1]For the purposes of this Recovery Plan, "cobble" is defined as light colored stones having a diameter between 1 cm (0.4 in) and 10 cm (4 in).

6. Breeding Habitat Availability

Physical habitat[2] is shoreline that meets the minimum physical characteristics of known piping plover nest sites in the Great Lakes, regardless of factors such as human disturbance or predator levels. The total amount of physical habitat likely does not limit the Great Lakes population to its current size, but whether enough remains to support a viable population remains uncertain. The relationship between the spatial arrangement of habitat and the needs of breeding piping plovers also is unknown.

Habitat destruction and development have greatly reduced the amount of nesting habitat in all states in the Great Lakes region from which piping plovers are extirpated. Human disturbance and high predator densities compromise the quality of habitat that otherwise currently possesses physical characteristics suitable for piping plover foraging and breeding. Additionally, many physically suitable sites that are no longer occupied are distant from the current breeding area, potentially limiting opportunities for recolonization. Finally, lake level fluctuations and winter storms periodically alter the quantity and quality of habitat at individual sites throughout the region.

Tracts of Lake Michigan shoreline in Indiana (Indiana Dunes National Lakeshore, Porter Co.) and Illinois (Illinois Beach State Park, Lake Co.) have physical characteristics suitable for piping plover breeding. Although the Nature Preserve at Illinois Beach State Park is closed to human use, the present high levels of recreational use at Indiana Dunes National Lakeshore may discourage re-establishment by breeding piping plovers. Transient individuals have frequented both Indiana Dunes National Lakeshore and areas near Illinois Beach State Park. Indiana Dunes National Lakeshore personnel annually close some areas of beach during the migration and early nesting period to protect migrating plovers and encourage nesting.

In New York, dune habitat that once supported piping plovers still exists along eastern Lake Ontario in New York from Salmon River to Stony Point (Oswego and Jefferson Cos.). The Nature Conservancy has curtailed ORV use along 12 km (7.5 mi) of shoreline through conservation easement or ownership (S. Bonnano, biologist, The Nature Conservancy, Pulaski, New York, pers. comm., 1999), although other recreational pressures continue to affect potential habitat. Along Lake Erie in Pennsylvania, a historic piping plover breeding site is preserved as a Natural Area at Presque Isle State Park (Erie Co.), Pennsylvania. In addition to recreation, a gull (*Larus* spp.) colony and vegetation encroachment from beach nourishment

[2] Physical habitat in the Great Lakes can be characterized as beaches having 0-50% average vegetation cover and 0-45% average cobble cover with areas where cobble cover is as high as 97%. Nesting has occurred in areas with a minimum beach width of 7 m (23 ft)(Wemmer 2000), a minimum shoreline length of 0.4 km (0.25 mi) and a minimum area, including open dunes, of 1.97 ha (4.87 ac)(Olivero 1994; Wemmer 2000).

presently threaten the quality of this site as piping plover nesting habitat (C. Copeyon, biologist, U.S. Fish and Wildlife Service, State College, Pennsylvania, pers. comm., 1999). Two Lake Erie beaches in Ohio, Sheldon Marsh State Nature Preserve (Erie Co.) and Headlands Dunes State Nature Preserve (Lake Co.), presently have physical habitat for piping plover nesting. Predation, recreation, and beach erosion may limit the suitability of these sites. Ohio Department of Natural Resources is currently attempting to reduce these threats at Sheldon Marsh (G. Obermiller, preserve manager, Sheldon Marsh, Ohio Department of Natural Resources, and J. Windus, biologist, Ohio Department of Natural Resources, pers. comm., 1998). Transient piping plovers were recorded there in 1999.

Depending on lake levels, an additional 5-25 km (3-15 mi) of Lake Erie shoreline on Long Point, Ontario is physically suitable nesting habitat for a potential 15-20 breeding pairs, but efforts are needed to control very high predator activity if piping plovers attempt to nest at this site (J. McCracken, Program Manager, Bird Studies Canada, Long Point Observatory, Port Rowan, Ontario, pers. comm., 1999). However, Canada has not specified a recovery goal for the Canadian Great Lakes, and our recovery goal is not dependant on a Canadian population. A transient plover was observed on Long Point in 2000 and 2001. Several of the nearly 9 km of beach at the Pinery Provencial Park on Lake Huron contain suitable nesting habitat, however, human disturbance is a potential problem that would need to be managed. Western and Great Duck Islands in Lake Huron each contain approximately 1 km of physically suitable habitat. These sites are remote, so human disturbance is unlikely to be problematic, however, little is known about predator activity on the island (Elizabeth Price, graduate student, University of Minnesota, pers. comm., 2002).

Matteson and Strand (1988) provided an overview of availability of habitat in Wisconsin for nesting piping plovers. They indicated historic nesting habitat on Lake Michigan south of Kenosha (Kenosha Co.) and at Lilly Bay (Door Co.) has been compromised by urban development, high water levels, and/or recreational pressure. Point Beach State Forest (Manitowoc Co.) and Whitefish Dunes State Park (Door Co.) have suitable habitat; some areas of the beaches are wide (greater than 20 m or 66 ft) but high levels of human disturbance may discourage nesting by piping plovers unless properly managed. Harrington Beach State Park (Ozaukee Co.), Kohler-Andrea State Park (Sheboygan Co.) and Seagull Bar (Marinette Co.) are no longer regularly occupied by piping plovers because of narrow beaches and/or human disturbance although a single pair of plovers nested at Seagull Bar in 2001. On Lake Superior, Long Island/Chequamegon Point (Ashland Co.), the only area in Wisconsin supporting regularly occurring nesting piping plovers since the 1970s, is currently the least disturbed habitat in the state. In 1998, approximately 4 km (2.5 mi) of wide sand and cobble beach existed. This beach may be capable of supporting 10-20 nesting pairs (Matteson 1996), but this may vary annually (J. van Stappen, biologist, Apostle Islands National Lakeshore, Bayfield, Wisconsin, pers. comm., 1998). Re-establishment of breeding plovers at Wisconsin Point and Interstate Island (Douglas Co.) will likely require the control of gulls and vegetation to increase the amount of suitable nesting substrate.

Wisconsin Department of Natural Resources (WDNR) already manages vegetation and gulls in some areas to maintain desirable conditions for nesting terns (F. Strand, natural resource manager, Wisconsin Department of Natural Resources, Brule, pers. comm., 1999). Areas adjacent to Duluth Harbor (St. Louis Co.), Minnesota were recently used by breeding piping plovers in the 1980s; some habitat still exists but is highly disturbed by human activity (F. Cuthbert, professor, University of Minnesota-Twin Cities, pers. comm., 1996).

Michigan has the largest amount of existing habitat for nesting piping plovers (see Figures 3 and 4), though many former breeding sites have been lost or degraded by development. Cottrille (1957) summarized sightings and collections made of piping plovers in Michigan through 1956. Piping plovers were documented as occurring in 24 counties. Nesting was recorded in 14 counties including Alcona, Alger, Benzie, Cheboygan, Charlevoix, Delta, Emmet, Huron, Leelanau, Macomb, Monroe, Muskegon, Schoolcraft, and Tuscola. Multiple reports of numerous individuals or nests suggest that Muskegon State Park, Manistique Beach, Port Inland, Waugoshance Point, North Manitou Island, and Sand Point were among the major breeding areas in the state, with up to 10 individuals recorded at each site during a single visit (Cottrille 1957). By the time Lambert and Ratcliff surveyed more than 800 km (500 mi) of Michigan shoreline in 1979, former piping plover breeding sites in Alcona, Benzie, Delta, Macomb, Monroe, Muskegon, and Tuscola counties were either destroyed or abandoned. Lambert and Ratcliff (1979) documented or inferred nesting at 14 beaches in 8 counties, including 10 breeding areas not mentioned by Cottrille.

More recent surveys of Michigan shoreline (Nordstrom 1990; Powell and Cuthbert 1990, 1991, 1992; Germain and Struthers 1995) provide mostly qualitative information on suitability of beaches to breeding piping plovers; studies that quantified characteristics of breeding and/or potential habitat are scarce (Olivero 1994, Wemmer 2000). Furthermore, the quality of habitat physically suitable for nesting may be substantially reduced by factors such as human disturbance and predator activity. Wemmer (2000) used aerial videography and photography and Geographic Information Systems (GIS) to map breeding habitat in Michigan. Total area and proportion of area suitable for nesting were quantified from GIS maps. Site suitability was also ranked based on additional data on human disturbance, accessibility, predator levels, adjacent land use, vulnerability to rising lake levels, and patterns of habitat use and reproduction by piping plovers. This research along with previous surveys has identified some of the breeding habitat essential to the survival and future recovery of the Great Lakes piping plover (see Appendix A).

7. Migration

Piping plovers depart Great Lakes breeding areas from mid-July to early September (Pike 1985; Wemmer 2000). Adult females typically depart first, followed in order by unpaired males, males with fledglings, and unaccompanied young (Haig 1992). Piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. A few individuals can be found on the wintering grounds throughout the year, but sightings are rare

in late May, June, and early July. Migration is poorly understood, but most piping plovers probably migrate non-stop from interior breeding areas to wintering grounds (Haig 1992). Piping plovers begin departing the wintering grounds in mid-February, although peak migration departure occurs in March (Haig 1992). Males and females may migrate separately, although they arrive simultaneously at major breeding sites. Males may then disperse to satellite breeding areas alone or accompanied by a female (Haig 1992).

Very little is known about migration routes of piping plovers. Haig and Plissner (1993) suggested paucity of piping plover sightings at inland shorebird stopover sites may indicate nonstop migration between the Great Lakes and the wintering grounds. Research currently underway at the University of Minnesota indicates additional observations of inland stopover sites have been recorded (F. Cuthbert, pers. comm., 2002). Additionally, many historic breeding sites within the Great Lakes presently function as foraging areas for migrating piping plovers. Transient individuals have been reported at a number of sites in Michigan as well as in other states. Cuthbert (unpubl. data) surveyed Michigan Audubon reports through 1996 and found spring or fall sightings of piping plovers at 24 beaches in 20 Michigan counties. Piping plovers were recorded at beaches in Ashland, Bayfield, Brown, Dane, Dodge, Douglas, Manitowoc, Marinette, Milwaukee, Ozaukee, Racine, Vernon and Waukesha counties in Wisconsin during a check-list study conducted from 1982–1986 (Temple and Cary 1987). Brock (1986) summarized migration reports since 1959 from Indiana's Lake Michigan Dunes, and a limited survey of birding literature for Illinois revealed migratory sightings at an inland site (Rend Lake) as late as 1992 (Robinson 1996). Further compilation of such information may reveal important resting and foraging habitat for piping plovers migrating along the Great Lakes and perhaps along inland migration routes as well.

8. Winter Distribution and Ecology

The wintering ranges of the three breeding populations of the piping plover overlap and extend from North Carolina to Florida on the Atlantic Coast and from the Florida Gulf Coast west to Texas and into Mexico, the West Indies and the Bahamas (Haig 1992). The amount of population mixing that occurs on the wintering grounds is not known. Piping plovers banded in Michigan have been sighted in both Atlantic and Gulf coast states, suggesting a strong eastward component to migration and dispersal throughout the wintering range by this population (Figure 7).

Recent observations from North Carolina identified the more northern limit of the winter range (Sidney Maddock, Center for Biological Diversity, pers. comm., 2003). Other recent sightings of plovers banded in Michigan have been made in southern Virginia and the Bahamas (Jennifer Stucker, University of Minnesota, pers. comm., 2003). Re-sightings of banded piping plovers in Alabama, Louisiana, North Carolina, Florida, Michigan, and Texas indicate piping plovers exhibit inter- as well as intra-annual fidelity to wintering sites (Johnson and Baldassarre 1988; Zonick and Ryan 1994; T. Below, biologist, National Audubon Society, Naples, Florida, pers. comm., 1998; K.R. Drake and K.L. Drake, graduate students, Department of Wildlife,

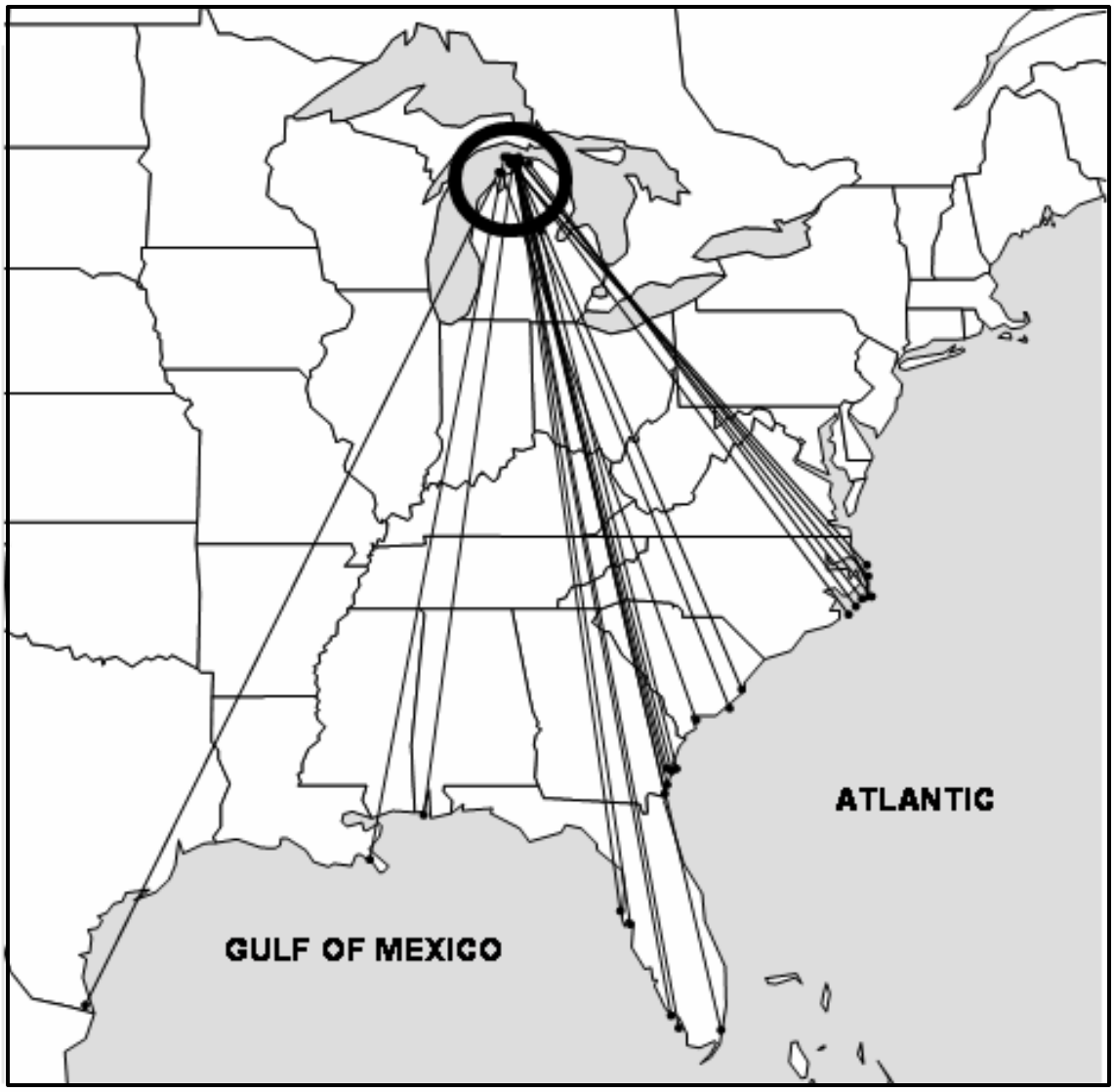

Figure 7. United States wintering locations of piping plovers banded in Michigan from 1993-2003. *This map is intended as a guide to wintering distribution and does not accurately depict breeding locations.*

Texas A & M, College Station, pers. comm., 1999; Wemmer 2000). Related or paired individuals may not necessarily winter in the same areas (Wemmer 2000).

Piping plovers spend up to 10 months of the year on the wintering grounds, thus emphasizing the importance of sufficient and suitable wintering habitat. At the time initial recovery plans were approved for this species little was known about wintering distribution or ecology. Since then, several studies attempted to predict winter habitat use on a broad scale. Nicholls and Baldassarre (1990b) recorded habitat types used by wintering piping plovers and surmised that habitat heterogeneity is a more important predictor of habitat use than specific habitat features. Building on this idea, Climo (1997) compared sites in the Gulf Coast of Florida with and without piping plovers and used significant differences in cover types from satellite imagery to generate predictive GIS models. The models, based on the Gulf Coast of Florida, were not useful for predicting suitable habitat in Texas. However, the ability to generate a GIS model to predict suitability of wintering habitat could aid conservation efforts. Only 40-63% of the 1991, 1996 and 2001 breeding populations have been accounted for on the wintering grounds, suggesting unidentified wintering habitat exists in or outside the U.S. (Haig and Plissner 1993; Plissner and Haig 1997; Ferland and Haig 2002).

Knowledge of winter ecology of piping plovers has also greatly increased since the initial recovery plan was produced in 1988. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990a; K. L. Drake 1999; K. R. Drake 1999). Primary prey for wintering plovers includes polychaete marine worms, various crustaceans, insects, and occasionally bivalve mollusks (Nicholls 1989; Zonick and Ryan 1996), which they peck from on top or just beneath the surface of moist or wet sand, mud, or fine shell. In some cases, a mat of blue-green algae may cover this substrate. When not foraging, plovers undertake various maintenance activities including roosting, preening, bathing, aggressive encounters (with other piping plovers and other species), and moving among available habitat locations (Zonick and Ryan 1996). The habitats used by wintering birds include beaches, mud flats, sand flats, algal flats, and washover passes (areas where breaks in the sand dunes result in an inlet). Individual plovers tend to return to the same wintering sites year after year (Nicholls and Baldassarre 1990a; K. L. Drake 1999). Wintering plovers are dependent on a mosaic of habitat patches, and move among these patches depending on local weather and tidal conditions (K. R. Drake 1999).

Important components of intertidal flats include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers. Such sites may have debris, detritus (decaying organic matter), or micro-topographic relief (less than 50 cm (19.7 in) above substrate surface) offering refuge from high winds and cold weather. Important components of the beach/dune ecosystem include surf-cast algae for feeding of prey; sparsely vegetated backbeach (beach area above mean high tide seaward of the dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or

road) for roosting and refuge during storms; and spits (a small point of land, especially sand, running into water), salterns (bare sand flats in the center of mangrove ecosystems that are found above mean high water and are only irregularly flushed with sea water (Myers and Ewel 1990) and washover areas for feeding and roosting. Washover areas are broad, unvegetated zones with little or no topographic relief that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action. Several of these components (sparse vegetation, little or no topographic relief) are mimicked in artificial habitat types used less commonly by piping plovers (e.g., dredge spoil sites).

These habitat components are a result of the dynamic geological processes that dominate coastal landforms throughout the wintering range of piping plovers. These geologically dynamic coastal regions are controlled by processes of erosion, accretion, succession, and sea-level change. The integrity of the habitat components depends upon daily tidal events and regular sediment transport processes, as well as episodic, high-magnitude storm events; these processes are associated with the formation and movement of barrier islands, inlets, and other coastal landforms. By their nature, these features are in a constant state of change; they may disappear, only to be replaced nearby as coastal processes act on these habitats.

In most areas, wintering piping plovers are dependent on a mosaic of sites distributed throughout the landscape. The annual, daily, and even hourly availability of the habitat patches is dependent on local weather and tidal conditions. For example, a single piping plover may leave a site if it becomes inundated by a high tide or storm event or if high winds or cold temperatures make the site unsuitable for foraging or roosting. This bird will move to other patches within the landscape mosaic that might provide refuge from inclement weather conditions, or that simply provide a roosting site until conditions become favorable to resume foraging.

Zonick (2000) investigated the winter ecology of piping plovers at 18 sites along the Texas Gulf Coast from Galveston Bay south to the Rio Grande from 1991-1994. He determined which factors (bay and beach tidal amplitudes, climatic conditions, season, time of day, habitat and ecosystem type, food resources, and human disturbance) most influenced piping plover abundance and densities. Piping plovers wintering in Texas foraged preferentially on bayshore mudflats and algal flats and used Gulf Coast beaches as secondary habitat when bayshore habitats were inundated (Zonick and Ryan 1996). Patterns of habitat use by plovers varied geographically along the Texas Gulf Coast with differences in habitat. The northern Gulf Coast of Texas progresses from an estuarine bay system (Galveston Bay) with geographically limited areas of bayshore flats through an ecotone (Mustang Island), where bay and mainland flats are completely submerged at high tide, to a hypersaline lagoon system (Laguna Madre) where some bayshore flats are almost continually available to plovers. Zonick's (2000) research suggested plovers are exposed to greater levels of human disturbance and expend greater levels of energy at beach habitat relative to bayshore tidal flats. A multiple regression model identified beach length and beach vehicular density as the factors most strongly influencing the number of piping plovers at nine winter sites along the Texas Coast (Zonick and

Ryan 1996; Zonick 2000).

During 1997 and 1998, winter movements of 49 piping plovers were monitored on South Padre Island, Texas. Radio-transmitters and band relocations were used to estimate home range size, determine the relationship of movements to environmental factors, and identify important foraging and roosting habitat types (Zonick et al. 1998; K. L. Drake 1999; K. R. Drake 1999). Plovers predominantly used algal mats and exposed sand flats of South Padre Island for foraging and roosting, although they also utilized washover passes and Gulf Coast sand beach, primarily when bayshore tidal flats were inundated. Thus, both habitats are essential for plovers wintering on the Texas Gulf Coast. Habitat use varied seasonally with greater use of algal flats in fall and spring and use of lower sand flats predominantly in winter. Birds roosted in close proximity to foraging areas (primarily on algal mats) with intra-annual fidelity to roost sites documented in some birds (K. L. Drake 1999). Mean home range size was 12.6 km^2 (4.9 mi^2) and most plover movements were less than 5 km (3.1 mi) (Drake et al. 2001). Plovers avoided dredge spoil placement areas and rarely used habitat adjacent to development (Zonick et al. 1998; Drake et al. 2001).

9. Population Viability [3]

Plissner and Haig (2000) examined viability of all three piping plover breeding populations using VORTEX metapopulation[4] viability analysis software (Lacy et al. 1995). They treated the Great Lakes population as a sub-population of a larger metapopulation consisting of both Great Lakes and Northern Great Plains breeding populations. A baseline model of the Great Lakes/Great Plains metapopulation indicated that 36% greater mean reproductive success (an increase from 1.25 fledglings per pair to 1.70 fledglings per pair) would result in a 95% probability of piping plovers persisting 100 years. In these simulations, fecundity of 2.0 fledglings per pair was needed to maintain a stable trend in this metapopulation, and even at this reproductive rate, the Great Lakes subpopulation was unlikely to persist. Plissner and Haig (2000) assumed adult mortality of 34.0%, and juvenile mortality of 56.8%; rates based on studies of sub-populations of the Great Plains and Atlantic breeding populations (MacIvor 1990; Ryan et al. 1993; Melvin and Gibbs 1994). Plissner and Haig (2000), assuming that limited dispersal occurs among breeding populations, estimated a dispersal rate of 0.01 birds per year between adjacent populations. Their model was highly sensitive to variation in both survivorship and dispersal, parameters that are poorly understood empirically.

Wemmer et al. (2001) created a habitat-based population model to examine the effect of habitat availability on persistence of the Great Lakes population. Model inputs were based on data for the Great Lakes population obtained by monitoring breeding pairs and reproductive

[3]Population viability is the degree to which a population is indefinitely self-sustaining.

[4]Metapopulations are networks of semi-isolated populations with some level of intermittent gene flow among them, in which individual populations may be extirpated but then be re-colonized from other populations (Meffe and Carroll 1997).

success from 1984–1997 and banding efforts conducted between 1993-1998. This model assumed a closed population with no immigration or emigration. Results of model simulations suggest the population will likely not persist for more than 25 years given current reproductive success, nest site use patterns, and nesting densities (total available territories at observed densities = 57). In simulations, raising mean reproductive success to 2.0 fledglings per pair for breeding areas where reproduction is currently lower, predicted 0.80 probability of survival for the next 100 years, but did not increase the population significantly from 35 breeding pairs. The model suggests piping plovers must also nest at densities more than double the maximum recorded at each of 29 breeding areas occupied since 1984 and/or colonize new or long-unoccupied breeding areas for the population to reach a size where it is likely to persist.

Historic observations and increasing nest densities on the Atlantic Coast suggest that higher nesting densities are possible in the Great Lakes region, but carrying capacity of breeding habitat remains very difficult to estimate without concrete historical information. Even if high densities can be reached, full recovery may take decades without additional human intervention. Together, these modeling efforts suggest that multiple and persistent measures to increase reproductive success and protection or creation of additional breeding habitat are required for the population to recover.

D. Reasons for Listing and Existing Threats

Hunting during the late 19th and early 20th centuries likely led to initial declines of the Atlantic piping plover population. The role hunting played in the decline of piping plovers in the Great Lakes region remains uncertain. Increasing habitat loss, recreational pressure, predation, and contaminants are likely responsible for continued population declines since the 1940s (USFWS 1985). Scientific collecting may also have contributed to reduction of breeding pairs in the early 1940s (Cuthbert, unpubl. data). These factors, with the exception of scientific collecting, are among those that presently threaten the Great Lakes population throughout its range.

1. Habitat Destruction and Modification

Shoreline development in the Great Lakes region and throughout the wintering grounds poses a threat to the Great Lakes population of piping plovers. The effects of habitat loss and degradation on Atlantic Coast populations are well documented (USFWS 1996). The extirpation of piping plovers from formerly occupied Great Lakes states has been associated with development that permanently converted shoreline to another type of land use or recreational uses that altered the physical nature of beaches (Russell 1983; Matteson and Strand 1988; Matteson 1996). Even with predator exclosures and psychological fencing, these piping plovers may experience increased disturbance by humans and their pets (Wemmer 2000).

Inlet dredging and artificial structures, such as breakwalls and groins, can eliminate breeding and wintering areas and alter sedimentation patterns leading to the loss of nearby habitat. Marina construction can also disrupt natural dynamic processes that maintain shoreline habitats. Deposition of dredge spoil, a practice occasionally considered beneficial to piping plovers and used to mitigate effects of habitat destruction, may actually be detrimental, depending on placement. In Texas, piping plovers avoid islands of dredged material in favor of natural habitats (Zonick et al. 1998). In the Laguna Madre, these artificial islands impede water flow between tidal flats and the lagoon, resulting in vegetation encroachment that lowers the quality of important foraging habitat for piping plovers (Zonick et al. 1998).

2. Predation and Disease

Predation was identified as the cause of nest failure of approximately 14.5% of clutches in Michigan from 1981 to 1999 (Wemmer 2000), and predators are suspected in the majority of disappearances of unfledged chicks. Determining that predation has occurred and identifying the species of predator responsible is difficult. In Michigan, identification of tracks in breeding areas, monitoring nests with video and still cameras, experimentation with artificial nests, and anecdotal data on predation have been used to identify potential predators of piping plover eggs, chicks and adults. Additionally, teams of investigators have participated in 24 hour per day monitoring projects at nests for an entire breeding season to determine predator risks (Germain and Struthers 1994; K. Struthers, biologist, pers. comm., 2001). These efforts identified a diversity of actual and potential predators including herring gull (*L. argentatus*), ring-billed gull (*L. delawarensis*), merlin (*Falco columbarius*), peregrine falcon (*F. peregrinus*), great horned owl (*Bubo virginianus*), snowy owl (*Nyctea scandiaca*), American crow (*Corvus brachyrhynchos*), common raven (*C. corvax*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), striped skunk (*Mephitis mephitis*), domestic cat (*Felis catus*), and dog (*Canis familiaris*). Human developments near beaches attract increased numbers of predators such as skunks and raccoons (USFWS 1985). Predator impacts and threats vary among seasons, years, and sites. Very little information exists on cues predators use to locate nests or chicks, the time predation occurs, or the relative importance of specific animals as predators (Cuthbert and Wemmer 1999). There are also increasing numbers of predators (fox, coyotes, dogs, and cats) which occur year round on the wintering grounds. Predation of adults or juveniles is not well documented on the wintering grounds but is still considered a possibility given the abundance of predators within coastal habitats. Disease is not currently a problem known to occur in this species.

3. Inadequacy of Existing Regulatory Mechanisms

Prior to listing under the ESA, several states listed the piping plover as threatened or endangered, and human intrusion at a few nesting sites was prohibited by local conservation efforts. Although the Migratory Bird Treaty Act (Act; 16 USC 703) protects the species from taking and bans trade in piping plovers and their parts, it was determined that because the Act does not protect habitat, the Act alone would not provide adequate protection to prevent further loss of the species' habitat. Listing under the ESA offers additional protection, primarily through the recovery and consultation processes.

Although the species is listed under the ESA, there remains inadequate regulatory mechanisms for full protection. Some Federal actions under the Coastal Zone Management Act, as administered by the National Oceanic and Atmospheric Administration (NOAA), have not yet been reviewed under section 7 of the ESA. These Federal actions have the potential to impact the species by funding or issuing permits for construction within essential habitat or in areas that may affect essential habitat. Similarly, some wetland permitting actions by the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) may result in diminished habitat quality for the piping plover. The USFWS consulted with EPA on water quality guidance for the Great Lakes, but full compliance with the guidance has not yet been achieved. Section 9 of the ESA prohibits unlawful take of endangered species, but incidents of take are difficult to prevent without constant law enforcement presence. Likewise, local ordinances and state laws that protect piping plovers are also infrequently applied because of the magnitude of habitat that makes constant surveillance difficult.

4. Other Natural or Man-made Factors

Disturbance by Humans and Pets

Use of motorized vehicles on beaches threatens both wintering and breeding piping plovers. Although driving is unlawful on publicly-owned Great Lakes shoreline, periodic vehicle use occurs at a number of sites (Pike 1985; S. Howard, MI Dept. of Natural Resources, pers. comm., 1996; R. Utych, Whitefish Point Bird Observatory, Paradise, Michigan, pers. comm., 1997). Vehicles have crushed eggs and killed adults and chicks (Pike 1985; Melvin et al. 1994). Additionally, driving on beaches early in the breeding season degrades the quality of substrate and may deter piping plovers from nesting or cause them to desert nests (Hoopes et al. 1992; Hoopes 1994). Vehicle use is legal in many areas of the wintering grounds and displaces piping plovers from preferred areas causing greater energy expenditure that may affect their survival (Zonick and Ryan 1996). In Texas for example, although dune areas are protected, beach driving is allowed in many areas from the mean low tide line to the line of vegetation on the shore. Other motorized activities, such as boating, jet-skiing, or flying aircraft may also be a disturbance if they occur too close to beaches that support piping plovers (M. Holden, resource specialist, Sleeping Bear Dunes National Lakeshore, Empire, Michigan, pers. comm., 1997; Wemmer, pers. obs.).

Beach-walking, bike riding, kite flying, fireworks (Howard et al. 1993), bonfires, horseback riding, kayaking, windsurfing, camping, and close-up photography are among the many non-motorized activities that disturb piping plovers and disrupt normal behavior patterns. High pedestrian use may deter piping plovers from using nesting habitat (Burger 1991, 1994). Pedestrians accompanied by pets present an even greater disturbance to breeding piping plovers (Pike 1985), as dogs frequently chase and attempt to capture adults and chicks (Lambert and Ratcliff 1979). Repeated flushing of birds from their nests by pedestrians exposes eggs to potentially lethal extremes in temperature (Welty 1982; Bergstrom 1991). Chicks may become separated from adults by pedestrians or displaced from preferred foraging habitats, which may make them more susceptible to the elements and predators and may ultimately affect their survival (Flemming et al. 1988).

In wintering sites in Texas, human disturbance continues to decrease the amount of undisturbed habitat and appears to limit local piping plover abundance (Zonick and Ryan 1996). The presence of pets increases disturbance to wintering piping plovers; pedestrians have been observed walking their dogs through congregations of feeding shorebirds and encouraging their dogs to chase the birds (P. Blair, volunteer, Florida State Department of Fish and Game, Seminole, pers. comm., 1999). Disturbance also reduces the time migrating shorebirds spend foraging (Burger 1991) and has been implicated as a factor in the long-term decline of migrating shorebirds at staging areas (Pfister et al. 1992).

Small Population Size

Endangered populations, by virtue of their small size and geographic isolation, are inherently at greater risk of extinction than larger populations (Caughley and Gunn 1996). Small, isolated populations are more likely to be destroyed by random environmental events than larger widespread populations. Similarly, very small isolated populations are more strongly affected by demographic stochasticity, random changes in sex ratios or ability to find mates ("Allee effect"), which all influence population persistence. In an analysis of the Great Lakes population through 1999, up to 29% of adults may remain unmated throughout the breeding season suggesting that Allee effect may occur (Wemmer 2000). Inbreeding depression, a reduction in fitness resulting from decreased genetic variability due to a high incidence of matings between close relatives, may also affect this population. Between 1993 and 1999, 6 of 14 matings of banded plovers, whose parents were known, were between close relatives (parents and offspring, full siblings or half siblings) (Wemmer 2000). These observations, along with small population size, indicate that inbreeding depression and loss of genetic diversity through a population bottleneck are potential concerns. Further analyses of band data and genetic material will provide greater insight into the extent of inbreeding and genetic variability present in this population.

Contaminants

Contaminants have sub-lethal as well as lethal effects on birds. Sub-lethal effects include behavioral impairment, deformities, and impaired reproduction (Rand and Petrocelli 1985; Gilbertson et al. 1991; Hoffman et al. 1996). Piping plovers may accumulate contaminants from point sources and non-point sources at breeding, migratory stop-over, and wintering sites. Oil spills represent an important concern for Great Lakes piping plovers wintering on both the Atlantic and Gulf Coasts; oiled piping plovers have been reported at a number of sites in these regions (USFWS 1996). Oiling also poses a potential threat to piping plovers migrating and breeding along Great Lakes waterways. The magnitude of threat that pollution plays to piping plover habitats and associated shorebirds is yet unknown. The carcass of one piping plover banded in Michigan was among 81 dead western sandpipers (*Calidris mauri*) discovered near Marco Island, Florida (T. Below, pers. comm., 1998); pesticide application (Fenthion®) for mosquito control may be implicated.

The endangered status of this species warrants an assessment of the sub-lethal impacts of contaminants. Addled eggs from all three breeding populations have been collected and analyzed for inorganic and organic residues (Day et al. 1991; Ruelle 1993; Welsh and Mayer 1993); the Great Lakes population offers the most complete sampling (n = 81 eggs) in which contaminant levels have been monitored since 1988. Several composites of piping plover eggs from Michigan had levels of total PCBs (polychlorinated biphenols) rivaling those in eggs of colonial piscivorous (fish eating) cormorants and terns (> 13 µg/g), species that occupy a higher trophic level than piping plovers and potentially bioaccumulate contaminants more rapidly (USFWS, unpubl. data). Contaminant levels in eggs from Great Lakes piping plovers generally exceeded those detected in eggs from the Atlantic and Great Plains populations. PCB concentrations in the range detected in the piping plover eggs from Michigan have the potential to cause reproductive impairment (D. Best, biologist, USFWS, East Lansing, Michigan, pers. comm., 1999). Analysis of prey available to piping plovers at representative Michigan breeding sites indicated that breeding areas along the upper Great Lakes are not likely the major source of contaminants to this population based on rates of biomagnification for other Great Lakes species (D. Best, pers. comm., 1999). The relative contribution of wintering and migratory stopover sites to contaminant levels in piping plovers is unknown.

E. Conservation Measures

Conservation measures underway to protect the piping plover include recognition, research, protective management, requirements for Federal protection, and prohibitions against certain practices. Listing encourages and results in increased conservation actions by Federal, state and private agencies, groups, and individuals. The ESA provides for possible voluntary land acquisition and cooperation with the states and requires that recovery plans be developed for all listed species. The protection required of Federal and state agencies and the prohibition against certain activities involving listed animals are discussed, in part, below. See Appendix B

for a list of principle Federal and state laws applicable to the protection of the piping plover and its habitat.

1. Regulatory Protection

Federal Protections: The ESA contains several sections that provide regulatory protections for the piping plover. Designation of critical habitat, consultations between the USFWS and other Federal agencies, and prohibitions against take are some of the important protections provided for in ESA regulations.

Critical Habitat

The ESA defines critical habitat as (1) the specific areas within the geographical area occupied by those species, at the time it is listed in accordance with the provisions of section 4 of this law, on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations for protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the ESA, upon a determination by the Secretary of the Interior (Secretary) that such areas are essential for the conservation and recovery of the species.

Except in those circumstances determined by the Secretary, critical habitat shall not include the entire geographical area that can be occupied by the threatened or endangered species. The provisions under section 4 state: "The Secretary shall designate critical habitat, and make revisions thereto, under subsection (a)(3) on the basis of the best scientific data available and after taking into consideration the economic impact, and any other relevant impact, of specifying any area as critical habitat. The Secretary may exclude any area from critical habitat if he/she determines that the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat, unless he/she determines, based on the best scientific and commercial data available, that the failure to designate such area as critical habitat will result in the extinction of the species concerned."

Section 4 of the ESA also requires the Secretary to designate critical habitat, to the maximum extent prudent and determinable, concurrently with the listing of a species as threatened or endangered (16 USC 1533(a)(3)). If critical habitat is not determinable at that time, the Secretary may extend the period for designating such habitat "by no more than one additional year" (16 USC 1533 (b)(6)C(ii)). The final rule listing the piping plover as endangered (USFWS 1985) indicated that designation of critical habitat was not determinable. Thus, in 1986 designation was deferred for one year.

In December 1996, Defenders of Wildlife (Defenders) filed a suit against the Department of the Interior and the USFWS over its failure to designate critical habitat for the Great Lakes population of the piping plover. Defenders filed a similar suit for the Northern

Great Plains piping plover population in 1997. On February 7, 2000, the United States District Court for the District of Columbia issued an order directing the USFWS to publish a proposed critical habitat designation for nesting and wintering areas of the Great Lakes population of the piping plover by June 30, 2000, and for nesting and wintering areas of the Northern Great Plains piping plover by May 31, 2001. A subsequent order by the Court directed the USFWS to finalize the two critical habitat designations by April 30, 2001, and March 15, 2002, respectively. The USFWS chose to designate critical habitat for the wintering grounds for all piping plovers in a separate rule that was published on July 10, 2001 (66 FR 36038)(USFWS 2001b).

Designation of critical habitat does not imply, however, that all areas that may be essential for the species are covered by the designation. The rule acknowledges that other areas may become essential over time or may be considered essential upon availability of better information. Critical habitat also does not establish refuges or wildlife management areas. Activities which may occur within areas designated as critical habitat are subject to the consultation requirements under section 7 of the ESA, but only if there is Federal involvement in the action. Recovery plans, however, address all areas important for the species and identify management and conservation actions needed to recover the species. As such, the recovery actions described in this plan are not limited to the areas designated as critical habitat but apply throughout the range where the species may be found. When addressing habitat concerns, "essential" habitat is often referred to. This differs from critical habitat in several ways. Critical habitat is defined by regulation; thus it is a legal definition of the areas of suitable piping plover habitat that are considered essential to the conservation and recovery of the species. However, because it is not all-inclusive of all areas of habitat that are or may become biologically essential to the species, essential habitat is the focus of the recovery plan. Essential habitat, collectively, is all of the area that is essential to piping plovers on their breeding and wintering grounds, and during migration. Federal designation of critical habitat is one mechanism of protecting essential habitat.

Critical Habitat on the Breeding Grounds

On July 6, 2000, the USFWS proposed to designate 37 units along the Great Lakes shoreline of Minnesota, Michigan, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania and New York as critical habitat for the Great Lakes breeding population of the piping plover. Following a series of public meetings and comment periods, the USFWS published a final rule designating critical habitat for the Great Lakes breeding population of the piping plover on May 7, 2001 (66 FR 22938)(USFWS 2001a). A total of 35 units (extending 500 m (1640 ft) inland) were designated along the Great Lakes shorelines of eight states. Approximately 325 km (201 mi) of shoreline were included in 26 counties in Minnesota, Michigan, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania and New York. The greatest number of critical habitat units (23) occurs in Michigan with a total shoreline length of 224 km (139 mi) (Table 2, Figure 8). The remaining units cover approximately 101 km (62 mi) of shoreline in seven states (Table 3, Figure 9a-f).

Table 2. Critical habitat designations for the breeding population of the Great Lakes piping plover in Michigan

County	Location	Ownership	Unit Number	Unit Length km	(mi)
Chippewa/Luce/Alger	Whitefish Point to Grand Marais	Federal/state/private	MI-1	14.3	(8.9)
Mackinac	Point Aux Chenes	Federal/private	MI-2	2.0	(1.2)
Mackinac/ Schoolcraft	Port Inland	state/private	MI-3	3.0	(1.9)
Emmet	Sturgeon Bay to Cross Village	state/private/municipal	MI-4	15.1	(9.4)
Emmet	Thornswift Nature Preserve	private	MI-5	0.9	(0.5)
Emmet	Petosky State Park	state/private	MI-6	2.0	(1.2)
Charlevoix	North Point	municipal	MI-7	1.1	(0.7)
Charlevoix	Fisherman=s Island State Park	state	MI-8	1.3	(0.6)
Charlevoix	Donegal Bay	private	MI-9	2.6	(1.6)
Charlevoix	McCauley=s Point	state	MI-10	0.8	(0.5)
Charlevoix	Greenes Bay	state/private	MI-11	1.8	(1.1)
Leelanau	Cathead Bay	state/private	MI-12	5.1	(3.2)
Leelanau	South Fox Island	state/private	MI-13	6.0	(3.7)
Leelanau	North Manitou Island	Federal	MI-14	3.3	(2.0)
Leelanau	Empire Beach	Federal/municipal	MI-15	18.6	(11.6)
Benzie	Platte River Point	Federal	MI-16	28.6	(17.8)
Mason	Nordhouse Dunes	Federal/state	MI-17	13.4	(8.3)
Muskegon	Muskegon State Park	state	MI-18	2.5	(1.6)
Chippewa	Lake Superior State Forest	state	MI-19	3.0	(1.9)
Cheboygan	Grass Bay	state/private	MI-20	3.0	(1.9)
Presque Isle	Hoeft State Park	state	MI-21	3.7	(2.3)
Presque Isle	Thompson=s Harbor	state/private	MI-22	2.8	(1.7)
Iosco	Tawas Point State Park	state	MI-23	2.0	(1.2)

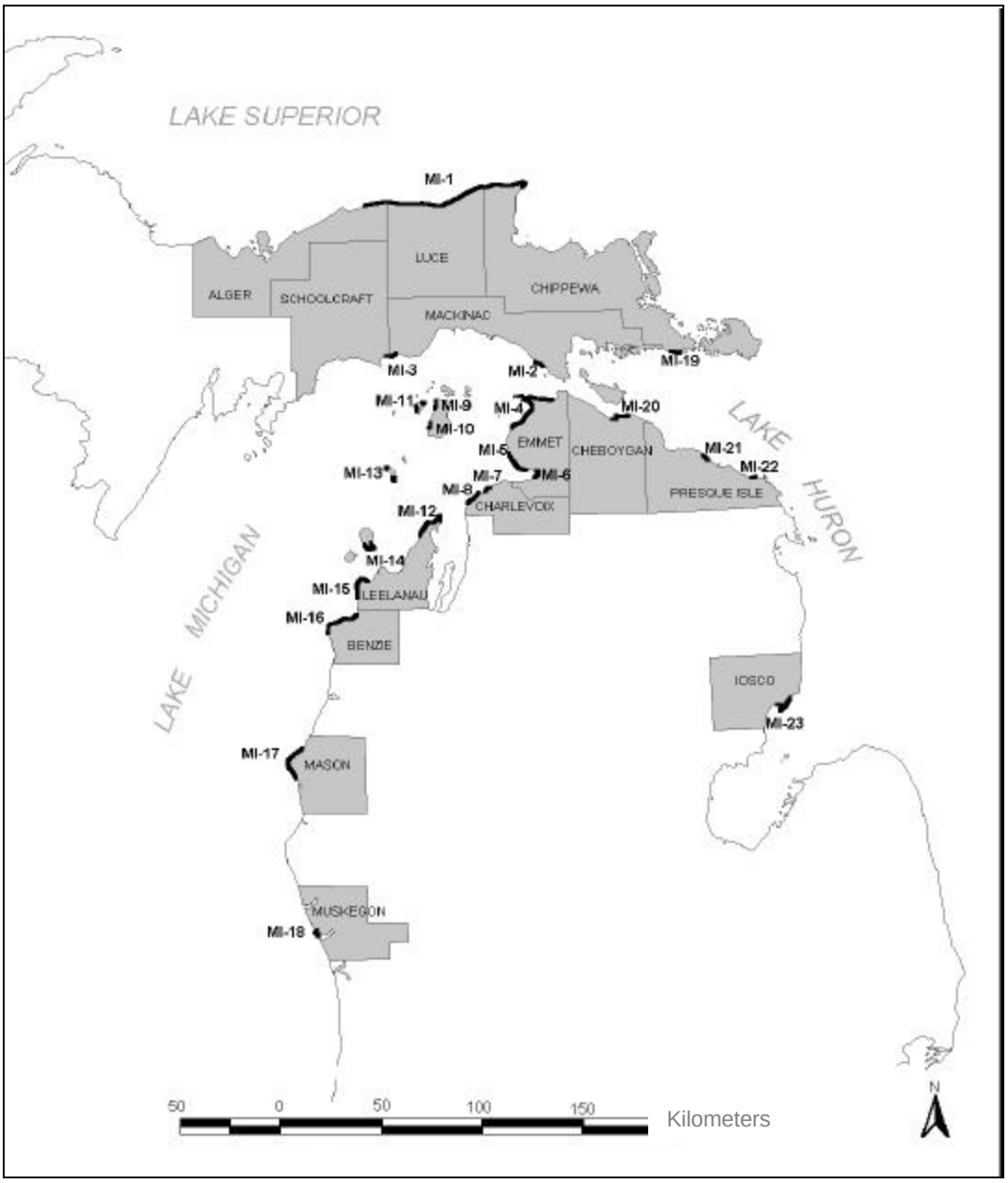

Figure 8. Piping plover critical habitat units in Michigan (see Table 2 for descriptions)

Table 3. Critical habitat designations for the breeding population of the Great Lakes piping plover outside of Michigan

State/County	Location	Ownership	Unit Number	Unit Length km	(mi)
Illinois					
Lake	Illinois Beach State Park	state	IL-1	10.2	(6.4)
Indiana					
Porter	Indiana Dunes National Lakeshore	Federal/state	IN-1	7.9	(4.9)
Minnesota					
St. Louis	Duluth Harbor	state/private	MN-1	0.6	(0.4)
New York					
Oswego & Jefferson	Salmon River to Stony Point	state/private	NY-1	27.4	(17.0)
Ohio					
Erie	Sheldon Marsh State Nature Preserve	state/private	OH-1	3.2	(2.0)
Lake	Headlands Dunes State Nature Preserve	state	OH-2	0.8	(0.5)
Pennsylvania					
Erie	Presque Isle State Park	state	PA-1	6.0	(3.7)
Wisconsin					
Douglas	Wisconsin Point/Interstate Island	Federal/municipal	WI-1	4.0	(2.5)
Ashland	Long Island/Chequamegon Pt	Federal/tribal/private	WI-2	25.3	(15.7)
Ashland	Western Michigan Island	Federal	WI-3	6.5	(4.0)
Marinette	Seagull Bar	state/municipal	WI-4	1.5	(0.9)
Manitowoc	Point Beach State Forest	state	WI-5	8.0	(5.0)

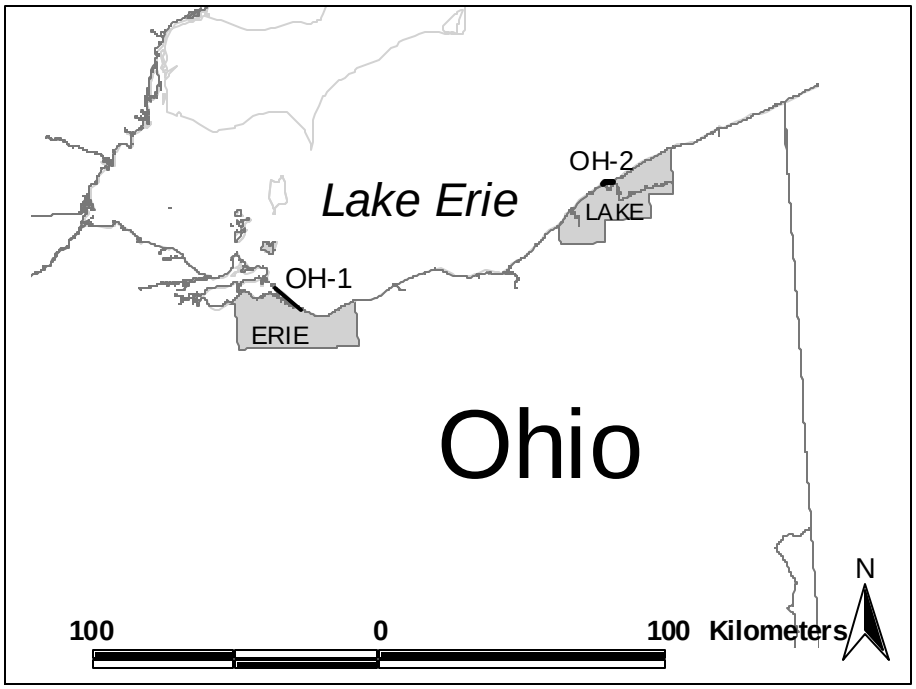

Figure 9a. Critical habitat units in Ohio.

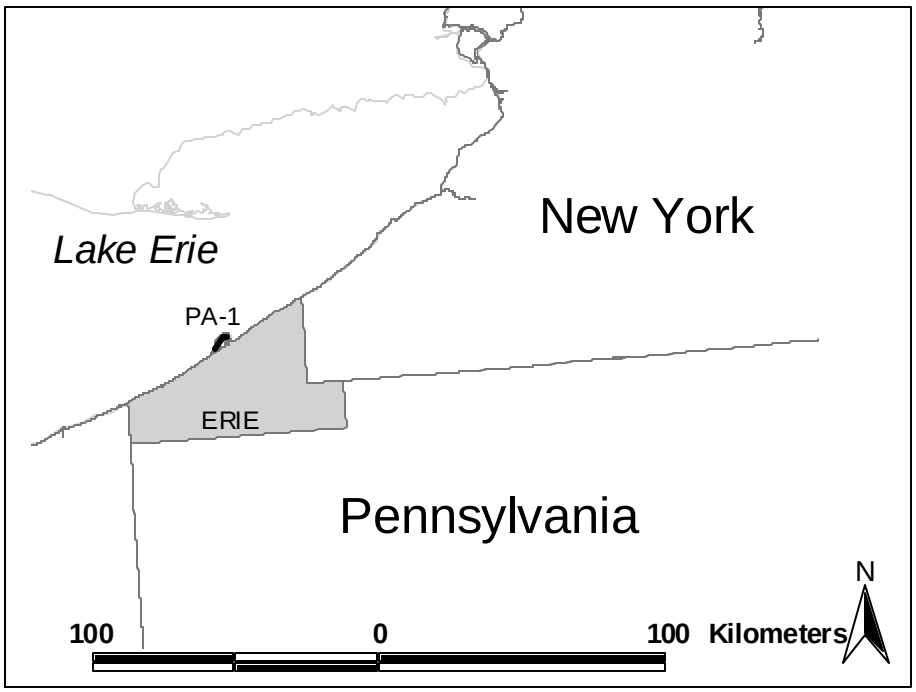

Figure 9b. Critical habitat units in Pennsylvania.

Figure 9a-f. Piping plover critical habitat units in the Great Lakes, outside Michigan (For illustrative purposes only. See table 3 for unit descriptions)

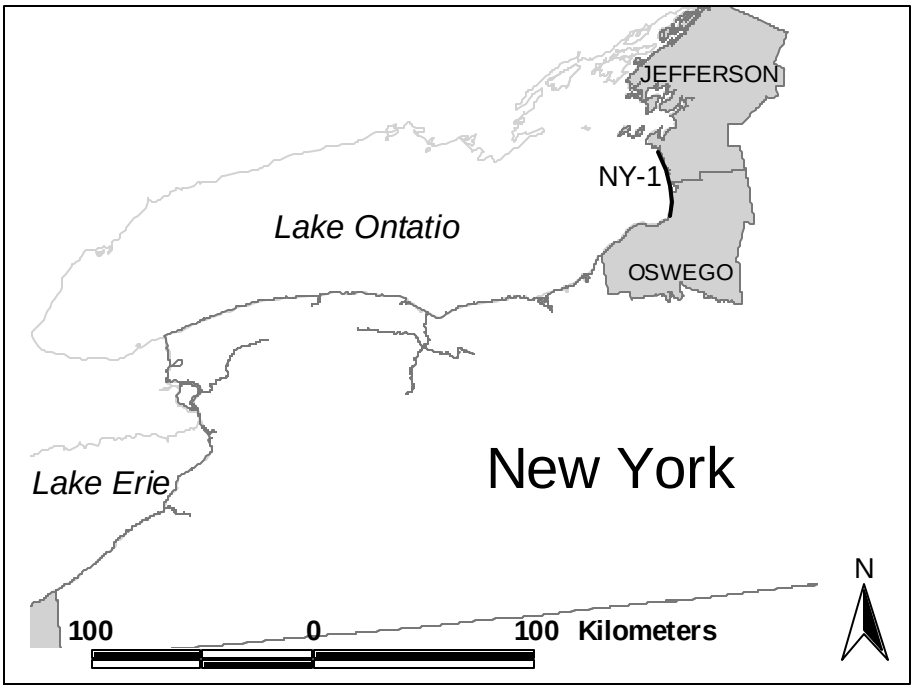

Figure 9c. Critical habitat units in New York.

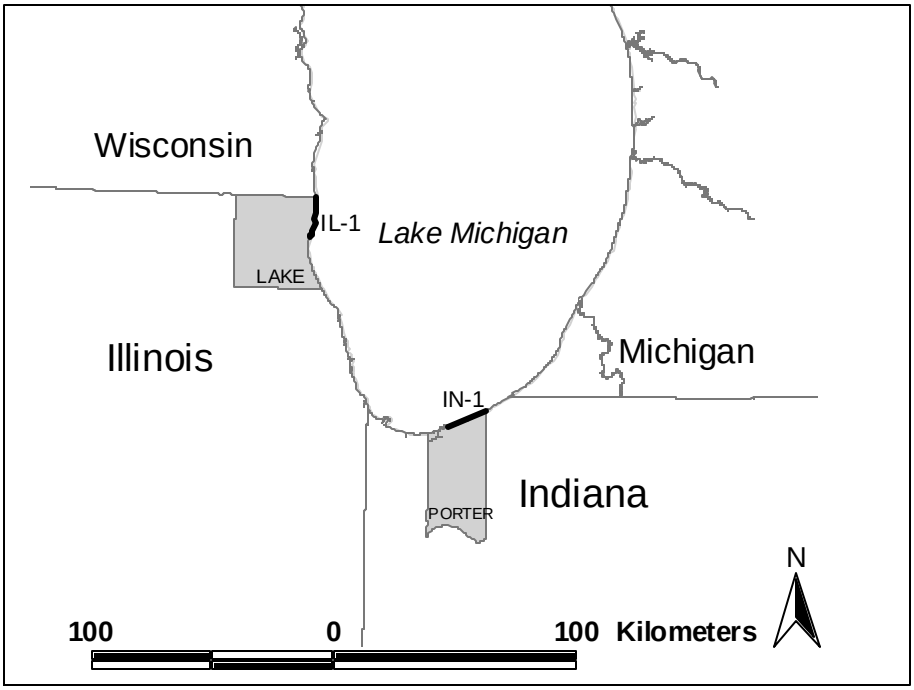

Figure 9d. Critical habitat units in Illinois and Indiana.

Figure 9a-f (cont.) Piping plover critical habitat units in the Great Lakes, outside Michigan (For illustrative purposes only. See table 3 for unit descriptions)

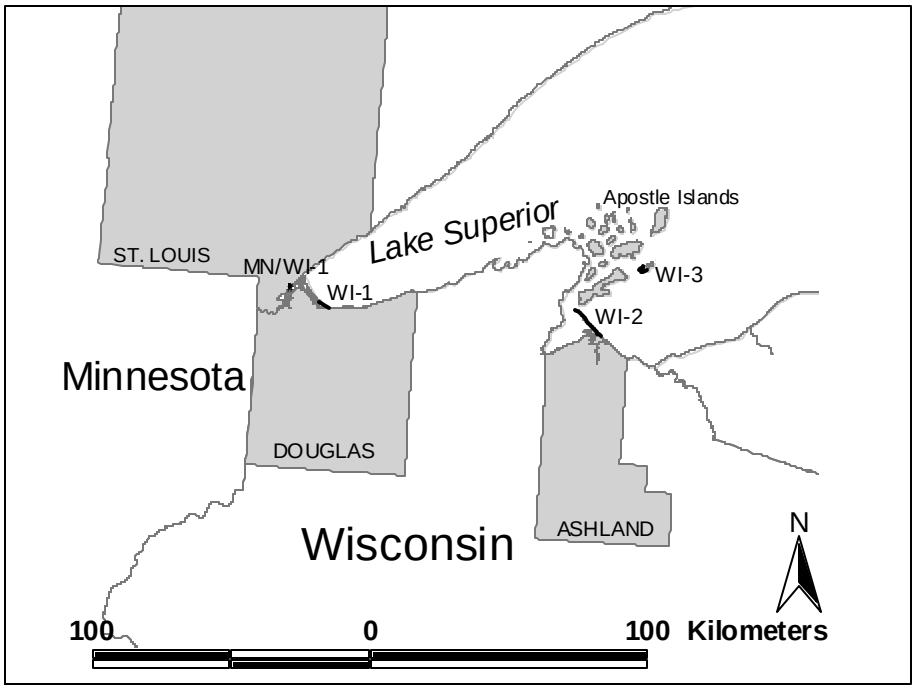

Figure 9e. Critical habitat units in Minnesota and Wisconsin.

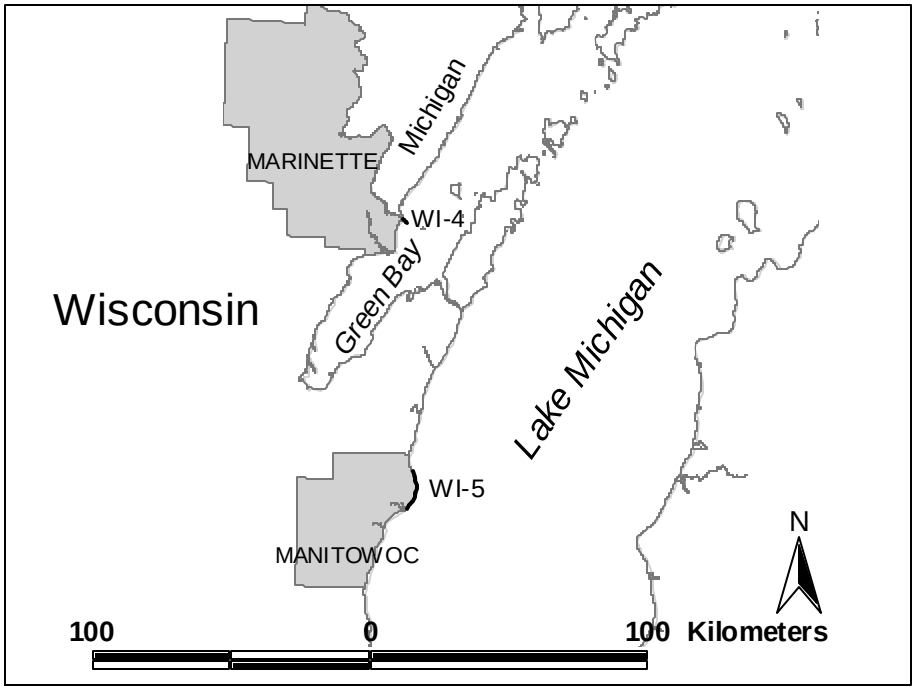

Figure 9f. Critical habitat units in Wisconsin.

Figure 9a-f (cont.) Piping plover critical habitat units in the Great Lakes, outside Michigan (For illustrative purposes only. See table 3 for unit descriptions)

Areas included in the critical habitat designation for the Great Lakes breeding population of piping plover were considered essential to the conservation of the species and were based on the best scientific and commercial data available at the time of the designation. Critical habitat areas were derived from research, historic records, surveys of habitat, information from local experts, and data on plover nest locations since 1984.

Within the geographic areas designated, only those areas that contain the primary constituent elements, as defined by 50 CFR 424.12(b), are considered as critical habitat. The primary constituent elements for the Great Lakes breeding population of the piping plover are defined as island and mainland shorelines that support open, sparsely vegetated, sandy habitats, such as sand spits or sand beaches, that are associated with wide, unforested systems of dunes and inter-dune wetlands. Per the rule, suitable sites must have at least 0.2 km (0.12 mi) length of gently sloping, sparsely vegetated (<50% herbaceous and woody cover) sand beach with a total beach area of at least 2 ha (5 ac). Within these size sites, the habitat must be at least 50 m (164 ft) in length where beach width is greater than 7 m (23 ft); there is protective cover for chicks; and the distance to the treeline from the normal high water line is more than 50 m (164 ft). The beach width may be narrower than 7 m (23 ft) if areas of sand and cobble of at least 7 m (23 ft) exist between the dune and treeline. Sites must also have a low level of disturbance from human activities and from domestic animals.

Critical Habitat on the Wintering Grounds

On July 10, 2001, the USFWS designated 142 units along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population (includes all birds from all breeding populations) of the piping plover (66 FR 36038) (USFWS 2001b). This includes approximately 2,891.7 km (1,798.3 mi) of mapped shoreline and approximately 66,881 ha (165,211 ac) of mapped area along the Gulf and Atlantic coasts and along margins of interior bays, inlets, and lagoons. Thirty-four designated critical habitat units have recent (1993-2003) documented use by Great Lakes piping plovers (Table 4). To date, five sites (Table 4) outside of the winter critical habitat designation have recent (2001-2003) documented use by Great Lakes piping plovers. With continued survey efforts, the number of sites with reported Great Lakes birds within and outside critical habitat units is expected to increase. Consultation under section 7 of the ESA should occur on all sites with piping plovers present if a Federal action is proposed that may affect plovers, regardless of whether or not critical habitat has been designated.

In determining areas that are essential to conserve the wintering population of piping plovers, the USFWS solicited information from knowledgeable biologists and reviewed the available information pertaining to habitat requirements of the species. Areas identified in approved recovery plans and current draft recovery plans were used initially to suggest important areas essential for the recovery of the species. These areas were then further evaluated using site-specific data, such as documented bird observations. Sources of data providing these locations include two international piping plover censuses (conducted by State

Table 4. Winter locations and corresponding critical habitat unit # (when applicable) of piping plovers known to have nested or hatched in the Great Lakes region, 1993-2003

State/County	Location	Critical Habitat Unit #	Ownership	# Marked Individuals (*)
GULF OF MEXICO COAST				
Florida				
Bay	Crooked Island West	FL-5	Federal	1 (1)
Franklin	Dog Island	not in unit	private	1
Pinellas/Pasco	Anclote Key	FL-15	state	1(1)
Pinellas	Three Rooker Bar Island	FL-16	state	3
Pinellas	Honeymoon Island State Park	FL-17/18	state	1
Pinellas	Shell Key and Mullet Key	FL-20	state	6(2)
Lee	Bonita Shores	not in unit		1
Collier	Marco Island	FL-27	county/state	6(1)
Alabama				
Baldwin	Fort Morgan	AL-1	state	1
Mobile	Pelican Island	AL-2	Federal	2
Louisiana				
St. Bernard Parish	Chandeleur Islands	LA-7	Federal	1
Texas				
Cameron	South Padre Island	TX-1/2	Federal/state	2(1)
	Port Isabella	not in unit	private	1
ATLANTIC COAST				
Florida				
Miami Dade	Key Biscayne, Crandon Park	not in unit	state	3
Duval	Little Talbot/Little Bird Island	FL-35	state	7(4)
Nassau	Tiger Islands	FL-36	private	1(1)
Georgia				
Chatham	Little Tybee Island	GA-2	municipal	1
	North Wassaw Island	GA-3	Federal	2
	Ossabaw Island	GA-5	state	2
Liberty	St. Catherine's Island	GA-8	private	2
McIntosh	Wolf Island	GA-11	Federal/private	2
	Egg Island Bar	GA-12	Federal/state	16
Glynn	Little St. Simon's Island	GA-13/14	private	22(6)
	Jekyll Island	GA-15		1(1)
Camden	Cumberland Island	GA-16	Federal	1

Table 4 (cont.) Winter locations and corresponding critical habitat unit # (when applicable) of piping plovers known to have nested or hatched in the Great Lakes region, 1993-2003

State/County	Location	Critical Habitat Unit #	Ownership	# Marked Individuals (*)
North Carolina				
Dare	Pea Island National Wildlife Refuge	NC-1	Federal	2(1)
Dare/Hyde	Cape Hatteras National Seashore	NC-4	Federal	2(2)
Hyde	Ocracoke Island	NC-5	Federal	2(1)
Carteret	Portsmouth Island Cape Lookout	NC-6	Federal	1
	South Core and Shackelford Banks	NC-7/8	Federal	4(3)
Onslow	Onslow Beach, Camp Lejeune	not in unit	Federal	1
South Carolina				
Georgetown	Litchfield	SC-4	Private	1
Charleston	Cape Romain NWR	SC-7	Federal	1
	Seabrook Island	SC-10	Private	2
	Deveaux Bank	SC-11	State	1

* Number in parentheses represents the number of individuals seen in successive years.

and Federal biologists and local birders) carried out in January of 1991 and 1996, published reports, Christmas bird counts, and other data from surveys focusing on shorebird distribution and abundance. Those areas along the coast for which occurrence data indicated a consistent use or had documented use by piping plovers were included in the critical habitat designation.

The primary constituent elements determined essential for conservation of wintering piping plovers are those habitat components that support foraging, roosting, and sheltering and the physical features necessary for maintaining the natural processes that support these habitat components. The primary constituent elements are found in geologically dynamic coastal areas that support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide.

Important components (primary constituent elements) of intertidal flats include sand and/or mud flats with no or very sparse emergent vegetation. In some cases, these flats may be covered or partially covered by a mat of blue-green algae. Adjacent unvegetated or sparsely vegetated sand, mud, or algal flats above high tide are also important, especially for roosting piping plovers. Such sites may have debris, detritus (decaying organic matter), or micro-topographic relief (less than 50 cm (19.7 in) above substrate surface) offering refuge from high winds and cold weather. Important components of the beach/dune ecosystem include surf-cast

algae for feeding of prey; sparsely vegetated backbeach (beach area above mean high tide seaward of the dune line, or in cases where no dunes exist, seaward of a delineating feature such as a vegetation line, structure, or road) for roosting and refuge during storms; spits (a small point of land, especially sand, running into water) for feeding and roosting; salterns (bare sand flats in the center of mangrove ecosystems that are found above mean high water and are only irregularly flushed with sea water (Myers and Ewel 1990)); and washover areas for feeding and roosting. Washover areas are broad, unvegetated zones with little or no topographic relief that are formed and maintained by the action of hurricanes, storm surge, or other extreme wave action.

Section 6 – Cooperation with States

State conservation agencies and their designated agents have certain "take" authority for species listed as endangered or threatened if the species are covered by a section 6 Cooperative Agreement with the USFWS.

Section 6 of the ESA allows the USFWS to grant money to states for the conservation of species. The USFWS has funded the Michigan Natural Features Inventory through grants to the Michigan Department of Natural Resources to conduct a Landowner Contact Program to notify landowners of the presence of piping plovers and other threatened or endangered plants and animals, and to suggest methods for protecting the species on their lands. Section 6 grants have also supported statewide surveys, monitoring, and research for the past several years.

State Protections: Several states within the breeding and wintering ranges of the Great Lakes piping plover have listed the species as threatened or endangered as a result of its Federal listing, including Michigan, Ohio, Indiana, Minnesota, Wisconsin, Illinois, New York, Texas, North Carolina, Georgia, Mississippi, Florida, and Louisiana (Table 5).

In Michigan, the piping plover was listed as a threatened species by the Michigan Department of Natural Resources (MDNR) in 1976. It was listed pursuant to Michigan's Endangered Species Act (Public Act 203 of 1974), now Part 365 of the Natural Resources and Environmental Protection Act of 1994 (Public Act 451). The piping plover was elevated to endangered status in Michigan in 1983. Other laws pursuant to Michigan's Natural Resources and Environmental Protection Act that provide protections to the piping plover and its habitat include Michigan Environmental Protection Act (part 17), Conservation and Historic Preservation Easement (subpart 11 of part 21: General Real Estate Powers), Sand Dunes Protection and Management (part 353), and Sand Dune Mining (part 637). Other states have similar acts or statutes that provide protection for the species and its habitat (Table 5, Appendix B).

Table 5. State listing status and legal protection of the piping plover in states within the breeding and wintering ranges of the Great Lakes population

State	State Legal Protections
Endangered	
Illinois	Illinois Endangered Species Protection Act-520 ILCS (Illinois Compiled Statutes) 10/1
Indiana	IC (Indiana Code) 14-22-34
Michigan	Part 365 of the Natural Resources and Environmental Protection Act of 1994 (Public Act 451)
Mississippi	Listed as Endangered under the Nongame and Endangered Species Conservation Act of 1974
Minnesota	Minnesota Endangered Species Statute, Section 84.0895; Minnesota Rules, Chapter 6134; Minnesota Rules 6212.1800-6212.2300
New York	6 NYCRR (New York Code of Rules and Regulations), Part 182; New York State Environmental Conservation Law, 11-0535[1]-[2], 11-0536[2],[4]
Ohio	Ohio Revised Code, Section 1531.25
Wisconsin	Wisconsin Statutes, Section 29.604; Wisconsin Administrative Codes, Chapter NR (Natural Resources) 27
Threatened	
Florida	Florida Endangered and Threatened Species Act, Sections 372.072, 372.0725 of Title 28
Georgia	Endangered Wildlife Act (1973)
North Carolina	North Carolina General Statutes, Chapter 113, Article 25
Texas	Texas Parks and Wildlife Code, Chapters 67 & 68; Texas Administrative Code, Sections 65.171-65.184 of Title 31
Threatened/Endangered	
Louisiana	RS (Revised Statutes) 56:1901, RS 56:1903, RS 56:1904
State Protected	
Alabama	Alabama Code 9-2-2 (1), the Department of Conservation and Natural Resources has the responsibility to protect, conserve, and increase the wildlife of the state.
Not Listed	
Pennsylvania	
South Carolina	

Section 7–Interagency Consultations with Federal Agencies

Regulations implementing interagency cooperation provisions of the ESA are codified at 50 CFR Part 402. Section 7(a)(2) of the ESA requires Federal agencies to consult with the USFWS when federally permitted, authorized, or funded actions may affect listed species, including the piping plover. This consultation process promotes interagency cooperation in finding ways to avoid or minimize adverse effects to listed species. If a Federal action is likely to adversely affect any listed species, the Federal agency must enter into formal consultation with the USFWS. The USACE is one of many agencies that have undergone formal consultation with the USFWS because of actions that may affect piping plovers. Section 7(a)(1) requires these agencies to use their authorities to further the conservation of federally listed species.

Section 9–Prohibitions against Take

Section 9 of the ESA prohibits any person subject to the jurisdiction of the United States to take listed wildlife species. The term "take" is defined to include harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting. It is also unlawful to attempt such acts, solicit another to commit such acts, or cause such acts to be committed. Regulations implementing the ESA (50 CFR 17.21) define "harm" to mean an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. "Harass" means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. These restrictions apply to all listed species not covered by a special rule. No special rule has been published for the piping plover.

Section 10–Permits and Funding for Scientific Research and Conservation Actions

Section 10 of the ESA provides for permits to authorize activities otherwise prohibited under section 9 for scientific purposes or to enhance the propagation or survival of a listed species. Section 10 (a)(1)(A) permits have been issued for research, management (predator exclosures), captive rearing, salvage of eggs and carcasses, and banding of piping plovers from the Great Lakes population. Also under section 10, it is legal for employees or designated agents of certain Federal or state agencies to take listed species without a permit, if the action is necessary to aid sick, injured, or orphaned animals or to salvage or dispose of a dead specimen. Activities that may proceed are limited by regulation, but may include many recovery research projects that are identified in this plan. The limits on this authority are detailed in 50 CFR 17.21 (c)(5).

Section 10 (a)(1)(B) permits can also provide for take that is incidental to an otherwise lawful activity, provided certain conditions have been met. In order to obtain an incidental take permit, an applicant must prepare a Habitat Conservation Plan (HCP). The HCP is designed to offset any harmful effects that the proposed activity may have on the species by minimizing and mitigating the effects of the authorized incidental take. In March, 2001, an HCP was submitted to the USFWS by the Magic Carpet Woods Association for a residential development in Leelanau County, Michigan. The HCP, which was approved and is currently being implemented, provides for a number of protections and conservation measures for the piping plover, including establishment of a Great Lakes piping plover conservation fund. This fund is to be used for piping plover research, monitoring, and recovery efforts consistent with this recovery plan.

2. Field-based Conservation Efforts

Field-based conservation measures for the piping plover have occurred primarily in Michigan as the Great Lakes population has been largely limited to Michigan since it was listed as endangered. Habitat surveys, beach restoration, and prey studies have occurred in Wisconsin (Matteson and Strand 1988) and several states have protected habitat under a variety of mechanisms.

Surveys and Monitoring

Breeding sites in Michigan are surveyed annually for piping plovers, and all located nests are monitored throughout the breeding season. Additionally, the International Piping Plover Census surveys historic breeding and wintering areas at least once every five years. MDNR funded the first statewide survey of Michigan breeding sites in 1979 and has coordinated annual statewide surveys and monitoring since 1983. In 1985, a Michigan state recovery team was founded. In 1987, Michigan recovery team members developed a state recovery plan independently from the first Federal recovery plan. Since 1994, the East Lansing, Michigan Field Office of the USFWS has sponsored coordination meetings attended by agency employees involved in piping plover management, seasonal field workers, researchers, Michigan recovery team members and invited guests to organize seasonal field efforts. In 1994, the USFWS initiated a program to organize volunteers to patrol piping plover nesting areas over holiday weekends. This program has been continued and expanded in subsequent years through participation of the MDNR and the National Park Service (NPS).

Protection of Eggs and Chicks

Since 1988, fencing has been consistently used to protect all known piping plover nests from predation. Two designs of predator exclosures have been used. The most common design is a 15 m (50 ft) roll of welded wire supported by fence posts around the nest and topped with monofilament line (Rimmer and Deblinger 1990). Smaller, 1 m (3.3 ft) by 1 m (3.3 ft) welded wire boxes have also been used to protect nests. Widespread use of the smaller box

exclosures was abandoned after a clutch of eggs protected by the box-type exclosure was depredated by a red fox in 1993. Box exclosures are still used periodically on private land with narrow beaches and/or when landowners object to the larger exclosure. They are also used on occasion to protect extremely vulnerable clutches during the laying phase prior to erection of a larger exclosure. Psychological fencing is currently used in concert with predator exclosures at most nest sites to limit human activity in the vicinity of piping plover nests. This fencing consists of bailing twine held in place with fence posts. Michigan DNR "Unlawful to Enter" signs and/or USFWS "Closed Area" signs are attached to the fencing. The closed area varies, depending on the site, and ranges from a small circular area approximately 100 m (330 ft) in radius to larger areas of approximately 800 m (2600 ft) on either side of the territory.

Consistent use of exclosures and psychological fencing increased hatching success from 37% to 72% between 1984 and 1999 (Cuthbert and Wemmer 1999; Wemmer 2000). Reasons for hatching failure despite this management include depredation prior to erection of exclosures, abandonment, inviable eggs, and egg loss to small, unidentified predators. Documented negative effects of exclosures on piping plovers include nest abandonment, entanglement of an adult piping plover in the monofilament line used to top an exclosure, increased disturbance to incubating birds by curious people, and destruction of eggs by vandals who likely located the nest by the predator exclosure. Because of the site specific nature of predator activities, additional management (e.g., removal of foxes denning near a breeding pair and communication with landowners to control domestic dog activity) has been used to reduce predation risks. However, loss of chicks remains a major source of mortality and is extremely difficult to predict or control (Cuthbert and Wemmer 1999).

Habitat Enhancement and Protection

Federal, state, and local actions have enhanced and increased protection of piping plover habitat. Guardrails or boulders placed at vehicle access points have prevented people from driving on piping plover habitat at some Michigan breeding sites. The U.S. Forest Service (USFS) enhanced nesting habitat at Pointe Aux Chenes, Mackinac County, Michigan by adding gravel to the beach. Piping plover nesting habitat was protected from marina development at Cross Village, Emmet County, Michigan in a section 7 consultation between the USFWS and the USACE in 1994 (USFWS 1994). The USFWS has worked with local planning and zoning boards to incorporate shoreline protection and piping plover habitat needs into land use plans and existing permitting processes. The USFWS administered a 3-year Great Lakes Protection Fund grant of $281,000 that began in 1999. The grant supported several private conservation groups that work with private landowners, citizen's groups, townships officials, and county planning commissions to demonstrate the economic and environmental benefits of coastline protection. The grant also supported piping plover research, management, and protection undertaken by university researchers. On the wintering grounds, the USFWS's Coastal Program targets restoration activities along coastal habitats and barrier islands that indirectly benefit piping plovers.

Banding and Population Studies

A long-term banding program has begun to yield important insights into population dynamics of Great Lakes piping plovers and has helped shape protective management measures. Sightings of piping plovers banded in the Great Lakes as well as other regions (e.g., Saskatchewan, Maritime Provinces and the Great Plains) have greatly enhanced the knowledge of winter distribution. Prior to banding, knowledge of survival, mortality, and adult and juvenile dispersal within the Great Lakes region was very limited (Pike 1985). Marking individuals has increased accuracy of population size estimates by allowing identification of re-nesting attempts. Banding has allowed monitoring of movements by individuals and provides information on post-fledging dispersal. Life history information about individuals has generated public interest in conserving these birds. However, trapping and banding piping plovers pose potential risks, including stress, injury, and mortality to adults, chicks, and eggs. Therefore, banding should continue only as long as necessary to obtain information that contributes to recovery of this population (see Appendix C for an assessment of concerns for the Great Lakes population).

Captive-rearing Abandoned Eggs

From 1988-1992, despite the use of protective fencing, piping plovers continued to abandon nests and fecundity remained low. Beginning in 1992, the USFWS permitted Dr. Francesca Cuthbert and her investigators to collect abandoned piping plover eggs and raise them in captivity using previously developed techniques (Powell 1991). These efforts have shown that captive-rearing can successfully produce fledglings from eggs that would otherwise not hatch in the wild and that fledglings reared in captivity exhibit behavior similar to wild counterparts (Powell et al. 1997). In 1998, three of four birds reared in captivity and released in 1997 (total released 1992-1998 =18) were sighted at beaches in Michigan (Wemmer 2000). Two of the three appeared to have paired with wild mates and one of these pairs was observed copulating. While no nests of these pairs were found, observations suggest that at least one adult laid eggs that were destroyed before a nest was located (Stucker et al. 1998). In 1999, one of these captive-reared plovers was documented to reproduce successfully (Stucker and Cuthbert 1999). Since 1999, additional observations of successful nesting by captive-reared plovers have been made. Similarly, breeding by six captive-reared individuals in the Great Plains was documented between 1997-2000 (C. Kruse, biologist, USACE, Yankton, South Dakota, and Robyn Niver, graduate student, University of Wisconsin-Madison, pers. comm., 2000). Although only 25 of 360 captive-reared piping plovers in the Great Plains were sighted in the years following release, logistical difficulties in monitoring plovers over vast areas likely led to an underestimation of returns (C. Kruse, biologist, USACE, Yankton, South Dakota, pers. comm., 1999).

Conservation on the Wintering Grounds

Conservation efforts directed at this population on the wintering grounds have been limited because winter distribution of the Great Lakes population was not known until very recently. Consultations by the USFWS on specific shoreline development projects, however, have been undertaken for wintering piping plovers (USFWS 1996). Broad management efforts that have likely benefited wintering Great Lakes piping plover populations have included protection of "Shorebird Resting Areas" in some state parks, designation of shorebird wintering sites as "Important Bird Areas" of the American Bird Conservancy, protection of sites under the Western Hemisphere Shorebird Reserve Program, and regular shorebird surveys in select states. Predator control along coastal systems for sea turtles and beach mice may indirectly benefit piping plovers.

3. Public Education

Public education efforts have been diverse. Several press releases are prepared annually by the USFWS to alert the public to the presence and protection needs of piping plovers. The USFWS Region 3 Office, Fort Snelling, Minnesota, prepared an informative brochure about piping plover (104,000 copies printed) and distributed it widely throughout the Great Lakes states. The USFWS East Lansing, Michigan, Field Office, and the MDNR created a lesson plan about piping plovers and distributed it to Michigan elementary school teachers in 1994. Also in 1994, the Michigan Chapter of The Nature Conservancy conducted a landowner contact program to inform private owners of Great Lakes coastline about endangered plants and animals on their property. The landowner contact program continued from 1999-2002. In 1995, 12 large interpretative displays featuring the piping plover were funded by the USFWS and erected at breeding areas receiving high human use. On-site interpretation is also provided during the nesting season at areas such as Sleeping Bear Dunes National Lakeshore and Wilderness State Park. Finally, numerous public presentations have been made to citizen groups in the Great Lakes region and on the wintering grounds on the status of piping plovers and various recovery efforts.

4. Involvement of Zoos in Recovery Efforts

The involvement of American Zoo and Aquarium (AZA) institutions in piping plover recovery started in 1995 when the USFWS and USACE requested assistance with an egg rescue operation for the Great Plains population on the Missouri River. The Milwaukee County Zoo and the Lincoln Park Zoo each salvaged 15 eggs and a total of 19 eggs hatched in the zoos. Through a Memorandum of Understanding (MOU) and the section 10 permitting process, the USFWS has officially allowed the zoo community to house the small rescued population for research and educational purposes.

A Piping Plover Specialist Group was formulated in 1995 under the AZA Charadriiformes Taxonomic Advisory Group (TAG). The purpose of the Piping Plover

Specialist Group is to create a network of zoos and organizations willing to assist with the recovery of the piping plover in all three geographic regions. Six AZA institutions currently participate in the program: Milwaukee County Zoo, Lincoln Park Zoo, Detroit Zoo, New England Aquarium, Houston Zoo and the San Antonio Zoo. Five of these institutions currently house captive piping plovers. Since 1995, participating zoos have been developing appropriate husbandry methods for piping plovers and researching nutrition and development, captive breeding requirements, and appropriate exhibit design. In January 2000, representatives from the participant institutions, USFWS, and USACE met at the Milwaukee County Zoo to formulate goals and objectives for the Piping Plover Specialist Group. Major program objectives are to create an official husbandry manual and studbook for piping plovers to measure the demographic and genetic potential of the population, increase awareness of the status of the species, and identify and develop new funding sources for piping plover conservation. Participant zoos have also assisted field research. In 1999, biologists at the Milwaukee County Zoo tested several radio transmitter harness designs on captive piping plovers in an effort to develop a safe design for use in the wild.

5. Research

A number of research projects directed specifically at the Great Lakes population are described in detail in previous sections of this document. Research projects have focused primarily on population dynamics, breeding ecology, habitat assessment, predator identification, and contaminant evaluation. Additional studies have evaluated the efficacy of using certain techniques as conservation tools to speed recovery by augmenting the Great Lakes population. Powell and Cuthbert (1993) compared the effectiveness of cross-fostering and captive-rearing piping plovers using killdeer (*C. vociferus*) as models. This study developed a protocol for rearing piping plovers in captivity and found captive-rearing more effective than cross-fostering in producing fledged young.

Doolittle (1998) used a stochastic population model to investigate the effects of using different captive-rearing strategies (single-egg removal and double-clutching[5]) to augment the Great Lakes population. She compared model results over a 20-year period including the first 5 years of implementation. She examined five different levels of intervention on the population and compared costs and benefits of each strategy in terms of magnitude of population trends and probabilities of extinction. Doolittle (1998) simulated the following five year strategies: no egg removal for captive rearing purposes (control), removal of entire clutches from 10% and 25% of nests, and removal of single eggs from 50% and 100% of nests. Model results showed captive-rearing strategies raised the population to significantly higher levels than did the control, even when the survival of captive-reared fledglings was halved. Model results also showed an increasing population trend that continued after captive-rearing ended. If assumptions about survival and behavior are accurate, Doolittle's (1998) modeling effort suggests that short-term

[5]Double-clutching is the process of removing eggs from a clutch during egg-laying, inducing the female to produce additional eggs.

captive-rearing efforts may boost piping plover populations over the long-term.

F. Strategy of Recovery

The recovery strategy for the Great Lakes piping plover considers both the species' biology and threats to its continued survival. The piping plover nests, forages, and rears young on open, sparsely vegetated sandy beaches associated with coastal dune ecosystems in the Great Lakes region. Nest sites vary widely in their physical characteristics, but typically, nests are laid in wide, sandy areas with sparse, low-lying vegetation and cobble substrate. Over the past decade, the species has bred primarily in Michigan and Wisconsin and has been observed migrating through other Great Lakes states. On the wintering grounds, piping plovers forage and roost on beaches, dunes, bayshore mudflats, algal flats, and sand flats of the Atlantic and Gulf Coasts.

Destruction of habitat, human disturbance, and increased predation rates due to elevated predator densities in piping plover habitat are the main reasons for the species' endangered status and continue to be the primary threats to recovery. The Great Lakes population primarily inhabits public or undeveloped private beaches on the breeding and wintering grounds where it is vulnerable to predation from natural predators and pets, disturbance by recreational beach users and ORVs, and increasing land development pressure. Contaminants may also threaten piping plover reproduction and survival.

Public and private efforts to manage and protect the piping plover are underway. State and Federal agencies as well as private citizens are managing recreation and other land uses to maintain beach habitats suitable for piping plovers. In 2001, critical habitat was designated by the USFWS in separate rules for the breeding (66 FR 22938) (USFWS 2001a) and wintering (66 FR 36038) (USFWS 2001b) grounds. The critical habitat designation identifies areas that provide essential life-cycle needs of the species and seeks to protect adequate habitat to meet the recovery goals. Field-based conservation efforts such as piping plover surveys and monitoring, protection of eggs and chicks, captive-rearing, banding studies, habitat enhancement and protection, and public education and outreach are also underway. Although these protection measures are currently being implemented and the population size has been increasing over the past decade (likely as a result of protection efforts), the Great Lakes population remains at a dangerously low population size and faces the risk of extirpation without continued efforts to recover the species. Therefore, it is necessary to implement recovery tasks outlined in the recovery narrative to achieve full recovery of this species.

The recovery objective is to restore and maintain a viable population (95% or greater chance of persisting 100 years) to the Great Lakes region and to remove the Great Lakes population from the list of Endangered and Threatened Species by 2020. Recovery criteria were developed based on population theory and modeling as well as estimates of the current capability of habitat in the Great Lakes region to support breeding pairs. The recovery objective can be achieved by a diverse, multi-partner strategy that seeks to increase average

fecundity, protect essential breeding and wintering habitat, increase genetic diversity to levels needed to maintain population persistence, increase public education and outreach, and establish and maintain funding mechanisms and partnerships for long-term protection and management. Several elements of this multifaceted approach to recovery are already underway and have demonstrated their potential effectiveness in achieving the goals of recovery.

The recovery objective and criteria in this plan are based on the best available scientific data regarding the Great Lakes piping plover. The recovery objective can be met by completing the recovery tasks found in the implementation schedule, which includes tasks for various individuals and agencies for the next 5 years. If the tasks in this table are implemented, full recovery of this species could occur by 2020. The recovery criteria and tasks should be reviewed and revised prior to the end of the next 5 years.

II. RECOVERY

A. Objective and Criteria

The objective of the recovery plan is to restore and maintain a viable population of piping plovers in the Great Lakes region and to remove the Great Lakes piping plover population from the federal List of Endangered and Threatened Species by 2020. Population viability is difficult to define in quantitative terms. Shaffer (1981) suggested that each population has a minimum threshold size below which the population is at imminent risk of extinction due to demographic and environmental effects. An effective population of 50-500 individuals is often quoted as the size necessary to avoid extinction due to random loss of genetic variation alone (Franklin 1980; Soulé 1980); populations must be much larger to persist in the face of environmental change. Although determining minimum viable population size (MVP) for a single species is nearly impossible, general MVP guidelines have been sought (Frankel and Soulé 1981; Mace and Lande 1991). However, no single number can be wisely applied to all populations (Soulé 1987). It follows that population viability analysis (PVA) is employed more appropriately to examine the effect of variation in demographic and environmental factors on theoretical population trends than it is to derive quantitative population goals (Caughley 1994; Beissinger and Westphal 1998). However, because the majority of PVAs specify a 95% or better probability of persisting 100 years as a criterion by which to judge model results, this level of risk in avoiding extinction appears to be socially and scientifically acceptable.

Five recovery criteria were developed based on population theory, observed population parameters, and estimates of the current capability of habitat in the Great Lakes region to support breeding pairs. These criteria are subject to modification as habitat availability is further investigated, essential habitat is refined, and viability of the Great Lakes piping plover population is better understood.

Reclassification to threatened status will be considered when Criteria 1-4 are met; removal from the Endangered and Threatened Species list will be considered when all five Criteria are met. Monitoring shall continue for at least 5 years after delisting to ensure maintenance of these criteria.

CRITERIA FOR RECLASSIFICATION TO THREATENED

The Great Lakes population of piping plover will be considered for reclassification from endangered to threatened status when all of the following criteria are achieved:

Criterion 1. The population has increased to at least 150 pairs (300 individuals), for at least 5 consecutive years, with at least 100 breeding pairs (200 individuals) in Michigan and 50 breeding pairs (100 individuals) distributed among sites in other Great Lakes states.

The recovery objective of the 1988 Great Lakes/Northern Great Plains Piping Plover Recovery Plan specified a population target of 150 breeding pairs for the Great Lakes population, with 100 pairs in Michigan, 35 pairs in Wisconsin and 15 pairs in other Great Lakes states (USFWS 1988b). Michigan habitat can potentially support 100 or more breeding pairs (see Appendix A). We expect that an additional 50 pairs would be supported by essential habitat in states other than Michigan. Breeding pair goals for individual states other than Michigan are not realistic, as it is difficult to predict how piping plovers will expand from the current core population in Michigan.

Criterion 2. Five-year average fecundity is within the range of 1.5-2.0 fledglings per pair, per year, across the breeding distribution, and ten-year population projections indicate the population is stable or continuing to grow above the recovery goal.

Results of recent modeling efforts suggest that a substantial increase in reproductive success must occur in order to achieve and maintain the 150 breeding pair target population size. Recent empirical observations, however, suggest the population can under go a significant increase in the absence of 5-year average fecundity rates of 2.0 fledglings per pair. In addition, it is expected that substantially improved probability of persistence can be obtained by increasing the breeding population above 150 pairs. As a result, it is currently anticipated that the population can reach recovery with a 5-year average fecundity that ranges between 1.5 and 2.0. Ten-year population projections that indicate the population is stable or continuing to grow are also required before this recovery criterion can be met.

Criterion 3. Ensure protection and long-term maintenance of essential breeding and wintering habitat, sufficient in quantity, quality, and distribution to support the recovery goal of 150 pairs (300 individuals).

Currently, habitat degradation and loss represent the greatest threat to successful recovery of the piping plover. Sufficient essential breeding and wintering habitat must be protected to recover the Great Lakes population and support the 150 pair (300 individuals) population goal for the future. While essential breeding habitat is fairly well-defined, studies are needed to better understand what potential wintering habitat is essential for a recovered Great Lakes population.

Protective measures will seek to ensure long-term maintenance of the biological and physical attributes of essential habitat in the Great Lakes and wintering range, sufficient in quantity, quality, and distribution to maintain a 150-pair population. Recovery tasks 1.3, 2, and 3 are aimed at protecting breeding, wintering and migration habitat. Initial efforts to protect essential habitat have been undertaken through designation of critical habitat. Other measures such as acquisition of land and establishment of conservation easements have also been initiated.

Essential breeding habitat is currently defined as any Great Lakes shoreline that meets the physical characteristics of piping plover breeding habitat. Appendix A and Table 6 lists locations currently containing essential breeding habitat in the Great Lakes. Specifically, essential habitat includes:

a. areas recently (since 1980) used by piping plovers for breeding,
b. areas occupied historically (before 1980) that still contain habitat physically suitable for breeding, or
c. potential breeding habitat, which is currently defined as areas with:

- beach width > 7 m (23 ft)
- shoreline length > 0.4 km (0.25 mi)
- dune area > 1.95 ha (4.82 ac)
- patches of > 0% cobble or debris
- areas of beach with up to 50% vegetation cover

Essential wintering habitat is currently defined as all areas where Great Lakes banded piping plovers have been reported in the winter (Table 4). However, we recognize that additional areas are likely to be identified over time, as most individuals from the Great Lakes population are not currently accounted for in the winter. Further studies are needed to:

1) obtain additional sightings of banded Great Lakes birds to better understand which areas are selected for wintering habitat, particularly as the population increases;

2) refine our understanding of what habitat attributes on wintering grounds constitute essential elements of winter habitat; and

3) understand the home range size requirements per plover while on the wintering grounds and to determine the amount, extent, and location of wintering habitat needed to support a recovered Great Lakes population (as described in Criterion 1).

Migration habitat has not yet been determined but may be added to the definition of essential habitat if identified through investigations of migratory patterns and ecology.

Table 6. Essential breeding habitat in the Great Lakes outside Michigan

State/County	Location	Ownership	Plover Use	Potential Pairs[a]
Illinois				
Lake	Illinois Beach State Park	state	historic[b]	15
Indiana				
Porter	Indiana Dunes National Lakeshore	Federal/state	recent[c] (transient)	3
Minnesota				
St. Louis	Duluth Harbor	private/state	recent	1-2
New York				
Oswego & Jefferson	Salmon River to Stony Point	private/state	historic	3
Ohio				
Lake	Headlands Dunes State Nature Preserve	state	potential[d]	1
Erie	Sheldon Marsh State Nature Preserve	state	recent (transient)	2
Pennsylvania				
Erie	Presque Isle State Park	state	recent (transient)	3
Wisconsin				
Ashland	Long Island/Chequamegon Pt/Western Michigan Island	Federal	recent	10-20
Douglas	Wisconsin Point/Interstate Island	state	recent	2-3
Manitowoc	Point Beach State Forest	state	historic	1-2
Marinette	Seagull Bar	municipal	historic	1-2
Canada				
Ontario	Long Point	National/ provincial/ Private	historic	15-20[e]

[a] Potential capacity of breeding pairs are preliminary estimates and were based roughly on the size and physical quality of the habitat, if known, or on personal communications with local experts. Because thorough surveys to quantify existing physical habitat throughout the Great Lakes have not been done, it is likely that all potential habitat has not been identified. Therefore, these preliminary **breeding pair estimates should not be construed as definitive population limits or as management targets for individual states or breeding sites**.

[b] Historic = used for breeding prior to the 1980s.

[c] Recent Transient = recently used but not for breeding.

[d] Potential = no record of nesting but habitat is suitable.

[e] **Potential pairs for Canadian Great Lakes are not counted toward U.S. recovery goal**.

Criterion 4. Genetic diversity within the population is deemed adequate for population persistence and can be maintained over the long-term.

Observations of inbreeding, along with small population size, indicate that inbreeding depression and loss of genetic diversity are potential concerns for the Great Lakes population. Current conditions also limit the potential for natural opportunities for genetic exchange with the other, larger breeding populations.

Genetic diversity can be effectively measured by estimating parameters such as heterozygosity and by using tools such as pedigree analysis. Initial genetic analysis of individuals from the Great Lakes suggests the current population may have a low level of genetic diversity. Sufficient data is lacking, however, to determine the level of genetic diversity that will be adequate to maintain population persistence over the long-term. Further analysis of band data and genetic material is needed to provide greater insight into the extent of inbreeding and genetic variability present in this population. If genetic research indicates the lack of genetic diversity threatens the population, methods to supplement gene flow to ensure species recovery will be considered.

CRITERIA FOR DELISTING

The Great Lakes population of piping plovers will be considered for delisting when all of the above criteria (1-4) are achieved, plus:

Criterion 5. Agreements and funding mechanisms are in place for long-term protection and management activities in essential breeding and wintering habitat.

As the recovery goal is approached, the USFWS will work with federal, state, and local government agencies to create and implement MOUs or long-range management plans (LRMPs) to protect and manage essential breeding and wintering habitats where plover activity has been recorded. Long-term agreements and mechanisms to fund protection efforts are necessary to prevent reversal of population increases after removal from the Endangered and Threatened Species list. Agreements should also provide for monitoring to evaluate whether population targets are maintained successfully.

B. Stepdown Recovery Action Outline

The stepdown outline lists actions required to meet the recovery objective of this recovery plan. The recovery objective can be accomplished by: 1) protecting piping plover breeding populations and managing habitat, 2) protecting wintering piping plovers and managing wintering habitat, 3) identifying and protecting migration habitat, 4) conducting scientific research to facilitate recovery efforts, 5) developing and implementing public education and outreach, 6) developing funding mechanisms and partnerships, 7) developing methods to prevent extirpation,

and 8) reviewing and revising recovery actions.

The stepdown outline and narrative are presented in order of task category; priority level of each sub-task is indicated at the end of the task description in parentheses. Implementation of all actions with Priority **(1)** is essential to prevent the endangered Great Lakes population of piping plovers from becoming extinct in the foreseeable future. Implementation of all actions with Priority level **(2)** is necessary to prevent a decline in population numbers or habitat quality and quantity. Actions assigned Priority **(3)** are necessary to create an increasing trend toward recovery of the endangered Great Lakes population of piping plovers.

Tasks are listed in order of priority and their costs outlined in the Implementation Schedule.

1. Protect the Great Lakes piping plover breeding population and manage breeding habitat to maximize survival and fecundity.

    1.1 Coordinate survey, monitoring, and management efforts in breeding range.

        1.11 Coordinate seasonal field activities at biannual meetings of Breeding Range Coordination Group. (1)

        1.12 Coordinate survey in Michigan to ensure consistent coverage and effort among years. (1)

        1.13 Identify survey coordinators and survey sites for other Great Lakes states and Ontario. (1)

        1.14 Develop standard, range wide monitoring and reporting protocol. (1)

        1.15 Develop guidelines and conduct annual training workshops for seasonal piping plover monitors. (1)

        1.16 Continue to support a coordinator to oversee data collection, maintain databases, analyze field data, and disseminate results. (1)

        1.17 Develop agreements with private landowners and townships to allow monitoring and management efforts on private and municipal lands. (1)

        1.18 Develop and implement protection guidelines for unoccupied or historic breeding habitat on state and Federal lands via MOU/MOA. (1)

        1.19 Organize and train volunteers to patrol nesting areas. (2)

1.2 Monitor and manage breeding pairs and reproductive success.

1.21 Survey known, historic, and potential breeding sites to locate breeding piping plovers. (1)

1.22 Reduce predation and disturbance of breeding piping plovers.

1.221 Protect nests with predator exclosures and limit human activity in nesting areas with fencing and signs. (1)

1.222 Clarify policies and protocol for predator control/removal and implement when and where warranted. (1)

1.223 Report dog leash law infractions in nesting areas and work with state and Federal conservation officers and local animal control officers to increase enforcement. (1)

1.224 Evaluate current use of vehicle blockades on public and privately-owned land with piping plovers and recommend changes as necessary. (2)

1.3 Protect natural processes that maintain dune ecosystems and essential breeding habitat.

1.31 Identify and update essential habitat in Great Lakes region. (1)

1.32 Work to minimize development and encourage activities that prevent degradation or destruction of essential habitat on public lands in the breeding range. (1)

1.33 Protect breeding population from oil spills in Great Lakes waterways. (1)

1.34 Work to minimize development and encourage activities that prevent degradation or destruction of essential habitat on private lands in the breeding range.

1.341 Incorporate protection of breeding areas into land use plans and existing permitting processes. (2)

1.342 Develop guidelines for landowner Habitat Conservation Plans. (2)

1.35 Assess and foster compatibility of management with efforts that benefit other threatened and endangered Great Lakes species. (3)

1.36 Restore and acquire habitat.

1.361 Control vegetation and conduct cobble nourishment at marginal breeding sites when and where appropriate. (3)

1.362 Purchase habitat and increase protection through conservation easements, deed restrictions, etc. (2)

2. Protect wintering piping plovers and manage habitat to promote survival and recruitment.

2.1 Organize protection efforts for wintering piping plover populations.

2.11 Create a Wintering Grounds Coordination Group to organize protection efforts on piping plover's wintering range. (1)

2.12 Organize winter surveys to locate banded birds and identify key wintering areas for the Great Lakes population. (1)

2.13 Annually monitor wintering populations at sites with sightings of birds banded in the Great Lakes. (1)

2.14 Reduce disturbance to piping plovers at wintering sites by humans and pets. (1)

2.15 Protect wintering populations from oil spills. (1)

2.16 Identify and reduce additional threats to winter populations. (1)

2.2 Protect natural processes that maintain coastal ecosystems and quality wintering habitat.

2.21 Identify and update essential wintering habitat locations. (1)

2.22 Work to minimize impacts of development and encourage activities that will prevent degradation or destruction of essential wintering habitat. (1)

2.23 Assess and foster compatibility of winter management with efforts that benefit other threatened and endangered species. (3)

2.24 Work with states to protect wintering habitat on private lands through conservation easements, deed restrictions, land purchases, or other appropriate mechanisms. (2)

3. Identify and protect migration habitat outside of wintering range.

3.1 Compile information from ornithological literature to identify probable migration sightings in each of the Great Lakes states and Ontario and along migratory pathways. (2)

3.2 Target bird watching groups in each state and Ontario and request assistance in locating migrating piping plovers. (2)

3.3 Identify and reduce threats to habitat and migrating piping plovers at key migration sites. (3)

4. Conduct scientific research to facilitate recovery efforts.

4.1 Continue to study survival, recruitment, dispersal, and ecology by banding Great Lakes population. (2)

4.2 Study breeding ecology.

4.21 Investigate factors influencing nest densities at breeding sites.

4.211 Study biotic and abiotic factors that influence nesting densities. (3)

4.212 Quantify other factors (disturbance, predation) limiting piping plovers at current and historic breeding sites. (2)

4.22 Investigate relationship of brood home range size to biotic and abiotic factors. (3)

4.3 Study migration ecology if important migration sites can be identified. (2)

4.4 Study wintering ecology and distribution.

4.41 Continue to investigate winter distribution. (2)

4.42 Characterize physical characteristics of wintering habitat. (2)

4.43 Determine spatial and temporal use of wintering habitat by piping

plovers with focus on sites known to be used by Great Lakes population. (3)

4.5 Evaluate effect of contaminants on piping plovers.

4.51 Analyze contaminant residues in salvaged eggs and carcasses. (2)

4.52 Analyze contaminant levels in prey at known wintering sites for Great Lakes population. (3)

4.53 Determine if registered pesticide use poses threat to breeding or wintering piping plovers or food base. (2)

4.6 Investigate genetic variation within the Great Lakes population and among the three breeding populations. (2)

4.7 Refine population viability models as new data become available. (3)

5. Develop and implement public education and outreach.

5.1 Develop and promote seasonal natural history programs and on-site interpretation for state parks and National Lakeshore users in the Great Lakes region. (3)

5.2 Conduct landowner contact and education programs to promote awareness of status and threats to piping plovers. (2)

5.3 Make educational presentations to citizen groups in communities in or near piping plover habitat. (3)

5.4 Prepare several press releases annually to apprise the public of the piping plover's special status, biology, and management. (2)

5.5 Evaluate and improve current educational materials and methods of distributing them. (3)

5.6 Design a piping plover sign appropriate for use on privately-owned land. (2)

5.7 Evaluate and improve educational opportunities and materials in zoos. (3)

6. Develop partnerships and additional funding mechanisms.

6.1 Identify similar or overlapping conservation efforts by other agencies to reduce

redundancy and increase complementarity. (3)

6.2 Create regional interagency task forces to develop funding initiatives for recovery efforts on wintering and breeding grounds. (3)

7. Develop emergency methods to prevent extirpation.

7.1 Develop criteria for use of population augmentation strategies on the Great Lakes population. (1)

7.2 Develop a protocol for population augmentation.

7.21 Captive-rear abandoned clutches from the wild and develop a threshold for discontinuing this task. (1)

7.22 Evaluate potential for a proactive captive-rearing program and outline methods for use. (1)

7.23 Evaluate translocation as an augmentation tool for piping plovers; assess benefits compared to captive-rearing and captive breeding. (3)

7.24 Re-evaluate role of zoos in piping plover conservation efforts and coordinate with American Zoo and Aquarium Association (AZA) and appropriate zoos in development of future population augmentation strategies.

7.241 Re-evaluate the role of zoos in piping plover conservation efforts through annual review of zoo section 10 permits. (2)

7.242 Coordinate with AZA and appropriate zoos in development of desired elements of captive breeding, rearing, or other population augmentation strategies. (2)

7.25 Establish networks necessary to determine and implement population augmentation protocol. (3)

8. Review progress toward recovery and revise recovery tasks as appropriate. (3)

C. Narrative for Recovery Actions

1. Protect the Great Lakes piping plover breeding population and manage breeding habitat to maximize survival and fecundity

Efforts to protect nests and manage recreation at Atlantic breeding sites have demonstrated that intensive management can achieve substantial increases in piping plover reproductive success and population numbers (USFWS 1996). Reproductive success is a measure that incorporates both nesting success and chick survival rates. Managers should consider both nest success and chick survival in order to effectively evaluate the potential success of management efforts. Appendix A provides a preliminary list of current and needed management actions for Michigan breeding sites within essential breeding habitat for the Great Lakes population. Updates to Appendix A will occur as new information becomes available regarding the current understanding of what constitutes essential piping plover habitat.

1.1 Coordinate survey, monitoring, and management efforts in breeding range. Since 1994, an informal coordination group involving the USFWS, representatives of state and Federal agencies and other land management organizations, seasonal field technicians, and Michigan working group members have met annually to plan management efforts for the year. These meetings function as the backbone of recovery efforts and have resulted in increased coordination, efficiency of piping plover protection and management efforts, and information sharing.

1.11 Coordinate seasonal field activities at biannual meetings of Breeding Range Coordination Group. (1) The Breeding Range Coordination Group (BRCG) should include census coordinators and key land managers from other Great Lakes states and Ontario. Several meetings held at the end of the breeding season identified management issues on breeding areas needing attention. Holding an additional meeting at the end of the breeding season allows adequate time to address issues the following year. These meetings should continue to be held twice annually (pre- and post- breeding season).

1.12 Coordinate surveys in Michigan to ensure consistent coverage and effort among years. (1) Annual surveys of breeding areas in Michigan are conducted to locate nests for monitoring reproductive success, assessing population trends, and success of protective management efforts. Extensive surveys have covered known breeding areas in many counties and some historic breeding areas. Because survey effort tends to vary among years, some sites are visited only once every five years during the International Piping Plover Census.

Observations of unbanded fledglings indicate that not all nests were found and that surveys need to be expanded. The USFWS should develop and maintain a complete list of sites that need checking for piping plover activity and identify parties responsible for checking sites each year.

1.13 Identify survey coordinators and survey sites for other Great Lakes states and Ontario. (1) As the number of breeding pairs in Michigan has gradually increased in recent years, breeding pairs have expanded into more distant breeding areas. In addition, birds breeding for the first time tend to nest far from their natal sites. In 1998, a pair of piping plovers banded as chicks in Michigan was fortuitously discovered nesting at Chequamegon Point, Long Island, Ashland Co., Wisconsin. As the Great Lakes population recovers, the incidence of piping plovers recolonizing historic habitat outside Michigan will likely increase. The USFWS should establish a network of census coordinators in other Great Lakes states and Ontario and generate lists of sites for annual surveys for each state. Survey coordinators should report sightings of banded birds to the USFWS, East Lansing, Michigan Field Office and the bander.

1.14 Develop standard, range wide monitoring and reporting protocol. (1) Quantity and quality of data provided by piping plover monitors varies. Developing a standard, range wide monitoring and reporting protocol will allow consistency in data collection and accurate measurement of population trends and progress toward recovery goals. At a minimum, data reported should include:

- The date monitoring began and ended,
- monitoring interval,
- nesting chronology including dates and numbers (pairs located, nests initiated, exclosures erected, eggs hatched, chicks fledged or disappeared, re-nests initiated, birds dispersed),
- locations of nests and brood foraging territories within sites,
- known and suspected reasons for chick loss,
- sightings of banded birds,
- locations of commonly used foraging areas throughout the season,
- problems encountered with exclosures, trespassers, dogs, vehicles, etc., and
- recommendations or improvements for future management.

1.15 Develop guidelines and conduct annual training workshops for

seasonal piping plover monitors. (1) Piping plover monitors are responsible for management which directly affects birds. Improper management may have detrimental consequences. Field skills and knowledge of piping plover biology and behavior vary among seasonal personnel who are supervised by several different agencies. A handbook describing appropriate methods for locating nests, erecting predator exclosures, and identifying abandoned nests (among other activities) will help ensure effective and non-disruptive monitoring and management. A handbook would also facilitate consistent methods to protect piping plovers throughout the Great Lakes region. The USFWS should use the best available information to develop the handbook which should include maps and contact lists in addition to protocol and information on the piping plover. Handbooks will need to be updated annually as new information is obtained. Field personnel would receive updated handbooks annually. A required workshop for field personnel led by experienced piping plover biologists early in the season would provide hands-on experience in locating birds and nests, setting up predator exclosures, and other duties.

1.16 Continue to support a coordinator to oversee data collection, maintain databases, analyze field data, and disseminate results. (1) The extensive information generated on nest locations, number of nesting pairs, habitat use and movements, reproduction, and banded individuals requires someone to coordinate data collection and manage and analyze resulting databases. Information generated from the data would be used to evaluate progress toward recovery and direct protective management each year. Ideally the data manager will have field and analytical experience with the ability to coordinate training for field personnel and oversee data collection.

1.17 Develop agreements with private landowners and townships to allow monitoring and management efforts on private and municipal lands. (1) One such agreement is currently in place in Burt Township, Alger County, Michigan. Another example is the Magic Carpet HCP in Leelanau County, Michigan. Developing similar agreements with landowners is important because approximately one-third of piping plover nests occur on private or municipal lands; therefore survival of this population depends on the protection of piping plovers from take on private lands. To reduce risk of illegal take, local conservancies should secure protection on private lands by negotiating long-term agreements that will allow standard monitoring and management efforts.

1.18 Develop and implement protection guidelines for unoccupied or historic breeding habitat on state and Federal lands via MOU/MOA. (1) Approximately two-thirds of piping plover nests and most historic breeding habitat occur on publicly-owned state and Federal land. Frequently piping plovers are observed at parks early in the breeding season but are driven off or discouraged from nesting because immediate protection from disturbance is not currently provided. Development and implementation of standard, region-wide guidelines for protecting potential nesting piping plovers when they are discovered on previously unoccupied state or Federal lands will expedite protection and increase the likelihood piping plovers will reproduce in these areas. The USFWS should develop guidelines and create a Memorandum of Understanding/Agreement (MOU/MOA) with state and Federal land management agencies. There are no MOUs or MOAs in place at this time.

1.19 Organize and train volunteers to patrol nesting areas. (2) For several years, volunteers have patrolled active breeding areas in some state and National Parks and educated the public about threats to piping plovers during busy holiday weekends. Regular patrol of nest sites in high recreation areas should also occur. State and Federal agencies are responsible for organizing volunteers and training them in compatible techniques. The USFWS should continue to organize and train volunteers and evaluate the use of volunteers on an annual basis to determine if patrols are cost-effective in reducing risks to nesting piping plovers.

1.2 Monitor and manage breeding pairs and reproductive success. A network of public agency staff and seasonal field workers monitor activities and reproductive success of all piping plover pairs and use management techniques to protect piping plovers and educate the public. Monitoring breeding pairs and reproductive success is necessary to determine population trends and evaluate effectiveness of management and progress toward recovery goals.

1.21 Survey known, historic, and potential breeding sites to locate breeding piping plovers. (1) Effective expansion of protection efforts on the breeding grounds depends on the ability to identify areas currently used by piping plovers. In Michigan, piping plovers readily nest at suitable breeding sites that were unoccupied for a number of years and also will nest in new areas. Therefore, it is important that piping plover researchers annually census all known current and historic breeding areas as well as potential habitat to determine management needs and further identify essential/critical habitat. Initially, censuses

should occur early in the breeding season (first or second week of May) to locate nesting piping plovers; several visits should be made later in the breeding season (mid-June and mid-July) to identify late nesting and re-nesting attempts.

1.22 Reduce predation and disturbance of breeding piping plovers. Throughout the breeding range, research has shown that reducing depredation of eggs, chicks and adults and minimizing disturbance of adults and chicks by humans and pets can effectively increase piping plover reproductive success.

1.221 Protect nests with predator exclosures and limit human activity in nesting areas with fencing and signs. (1) Consistent use of predator exclosures has significantly increased hatching success of piping plover nests but does not provide protection to mobile chicks after hatching. Limiting human activity in breeding areas by strategic placement of psychological fencing provides additional protection to piping plovers during courtship, nest-building, incubation, and brood-rearing. Public agency staff and trained volunteers should erect predator exclosures and fencing around all nesting areas to reduce risk of take during the breeding season on public land and private lands (where landowners have granted access). See Appendix D for guidelines on use of predator exclosures.

1.222 Clarify policies and protocol for predator control/removal and implement when and where warranted. (1) Predation is an important limiting factor for piping plover populations throughout the breeding range. Establishment of predator control/removal protocols for all sites and identification of responsible parties for implementation of a suite of predator control actions is needed. The NPS, for example, may need to reevaluate and clarify policies on predator management when predators jeopardize piping plovers, especially breeding adults. The need to control or remove specific predators that pose a threat to nesting adults should be assessed annually by field personnel and land managers. Removal of predators by lethal or non-lethal means should be pursued as necessary with sensitivity to public relations.

1.223 Report dog leash law infractions in nesting areas and work with state and Federal conservation officers and local animal control officers to increase enforcement. (1)

Domestic dogs have killed piping plovers, and experts frequently suspect dogs as the cause of disappearing chicks. Repeated disturbance by dogs may compromise piping plover reproduction and survival. Michigan State Parks prohibit dogs on swimming beaches and require a 2 m (6 ft) leash at all times. Dog leash laws are currently not well enforced on state or Federal lands and increased enforcement will reduce risk of take. Land managers and field personnel should contact local conservation officers early in the breeding season and apprise them of the potential threat dogs present to piping plovers at individual breeding sites. Field personnel should report leash law infractions to local conservation officers and to the Report All Poaching Hotline (Michigan: 1-800-292-7800). If landowners' dogs jeopardize piping plovers in breeding areas on private land, education and subsequent law enforcement action may be necessary.

1.224 Evaluate current use of vehicle blockades on public and privately-owned land with piping plovers and recommend changes as necessary. (2) Vehicle use occurs at a number of piping plover breeding areas and endangers both adults and chicks. Placement of boulders or guardrails at vehicle access points has helped keep vehicles off public beaches occupied by piping plovers. The Piping Plover Coordination Group should assess current placement of vehicle blockades and make recommendations to appropriate land managers as necessary. Field personnel should report incidents of unlawful vehicle use on Michigan beaches to the Report All Poachers Hotline. Landowners need to be informed of the risk of taking endangered species by driving through nesting areas on their land.

1.3 Protect natural processes that maintain dune ecosystems and essential breeding habitat. Ecosystems the piping plover inhabits throughout the year are dynamic and dependent on natural processes of sediment deposition, erosion, and scouring for maintenance. Shoreline dredging, construction of break-walls, jetties, marinas, and rip rap disrupt these processes by altering sedimentation patterns or hydrology. Beach stabilization and "nourishment" projects also degrade the quality of beach habitat for piping plovers and other coastal species. To ensure adequate habitat for survival, reproduction and recovery, natural processes within the ecosystems piping plovers utilize must be protected.

1.31 Identify and update essential habitat in Great Lakes region. (1) A preliminary definition of essential habitat for breeding appears in the Objective and Criteria section. This information is based on current and historic breeding site use by piping plovers, characteristics of past nest sites, and potential of habitat for reproduction based on physical characteristics and threats. This information should be reviewed for updating at least once every three years.

1.32 Work to minimize development and encourage activities that prevent degradation or destruction of essential habitat on public lands in the breeding range. (1) Public land managers should limit activities that reduce the likelihood of piping plover use, preventing alteration of physical and biological components of essential habitat. In addition, they should maintain and improve features of historic habitat to increase the likelihood that piping plovers will re-colonize historic breeding areas. Construction practices, pollution control, pesticide application, and recreation management should maintain or improve conditions for foraging, nesting, and brood-rearing.

1.33 Protect breeding population from oil spills in Great Lakes waterways. (1) Atlantic Coast oil spills have resulted in oiled piping plovers. Oils spills are also a risk to piping plovers breeding on the Great Lakes. The USFWS Region 3 should contact appropriate individuals in Region 5 to gather information on how to rehabilitate oiled piping plovers. Region 3 should also coordinate with other USFWS regions to develop standard oil spill emergency response protocols (see task 2.15).

1.34 Work to minimize development and encourage activities that prevent degradation or destruction of essential habitat on private lands in the breeding range. The USFWS and other public agencies should discourage activities on private lands that degrade or destroy piping plover habitat.

1.341 Incorporate protection of breeding areas into land use plans and existing permitting processes. (2) Recovery also requires protection and maintenance of essential habitat on private land; therefore, the USFWS should continue to work with local planning and zoning boards to incorporate piping plover protection into existing land use plans and permitting and zoning processes.

1.342 Develop guidelines for landowner Habitat Conservation

Plans. (2) Habitat Conservation Plans (HCPs), such as the Magic Carpet HCP, are plans that seek to mitigate effects of otherwise lawful activities that may result in incidental take. Development of standard guidelines to assist landowners with preparation of HCPs will also facilitate protection of breeding and wintering areas that occur within or encompass privately-owned land.

1.35 Assess and foster compatibility of management with efforts that benefit other threatened and endangered Great Lakes species. (3) The plight of the piping plover demonstrates the imperiled nature of the ecosystems it inhabits. Breeding sites of the Great Lakes piping plover provide habitat for a number of species of special conservation concern such as the federally threatened Pitcher's thistle and Houghton's goldenrod, the locally rare Lake Huron tansy *(Tanacetum huronense)* and Lake Huron locust, among other rare species. Additionally, freshwater dunes are features important to the natural heritage of the Great Lakes region. Encouraging compatibility among management efforts for multiple species co-occurring in beach ecosystems may result in more streamlined management processes for all vulnerable species and landscape features. Additionally, consideration of these species as a group for management purposes may lead to more efficient use of limited funding resources.

1.36 Restore and acquire habitat. Full recovery of the Great Lakes population requires preservation of sites that piping plovers currently do not occupy but meet the physical characteristics of breeding habitat. Enhancement of some of these sites by improving the physical characteristics of the habitat or by decreasing levels of human disturbance would increase the likelihood piping plovers will recolonize or utilize them on a regular basis.

1.361 Control vegetation and conduct cobble nourishment at marginal breeding sites when and where appropriate. (3) Observations at breeding sites over the past six or more years suggest that succession may eventually deter piping plovers from nesting at some sites (Appendix A). Removal of vegetation to improve suitability of nesting areas on the Atlantic Coast seems to encourage immediate use of treated areas by piping plovers and other shorebirds (USFWS 1996). Efforts to improve the physical suitability of Great Lakes sites, such as Pointe Aux Chenes, Michigan, through the addition of cobble, appeared to increase use by nesting plovers (S. Sjogren, District Biologist,

USFS, St. Ignace, Michigan, pers. comm., 1996). Researchers should consider sites where piping plover use has declined due to succession or sand deposition as primary candidates for restoration activities such as vegetation removal (woody vegetation and non-native species) and/or cobble augmentation. Researchers should monitor treated sites to determine the effectiveness of habitat modification in attracting and retaining piping plovers.

1.362 Purchase habitat and increase protection through conservation easements, deed restrictions, etc. (2) The USFWS should work with The Nature Conservancy, local land trusts, and state organizations to assist in the purchase or acquisition of deed restrictions, dedications, and conservation easements. These groups should also identify other mechanisms for protection of private land that meets physical characteristics of piping plover breeding habitat but lacks sufficient protection from human disturbance or development under current ownership.

2. Protect wintering piping plovers and manage habitat to promote survival and recruitment

Piping plovers spend eight or more months annually on the wintering grounds, so threats there can significantly affect individual survival and ultimately, population recovery. Protection and habitat management for piping plovers on the wintering grounds falls short of the protection on the breeding grounds, primarily due to lack of knowledge about winter distribution. Sightings of banded piping plovers during the winter are beginning to identify essential wintering sites for the Great Lakes population. This information allows more focused and stringent protection of these areas.

2.1 Organize protection efforts for wintering piping plover populations. The formation of a Winter Grounds Coordination Group (WGCG) that parallels the Breeding Grounds Group will allow more effective protection efforts for wintering piping plovers. Members of this group should collaborate to establish surveys as well as monitoring and protection programs for winter populations. This effort will increase knowledge of wintering distribution and threats, allowing more effective protection of wintering areas.

2.11 Create a WGCG to organize protection efforts on piping plover's wintering range. (1) USFWS Regions 4 and 2 should coordinate with USFWS Regions 3, 5, and 6 to initiate formation of a group of USFWS employees, biologists and state land managers in the piping

plover's wintering range. This group should convene annually to develop recovery efforts for wintering sites, assure consistency in monitoring and protection efforts, share information on threats and management efforts across the wintering range, and address conservation issues.

2.12 Organize winter surveys to locate banded birds and identify key wintering areas for the Great Lakes population. (1) Most winter sightings of piping plovers banded in the Great Lakes have been the fortuitous result of informal surveys or research by local amateur ornithologists and agency biologists. There has been no organized effort, other than the International Census, to locate banded piping plovers on the wintering grounds. The USFWS and the WGCG should create a parallel network of individuals and birding groups to survey wintering habitat annually. Such an effort would increase knowledge of winter distribution of Great Lakes breeders.

2.13 Annually monitor wintering populations at sites with sightings of birds banded in the Great Lakes. (1) Piping plovers appear to exhibit fidelity to wintering sites, and several wintering sites that host a number of birds from the Great Lakes population have been identified. Land management agencies should monitor these sites annually to determine trends in piping plover populations and identify potential threats and necessary protection efforts. The WGCG should agree upon consistent monitoring and data reporting methods. Agencies would report banded birds to the WGCG, the BRCG, and the Great Lakes piping plover data manager.

2.14 Reduce disturbance to piping plovers at wintering sites by humans and pets. (1) As on the breeding grounds, public land managers should use recreation management techniques such as vehicle and pet restrictions and psychological fencing to reduce disturbance and risk of take of piping plovers during winter.

2.15 Protect wintering populations from oil spills. (1) The WGCG and International Piping Plover Working Group should work with experts to devise emergency response protocol and networks for cleaning up oil/chemical spills, rehabilitating oiled piping plovers, and filing for damages for restoration efforts. The group should make protocol and networks known to piping plover biologists throughout the wintering range so that oiled birds and habitat can be dealt with in the most expeditious manner.

2.16 Identify and reduce additional threats to winter populations. (1) As winter distribution is further refined and piping plover populations and habitat on the wintering ground are monitored more closely, additional threats to winter populations and essential habitat will likely be discovered.

2.2 Protect natural processes that maintain coastal ecosystems and quality wintering habitat.

2.21 Identify and update essential wintering habitat locations. (1) Table 4 summarizes initial information on essential wintering habitat from sightings of piping plovers banded in the Great Lakes. Surveys and monitoring of wintering populations and banded piping plovers would allow further definition and refinement of essential wintering habitat. Locations of essential wintering habitat should be reviewed for updating at least every 3 years.

2.22 Work to minimize impacts of development and encourage activities that will prevent degradation or destruction of essential wintering habitat. (1) The USACE and the Federal Emergency Management Agency (FEMA) have major programs affecting barrier beach dynamics. USACE issues permits to state and local governments and private parties for shoreline alteration. For example, current placement of dredge spoil in the Laguna Madre negatively affects wintering piping plovers. These agencies must enter into consultation with the USFWS as required by section 7 of the ESA if their activities may affect piping plover populations or their habitat. Accomplishment of this task would result in protection of habitat used by many other species of shorebirds.

2.23 Assess and foster compatibility of winter management with efforts that benefit other threatened and endangered species. (3) As in the Great Lakes region, wintering areas used by Great Lakes piping plovers provide habitat for other species of special concern. On the wintering grounds, piping plovers co-occur with the federally listed, threatened sea beach amaranth and loggerhead sea turtle. Again, encouraging coordination among beach ecosystems management efforts would likely result in more streamlined management for all species considered and benefit the entire ecosystem.

2.24 Work with states to protect wintering habitat on private lands through conservation easements, deed restrictions, land purchases, or other appropriate mechanisms. (2) State and

Federal ownership protects much wintering habitat, but wintering piping plovers may benefit from acquisition or protective legal agreements on privately owned land. More information on winter distribution and threats to piping plovers at wintering sites would determine which private sites are candidates for purchase or other protection. The USFWS and the WGCG, in conjunction with state agencies, should contact land trusts to identify mechanisms for private land protection in each state and work with willing landowners to apply protection.

3. Identify and protect migration habitat outside of wintering range

While little is known about sites used by migrating piping plovers, availability of quality migration sites is likely important to piping plover survival. This task is currently of lower priority than others, but may be elevated to Priority 1 if information suggests migration sites are limiting or highly threatened.

3.1 Compile information from ornithological literature to identify probable migration sightings in each of the Great Lakes states and Ontario and along migratory pathways. (2) Preliminary efforts suggest that compilation of migrating piping plover sightings from ornithological literature (e.g., state bird journals and Audubon reports) would greatly aid identification of probable migration sites and routes. This information would allow targeting of areas to survey for migrating piping plovers and assess potential threats. Initially, the effort should compile literature from all Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) and Ontario. The literature search may expand to inland states along potential migration routes if initial investigations suggest inland stopover sites exist.

3.2 Target bird watching groups in each state and Ontario and request assistance in locating migrating piping plovers. (2) Bird watchers are a largely untapped resource that can help locate migrating piping plovers and key migration areas. The USFWS should contact bird watching groups in each state and Ontario with mailings identifying potential migration sites and request assistance in checking these areas for piping plovers between April 15 and May 15. A web-page linked to popular bird websites could track sightings and may increase bird watchers' interest in this effort.

3.3 Identify and reduce threats to habitat and migrating piping plovers at key migration sites. (3) Once probable migration sites are identified, information on threats to habitat and migrating piping plovers should be gathered for each site from local agencies/sources or from new surveys if no local information source can be identified.

4. Conduct scientific research to facilitate recovery efforts

Research has provided key information to management agencies involved with recovery efforts for this population. Additional research will refine current management efforts in both breeding and wintering habitat.

4.1 Continue to study survival, recruitment, dispersal, and ecology by banding Great Lakes population. (2) Banding the breeding population has contributed greatly to knowledge of adult and juvenile survival, recruitment of juveniles into the breeding population, dispersal and distribution in the breeding range and wintering grounds, and has aided ecological studies. Identification and monitoring of key wintering sites for this population depends on continued banding, including the use of color bands, on the breeding grounds. Banding of the Great Lakes population should continue at least until 2005 (in concert with intensive efforts to locate banded birds on the wintering grounds) after which the need for additional banding should be assessed. Any evidence of band-related injuries may warrant assessment of banding practices prior to this date. Banding of captive-reared individuals, however, should continue for the duration of captive-rearing efforts to gather information on survival and reproduction by these individuals.

4.2 Study breeding ecology. The breeding ecology of piping plovers has been generally well studied, but additional investigations are needed to help determine essential habitat and management efforts for both unoccupied essential habitat and active breeding areas, especially during the brood-rearing phase.

4.21 Investigate factors influencing nest densities at breeding sites. The amount of habitat needed to support a recovered population in the Great Lakes region depends on the densities at which breeding piping plovers occupy sites. Nesting densities likely depend on habitat quality, physical habitat features, available food resources, and other factors, such as disturbance and predator populations. These factors have not been measured or are poorly known for most breeding areas.

4.211 Study biotic and abiotic factors that influence nesting densities. (3) The biotic and abiotic factors that potentially affect nesting density need to be evaluated. These factors can include habitat quality, physical habitat features, and available food resources.

4.212 Quantify other factors (disturbance, predation) limiting piping plovers at current and historic breeding sites. (2) Disturbance and predation likely limit piping plover densities,

diminish breeding success, or deter piping plovers from using certain breeding areas. Quantification of levels of disturbance and predator activity at current and historic breeding areas would help determine where human use or predator management should occur. With little additional effort, these data could be gathered during annual habitat surveys and monitoring of breeding pairs.

4.22 Investigate relationship of brood home range size to biotic and abiotic factors. (3) Observations (Shutt 1996; Fadroski 1998) have shown that the extent of shoreline used by piping plover broods is highly variable. The minimum area needed for brood survival is unknown and may be specific to breeding area and dependent on factors such as food resources, physical features of the beach, disturbance levels, predation risks, and presence of other piping plover families. Investigations of these factors in relation to brood home range size would aid management directed at protecting broods and increasing fledging success at breeding sites.

4.3 Study migration ecology if important migration sites can be identified. (2) If important migration sites are identified, ecological studies would help identify threats to migrating piping plovers and determine management needed to protect birds during this stage. Studies should focus on identifying the timing and duration of use of migration sites by piping plovers, the area and types of habitat used as well as how it is used. Additionally, studies should include identification of the major threats to migrating piping plovers at these sites and how to alleviate them.

4.4 Study wintering ecology and distribution. The winter distribution of piping plovers is very widespread, but a large proportion (44%) of birds winter along the Gulf Coast of Texas (Ferland and Haig 2002), with as many as 15-25% of all piping plovers wintering on South Padre Island (K. L. Drake and K. R. Drake, pers. comm., 1999). This region deserves greater attention with regard to conservation; however, winter sightings of Great Lakes piping plovers suggest that a focus on preservation of the Texas Gulf Coast alone may not ensure the survival of the Great Lakes population. Most reports of birds from this population are from the southern Atlantic Coast and Gulf Coast of Florida. Greater effort at pinpointing the winter distribution of the Great Lakes population would help identify wintering habitat in need of preservation and management for this population's continued survival.

Very little is known about wintering ecology of piping plovers, particularly in areas that currently appear to be key wintering sites for the Great Lakes population (e.g., Altamaha Estuary, Georgia, and Marco Island, Florida).

Studies focusing on wintering sites where piping plovers that were banded in the Great Lakes region have been sighted will help determine threats and shape protective management. This management also would benefit piping plovers breeding on the Northern Great Plains and Atlantic Coast that winter in the same areas.

4.41 Continue to investigate winter distribution. (2) The International Piping Plover Census has conducted surveys of winter populations once every 5 years since 1991. This survey should continue to provide population trend information and identify additional key wintering sites. Previous surveys identified areas requiring greater effort (e.g., Louisiana, Texas, Mexican Gulf Coast and Caribbean islands)

4.42 Characterize physical characteristics of wintering habitat. (2) Information characterizing piping plover foraging and roosting habitat is lacking for sites on the Atlantic and Gulf coasts of Florida. Characterization at multiple scales (from microhabitats to landscapes) in a number of different regions is needed to determine appropriate protection actions for wintering habitat.

4.43 Determine spatial and temporal use of wintering habitat by piping plovers with focus on sites known to be used by Great Lakes population. (3) Research along the Texas Gulf Coast indicates that piping plovers use different habitats for foraging and resting and that temporal and spatial factors influence these patterns of habitat use. Development of protective management for wintering Great Lakes piping plovers requires habitat use data along the Atlantic and Gulf coasts.

4.5 Evaluate effect of contaminants on piping plovers. Elevated contaminant levels in eggs of some Great Lakes piping plovers suggest that exposure to contaminants may jeopardize this population. Further study would determine if contaminant loads are detrimental, pinpoint the sources of contaminants, and ascertain if pesticide use in breeding and/or wintering areas warrants stricter regulation.

4.51 Analyze contaminant residues in salvaged eggs and carcasses. (2) The USFWS should continue to analyze contaminant levels in addled eggs and carcasses salvaged from the Great Lakes population and attempt to track residue levels in eggs of banded females to identify potential sources of exposure (breeding vs. wintering areas). Contaminant analysis of tissue from live piping plovers (e.g. blood, feathers) should be pursued if signs of threat from contamination are

indicated by observation of: 1) decreased hatching, fledging, or juvenile return rates not attributed to predation, 2) deformed chicks, 3) altered adult breeding behavior following a reduction in human disturbance on breeding grounds, and 4) analysis of available specimens continues to indicate high contaminant levels in tissues.

4.52 Analyze contaminant levels in prey at known wintering sites for Great Lakes population. (3) Analysis of prey at major breeding sites suggests that breeding areas are not likely the primary source of contaminants to the Great Lakes population. A parallel study of known wintering sites of Great Lakes piping plover will aid understanding of contaminant levels present in prey throughout the range.

4.53 Determine if registered pesticide use poses threat to breeding or wintering piping plovers or food base. (2) Pesticide use in breeding and wintering areas may threaten piping plovers directly and/or impact the food base. The magnitude, timing, and proximity of pesticide applications to breeding and wintering areas of Great Lakes birds should be assessed from local sources. Results would be used to identify areas where further study of pesticide impacts on shorebirds may be warranted or where pesticide use needs stricter regulation.

4.6 Investigate genetic variation within the Great Lakes population and among the three breeding populations. (2) Populations that remain small for many years may lose the genetic variability required for long-term survival in the face of environmental change. An assessment of the genetic variability of the Great Lakes population and its distinctness from the other two breeding populations would indicate whether genetic concerns exist for this population. Development of genetic markers for the three breeding populations is currently underway and should help clarify this question (S. Haig, USGS-BRD, Oregon State University, pers. comm., 1998). The USFWS should continue to provide tissue for Haig's study. Techniques (such as translocation of individuals from other populations) are available to increase genetic variability if low variability threatens population persistence. Increasing genetic variation in the Great Lakes population may become a recovery task if evidence suggests low genetic variation negatively affects fitness (for example, reduced hatching success, impaired reproductive behavior, or reduced fertility).

4.7 Refine population viability models as new data become available. (3) Population viability models are useful for evaluating quantitative recovery goals and the impact of different management strategies on population trends. Initial models require refinement as better data on survival, dispersal, habitat, and genetics become available.

5. Develop and implement public education and outreach

Effective management to protect the piping plover depends on the public abiding by protective regulations. Intense human activity on piping plover breeding and wintering areas each year create a great need and opportunity for public education. Public education efforts within Michigan are diverse; current programs should continue and be expanded to reach other Great Lakes audiences.

5.1 Develop and promote seasonal natural history programs and on-site interpretation for state park and National Lakeshore users in the Great Lakes region. (3) The state park and National Park Service systems protect a large amount of piping plover breeding habitat. A natural history program on the piping plover and the dune ecosystem it inhabits, presented in state and National Parks and Natural Areas with Great Lakes shoreline would reach a large audience of residents and visitors. This program should educate users of public lands about the importance of piping plover dune ecosystem protection.

5.2 Conduct landowner contact and education program to promote awareness of status and threats to piping plovers. (2) The cooperation of private landowners in piping plover protection and research has been vital to the success of recovery efforts in the Great Lakes. Appropriate organizations (e.g., TNC, Michigan Natural Features Inventory, local land trusts) in cooperation with the USFWS should conduct a contact program to promote awareness of piping plover status for private owners of occupied, historic, or potential habitat occurring in both the breeding and wintering ranges.

5.3 Make educational presentations to citizen groups in communities in or near piping plover habitat. (3) The USFWS in cooperation with conservation groups or land conservancies should target citizen groups (landowner associations and township boards) for educational presentations in communities affected by piping plover recovery efforts. These presentations will enhance communication among natural resource agencies and communities and cultivate positive attitudes in people affected by recovery efforts.

5.4 Prepare several press releases annually to apprise the public of the piping plover's special status, biology, and management. (2) The USFWS should continue to use press releases in Michigan to promote public understanding of the piping plover's endangered status, biology, and management. Also, in cooperation with state natural resource agencies, the USFWS should develop appropriate press releases for other states in the Great Lakes region and in the wintering range.

5.5 Evaluate and improve current educational materials and methods of distributing them. (3) The USFWS piping plover brochure and elementary school slide program need periodic revision to include current information and improved designs. The USFWS should continue to revise existing educational videos on piping plovers in the Great Lakes. The USFWS also should periodically evaluate the use and educational effectiveness of these materials through consultation with professional educators and primary users such as state and National Park Service staff and elementary school teachers. Additionally, the USFWS should continue to broaden its audience by providing brochures, videos, and slide programs to state and Federal agencies, nature centers, zoos and others involved in public education and piping plover recovery. Finally the USFWS should develop an ongoing distribution program for these materials.

5.6 Design a piping plover sign appropriate for use on privately-owned land. (2) Current signs available for use with psychological fencing of nesting areas are geared toward beach closures on publicly-owned land. The USFWS should coordinate with local communities to gather input to create an appropriate sign for use on private land.

5.7 Evaluate and improve educational opportunities and materials in zoos. (3) Several zoos in the Great Lakes region currently have piping plovers rescued from the Great Plains population on exhibit. The locations of the zoos present opportunities to educate the public in the Great Lakes region about the piping plover. The USFWS should collaborate with zoos having piping plover educational materials and programs to evaluate their effectiveness and to find ways to expand education opportunities. Materials should emphasize methods to reduce threats to the Great Lakes population in the broader context of the North American distribution of this species. Piping plover educational programs should be evaluated annually to assess effectiveness.

6. Develop partnerships and additional funding mechanisms

The piping plover cannot survive without continual management of breeding and wintering areas due to its beach-dwelling habits and sensitivity to disturbance. Development of a self-sustaining network of partnerships with cooperating agencies, conservation organizations, and landowners is needed to ensure future management that will promote piping plover survival. This network, along with long-term mechanisms for the funding of management activities, would ensure long-term protection and management of breeding and wintering areas.

6.1 Identify similar or overlapping conservation efforts by other agencies to reduce redundancy and increase complementarity. (3) A number of conservation organizations have programs directed at protecting the piping

plover as an element of biological diversity. The USFWS should identify overlapping efforts by other agencies/organizations and collaborate with these groups to reduce duplication and increase complementarity of efforts. Collaboration and coordination among organizations should increase the efficiency with which funds are used to manage and protect piping plovers.

6.2 Create regional interagency task forces to develop funding initiatives for recovery efforts on wintering and breeding grounds. (3) The USFWS should foster creation of regional interagency task forces for both breeding and wintering grounds. Groups composed of a few key personnel (upper level managers and fund-raisers) from state, Federal and Provincial agencies and non-governmental organizations would comprise the task forces. The task forces should meet at least once annually (prior to the Management Coordination Groups) to collaborate on obtaining funding for recovery efforts and to identify or develop long-term funding mechanisms for protection of piping plovers and their habitat.

7. Develop emergency methods to prevent extirpation

Emergency methods to rescue the population from extirpation (e.g., captive-rearing, translocation of eggs/juveniles from other populations, captive breeding) are potentially important strategies for recovery. Prior to implementation, methods need to be developed and criteria established that would trigger action on these tasks. Delays in planning for emergency population rescue results in limited choices. Planning delays directly affect the ability to prevent extinction of rapidly declining wild populations and reestablishment of populations in the wild from captive stock.

7.1 Develop criteria for use of population augmentation strategies on the Great Lakes population. (1) Criteria should be developed for use of various population augmentation strategies. Population augmentation strategies will not, however, take precedent to tasks to improve reproductive success in the wild and protect habitat throughout the breeding range. Criteria should consider population status and trends as well as the risks and costs of the various potential strategies. All criteria will require reevaluation as population dynamics, risk factors, and costs of implementing population augmentation become better understood.

7.2 Develop a protocol for population augmentation. Development of appropriate methods to augment the Great Lakes population requires thorough knowledge of species biology and adequate prior testing. In addition to captive-rearing abandoned eggs, methods recommended to boost the endangered Great Lakes population from perilously low levels include proactive captive-rearing (using eggs produced locally by double-clutching, Michigan

DNR 1987), translocation of eggs or individuals from other populations, and captive breeding in zoos. Each method poses risks that, while not fully understood, may affect the ultimate success of augmentation measures. For example, translocating individuals from other populations may significantly alter the genetic makeup of the Great Lakes population, potentially resulting in outbreeding depression[6] and increased risk of disease transmission. In the case of double-clutching, the effects of egg or clutch removal on piping plovers' immediate or subsequent behavior (i.e., site fidelity) and reproductive success remains unknown. Adult survival, return rates, and reproductive success of piping plovers reared in captivity remain poorly known. Like translocation, introducing captive-reared birds into the wild gene pool may alter genetic diversity depending on the egg collection strategy and increase the possibility of disease transmission to wild stock. In addition to biological risks to the species, population augmentation efforts involve considerable costs, logistics, and political implications. Finally, successful implementation of augmentation measures requires removal of the causes of population declines, unsaturated and sufficiently protected habitat, and appropriately developed technology for augmentation (Kleiman and Beck 1994).

7.21 Captive-rear abandoned clutches from the wild and develop a threshold for discontinuing this task. (1) Captive-rearing of abandoned piping plover eggs in Michigan has supplemented natural fledging rates 10% to 17%. Several captive-reared individuals have returned to breeding areas, exhibited normal breeding behavior and produced young. Others have returned and appear to exhibit natural behavior but have not nested. Captive-rearing appears to have important potential for population enhancement. However, captive-rearing methods remain costly and pose risks (e.g., incorrect determinations of abandonment - see Appendix E for guidelines for determining abandonment for captive-rearing purposes). Hence, continued use of this emergency measure requires clearly defined criteria. A significant increase in population size would allow lowering the priority of this task to three. Continued captive-rearing for a specified number of nests in a portion of the range may be considered to expedite population increases.

7.22 Evaluate potential for a proactive captive-rearing program and outline methods for use. (1) Proactive captive-rearing involves a systematic and deliberate effort to take piping plover eggs from the wild for the purpose of rearing and reintroduction the same breeding season.

[6]Outbreeding depression is lowered evolutionary fitness that resulting from mixing two very genetically dissimilar populations.

Research should be undertaken to fully understand the potential risks and benefits of a formal captive-rearing program. Researchers from universities, wildlife agencies, and zoos should individually, or in collaboration, evaluate the feasibility of an active program to captive-rear piping plover eggs from the wild. This research should fully investigate the potential biological, genetic, and political implications for such a program, as well as describe the methods and materials required to undertake such a program. To the degree possible, research should utilize existing population viability models to evaluate potential captive-rearing scenarios. Other programs to captive-breed and/or captive-rear piping plovers or other endangered species for reintroduction should be examined for applicability to the Great Lakes piping plover population.

7.23 Evaluate translocation as an augmentation tool for piping plovers; assess benefits compared to captive-rearing and captive breeding. (3) Translocation from other populations may be preferable to double-clutching within the Great Lakes population because translocation decreases the risk of negatively affecting the Great Lakes population through egg manipulation and removal. Potential impediments to translocation include lack of available wild stock from one of the other breeding populations, high cost, greater genetic and disease risks, and logistic problems similar to captive-rearing. An evaluation of the relative benefits of translocation requires clarification of population increase desired and level of risk tolerable to attain the increase. Further study of the genetic composition of the other populations may also be needed.

7.24 Re-evaluate the role of zoos in piping plover conservation efforts and coordinate with the American Zoo and Aquarium Association (AZA) and appropriate zoos in development of future population augmentation strategies. USFWS permitted zoos to keep piping plovers that were rescued from the Missouri River in 1995. The objective of the zoo programs are to 1) provide the public an opportunity to see and learn about piping plovers and 2) maintain a captive population to supply zoos and provide stock for reintroduction[7] in the unlikely event that the wild population crashes and wild birds from other populations are not available. Current permits do not allow a formal captive breeding effort and provide few guidelines for zoos. The USFWS in concert with the AZA Piping Plover Specialist Group

[7]Reintroduction is the release of captive-bred animals into a species historical range to reestablish or augment wild populations.

should reevaluate the role of zoos in Great Lakes piping plover conservation efforts and establish agreements, in the form of MOUs, to identify a role for zoos in captive breeding, rearing, or other population strategies that may be developed.

7.241 Reevaluate the role of zoos in piping plover conservation efforts through annual review of zoo section 10 permits. (2) The USFWS should annually reevaluate ESA section 10 permits issued to AZA-accredited zoos that keep piping plovers. The USFWS should also require an annual report that describes the status of piping plovers in captivity, progress towards improved husbandry techniques, and any zoo activities including education that relate to the piping plover. Any zoo that houses a piping plover should sign an agreement with the USFWS to participate in the recovery program.

7.242 Coordinate with AZA and appropriate zoos in development of desired elements of captive breeding, rearing, or other population augmentation strategies. (2) Reintroduction of zoo-raised piping plovers into the wild is not currently considered a task needed for recovery of the Great Lakes population. However, zoos should seek to maintain captive populations that have characteristics desirable for reintroduction in the event it becomes necessary in the Great Lakes. In addition, information obtained through maintenance of captive populations may be relevant to other population augmentation efforts such as captive rearing. Zoos should carefully manage breeding to maintain genetic diversity and provide environmental enrichment for captive piping plovers by simulating natural environments to promote skills necessary for survival in the wild. The USFWS should establish relationships and agreements with AZA and appropriate zoos to identify roles and actions such as development of guidelines for piping plover husbandry in the event captive breeding of piping plovers is identified as a task necessary for recovery.

7.25 Establish networks necessary to determine and implement population augmentation protocol. (3) The USFWS should establish partnerships with groups and individuals needed for population augmentation efforts (e.g. natural resource agencies, zoos and other AZA-affiliated organizations, wildlife veterinarians, field biologists, population geneticists) to develop protocols and lay the groundwork for possible future implementation. Once a particular augmentation method is chosen,

protocol development should consider:

- source of supplemental stock,
- collection procedures,
- transportation procedures,
- husbandry techniques,
- genetic and medical screening methods,
- pre-release training (e.g. predator avoidance training for plovers),
- appropriate release sites and time periods,
- post-release training for plovers,
- monitoring procedures,
- community education about effort,
- criteria to evaluate the success of the effort,
- responsible parties for carrying out each action, and
- implementation costs.

8. Review progress toward recovery and revise recovery tasks as appropriate (3)

Progress on recovery of the Great Lakes population involves many parties in many different states and requires a high degree of coordination and communication. Annual review of progress is needed to ensure changes or recommendations are conveyed to field personnel in time for incorporation into seasonal field efforts. The USFWS should host an annual workshop for the interagency task force and the Piping Plover Management Coordination Group to bring wintering and breeding grounds personnel into contact for smooth and effective flow of information. These groups should also review recovery efforts and apply adaptive management strategies as additional information becomes available and progress towards recovery is made. Tasks should be updated as needed.

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III. IMPLEMENTATION

The following Implementation Schedule outlines actions and estimates costs over the next five years for recovery of the Great Lakes piping plover population. Some tasks and expenses (e.g., those broadly pertaining to winter populations and habitat) may be repeated in the U.S. Atlantic Coast, Northern Great Plains, and Canadian recovery plans because of overlapping winter distributions. Recovery teams for these regions will collaborate to implement shared tasks in the most cost effective manner. Tasks appear in order of priority.

A. Key to Priority Descriptions in Column 1:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species. (Recognizing that the ultimate success of the Program is species recovery, some priority 3 actions likely to lead to full recovery and delisting of a species in the foreseeable future will tend to rank higher than other priority 3 actions).

B. Key to Agency Designations (Columns 5 and 6):

AZA	American Zoo and Aquarium Association
CWS	Canadian Wildlife Service
ES	USFWS Division of Ecological Services (includes Endangered Species and Environmental Quality)
FEMA	Federal Emergency Management Agency
LE	USFWS Division of Law Enforcement
LMAO	Land Management Agencies and Other Cooperators: This designation includes other local land management agencies (e.g., municipal and county governments), conservation organizations and land trusts (e.g., Little Traverse Conservancy, local and National Audubon Societies, Whitefish Point Bird Observatory), and private individuals that own or manage piping plover wintering or breeding habitat or assist in protection efforts.
MDNR	Michigan Department of Natural Resources
NPS	National Park Service
OMNR	Ontario Ministry of Natural Resources
R2	USFWS Region 2 (Texas)

R3	USFWS Region 3 (Great Lakes)
R4	USFWS Region 4 (North Carolina to Louisiana)
RSCH	Research institutions
RW	USFWS Division of Refuges and Wildlife (includes Realty)
SCRA	State Coastal Regulatory Agencies
SWA	State Wildlife Management Agencies
TNC	The Nature Conservancy
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WS	U.S. Department of Agriculture, Wildlife Services (formerly Animal Damage Control)

Key to Columns 7, 8, 9: **FY** = fiscal year.
TBD = to be determined.

C. Implementation Schedule

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
1	Coordinate survey, monitoring and management efforts in breeding range	1.11	biannual	R3 ES R5 ES	MDNR, NPS, USFS, SWA, LMAO, RSCH, OMNR	1	1	3	
1	Survey known, historic and potential breeding sites to locate breeding piping plovers	1.12 1.21	annual	R3 ES	MDNR, NPS USFS,RSCH LMAO	20	20	20	Costs for travel to survey sites.
1	Identify survey coordinators and survey sites for other Great Lakes states and Ontario	1.13	annual	R3 ES R5 ES	CWS, SWA, LMAO, OMNR,	2			Initial cost to identify sites and coordinators; additional costs contingent on number of areas to be surveyed and existence of other funding.
1	Develop standard, range wide monitoring and reporting protocol; develop guidelines and conduct annual training workshops for seasonal piping plover monitors	1.14 1.15	annual	R3 ES	MDNR, NPS, USFS, LMAO	5	cost included in tasks 1.221 1.222		Initial cost to develop protocol and produce manuals.
1	Continue to support a coordinator to oversee data collection, maintain databases, analyze field data and disseminate results	1.16	on-going	R3 ES		25	25	75	

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
1	Develop agreements with private landowners and townships to allow monitoring and management efforts on private and municipal lands	1.17	on-going	R3 ES	TNC, LMAO, SWA	80	80	240	
1	Develop and implement protection guidelines for unoccupied or historic breeding habitat on state and Federal lands via MOU/MOA	1.18	annual	R3 ES R5 ES	MDNR, NPS, SWA, CWS/OMNR	60	20	30	
1	Protect nests with predator exclosures and signs/fencing; enforce dog leash laws	1.221 1.223	annual	R3 ES LE	MDNR, LE, NPS, USFS, LMAO	130	130	360	
1	Clarify policies and protocol for predator control/removal and implement when and where warranted	1.222	as needed	R3 ES	WS, LMAO, SWA, NPS	35	35	35	Assess need for predator removal annually. Final costs contingent on areas and numbers of predators.
1	Identify and update essential habitat in Great Lakes region	1.31	on-going	R3 ES R5 ES	RSCH, LMAO, SWA	5	5	15	$5K each year for breeding; $3K for updates every 3 years after FY07.

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
1	Work to minimize development and encourage activities that prevent degradation or destruction of essential habitat on public lands in the breeding range	1.32	on-going	R3 ES R5 ES	USACE, SWA, NPS, MDNR, LMAO, USCG	contingent on number of development projects			
1	Protect breeding population from oil spills in Great Lakes waterways	1.33	as needed	R3 ES R5 ES	CWS, SWA	dependent on occurrence and magnitude of spills			
1	Create a Wintering Grounds Coordination Group to organize protection efforts on piping plover's wintering range	2.11	annual	R2 ES R3 ES R4 ES R5 ES R6 ES	LMAO, SWA, NPS	5	5	15	
1	Organize winter surveys to locate banded birds and identify key wintering areas for the Great Lakes population	2.12	annual	R2 ES & RW R4 ES & RW	SWA, NPS, LMAO	25	25	75	
1	Monitor wintering populations at sites with sightings of birds banded in the Great Lakes	2.13	annual	R2 ES R4 ES	NPS, LMAO, SWA	40	40	120	
1	Reduce disturbance to piping plovers at wintering sites by humans and pets	2.14	annual	R2 & R4 ES, RW, & LE	SWA, NPS, LMAO	40*	40*	120*	*Costs shared by Atlantic Recovery plan.

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
1	Protect wintering populations from oil spills	2.15	as needed	R2 ES R4 ES	USCG, SWA, SCRA	contingent on number and magnitude of oil spills			
1	Identify and reduce additional threats to winter populations	2.16	on-going	R2 ES & RW R4 ES & RW	RSCH, NPS, SWA	TBD			
1	Identify and update essential wintering habitat	2.21	3 years	R2 ES R3 ES R4 ES R5 ES	RSCH, LMAO, SWA, NPS	10	10	30	$10K for wintering; $3K for updates every 3 years after FY07.
1	Work to minimize impacts of development and encourage activities that will prevent degradation or destruction of essential wintering habitat	2.22	on-going	R2 ES R4 ES	USACE, USCG, FEMA	contingent on number of development projects			
1	Develop criteria for use of population augmentation strategies on the Great Lakes population	7.1	3 years	R3 ES	RSCH	30	30	60	This task should not divert funding from tasks aimed at protecting the wild population or reproductive success.
2	Organize and train volunteers to patrol nesting areas	1.19	annual	R3 ES	MDNR	5	5	15	

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
2	Evaluate current use of vehicle blockades on public and privately-owned land with piping plovers	1.224	annual	R3 ES LE	MDNR, NPS, USFS, LMAO	20	20	20	Enhancement of vehicle blockades will incur additional cost contingent on need.
2	Incorporate protection of breeding areas into land use plans and existing permitting processes; develop HCP guidelines.	1.341 1.342	on-going	R3 ES		10	10	30	
2	Purchase habitat (breeding and wintering) and increase protection through conservation easements, deed restrictions, etc.	1.362 2.24	on-going	R2 RW R3 RW R4 RW R5 RW	TNC, LMAO, NPS, SWA	cost dependent on number and area of purchases			Potential costs could exceed 2 million dollars.
2	Target birding groups to locate migrating piping plovers	3.2	on-going	R2 ES & RW R3 ES R4 ES & RW	CWS, NPS, SWA, LMAO, OMNR	5	5	15	Additional costs for site protection, depending on number and magnitude of sites and threats.
2	Continue to study survival, recruitment, dispersal, and ecology by color-banding Great Lakes population	4.1	TBD	R3 ES	RSCH	3	3	9	Re-evaluate need for continued banding after 2005; expenses are for travel and may be shared with tasks 1.21 and 1.221 if bander is involved in monitoring and management.

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
2	Quantify factors limiting piping plover use of current and historic breeding sites	4.212	annual	R3 ES R5 ES	SWA, LMAO	5	5	15	
2	Study migration ecology if important migration sites can be identified	4.3	TBD	R3 ES	RSCH	TBD			TBD
2	Continue to investigate winter distribution	4.41	every 5 years	R2 ES & RW R3 ES R4 ES & RW	LMAO, SWA, NPS	10			Began in 2001.
2	Characterize physical characteristics of wintering habitat.	4.42	2 years	R2 ES R4 ES	RSCH	30	30		
2	Analyze contaminant residues in salvaged eggs and carcasses	4.51	As needed	R3 ES	RSCH				Cost contingent on number of samples and level of analysis.
2	Determine if registered pesticide use poses threat to breeding or wintering piping plovers or food base	4.53	2 years	R2 ES R3 ES R4 ES	RSCH	30	30	60	FY05-07 cost to compile data and produce reports.

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
2	Investigate genetic variation within the Great Lakes population and among the three breeding populations	4.6	TBD	R3 ES	RSCH	TBD			
2	Conduct landowner contact and education programs to promote awareness of status and threats to piping plovers	5.2	every 3 years	R3 ES	TNC, LMAO	20		60	
2	Prepare several press releases annually to apprise the public of the piping plover's special status, biology and management	5.4	annual	R3 ES		1	1	3	
2	Design a piping plover sign appropriate for use on privately-owned land	5.6	1 year	R3 ES		1			

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
2	Re-evaluate the role of zoos in piping plover conservation efforts through annual review of zoo section 10 permits; Coordinate with AZA and appropriate zoos in development of desired elements of captive breeding, rearing, or other population augmentation strategies	7.241 7.242	annually	R3 ES R6 ES	AZA	5	5	15	
3	Assess and foster compatibility of Great Lakes and wintering management with efforts that benefit other threatened and endangered species	1.35 2.23	on-going	R3 ES R2 ES R4 ES	TNC, SMA, MDNR	5	5	15	
3	Control vegetation and conduct cobble nourishment at marginal breeding sites when and where appropriate	1.361	on-going	R3 ES R5 ES	MDNR, NPS, SWA	50	50	150	Costs outlined for habitat enhancement only; habitat acquisition will incur additional costs depending on habitat to be purchased.
3	Identify and reduce threats to habitat and migrating piping plovers at key migration sites	3.3	on-going	R3 ES	CWS, NPS, SWA, LMAO, OMNR	5	5	15	Additional costs for site protection, depending on number and magnitude of sites and threats.

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
3	Study biotic and abiotic factors that influence nesting densities	4.211	3 years	R3 ES	RSCH	5	5	5	
3	Investigate relationship of brood home range size to biotic and abiotic factors	4.22	3 years	R3 ES	RSCH	10	10	10	
3	Determine spatial and temporal use of wintering habitat by piping plovers with focus on sites known to be used by Great Lakes population	4.43	2 years	R2 ES R4 ES	RSCH, SWA, LMAO, NPS	30	30		
3	Analyze contaminant levels in prey at known wintering sites for Great Lakes population	4.52	5 years	R2 ES & RW R3 ES R4 ES & RW	RSCH	60	60	180	
3	Refine population viability models as new data become available	4.7	1 year	R3 ES	RSCH	20			Contingent on availability of data.
3	Develop and promote seasonal natural history programs for state parks and National Lakeshore users in Great Lakes region	5.1	annual	R3 ES	MDNR, SWA, NPS	5			

C. Implementation Schedule (cont.)

Priority	Description	Task Number	Task Duration	Responsible Organization		Est. Cost ($1,000)			Comments
				USFWS	Other	FY04	FY05	FY06-08	
3	Make educational presentations to citizen groups in communities in or near piping plover habitat	5.3	as needed	R3 ES					
3	Evaluate and improve current educational materials and methods of distributing them	5.5	every other year	R3 ES		1		2	
3	Evaluate and improve educational opportunities and materials in zoos	5.7	every 5 years	R3 ES	AZA	5			
3	Identify similar or overlapping conservation efforts by other agencies to reduce redundancy and increase complementarity	6.1	on-going	R3 ES	TNC, LMAO				
3	Create regional interagency task forces to develop funding initiatives for recovery efforts on wintering and breeding grounds	6.2	on-going	R2 ES R3 ES R4 ES R5 ES		6	6	6	
3	Review progress toward recovery and revise recovery tasks	8	annual	R3 ES	SWA	3	3	9	

IV. APPENDICES

Appendix A. Characteristics of essential piping plover breeding sites in Michigan

The following table outlines reproductive patterns in terms of total numbers of breeding pairs, total fledglings produced, maximum number of breeding pairs, last year occupied, and average reproductive success (fledglings per pair) observed at each Michigan site between 1984-1998. The tables also identify recent threats (LL = periodic lake levels rises, HD = human disturbance, DG = domestic dogs, SC = succession, DV = intensified development, PR = predator problems, ER = long-term beach erosion, VH = vehicles) observed at each site and management needs based on recurring threats, piping plover use, and current ownership of each site. Some management needs may be on-going. Tables reflect recent and historic records of use by piping plovers and potential for use based on physical characteristics and threats. GIS databases provided approximate shoreline lengths and area of site. Estimated maximum number of breeding pairs that could potentially occupy each site annually were based on approximate shoreline length and densities of one breeding pair per 200 m (656 ft) of shoreline which mirrors high density sites on the Atlantic Coast (S. Melvin, Department of Forestry and Wildlife, University of Massachusetts, Amherst, pers. comm., 1998). These estimates were designed to aid in a habitat based population viability analysis (see Wemmer et al. 2001) and do not account for differences in habitat dimensions or other factors that may influence carrying capacities at sites. For these reasons and because breeding pair capacities of sites undoubtedly change over time, estimates should not be construed as management targets. This list is not all inclusive and is subject to modification as monitoring efforts and new findings dictate.

Key to "management needs" column with corresponding recovery task numbers:

1) increase survey effort to identify piping plover use (1.11, 1.12, 1.13, 1.21)
2) intensify monitoring of breeding piping plovers (1.2)
3) employ an on-site piping plover warden to monitor piping plovers and deter human disturbance (1.19, 1.221)
4) install vehicle blockades or otherwise restrict vehicle access (1.224)
5) control predators on sites where they are repeatedly problematic (1.222)
6) institute full or partial beach closure to protect piping plovers from high levels of human disturbance (1.19, 1.221)
7) educate landowners about status of piping plovers on their land in breeding and wintering ranges (5.2)
8) restrict domestic dogs in breeding areas (1.223)
9) develop management agreements with landowners (1.17)
10) assess need for cobble nourishment or vegetation removal (1.361)
11) restrict or regulate building or development at breeding sites (1.32, 1.34)
12) assess threats for sites where they are not well known (4.212)
13) acquire property or conservation easement (1.362)
14) conduct public education on public land, including installation of interpretive signs (5.1)

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Many breeding sites contain other federally listed species that may require consideration in implementing piping plover management. Rare species or features identified in the Michigan Natural Features Inventory database that occur in or are adjacent to piping plover habitat include: interdunal wetland, open dune system, wooded dune/swale complex, Pitcher's thistle, Houghton's goldenrod, dwarf lake iris, ram's head lady-slipper (*Cypripedium arietinum*), Lake Huron locust, and bald eagle (*Haliaeetus leucocephalus*). Only three rare coastal species, rock whitlow-grass (*Draba arabisans*), prairie dunewort (*Botrychium campestre*), and moonwort (*B. acuminatum*), and two community types, cobble beach and bedrock beach, have no known occurrences within essential breeding habitat. Houghton's goldenrod (HG) and Pitcher's thistle (PT) have the largest proportion of all federally listed coastal species falling within piping plover habitat. The table indicates their presence if known from current databases (note: some areas have not been adequately surveyed for these species). The tables also indicate sites nominated as Critical Dune Areas under Michigan's Coastal Zone Management Act of 1972.

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
RECENT SITES: (Nest record from 1984-1998)												
UPPER PENINSULA Alger County												
Grand Marais Superior Beach	Federal (NPS) multiple private	27.72 (68.5)	1.20 (0.75)		12	2(6)	1.08	1998		HD, DV, DG	hire warden, bldg restrictions, restrict dogs, educate public	
Grand Marais Inner Bay	multiple private	18.22 (45.02)	1.80 (1.12)		16	3(8)	1.88	1994		DV	educate landowners, building restrictions	
Grand Marais Lonesome Point/ East bay Sucker River	multiple private	5.06 (12.5)	1.05 (0.65)		13	3(4)	1.46	1998		HD, PR, DV, VH	restrict dogs, restrict ORV, building restrictions, control predators	
Luce County												
Deer Park	state	48.80 (120.58)	2.78 (1.73)		4	1(13)	1.00	1988		HD	survey effort	
West Beach Little Lake Harbor	private	9.27 (22.91)	1.57 (0.98)		1	1(7)	0	1987		VH	survey effort, landowner education, conservation easement	
Crisp Point	municipal	3.05 (7.54)	1.00 (0.62)		4	1(5)	0.75	1987		HD, ER	survey effort	
Chippewa County												
Vermilion/ Weatherhogs	multiple	37.32 (92.22)	2.32 (1.44)		41	7(11)	1.51	1998		VH, PR	intensify monitoring, vehicle blockades, control predators, conservation easement	HG

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
Whitefish Point	private Federal (USCG)	25.59 (63.23)	2.52 (1.57)		2	1(12)	0	1985		HD	beach closure during migratory p eriod	
Mackinac County												
Pointe Aux Chenes	Federal (USFS)	35.96 (88.86)	1.73 (1.08)		9	2(8)	1.67	1996		SC, PR, DG, VH	cobble nourishment, assess need for vegetation removal, intensify monitoring	PT HG
LOWER PENINSULA Emmet County												
Wilderness State Park - Temperance Isl.	state	2.15 (5.31)	0.14 (0.09)		8	1(1)	3.00	1998		SC	vegetation removal	PT
Wilderness State Park - Waugoshance Point	state	33.32 (82.33)	4.81 (2.99)		38	4(24)	1.66	1998		PR,HD	beach closure, hire warden	PT HG
Wilderness State Park - Sturgeon Bay	state	43.84 (108.33)	3.91 (2.43)		23	3(19)	1.61	1998	✓	PR,HD	beach closure, hire warden	PT HG
Bliss Twp Park	municipal	25.0 (61.77)	1.09 (0.68)		1	1(5)	3.00	1998	✓	HD, DG	restrict dogs, beach closure, hire warden, public education	
Cross Village Shores	multiple private	42.68 (105.46)	2.35 (1.46)		12	4(11)	0.67	1998	✓	HD, DG, DV	educate landowners, mgmt. agreement, restrict dogs	PT HG

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
Cross Village Twp Beach and south	municipal multiple private	13.2 (32.62)	1.27 (0.79)		7	2(6)	1.29	1998		HD, DG, DV, VH	vehicle blockades, mgmt. agreement, beach closures, building restrictions, landowner education	PT
Cross Village South - Rentrop Property	private	1.97 (4.87)	0.45 (0.28)		1	1(1)	0	1994		LL, HD	landowner education	
Cross Village South	private	7.60 (18.78)	0.90 (0.56)		10	1(4)	0.60	1997	✓	HD, PR SC, DG	acquire easement, vegetation removal, restrict dogs	PT
Thorne-Swift Preserve	private	2.28 (5.63)	0.42 (0.26)		1	1(2)	0	1995		HD, DG	survey effort, public education, landowner education	PT
Charlevoix County												
Fisherman's Island State Park	state	11.24 (27.77)	1.29 (0.8)		1	1(6)	0	1996	✓	HD, PR, DG	beach closure, intensify monitoring, hire warden, restrict dogs	PT HG
Beaver Island - Donegal Bay	multiple private	28.70 (70.92)	2.04 (1.27)		5	1(10)	1.20	1995	✓	HD, DG, DV	survey effort, building restrictions, landowner education, restrict dogs	PT HG

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
Beaver Island – McCauley's Point	state	7.74 (19.13)	0.52 (0.32)		1	1(2)	0	1993	✓	SC, DG	landowner education, restrict dogs, survey effort, vegetation removal	
Beaver Island – McFadden Point	state	22.20 (54.86)	0.76 (0.47)		1	1(3)	0	1989	✓	DV, HD, DG	survey effort, building restrictions, landowner education, restrict dogs	PT
High Island	state	43.91 (108.5)	1.84 (1.14)		16	3(8)	1.38	1997	✓	PR	survey effort	PT
Leelanau County												
Leelanau State Park – Cathead Bay	state multiple private	85.31 (210.8)	3.43 (2.13)		9	3(17)	0.78	1998	✓	DV, HD	beach closure, building restrictions, intensify monitoring	PT
North Manitou Island – Dimmick Point	Federal (NPS)	45.04 (111.29)	2.26 (1.4)		19	3(11)	1.15	1998		PR	beach closure, control predators, intensify monitoring	PT
North Manitou Island – Donner Point	Federal (NPS)	15.47 (38.23)	1.00 (0.62)		3	2(3)	0.67	1996	✓	PR, LL	survey effort, beach closure	PT
Benzie County												
Sleeping Bear Dunes-Platte River Mouth and Bay to south	Federal (NPS)	119.01 (294.07)	4.86 (3.02)		6	2(25)	2.17	1998	✓	HD, DG	beach closures, restrict dogs, hire warden, public education	PT
Cheboygan County												

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
Cheboygan State Park-Lighthouse Point	state	8.35 (20.63)	1.36 (0.85)		1	1(6)	3.00	1989		HD,SC	survey effort, vegetation removal	PT
HISTORIC SITES (before 1984)												
Port Inland* (Schoolcraft Co)	state	NA	NA	nest record		(5)		1956		NA	survey effort, assess threats	
De Tour State Forest (Chippewa Co.)	state	NA	NA	nest record		(1)		1979		LL, HD	survey effort	
Grass Bay Preserve* (Cheboygan Co.)	TNC	12.88 (31.83)	1.57 (0.98)	nest record, speci-men		(7)		1937		LL, SC	survey effort, protect transient birds	PT HG
South Fox Island (southern tip) (Leelanau Co.)	state	28.32 (69.98)	0.98 (0.61)	speci-men		(4)		----	✓	HD	survey effort, restrict horses	PT
South Manitou (Leelanau Co.)	Federal (NPS)	NA	NA	sight-ing		(5)				PR	survey effort, assess threats	
Point Betsie (Benzie Co.)	Federal (USCG) TNC	108.77 (268.77)	2.74 (1.7)	nest record		(4)		1926	✓	HD	survey effort, public education, interpretative signs	
Ludington State Park (Mason Co.)	state	NA	NA	sight-ing		(41) (shared with Nordhouse Dunes)		----	✓	HD	survey effort, public education interpretative signs	PT
Muskegon State Park (Muskegon Co.)	state	NA	NA	nest record		(5)		1954		HD	survey effort	

NA = No data available.

* = Nesting occurred at Port Inland in 1999 and Grass Bay in 2000.

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
POTENTIAL SITES												
Two-hearted River State Park (Luce Co.)	state	3.15 (7.78)	0.84 (7.52)			(4)			✓	HD	survey effort	
Harbor Springs-Sevenmile Point (Emmet Co.)	multiple private	5.83 (14.41)	0.50 (0.31)			(2)				LL, HD	landowner education	PT
Petoskey State Park (Emmet Co.)	state	22.88 (56.54)	1.99 (1.24)			(9)			✓	HD		PT
North Point Charlevoix (Charlevoix Co.)	municipal	10.70 (26.44)	1.13 (0.7)			(5)			✓	HD	survey effort	PT
Cathead Point (Leelanau Co.)	private	2.90 (7.17)	4.67 (2.9)			(2)			✓	LL	landowner education, survey effort	PT
Sleeping Bear Dunes-Platte Bay (Otter Creek) (Leelanau Co.)	Federal (NPS)	NA	NA			(35)			✓	HD	survey/monitoring effort	PT
Nordhouse Dunes Wilderness Area (Mason Co.)	Federal (USFS)	NA	NA			see Ludington			✓	HD	survey effort, assess threats	PT
P.H. Hoeft State Park (Presque Isle Co.)	state	NA	NA			(2)				HD, DV	survey effort	PT

Appendix A (cont.) Characteristics of essential piping plover breeding sites in Michigan

Site Name	Owner	Approx. area unforested dunes in ha (ac)	Approx. shoreline length in km (mi)	Record Type	Total # pairs (198)	Max # pairs in a given yr. '84-98 (estimated)	Reproductive success (fledglings per pair)	Year of last known nest	Critical Dune?	Recent Threats	Management Needs	Other Federally-Listed Species Present
Thompson Harbor State Park (Presque Isle Co.)	state	NA	NA			NA				NA	survey effort, assess threats	PT HG
Tawas Point State Park (Iosco Co.)	state	NA	NA			(2)				HD	beach closure during migration, public education, interpretive signs	

Appendix B. Federal and state laws applicable to the protection of piping plover

Federal laws

Endangered Species Act of 1973, (16 U.S.C. 1531-1544), as amended. Regulations, in part, at 50 CFR 17 and 50 CFR 402.

Water Pollution Control Act of 1948, (33 U.S.C. 1251-1376) as amended ("Clean Water Act"). Regulations at 33 CFR 320-338.

Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712), as amended. Regulations at 50 CFR 10.

National Environmental Policy Act of 1969, (U.S.C. 4321-4347), as amended.

State Laws

Alabama	All listed species are state protected. There is no state endangered species act. Alabama Code 9-2-2 (1), the Department of Conservation and Natural Resources has the responsibility to protect, conserve, and increase the wildlife of the state.
Florida	Florida Endangered and Threatened Species Act, Sections 372.072, 372.0725 of Title 28
Georgia	Endangered Wildlife Act (1973)
Illinois	Illinois Endangered Species Protection Act-520 ILCS (Illinois Compiled Statutes) 10/1
Indiana	IC (Indiana Code) 14-22-34
Louisiana	RS (Revised Statutes) 56:1901, RS 56:1903, RS 56:1904
Michigan	State of Michigan, Part 17, Michigan Environmental Protection Act, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. MCL Sections 324.1701 to 324.1706. State of Michigan, Part 21, General Real Estate Powers, Subpart 11: Conservation and Historic Preservation Easement, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. MCL Sections 324.2140 to 324.2144. State of Michigan, Part 353, Sand Dunes Protection and Management, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. MCL Section 324.35302.

Appendix B (cont.) Federal and state laws applicable to the protection of piping plover

	State of Michigan, Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. MCL Sections 324.36501 to 324.36507.
	State of Michigan, Part 637, Sand Dune Mining, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. MCL Section 324.63702.
Minnesota	Minnesota Endangered Species Statute, Section 84.0895; Minnesota Rules, Chapter 6134; Minnesota Rules 6212.1800-6212.2300
Mississippi	The Nongame and Endangered Species Conservation Act of 1974
New York	6 NYCRR (New York Code of Rules and Regulations), Part 182; New York State Environmental Conservation Law, 11-0535[1]-[2], 11-0536[2],[4]
N. Carolina	North Carolina General Statutes, Chapter 113, Article 25
Ohio	Ohio Revised Code, Section 1531.25
Texas	Texas Parks and Wildlife Code, Chapters 67 & 68; Texas Administrative Code, Sections 65.171-65.184 of Title 31
Wisconsin	Wisconsin Statutes, Section 29.604; Wisconsin Administrative Codes, Chapter NR (Natural Resources) 27

Appendix C. An assessment of banding concerns for the Great Lakes population

Ed Pike (MDNR, Michigan Recovery Team leader) banded piping plovers in Michigan from 1976-1985. In 1986 the USFWS declared a moratorium on piping plover banding in response to reports of leg injuries in banded birds on rivers in the Great Plains (Lingle and Sidle 1993; Lingle et al. 1999). In 1993 Dr. Francie Cuthbert and Lauren Wemmer (University of Minnesota) reinitiated banding Great Lakes population piping plovers after the USFWS decided survival and recruitment information was needed to determine appropriate management strategies for this population.

Since 1993, Wemmer or Cuthbert, and banding assistants, captured and color-banded approximately 80% of piping plover adults and 70% of all chicks that fledged using methods pursuant to permits issued by the USFWS. Banders take many safety precautions to minimize disruption of nesting plovers. Attempts to capture adults occur only after the first week of incubation and during fair weather (temperatures 16°-32°C, (60°-90°F), no precipitation). Banders carefully observe piping plover behavior during capture and banding and after release until the bird returns to the nest to incubate. Piping plover monitoring following banding often continues until the returning adult switches incubation duties with its mate. At most sites, nest monitoring occurs every 1-3 days and allows detection of any significant negative effects of banding. Monitoring occurs less frequently at nests that are logistically difficult to visit (e.g., island nests), and therefore discerning banding effects at these sites is more difficult. Following the banding of the chicks, banders observe piping plover families from a distance (at least 100 m (330 ft) depending on the site) to verify that chicks and adults reunite. At most sites, monitors continue to observe piping plover broods frequently until they disappear or fledge. Banding activities are summarized each year in reports provided in requirement of bird banding permits. Banding data is provided to the US Army Corps of Engineers in Yankton, South Dakota, who are currently maintaining a database of all piping plover records.

Wemmer and Cuthbert (1999) analyzed banding data from 1993-1997 to quantify obvious indications (e.g., injuries, nest desertion, hatching failure, and chick mortality) of negative impacts of banding activity on breeding piping plovers. Only one of 156 resightings of 46 piping plovers banded as adults was observed with a leg injury during this time period. The injury could neither be definitively attributed to the metal band, which appeared in good condition, nor to some other cause (e.g. traumatic injury during a storm). The injury eventually resulted in the loss of the lower leg and foot, but this bird continued to nest and raise young successfully at Wilderness State Park. Injuries to piping plovers during trapping were also infrequent. Occasionally (ca. 1 out of 10) captured adults abraded their cere or alula against the trap. Most individuals successfully hatched young. Rates of nest desertion and hatching success did not differ significantly between nests where birds were captured and banded and those undisturbed by banding efforts. The overall abandonment rate of 8% approximated rates reported for piping plover nests with and without exclosures on the Atlantic Coast (Vaske et al. 1994; Cairns 1977). Evaluating effects of capture and banding on chicks is difficult. Most chicks that disappear do so within the first 10 days after hatching (Loegering and Fraser 1995; Wemmer and Cuthbert 1999), and age specific mortality makes it difficult to determine what impact capture and banding has on survival. However, average fledging rates have

increased, rather than decreased, since banding was reinitiated in 1993. Since this initial assessment of banding, a small number (8-9) of plovers have been reported with leg injuries, which may be band-related.

An increase in the rate of observations of piping plovers with potential band-related injuries occurred during the 2002-2003 breeding season. A total of 5 piping plovers were observed during this time period, with injuries that included limb loss and temporary limping. Capture and examination of one plover, however, believed to be suffering a band-related injury (limping) was found to have a unrelated cause for the condition. Banding with USFWS incoloy leg bands was temporarily halted in 2002, in response to the increase in injury reports. Following an examination of band data during this time period, the use of USFWS incoloy bands was permanently halted. Banding proceeded in mid-2003 with the use of USFWS aluminum bands. Evaluation of the significance of these band injury reports will continue as part of the annual permit review process.

Appendix D. Guidelines for predator exclosure use to protect piping plover nests

Authorization

Any person constructing predator exclosures must have a letter of authorization from the U.S. Fish and Wildlife Service or the State Wildlife Department designating him/her an agent of the State for the purpose of constructing and monitoring the exclosures. Persons authorized to erect exclosures should be very familiar with the biology and behavior of Piping Plovers. Persons authorized to erect exclosures should understand the *Birds of North America* Piping Plover account in the Piping Plover Protocols notebook.

Exclosure materials and design

- 50 ft roll 2X4 inch welded wire fencing ≥14 gauge
- 4 heavy steel fence posts at least 5 ft. long
- several rolls of clear monofilament ≥ **18 lb test** on small spools that can pass through the fencing
- sledge hammer
- wire cutters
- pliers
- thin aluminum wire for securing fencing to stakes
- pocket knife
- blueberry or bird netting (optional)

Circular or square exclosures are recommended. Minimum distance from the nest to fence should be five feet (10 ft diameter for a circular exclosure). Stakes must be buried in the sand to at least 1 inch below the top of the fence so that avian predators cannot use the stakes as perches. Fencing should be buried and bottom wire should be flush with the sand, allowing plovers to walk through the squares in the fence. String parallel lines of monofilament taut across the top at intervals of 4-6 inches. Do NOT criss-cross monofilament as birds may become entangled if they fly out the top of the exclosure.

Exclosures should be constructed after a full clutch of eggs is confirmed during good weather (rainy, very windy, cold or extremely hot weather should be avoided), preferably when people (who may become curious) are not around. Exclosures may be constructed earlier (after 2nd or 3rd egg) if experienced plover monitors determine there is a predator risk or the nest is located in an area where the eggs might be easily crushed.

Exclosure construction is most easily accomplished with a crew of two to four people, but not more than four. Construction should be practiced around a "dummy nest" until the operation can be done quickly and smoothly. Construction time should be recorded and time should not exceed 20 minutes. A baseball cap or similar device should be inverted on the nest to mark its location during fence positioning, but removed prior to stringing monofilament.

Appendix D (cont.) Guidelines for predator exclosure use to protect piping plover nests

Behavior of plovers should be monitored throughout exclosure construction and continued from a distance out of sight of the birds after the exclosure is complete. The nest should be monitored until an adult returns to nest, resumes incubation, and then exchanges with its mate. If neither adult returns to the nest within 60 minutes, or the bird's behavior appears abnormal, the exclosure should be removed and the nest should continue to be monitored to determine if abandonment of eggs has occurred (See guidelines for determining abandonment).

Psychological fencing (bailing twine and Piping Plover closed area signs) should be used in concert with exclosures to prevent people from approaching exclosures out of curiosity.

Monitors should be alert for evidence of predators near the exclosures. Birds repeatedly perching on the exclosure tops or predators circling exclosures may cause plovers to abandon the nest. In these cases, removal of predators may be warranted after consultation with the DNR or USFWS.

If a nest failure (predation or abandonment) is detected, a thorough investigation of the site should be made to document species of predator if possible and means of entry into the exclosure. In cases of suspected nest abandonment, a thorough search of the area should be made for signs of adult mortality (predator tracks, plover remains) and for sightings of both adults.

Exclosures should be removed after chicks have fledged or the plover family has left the nest territory and will not be disturbed by exclosure removal. Exclosures may be safely removed usually 20-25 days after plovers leave the immediate area or fledge. Nest cups should be marked with well anchored, small stakes so that their location can later be recorded with a Geographic Positioning System.

Amendment

Guidelines for the Use of Predator Exclosures to Protect Piping Plover Nests

The following amendment to the current *Guidelines for the Use of Predator Exclosures to Protect Piping Plover Nests* (1999) is proposed to allow for the use of bird netting as a top cover material for nest protection:

At some locations penetration of monofilament covered exclosures by avian predators such as crows or ravens has occurred. As additional protection against avian predation, fruit tree or blueberry netting can be used as a top cover in place of monofilament. Material used for a top cover should have mesh size of 3/4 inches or less, it should lie flat and form square holes without stretching (do not use nets that are intended to be stretched). Nets should be cut to fit the top of the exclosure with minimum overhang,

pulled taut, and securely attached to the wire fence with hog clips or other similar devices such as cable ties. No gaps or openings in the net should be present to allow predator access. Do not stretch the netting to such a degree as to allow for a firm perch by potential avian predators. Bird-X brand 3/4" polypropylene netting is a suitable choice. Never use the bird netting in combination with monofilament covers as this may increase the potential for entanglement. Monitor plover use of the nest site, per existing protocols. If birds to not return to the nest following the specified time, remove the netting and replace with monofilament.

Appendix E. Guidelines for determining egg abandonment and protocol for salvage

Authorization

Any person who collects Piping Plover eggs or chicks must have a letter of authorization from the U.S. Fish and Wildlife Service or the State Wildlife Department designating him/her an agent of the State for the purpose of salvaging abandoned eggs or chicks. Persons authorized to collect eggs or chicks should be very familiar with the biology and behavior of Piping Plovers. Persons should understand the *Birds of North America* Piping Plover account in the Piping Plover Protocols notebook.

Abandonment Determination

One piping plover management goal is for incubation, hatching and rearing to be accomplished by the parents. Another management goal is to take actions to fledge as many chicks as possible. To reach these two goals, daily or more frequent observation of nests is necessary to discover abandonment soon after it occurs. In addition, careful observation is necessary to assure eggs are not collected if parents have not actually abandoned their nest.

NOTE: Adults do not incubate eggs until the clutch is complete, usually with four eggs. During the period after the first egg is laid and the clutch is completed, eggs are often left seemingly alone. These eggs should not be considered abandoned using the criteria below.

Abandonment may have occurred if one or more of the CRITERIA is observed. If abandonment is suspected, the nest should be observed for one hour from a location where plovers cannot detect or do not react to the observer. (If eggs are under water or buried by sand, this observation period is not necessary.) During this hour, observers should record the presence and behavior of any piping plovers.

Eggs and young may be collected for salvage and delivered to University of Michigan Biological Station (UMBS) in Pellston, MI only if:
strong evidence of parental abandonment is observed (one or more of the CRITERIA below are true) and one of the following experts agrees the eggs should be collected for salvage.

> Dr. Cuthbert or the head field monitor at the University of Michigan Biological Station at 231-539-8406 or 8408.
>
> Max Holden or Kim Struthers of Sleeping Bear Dunes National Lakeshore at 231 326-5134
>
> Jack Dingledine, US Fish and Wildlife Service, East Lansing Field Office at 517 351-6320
>
> Christie Deloria, US Fish and Wildlife Service, UP Sub-office at 906 226-1240

Appendix E (cont.) Guidelines for determining egg abandonment and protocol for salvage

CRITERIA

1). Adults making a new nest scrape elsewhere in the territory and not defending previous nest
2) Adults not incubating for more than 2 hours, unless due to disturbance by potential predators, humans or other plovers
3) Lack of adult nest attendance at night
4) Adults absent from territory for more than 30 minutes (This is evidence only in conjunction with other CRITERIA.)
5) Adults tending chicks in another portion of the territory, but incubation of remaining eggs has not occurred for at least 2 hours and adults do not defend eggs when they are approached
6) Nest cup and/or eggs buried by sand or partially covered by high water (One hour of observation not necessary and an expert need not confirm collection is necessary if eggs are buried or under water.)

Facilities have been established for incubating eggs and rearing plover chicks at the University of Michigan Biological Station (UMBS) in Pellston, MI. If abandoned eggs or chicks are found, please contact the UMBS plover team immediately at (231)539-8626 or -8408.

Eggs:

- Record exact location of nest and reasons for abandonment.

- Record approximate age of eggs (incubation is 25-30 days, usually 28).

- Place eggs in a padded container (NOT airtight); a small box filled with cotton works well. Water bottles filled with warm water may be well padded and placed in the container (but not in contact with the eggs) to provide warmth.

- Place an equal number of small egg-sized and shaped stones in nest to replace eggs. If parents return, they will incubate the stones and not find eggs missing.

- Do NOT let eggs warm > 99° F or cool below 65° F; eggs can tolerate cooling for up to 24 hours, but must **never** overheat. If you think overheating or cooling has occurred, please record that observation but continue to follow procedures because **the eggs may still be viable**.

- Observe the nest from which eggs have been removed for an additional hour.

Appendix E (cont.) Guidelines for determining egg abandonment and protocol for salvage

- Observe and record the presence and behavior of any adult piping plover in the nesting territory (and band combinations if banded).

- Nest abandonment must be reported within 24 hours to the East Lansing Field Office (ELFO) (517)351-6320. If subsequent adult behavior indicates eggs had not been abandoned, consideration must be given to returning eggs to the nest immediately. Further egg salvage activities may not continue without approval from the ELFO.

- Arrange for transport to UMBS and fill out egg abandonment form from your Notebook.

- **Note:** Occasionally, one egg of a clutch does not hatch and is left behind in the nest cup after the chicks have left the nest cup. Following the observations described above, these eggs should also be transferred to the UMBS team.

UMBS Team Only-if UMBS team determines an egg is infertile or otherwise nonviable or dead, wrap the egg in aluminum foil and refrigerate. Then send foil-wrapped eggs, carefully packaged in coolers to ELFO for contaminant analysis. Include copies of data sheets with information specified above.

Chicks:

- Record exact location, reasons for abandonment and age of chicks.

- Keep chicks together in a box without visual contact of people or the outdoors; make sure box has sufficient air holes.

- Reduce visual stress and noise levels.

- Chicks less than 7 days old should be kept warm with a heat lamp (or light bulb for the short-term); 93° F is ideal. Older chicks should be kept at approximately 85° F.

- Water should be supplied at all times in a shallow dish or pie pan. If chicks are dehydrated and weak, drops of water can be applied to the edge of the beak using an eye-dropper; do NOT attempt to force food or water by prying beak open; this is too stressful to the bird.

- Observe territory from which chicks have been removed for an additional hour.

- Observe and record the presence and behavior of any adult piping plovers in the nesting territory (and band combinations if banded).

Appendix E (cont.) Guidelines for determining egg abandonment and protocol for salvage

- Chick abandonment must be reported within 24 hours to the ELFO. If subsequent adult behavior indicates chicks had not been abandoned, consideration must be given to reuniting chicks with adults immediately. Further chick salvage activities may not continue without approval from the ELFO.

- Arrange for transport to UMBS.

Appendix F. Federal, state, and Canadian contacts in the breeding and wintering range

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Appendix F (cont.) Federal, state, and Canadian contacts in the breeding and wintering range

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Appendix F (cont.) Federal, state, and Canadian contacts in the breeding and wintering range

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Appendix F (cont.) Federal, state, and Canadian contacts in the breeding and wintering range

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Appendix G. Summary of comments on Draft Recovery Plan and U.S. Fish and Wildlife Service responses

On August 5, 2002, the U.S. Fish and Wildlife Service (Service) released the Agency Draft Recovery Plan for the Piping Plover, Great Lakes Population, for a 30-day review and comment period ending on September 4, 2002. Availability of the plan was announced in the Federal Register (FR 66 50687) and via a news release to media contacts throughout the species' U.S. range.

In accordance with Service policy, requests for peer review of the draft plan were sent to experts outside the Service. In particular, these experts were asked to comment on (1) issues and assumptions relating to the biological and ecological information of the plan, and (2) scientific data relating to the tasks in the proposed recovery program. Requests for peer review were sent to the following individuals:

Dr. James Fraser, Virginia Tech, Blacksburg, Virginia
Dr. Susan Haig, National Biological Service, Corvallis, Oregon
Dr. Pat Lederle, Michigan Department of Natural Resources, Lansing, Michigan
Dr. Abby Powell, Alaska Cooperative Fish and Wildlife Research Unit, Fairbanks, Alaska

During the comment period, 89 copies of the Draft Recovery Plan were distributed to affected government agencies, organizations, and interested individuals.

Twenty-two comment letters were received during the official comment period. Eight comment letters were received after the close of the official comment period. Affiliations of the originators of these thirty comment letters are tabulated below:

Peer reviews	3 letters
Federal agencies	11 letters
State governments	5 letters
Recreation groups	1 letter
Environmental/conservation organizations	1 letter
Academic institutions	1 letter
Landowner associations	1 letter
Individuals/Private citizens	6 letters
AZA institution	1 letter

Each letter contained one or more comments, with some letters raising similar issues. Most letters requested explanation or clarification of points made in the plan and included suggestions for changes. A few letters provided updated information on population occurrences on the wintering grounds. Many commenters expressed strong support for the conservation of this species and commented on the thoroughness and importance of the plan. Most comments were incorporated into the approved recovery plan. Information and comments not incorporated into the approved plan were

considered and noted. Significant comments that were not incorporated or that require further clarification are addressed below.

The letters received from the independent peer reviewers, as well as other comment letters on the Draft Recovery Plan, are on file at the U.S. Fish and Wildlife Service, 2651 Coolidge Road, Suite 101, East Lansing, Michigan, 48823.

Comments from Peer Reviewers and Service Responses

- **Comment:** One reviewer and one commenter expressed concern with the statement in recovery task 4.1 that color banding should continue until at least 2003 and then be reevaluated. Both suggested emphasizing the importance of continuing to band plovers to facilitate research and monitoring efforts. The commenter also suggested removing the term "color," stating that the most important thing to do is band with Service bands, of which color bands are just one component.

  Response: The plan was revised to reflect these comments and to extend the calendar year when banding will be reevaluated. This will include all aspects of banding, not just color banding. Banding has contributed significantly to the knowledge of the Great Lakes population and it is expected to continue to be used into the foreseeable future.

- **Comment:** One reviewer stated that a significant commitment of funds is essential to implement the recovery plan.

  Response: Implementing all aspects of the recovery plan will require a significant source of funding. Several recovery actions identified in the plan are underway currently. Additional recovery tasks will be implemented as funding becomes available.

- **Comment:** One reviewer suggested establishing specific goals for nest success and chick survival under the goal of reaching 2.0 chicks fledged per pair per year (Recovery Criterion 2).

  Response: Although fledging rates are a measure of both nesting success and chick survival rates, it was determined that a single measure of reproductive success, expressed as average fledge rate, would be most appropriate for a recovery criterion. It is acknowledged that establishing goals for nest success and chick survival could be important for management considerations. The plan was amended to include this consideration. Recovery activities currently underway assess population status and nesting success each year and include identification of both hatching rates and chick survival rates.

Appendix G (cont.) Summary of comments on Draft Recovery Plan and U.S. Fish and Wildlife Service responses

- **Comment:** One reviewer believes the emphasis on predator control/removal should be increased, as excluding or removing predators from an area where piping plovers nest can improve nest success and chick survival.

  Response: Predation is considered to be a significant threat to the population and it is acknowledged that nest success and chick survival could be improved through predator management. A number of measures identified in the plan to protect nests from predators are considered to be priority 1 tasks. Management of predators, themselves, is also identified in the recovery plan and will be considered during implementation.

- **Comment:** One reviewer expressed the need to incorporate new population data that are now available into the plan. The reviewer stated the most important additional information needed are population modeling results that incorporate an additional five years (1998-2002) of fecundity data, which could significantly alter model outcomes. The reviewer suggested reevaluating the recovery criteria in light of the new data.

  Response: The plan was revised to incorporate 2001 and 2002 data as available. The plan describes the need to periodically review and reassess population data using current models for the Great Lakes population. Complete re-analysis of population models was not possible at this time. Recovery criteria were revised to reflect more current population information, based primarily on empirical data. In addition, recovery criteria now include consideration of future population projections that will be based on future information obtained through recovery implementation.

- **Comment:** One reviewer commented that more details are needed on what specific protective measures, beyond those already taken to protect essential breeding and wintering habitat (e.g., critical habitat designation), the Service expects to be implemented.

  Response: The recovery plan identifies a number of potential measures to be implemented on both public and private land, which will provide for protections of essential habitat into the future. The plan identifies that measures to protect essential habitat will focus on preservation of those biotic and abiotic factors that currently define essential habitat elements. Additional work is needed before more specific measures can be identified for areas of essential winter habitat in particular.

Appendix G (cont.) Summary of comments on Draft Recovery Plan and U.S. Fish and Wildlife Service responses

Other Major Substantive Comments and Service Responses

1. **Comment:** One commenter asked if the Great Lakes population is included with the Atlantic coast subspecies C. *m. melodus* or the "inland bird" subspecies C. *m. circumcinctus*? Another commenter stated that in 1998 the AOU did not refer to subspecies but grouped all piping plovers into one species.

   Response: The Great Lakes population is part of the inland subspecies, *C. m. circumcinctus*, and it does not appear that AOU has changed the subspecies designation since 1998. Subspecies designation and inclusion with the Great Plains population, however, fails to consider several factors relevant to the Great Lakes population including its ecological isolation, distribution, and habitat preferences that differ from the other two populations in North America.

2. **Comment:** Several comments focused on recreational use and development of as well as access to beaches. One commenter stated that recreational pressure continues to threaten piping plover essential habitat. One commenter was opposed to and one commenter was in favor of closing public beaches where piping plovers nest. Two commenters stated the need to regulate development along beaches. One of them stated that ORV use should also be regulated. One commenter is concerned that policies in the recovery plan could severely restrict ORV beach access within the Cape Hatteras National Seashore without significantly enhancing plover recovery and cautions against blanket ORV bans as a management tool.

   Response: Public use of beaches inhabited by piping plovers, including use by ORVs is identified as a continuing threat to the Great Lakes population. Support for measures to manage public uses is appreciated. Efforts currently underway in the Great Lakes seek to manage public uses while minimizing inconveniences to recreational users. Permanent bans on ORV use are not identified in the final plan.

3. **Comment:** One commenter suggested separating the discussion of Section 10 permits into 10(a)(1)(A) and 10(a)(1)(B). The commenter also pointed out that discussion of Safe Harbor agreements is omitted from the section regarding Section 10 permits.

   Response: The discussion of Section 10 permits in the plan was modified and now includes separate reference to 10(a)(1)(A) and 10(a)(1)(B) permits provided under the ESA. The Safe Harbor provision of ESA is currently considered to have limited potential application to piping plovers in the Great Lakes.

Appendix G (cont.) Summary of comments on Draft Recovery Plan and U.S. Fish and Wildlife Service responses

4. **Comment:** One commenter asked if the Service considered including recommendations on banding methods in Appendix C.

   Response: Banding methods currently used in the Great Lakes are summarized in Appendix C, along with a discussion of potential band related injuries. Detailed descriptions of banding methods were not considered necessary for the Recovery Plan. Banders provide details of their efforts in annual reports required in support of banding permits.

5. **Comment:** Two commenters asked for clarification of the definition of cobble.

   Response: Additional description of the term "cobble" was added to the plan. It is acknowledged that the term used in conjunction with Great Lakes piping plover habitat may not meet other technical definitions based on particle size classes. Nevertheless, the term is used consistently throughout the plan.

6. **Comment:** No mention of using still cameras or infrared motion/heat sensitive cameras as methods to identify predators.

   Response: A comment on the use of additional predator surveillance methods was added to the plan. Failure to mention other potential methods of predator monitoring does not exclude their possible use in the future.

7. **Comment:** Is Ontario included in the "other Great Lakes States" mentioned in the first recovery criterion?

   Response: As described in the footnote to Table 5, Ontario, Canada is not included in any recovery goals. Although Great Lakes piping plovers may occur in Canada, occurrences of breeding pairs outside of the U.S. will not be counted towards recovery.

8. **Comment:** Two commenters suggested making changes to priority numbers for some recovery tasks. One stated that recovery task #7 (emergency methods to prevent extirpation) should be the highest priority. The other recommended that recovery actions 1.341, 1.361, and 1.362 (relating to the acquisition and protection of habitat) receive higher priority levels.

   Response: Recovery priority numbers were assigned to recovery tasks on the basis of current recovery plan guidance. Recovery 1 tasks are those actions that are considered necessary to prevent extinction. Recovery priority numbers were adjusted for some tasks based on reconsideration of the importance of the task in preventing extinction. Other tasks were not modified from the originally proposed priority.

9. **Comment:** The list of federal and state contacts in Appendix F seems deficient. There is also no readily identifiable federal contact person for the Great Lakes piping plover.

   Response: State agency contacts were updated, as names were available, for the Great Lakes. The current Great Lakes Piping Plover coordinator for the U.S. Fish and Wildlife Service resides in the East Lansing Ecological Services Office in Michigan, which is listed in the plan.

10. **Comment:** Two commenters expressed the need to update winter sightings of piping plovers.

    Response: Additional information on more recent winter sightings were added to the plan and figures were modified to reflect updated migratory route information. It is anticipated that winter sightings will continue to increase as more reports of banded piping plovers are received.

11. **Comment:** Three commenters recommended increasing education geared toward children and adults. Suggestions include creating a piping plover festival or museum and educating elementary-age schoolchildren and local officials.

    Response: Outreach and education are identified as important recovery tasks, including those geared towards teachers and schoolchildren. Specific suggestions for a festival or museum were not added to the plan at this time, although these activities are not precluded from taking place in the future as sponsors are identified.

12. **Comment:** Two commenters recommended increasing predator control efforts for gulls. One of them stated that fisher populations also need to be controlled.

    Response: Predation is considered to be a significant threat to the population. A number of measures identified in the plan to protect nests from predators are considered to be priority 1 tasks. Management of predator is also identified in the recovery plan and will be considered during implementation. These measures are expected to target a variety of species depending on the location and particular circumstances of the area.

13. **Comment:** One commenter recommended enhancement of piping plover habitat and testing for contaminants in the St. Louis River Estuary in Minnesota and Wisconsin.

Response: Although habitat improvements are identified as a recovery task in the final plan, site-specific projects are not identified. Habitat enhancement projects will be undertaken on a site by site basis as needs are identified and funding sources acquired.

14. **Comment:** Recovery criteria 1 and 2 need further clarification and possible reevaluation. The fecundity criterion exceeds that observed naturally in the Great Plains, Great Lakes or Atlantic Coast populations. Long-term growth and recovery would likely be attained at a level lower than 2.0 fledged/pair. It may also be necessary to specify the length of time over which population projections indicate stability or growth above the recovery goal.

Response: Recovery criteria 1 and 2 were modified, in part, on the basis of comments received. Fecundity criteria were adjusted to account for historical information and the most recent empirical data that suggests population increases can occur in absence of an average 5-year fecundity rate of 2.0. It is acknowledged that additional population modeling could be accomplished which may result in further changes to these recovery criteria. As the opportunity for model refinements become available, additional consideration will be given to changes to the criteria, if warranted by these efforts. The length of time over which population projections indicate stability or growth above the recovery goal were specified.

15. **Comment:** Several comments concerned recovery task #7. One commenter stated that it is not clear who is responsible for recovery tasks outlined under recovery task #7 and in what timeframe these tasks should be accomplished. One commenter recommended deleting recovery task 7.1 (evaluating population augmentation strategies) and focusing instead on implementing augmentation programs. Two commenters expressed the need to reevaluate 50 pairs as a threshold for recovery task 7.21.

Response: Several aspects of recovery task #7 were adjusted for the final plan, including the timeframe under which these tasks will be accomplished. The 50 pair threshold for recovery task 7.21 was also adjusted. Future actions include developing appropriate thresholds for these activities based on the most recent information available. Population augmentation programs will not be initiated without clear and concise criteria for implementation and a thorough understanding of the risk and benefits of such actions. All population augmentation strategies represent some element of risk to individuals and the population and must be carefully considered prior to implementation.

16. **Comment:** Several comments were received regarding genetic information. Two commenters stated that information about genetic variation among Great Lakes, Great Plains, and Atlantic Coast piping plover populations needs to be updated. Another commenter recommended including further study on genetic information in the narrative for recovery task 7.23.

    Response: Additional data on the genetic composition of the Great Lakes population has been gathered over the last 2 to 3 years. Analysis is not complete, however, and data has yet to be published. Additional information on the genetic composition of the population, as well as comparisons between populations, is expected to be developed in the near future. This information will be carefully considered as recovery tasks are implemented throughout the species range.

17. **Comment:** One commenter recommended adding a caveat into the delisting criteria that recognizes that substantially improved probability of persistence can be attained by increasing the breeding population above 150 pairs, especially while long-term productivity potential is being explored further.

    Response: Further consideration was given to the potential for improved probability of persistence by attaining an increase in the breeding population above 150 pairs, especially when long-term productivity is being further explored. The current recovery criteria takes this potential into consideration and allows for higher population levels to potentially offset lower levels of reproductive productivity. Long-term projections, however, must demonstrate population stability or improvement before delisting would occur.

18. **Comments:** One commenter stated that the Service should designate some of those unoccupied areas meeting the physical characteristics of wintering and breeding habitat as additional critical habitat. The commenter stated that because the snowy plover and piping plover occupy similar habitat, additional critical winter habitat for the piping plover could be protected by listing the snowy plover and designating critical habitat for that species.

    Response: This comment is acknowledged, however, additional action on designation of critical habitat cannot be undertaken with the context of development of the recovery plan.

19. **Comment:** One commenter had several suggestions concerning the incorporation of information about the Magic Carpet HCP into the plan. The commenter stated that the plan should be updated to state that the Magic Carpet HCP was approved and is being implemented and discuss what activities the Great Lakes piping plover conservation fund supports. The commenter recommended identifying the Magic Carpet HCP as an example of an effort consistent with recovery task 1.17.

The commenter also stated that development of standard guidelines for landowner HCPs (recovery task 1.342) should not be used as a basis for altering any provisions in the existing Magic Carpet Woods HCP.

Response: Updated information on the Magic Carpet HCP was added to the plan. The Magic Carpet HCP is an example of efforts consistent with established recovery actions described in the plan. Future development of landowner guidelines relating to HCPs will not alter existing permits or agreements relating to the Magic Carpet HCP.

20. **Comment:** The AZA's role in captive rearing and translocation should be evaluated, and a MOU should be developed between the AZA and Service to clearly describe AZA's role.

Response: Additional descriptions of the potential role of the AZA in piping plover captive rearing and possible translocation programs were added. The AZA's role in plover conservation has increased in recent years and additional involvement is expected. Formal MOUs may or may not be necessary to facilitate this involvement.

21. **Comment:** Should consideration be given to developing a captive population with a surrogate species so techniques can be developed if a captive breeding program is necessary?

Response: Captive breeding remains a potential element of piping plover recovery, although many researchers and managers believe there are significant limitations to undertaking such a program. Use of a surrogate species may provide an opportunity to evaluate some of the current limitations, but other population augmentation strategies are considered a higher priority for recovery.

22. **Comment:** One commenter asked if radio telemetry has been considered to map migration routes and stopovers.

Response: Radio telemetry has been considered for mapping migration routes and stopover areas but has not yet been used for those purposes. In 1999, biologists from the Milwaukee County Zoo tested several radio transmitter harness designs on captive piping plovers to develop a safe design for use in the wild.

23. **Comment:** One commenter asked if it was possible to place the metal USFWS band above the knee joint of piping plovers to avoid sand becoming lodged underneath.

Response: Placing the band above the knee joint has been considered, but it has been determined that the current placement of the bands is the best.

24. **Comment:** One commenter said they thought Sleeping Bear Bay was listed as critical habitat in the *Federal Register* and suggested including Sleeping Bear Bay in Table 2 (critical habitat units in Michigan).

Response: Upon review of the final critical habitat rule for the breeding population of piping plovers, we did not find Sleeping Bear Bay listed as a critical habitat unit. Table 2 currently reflects critical habitat units as they are listed in the final rule.

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September 2003