Piping Plover
(Charadrius melodus)

5-Year Review:
Summary and Evaluation

Piping plover in nonbreeding plumage, photographed October 2002 at Ocracoke Inlet Spit, North Carolina.

U.S. Fish and Wildlife Service

Northeast Region, Hadley, Massachusetts
and
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with major contributions from

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Panama City, Florida Field Office
South Carolina Field Office
Corpus Christi, Texas Field Office

September 2009

5-YEAR REVIEW

Species reviewed: Piping Plover (*Charadrius melodus*)

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1.0 GENERAL INFORMATION

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1.2 Methodology Used to Complete the Review

Sources of data informing this review include recovery plans, published literature, unpublished reports, and other communications (see References sections). An October 2008 workshop with Canadian Wildlife Service (CWS) biologists and U.S. and Canadian piping plover researchers facilitated review of recent studies and other information. Many experts and field office biologists generously provided information and technical review of draft sections of this document (see Appendix A).

1.3 Background

1.3.1 Federal Register Notice citation announcing initiation of this review

September 30, 2008 (73 FR 56860). We received information that explicitly referenced this Federal Register announcement from five individuals, agencies, and organizations.

1.3.2 Listing history

FR notice:	50 FR 50726, Determination of Endangered and Threatened Status for Piping Plover
Date listed:	Rule published December 11, 1985; effective January 10, 1986
Entity listed:	Piping plover (*Charadrius melodus*), listed rangewide
Classification:	Endangered (Great Lakes watershed in States of IL, IN, MI, MN, NY, OH, PA, and WI and Province of Ontario) and Threatened (Entire, except those areas where listed as endangered)

1.3.3 Associated rulemakings

Critical habitat for the Great Lakes breeding population: Designated May 7, 2001 (66 FR 22938). Includes 35 units along approximately 201 miles of shoreline in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York.

Critical habitat for the Northern Great Plains breeding population: Designated September 11, 2002 (67 FR 57637). Nineteen critical habitat units originally contained approximately 183,422 acres of prairie alkali wetlands, inland and reservoir lakes, and portions of four rivers totaling approximately 1,207.5 river miles in Montana, Nebraska, South Dakota, North Dakota, and Minnesota. The Nebraska portion of the critical habitat was vacated by U.S. District Court on October 13, 2005.

Critical habitat for wintering piping plovers (including individuals from the Great Lakes and Northern Great Plains breeding populations as well as birds that nest along the Atlantic Coast): Designated on July 10, 2001 (66 FR 36038). Designated wintering piping plover critical habitat originally included 142 areas (the rule erroneously states 137 units) encompassing about 1,793 miles of mapped shoreline and 165,211 acres of mapped areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas.

In 2004, the Courts vacated and remanded back to the U.S. Fish and Wildlife Service (USFWS) for reconsideration four units within Cape Hatteras National Seashore, North Carolina (*Cape Hatteras Access Preservation Alliance v. U.S. Department of Interior* (344 F. Supp. 2d 108 (D.D.C. 2004)). A revised designation for these four units was published on October 21, 2008 (73 FR 62816). On February 6, 2009, Cape Hatteras Access Preservation Alliance and Dare and Hyde counties, North Carolina, filed a legal challenge to the revised designation.

In 2006, 19 units (TX- 3,4,7-10, 14-19, 22, 23, 27,28, and 31-33) in Texas were vacated and remanded back to the USFWS for reconsideration by Court order (*Texas General Land Office v. U.S. Department of Interior* (Case No. V-06-CV-00032)). On May 19, 2009, the USFWS published a final rule designating 18 revised critical habitat units in Texas, totaling approximately 139,029 acres (74 FR 23476).

1.3.4 Review history

The piping plover was included in a cursory 5-year review of all species listed before 1991(56 FR 56882). No new information regarding piping plover status was received, nor was a change in status recommended. This review constitutes the first species-specific 5-year review of the piping plover since its listing.

1.3.5 Species' Recovery Priority Number at start of 5-year review

2C. This ranking refers to an entity listed at the species level with a high degree of threat and high recovery potential. The "C" denotes taxa that are in conflict with construction, other development projects, or other forms of economic activity.

1.3.6 Recovery plans

Name:	Piping Plover (*Charadrius melodus*) Atlantic Coast Population, Revised Recovery Plan
Date issued:	May 1996
Date of previous plan:	March 1988

Name:	Recovery Plan for the Great Lakes Piping Plover (*Charadrius melodus*)
Date issued:	September 2003
Date of previous plan:	Supersedes pertinent portions of the 1988 Great Lakes and Northern Great Plains Piping Plover Recovery Plan

Name:	Great Lakes and Northern Great Plains Piping Plover Recovery Plan[1]
Date issued:	May 1988

[1] Because the sections of this plan that pertain to the Great Lakes breeding population have been superseded by the 2003 recovery plan, the 1988 plan is generally referred to as the Northern Great Plains Piping Plover Recovery Plan, a convention that we follow in this review.

2.0 REVIEW ANALYSIS

2.1 TAXONOMIC CLASSIFICATION AND APPLICATION OF THE 1996 DISTINCT POPULATION SEGMENT (DPS) POLICY

2.1.1 Background and history of taxonomic and DPS treatment under the ESA

The final listing rule (50 FR 50726), effective January 10, 1986, did not utilize subspecies. The rule's preamble acknowledged the continuing recognition of two subspecies, *Charadrius melodus melodus* (Atlantic Coast of North America) and *Charadrius melodus circumcinctus* (Northern Great Plains of North America) in the American Ornithologists' Union's most recent treatment of subspecies (AOU 1957). However, the rule also noted that allozyme studies with implications for the validity of the subspecies were in progress. The final rule determined the species as endangered in the Great Lakes watershed of both the U.S. and Canada and as threatened in the remainder of its range in the U.S. (Northern Great Plains, Atlantic and Gulf Coasts, Puerto Rico, Virgin Islands), Canada, Mexico, Bahamas, and the West Indies (USFWS 1985).

Subsequent Endangered Species Act (ESA) actions have consistently recognized three separate breeding populations of piping plovers, on the Atlantic Coast (threatened), Great Lakes (endangered), and Northern Great Plains (threatened). Two successive recovery plans established delisting criteria for the threatened Atlantic Coast breeding population (USFWS 1988a, 1996). A joint recovery plan specified separate criteria for the endangered Great Lakes and threatened Northern Great Plains populations (USFWS 1988b), and the USFWS later approved a recovery plan exclusive to the Great Lakes population (USFWS 2003). Critical habitat was designated for the Great Lakes population in 2001 (USFWS 2001a), while a different rule-making determined critical habitat for the Northern Great Plains population in 2002 (USFWS 2002). No critical habitat has been proposed or designated for the Atlantic Coast breeding population, but the needs of all three breeding populations were considered in the 2001 critical habitat designation for wintering piping plovers (USFWS 2001b) and subsequent re-designations (USFWS 2008, 2009). Although all piping plovers are classified as threatened on their shared migration and wintering range outside the watershed of the Great Lakes, USFWS biological opinions prepared under section 7 of the ESA recognize that activities affecting wintering and migrating plovers differentially influence the survival and recovery of the three breeding populations.

Piping plover recovery plans (USFWS 1988a, 1988b, 1996, 2003) allude to the continuing recognition of two subspecies by the American Ornithologists' Union (AOU 1957, 1983), which was originally based on arguments by Moser (1942) that the extent and brightness of breast bands distinguished inland and Atlantic breeders. The recovery plans also cite Wilcox's (1959) report of variable breast bands on Long Island piping plovers as well as Haig and Oring's (1988a) allozyme data from birds breeding in Saskatchewan, Manitoba, North Dakota, Minnesota, and New Brunswick that failed to support subspecific differentiation. However, the 1996 revised Atlantic Coast plan recognized that banding and intensive surveys had not identified any interchange between Atlantic and inland breeding populations despite mingling in their wintering range, and the 2003 Great Lakes plan noted preliminary results of ongoing analyses suggesting genetic differences between populations that were not revealed by earlier studies.

A recently completed study (Miller et al. 2009, discussed below) provides new insight into piping plover taxonomy. Furthermore, notwithstanding a 22-year history of recovery programs predicated on three populations, no formal analysis of these populations has been conducted pursuant to the 1996 DPS policy. We therefore review these interrelated issues in light of currently available scientific information.

2.1.2 Taxonomic classification or changes in nomenclature

A molecular genetic-based investigation of piping plovers, including mitochondrial DNA sequences (580 bp, n = 245 individuals) and eight nuclear microsatellite loci (n = 229 individuals) from 15 U.S. states and eight Canadian provinces, was completed in 2009 (Miller et al. 2009). Only four of 70 unique mitochondrial haplotypes were shared between interior (i.e., Northern Great Plains and Great Lakes) and Atlantic groups, and four phylogenetic reconstruction procedures revealed strong differentiation between interior and Atlantic populations. Consistent with these analyses, a Bayesian clustering procedure implemented using STRUCTURE (version 2.2.3) found that the most likely partitioning of the data supported two groups, Atlantic and interior. Differential genetic structure patterns were also observed within the two groups, with stronger spatial genetic structure in both mitochondrial and microsatellite data sets for Atlantic birds. Miller et al. (2009) confirmed separate Atlantic and interior piping plover subspecies (*C. m. melodus* and *C. m. circumcinctus*, respectively). This study found that birds from the Great Lakes region were allied with the interior subspecies group and should be taxonomically referred to as *C. m. circumcinctus*.

Genetic evidence for the two subspecies described above is consistent with data from resightings of banded piping plovers (Table 1). Despite intensive surveys of breeding sites and marking of at least 7,374 birds (1,424 Atlantic Coast; 5,950 Great Lakes and Northern Great Plains combined) between 1982 and 2007, no interchange between subspecies has been reported. Although the subspecies mix to varying extents on their wintering grounds (Gratto-Trevor et al. 2009) and interior birds have been observed at migration stopovers in the Atlantic breeding range as far north as New Jersey (Stucker and Cuthbert 2006), they form pairs on the breeding grounds (Elliott-Smith and Haig 2004). We do not completely discount the possibility that a very few undetected birds could occasionally move between the breeding ranges of the two subspecies, but complete lack of observed exchanges of banded birds, coupled with genetic differences, provide further evidence of existence of separate subspecies.

Ecological exchangeability (e.g., life history traits, morphology, habitat) of coastal and interior breeders has received little explicit attention in recent scientific literature. Moser (1942) found no differences in measurements of birds with different plumage types. As noted in section 2.1.1 of this review, Wilcox (1959) rejected assertions by Moser (1942) regarding differences in extent of breast bands. However, the differences in genetic structure between *C. m. melodus* and *circumcinctus* observed by Miller et al. (2009) may be evolutionarily important. Atlantic birds demonstrated the signature of a genetic isolation-by-distance pattern that was not apparent among interior birds. Miller et al. (2009) suggested that these genetic structure differences may reflect relatively higher breeding and natal site

Table 1. Number of piping plover adults and chicks banded with combinations identifiable to breeding range study area, 1982-2007.

Banding location (population / state or province)	Banding years	No. of birds banded with combinations identifiable to study area		Source[a]
		Adults	Chicks	
ATLANTIC COAST[b]				
Massachusetts	1985-1988	103	61	Melvin & Gibbs 1996
Massachusetts	1982-1989	59	93	Strauss 1990
Maryland, Virginia	1987-1989	68	53	Loegering 1992
Virginia	1987-1988	34	15	Cross 1988
Virginia	1989	25	25	Cross 1996
Nova Scotia, Newfoundland, Prince Edward Island, New Brunswick, Quebec	1998-2003	329	559	Amirault et al. 2006a
***C. m. melodus* (Atlantic Coast) total**		618	806	
GREAT LAKES				
Michigan, Wisconsin, Ontario	1993-2007	94	436[c]	E. Roche and F. Cuthbert
NORTHERN GREAT PLAINS				
Manitoba	1982-1985	97	122	Haig & Oring 1988b
Minnesota (Lake of Woods)	1982-1986	53	110	Haig & Oring 1988b
North Dakota	1984-1987	204	143	Larson et al. 2000
Nebraska	1985-1989	83	246	Lingle & Sidle 1989
South Dakota, Nebraska	2005-2007	359	694	D. Catlin
Saskatchewan	2002-2006	798	1,044	C. Gratto-Trevor
Saskatchewan	1997-2005		1,002	J. P. Goossen
North Dakota	2006-2007		465	M. Sherfy
Northern Great Plains total		1,594	3,826	
***C. m. circumcinctus* (Interior) total**		1,688	4,262	
Species total		2,306	5,068	

[a] Sources without dates included in conversations and electronic communications portion of References (section 2.1.5).
[b] Banding by Cohen et al. (2006) not included due to limited observability of bands on only the upper leg. However, none of these birds was reported breeding outside the Atlantic Coast.
[c] Includes only wild-reared chicks. None of 114 captive-reared chicks released 1992-2007 in the Great Lakes has been observed breeding elsewhere.

fidelity of Atlantic birds, potentially as a consequence of reduced spatiotemporal variability in habitat conditions. Conversely, greater temporal climatic variation may cause flooding or complete desiccation of habitats used by interior populations, thereby forcing more dispersal. This difference in genetic structure between *C. m. melodus* and *circumcinctus* may reflect important adaptations to differences in habitat stability, although we cannot exclude the possibility of a plastic (i.e., not hereditary) response to varying environments. Furthermore, while *C. m. circumcinctus* breed on a range of habitat types (see discussion in section 2.1.3.1), habitat factors such as coastal tides, which affect *C. m. melodus* (but not *C. m. circumcinctus*) nest site selection and foraging behaviors during critical stages in the breeding cycle, may constitute an important ecological difference between subspecies. Casual comparison of studies suggests other possible behavioral differences (e.g., prevalence and timing of brood desertion by female parents, rates of inter-year mate retention) between subspecies, but no formal analyses have been conducted.

In 2001, the Canadian Committee on the Status of Endangered Wildlife in Canada recognized *C. m. melodus* and *C. m. circumcinctus* as separate taxa and designated each subspecies as "Endangered" (Department of Justice Canada 2002). This superseded 1978 and 1985 designations assigned to the entire Canadian population of piping plovers (COSEWIC 2001).

We are not aware of any current publications in the peer-reviewed literature that reject these subspecies. S. M. Haig, first author of a 1988 allozyme study (Haig and Oring 1988a) that failed to detect differences supporting piping plover subspecies, is also a co-author of Miller et al. (2009). Thus, this more recent study employing modern and variable genetic information systems to analyze a substantially larger data set fully supersedes Haig and Oring (1988a).

The subspecies *C. m. melodus* exactly coincides with the geographic coverage of the Atlantic Coast piping plover recovery plan (USFWS 1996), while the Great Lakes plan (USFWS 2003) and the Northern Great Plains plan (USFWS 1988b) pertain to *C. m. circumcinctus*.

2.1.3 Application of the 1996 DPS policy

Section 3 of the ESA defines "species" to include subspecies and "any distinct population segment of any species of vertebrate fish or wildlife *which interbreeds when mature* (emphasis added)." In 1996, the USFWS and the National Marine Fisheries Service published a joint policy guiding the recognition of DPSs of vertebrate species (61 FR 4722). As discussed in section 2.1.2 above, new information supports subspecies designation for *C. m. melodus* and *circumcinctus*. However, because the piping plover is a vertebrate listed prior to 1996, we evaluate evidence for DPSs within these two subspecies (see 61 FR 4724: "The Services maintain that the authority to address DPSs extends to species in which subspecies are recognized …").

The DPS policy specifies three elements to assess whether a population segment under consideration for listing may be recognized as a DPS: (1) the population segment's discreteness from the remainder of the species to which it belongs, (2) the significance of the population segment to the species to which it belongs, and (3) the population segment's conservation status in relation to the ESA's standard for listing (61 FR 4722).

2.1.3.1 Discreteness:

A vertebrate population segment may be considered discrete if it satisfies either of the following two conditions:

1. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.

2. It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the ESA.

We address both of these conditions. First, with respect to marked separation of populations, we consider evidence pertaining to separation within *C. m. circumcinctus* between the Great Lakes and Northern Great Plains populations. This condition is not, however, considered for *C. m. melodus* (i.e., Atlantic Coast piping plovers) because we know of no information indicating marked separation of populations within that subspecies. Second, we evaluate whether the international boundary between the U.S. and Canada delimits populations within which differences are significant in light of ESA section 4(a)(1)(D).

Evaluation of whether the Great Lakes and Northern Great Plains populations are markedly separated

The discreteness of the Great Lakes and Northern Great Plains (including the Canadian Great Plains, also referenced in piping plover literature as "Prairie Canada") is evaluated with respect to genetic information, breeding fidelity and dispersal evidenced from banding studies, wintering distribution, and habitat.

Genetic information – As noted in section 2.1.2, Miller et al. (2009) found that piping plovers breeding in the Great Lakes were genetically allied with other interior populations. While genetic distinctness can inform our analysis of discreteness of a population, such evidence is not required to recognize a DPS. As noted with respect to snowy plovers (*Charadrius alexandrinus*), "Only a few dispersers per generation are necessary to homogenize gene pools between breeding habitats (Wright 1931; Slatkin 1985, 1987; Mills and Allendorf 1986) … Although a few individuals are sufficient to prevent genetic differentiation among populations, a few individuals are not sufficient to maintain demographic connectivity" (Funk et al. 2007). Haig et al. (2006) also cautioned that, "Recent work emphasizes that adaptive divergence can take place despite gene flow (Wu 2001; Beaumont & Balding 2004). It is, therefore, important to use multiple sources of information when evaluating a taxon's status including tools that address the questions of reproductive isolation, adaptive divergence, and spatial patterns of local adaptation (Crandall et al. 2001; Fraser & Bernatchez 2001)."

Currently available genetic information does not provide evidence that Great Lakes and Northern Great Plains piping plovers are genetically discrete. As outlined above, however, it is important to consider other potential evidence that Great Lakes and Northern Great Plains piping plovers may be "markedly separated", therefore meeting the discreteness criterion of the DPS policy.

Breeding fidelity and dispersal evidence from banding studies – Banding and monitoring studies are useful methods for evaluating the discreteness of two populations, provided that the banding effort adequately samples each population and that the monitoring effort is sufficient to provide reasonable probabilities of detecting banded individuals. Between 1982 and 2007, 530 Great Lakes and 5,420 Northern Great Plains piping plovers were marked with band combinations identifiable to study area (see Table 1). Although most of these banding studies were designed for other purposes, they nonetheless provide useful information for this analysis.

None of the >5,000 Northern Great Plains piping plovers banded between 1982 and 2007 has been reported breeding in the Great Lakes (E. Roche and F. Cuthbert, University of Minnesota, pers. comm. 2008)[1]. Likewise, no Great Lakes piping plovers have been detected breeding on the Northern Great Plains, although two birds carrying identifiable Great Lakes brood markers have been reported at Lake of the Woods, Minnesota, during the spring migration (since these birds were not uniquely marked, their subsequent recruitment into the Great Lakes population cannot be positively confirmed).

The absence of observed exchanges is particularly significant in the context of very intensive sustained monitoring, especially on the Great Lakes. Roche et al. (2008) reported a 96% probability of detecting a banded adult breeding in the Great Lakes. Thus, the chance that a dispersing bird banded on the Northern Great Plains would be missed in the Great Lakes is extremely low. Furthermore, 94% of adults breeding on the Great Lakes as of 2007 were banded (E. Roche pers. comm. *in* LeDee 2008), as were more than 95% of chicks surviving to fledging, 2003-2007 (E. Roche pers. comm. 2009). Although annual survey coverage on the Northern Great Plains is less complete, it is striking that no piping plovers banded in the Great Lakes have been observed. Three comprehensive International Piping Plover Censuses have been conducted since the initiation of Great Lakes banding in 1993. Furthermore, the core area of the U.S. alkali lakes, as well as the Missouri River and most rivers and reservoirs in Nebraska, have been surveyed annually since at least 1994 (C. Aron, USFWS, pers. comm. 2009). In Manitoba, piping plovers have been counted annually since 1986, including complete coverage of all known occupied habitat in 2006-2008 (J.P. Goossen, CWS, pers. comm. 2009). Intensive searches were conducted in conjunction with a large scale banding study in Saskatchewan, 2002-2008 (C. Gratto-Trevor, Environment Canada, pers. comm. 2008).

The large number of banded hatch-year birds (436 and 3,826 from the Great Lakes and Northern Great Plains, respectively) is also an important consideration, because their dispersal rates and distances from natal sites are much higher than inter-year movements of

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[1] A Manitoba piping plover observed on Lake Erie in August, 1986 (Haig and Oring 1988b) was later determined to be a migrant (J. Dingledine, USFWS, pers. comm. 2009).

breeding adults (unpubl. data from Massachusetts and Saskatchewan, summarized in Cohen 2009). E. Roche and F. Cuthbert (pers. comm. 2008) report mean dispersal from natal sites of 94 km and 88 km for females (n = 79, range = 0.1 to 459) and males (n = 86, range = 0 to 432), respectively. Thus, notwithstanding their lower annual survival rates, the likelihood of chicks moving to another population in a subsequent breeding season is expected to be higher than between-year exchanges by adults. Absence of observed exchanges among this large sample of hatch-year birds bolsters our assessment of marked separation between Great Lakes and Northern Great Plains piping plovers.

Although no interchange of Great Lakes and Northern Great Plains piping plovers banded as either adults or chicks has been observed, it is noteworthy that studies report relatively high numbers of movements within each of the two areas. In addition to natal dispersal discussed above, E. Roche and F. Cuthbert (pers. comm. 2008) have documented inter-year movements for 547 adults with an upper range of 384 km within the Great Lakes. C. Gratto-Trevor (pers. comm. 2008) reported five adults and two chicks marked in Saskatchewan later found breeding on the U.S. Great Plains, plus two chicks found in Alberta. Four chicks banded during other studies in Saskatchewan in 1997-2005 have been reported breeding in North Dakota, Nebraska, and Colorado (J.P. Goossen pers. comm. 2009). D. Catlin (Virginia Polytechnic Institute and State University, pers. comm. 2008) reported a chick fledged from his Missouri River study area breeding at Lake of the Woods, Minnesota, the following year. Observations of movements within the Great Lakes and Northern Great Plains breeders contrasts with absence of between-population exchanges, but we do not completely dismiss the possibility that some low rate of undetected movement is occurring.

Very rare (perhaps completely absent) reproductive interchange between the Great Lakes and the Northern Great Plains populations constitutes a marked separation of breeding ranges, albeit insufficient or too recent to result in substantial genetic differences demonstrated by available studies. The DPS policy does not require complete reproductive isolation, and it allows for some limited interchange among population segments considered to be discrete (61 FR 4722). Absence or a very low rate of interchange of banded Northern Great Plains and Great Lakes piping plovers provides evidence of a marked separation due to breeding behavior.

Wintering distribution – Pronounced differences in wintering distribution provide a second line of evidence of behavioral divergence between Great Lakes and Northern Great Plains piping plovers. Although no exclusive partitioning of the wintering range was observed, Gratto-Trevor et al. (2009) found strong differences in distribution of piping plovers from four breeding areas (see Figure WM1 in section WM 2.2.1.1). Seventy-five percent of Great Lakes breeders were found along the Atlantic Coast from North Carolina to the Florida Keys (also used by 77% of eastern Canada breeders), compared to only 7% of breeders from the U.S. Northern Great Plains and 4% from Prairie Canada (C. Gratto-Trevor pers. comm. 2009, regarding data supporting Figure 1 in Gratto-Trevor et al. 2009). By contrast, the Mississippi, Louisiana, and Texas coast harbored 71% of observed birds from the U.S. Northern Great Plains and 88% of those from Prairie Canada, but only 2% of Great Lakes breeders. Since parents and offspring winter at sites distant from each other (Stucker and Cuthbert 2006), it is extremely unlikely that this is a learned difference. Marked differences in concentration across their wintering range, which is 800-2,000 miles (1,300-3,200 km) from interior breeding areas, constitute an important behavioral difference distinguishing Great Lakes and Northern Great Plains breeding populations.

Breeding habitat – Although they may be less pronounced than those between the subspecies (see section 2.1.2), differences in habitat also separate Great Lakes and Northern Great Plains breeding populations. These differences are illustrated by the primary constituent elements defined in the critical habitat designations for the two populations. Primary constituent elements for both *C. m. circumcinctus* populations include sparsely vegetated beaches; however, those for the Great Lakes place a much greater emphasis on sandy substrates associated with wide, unforested systems of dunes and inter-dune wetlands (66 FR 22960). Similarly, Wemmer (2000) and Price (2002) found Great Lakes breeding sites to be largely restricted to Great Lakes shoreline areas, which are separated from nearby forest by wide expanses of unforested dune habitat. These freshwater dune complexes are unique to the Great Lakes basin, and they harbor many endemic species. Although other large inland lakes, rivers, and reservoirs are found within the Great Lakes area, no piping plover breeding sites have been documented in these habitat types.

In contrast, primary constituent elements described for the Northern Great Plains population reveal an affinity for more gravelly substrates along alkali lakes, rivers, reservoirs, and inland lakes, with a notable absence of dune systems (67 FR 57680). Despite the variety of Northern Great Plains habitats, observations show banded birds moving among them but not to or from the Great Lakes. Thus, habitat differences constitute an ecological factor that markedly separates Great Lakes and Northern Great Plains piping plovers.

Summary – Behavioral and ecological factors provide evidence of marked separation of Great Lakes and Northern Great Plains piping plover populations within *C. m. circumcinctus*. Extensive banding studies demonstrate that the two populations segregate geographically during breeding. Notwithstanding lack of substantial genetic differences, exchanges have not been detected in more than 25 years of banding and intensive monitoring – if exchanges are occurring, they are extremely rare. Marked differences in wintering distribution and habitat differences provide further evidence that the Great Lakes and Northern Great Plains breeding populations are discrete. We know of no evidence of marked separation of populations within *C. m. melodus*.

Evaluation of differences delimited by the international boundary between the U.S. and Canada

The ESA listing of the piping plover includes, without distinction, populations breeding in both the U.S. and Canada. As discussed in section 2.1.2, both subspecies span the international boundary. Exchanges of banded piping plovers within each population have also crossed the international boundary (albeit at very low rates on the Atlantic Coast). Regardless of biological connections, however, the DPS policy allows for identification of discrete population segments delimited by international boundaries if there are important differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms (61 FR 4722).

Piping plovers in both the U.S. and Canada are currently protected under national legislation for the protection of imperiled species[1]. Listing under the Canadian Species at Risk Act (SARA) confers parallel conservation status and protection from exploitation to that of the ESA. These include prohibitions and penalties for killing, harming, or harassing species listed under SARA (Environment Canada 2003). Listing under SARA triggers preparation of a recovery strategy, measures to reduce and monitor impacts of projects requiring environmental assessments, and protection of critical habitat. Furthermore, U.S. and Canadian piping plovers from the Atlantic Coast, Northern Great Plains, and Great Lakes spend seven to nine months of the annual cycle in shared migration and wintering habitats, where they are exposed to the same threats and regulatory mechanisms, including those provided by the ESA in the U.S. portion of their nonbreeding range.

The Canadian Wildlife Service's recovery strategy for *C. m. circumcinctus* (Environment Canada 2006) identifies primary threats (i.e., predation, habitat loss or degradation, livestock grazing, human disturbance, and threats on the wintering grounds) identical to those in the U.S. plan for the Northern Great Plains (USFWS 1988b). Likewise, major threats to piping plovers in eastern Canada and the U.S. Atlantic Coast are habitat loss, predation, and human disturbance (USFWS 1996, Environment Canada 2008). U.S. and Canadian piping plover biologists maintain frequent communication and employ similar management strategies. The per-pair effort devoted to protection of breeding piping plovers in eastern Canada in 2002 and 2003 was at least as great as in the U.S. Atlantic Coast range (Hecht and Melvin 2009).

Summary – We find many similarities and discern no noteworthy differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms of piping plovers in the U.S. and Canada that are significant in light of section 4(a)(1)(D) of the ESA. Therefore, we conclude that the international boundary does not delimit discrete piping plover population segments within *C. m. melodus* or *C. m. circumcinctus*.

2.1.3.2 Significance:

Under the DPS policy (61 FR 4722), if a population segment is discrete, we consider its biological and ecological significance to the larger taxon to which it belongs. This consideration may include, but is not limited to, the following factors:

1. Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon,

2. Evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon,

[1] Unlike discreteness criterion 1 of the DPS policy (which considers characteristics intrinsic to a population segment), evaluation of discreteness based on an international boundary considers adequacy of regulations and other factors (such as conservation status and habitat management) that may change over time. When contemplating near-term delisting of a species, it is appropriate to evaluate the adequacy of regulatory mechanisms to sustain the segments on each side of an international boundary after the posited delisting. However, the many commonalities in piping plover threats and dependence on management, described in this document, are likely to dominate future conservation needs of *C. m. melodus* and *C. m. circumcinctus* in both the U.S. and Canada.

3. Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or

4. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

Having found evidence that the Great Lakes and Northern Great Plains populations of *C. m. circumcinctus* are discrete, we consider whether each is significant to the subspecies as a whole. In particular, we evaluate evidence that loss of the Great Lakes or Northern Great Plains population would result in a significant gap in the range of the taxon. We also examine evidence that the Great Lakes population persists in an ecological setting that is unique for *C. m. circumcinctus*.

Evaluation of population loss resulting in a significant gap in the range of the taxon

Northern Great Plains piping plovers currently breed in eight states and three Canadian provinces (Elliott-Smith et al. 2009). Their range extends about 1,000 miles (1,600 km) from north to south and spans more than 800 miles (1,300 km) from west to east. There is no estimate of the historical population or carrying capacity of Northern Great Plains habitat, but the significance of the population is evident from the 2006 estimate that it constituted 98% of *C. m. circumcinctus* (Elliott-Smith et al. 2009).

Although its current range is much reduced, the Great Lakes population once spanned about 800 miles (1,300 km) from east to west, inhabiting eight states and the Province of Ontario and breeding on all five Great Lakes. Russell (1983) estimated a total population of 492-682 breeding pairs in the Great Lakes region in the late 1800s. Bull (1974) reported 26 pairs at the eastern end of Lake Ontario, New York, in 1935. At the other extreme end of the Great Lakes, small numbers of pairs nested in Duluth Harbor, Minnesota, as recently as the early 1980s (B. Eliason, Minnesota Dept. of Natural Resources, pers. comm. 1999 *in* USFWS 2003). Some biologists believe that Russell's estimates may be high (S. Matteson, Wisconsin Dept. of Natural Resources, pers. comm. 1988 *in* USFWS 2003), but it is evident that the range of the Great Lakes population was significant. Furthermore, critical habitat for the Great Lakes piping plover population encompasses the full geographic extent of this population's U.S. historic range, from Minnesota to New York (USFWS 2001a).

Twenty years of banding observations also show that neither the Northern Great Plains nor the Great Lakes population would recolonize the other if one was lost. The absence of immigration to abundant vacant habitat in the Great Lakes over more than 25 years is particularly striking. Both the Northern Great Plains and the Great Lakes constitute a significant part of the range of *C. m. circumcinctus*, and loss of either would result in a significant retraction in the range of the subspecies; for example, loss of the Great Lakes population could potentially contract the range of *C. m. circumcinctus* by over 800 miles (1,300 km).

Evaluation of the persistence of the population in a unique ecological setting

The freshwater dune system of the Great Lakes constitutes a unique ecological setting. Many Great Lakes piping plover breeding sites are found in association with several endemic and rare dune features (USFWS 2003). Wemmer (2000), in her analysis of piping plovers and the implications for coastal biodiversity conservation, found that piping plover habitat in Northern Michigan contained five times as many rare elements as randomly selected shoreline areas. This includes two other federally listed species: Pitcher's thistle (*Cirsium pitcheri*) and Houghton's goldenrod (*Solidago houghtonii*). The Great Lakes freshwater sand dunes, which are among the most extensive on earth, support more endemic species than any other habitat within the Great Lakes basin.

This setting is also unique for *C. m. circumcinctus*. Piping plovers in the Northern Great Plains population inhabit unvegetated shorelines of alkali lakes, reservoirs, or river sandbars, landscape types not utilized by piping plovers in the Great Lakes. Continued occupation of the unique ecological setting of the Great Lakes may be important to the long-term viability of the subspecies. Conserving populations found within distinct ecological settings increases the probability of preserving adaptive traits that may prove important for the long-term survival of the entire taxon. Further analysis, including the results of ongoing genetic research, may further substantiate the uniqueness of piping plovers found within the Great Lakes basin and their concomitant value to the diversity of the interior subspecies.

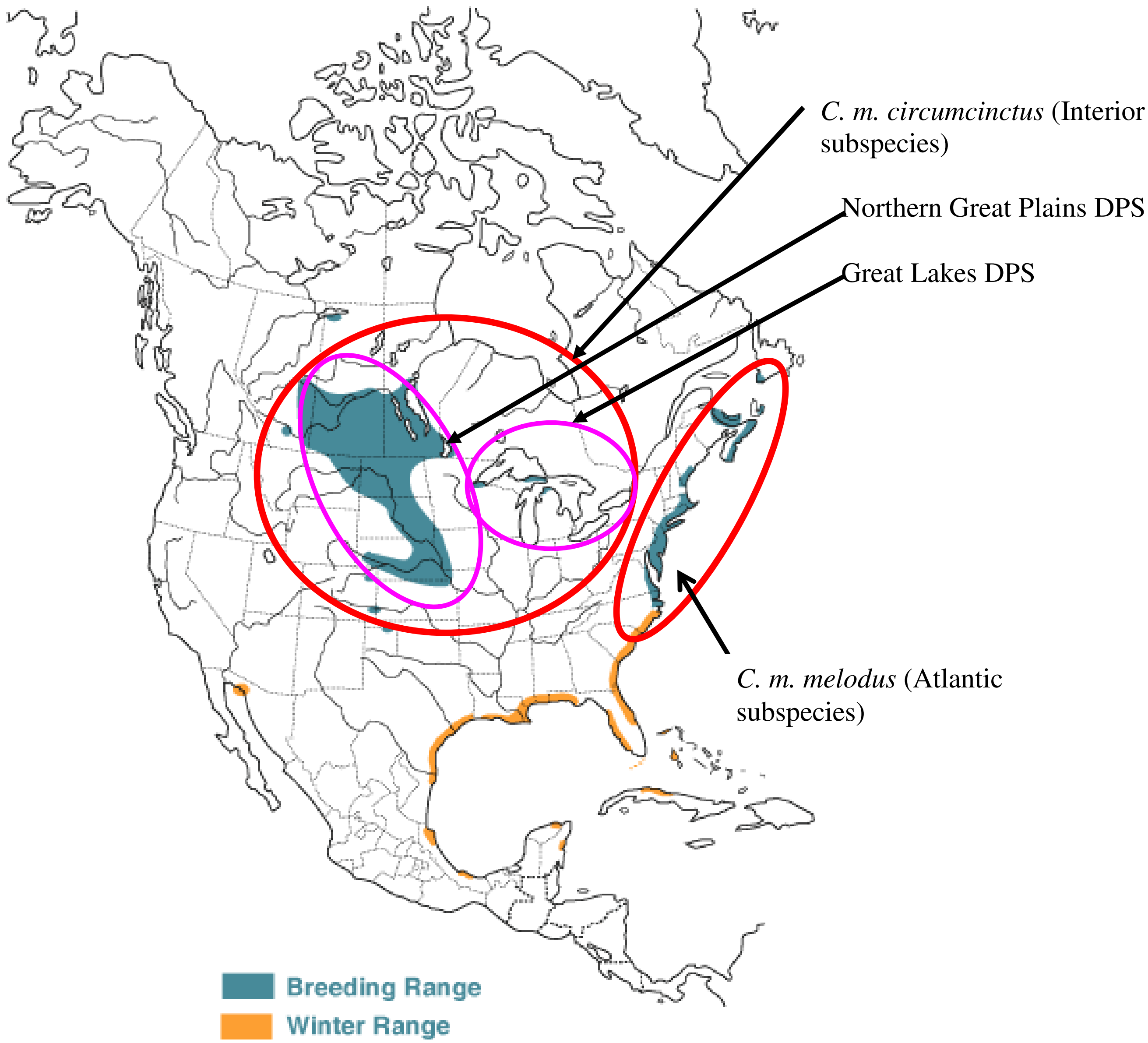
Piping plovers in the Great Lakes have demonstrated a high degree of fidelity to this ecological setting, with little to no dispersal into breeding ranges of other populations, as discussed in section 2.1.3.1 above. Great Lakes plovers also concentrate in different wintering areas than those from the Northern Great Plains. The underlying basis of the segregation demonstrated by the Great Lakes population is not well understood, but it may be reflective of traits unique to the population and its ecological setting. Continued conservation of Great Lakes piping plovers and their habitat may also be valuable in preserving evolutionary processes beneficial to the subspecies.

***Summary* –** The Great Lakes and Northern Great Plains populations are each biologically significant to *C. m. circumcinctus*, because the loss of either would result in a significant gap (contraction) in the range. The Great Lakes population also persists in an ecological setting that is unique for *C. m circumcintus*. Each discrete population segment satisfies the significance criterion of the DPS policy.

2.1.4 Conclusions regarding taxonomic classification and DPS analysis

The best available scientific information supports recognition of three separate entities consistent with the ESA definition of "species" (Figure 1). Piping plovers that breed on the Atlantic Coast of the U.S. and Canada belong to the subspecies *C. m. melodus*. The second subspecies, *C. m. circumcinctus,* comprises two DPSs. One DPS breeds on the Northern Great Plains of the U.S. and Canada, while the other breeds on the Great Lakes. Each of these three entities is demographically independent. Furthermore, the conservation status of each of the three entities reflects factors affecting it throughout its entire life cycle. Although

Figure 1. Distribution and range[1] of *C. m. melodus*, Great Lakes DPS of *C. m. circumcinctus*, Northern Great Plains DPS of *C. m. circumcinctus* (base map from Elliott-Smith and Haig 2004 by permission of Birds of North America Online, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology).



[1] Conceptual presentation of subspecies and DPS ranges, not intended to convey precise boundaries.

clarification of the listing would require revision of CFR 17.11, it is important in the meantime that recovery planning and implementation continue to respect the biological integrity of each entity.

Subsequent sections of this status review evaluate progress towards recovery criteria for Atlantic Coast, Northern Great Plains, and Great Lakes piping plovers provided in their respective recovery plans. New information about biology, habitat, and threats is also assessed for each population. For purposes of conciseness, new information regarding biology, habitat, and threats in their migration and wintering ranges is presented in a single section, but the Synthesis section for each population (i.e., sections GL 2.3.4, NGP 2.4.4, and AC 2.5.4) evaluates the implications of factors affecting the migration/wintering portion of the annual cycle within the context of the overall status of each population.

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WM 2.2 UPDATED INFORMATION AND CURRENT SPECIES STATUS FOR THE WINTERING AND MIGRATION RANGE

Piping plover subspecies are phenotypically indistinguishable, and most studies in the nonbreeding range, i.e, wintering and migration range, report results without regard to breeding origin. Although a recent analysis shows strong patterns in the wintering distribution of piping plovers from different breeding populations, partitioning is not complete and major information gaps persist (see section WM 2.2.1.3 below). Therefore, new information summarized here pertains to the species as a whole (i.e., all three breeding populations delineated in section 2.1), except where a particular breeding population is specified.

WM 2.2.1 Biology and habitat

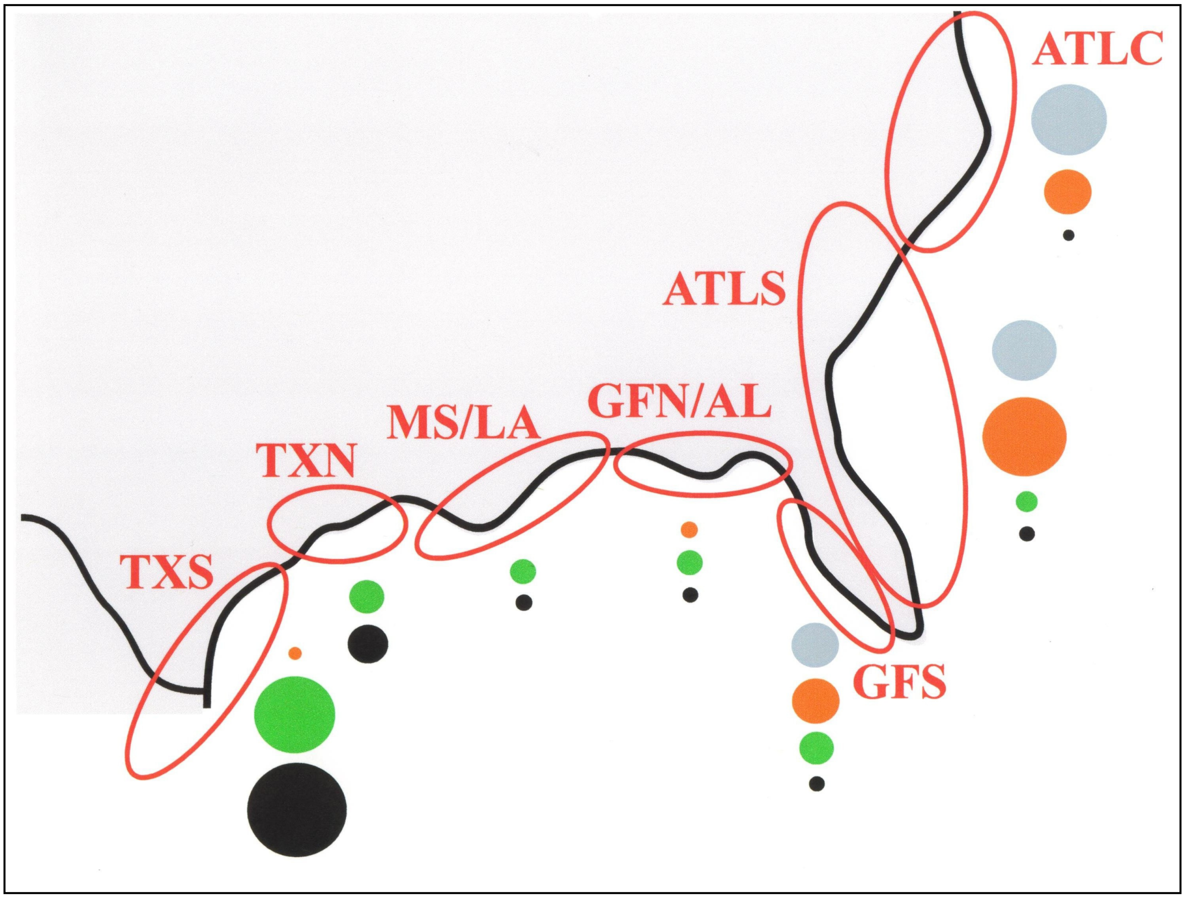
A large body of information regarding the biology, habitat, and status of wintering and migrating piping plovers has become available since publication of the 1985 final rule, the 1988 Northern Great Plains recovery plan, and the 1991 five-year review. Much of this information was incorporated into the 1996 revised Atlantic Coast and 2003 Great Lakes recovery plans. Here, we summarize recent information pertinent to the nonbreeding portion of the annual cycle, emphasizing studies and reports that have become available since 2003, with brief references to a few earlier studies.

WM 2.2.1.1 Life history:

New information confirms inter- and intra-annual fidelity of piping plovers to migration and wintering sites as described in the 1996 Atlantic Coast and 2003 Great Lakes recovery plans. Gratto-Trevor et al. (2009) reported that six of 259 banded piping plovers observed more than once per winter moved across boundaries of seven continental U.S. regions (subdivisions of the migration and wintering range as depicted in Figure WM1). Of 216 birds observed in different years, only eight changed regions between years, and several of these shifts were associated with late summer or early spring migration periods (Gratto-Trevor et al. 2009). Local movements are more common. In South Carolina, Maddock et al. (2009) documented many cross-inlet movements by wintering banded piping plovers as well as occasional movements of up to 18 km by approximately 10% of the banded population; larger movements within South Carolina were seen during fall and spring migration. Similarly, eight banded piping plovers that were observed in two locations during 2006-2007 surveys in Louisiana and Texas were all in close proximity to their original location, such as on the bay and ocean side of the same island or on adjoining islands (Maddock 2008).

The mean home range size (95% of locations) for 49 radio-marked piping plovers in southern Texas in 1997-1998 was 12.6 km^2, the mean core area (50% of locations) was 2.9 km^2, and the mean linear distance moved between successive locations (1.97 $\pm$ 0.04 days apart), averaged across seasons, was 3.3 km (Drake et al. 2001). Seven radio-tagged piping plovers used a 20.1 km^2 area (100% minimum convex polygon) at Oregon Inlet,

Figure WM1. Breeding population distribution in the wintering/migration range. From Gratto-Trevor et al. 2009, reproduced by permission.



Regions: ATLC = Atlantic (eastern) Canada, GFS = Gulf Coast of southern Florida, GFN/AL = Gulf Coast of north Florida and Alabama, MS/LA = Mississippi and Louisiana, TXN = northern Texas, and TXS = southern Texas.

For each breeding population, circles represent the percentage of individuals reported wintering along the eastern coast of the U.S. from the central Atlantic to southern Texas/Mexico up to December 2008. Each individual was counted only once. Grey circles represent eastern Canada birds, orange represent U.S. Great Lakes, green represent U.S. Great Plains, and black represent Prairie Canada. The relative size of each circle represents the percentage from a specific breeding area seen in that winter region. Total number of individuals observed on the wintering grounds was 46 for Eastern Canada, 150 for the U.S. Great Lakes, 169 for the U.S. Great Plains, and 356 for Prairie Canada.

North Carolina, in 2005-2006, and piping plover activity was concentrated in 12 areas totaling 2.2 km^2 (Cohen et al. 2008). Noel and Chandler (2008) observed high fidelity of banded piping plovers to 1 km - 4.5 km sections of beach on Little St. Simons Island, Georgia.

WM 2.2.1.2 Survival:

The most consistent finding in the various population viability analyses (PVAs) conducted for piping plovers (Ryan et al. 1993, Melvin and Gibbs 1996, Plissner and Haig 2000, Wemmer et al. 2001, Larson et al. 2002, Calvert et al. 2006, Brault 2007) is the sensitivity of extinction risk to even small declines in adult and/or juvenile survival rates.

Efforts to partition survival within the annual cycle are beginning to receive more attention, but current information remains limited. Drake et al. (2001) observed no mortality among 49 radio-marked piping plovers (total of 2,704 transmitter days) in Texas in 2007-2008. Cohen et al. (2008) documented no mortality of radio-tracked wintering piping plovers at Oregon Inlet in 2005-2006, but this was based on only seven individuals. Analysis of South Carolina resighting data for 87 banded piping plovers (78% Great Lakes breeders) in 2006-2007 and 2007-2008 found 100% survival from December to April[1] (J. Cohen, Virginia Polytechnic Institute and State University, pers. comm. 2009). Noel et al. (2007) inferred two winter (November to February) mortalities[2] among 21 banded (but not radio-tagged) overwintering piping plovers in 2003-2004 and nine mortalities among 19 overwintering birds during the winter of 2004-2005 at Little St. Simons Island, Georgia. LeDee (2008) found higher apparent survival[3] rates during breeding and southward migration than during winter and northward migration for 150 adult (i.e., after-hatch year) Great Lakes piping plovers.

Mark-recapture analysis of resightings of uniquely banded piping plovers from seven breeding areas by Roche et al. (2009) found that apparent adult survival declined in four populations and increased in none over the life of the studies[4]. Some evidence of correlation in year-to-year fluctuations in annual survival of Great Lakes and eastern Canada populations, both of which winter primarily along the southeastern U.S. Atlantic

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[1] However, of those birds, one unique and one non-uniquely banded piping plover were seen in the first winter and were resighted multiple times in the second fall at the same location but were not seen during the second winter; whether these two birds died in the fall or shifted their wintering location is unknown (Maddock et al. 2009).

[2] Noel et al. (2007) inferred mortality if a uniquely banded piping plover with multiple November to February sightings on the survey site disappeared during that time and was never observed again in either its nonbreeding or breeding range. Note that most of these birds were from the Great Lakes breeding population, where detectability during the breeding season is very high.

[3] "Apparent survival" does not account for permanent emigration. If marked individuals leave a survey site, apparent survival rates will be lower than true survival. If a survey area is sufficiently large, such that emigration out of the site is unlikely, apparent survival will approach true survival.

[4] Data were analyzed for 3-11 years per breeding area, all between 1998 and 2008.

Coast, suggests that shared over-wintering and/or migration habitats may influence annual variation in survival. Further concurrent mark-resighting analysis of color-banded individuals across piping plover breeding populations has the potential to shed light on threats that affect survival in the migration and wintering range.

WM 2.2.1.3 Spatial and temporal distribution:

Except at inland sites, piping plover migration routes and habitats overlap breeding and wintering habitats, and, unless banded, migrants passing through a site usually are indistinguishable from breeding or wintering piping plovers.

Little new information about migration through the Atlantic Coast breeding range has become available since 1996. Migration stopovers by banded piping plovers from the Great Lakes have been documented in New Jersey, Maryland, Virginia, and North Carolina (Stucker and Cuthbert 2006). Migrating breeders from eastern Canada have been observed in Massachusetts, New Jersey, New York, and North Carolina (Amirault et al. 2005). As many as 85 staging piping plovers have been tallied at various sites in the Atlantic breeding range (S. Perkins, Massachusetts Audubon Society, pers. comm. 2008), but the composition (e.g., adults that nested nearby and their fledged young of the year versus migrants moving to or from sites farther north), stopover duration, and local movements are unknown. In general, distance between stopover locations and duration of stopovers throughout the coastal migration range remain poorly understood.

Review of published records of piping plover sightings throughout North America by Pompei and Cuthbert (2004) found more than 3,400 fall and spring stopover records at 1,196 sites. Published reports indicated that piping plovers do not concentrate in large numbers at inland sites and that they seem to stop opportunistically. In most cases, reports of birds at inland sites were single individuals.

Piping plovers migrate through and winter in coastal areas of the U.S. from North Carolina to Texas and in portions of Mexico and the Caribbean. Four rangewide mid-winter (late January to early February) population surveys, conducted at five-year intervals starting in 1991, are summarized in Table WM1. Total numbers have fluctuated over time, with some areas experiencing increases and others decreases. Regional and local fluctuations may reflect the quantity and quality of suitable foraging and roosting habitat, which vary over time in response to natural coastal formation processes as well as anthropogenic habitat changes (e.g., inlet relocation, dredging of shoals and spits). See, for example, discussions of survey number changes in Mississippi, Louisiana, and Texas by Winstead, Baka, and Cobb, respectively, *in* Elliott-Smith et al. (2009). Fluctuations may also represent localized weather conditions (especially wind) during surveys, or unequal survey coverage. For example, airboats facilitated first-time surveys of several central Texas sites in 2006 (Cobb *in* Elliott-Smith et al. 2009). Similarly, the increase in the 2006 numbers in the Bahamas is attributed to greatly increased census efforts; the extent of additional habitat not surveyed remains undetermined (Maddock and Wardle *in* Elliott-Smith et al. 2009). Changes in wintering numbers may also be influenced by growth or decline in the particular breeding populations that concentrate

Table WM1. Results of the 1991, 1996, 2001, and 2006 International Piping Plover Winter Censuses (Haig et al. 2005, Elliott-Smith et al. 2009).

Location	**1991**	**1996**	**2001**	**2006**
Virginia	not surveyed (ns)	ns	ns	1
North Carolina	20	50	87	84
South Carolina	51	78	78	100
Georgia	37	124	111	212
Florida	551	375	416	454
-Atlantic	*70*	*31*	*111*	*133*
-Gulf	*481*	*344*	*305*	*321*
Alabama	12	31	30	29
Mississippi	59	27	18	78
Louisiana	750	398	511	226
Texas	1,904	1,333	1,042	2,090
Puerto Rico	0	0	6	Ns
U.S. Total	**3,384**	**2,416**	**2,299**	**3,355**
Mexico	27	16	Ns	76
Bahamas	29	17	35	417
Cuba	11	66	55	89
Other Caribbean Islands	0	0	0	28
GRAND TOTAL	**3,451**	**2,515**	**2,389**	**3,884**
Percent of Total International Piping Plover Breeding Census	62.9%	42.4%	40.2%	48.2%

their wintering distribution in a given area (see Figure WM1; see also the related discussion below). Major opportunities to locate previously unidentified wintering sites are concentrated in the Caribbean and Mexico (see pertinent sections in Elliott-Smith et al. 2009). Further surveys and assessment of seasonally emergent habitats (e.g., seagrass beds, mudflats, oyster reefs) within bays lying between the mainland and barrier islands in Texas are also needed.

Mid-winter surveys may substantially underestimate the abundance of nonbreeding piping plovers using a site or region during other months. In late September 2007, 104 piping plovers were counted at the south end of Ocracoke Island, North Carolina (NPS 2007), where none were seen during the 2006 International Piping Plover Winter Census (Elliott-Smith et al. 2009). Noel et al. (2007) observed up to 100 piping plovers during peak migration at Little St. Simons Island, Georgia, where approximately 40 piping plovers wintered in 2003–2005. Differences among fall, winter, and spring counts in South Carolina were less pronounced, but inter-year fluctuations (e.g., 108 piping plovers in spring 2007 versus 174 piping plovers in spring 2008) at 28 sites were striking (Maddock et al. 2009). Even as far south as the Florida Panhandle, monthly counts at Phipps Preserve in Franklin County ranged from a mid-winter low of four piping plovers in December 2006 to peak counts of 47 in October 2006 and March 2007 (Smith 2007). Pinkston (2004) observed much heavier use of Texas Gulf Coast (ocean-facing) beaches between early September and mid-October (approximately 16 birds per mile) than during December to March (approximately two birds per mile).

Local movements of nonbreeding piping plovers may also affect abundance estimates. At Deveaux Bank, one of South Carolina's most important piping plover sites, five counts at approximately 10-day intervals between August 27 and October 7, 2006, oscillated from 28 to 14 to 29 to 18 to 26 (Maddock et al. 2009). Noel and Chandler (2008) detected banded Great Lakes piping plovers known to be wintering on their Georgia study site in 73.8 $\pm$ 8.1 % of surveys over three years.

Abundance estimates for nonbreeding piping plovers may also be affected by the number of surveyor visits to the site. Preliminary analysis of detection rates by Maddock et al. (2009) found 87% detection during the mid-winter period on core sites surveyed three times a month during fall and spring and one time per month during winter, compared with 42% detection on sites surveyed three times per year (J. Cohen pers. comm. 2009).

Gratto-Trevor et al. (2009) found strong patterns (but no exclusive partitioning) in winter distribution of uniquely banded piping plovers from four breeding populations (see Figure WM1). All eastern Canada and 94% of Great Lakes birds wintered from North Carolina to southwest Florida. However, eastern Canada birds were more heavily concentrated in North Carolina, and a larger proportion of Great Lakes piping plovers were found in South Carolina and Georgia. Northern Great Plains populations were primarily seen farther west and south, especially on the Texas Gulf Coast. Although the great majority of Prairie Canada individuals were observed in Texas, particularly southern Texas, individuals from the U.S. Great Plains were more widely distributed on the Gulf Coast from Florida to Texas.

The findings of Gratto-Trevor et al. (2009) provide powerful evidence of differences in the wintering distribution of piping plovers from these four breeding areas. However, the distribution of birds by breeding origin during migration remains largely unknown. Other major information gaps include the wintering locations of the U.S. Atlantic Coast breeding population[1] and the breeding origin of piping plovers wintering on Caribbean islands and in much of Mexico.

Banded piping plovers from the Great Lakes, Northern Great Plains, and eastern Canada breeding populations showed similar patterns of seasonal abundance at Little St. Simons Island, Georgia (Noel et al. 2007). However, the number of banded plovers originating from the latter two populations was relatively small at this study area.

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[1] As indicated in Table 1, section 2.1.2, banding of U.S. Atlantic Coast piping plovers has been extremely limited.

WM 2.2.1.4 Habitat use and conditions:

Recent study results in North Carolina, South Carolina, and Florida complement information from earlier investigations in Texas and Alabama (summarized in the 1996 Atlantic Coast and 2003 Great Lakes recovery plans) regarding habitat use patterns of piping plovers in their coastal migration and wintering range. As documented in Gulf Coast studies, nonbreeding piping plovers in North Carolina primarily used sound (bay or bayshore) beaches and sound islands for foraging and ocean beaches for roosting, preening, and being alert (Cohen et al. 2008). The probability of piping plovers being present on the sound islands increased with increasing exposure of the intertidal area (Cohen et al. 2008). Maddock et al. (2009) observed shifts to roosting habitats and behaviors during high-tide periods in South Carolina.

As observed in Texas studies, Lott et al. (2009) identified bay beaches (bay shorelines as opposed to ocean-facing beaches) as the most common landform used by foraging piping plovers in southwest Florida. In northwest Florida, however, Smith (2007) reported landform use by foraging piping plovers about equally divided between Gulf (ocean-facing) and bay beaches. Exposed intertidal areas were the dominant foraging substrate in South Carolina (accounting for 94% of observed foraging piping plovers; Maddock et al. 2009) and in northwest Florida (96% of foraging observations; Smith 2007). In southwest Florida, Lott et al. (2009) found approximately 75% of foraging piping plovers on intertidal substrates.

Several studies identified wrack (organic material including seaweed, seashells, driftwood, and other materials deposited on beaches by tidal action) as an important component of roosting habitat for nonbreeding piping plovers. Lott et al. (2009) found >90% of roosting piping plovers in southwest Florida in old wrack. In South Carolina, 45% of roosting piping plovers were in old wrack, and 18% were in fresh wrack (Maddock et al. 2009). Thirty percent of roosting piping plovers in northwest Florida were observed in wrack substrates (Smith 2007). In Texas, seagrass debris (bayshore wrack) was an important feature of piping plover roost sites (Drake 1999). Mean abundance of two other plover species in California, including the listed western snowy plover (*Charadrius alexandrinus nivosus*), was positively correlated with abundance of wrack during the nonbreeding season (Dugan et al. 2003).

Atlantic Coast and Florida studies highlighted the importance of inlets for nonbreeding piping plovers. Almost 90% of observations of roosting piping plovers at ten coastal sites in southwest Florida were on inlet shorelines (Lott et al. 2009). Piping plovers were among seven shorebird species found more often than expected ($p = 0.0004$; Wilcoxon Scores test) at inlet locations versus non-inlet locations in an evaluation of 361 International Shorebird Survey sites from North Carolina to Florida (Harrington 2008).

Recent geographic analysis of piping plover distribution on the upper Texas coast noted major concentration areas at the mouths of rivers and washover passes (low, sparsely vegetated barrier island habitats created and maintained by temporary, storm-driven water channels) into major bay systems (Arvin 2008). Earlier studies in Texas have drawn attention to washover passes, which are commonly used by piping plovers during periods of high bayshore tides and during the spring migration period (Zonick 1997, Zonick 2000). Cobb (*in* Elliott-Smith et al. 2009) reported piping plover concentrations on exposed seagrass beds and oyster reefs during seasonal low water periods in 2006. These reports indicate the complexity of piping plover habitat use patterns in Texas and demonstrate the need for further studies to reinforce habitat conservation in this important portion of the nonbreeding range.

Several studies highlight concerns about adverse effects of development and coastline stabilization on the quantity and quality of habitat for migrating and wintering piping plovers and other shorebirds. Drake et al. (2001) observed that radio-tagged piping plovers overwintering along the southern Laguna Madre of Texas seldom used tidal flats adjacent to developed areas (five of 1,371 relocations of radio-marked individuals), "suggesting that development and associated anthropogenic disturbances influence piping plover habitat use." Detections of piping plovers during repeated surveys of the upper Texas coast in 2008 were lower in areas with significant beach development (Arvin 2008). Similarly, Lott (2009) found a strong negative correlation between ocean shoreline sand placement projects and presence of piping and snowy plovers in the Panhandle and southwest Gulf Coast regions of Florida. He recommended future research to clarify whether or not this is the result of habitat degradation, which can be directly attributable to sand placement projects, or if the tendency for sand placement projects to occur in areas of high population density, where human disturbance is higher, may limit the distribution of plover species. Harrington (2008) noted the need for a better understanding of potential effects of inlet-related projects, such as jetties, on bird habitats.

The effects of dredge-material deposition also merit further study. Drake et al. (2001) concluded that conversion of southern Texas mainland bayshore tidal flats to dredged material impoundments results in a net loss of habitat for wintering piping plovers, because impoundments eventually convert to upland habitat not used by piping plovers. Zonick et al. (1998) reported that dredged material placement areas along the Intracoastal Waterway in Texas were rarely used by piping plovers, and noted concern that dredge islands block wind-driven water flows, which are critical to maintaining important shorebird habitats. By contrast, most of the sound islands used by foraging piping plovers at Oregon Inlet were created by the U.S. Army Corps of Engineers (USACE) by deposition of dredged material in the subtidal bay bottom, with the most recent deposition ranging from 28 to less than 10 years prior to the study (Cohen et al. 2008).

WM 2.2.2 Five-factor analysis

In the following sections, we provide an analysis of threats to piping plovers in their migration and wintering range. We update information obtained since the 1985 rule, the 1991 status review, and the three recovery plans. Both previously identified and new threats are discussed. With minor exceptions, this analysis is focused on threats to piping plovers within the continental U.S. portion of their migration and wintering range. Threats in the Caribbean and Mexico remain largely unknown.

WM 2.2.2.1 Factor A. Present or threatened destruction, modification, or curtailment of its habitat or range:

The 1985 final rule stated that the number of piping plovers on the Gulf of Mexico coastal wintering grounds may be declining as indicated by preliminary analysis of Christmas Bird Count data. Independent counts of piping plovers on the Alabama coast indicated a decline in numbers between the 1950s and early 1980s. At the time of listing the Texas Parks and Wildlife Department stated that 30% of wintering habitat in Texas had been lost over the previous 20 years. The final rule also stated that in addition to extensive breeding area problems, the loss and modification of wintering habitat was a significant threat to the piping plover.

The three recovery plans stated that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The plans further stated that beach maintenance and nourishment, inlet dredging, and artificial structures, such as jetties and groins, can eliminate wintering areas and alter sedimentation patterns leading to the loss of nearby habitat.

Priority 1 actions in the 1996 Atlantic Coast and 2003 Great Lakes recovery plans identify tasks to protect natural processes that maintain coastal ecosystems and quality wintering piping plover habitat and to protect wintering habitat from shoreline stabilization and navigation projects. The 1988 Northern Great Plains plan states that, as winter habitat is identified, current and potential threats to each site should be determined.

Important components of ecologically sound barrier beach management include perpetuation of natural dynamic coastal formation processes. Structural development along the shoreline or manipulation of natural inlets upsets the dynamic processes and results in habitat loss or degradation (Melvin et al. 1991). Throughout the range of migrating and wintering piping plovers, inlet and shoreline stabilization, inlet dredging, beach maintenance and nourishment activities, and seawall installations continue to constrain natural coastal processes. Dredging of inlets can affect spit formation adjacent to inlets and directly remove or affect ebb and flood tidal shoal formation. Jetties, which stabilize an island, cause island widening and subsequent growth of vegetation on inlet shores. Seawalls restrict natural island movement and exacerbate erosion. As discussed in more detail below, all these efforts result in loss of piping plover habitat. Construction of these projects during months when piping plovers are present also causes disturbance that disrupts the birds' foraging efficiency and hinders their ability to build fat reserves over the winter and in preparation for migration, as well as their recuperation from migratory flights. Additional investigation is needed to determine the extent to which these factors cumulatively affect piping plover survival and how they may impede conservation efforts for the species.

Any assessment of threats to piping plovers from loss and degradation of habitat must recognize that up to 24 shorebird species migrate or winter along the Atlantic Coast and almost 40 species of shorebirds are present during migration and wintering periods in the

Gulf of Mexico region (Helmers 1992). Continual degradation and loss of habitats used by wintering and migrating shorebirds may cause an increase in intra-specific and inter-specific competition for remaining food supplies and roosting habitats. In Florida, for example, approximately 825 miles of coastline and parallel bayside flats (unspecified amount) were present prior to the advent of high human densities and beach hardening projects. We estimate that only about 35% of the Florida coastline continues to support natural coastal formation processes, thereby concentrating foraging and roosting opportunities for all shorebird species and forcing some individuals into suboptimal habitats. Thus, intra- and inter-specific competition most likely exacerbates threats from habitat loss and degradation.

Sand placement projects

In the wake of episodic storm events, managers of lands under public, private, and county ownership often protect coastal structures using emergency storm berms; this is frequently followed by beach nourishment or renourishment activities (nourishment projects are considered “soft” stabilization versus “hard” stabilization such as seawalls). Berm placement and beach nourishment deposit substantial amounts of sand along Gulf of Mexico and Atlantic beaches to protect local property in anticipation of preventing erosion and what otherwise would be considered natural processes of overwash and island migration (Schmitt and Haines 2003).

Past and ongoing stabilization projects fundamentally alter the naturally dynamic coastal processes that create and maintain beach strand and bayside habitats, including those habitat components that piping plovers rely upon. Although impacts may vary depending on a range of factors, stabilization projects may directly degrade or destroy piping plover roosting and foraging habitat in several ways. Front beach habitat may be used to construct an artificial berm that is densely planted in grass, which can directly reduce the availability of roosting habitat. Over time, if the beach narrows due to erosion, additional roosting habitat between the berm and the water can be lost. Berms can also prevent or reduce the natural overwash that creates roosting habitats by converting vegetated areas to open sand areas (see summary of studies documenting importance of bay beach habitats for piping plover foraging, section WM 2.2.1.4). The vegetation growth caused by impeding natural overwash can also reduce the maintenance and creation of bayside intertidal feeding habitats. In addition, stabilization projects may indirectly encourage further development of coastal areas and increase the threat of disturbance (see WM 2.2.2.5).

Lott et al. (2007 in review) documented an increasing trend in sand placement events in Florida (Figure WM2). Approximately 358 miles of 825 miles (43%) of Florida’s sandy beach coastline were nourished from 1959-2006 (Table WM2), with some areas being nourished multiple times. In northwest Florida, the USFWS consulted on first time sand placement projects along 46 miles of shoreline in 2007-2008, much of which occurred on public lands (Gulf Islands National Seashore (USFWS 2007a), portions of St. Joseph State Park (USFWS 2007b), and Eglin Air Force Base (USFWS 2008a)).

Figure WM2. Number of sand placement events in Florida between 1959-2006.

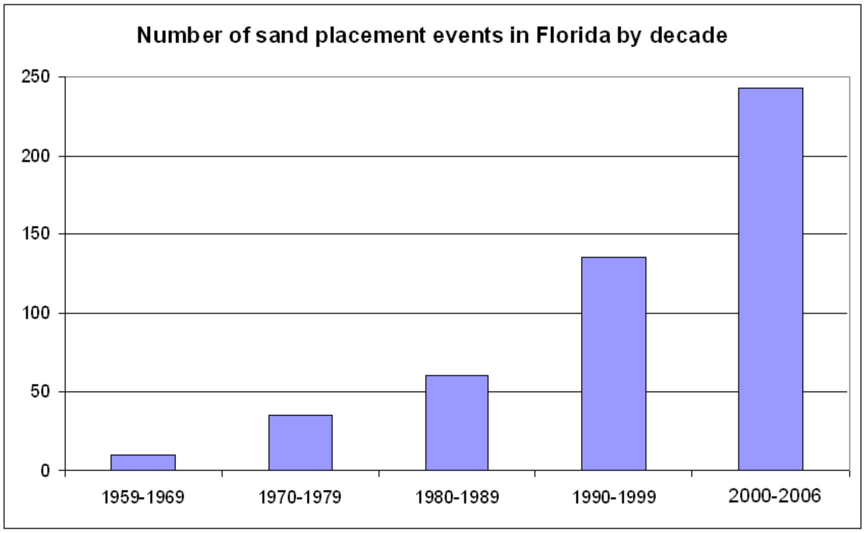

Table WM2. Summary of the extent of nourished beaches in piping plover wintering and migrating habitat within the conterminous U.S. From USFWS unpublished data (project files, gray literature, and field observations).

State	**Sandy beach shoreline miles available**	**Sandy beach shoreline miles nourished to date (within critical habitat units)**	**Percent of sandy beach shoreline affected (within critical habitat units)**
North Carolina	301[1]	117[5] (unknown)	39 (unknown)
South Carolina	187[1]	56 (0.6)	30 (0.003))
Georgia	100[1]	8 (0.4)	8 (0.004)
Florida	825[2]	404 (6)[6]	49 (0.007)
Alabama	53[1]	12 (2)	23 (0.04)
Mississippi	110[3]	≥6 (0)	5 (0)
Louisiana	397[1]	Unquantified (usually restoration-oriented)	Unknown
Texas	367[4]	65 (45)	18 (0.12)
Overall Total	2,340 (does not include Louisiana)	≥668 does not include Louisiana (54 in CH)	29% (≥.02% in CH)

Data from [1]www.50states.com; [2] Clark 1993; [3]N.Winstead, Mississippi Museum of Natural Science, in litt. 2008; [4] www.Surfrider.org; [5] H. Hall, USFWS, pers. comm. 2009; [6] partial data from Lott et al. (2007 in review).

At least 668 of 2,340 coastal shoreline miles (29% of beaches throughout the piping plover winter and migration range in the U.S.) are bermed, nourished, or renourished, generally for recreational purposes and to protect commercial and private infrastructure. In Louisiana, sediment placement projects are deemed environmental restoration projects by the USFWS, because without the sediment, many areas would erode below sea level.

Inlet stabilization/relocation

Many navigable mainland or barrier island tidal inlets along the Atlantic and Gulf of Mexico coasts are stabilized with jetties, groins, or by seawalls and/or adjacent industrial or residential development (see section WM 2.2.1.4 summary of studies documenting piping plover reliance on inlet habitats). Jetties are structures built perpendicular to the shoreline that extend through the entire nearshore zone and past the breaker zone (Hayes and Michel 2008) to prevent or decrease sand deposition in the channel. Inlet stabilization with rock jetties and associated channel dredging for navigation alter the dynamics of longshore sediment transport and affect the location and movement rate of barrier islands (Camfield and Holmes 1995), typically causing downdrift erosion. Sediment is then dredged and added back to islands which subsequently widen. Once the island becomes stabilized, vegetation encroaches on the bayside habitat, thereby diminishing and eventually destroying its value to piping plovers. Accelerated erosion may compound future habitat loss, depending on the degree of sea-level rise. Unstabilized inlets naturally migrate, re-forming important habitat components, whereas jetties often trap sand and cause significant erosion of the downdrift shoreline. These combined actions affect the availability of piping plover habitat (Cohen et al. 2008).

Using Google Earth© (accessed April 2009), USFWS biologists visually estimated the number of navigable mainland or barrier island tidal inlets throughout the wintering range of the piping plover in the conterminous U.S. that have some form of hardened structure. This includes seawalls or adjacent development, which lock the inlets in place (Table WM3).

Table WM3. Number of hardened inlets by state. Asterisk (*) represents an inlet at the state line, in which case half an inlet is counted in each state.

State	**Visually estimated number of navigable mainland and barrier island inlets per state**	**Number of hardened inlets**	**% of inlets affected**
North Carolina	20	2.5*	12.5%
South Carolina	34	3.5*	10.3%
Georgia	26	2	7.7%
Florida	82	41	50%
Alabama	14	6	42.9%
Mississippi	16	7	43.8%
Louisiana	40	9	22.5%
Texas	17	10	58.8%
Overall Total	249	81	32.5%

Tidal inlet relocation can cause loss and/or degradation of piping plover habitat; although less permanent than construction of hard structures, effects can persist for years. For example, a project on Kiawah Island, South Carolina, degraded one of the most important piping plover habitats in the State by reducing the size and physical characteristics of an active foraging site, changing the composition of the benthic community, decreasing the tidal lag in an adjacent tidal lagoon, and decreasing the exposure time of the associated sandflats (USFWS and Town of Kiawah Island unpubl. data). In 2006, pre-project piping plover numbers in the project area recorded during four surveys conducted at low tide averaged 13.5 piping plovers. This contrasts with a post-project average of 7.1 plovers during eight surveys (four in 2007 and four in 2008) conducted during the same months (USFWS and Town of Kiawah Island unpubl. data). USFWS biologists are aware of at least seven inlet relocation projects (two in North Carolina, three in South Carolina, two in Florida), but this number likely under-represents the extent of this activity.

Sand mining/dredging

Sand mining, the practice of extracting (dredging) sand from sand bars, shoals, and inlets in the nearshore zone, is a less expensive source of sand than obtaining sand from offshore shoals for beach nourishment. Sand bars and shoals are sand sources that move onshore over time and act as natural breakwaters. Inlet dredging reduces the formation of exposed ebb and flood tidal shoals considered to be primary or optimal piping plover roosting and foraging habitat. Removing these sand sources can alter depth contours and change wave refraction as well as cause localized erosion (Hayes and Michel 2008). Exposed shoals and sandbars are also valuable to piping plovers, as they tend to receive less human recreational use (because they are only accessible by boat) and therefore provide relatively less disturbed habitats for birds. We do not have a good estimate of the amount of sand mining that occurs across the piping plover wintering range, nor do we have a good estimate of the number of inlet dredging projects that occur. This number is likely greater than the number of total jettied inlets shown in Table WM3, since most jettied inlets need maintenance dredging, but non-hardened inlets are often dredged as well.

***Groin*s**

Groins (structures made of concrete, rip rap, wood, or metal built perpendicular to the beach in order to trap sand) are typically found on developed beaches with severe erosion. Although groins can be individual structures, they are often clustered along the shoreline. Groins act as barriers to longshore sand transport and cause downdrift erosion, which prevents piping plover habitat creation by limiting sediment deposition and accretion (Hayes and Michel 2008). These structures are found throughout the southeastern Atlantic Coast, and although most were in place prior to the piping plover's 1986 ESA listing, installation of new groins continues to occur. Table WM4 tallies recent groin installation projects in wintering and migration habitat, as estimated by USFWS biologists.

Table WM4. Number of recent groin installation projects in two states, as reported by USFWS staff.

State	Timeframe	# Projects
South Carolina	2006–2009	1
Florida	2000–2009	11

Seawalls and revetments

Seawalls and revetments are vertical hard structures built parallel to the beach in front of buildings, roads, and other facilities to protect them from erosion. However, these structures often accelerate erosion by causing scouring in front of and downdrift from the structure (Hayes and Michel 2008), which can eliminate intertidal foraging habitat and adjacent roosting habitat. Physical characteristics that determine microhabitats and biological communities can be altered after installation of a seawall or revetment, thereby depleting or changing composition of benthic communities that serve as the prey base for piping plovers. At four California study sites, each comprised of an unarmored segment and a segment seaward of a seawall, Dugan and Hubbard (2006) found that armored segments had narrower intertidal zones, smaller standing crops of macrophyte wrack, and lower shorebird abundance and species richness. Geotubes (long cylindrical bags made of high-strength permeable fabric and filled with sand) are softer alternatives, but act as barriers by preventing overwash. We did not find any sources that summarize the linear extent of seawall, revetment, and geotube installation projects that have occurred across the piping plover's wintering and migration habitat. Table WM8 in section WM 2.2.2.5 summarizes the number of piping plover survey sites with at least some shoreline armoring.

Exotic/invasive vegetation

A recently identified threat to piping plover habitat, not described in the listing rule or recovery plans, is the spread of coastal invasive plants into suitable piping plover habitat. Like most invasive species, coastal exotic plants reproduce and spread quickly and exhibit dense growth habits, often outcompeting native plant species. If left uncontrolled, invasive plants cause a habitat shift from open or sparsely vegetated sand to dense vegetation, resulting in the loss or degradation of piping plover roosting habitat, which is especially important during high tides and migration periods.

Beach vitex (*Vitex rotundifolia*) is a woody vine introduced into the southeastern U.S. as a dune stabilization and ornamental plant (Westbrooks and Madsen 2006). It currently occupies a very small percentage of its potential range in the U.S.; however, it is expected to grow well in coastal communities throughout the southeastern U.S. from Virginia to Florida, and west to Texas (Westbrooks and Madsen 2006). In 2003, the plant was documented in New Hanover, Pender, and Onslow counties in North Carolina, and at 125 sites in Horry, Georgetown, and Charleston counties in South Carolina. One Chesapeake Bay site in Virginia was eradicated, and another site on Jekyll Island, Georgia, is about 95% controlled (D. Suiter, USFWS, pers. comm. 2009). Beach vitex has been documented from two locations in northwest Florida, but one site disappeared after erosional storm events. The landowner of the other site has indicated an intention to eradicate the plant, but follow through is unknown (R. Farley, PBS&J, Inc., pers. comm. 2009). Task forces formed in North and South Carolina in 2004-05 have made great strides to remove this plant from their coasts. To date, about 200 sites in North Carolina have been treated, with 200 additional sites in need of treatment. Similar efforts are underway in South Carolina.

Unquantified amounts of crowfootgrass (*Dactyloctenium aegyptium*) grow invasively along portions of the Florida coastline. It forms thick bunches or mats that may change the vegetative structure of coastal plant communities and alter shorebird habitat.

The Australian pine (*Casuarina equisetifolia*) changes the vegetative structure of the coastal community in south Florida and islands within the Bahamas. Shorebirds prefer foraging in open areas where they are able to see potential predators, and tall trees provide good perches for avian predators. Australian pines potentially impact shorebirds, including the piping plover, by reducing attractiveness of foraging habitat and/or increasing avian predation.

The propensity of these exotic species to spread, and their tenacity once established, make them a persistent threat, partially countered by increasing landowner awareness and willingness to undertake eradication activities.

Wrack removal and beach cleaning

Wrack on beaches and baysides provides important foraging and roosting habitat for piping plovers (Drake 1999, Smith 2007, Maddock et al. 2009, Lott et al. 2009; see also discussion of piping plover use of wrack substrates in section 2.2.1.4) and many other shorebirds on their winter, breeding, and migration grounds.

There is increasing popularity in the Southeast, especially in Florida, for beach communities to carry out "beach cleaning" and "beach raking" actions. Beach cleaning occurs on private beaches, where piping plover use is not well documented, and on some municipal or county beaches that are used by piping plovers. Most wrack removal on state and federal lands is limited to post-storm cleanup and does not occur regularly.

Man-made beach cleaning and raking machines effectively remove seaweed, fish, glass, syringes, plastic, cans, cigarettes, shells, stone, wood, and virtually any unwanted debris (Barber Beach Cleaning Equipment 2009). These efforts remove accumulated wrack, topographic depressions, and sparse vegetation nodes used by roosting and foraging piping plovers. Removal of wrack also eliminates a beach's natural sand-trapping abilities, further destabilizing the beach. In addition, sand adhering to seaweed and trapped in the cracks and crevices of wrack is removed from the beach. Although the amount of sand lost due to single sweeping actions may be small, it adds up considerably over a period of years (Neal et al. 2007).

Tilling beaches to reduce soil compaction, as sometimes required by the USFWS for sea turtle protection after beach nourishment activities, has similar impacts. Recently, the USFWS improved sea turtle protection provisions in Florida; these provisions now require tilling, when needed, to be above the primary wrack line, not within it.

Currently, the Florida Department of Environmental Protection's Beaches and Coastal Management Systems section has issued 117 permits for beach raking or cleaning to multiple entities. We estimate that 240 of 825 miles (29%) of sandy beach shoreline in Florida are cleaned or raked on various schedules, i.e., daily, weekly, monthly (L. Teich, Florida DEP, pers. comm. 2009). USFWS biologists estimate that South Carolina mechanically cleans approximately 34 of its 187 shoreline miles (18%), and Texas mechanically cleans approximately 20 of its 367 shoreline miles (5.4%). We are not aware of what percentage of mechanical cleaning occurs in piping plover critical habitat.

Efforts to avoid and reduce adverse effects

Through the section 7 consultation process, 11 USFWS field offices consult formally and informally to avoid or minimize project impacts to wintering and migrating piping plovers and their habitat. In certain cases, the consultation process has resulted in minimization actions that benefit piping plovers. For example, one informal consultation aided in eliminating subsurface armoring proposed along a coastal road within a national seashore (USFWS 2007a). At least two consultations have required "notches" (breaks in dune placement to increase likelihood of overwash) in proposed sand placement projects on public lands (USFWS 2007a, 2008a). At least three other formal consultations greatly reduced the impacts of inlet relocation projects (USFWS 2001, 2004, 2006). Two completed consultations (USFWS 2009a, 2009b) requested that the USACE consider creating potential piping plover habitat with sediments removed from dredged inlets.

The USFWS often requests post-project surveys and eradication of coastal exotic plant species in Florida as permit conditions for beach berm or nourishment projects to reduce impacts to piping plover habitat. Four recent biological opinions for sand placement events in Florida included requirements that restricted the removal of wrack to minimize project effects (USFWS 2007b, 2008b, 2008c, 2008d). A statewide consultation with the Federal Emergency Management Agency to minimize emergency berm repair and construction projects in Florida was completed in 2008 (USFWS 2008b). In Texas, four biological opinions required avoidance and minimization measures for beach maintenance, oil and gas activities, and inlet dredging and stabilization projects (USFWS 2003b, 2003c, 2008e, 2009c). Terms and conditions included restricted activities in the coastal foredunes, restoration of beach elevations post-project, reductions in oil and gas leaks from vehicles, avoidance of driving in the swash zone (wet sand where water washes onto the shore after an incoming wave has broken), requirements to keep dogs on leashes, and avoidance of work during inclement weather when piping plovers are roosting.

Section 10(a)(2)(A) of the ESA requires an applicant for an incidental take permit to submit a conservation plan that specifies, among other things, the impacts that are likely to result in the taking and the measures the permit applicant will undertake to minimize and mitigate such impacts. Incidental take of piping plovers associated with beach driving activities in Volusia County, Florida, were addressed in a Habitat Conservation Plan (Ecological Associates, Inc. 2005). Minimization efforts within the Habitat Conservation Plan include daytime driving only, 10 mile-per-hour speed limits, a no-drive area in critical habitat, and seasonal field surveys. Three other Florida county governments (Gulf, Escambia, Walton) are in various stages of drafting Habitat Conservation Plans for beach driving, coastal developments, and associated activities. All three consultations include consideration of effects on piping plovers.

Coordinated efforts for several large projects are currently underway. Florida USFWS field offices are engaged in statewide programmatic consultation on Florida coastal USACE projects and permitting (dredging, jetty maintenance, and nourishment). Also, Florida's Department of Environmental Protection and Fish and Wildlife Commission are drafting a statewide Habitat Conservation Plan for coastal actions permitted through the Florida Department of Environmental Protection. The primary purpose of this plan is to minimize or mitigate habitat impacts associated with wrack removal, seawall installation, and geotube placement.

As noted above, some project sponsors have incorporated recommended avoidance and minimization measures. Nonetheless, considerable challenges remain. Other project sponsors have not reacted positively to USFWS recommendations, citing financial costs and engineering restrictions.

Summary

Habitat loss and degradation on winter and migration grounds from shoreline and inlet stabilization efforts, both within and outside of designated critical habitat, remain a serious threat to all piping plover populations.

In some areas, beaches that abut private property are needed by wintering and migrating piping plovers. However, residential and commercial developments that typically occur along private beaches may pose significant challenges for efforts to maintain natural coastal processes. The threats of habitat loss and degradation, when combined with the threat of sea-level rise associated with climate change (WM 2.2.2.5), raise serious concerns regarding the ability of private beaches to support piping plovers over the long term.

The future actions that are taken on private beaches will determine whether piping plovers continue to use these beaches or whether the recovery of piping plovers will principally depend on public property. As Lott (2009) concludes, "The combination of development and shoreline protection seems to limit distribution of non-breeding piping plovers in Florida. If mitigation or habitat restoration efforts on barrier islands fronting private property are not sufficient to allow plover use of some of these areas, the burden for plover conservation will fall almost entirely on public land managers."

While public lands may not be at risk of habitat loss from private development, significant threats to piping plover habitat remain on many municipal, state, and federally owned properties. These public lands may be managed with competing missions that include conservation of imperiled species, but this goal frequently ranks below providing recreational enjoyment to the public, readiness training for the military, or energy development projects.

Public lands remain the primary places where natural coastal dynamics are allowed. Of recent concern are requests to undertake beach nourishment actions to protect coastal roads or military infrastructure on public lands. If project design does not minimize impediments to shoreline overwash, which are needed to help replenish bayside tidal flat sediments and elevations, significant bayside habitat may become vegetated or inundated, thereby exacerbating the loss of preferred piping plover habitat. Conversely, if beach fill on public lands is applied in a way that allows for "normal" system overwash processes, and sediment is added back to the system, projects may be less injurious to barrier island species that depend on natural coastal dynamics.

Maintaining wrack for food and cover in areas used by piping plovers may help offset impacts that result from habitat degradation due to sand placement associated with berm and beach nourishment projects and ensuing human disturbance. Leaving wrack on private beaches may improve use by piping plovers, especially during migration when habitat fragmentation may have a greater impact on the species.

In addition, using recreation management techniques, Great Lakes recovery action 2.14 may minimize the effects of habitat loss. As discussed in WM 2.2.2.5, addressing off-road vehicles and pet disturbance may increase the suitability of existing piping plover habitat.

WM 2.2.2.2 Factor B. Overutilization for commercial, recreational, scientific or educational purposes:

The 1985 final listing rule found no evidence to suggest that this factor is a threat to piping plovers while on migration or winter grounds. The various recovery plans state that hunting in the late 1800s may have severely reduced piping plover numbers. The plans did not identify hunting as an existing threat to piping plovers wintering in the U.S., as take is prohibited pursuant to the Migratory Bird Treaty Act. No credible information indicates that hunting is a threat in the U.S. or in other countries. Based on the current information, overutilization is not a threat to piping plovers on their wintering and migration grounds.

WM 2.2.2.3 Factor C. Disease or predation:

Disease

Neither the final listing rule nor the recovery plans state that disease is an issue for the species, and no plan assigns recovery actions to this threat factor. Although researchers increased vigilance following detection of several cases of West Nile virus in breeding Northern Great Plains piping plovers and Type E botulism in the Great Lakes breeding population, the USFWS is not aware of instances of disease in nonbreeding piping plovers. Of the 181 piping plovers submitted to the USGS National Wildlife Health Center in Madison, Wisconsin, since 1986, 164 died from unknown causes, trauma, or emaciation. In the southeastern U.S., the cause of death of one piping plover received from Texas was emaciation (C. Acker, USGS, pers. comm. 2009). These data, obtained from the National Wildlife Health Center do not include data from necropsies performed on piping plovers by other laboratories.

Avian influenza testing is conducted on a large variety of shorebirds from most of the 50 states and associated islands. Only two documented samples were collected from live piping plovers and sent to the Kissimmee Diagnostic Laboratory in Florida for avian influenza testing in 2006. Both birds tested negative (M. Hines, USGS, pers. comm. 2009). The Department of the Interior has tested 14,261 shorebirds in the families of *Charadriidae* and *Scolopacidae* since 2006. Bird species testing positive for low pathogenic avian influenza consist of Pacific golden-plover (1), bar-tailed godwit (3), dunlin (8), marsh sandpiper (1), red knot (1), sanderling (1), sharp-tailed sandpiper (1), and western sandpiper (1) (Acker, pers. comm. 2009). Other laboratories have ongoing shorebird testing, but results were not available for this review.

Based on information available to date, we conclude that West Nile virus and avian influenza remain a minor threat to shorebirds, including the piping plover, on their wintering and migration grounds.

Predation

The 2003 Great Lakes recovery plan expressed concern about the increase in predators (fox, coyotes, dogs, and cats) that are present year-round on the wintering grounds. Although not the subject of a specific recovery plan action, investigations into effects of predation on nonbreeding piping plovers falls under Great Lakes recovery plan priority 1 action 2.16, i.e., identification and reduction of additional threats to winter populations.

The impact of predation on migrating or wintering piping plovers remains largely undocumented. Except for one incident involving a cat in Texas (NY Times 2007), no depredation of piping plovers during winter or migration has been noted, although it would be difficult to document. Avian and mammalian predators are common throughout the species' wintering range. Predatory birds are relatively common during fall and spring migration, and it is possible that raptors occasionally take piping plovers (Drake et al. 2001). It has been noted, however, that the behavioral response of crouching when in the presence of avian predators may minimize avian predation on piping plovers (Morrier and McNeil 1991, Drake 1999, Drake et al. 2001). Drake (1999), based on observations of piping plovers roosting in bayside cracked algal mats at a distance of >100 m from the nearest coastal prairie vegetation on South Padre Island in Texas, theorized that this behavior decreased their risk of mammalian predation by enhancing concealment and increasing their distance from, and ability to spot, approaching predators.

The 1996 Atlantic Coast recovery plan summarized evidence that human activities affect types, numbers, and activity patterns of some predators, thereby exacerbating natural predation on breeding piping plovers. Nonbreeding piping plovers may reap some collateral benefits from predator management conducted for the primary benefit of other species. In 1997, the U.S. Department of Agriculture (USDA) implemented a public lands predator control partnership in northwest Florida that included the Department of Defense, National Park Service (NPS), the State of Florida (state park lands) and USFWS (National Wildlife Refuges and Ecological Services). The program continues with all partners except Florida – in 2008, lack of funding precluded inclusion of Florida state lands (although Florida Department of Environmental Protection staff conduct occasional predator trapping on state lands, trapping is not implemented consistently).

National Park Service and individual state park staff in North Carolina participate in predator control programs (D. Rabon, USFWS, pers. comm. 2009). The USFWS issued permit conditions for raccoon eradication to Indian River County staff in Florida as part of a coastal Habitat Conservation Plan (T. Adams, USFWS, pers. comm. 2009). Destruction of turtle nests by dogs or coyotes in the Indian River area justified the need to amend the permit to include an education program targeting dog owners regarding the appropriate means to reduce impacts to coastal species caused by their pets. The USFWS partnered with Texas Audubon and the Coastal Bend Bays and Estuaries Program in Texas to implement predator control efforts on colonial waterbird nesting islands (R. Cobb, USFWS, pers. comm. 2009). Some of these predator control programs may provide very limited protection to piping plovers, should they use these areas for roosting or foraging. Table WM5 summarizes predator control actions on a state-by-state basis. The USFWS is not aware of any current predator control programs targeting protection of coastal species in Georgia, Alabama, Mississippi, or Louisiana.

Regarding predation, the magnitude of this threat to nonbreeding piping plovers remains unknown, but given the pervasive, persistent, and serious impacts of predation on other coastal reliant species, it remains a potential threat. Focused research to confirm impacts as well as to ascertain effectiveness of predator control programs may be warranted, especially in areas frequented by Great Lakes birds during migration and wintering months. We consider predator control on their wintering and migration grounds to be a low priority at this time.[1]

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[1] The threat of direct predation should be distinguished from the threat of disturbance to roosting and feeding piping plovers posed by dogs off leash, which is discussed in WM 2.2.2.5.

Table WM5. Summary of predator control programs that may benefit piping plovers on winter and migration grounds.

State	**Entities with Predator Control Programs**
North Carolina	State Parks, Cape Lookout and Cape Hatteras National Seashores.
South Carolina	As needed throughout the state-targets raccoons and coyotes.
Georgia	No programs known.
Florida	Merritt Island NWR, Cape Canaveral AFS, Indian River County, Eglin AFB, Gulf Islands NS, northwest Florida state parks (up until 2008), St. Vincent NWR, Tyndall AFB.
Alabama	Late 1990's Gulf State Park and Orange Beach for beach mice, none current.
Mississippi	None known.
Louisiana	None known.
Texas	Aransas NWR (hog control for habitat protection). Audubon (mammalian predator control on colonial waterbird islands that have occasional piping plover use).

WM 2.2.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

Non-ESA regulatory protections for wintering and migrating piping plovers are inherent in the Coastal Barrier Resources Act and the Migratory Bird Treaty Act. The 2003 Great Lakes recovery plan (page 39, table 5) provides listing status and statutes for each state within the wintering range. At the time the plan was finalized, all but South Carolina had some form of State protection; since then, South Carolina, through its Non-Game and Endangered Species Codes 50–15–30, 50–15–40, 50–15–50, and 50–15–70, has provided some protective measures for piping plovers. Most state laws focus on direct protection of the birds but not their habitat.

Protections for piping plovers migrating and wintering outside the U.S. include the 2005 designation of 1.5 million acres of the Laguna Madre de Tamaulipas region in Mexico as a Federal Natural Protected Area. Any land-use alterations to piping plover habitats within this area are now subject to review under a federal permitting process that encourages avoidance and minimization of impacts; however, it does not preclude alterations. This is similar to the ESA in allowing some adverse effects to designated critical habitat. Regulatory protections for piping plovers in the Caribbean and Cuba are currently unknown.

In the continental U.S., piping plover wintering and migration habitats are under various types of ownership (private, municipal, state, and federal). Available regulatory mechanisms include local land use ordinances and state and federal regulations. However, implementation of these mechanisms is often constrained by practical limitations such as lack of staff and funding. Enforcement limitations and/or legal insufficiency of regulations to protect important habitat components result in continued degradation of a significant amount of wintering piping plover coastal habitat, including designated critical habitat units, resulting in a cumulative loss of habitat.

Federal lands in the U.S. provide varying levels of protection for piping plovers. National Wildlife Refuges develop and implement Comprehensive Conservation Plans that can specify management for piping plovers. For example, in Florida, the St. Marks National Wildlife Refuge's 2006 Comprehensive Conservation Plan identifies a strategy to evaluate, identify, and implement management actions to protect important shorebird sites from human disturbance. National Park Service lands have requisite management plans, and Department of Defense lands have Integrated Natural Resource Management Plans. In northwest Florida, Eglin Air Force Base's threatened and endangered species component plan, a subset of their Integrated Natural Resource Management Plan, requires surveys for piping plovers as well as sign posting to prohibit human disturbance in piping plover critical habitat areas; other areas used on a regular basis by piping plovers are also sign-posted. All of these plans require review by local USFWS staff, whose input is generally incorporated. Most plans also include monitoring provisions and protective measures when needed.

Some states in the plover's wintering range also require resource management plans for their state parks, although implementation of these plans can be limited by lack of staff and funding and/or low prioritization. For example, some state parks and managed islands in South Carolina post areas important to piping plovers and close the areas to dogs, but enforcement is periodic at best. At the current time, if the protections of the ESA were removed, existing local, state, and other federal regulatory provisions would provide insufficient protection to nonbreeding piping plover habitats used during migration and winter.

Formal and informal ESA section 7 consultations with federal agencies or state and private entities receiving federal funds, permits, or undertaking federal projects on the wintering grounds continue to play a critical role in piping plover conservation. Enhanced coordination of project review throughout the migration and wintering range could help to streamline consultations and possibly facilitate further reductions in project impacts to the piping plover and its habitat; however, nonbreeding habitat degradation continues despite ESA protections. Other threats, such as human disturbance, are currently being managed but not eliminated. Therefore, removal of ESA protections is likely to require institution of alternative regulatory mechanisms or contractual agreements that currently do not exist.

In sum, existing regulatory protections are currently insufficient, absent the ESA, to adequately protect piping plovers on their wintering and migration grounds.

WM 2.2.2.5 Factor E. Other natural or manmade factors affecting its continued existence:

Recreational disturbance

The final listing rule and the three recovery plans identified human recreational disturbance on the breeding and wintering grounds as a threat. The Atlantic Coast plan's recovery task 2.22 calls for protecting plovers on their winter habitat from disturbance caused by recreating people and their pets. The Great Lakes plan's recovery action 2.14, ranked as a priority 1 action, calls for reducing human and pet disturbance at wintering sites by using recreation management techniques such as vehicle and pet restrictions and symbolic fencing. Task 3221 in the Northern Great Plains plan calls for investigating the effects of human activities on winter survival.

Intense human disturbance in shorebird winter habitat can be functionally equivalent to habitat loss if the disturbance prevents birds from using an area (Goss-Custard et al. 1996), which can lead to roost abandonment and local population declines (Burton et al. 1996). Pfister et al. (1992) implicate anthropogenic disturbance as a factor in the long-term decline of migrating shorebirds at staging areas. Disturbance, i.e., human and pet presence that alters bird behavior, disrupts piping plovers as well as other shorebird species. Disturbance can cause shorebirds to spend less time roosting or foraging and more time in alert postures or fleeing from the disturbances (Johnson and Baldassarre 1988; Burger 1991; Burger 1994; Elliott and Teas 1996; Lafferty 2001a, 2001b; Thomas et al. 2002), which limits the local abundance of piping plovers (Zonick and Ryan 1995, Zonick 2000). Shorebirds that are repeatedly flushed in response to disturbance expend energy on costly short flights (Nudds and Bryant 2000).

Shorebirds are more likely to flush from the presence of dogs than people, and birds react to dogs from farther distances than people (Lafferty 2001a, 2001b; Thomas et al. 2002). Dogs off leash are more likely to flush piping plovers from farther distances than are dogs on leash; nonetheless, dogs both on and off leashes disturb piping plovers (Hoopes 1993). Pedestrians walking with dogs often go through flocks of foraging and roosting shorebirds; some even encourage their dogs to chase birds.

Off-road vehicles can significantly degrade piping plover habitat (Wheeler 1979) or disrupt the birds' normal behavior patterns (Zonick 2000). The 1996 Atlantic Coast recovery plan cites tire ruts crushing wrack into the sand, making it unavailable as cover or as foraging substrate (Hoopes 1993, Goldin 1993). The plan also notes that the magnitude of the threat from off-road vehicles is particularly significant, because vehicles extend impacts to remote stretches of beach where human disturbance would otherwise be very slight. Godfrey et al. (1980 as cited *in* Lamont et al. 1997) postulated that vehicular traffic along the beach may compact the substrate and kill marine invertebrates that are food for the piping plover. Zonick (2000) found that the density of off-road vehicles negatively correlated with abundance of roosting piping plovers on the ocean beach. Cohen et al. (2008) found that radio-tagged piping plovers using ocean beach habitat at Oregon Inlet in North Carolina were far less likely to use the north side of the inlet where off-road vehicle use is allowed, and recommended controlled management experiments to determine if recreational disturbance drives roost site selection. Ninety-six percent of piping plover detections were on the south side of the inlet even though it was farther away from foraging sites (1.8 km from the sound side foraging site to the north side of the inlet versus 0.4 km from the sound side foraging site to the north side of the inlet; Cohen et al. 2008).

Based on surveys with land managers and biologists, knowledge of local site conditions, and other information, we have estimated the levels of eight types of disturbance at sites in the U.S. with wintering piping plovers. There are few areas used by wintering piping plovers that are devoid of human presence, and just under half have leashed and unleashed dog presence (Smith 2007, Lott et al. 2009, USFWS unpubl. data 2009, Maddock and Bimbi unpubl. data 2009). Table WM6 summarizes the disturbance analysis results. Data are not available on human disturbance at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table WM6. Percent of known piping plover winter and migration habitat locations, by state, where various types of anthropogenic disturbance have been reported.

	Percent by State							
Disturbance Type	**AL**	**FL**	**GA**	**LA**	**MS**	**NC**	**SC**	**TX**
Pedestrians	67	92	94	25	100	100	88	54
Dogs on leash	67	69	31	25	73	94	25	25
Dogs off leash	67	81	19	25	73	94	66	46
Bikes	0	19	63	25	0	0	28	19
ATVs	0	35	0	25	0	17	25	30
ORVs	0	21	0	25	0	50	31	38
Boats	33	65	100	100	0	78	63	44
Kite surfing	0	10	0	0	0	33	0	0

Although the timing, frequency, and duration of human and dog presence throughout the wintering range are unknown, studies in Alabama and South Carolina suggest that most disturbance to piping plovers occurs during periods of warmer weather, which coincides with piping plover migration (Johnson and Baldassarre 1988, Lott et al. 2009, Maddock et al. 2009). Smith (2007) documents varying disturbance levels throughout the nonbreeding season at northwest Florida sites.

In South Carolina, 33% (13 out of 39) of sites surveyed during the 2007–2008 season had ≥5 birds. Of those 13 sites, 46.2% (6 out of 13) had ≥10 people present during surveys, and 61.5% (8 out of 13) allow dogs, indicating that South Carolina sites with the highest piping plover density are exposed to disturbance. Only 25.7% (9 out of 35) of sites in South Carolina prohibit dogs and restrict public access to the entire site or sections of sites used by piping plovers (Maddock and Bimbi unpubl.data). Compliance with the restrictions at these sites is unknown.

LeDee (2008) collected survey responses in 2007 from 35 managers (located in seven states) at sites that were designated as critical habitat for wintering piping plovers. Ownership included federal, state, and local governmental agencies and non-governmental organizations managing national wildlife refuges; national, state, county, and municipal parks; state and estuarine research reserves; state preserves; state wildlife management areas; and other types of managed lands. Of 44 sites, 40 allowed public beach access year-round and four sites were closed to the public. Of the 40 sites that allow public access, 62% of site managers reported >10,000 visitors during September-March, and 31% reported >100,000 visitors. Restrictions on visitor activities on the beach included automobiles (at 81% of sites), all-terrain vehicles (89%), and dogs during the winter season (50%). Half of the survey respondents reported funding as a primary limitation in managing piping plovers and other threatened and endangered species at their sites. Other limitations included "human resource capacity" (24%), conflicting management priorities (12%), and lack of research (3%).

Disturbance can be addressed by implementing recreational management techniques such as vehicle and pet restrictions and symbolic fencing (usually sign posts and string) of roosting and feeding habitats. In implementing conservation measures, managers need to consider a range of site-specific factors, including the extent and quality of roosting and feeding habitats and the types and intensity of recreational use patterns. In addition, educational materials such as informational signs or brochures can provide valuable information so that the public understands the need for conservation measures.

In sum, although there is some variability among states, disturbance from human beach recreation and pets poses a moderate to high and escalating threat to migrating and wintering piping plovers. Systematic review of recreation policy and beach management across the nonbreeding range would assist in better understanding cumulative impacts. Site-specific analysis and implementation of conservation measures should be a high priority at piping plover sites that have moderate or high levels of disturbance, and USFWS and state wildlife agencies should increase technical assistance to land managers to implement management strategies and monitor their effectiveness.

Military Actions

Military actions are not listed as threats in either the listing rule or recovery plans. Twelve coastal military bases are located in the Southeast (Table WM7). To date, five bases have consulted with the USFWS under section 7 of the ESA, on military activities on beaches and baysides that may affect piping plovers or their habitat (Table WM7). Camp Lejeune in North Carolina consulted formally with USFWS in 2002 on troop activities, dune stabilization efforts, and recreational use of Onslow Beach. The permit conditions require twice-monthly piping plover surveys and use of buffer zones and work restrictions within buffer zones.

Naval Station Mayport in Duval County, Florida, consulted with USFWS on Marine Corps training activities that included beach exercises and use of amphibious assault vehicles. The area of impact was not considered optimal for piping plovers, and the consultation was concluded informally. Similar informal consultations have occurred with Tyndall Air Force Base (Bay County) and Eglin Air Force Base (Okaloosa and Santa Rosa counties) in northwest Florida. Both consultations dealt occasional use of motorized equipment on the beaches and associated baysides. Tyndall Air Force Base has minimal on-the-ground use, and activities, when conducted, occur on the Gulf of Mexico beach, which is not considered the optimal area for piping plovers within this region. Eglin Air Force Base conducts twice-monthly surveys for piping plovers, and habitats consistently documented with piping plover use are posted with avoidance requirements to minimize direct disturbance from troop activities. A 2001 consultation with the Navy for training exercises on the beach and retraction operations on Peveto Beach, Cameron Parish, Louisiana, concluded informally.

Table WM7. Military bases that occur within the wintering/migration range of piping plovers and contain piping plover habitat. An asterisk (*) indicates bases which conduct activities that may affect piping plovers or their habitat.

State	**Coastal Military Bases**
North Carolina	Camp Lejeune*
South Carolina	No coastal beach bases
Georgia	Kings Bay Naval Base
Florida	Key West Base, Naval Station Mayport*, Cape Canaveral Air Force Station, Patrick AFB, MacDill AFB, Eglin AFB*, Tyndall AFB*
Alabama	No coastal beach bases
Mississippi	Keesler AFB
Louisiana	US Navy* operations on Peveto Beach
Texas	Corpus Christi Naval Air Station

Overall, project avoidance and minimization actions currently reduce threats from military activities to wintering and migrating piping plovers to a minimal threat level. However, prior to removal of the piping plover from ESA protections, Integrated Resource Management Plans or other agreements should clarify if and how a change in legal status would affect plover protections.

Contaminants

The various piping plover recovery plans identify contaminants, particularly oil spills, as a threat. The 1996 Atlantic Coast plan's recovery task 2.23 and the 2003 Great Lakes plan's recovery action 2.15 call for protecting wintering piping plovers from oil spills. The Great Lakes plan also states that concentration levels of polychlorinated biphenol (PCB) detected in Michigan piping plover eggs have the potential to cause reproductive harm. They further state that analysis of prey available to piping plovers at representative

Michigan breeding sites indicated that breeding areas along the upper Great Lakes region are not likely the major source of contaminants to this population.

Contaminants have the potential to cause direct toxicity to individual birds or negatively impact their invertebrate prey base (Rattner and Ackerson 2008). Depending on the type and degree of contact, contaminants can have lethal and sub-lethal effects on birds, including behavioral impairment, deformities, and impaired reproduction (Rand and Petrocelli 1985, Gilbertson et al. 1991, Hoffman et al. 1996).

Beach-stranded 55-gallon barrels and smaller containers, which may fall from moving cargo ships or offshore rigs and are not uncommon on the Texas coast, contain primarily oil products (gasoline or diesel), as well as other chemicals such as methanol, paint, organochlorine pesticides, and detergents (C. Lee, USFWS, pers. comm. 2009). Federal and state land managers have protective provisions in place to secure and remove the barrels, thus reducing the likelihood of contamination.

The extent to which contaminant levels in piping plovers can be attributed to wintering and migratory stopover sites is unknown. Research focused on known winter and migration habitats of the Great Lakes birds may be necessary should any breeding issues arise with regard to PCB levels.

Petroleum products are the contaminants of primary concern, as opportunities exist for petroleum to pollute intertidal habitats that provide foraging substrate. Impacts to piping plovers from oil spills have been documented throughout their life cycle (Chapman 1984; USFWS 1996; Burger 1997; Massachusetts Audubon 2003; Amirault-Langlais et al. 2007; A. Amos, University of Texas, pers. comm. 2009). This threat persists due to the high volume of shipping vessels (from which most documented spills have originated) traveling offshore and within connected bays along the Atlantic Coast and the Gulf of Mexico. Additional risks exist for leaks or spills from offshore oil rigs, associated undersea pipelines, and onshore facilities such as petroleum refineries and petrochemical plants.

Lightly oiled piping plovers have survived and successfully reproduced (Chapman 1984, Amirault-Langlais et al. 2007, A. Amos pers. comm. 2009). Chapman (1984) noted shifts in habitat use as piping plovers moved out of spill areas. This behavioral change was believed to be related to the demonstrated decline in benthic infauna (prey items) in the intertidal zone and may have decreased the direct impact to the species. To date, no plover mortality has been attributed to oil contamination outside the breeding grounds, but latent effects would be difficult to prove. The U.S. Coast Guard, the states, and responsible parties form the Unified Command, which, with advice from federal and state natural resource agencies, has prepared contingency plans to deal with petroleum and other hazardous chemical spills for each state's coastline. The contingency plans identify sensitive habitats, including all federally listed species' habitats, which receive a higher priority for response actions. The plans allow immediate habitat protective and clean-up measures in response to large contaminant spills, thus ameliorating this threat to piping plovers.

In sum, although the risk for impacts from contamination to piping plovers and their habitat is recognized, the safety contingency plans in place alleviate most of these concerns, making contaminants a minor issue at this time.

Pesticides

Neither the final listing rule nor the recovery plans identified pesticides as a threat to piping plovers on the wintering grounds. In 2000, mortality of large numbers of wading birds and shorebirds, including one piping plover, at Audubon's Rookery Bay Sanctuary on Marco Island, Florida, occurred following the county's aerial application of the organophosphate pesticide Fenthion for mosquito control purposes (Williams 2001). Fenthion, a known toxin to birds, was registered for use as an avicide by Bayer chemical manufacturer. Subsequent to a lawsuit being filed against the Environmental Protection Agency (EPA) in 2002, the manufacturer withdrew Fenthion from the market, and EPA declared all uses were to end by November 30, 2004 (American Bird Conservancy 2007, which also states that all other counties in the U.S. now use less toxic chemicals for mosquito control).

With one reported plover death from pesticide use, and with the causative pesticide now removed from use, this threat to piping plovers in the U.S. currently appears low. However, it is unknown whether pesticides are a threat for piping plovers wintering in the Bahamas, other Caribbean countries, or Mexico.

Accelerating sea-level rise

Climate change was not identified as a threat in the final rule listing the piping plover or in any of the USFWS piping plover recovery plans. Here we address potential effects of accelerating sea-level rise (Intergovernmental Panel on Climate Change [IPCC] 2007) on all populations of piping plovers during the migration and wintering portions of their life cycle; this does not discount the potential for other climate change-related effects on migrating and wintering piping plovers.

Over the past 100 years, the globally-averaged sea level has risen approximately 10-25 centimeters (Rahmstorf et al. 2007), a rate that is an order of magnitude greater than that seen in the past several thousand years (Douglas et al. 2001 as cited in Hopkinson et al. 2008). The IPCC suggests that by 2080 sea-level rise could convert as much as 33% of the world's coastal wetlands to open water (IPCC 2007). Although rapid changes in sea level are predicted, estimated time frames and resulting water levels vary due to the uncertainty about global temperature projections and the rate of ice sheets melting and slipping into the ocean (IPCC 2007, CCSP 2008).

As discussed in section AC 2.5.3.5, potential effects of sea-level rise on coastal beaches may vary regionally due to subsidence or uplift as well as the geological character of the coast and nearshore (CCSP 2009, Galbraith et al. 2002). In the last century, for example, sea-level rise along the U.S. Gulf Coast exceeded the global average by 13-15 cm, because coastal lands there are subsiding (EPA 2009). Sediment compaction and oil and gas extraction compound tectonic subsidence (Penland and Ramsey 1990, Morton et al. 2003, Hopkinson et al. 2008). Low elevations and proximity to the coast make all nonbreeding coastal piping plover foraging and roosting habitats vulnerable to the effects of rising sea level. Furthermore, areas with small astronomical tidal ranges (e.g., portions of the Gulf Coast where intertidal range is <1 meter) are the most vulnerable to loss of intertidal wetlands and flats induced by sea-level rise (EPA 2009). Sea-level rise was cited as a contributing factor in the 68% decline in tidal flats and algal mats in the Corpus Christi area (i.e., Lamar Peninsula to Encinal Peninsula) in Texas between the 1950s and 2004 (Tremblay et al. 2008). Mapping by Titus and Richman (2001) showed that more than 80% of the lowest land along the Atlantic and Gulf coasts was in Louisiana, Florida, Texas, and North Carolina, where 73.5% of all wintering piping plovers were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009).

Inundation of piping plover habitat by rising seas could lead to permanent loss of habitat that lies immediately seaward of numerous structures or roads, especially if those shorelines are also armored with hardened structures. Without development or armoring, low undeveloped islands can migrate toward the mainland, pushed by the overwashing of sand eroding from the seaward side and being re-deposited in the bay (Scavia et al. 2002). Overwash and sand migration are impeded on developed portions of islands. Instead, as sea-level increases, the ocean-facing beach erodes and the resulting sand is deposited offshore. The buildings and the sand dunes then prevent sand from washing back toward the lagoons, and the lagoon side becomes increasingly submerged during extreme high tides (Scavia et al. 2002), diminishing both barrier beach shorebird habitat and protection for mainland developments.

Modeling for three sea-level rise scenarios (reflecting variable projections of global temperature rise) at five important U.S. shorebird staging and wintering sites predicted loss of 20-70% of current intertidal foraging habitat (Galbraith et al. 2002). These authors estimated probabilistic sea-level changes for specific sites partially based on historical rates of sea-level change (from tide gauges at or near each site); they then superimposed this on projected 50% and 5% probability of global sea-level changes by 2100 of 34 cm and 77 cm, respectively. The 50% and 5% probability sea level change projections were based on assumed global temperature increases of 2° C (50% probability) and 4.7° C (5% probability). The most severe losses were projected at sites where the coastline is unable to move inland due to steep topography or seawalls. The Galbraith et al. (2002) Gulf Coast study site, Bolivar Flats, Texas, is a designated critical habitat unit known to host high numbers of piping plovers during migration and throughout the winter; e.g., 275 individuals were tallied during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009). Under the 50% likelihood scenario for sea-level rise, Galbraith et al. (2002) projected approximately 38% loss of intertidal flats at Bolivar Flats by 2050; however, after initially losing habitat, the area of tidal flat habitat was predicted to slightly increase by the year 2100, because Bolivar Flats lacks armoring, and the coastline at this site can thus migrate inland. Although habitat losses in some areas are likely to be offset by gains in other locations, Galbraith et al. (2002) noted that time lags may exert serious adverse effects on shorebird populations. Furthermore, even if piping plovers are able to move their wintering locations in response to accelerated habitat changes, there could be adverse effects on the birds' survival rates or reproductive fitness.

Table WM8 displays the potential for adjacent development and/or hardened shorelines to impede response of habitat to sea-level rise in the eight states supporting wintering piping plovers. Although complete linear shoreline estimates are not readily obtainable, almost all known piping plover wintering sites in the U.S. were surveyed during the 2006 International Piping Plover Census. To estimate effects at the census sites, as well as additional areas where piping plovers have been found outside of the census period, USFWS biologists reviewed satellite imagery and spoke with other biologists familiar with the sites. Of 406 sites, 204 (50%) have adjacent structures that may prevent the creation of new habitat if existing habitat were to become inundated. These threats will be perpetuated in places where damaged structures are repaired and replaced, and exacerbated where the height and strength of structures are increased. Data do not exist on the amount or types of hardened structures at wintering sites in the Bahamas, other Caribbean countries, or Mexico.

Table WM8. Number of sites surveyed during the 2006 winter International Piping Plover Census with hardened or developed structures adjacent to the shoreline.
An asterisk (*) indicates additional piping plovers sites not surveyed in the 2006 Census.

State	**Number of sites surveyed during the 2006 winter Census**	**Number of sites with some armoring or development**	**Percent of sites affected**
North Carolina	37 (+2)*	20	51
South Carolina	39	18	46
Georgia	13	2	15
Florida	188	114	61
Alabama	4 (+2)*	3	50
Mississippi	16	7	44
Louisiana	25 (+2)*	9	33
Texas	78	31	40
Overall Total	406	204	50

Sea-level rise poses a significant threat to all piping plover populations during the migration and wintering portion of their life cycle. Ongoing coastal stabilization activities may strongly influence the effects of sea-level rise on piping plover habitat. Improved understanding of how sea-level rise will affect the quality and quantity of habitat for migrating and wintering piping plovers is an urgent need.

Storm events

Although coastal piping plover habitats are storm-created and maintained, the 1996 Atlantic Coast recovery plan also noted that storms and severe cold weather may take a toll on piping plovers, and the 2003 Great Lakes recovery plan postulated that loss of habitats such as overwash passes or wrack, where birds shelter during harsh weather, poses a threat.

Storms are a component of the natural processes that form coastal habitats used by migrating and wintering piping plovers, and positive effects of storm-induced overwashand vegetation removal have been noted in portions of the wintering range. For example, Gulf Islands National Seashore habitats in Florida benefited from increased washover events that created optimal habitat conditions during the 2004 and 2005 hurricane seasons, with biologists reporting piping plover use of these habitats within six months of the storms (M. Nicholas, Gulf Islands National Seashore, pers. comm. 2005). Hurricane Katrina (2005) overwashed the mainland beaches of Mississippi, creating many tidal flats where piping plovers were subsequently observed (N.Winstead in litt. 2008). Hurricane Katrina also created a new inlet and improved habitat conditions on some areas of Dauphin Island, Alabama (D. LeBlanc, USFWS, pers. comm. 2009). Conversely, localized storms, since Katrina, have induced habitat losses on Dauphin Island (D. LeBlanc pers. comm. 2009).

Noel and Chandler (2005) suspect that changes in habitat caused by multiple hurricanes along the Georgia coastline altered the spatial distribution of piping plovers and may have contributed to winter mortality of three Great Lakes piping plovers. Following Hurricane Ike in 2008, Arvin (2009) reported decreased numbers of piping plovers at some heavily eroded Texas beaches in the center of the storm impact area and increases in plover numbers at sites about 100 miles to the southwest. However, piping plovers were observed later in the season using tidal lagoons and pools that Ike created behind the eroded beaches (Arvin 2009).

The adverse effects on piping plovers attributed to storms are sometimes due to a combination of storms and other environmental changes or human use patterns. For example, four hurricanes between 2002 and 2005 are often cited in reference to rapid erosion of the Chandeleur Islands, a chain of low-lying islands in Louisiana where the 1991 International Piping Plover Census tallied more than 350 piping plovers. Comparison of imagery taken three years before and several days after Hurricane Katrina found that the Chandeleur Islands lost 82% of their surface area (Sallenger et al. 2009 in review), and a review of aerial photography prior to the 2006 Census suggested little piping plover habitat remained (Elliott-Smith et al. 2009). However, Sallenger et al. (2009 in review) noted that habitat changes in the Chandeleurs stem not only from the effects of these storms but rather from the combined effects of the storms, long-term (>1,000 years) diminishing sand supply, and sea-level rise relative to the land.

Other storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, and berm and seawall construction. As discussed in more detail in WM 2.2.2.1, such stabilization activities can result in the loss and degradation of feeding and resting habitats. Storms also can cause widespread deposition of debris along beaches. Removal of debris often requires large machinery, which can cause extensive disturbance and adversely affect habitat elements such as wrack. Another example of indirect adverse effects linked to a storm event is the increased access to Pelican Island (D. LeBlanc pers. comm. 2009) due to merging with Dauphin Island following a 2007 storm (Gibson et al. 2009).

Recent climate change studies indicate a trend toward increasing hurricane numbers and intensity (Emanuel 2005, Webster et al. 2005). When combined with predicted effects of sea-level rise, there may be increased cumulative impacts from future storms.

In sum, storms can create or enhance piping plover habitat while causing localized losses elsewhere in the wintering and migration range. Available information suggests that some birds may have resiliency to storms and move to unaffected areas without harm, while other reports suggest birds may perish from storm events. Significant concerns include disturbance to piping plovers and habitats during cleanup of debris, and post-storm acceleration of shoreline stabilization activities, which can cause persistent habitat degradation and loss.

WM 2.2.3 Synthesis

The survival and recovery of all breeding populations of piping plovers are fundamentally dependent on the continued availability of sufficient habitat in their coastal migration and wintering range, where the species spends more than two-thirds of its annual cycle. All piping plover populations are inherently vulnerable to even small declines in their most sensitive vital rates, i.e., survival of adults and fledged juveniles. Progress towards recovery, attained primarily through intensive protections to increase productivity on the breeding grounds, would be quickly slowed or reversed by even small sustained decreases in survival rates during migration and wintering.

Recent information (section 2.2.1.3) confirms that assessing the importance of a site to nonbreeding piping plovers requires multiple surveys conducted across several migration and wintering seasons. Although there is no exclusive partitioning of the wintering range, piping plovers from the Atlantic Coast (i.e., eastern Canada) and the Great Lakes are most prevalent during migration and winter along the southern Atlantic Coast; while those breeding on the Northern Great Plains predominate in coastal Mississippi, Louisiana, and Texas; wintering ranges of all three breeding populations overlap on the Gulf Coast of Florida. Piping plovers demonstrate high fidelity to winter regions where they use a mosaic of habitats within their home ranges. Efforts to further improve understanding of factors affecting survival of migrating and wintering piping plovers merit high priority.

Review of threats to piping plovers and their habitat in their migration and wintering range indicates a continuing loss and degradation of habitat due to sand placement projects, inlet stabilization, sand mining, groins, seawalls and revetments, exotic and invasive vegetation, and wrack removal. This cumulative habitat loss is, by itself, of grave concern for piping plovers, as well as the many other shorebird species competing with them for foraging resources and roosting habitats in their nonbreeding range. However, artificial shoreline stabilization also impedes the processes by which coastal habitats adapt to accelerating sea-level rise, thus setting the stage for compounding future losses.

Furthermore, inadequate management of increasing numbers of beach recreationists reduces the functional suitability of habitat and increase pressure on piping plovers and other shorebirds depending upon a shrinking habitat base. At piping plover sites with moderate or high levels of human disturbance, increased management of disturbance should be a high priority action.

Notwithstanding the difficulties associated with measuring the effects of stressors that affect piping plovers during migration and wintering, efforts to reduce habitat loss and degradation and human disturbance must be accelerated. Indeed, allowing continued habitat loss until reductions in survival are evident poses a high risk of irreversible effects that could preclude piping plover recovery. Increased focus on conservation actions in the migration and wintering range is a high priority for all three piping plover breeding populations.

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GL 2.3 UPDATED INFORMATION AND CURRENT SPECIES STATUS FOR THE BREEDING RANGE OF THE GREAT LAKES POPULATION

GL 2.3.1 Recovery criteria

GL 2.3.1.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

GL 2.3.1.2 Adequacy of recovery criteria:

Do the recovery criteria reflect the best available information on the biology of the species and its habitat?

Yes. The recovery criteria described in the 2003 recovery plan for the Great Lakes piping plover generally reflect the best available information on the biology of this breeding population. New information on biology and habitat in the Great Lakes has been very limited.

There is increasing concern, however, regarding the adequacy of the population abundance criterion (criterion 1) of 150 breeding pairs. As the current population has reached only 63 pairs in total, additional demographic, habitat, and genetic data should become available as the population increases. We anticipate that this criterion will warrant reconsideration if and when the population approaches 100-125 breeding pairs and more information becomes available.

Are all relevant listing factors addressed in the recovery criteria?

The most important listing factors evaluated in the 2003 recovery plan are addressed in the criteria. Section GL 2.3.3 discusses these factors and includes additional threats not addressed in the 2003 recovery criteria. With regard to factors not addressed in the criteria, overutilization and environmental contaminants are present but are still considered minor threats to Great Lakes piping plovers. Disease, specifically Type E botulism, arose as a threat in 2007 with the death of four individuals. No known disease-related mortality has occurred since then, but this threat should be monitored to determine if additional recovery criteria should be developed to address it.

Two new rangewide threats have emerged since the 2003 recovery plan: wind turbine generators and climate change. Both threats merit further evaluation to determine if recovery criteria are needed to address them. Effects of wind turbine generators on piping plovers are expected to be similar across the species' range, although piping plovers may be most vulnerable during the migratory period. The effects of climate change on piping plovers in the Great Lakes are anticipated to be much different than on plovers in other portions of the range, with water level declines being of greatest concern. However, additional information on the effects of wind turbines and climate change is needed before any determination is made regarding revision of existing recovery criteria.

List the recovery criteria as they appear in the recovery plan and discuss how each criterion has or has not been met.

The 2003 Great Lakes recovery plan describes five recovery criteria. The population will be considered for reclassification to threatened when the first four criteria are accomplished, and then considered for delisting when all five criteria are met. Progress towards each recovery criterion is discussed below.

Recovery 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.

> This criterion has not been met. In 2008, the current Great Lakes piping plover population was estimated at 63 breeding pairs (126 individuals). Of these, 53 pairs were found nesting in Michigan, while 10 were found outside the state, including six pairs in Wisconsin and four in Ontario, Canada. The 53 nesting pairs in Michigan represent approximately 50% of the recovery criterion. The 10 breeding pairs outside Michigan in the Great Lakes basin, represents 20% of the goal, albeit the number of breeding pairs outside Michigan has continued to increase over the past five years. The single breeding pair discovered in 2007 in the Great Lakes region of Canada represented the first confirmed piping plover nest there in over 30 years, and in 2008 the number of nesting pairs further increased to four.

Recovery 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.

> This criterion has been met, in part, for the period of 2003-2008. During this time, the annual fledgling rate ranged from a low of 1.60 in 2005 to a high of 1.97 in 2007, with an overall average rate of 1.76 (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a). This is well within the goal of 1.5 to 2.0 fledglings per pair per year.
>
> Recent population trends also indicate a growing population. Between 2003 and 2008 the population increased 26% to 63 breeding pairs. The long-term trend, from 1986-2008 also indicates an increasing population size, but current levels are not at or above the recovery goal of 150 breeding pairs. Therefore, all elements of this criterion cannot yet be evaluated.

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

Habitat degradation and loss continue to represent the greatest threat to successful recovery of the piping plover in the Great Lakes breeding range. Protective measures to ensure long-term maintenance of the biological and physical attributes of essential breeding and wintering habitat are underway, but many are still needed to recover the Great Lakes population and support the population goal for the future.

Initial efforts to protect essential habitat were undertaken through designation of critical habitat. Thirty-five units were designated as critical habitat along a total of approximately 325 km (201 mi) of Great Lakes shoreline in Minnesota, Michigan, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania, and New York. Other measures such as land acquisition and establishment of conservation easements have also been initiated (see criterion 5 below).

A multi-partner recovery program has been established that involves a number of federal and state land management agencies as well as non-governmental organizations. These partners have demonstrated a long-term commitment to piping plover conservation. For example, both National Forests in Michigan, where piping plovers currently occur, have completed Land and Resource Management Plans that include a number of actions related to piping plover conservation, such as limits on off-road vehicle use and other recreational uses which potentially disturb nesting plovers.

The States of Michigan and Wisconsin have recently completed Wildlife Action Plans, which provide a strategic framework and set of management tools for a long-term conservation approach for state species of concern. The Great Lakes piping plover is identified as a species of greatest conservation need in both plans, and additional action by the states is anticipated.

Because ESA protections are a major underlying motivator for many recovery partners and landowners, it is unclear how ESA delisting would affect management practices and commitments that are needed to manage those major threats, such as human beach recreation and predation, which cannot be eliminated. Although progress has been made toward protecting and maintaining habitat at several sites, many stakeholders understand that the continuation of protections (at some level) will be needed in perpetuity. As such, efforts to develop formal mechanisms to provide for post-delisting conservation must be increased.

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

This criterion has not been met. As discussed in section GL 2.3.3.5 below, Miller et al. (2009) recently conducted a molecular genetic investigation of piping plovers based on mitochondrial DNA sequences and eight nuclear microsatellite loci of samples from 23 U.S. states and Canadian provinces, including analysis of samples from 17 individuals in the Great Lakes population.

Genetic diversity estimates for both mitochondrial and microsatellite data sets for Great Lakes piping plovers were presented by Miller et al. (2009). Although diversity measures for Great Lakes population mitochondrial DNA were somewhat lower than those for other piping plover populations, microsatellite marker diversity measures were close to or higher than for the Northern Great Plains and Atlantic Coast populations in the U.S. and Canada. No conclusions were made, however, regarding the adequacy of genetic diversity of the Great Lakes population or of vulnerability of the population to genetic drift over the long term. Ongoing research by the University of Minnesota may provide additional information and insight into this criterion.

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

The primary goal of this criterion, which has not been met, is the creation and implementation of Memoranda of Understanding or long-range management plans with federal, state, and local government agencies 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. All of these needs, however, cannot be completely defined at this time, as the population is likely to continue its geographic expansion in the Great Lakes basin.

Long-term protection and management of breeding areas in the Great Lakes basin is underway. As indicated in GL 2.3.3.1, habitat protection in Michigan has occurred through land acquisition as a result of the USFWS Recovery Land Acquisition and HCP Land Acquisition Programs under section 6 of ESA. This includes a shoreline site of approximately 90 acres in Benzie County, Michigan, and a 750-acre site in Cheboygan County. These sites are currently being protected and/or managed through a joint agreement between the Michigan Department of Natural Resources and The Nature Conservancy (TNC). Activities underway at these sites include invasive species plant removal and protective measures to limit human disturbance.

In Wisconsin, the USFWS recently (2008) entered into a Memorandum of Understanding with the National Park Service and the Bad River Band of Lake Superior Tribe of the Chippewa Indians for the protection, monitoring, and management of occupied piping plover nesting areas in northern Wisconsin. The agreement provides for coordination of protection efforts and establishes roles and responsibilities of each partner.

Long-term protection and management of wintering habitat is also underway. As indicated in section WM 2.2.2 of this document, progress towards understanding and managing threats to migration and wintering piping plovers and their habitats has accelerated in recent years. Considerable effort is needed, however, to further refine management needs and techniques. These efforts must precede long-term commitments to implementation. Increasing emphasis on conservation needs during migration and wintering portions of the piping plover's life cycle is a very high priority recommended future action for Great Lakes piping plovers, as well as for Atlantic Coast and Northern Great Plains populations (see section WM 4.1).

GL 2.3.2 Biology and habitat

Since the 1991 five-year review, considerable new information has been developed on the biology and habitat use of the Great Lakes population. Most of this new information was incorporated into the 2003 recovery plan; this review provides additional informational obtained since 2003.

GL 2.3.2.1 Life history:

New information on the life history of the Great Lakes piping plover is limited. Haffner's (2005) study of home range size of breeding pairs in the Great Lakes found the home range size of piping plovers, fledging at least one chick, ranged from 0.4–11.2 hectares (ha), with an average of 2.9 ± 0.5 ha (1 SE), while linear beach distance traversed ranged from 130–1435 m, averaging 475 ± 53 m (1 SE). The study also found that home range area was smallest on beaches with low public use, suggesting that human disturbance may cause greater movement by individual plovers.

GL 2.3.2.2 Abundance, population trends, and demography:

Abundance and population trends

Annual counts of breeding pairs are conducted throughout the Great Lakes basin by a recovery program partnership consisting of federal and state agencies, as well as universities and non-governmental organizations. These counts have been underway since 1984, two years prior to listing. Monitoring of occupied sites occurs on a daily basis at many locations, and at slightly less frequent rates at others. As of 2008, approximately 82% of breeding adults were uniquely color banded, which greatly increases the accuracy of breeding pair estimates.

The Great Lakes piping plover population, which has been traditionally represented as the number of breeding pairs, has increased since the completion of the recovery plan in 2003 (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a). The Great Lakes piping plover recovery plan documents the 2002 population at 51 breeding pairs (USFWS 2003). The most recent census conducted in 2008 found 63 breeding pairs, an increase of approximately 23%. In addition, the number of non-nesting individuals has increased annually since 2003. Between 2003-2008 an annual average of approximately 26 non-nesting piping plovers were observed, based on limited data from 2003, 2006, 2007, and 2008. Although there was some fluctuation in the total population from 2002-2008, the overall increase from 51 to 63 pairs combined with the increased observance of non-breeding individuals indicates the population is increasing (Figure GL1).

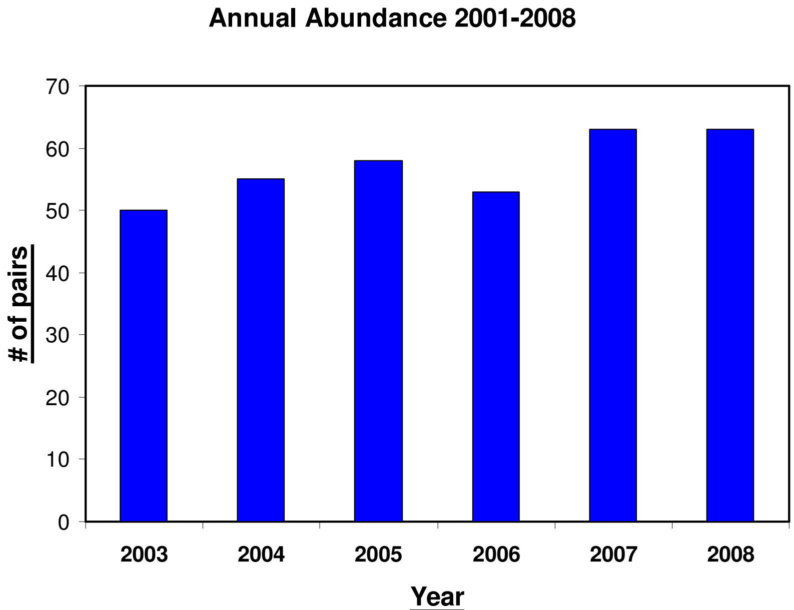

Figure GL1. Annual abundance estimates for Great Lakes piping plovers (2003-2008).

Demographic features and trends

As previously indicated, historical, recent and potential nesting habitats are surveyed in the Great Lakes at the beginning of each breeding season to locate breeding pairs. Once located, pairs are monitored from nest initiation through chick fledging.

All piping plovers captured for banding are currently banded with U.S. Geological Survey (USGS) metal bands and Darvic color bands. Nesting adults and captive-reared chicks receive unique color combinations, whereas wild-reared chicks receive brood-specific color combinations. Nesting adults are trapped on the nest using a single-chambered Potter trap (Lincoln 1947); chicks are caught by hand. Individually banded piping plovers increase the accuracy of demographic estimates, including reproductive success, and make it possible to calculate annual estimates of apparent survival (Φ) and detection probabilities (ρ) using programs such as MARK (White and Burnham 1999).

Productivity

The reproductive success of the Great Lakes piping plover, traditionally called the fledgling rate, is determined by calculating the total number of chicks fledged per breeding pair in a given year. The 2003 recovery plan includes the fledgling rate for each year between 1984-2002. Within these years the rate ranged from a low of 0.63 in 1986 to a high of 2.22 in 2001, with an overall average of 1.39 (USFWS, 2003). Between 2003-2008 the annual fledgling rate ranged from a low of 1.60 in 2005 to a high of 1.97 in 2007, with an overall average rate of 1.76 (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a) (Figure GL2).

Despite the apparent increase between the years of 1984-2002 and 2003-2008, annual fledgling rates vary from year to year and are dependent on several external factors. Seasonal storms can temporarily raise water levels in the Great Lakes, inundating and destroying nest sites. Other stochastic factors such as predation and human encroachment also have a significant impact on annual fledgling rates.

In response to potential nest losses from storms and other factors, a salvage captive-rearing program was initiated in 1998. Under this program, abandoned eggs are collected and artificially incubated. Chicks are hand-reared and subsequently released once they have reached the fledge stage. Since its beginning the captive rearing program has increased the annual number of chicks fledged by an average of approximately 14% (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a).

In a recent evaluation of the captive-rearing effort, Roche et al. (2008) found that wild-reared plovers appear to have higher survival rates than captive-reared birds. Captive-reared (n = 10) and wild-reared (n = 57) plovers laid similar numbers of eggs, but wild-reared plovers hatched 36% more chicks and fledged 56% more young. Furthermore, reproductive values derived from matrix models suggest captive-reared piping plovers are less fit than similarly aged wild-reared birds upon release and demonstrate reduced fitness in subsequent years (Roche et al. 2008). The Great Lakes captive-rearing effort has successfully produced a minimum of 10 breeding adults from 192 eggs that otherwise would have had no reproductive value. These captive-reared individuals now constitute up to 3% of the total population.

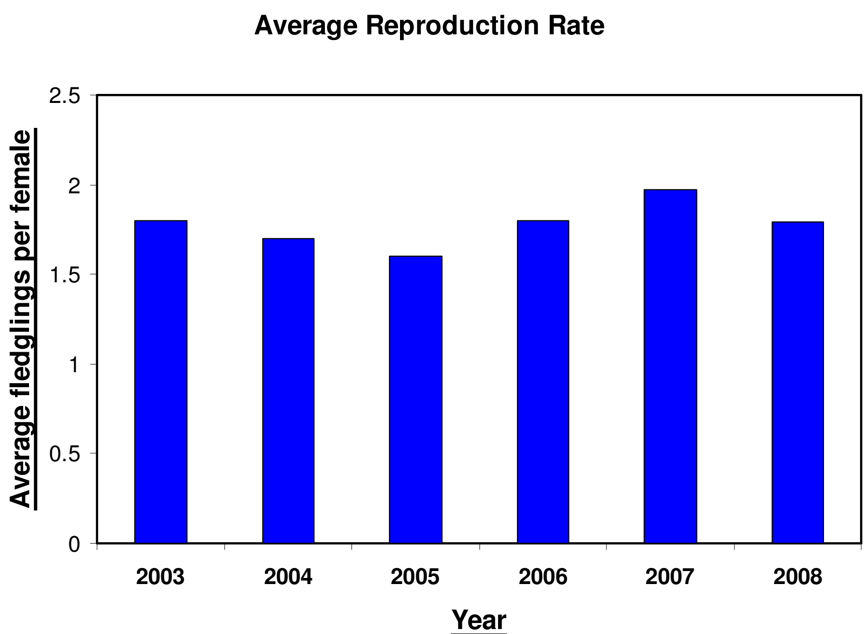

Figure GL2. Average reproductive rates of Great Lakes piping plovers (2003-2008).

Survival

The 2003 recovery plan reported a piping plover adult (after-hatch year) survival rate ranging from 73% to 83% and a fledgling to adult (hatch year) survival rate of 28% (Wemmer 2000 *in* USFWS 2003). More recently, Cuthbert and Roche (2007a) found an average after-hatch year survival rate of 77% and an average hatch year survival rate of approximately 24% (based on data collected from 1993-2005). Significant efforts to reduce predation during the breeding season are underway, but some mortality-causing factors remain undiscovered (Cuthbert and Roche 2007a) and/or difficult to mitigate.

In a mark-recapture analysis of resightings of uniquely banded piping plovers from seven different breeding areas, Roche et al. (2009) found that apparent adult (after-hatch year) survival declined in four populations, including the Great Lakes. None of the populations increased over the life of these banding studies. Some evidence of correlation in year-to-year fluctuations in annual survival of Great Lakes and Atlantic (eastern) Canada populations, both of which winter primarily along the southeastern U.S. Atlantic Coast, suggests that shared over-wintering and/or migration habitats may be influencing annual variation in survival.

Population viability

In 2006 a population viability analysis (PVA) for the Great Lakes piping plover population was conducted by Cuthbert and Roche (2007a). The Great Lakes piping plover PVA used demographic parameters determined on the basis of field data collected from 1993-2005, to examine the viability of the Great Lakes piping plover over the next 100 years. In addition to this custom model, VORTEX was also applied to the Great Lakes population utilizing the same demographic data. Both models, using time average demographic parameters, projected negative growth rates and eventual extirpation of the Great Lakes population within 100 years. Model scenarios to test the predictive accuracy of the PVAs revealed that both had a tendency to underestimate the observed population growth (Cuthbert and Roche 2007a). The PVA models also showed after-hatch year survival rates had the greatest impact on the overall viability of the population. In exploring possible mechanisms by which the models could be made to mimic the observed levels of the Great Lakes population, Cuthbert and Roche (2007a) determined that a minor increase in the model input for hatch-year survival along with the additional recruitment of approximately six individuals per year could cause the models to project population growth that more accurately reflects the observed number of breeding pairs. This observation suggests a small number of breeding pairs go undetected each year at sites not currently surveyed/monitored as part of the annual recovery program. This conclusion has led to increased survey efforts in historical locations or other areas of potential habitat.

GL 2.3.2.3 Genetics, genetic variation, or trends in genetic variation:

See section GL 2.3.3.5.

GL 2.3.2.4 Taxonomic classification or changes in nomenclature:

Miller et al.'s (2009) recent genetic investigation of North American piping plovers included an analysis of samples from 17 individuals in the Great Lakes population. They confirmed that birds from the Great Lakes region are allied with the interior subspecies group and should be taxonomically referred to as *C. m. circumcinctus*. (See the discussion of taxonomy in section 2.1.2.)

GL 2.3.2.5 Spatial distribution:

The 2003 Great Lakes piping plover recovery plan states that from 1986-2002, nests were found in 12 counties in Michigan and two counties in Wisconsin, as discussed below. Since then, the population has increased and expanded east into Ontario along the eastern shoreline of Lake Huron, and both west and south along the northern and eastern shorelines of Lake Michigan (Figures GL3 and GL4).

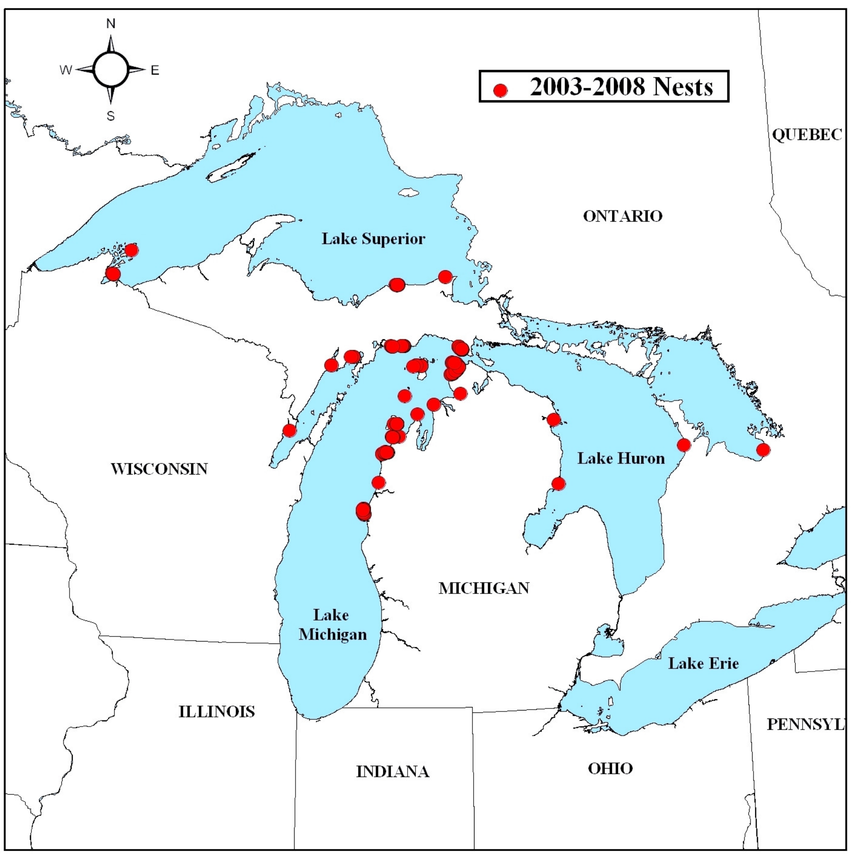

Figure GL3. Piping plover nest site locations for the Great Lakes region, 2003-2008.

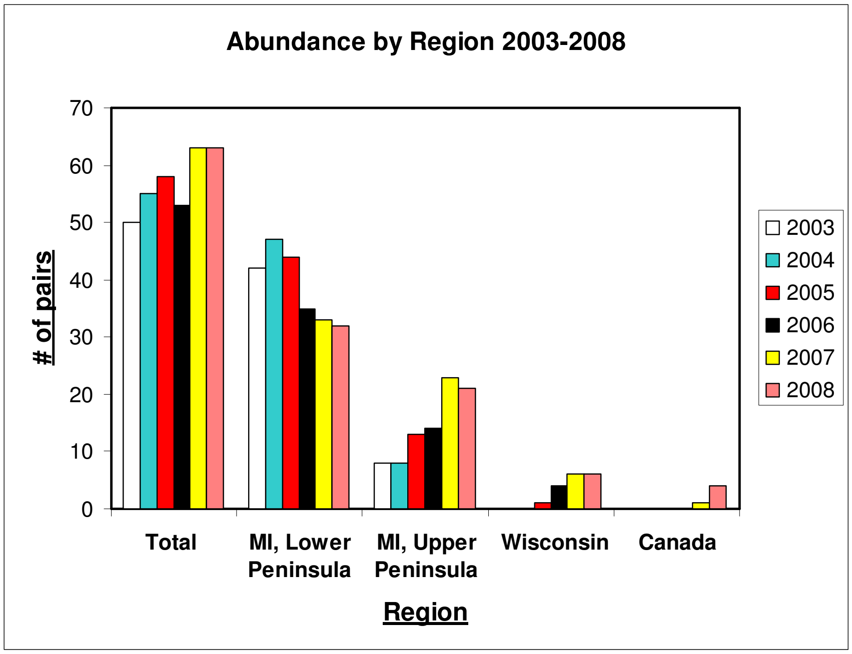

Figure GL4. Annual abundance estimates, per region, for Great Lakes piping plovers (2003-2008).

Michigan

In Michigan, between 2003-2008, nests were found on beaches in Delta and Manistee counties, areas not previously used as nesting sites (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a). While this may indicate some level of range expansion, several previously utilized beaches along the western shore of Lake Huron were virtually abandoned. Between 1986 and 2002, several sites in Iosco and Alpena counties were routinely used for nesting; however, from 2003-2006 none of these beaches were found to be used by nesting piping plovers (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a). In 2007, a nest was discovered at Au Sable Point in Iosco County, but the nest was abandoned prior to any chicks hatching (Cuthbert and Roche 2007b). The reasons for the shift away from Lake Huron sites are unclear, but many of these sites are privately owned and human disturbance may be a factor. Additional sites along the southern shore of Lake Superior traditionally utilized as nesting areas in the 1980s have gone unused in recent years. The reduction in range along the shorelines of Lakes Huron and Superior, combined with the expansion along the Lake Michigan shoreline, appears to indicate a distributional trend toward the Lake Michigan basin. In addition to this trend, there appears to be a growing trend toward use of public land. Since 2003 at least 70% of the nests have been located on publicly owned lands (Figure GL5). Nearly 25 % of these nests are found in Michigan's Sleeping Bear Dunes National Lakeshore. This relatively high nesting density may be attributed to a predation control program implemented in 2003. Under this joint program, the NPS and the USDA Wildlife Services attempted to reduce and control predator populations on North Manitou

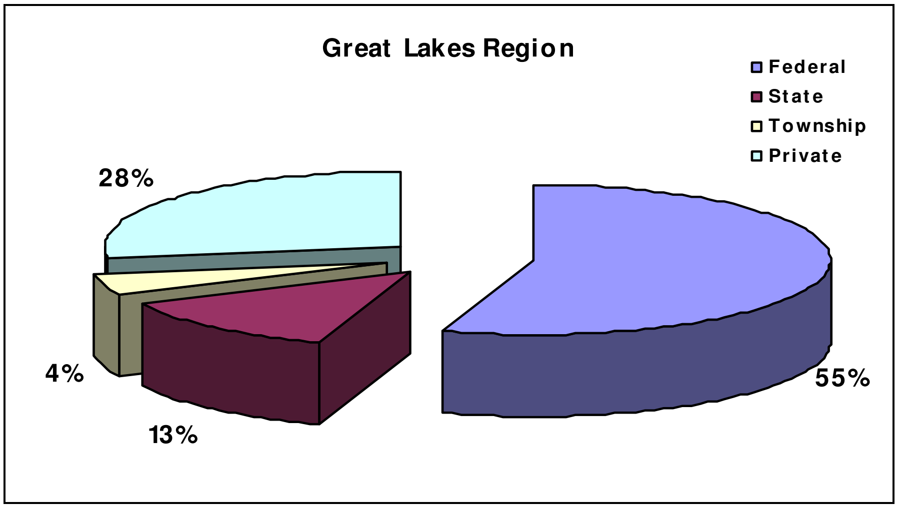

Figure GL5. Distribution of piping plover nest locations by land ownership in the Great Lakes region, 2003-2008.

Island. Since the program's start, the number of nesting pairs found on the island has increased from an average of approximately five for the years 2000-2002 to an average of approximately12 for the years 2005-2007. Limited access and restrictions on the use of recreational vehicles on most publicly owned lands in Michigan may be additional factors associated with the increasing trend of piping plovers on public land.

Wisconsin

Although there were no nesting pairs in Wisconsin from 2003-2004, since 2005 there has been at least one nesting pair each year (Stucker et al. 2003, Stucker and Cuthbert 2004). Both the 2007 and 2008 surveys found a total of six nesting pairs scattered across the public and private lands of the Apostle Islands National Lakeshore; this is the greatest number of Wisconsin nesting pairs recorded since listing (Cuthbert and Roche 2007a). In 2008, one of the six breeding pairs in Wisconsin was found on Lake Michigan in Marinette County.

Ontario

In 2007, a pair of piping plovers nested successfully on the Bruce Peninsula in Ontario, Canada (Cuthbert and Roche 2007a). This was the first time in 30 years a nesting pair was located on the Canadian Great Lakes shoreline. In 2008, four nesting pairs were found in Canada: one on Sable Beach, two on Wasaga Beach, and one pair near Oliphant. All of the recent occurrences of nesting piping plovers in Ontario, Canada, are part of the Great Lakes population, as indicated by leg band observations.

Other Great Lakes states and provinces

Regular to intermittent reports of piping plovers during the migratory period have been reported from several locations throughout the Great Lakes basin. Sites with more regular occurrences of migrating piping plovers include Indiana Dunes National Lakeshore in Indiana and Illinois Beach State Park in Illinois. Sites with infrequent occurrences of piping plovers during migration include Mentor Headlands Beach and Sheldon Marsh in Ohio, Presque Isle State Park in Pennsylvania, and Point Pelee and Long Point in Ontario.

GL 2.3.2.6 Habitat or ecosystem conditions:

Habitat changes

Some changes in the amount and suitability of breeding habitat in the Great Lakes have occurred since the 2003 recovery plan. From 2003-2008, the Great Lakes experienced a period of lower than average water levels. The Detroit District of the U.S. Army Corps of Engineers (USACE) reported in January of 2009 that Lake Superior remains in its longest period of continuous below-average water levels since 1918, while Lake Michigan-Huron continued its second longest period of continuous below-average water levels (USACE 2009). In August of 2007, Lake Superior set a new record for low water levels. At the end of 2008, however, both lakes were above 2007 levels and projections suggest both lakes will again be higher in 2009 (USACE 2009).

The extended period of lower than average water levels in the Great Lakes led to a general increase in beach width and length at various locations throughout the basin. At some sites, this beach width and length increase has equated to an increase in piping plover habitat and use, but this has not been the case in all areas. For example, although Lake Superior has been at historic water level lows for a period of several years, piping plover use has not generally increased along the Lake Superior shoreline (Cuthbert and Roche 2007a). In addition, potential increases in habitat availability have been offset to some degree by vegetative encroachment and continued habitat development and disturbance (see section GL 2.3.3.1).

Critical habitat

In 2001, the USFWS designated over 200 miles of Great Lakes shoreline as critical habitat (USFWS 2001). The rule has not been revised since publication. While varying lengths of shoreline in all eight Great Lakes states were designated, nearly all the critical habitat currently used for nesting is located in Michigan. One possible explanation for this may be the greater amount of development in and around the areas of critical habitat outside of Michigan. For example, critical habitat areas in Ohio receive considerable recreational use and are adjacent to areas of private residential development. Regular observations of plovers in these areas during periods of migration, however, suggest their continuing importance as plover habitat and suggest the potential for future expansion of nesting areas.

GL 2.3.3 Five-factor analysis

In the following sections, we provide an analysis of the new information pertinent to the Great Lakes piping plover's environment. Within each section we update existing information obtained since the 1991 status review and the 2003 recovery plan. Existing and new threats are discussed, including climate change which is identified as a manmade factor that may affect the species' continued existence.

GL 2.3.3.1 Factor A. Present or threatened destruction, modification or curtailment of habitat or range:

Development

The recovery plan cites shoreline development as the leading cause of habitat destruction in the Great Lakes, and it remains a major threat. As shown in Figure GL5 above, over one-quarter of the available breeding habitat lies on private lands that are particularly vulnerable to development. Activities such as homebuilding; shoreline stabilization; and jetty, pier, and rip rap installation are common examples of coastal changes that occur within the Great Lakes, and these activities continue to threaten piping plover habitat to varying degrees. Although development of occupied sites is controlled, in part, through the section 10 permit process under the ESA, currently unoccupied habitat on private land is subject to unrestricted development, with the exception of actions that have a federal nexus within areas designated as critical habitat.

To date, one Habitat Conservation Plan (HCP) has been developed for piping plovers in the Great Lakes region. The Magic Carpet Woods Association HCP (2001) was created in response to a private housing development along the shores of Lake Michigan in Leelanau County, Michigan. The plan calls for the protection of plover habitat through landowner agreements that restrict activities known to impact piping plovers, such as off-road vehicle use. The HCP also established a fund to support piping plover conservation activities in the Great Lakes.

Loss of habitat due to development pressure also occurs to a limited degree on federal lands, which currently support approximately 55% of the breeding sites. Informal and formal consultations under section 7 of the ESA have been conducted at a number of sites throughout the basin. Recently completed or ongoing formal consultations include navigational and shoreline stabilization projects with the U.S. Army Corps of Engineers, Forest Management Plans with the U.S. Forest Service, and shoreline habitat restoration projects with the National Park Service. Other projects with federal jurisdiction subject to previous consultation include boat ramps and launches and even hazardous waste remediation.

Disturbance in the form of recreational uses also continues at these sites, although nearly all federal land management agencies are currently participating in the ongoing recovery program and actively support various recovery actions. These include management of current nesting sites, limiting recreational uses, conducting regular outreach activities, and managing habitat conditions.

Vegetative encroachment

Several coastal areas traditionally used by piping plovers in the past have gone unused in recent years (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a). These include several sites in northern Michigan, such as Wilderness State Park. As recently as 2001, Wilderness State Park supported over 35% of the entire Great Lakes population. By 2008, the number of breeding pairs at the park was down to one. One possible explanation for this is that increases in vegetation have reduced the overall width of open beach. Piping plovers usually require approximately 30 m of open sandy beach for nesting (Lambert and Ratcliff 1981, Powell and Cuthbert 1992, Allan 1993 *in* USFWS 2003). In areas lacking natural disturbances (e.g., lake level fluctuations, storms, ice scour), vegetation can cover beaches and grow nearly to the water's edge, making the area unsuitable for nesting. The percentage of vegetative cover along the shoreline at Wilderness State Park, for example, has increased in the past six years and may have contributed to the reduction of breeding habitat (Stucker and Cuthbert 2005).

Habitat improvement

Several management agencies have attempted to improve the suitability of breeding habitat through various methods. The U.S. Forest Service has deposited gravel onto various areas of open beach in an attempt to encourage nesting. Both TNC and the NPS have conducted small scale invasive species plant removal and control, which aids in maintaining the natural coastal ecosystem that plovers require for breeding. Although these efforts have not been the subject of formal scientific inquiry to evaluate success, the fact these areas continue to be selected as breeding sites suggests that plovers find them suitable for nesting.

Habitat protection through acquisition

Habitat protection through acquisition has occurred in Michigan as a result of the Service's Recovery Land Acquisition and HCP Land Acquisition Programs under section 6 of ESA. This includes a shoreline site of approximately 90 acres in Benzie County, Michigan, and a 750-acre site in Cheboygan County, Michigan. These sites are currently being protected and/or managed through a joint agreement between the Michigan Department of Natural Resources and TNC. Activities underway at these sites include invasive species plant removal and protective measures to limit human disturbance.

Summary

Shoreline development continues as the leading cause of habitat destruction in the Great Lakes. Habitat improvement and protection through acquisition has occurred, but not at rates which offset the impacts of development.

GL 2.3.3.2 Factor B. Overutilization for commercial, recreational, scientific or educational purposes:

Overutilization for commercial, recreational, scientific or educational purposes was identified as a low threat in the 2003 recovery plan, and that threat level remains unchanged. Collection of an endangered species in any form is prohibited under the Endangered Species Act. As such, threats from most forms of overutilization do not represent a current danger to the Great Lakes piping plover. In the absence of ESA protections, provisions of the Migratory Bird Treaty Act would continue to limit collection of the species. Scientific investigations currently underway are conducted under the authority of permits issued under section 10 of the ESA, and are closely monitored. Current investigations include collection of feather samples for genetic analysis, close observation and monitoring of nest sites, and leg banding. Activities such as banding may result in short-term disturbances during capture, and have the potential for leg injury. Since 2003, a small number of individuals (<5) in the Great Lakes population have been reported with conditions that may have been related to leg bands. It should be noted, however, that some leg injuries may have been due to other causes. In 2004, banding protocols were modified, including a change in leg band position; since that time no observations of band-related injuries have been reported.

In summary, any threats posed by commercial, recreational, scientific, or educational purposes remain low and unchanged from the 2003 recovery plan.

GL 2.3.2.3 Factor C. Disease or predation:

Disease

The 2003 recovery plan describes the impacts of disease as insignificant. However, since then, two disease-related mortality events have occurred in the Great Lakes population. In 2004, two young-of-the-year piping plovers were found dead in Benzie County, Michigan. Upon diagnosis from the USGS National Wildlife Health Center (NWHC), aspergillosis, was determined to be the cause of death. No further cases of aspergillosis in the Great Lakes have been reported.

In 2007, two chicks and two adult piping plovers succumbed to Type E botulism poisoning at Sleeping Bear Dune National Lakeshore, Benzie and Leelanau counties, Michigan. Type E botulism is a paralytic, typically fatal disease of birds. Outbreaks have occurred at various times in the Great Lakes basin, with some of the earliest outbreaks documented in Michigan in 1963. Significant outbreaks also occurred in 1976 and 1981 (T. Cooley, Michigan Department of Natural Resources, pers. comm. 2008). The recent outbreak began in 2006, when several thousand waterbirds succumbed to the disease in the northern Lake Michigan area. Two relatively new invasive species to the Great Lakes are suspected as playing a role in recent outbreaks. Current information suggests that zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*), which live in close association with bottom sediments, pick up the Type E toxin produced by the *Clostridium botulinum* bacteria. These mussels are then consumed by non-native round gobies

(*Neogobius melanostomus*), which die from toxin exposure. Dead and dying round gobies are subsequently consumed by a variety of fish-eating birds common in the Great Lakes.

Another potential route of exposure is through the "maggot cycle." As birds die and begin to decompose, maggots infest the carcass and concentrate the Type E toxin. The maggots may then be ingested by other birds, including piping plovers, affecting them with the toxin and eventually causing death. In an attempt to control the spread of the disease, carcasses found along the shoreline are now removed and disposed of. Although fewer waterbird and shorebird mortalities associated with Type E botulism were reported in 2008 compared to 2007 and 2006, potential disease-related mortality remains a concern for the Great Lakes piping plover population.

Rangewide, there were 174 piping plovers submitted to the NWHC between 1986-2008 (A. Ballmann, U.S. Geological Survey, pers. comm. 2008). Although there were a significant number of cases where the cause of death could not be deduced, disease was confirmed in several others. Disease was confirmed as the cause of death in 14 cases and included such diseases as aspergillosas, West Nile virus, avian cholera, and Type E botulism.

Overall, disease has emerged as a potential new threat in the Great Lakes population, although currently the threat level remains low. This could change rapidly, however, as disease outbreaks in the vicinity of piping plover breeding areas are increasing.

Predation

Predation remains one of the most significant threats to the Great Lakes population, as discussed in the 2003 recovery plan. The piping plover is preyed upon by a number of different species in the Great Lakes. The routine use of predator exclosures (cages which keep larger predators out while allowing the attending adults free access to and from the nest) has reduced egg predation and increased hatching success to approximately 85%. To date, few observations have been made to suggest predators have "keyed" into exclosures and increased rate of adult predation. As a result, nest exclosures are used at all sites throughout the Great Lakes.

Although the use of predator exclosures has reduced egg predation, chicks and adults remain vulnerable to a variety of terrestrial and avian predators (Melvin et al. 1992). In 2003, a joint program between the NPS and USDA Wildlife Services was initiated to control predator populations on North Manitou Island in the Sleeping Bear Dunes National Lakeshore. Increases in the number of pairs nesting on the island reflect the relative success of this program (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a).

Of notable concern is the number of piping plovers killed by merlins (*Falco columbarius*). Since 2005, a total of 18 individuals are suspected to have been killed (approximately six per year) by merlins (Cuthbert and Roche 2007a). Most of these attacks occurred at sites in the northwestern portion of Michigan's Lower Peninsula, an area with high densities of nesting plovers. As predation by merlins is likely to increase, studies addressing merlin foraging ecology and the relationship between merlins and piping plovers should be examined.

In sum, predation remains a major threat to the Great Lakes population. Predation of piping plover adults by predatory birds has increased in recent years.

GL 2.3.3.4 Factor D. Inadequacy of existing regulatory mechanisms:

The threats associated with the inadequacy of the existing regulatory mechanisms remain unchanged since the 1991 status review and 2003 recovery plan. The piping plover is protected at the federal level by both the Migratory Bird Treaty Act (MBTA) and the ESA. The MBTA bans the trade of piping plovers and their parts and protects the species from take; in general, however, the MBTA provides far less protection than does the ESA, and the loss of ESA protection could result in increased disturbance and threats to the species. Section 7 of the ESA requires all federal agencies to consult with the USFWS prior to taking actions that may affect the species or its habitat. Federal agencies in the Great Lakes basin are generally aware of piping plovers and piping plover critical habitat, and compliance is considered good.

Section 9 of the ESA prohibits the unlawful take of an endangered species, although this can be difficult to enforce without the regular presence of monitors and/or law enforcement officers. The scale of the habitat area occupied by the Great Lakes population also makes enforcement more difficult. Although lethal take is considered to be very rare, other forms of take such as harassment of nesting adults are considered to be more common.

In addition to federal protection, the Great Lakes piping plover is listed as endangered in Michigan, Wisconsin, Illinois, Indiana, Ohio, and New York. The adequacy of these laws with regard to protection of the species and its habitat, particularly absent the ESA, is of concern. For example, Part 365 of the Michigan Natural Resources and Environmental Protection Act of 1994 extends protection to individuals of a state-listed species, but these protections do not extend to habitat. In the case of piping plovers, therefore, significant habitat loss or destruction could occur, particularly during the nonbreeding season when individuals are not present.

In the Great Lakes, piping plovers nest at sites under private, local government, state, and federal ownership. In some cases regulatory mechanisms such as local ordinances or state laws may provide protections for the population. For example, some state lands are subject to seasonal closure to benefit piping plovers and other migratory bird species. However, implementation of these mechanisms is often constrained by practical limitations such as lack of staff and funding. It is also unknown to what degree these mechanisms would persist in the absence of federal listing of the piping plover.

In conclusion, existing regulatory protections are currently insufficient to eliminate all threats to the population in the Great Lakes. In the absence of the ESA, other existing local, state, and federal regulations would be even less sufficient in terms of protecting piping plovers.

GL 2.3.3.5 Factor E. Other natural or manmade factors affecting the species' continued existence:

Most of the natural and manmade threats outlined in the recovery plan, including human disturbance and small population size, continue to threaten the piping plover's long term viability. Two new threats, wind power and climate change, have recently emerged and are discussed in more detail below.

Disturbance by humans and pets

Human activities such as illegal off-road vehicle usage, unleashed pets, bike riding, bonfires, horseback riding, camping, and beach walking, have all been shown to disturb piping plover nesting habitat and behaviors (Cuthbert and Roche 2008a). Although a large section of beach around each nest is typically enclosed by an arrangement of educational signs, posts, and twine, this psychological boundary is sometimes ignored by pedestrians and unleashed pets. Human disruption of these areas is likely to increase as the shoreline of the Great Lakes becomes an increasingly popular vacation destination.

Small population size/genetic diversity

The recovery plan describes an analysis of the Great Lakes population that found up to 29% of adult plovers remained unmated, suggesting a possible Allee effect[1] (Wemmer 2000 *in* USFWS 2003). On average, from 2003-2008, 18% of adult piping plovers remained unmated (based on limited figures from 2003 and 2006-2008). This decrease may be a reflection of the increased nesting densities in areas of high quality habitat or the overall increase in the population. Other factors, such as uneven sex ratios, may also contribute to this condition.

Increased susceptibility to stochastic events also occurs with a small population size. Small populations are less able to recover from losses associated with events such as severe weather, oil spills, and disease outbreaks. The population-level impacts of threats already mentioned, such as human disturbance, increase when there are fewer individuals in the population.

Another factor often associated with small population size is the potential for low and/or declining genetic diversity. The recovery plan reported a limited occurrence of piping plovers breeding with close relatives based on observations from 1993-1999 (Wemmer 2000 *in* USFWS 2003). Since then, there have been relatively few inquiries into the genetic diversity of the Great Lakes piping plover. In 2007, Cuthbert and Roche (2007a) performed a pedigree analysis that suggested a substantial loss of at least 14 of the 17 founder lineages and an over-representation of the remaining three. In addition they established that the number of observed pairs known to be closely related increased from 1997-2007. Although these data may be seen as somewhat alarming, Cuthbert and Roche (2007a) also

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[1] The Allee or under-population effect arises when population density is reduced to the point where individual reproductive and survival rates are negatively affected.

acknowledged that a large percentage of the Great Lakes piping plover pedigree is unknown, and their results should be considered preliminary.

Miller et al. (2009) recently conducted a molecular genetic investigation of piping plovers, including mitochondrial DNA sequences, and eight nuclear microsatellite loci, based on samples from 23 U.S. states and Canadian provinces. This included an analysis of samples from 17 individuals in the Great Lakes population. They found genetic evidence suggesting that interior birds have experienced genetic bottlenecks and that the Great Lakes region has also experienced a post-bottleneck population expansion. This finding may be interpreted as population growth following a previous bottleneck event (Miller et al. 2009).

Miller et al. (2009) also reported genetic diversity measures for both mitochondrial and microsatellite data for Great Lakes piping plovers. Mitochondrial control region nucleotide diversity and gene diversity were somewhat lower for the Great Lakes population compared with the Atlantic Coast and Northern Great Plains populations in the U.S. and Canada (Miller et al. 2009). The average Great Lakes mitochondrial nucleotide diversity was also below the mean (but still within the range) observed at the same locus in a study of snowy plovers (*Charadrius alexandrinus*). The lower mitochondrial nucleotide diversity associated with Great Lakes birds may be attributed to historically low (or currently small) population sizes, founder events, or bottlenecks. For microsatellite markers, however, the average number of alleles per locus and heterozygosity in the Great Lakes samples were in the middle of the range observed for all piping plover populations.

Although diversity measures observed by Miller et al. (2009) suggest that the current level of genetic diversity may not be deleterious to Great Lakes piping plovers, further consideration of this issue is warranted. Furthermore, this small population may still be vulnerable to genetic drift over the long term. Ongoing research by the University of Minnesota may provide additional information and insight into these issues.

Wind power

As the pressure to produce energy from alternative sources increases, the potential for wind farm construction in and around the Great Lakes will also increase. Wind turbines can be detrimental to local and migrating populations of birds. While little is known about the exact migration routes of piping plovers, individual observations along the Great Lakes coastline suggest they may use the shorelines as travel corridors. As these are typically the same areas targeted for wind farms, the potential for impacts could be large. Close monitoring and planning will be necessary to limit these impacts as the demand for wind power increases.

Climate change

The potential impacts of climate change are increasingly evident in the Great Lakes region. Summer lake water temperatures are increasing, with Lake Superior's average summer surface water temperature increasing by 4.5° F since 1980 (Austin and Colman 2007). Ice is forming later and melting earlier throughout the region. According to scenarios used in the National Assessment, average temperatures in the Great Lakes region could increase 4° to 8°

F by 2100, while precipitation could increase by 25% (Sousounis and Glick 2000). Despite projected increases in precipitation, increased air temperatures and reduced ice cover are expected to result in lake level decreases of 1.5 to as much as 8 feet. These changes could have significant effects on both aquatic and terrestrial ecosystems.

Expected changes due climate change could have both positive and negative effects on piping plovers and their habitats. Reductions in lake levels could potentially increase the amount of available habitat by increasing the width and length of open beach, areas preferred by Great Lakes piping plovers. Conversely, a longer growing season, coupled with the loss of ice scour, may allow for additional vegetative encroachment, thus decreasing the amount of available habitat. Increases in regional temperatures may also alter the frequency and intensity of seasonal storms, which can inundate and wash out nests. Such changes could have a particularly significant impact in areas where nest densities are high. Overall, the magnitude of the threats regarding climate change is yet unknown, but the impact of regional changes will have to be monitored closely to ensure the piping plover's persistence.

GL 2.3.4 Synthesis

In assessing the status of the Great Lakes piping plover population, we considered whether the population continues to warrant protection as an endangered species, whether it should be reclassified as threatened, or whether it no longer requires ESA protection. Progress towards recovery (summarized in section GL 2.3.1); new information about demographic characteristics, genetics, distribution, and habitat conditions (section GL 2.3.2.); and analysis of listing factors and relevant conservation measures (section GL 2.3.3) were all considered in this review. Other pertinent considerations include new information regarding demographic characteristics, distribution, and habitat conditions, as well as analysis of threats facing Great Lakes piping plovers in their coastal migration and wintering range (section WM 2.2.2).

The population has shown significant growth, from approximately 17 pairs at the time of listing in 1986 to 63 pairs in 2008. The total of 63 breeding pairs represents approximately 42% of the current recovery goal of 150 breeding pairs for the Great Lakes population. Productivity goals, as specified in the 2003 recovery plan, have been met over the past five years. During this period, the average annual fledging rate has been 1.76, well above the 1.5 fledglings per breeding pair recovery goal. A recent analysis of banded piping plovers in the Great Lakes, however, suggests that after-hatch year survival (adult) rates may be declining. Continued population growth will require the long-term maintenance of productivity goals concurrent with measures to sustain or improve other important vital rates.

Although information considered at the time of the 2003 recovery plan suggested the population may be at risk from a lack of genetic diversity, currently available information suggests that low genetic diversity may not pose a high risk to the Great Lakes population. Additional genetic information is needed to assess genetic structure of the population and verify the adequacy of a 150-pair population to maintain long-term heterozygosity and allelic diversity.

Several years of population growth are evidence of the effectiveness of the ongoing Great Lakes piping plover recovery program. Most major threats, however, including habitat degradation, predation, and human disturbance, remain persistent and pervasive. Severe threats from human disturbance and predation remain ubiquitous within the Great Lakes basin. Expensive, labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private partners. Because threats to Great Lakes piping plovers persist, reversal of gains in abundance and productivity are expected to quickly follow if current protection efforts are reduced. Considerable work is still needed to meet recovery criteria 3 and 5, including the establishment of long-term agreements among cooperating agencies, landowners, and conservation organizations to ensure sufficient protection and management to maintain population and productivity targets in the population.

Piping plover populations, including the Great Lakes population, are inherently vulnerable to even small declines in their most sensitive vital rates, i.e., survival of adults and fledged juveniles. Therefore, ensuring the persistence of the Great Lakes piping plover also requires maintenance and protection of habitat in their migration and wintering range, where the species spends more than two-thirds of its life cycle. As discussed in section WM 2.2.2 of this status review, habitat degradation and increasing human disturbance are particularly significant threats to nonbreeding piping plovers. Although progress towards understanding and managing threats in this portion of the range has accelerated in recent years, substantial work remains to fully identify and remove or manage migration and wintering threats, which is needed to meet recovery criterion 3.

Emerging potential threats to piping plovers in the Great Lakes basin include disease, wind turbine generators, and, potentially, climate change. A recent outbreak of Type E botulism in the northern Lake Michigan basin resulted in several piping plover mortalities. Future outbreaks in areas that support concentrations of breeding piping plovers could substantially impact survival rates and population abundance. Wind turbine projects, many of which are currently in the planning stages, need further study to determine potential risks to piping plovers and/or their habitat as well as the need for specific protections to prevent or mitigate impacts. Climate-change projections for the Great Lakes include the potential for significant water-level decreases. The degree to which this factor will affect piping plover habitat is unknown, but prolonged water-level decreases are likely to alter habitat conditions and distribution.

We conclude that the Great Lakes piping plover is likely to become extinct throughout its range, and is therefore properly classified as endangered under the ESA. Although more than 20 years of intensive recovery efforts have reduced near-term extinction risks, the population remains susceptible to extinction due to its small size, limited distribution, and vulnerability to stochastic events, such as disease outbreak. In addition, the factors that led to the piping plover's 1986 listing are still present, and regulatory mechanisms are needed to ensure long-term conservation of habitat and continuation of intensive annual management activities. Increased understanding of threats and management is also needed to protect the population during the two-thirds of its life cycle spent in the migration and wintering range. The Great Lakes piping plover continues to warrant ESA protection as an endangered species.

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NGP 2.4 UPDATED INFORMATION AND CURRENT SPECIES STATUS FOR THE BREEDING RANGE OF THE NORTHERN GREAT PLAINS POPULATION

NGP 2.4.1 Recovery criteria

NGP 2.4.1.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Although the Great Lakes and Northern Great Plains Piping Plover recovery plan approved in 1988 contains recovery criteria providing a benchmark for measuring progress toward recovery, not all criteria are considered objective or measurable. For example, Criterion B (protecting essential breeding and wintering habitat) is not well-defined and cannot be measured.

NGP 2.4.1.2 Adequacy of recovery criteria:

Do the recovery criteria reflect the best available information on the biology of the species and its habitat?

No. At the time of the 1988 recovery plan, there was little information available concerning how many piping plovers were necessary to secure the population, the reproduction level needed for stability, and the habitat needed to sustain this population level over time. Since that time, substantial new information has become available to inform recovery needs.

Are all relevant listing factors addressed in the recovery criteria?

In addition to numeric population recovery goals, the plan requires that we provide long-term protection of essential breeding and wintering habitat. This addresses the primary threats to Great Plains piping plovers identified in 1988 – habitat alteration and destruction – that are still relevant today. Other threats known at the time of the plan, such as predation, were not addressed in the criteria but are now understood to be important ongoing threats. Potentially important new threats that have emerged since the 1988 recovery plan include energy development (oil and gas production and wind production) and climate change.

Discussion of how each criterion has or has not been met, citing information:

The criteria from the 1988 recovery plan are discussed below to the extent that they provide useful information on the status and conservation needs of the Northern Great Plains population.

Recovery Criterion A. Number of birds in the Northern Great Plains states will increase to 1,300 pairs.

Although recent annual survey numbers suggest that the U.S. Northern Great Plains population has been at or close to 1,300 pairs since 2004, this number is likely a high estimate. Along the Missouri River (with up to 70% of the U.S. Northern Great Plains population), the U.S. Army Corps of Engineers (USACE) counts adult birds and divides by two instead of counting pairs. The USACE does not track pairs because of the vast area being surveyed and the difficulty in differentiating pairs where there are a large number of densely nesting birds. This method likely overestimates pairs, as it does not take into account nonbreeding birds. Studies have estimated that the percent of nonbreeding birds ranges from 10% to 34% (Prindiville 1986; F. Cuthbert, University of Minnesota, in litt. 2009). Thus, by incorporating the low correction factor of only 10% nonbreeders, the population goal was met only once, in 2005. If we assume that 34% of the birds did not breed, the goal of 1,300 pairs has not yet been achieved. Ongoing studies are expected to help clarify and account for this apparent discrepancy.

The International Piping Plover Census, conducted every five years, also estimates the number of piping plover pairs in the Northern Great Plains. The International Piping Plover Census provides more complete coverage of breeding habitat than the annual surveys, but the five-year window does not allow for rapid trend evaluation. As illustrated in Table NGP1, none of the International Piping Plover Census estimates of the number of pairs in the U.S. suggests that the Northern Great Plains population has yet satisfied this recovery criterion (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

Collectively, this suggests the numeric portion of the recovery goal remains unmet.

Table NGP1. The number of adult piping plovers and breeding pairs reported in the U.S. Northern Great Plains by the IPPC efforts.

Year	Adults	Pairs Reported by the Census
1991	2,023	891
1996	1,599	586
2001	1,981	899
2006	2,959	1,212

Source: Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009.

Recovery Criterion B. Essential breeding and winter habitat will be protected.

The 1988 recovery plan does not define what is meant by protected. This problem is further complicated by the problems associated with protecting an inherently ephemeral habitat. For example, the USACE manages the piping plover habitat on the Missouri River system. During the first few years of a drought, the reservoirs provide breeding habitat to piping plovers along the shoreline and islands exposed from low water. However, over time these areas vegetate over so that they are no longer suitable habitat.

Additionally, even on public lands along river systems that are managed in part for wildlife, piping plover habitat is frequently flooded during the nesting season to provide for other authorized system purposes (e.g., navigation and flood control). On the Missouri River, the USACE must often choose between inundating shoreline nests in a rising reservoir or releasing water from the dam and inundating habitat downstream. Thus, even though the habitat is in federal ownership and protected from development, it is still often flooded during the breeding season.

On the other hand, while most of the alkali lakes (salt lakes in which evaporation leaves a salty crust on the shoreline, precluding most plant growth) in Montana and North Dakota are privately owned, the soil type and blowing salt from the alkali wetlands make most development or farming of these areas impractical, so they remain in pasture. Although the 1988 recovery plan accurately notes that cattle can destroy nests, this has proven to be a relatively minor impact. Therefore, although most alkali lakes have no formal protection, the risk of human-caused disturbance is low.

In Nebraska, a number of piping plovers nest on man-made sand pits. These areas are privately owned and enjoy no formal protection, but the Nebraska Tern and Plover Conservation Partnership works with the pit owners and operators to avoid impacts to piping plovers. However, the sandpits only provide piping plover habitat for a few years before becoming vegetated, and after the sand or gravel has been removed, housing developments are often built around them. Even if they remained undeveloped, without extensive work to keep the shorelines free of vegetation, these areas do not provide long-term habitat for piping plovers.

Section NGP 2.4.3 further discusses current and foreseeable threats to habitat and the adequacy of regulatory protections in ameliorating these threats.

This recovery criterion needs to be clarified to make it objective and measurable. Most piping plover habitat on the Northern Great Plains is not protected, and the habitat along river systems that is state or federally owned is not managed to benefit piping plovers. As discussed in WM 2.2.2.1, there are many ongoing activities on the wintering grounds that are degrading and eliminating piping plover habitat.

Recovery Criterion C. The Canadian Recovery Objective of 2,500 birds for the prairie region will be attained.

The 1988 plan calls for attaining 2,500 adult piping plovers in the prairie region of Canada. The International Piping Plover Census is the only complete survey of this portion of the range (Table NGP2). The most adults counted in prairie

Table NGP2. The number of adult birds counted during each IPPC in Canada and the recovery goal for Canada laid out in the 1988 recovery plan

	FWS Goal	**1991 adults**	**1996 adults**	**2001 adults**	**2006 adults**
Prairie Canada Total	**2,500**	**1,437**	**1,687**	**972**	**1,703**
Alberta	-	180	276	150	274
Saskatchewan	-	1,172	1,348	805	1,420
Manitoba	-	80	60	16	8
Ontario	-	5	3	1	1

Source: Elliot-Smith *et al.* 2009.

Canada reported 1,703 adult birds in 2006, well short of the goal in the 1988 recovery plan (USFWS 1988)[1]. A revision of the USFWS recovery plan will need to include an analysis of the number of plovers necessary to secure the population both in the U.S. and Canada. Some birds hatched in Canada have been documented nesting in the U.S., although the amount of interchange is not known (Miller et al. 2009).

[1] While not deterministic in whether U.S. recovery goals have been achieved, Canada has drafted three recovery plans for their portion of the Northern Great Plains piping plover population (Atlantic and the Prairie Piping Plover Recovery Teams 1989, Goossen et al. 2002, Environment Canada 2006). The most recent Canadian recovery strategy (Environment Canada 2006) has a population goal of 1,626 adult piping plovers for the Northern Great Plains region over 11 years (or three consecutive IPPCs) to consider reclassifying the species as threatened. This number is broken down by region, i.e., 300 in Alberta, 1,200 in Saskatchewan, 120 in Manitoba, and six in Ontario (Lake of the Woods). Although the overall numeric goal was achieved in 1996 and 2006 (it was missed in 2002), the birds were not distributed as laid out in the Canadian recovery strategy. The 2006 Canadian recovery strategy does not specify what would be required for delisting.

Recovery Criterion D. The 1,300 pairs will be maintained in the following distribution for 15 years (assuming at least three major censuses will have been conducted during this time): 60 pairs in Montana, 650 pairs in North Dakota (including 550 pairs in the Missouri Coteau and 100 pairs along the Missouri River), 350 pairs in South Dakota (including 250 pairs along the Missouri River below Gavins Point (shared with Nebraska), 75 pairs at other Missouri River sites, 25 pairs at other sites), 465 pairs in Nebraska (including 140 pairs along the Platte River, 50 pairs along the Niobrara River, 250 pairs along the Missouri River (shared with South Dakota), and 25 pairs in Minnesota (Lake in the Woods).

Results by state and within states (as appropriate) are discussed below. Overall, the distributional and temporal elements of this criterion have not been met.

Montana: The number of pairs in Montana has been near the goal of 60 pairs since 2005 (not less than 56 pairs). Although the goal has been exceeded in a number of years, the target has not been consistently achieved (Figure NGP1).

North Dakota: The overall North Dakota goal of 650 pairs has been exceeded annually since 2004 (Figure NGP2). This is mostly due to birds on the Missouri River, which has been much greater than the North Dakota goal of 100 pairs since 1998. The North Dakota alkali lakes population is well below the goal of 550 pairs (Figure NGP2).

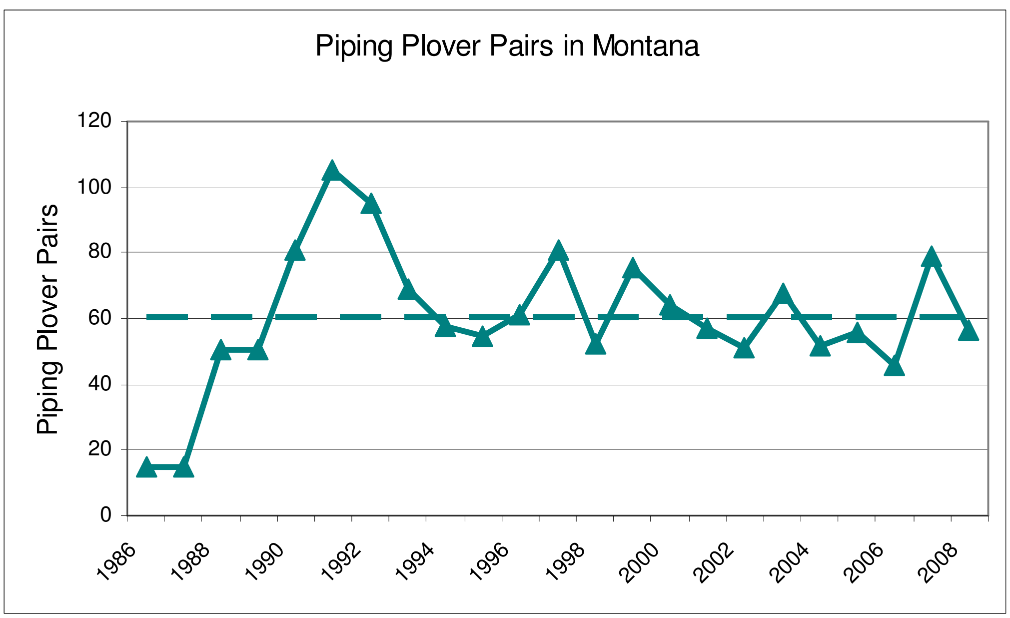

Figure NGP1. The number of piping plover pairs surveyed in Montana from 1986-2008.
Dashed line indicates 1988 recovery plan goals. Source: Missouri River data – USACE in litt. 2008a, USFWS in litt. 2008. Note: Missouri River pairs were estimated by dividing the number of adults counted by two. The IPPC numbers were substituted for 1991, 1996, 2001, and 2006 (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

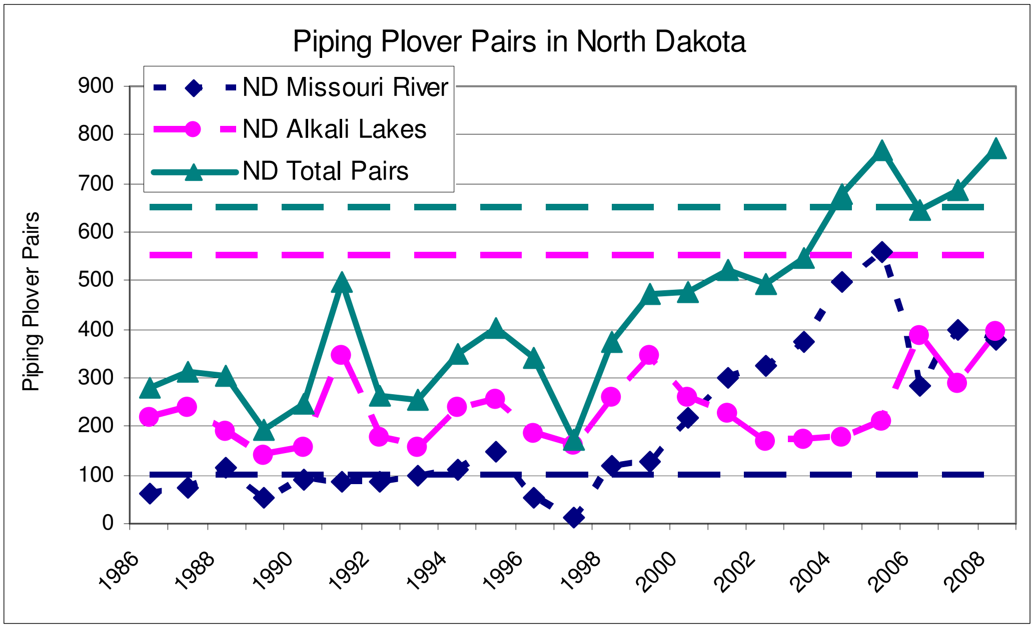

Figure NGP2. The number of piping plover pairs surveyed in North Dakota from 1986-2008.

Dashed lines indicate 1988 recovery plan goals. The goal in the 1988 recovery plan for North Dakota is 650 pairs. This includes 100 pairs on the Missouri River system and 550 pairs on the alkali lakes. The Missouri River goals have been exceeded since 1998, but the goal for the alkali lakes has not yet been achieved. Source: Missouri River data – USACE in litt. 2008a, USFWS *in litt.* 2008a. Note: Missouri River pairs were estimated by dividing the number of adults counted by two. The IPPC numbers were substituted for 1991, 1996, 2001, and 2006 (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

South Dakota: The number of pairs surveyed in South Dakota overall has fallen well short of the goal of 350 pairs (Figure NGP3). The reach below Gavins Point Dam (shared with Nebraska) has been about 100 pairs or more short of the goal of 250 pairs. On other Missouri River sites in South Dakota where piping plovers nest (Lake Oahe, Fort Randall River reach, and Lewis and Clark Lake), the number of pairs has exceeded the goal of 75 pairs since 2000. Off-river sites in South Dakota have only been checked during the International Piping Plover Census efforts, or reported by birders on occasion (R. Olson, South Dakota Ornithologists' Union, in litt. 2008). The numbers have fallen well short of the goal of 25 pairs.

Nebraska: The Nebraska Tern and Plover Conservation Partnership, with help from the USFWS and the National Park Service, monitors these rivers for nesting birds. As discussed above, the number of pairs in the reach below Gavins Point (shared with South Dakota) has been about 100 pairs or more below the goal of 250 pairs (Figure NGP4).

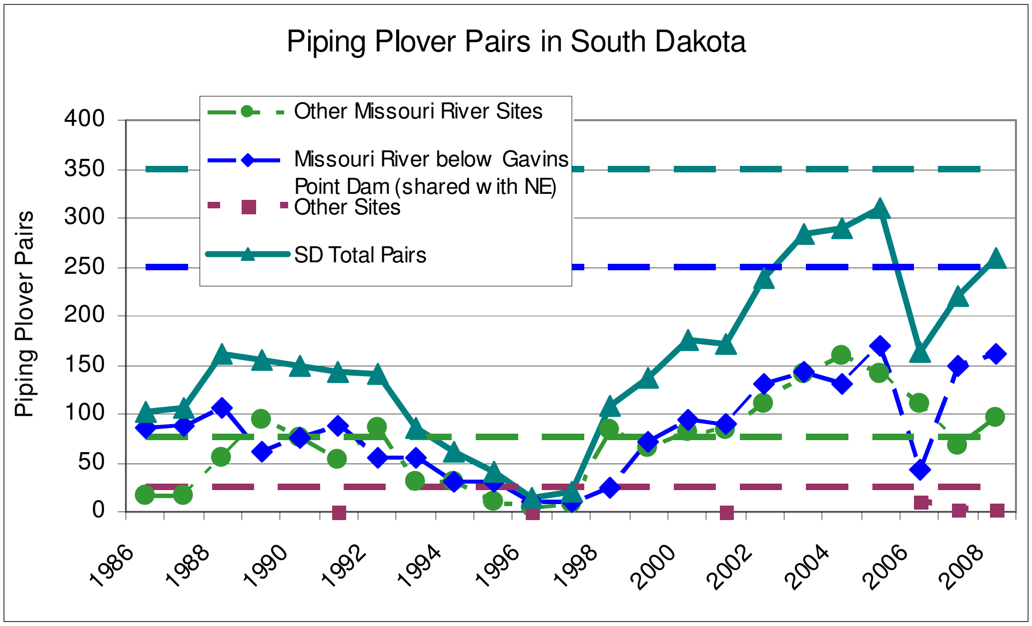

Figure NGP3. The number of piping plover pairs surveyed in South Dakota from 1986-2008.

Dashed lines indicate 1988 recovery plan goals. The goal in the 1988 recovery plan for South Dakota is 350 pairs. This includes 250 pairs on the Gavins Point Dam reach shared with Nebraska, 75 pairs on other sites on the Missouri River and 25 pairs on other sites in the state. The overall state goal has not yet been achieved, nor has the goal for the Gavins Point Reach. The pairs on other parts of the Missouri have exceeded the goal in most years since 1998. Surveys only been performed in most off-river sites in South Dakota only during the census years, 2007 and 2008. The off-river goal has not been achieved. Source: Missouri River data – USACE in litt. 2008, R. Olson, in litt. 2008, Note: Missouri River pairs were estimated by dividing the number of adults counted by two. The IPPC numbers were substituted for 1991, 1996, 2001, and 2006 (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

The Platte River has been near or over its goal of 140 pairs since 2003. This is largely due to a combination of region-wide drought in the 2000s and water management of the dam forming Lake McConaughy exposing reservoir shoreline. The plover pairs on the Niobrara have only been about half of the 50 called for in the recovery plan. The Loup River has not been surveyed regularly, but has never approached the goal of 25 pairs (Figure NGP4).

<u>Minnesota: </u> Minnesota DNR monitors plovers at Lake of the Woods annually. They attempt to estimate both the number of breeding pairs and non-breeding plovers in the area. The number of pairs has never approached the recovery goal of 25 pairs and has dwindled down to one or two pairs since 2002 (Figure NGP5).

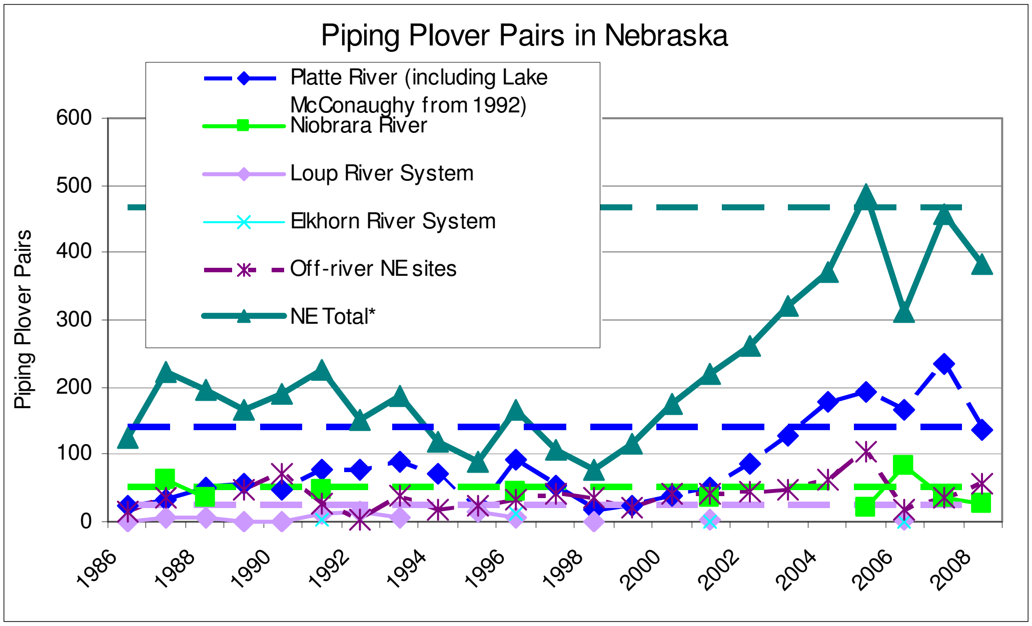

Figure NGP4. The number of piping plover pairs surveyed in Nebraska from 1986-2008.

Dashed lines indicate 1988 recovery plan goals. The goal in the 1988 recovery plan for Nebraska is 465 pairs. This includes 250 pairs on the Gavins Point Dam reach shared with South Dakota, 140 pairs on the Platte River, 50 pairs on the Niobrara River, and 25 pairs on the Loup River system. The overall state goal was achieved in 2005 and came close (457 pairs) in 2007 but was 100 or more pairs off from the goal in other years. The Platte River goals have been at or near the target since 2003. Surveys on the Niobrara have been conducted annually since 2005, but were only done for the IPPC previously. The Loup has only been surveyed in IPPC years and has been well below the goal. The 1988 recovery plan did not mention off-river sites, but a number of pairs have nested at sandpits. Source: Brown and Jorgensen 2008, Peyton and Wilson 2008. Note: The IPPC numbers were substituted for 1991, 1996, 2001, and 2006 (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

<u>Colorado, Kansas, and Iowa</u> (areas not discussed in the recovery plan): Although the recovery plan does not have goals for Colorado, Kansas, or Iowa, a few nesting piping plovers have been documented in these states as seen in Figure NGP6. Colorado and Kansas have been surveyed annually since 1990 and 1998 respectively. The number of pairs in Colorado has ranged between 2 and 18 pairs.

The numbers in Kansas have been very low, with only two to four pairs counted annually, and none reported in 2007-2008. We only have reports of surveys from Iowa during the International Piping Plover Census years. The number of pairs has ranged from four to seven (Haig and Plissner 1992, Plissner and Haig 1996, Ferland and Haig 2002, Elliott-Smith *et al.* 2009).

Overall, the Northern Great Plains population seems to be trending upwards in recent years, but collectively the criterion D targets have not been met.

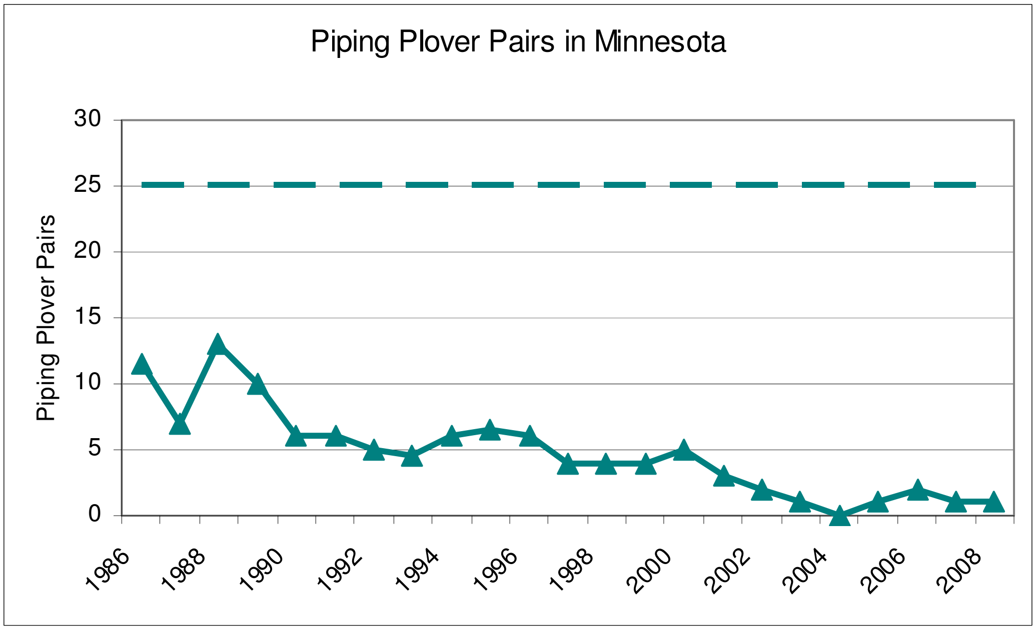

Figure NGP5. The number of piping plover pairs surveyed in Minnesota from 1986-2008.

Dashed line indicates 1988 recovery plan goals. The goal in the 1988 recovery plan for Minnesota is 25 pairs. Source: Haws 2008, K. Haws, Minnesota Department of Natural Resources, in litt. 2009. Note: The IPPC numbers were substituted for 1991, 1996, 2001, and 2006 (Plissner and Haig 1996, Ferland and Haig 2002, Elliot-Smith *et al.* 2009).

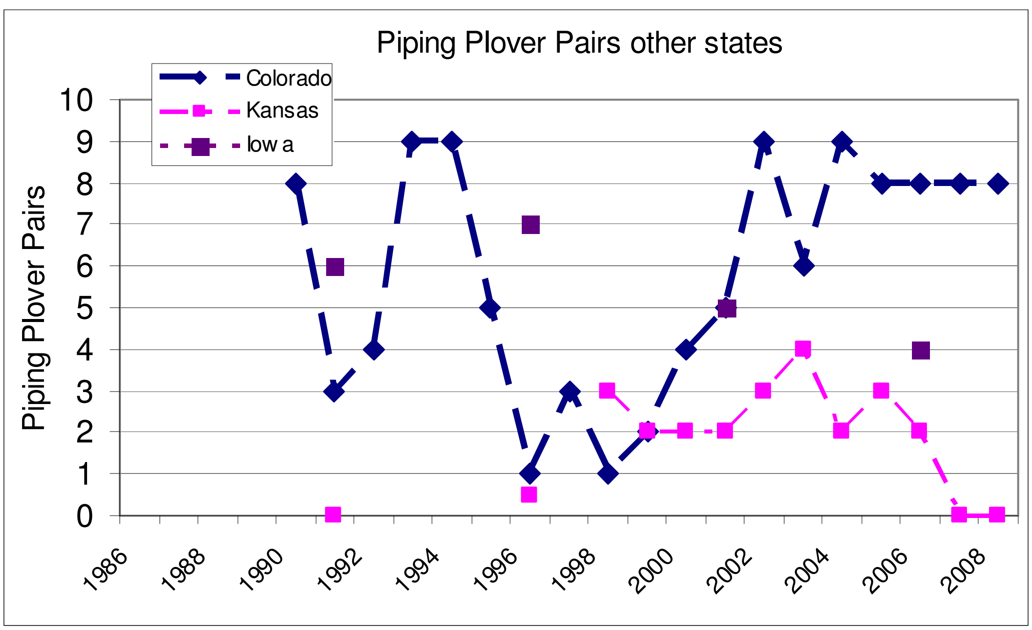

Figure NGP6. The number of piping plover pairs surveyed in other states not included in the 1988 recovery plan.

There were no goals set for these states in the 1988 recovery plan. Source: Colorado - USACE 2007a, D. Nelson, Contractor for the USACE and Colorado Division of Wildlife, in litt. 2009; Kansas – USACE 2006b, G. Covington, USACE, in litt. 2009; Iowa - Elliott-Smith et al. 2009. Note: The IPPC numbers were substituted for 1991, 1996, 2001, and 2006.

NGP 2.4.2 Biology and habitat

Since the previous five-year review in 1991, considerable new information has been developed on the biology and habitat use of the Northern Great Plains population. This review provides additional informational obtained since 1991.

NGP 2.4.2.1 Life history:

Nesting habitat

In the Northern Great Plains, most piping plovers nest on the unvegetated shorelines of alkali lakes, reservoirs, or river sandbars, as described in the 1988 recovery plan. On occasion, however, they will select non-typical sites for nesting.

In the alkali lakes area, plovers have been documented to successfully nest and raise young on dry alkali lake basins, with similar fledge ratios (the number of young able to fly divided by the number of adult pairs) to those in nearby lakes with water (Weber and Martin 1991; E. Madden, USFWS, in litt. 2008). However, fewer birds use the lakes when they are dry compared with years when water is present at the start of nesting (Weber and Martin 1991). On the Missouri River, plovers have been documented to nest among cottonwood seedlings in habitat previously thought too densely vegetated for plovers to select (McGowan et al. 2007). Plovers have also nested much farther from water than previously believed possible. This has been observed on reservoirs as water has dropped during the drought of the 2000s. On Lake Sakakawea in North Dakota, 19 nests were documented to be more than 1,000 feet from water, with one nest more than one-half mile away (G. Pavelka, USACE, in litt. 2008). Presumably, these locations are sub-prime habitats that are selected because of a limited amount of more suitable habitat. On the riverine stretches of the Missouri River, most nests (255) on the Gavins Point Dam river reach were in unvegetated areas, with only one nest in less typical tall vegetation (Felio et al. 2009).

Site fidelity

An ongoing study of banded plovers on the free-flowing stretch of the Missouri River below Gavins Point Dam has shown extremely high site fidelity (the behavior of certain animals whereby they return repeatedly to the same nest site year after year) of adult plovers to an area (not necessarily the same sandbar). In 2006 and 2007, researchers reported return rates of 100% and 89%, respectively, of the known surviving adults to a river reach (D. Catlin, Virginia Polytechnic Institute and State University, in litt. 2009). First-year birds are thought to disperse more broadly than adults (Haig and Oring 1985, D. Catlin in litt. 2009).

Food availability

The 1988 recovery plan focused on information about the specific invertebrates that piping plovers may eat and gaps in information about forage preferences. Exactly what piping plovers eat is still largely unknown, but since 1988 there has been speculation that food availability may vary depending on habitat type (e.g., Missouri River versus alkali lakes). Differences in food availability appear to lead to different fledging success (LeFer 2006).

Limited available forage may reduce plover success in some locations (Nordstrom and Ryan 1996). However, a study comparing forage on the alkali lakes versus three Missouri River areas (two river reaches and a reservoir), did not find a relationship between daily chick survival rates and the number or biomass of invertebrates sampled (LeFer et al. 2008). Other factors such as predation may have had a much stronger impact on chick survival than food availability (LeFer et al. 2008). Plovers on the alkali lakes seem to fledge sooner than those on the Missouri River system (Murphy et al. 1999, D. Catlin in litt. 2009). This has been postulated to be a result of more food resources available on the alkali lakes than on the Missouri River (LeFer 2006). Heavier chicks are more likely to survive to fledging (LeFer et al. 2008). Since fledged birds are presumably better able to avoid predation, reproductive success may be higher in areas with better food resources (LeFer 2008).

There is some very limited evidence that plover forage on the alkali lakes may be produced on the nearby prairie (Nordstrom 1990). If so, changes in surrounding land use may change the available prey on alkali lakes.

In Nebraska, where piping plovers nest on sandpits, researchers have suggested that the sandpits do not provide the same amount of forage as is available on the nearby river systems (Corn and Armbruster 1993).

NGP 2.4.2.2 Abundance, population trends, and demography:

Abundance and viability

The Northern Great Plains population is geographically widespread, with many birds in very remote places, especially in the U.S. and Canadian alkali lakes region. Thus, determining the number of birds or even identifying a clear trend in the population is a difficult task. The International Piping Plover Census was designed, in part, to help deal with this problem by instigating a large effort every five years. During a two-week window, monitors attempt to survey every area with known or potential piping plover breeding habitat. The relatively short window is designed to minimize double counting if birds move from one area to another. The 1988 recovery plan uses the numbers from the International Piping Plover Census as a basis for measuring recovery, as does the 2006 Canadian Recovery Plan (Environment Canada 2006).

Participation in the International Piping Plover Census has been excellent on the Northern Great Plains (Elliot-Smith et al. 2009). The large area to be surveyed and sparse human population in the Northern Great Plains make annual surveys of the entire area impractical, so the International Piping Plover Census provides a tool to help determine the population trend for the entire region. Many areas are only surveyed during the Census years.

Figure NGP7 shows the approximate number of adult plovers in the Northern Great Plains (U.S. and Canada) as estimated by the four International Censuses. The International Piping Plover Census shows that the U.S. population decreased between 1991 and 1996, then increased in 2001 and 2006. The Canadian population showed the opposite trend for the first three censuses, increasing slightly as the U.S. population decreased, then decreasing in 2001. Combined, the International Piping Plover Census numbers suggest that the population declined from 1991 through 2001, then increased almost 58% between 2001 and 2006 (Elliott-Smith 2009).

The increase in 2006 was likely due in large part to a multi-year drought across the much of the region starting in 2001 that exposed thousands of acres of nesting habitat. The USACE ran low flows on the riverine stretches of the Missouri River for most of the years between censuses, allowing more habitat to be exposed and resulting in relatively high fledge ratios (USACE 2008a). The USACE began to construct habitat using mechanical means (dredging sand from the riverbed) on the Missouri River in 2004, providing some new nesting and foraging habitat. The drought caused reservoir levels to drop on many reservoirs throughout the Northern Great Plains (e.g., Missouri River reservoirs in North and South Dakota, Lake McConaughey in Nebraska), providing

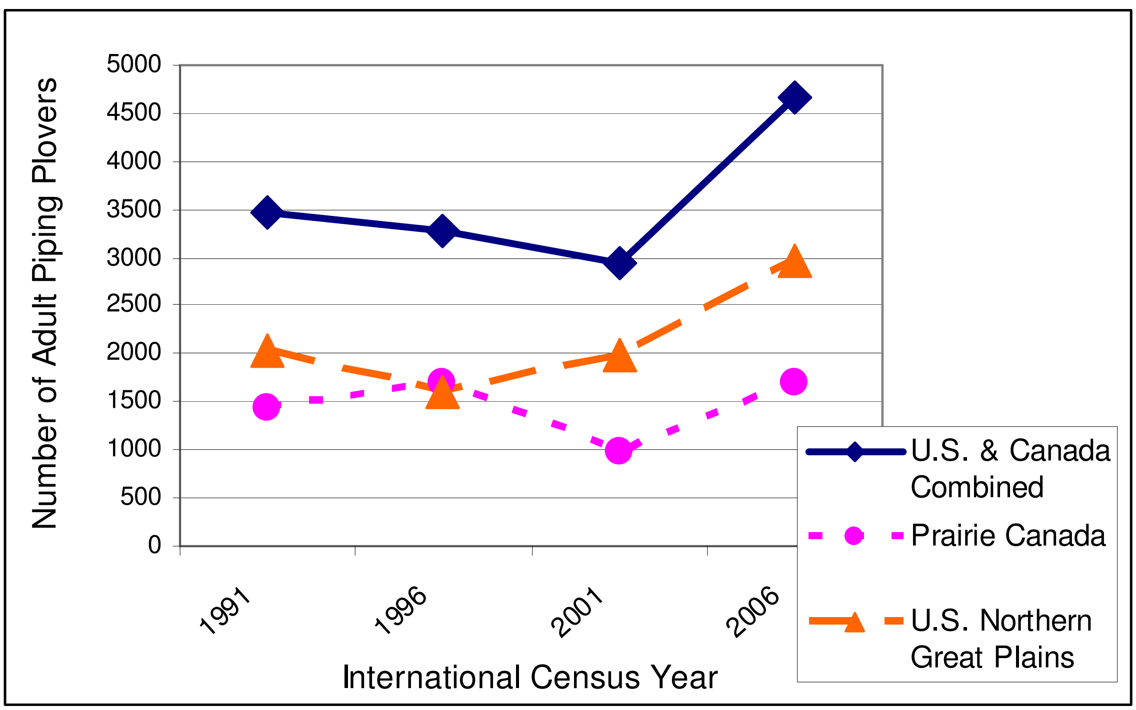

Figure NGP7. The number of adults reported for the U.S. and Canada Northern Great Plains during the International Censuses compared with the U.S. recovery goal.

shoreline habitat. The population increase may also be partly due to more intensive management activities on the alkali lakes, with increased management actions to improve habitat and reduce predation pressures.

While the International Piping Plover Census provides an index to the piping plover population, the design does not always provide sufficient information to understand the population's dynamics. The five-year time interval between Census efforts may be too long to allow managers to get a clear picture of short-term population trends and how to respond accordingly. As noted above, the first three International Piping Plover Censuses (1991, 1996, and 2001) showed a declining population, while the fourth (2006) indicated a dramatic population rebound of almost 58% for the combined U.S. and Canada Northern Great Plains population between 2001 and 2006. With only four data points over 15 years, it is impossible to determine if and to what extent the apparent upswing reflects a real population trend versus error(s) in the 2006 Census count and/or a previous count. The 2006 International Piping Plover Census included a detectability component, in which a number of pre-selected sites were visited twice by the same observer(s) during the two-week window to get an estimate of error rate. This study found an approximately 76% detectability rate through the entire breeding area, with a range of between 39% to 78% detectability among habitat types in the Northern Great Plains.

Such a large increase in population reported may indeed indicate a positive population trend, but with the limited data available, it is impossible to determine by how much. Furthermore, with the next International Piping Plover Census not scheduled until 2011, there is limited feedback in many areas on whether this increase is being maintained or if the population is declining in the interim. Additionally, census results have been slowly released, adding to the time lag between data collection and possible management response.

In 2008, a model was completed to examine the potential impact of incidental take on the Missouri River system on the Great Plains piping plover population (McGowan 2008). The model was developed as an interactive tool, allowing users to input different parameters (e.g., incidental take, adult and juvenile survival, initial population size) as better information becomes available. A number of estimates have been developed for survival (Prindiville Gaines and Ryan 1988, Root et al. 1992, Melvin and Gibbs 1994, Larson et al. 2000, Wemmer et al. 2001, D. Catlin in litt. 2009), ranging from 0.664 to 0.82 for adult survival (Root et al.1992, D. Catlin in litt. 2009) to 0.24 to 0.48 for juvenile survival (Melvin and Gibbs 1994, Wemmer et al. 2001)

Because the numbers reported in the 2006 International Piping Plover Census seemed so high, we ran the model using the higher-end adult and juvenile survival estimates from the literature and no incidental take from USACE operations on the Missouri River (albeit the average take from 2001-2005 was 51 eggs, as reported by the USACE). We reasoned that although average survival is probably somewhere between the lower and higher-end estimates, by using the higher-end numbers we could assess whether the very high numbers reported in the 2006 International Piping Plover Census seemed plausible. With the high-end survival estimates, the model shows only a 13% increase over the five-year period on average. The upper bound using these high-end survival estimates of one standard deviation above average is 51%, 7% below the increase found during the 2006 Census.

This suggests that despite the likelihood of some population increase between 2001 and 2006, it is unlikely that the population has actually grown to the extent indicated by the International Piping Plover Census (even with good habitat conditions in the last five years). Rather, a number of other factors may explain the apparent increase. The breeding population may have been under-counted in 2001 and/or over-counted in 2006 (the tight survey window and large survey area result in participation by less experienced plover surveyors). Plovers can easily be missed because of their cryptic coloration and secretive behavior, especially when surveying from a distance; conversely, the birds are also easy to over-count, especially when walking along a shoreline with a number of territorial pairs. The birds will often mob and follow an observer for some distance, making it difficult to determine which individuals have already been counted. These problems are compounded when the count is done during a single visit to the area, making it difficult to ascertain how many plovers have been using the area that year or how they are distributed along the shoreline. In 2001, the Missouri River reservoirs were relatively low due to drought conditions, exposing many acres of habitat that the survey crews were not accustomed to searching (for example, Lake Sakakawea was approximately 14 feet lower in 2001 than 1996).

In Canada, weather events in the middle of the 2006 survey window caused many nests to fail, which may have led to bird movement from one area to another. Because of the weather, surveyors continued to count after the survey window (Elliott-Smith 2009). The number of adult plovers counted in Canada nearly doubled between 2001 and 2006 (Elliot-Smith et al. 2009, Ferland and Haig 2002). Both of these factors may have led to double-counting an unknown number of birds.

Additionally, it is possible that there are a number of alkali lakes used by nesting piping plovers that have not been included in International Piping Plover Census efforts to date. Some of the birds counted during the 2006 International Piping Plover Census may have been produced on these unsurveyed alkali lakes. Thus, a dramatic increase may reflect immigration from unsurveyed areas rather than a real increase in numbers. Although surveyors strive to check all potential plover habitat during the International Piping Plover Census years, a potentially large number of lakes may be missed. Such a possibility was illustrated by surveys conducted at Long Lake Wetland Management District in central North Dakota. Nine wetlands were surveyed for the first time in 2008, with plovers found at seven. Approximately one-third of the piping plovers found in the District (i.e., 104 out of 339) were at these previously unsurveyed sites.

There have been a number of studies evaluating the reproductive success necessary to stabilize and increase the plover population. Estimates of the fledge ratio needed to maintain a stable piping plover population range from 1.15 to 2.0 fledglings per adult pair (Prindiville-Gaines and Ryan 1988, Melvin and Gibbs 1994, Plissner and Haig 2000, Larson et al. 2002). The most recent model examining population viability suggested that a region-wide fledge ratio of 1.24 would be required for stability (Larson et al. 2002). However, because of the labor-intensive nature of tracking adults and fledglings, many areas do not collect this information. In some areas, e.g., the Missouri River, individual breeding pairs are not tracked and the fledge ratio is calculated by dividing the number of fledglings by one-half of the total adults counted in June of the year (USACE 2009a). The results of this method cannot be compared with the number calculated using breeding pairs, because it includes an unknown number of non-breeding adults. As discussed in NGP 2.4.1.2, the number of non-breeding birds has been estimated to be between 10% and 34% (Prindiville 1986, F. Cuthbert in litt. 2009). In areas where fledge ratios have been collected using breeding pairs, they have often been below even the minimum thought to be necessary for population stability (Larson et al. 2002).

Population distribution

It is unknown whether plovers move to new areas (rather than not breeding) if suitable habitat for nesting is not available in their previous nesting area. Based on International Piping Plover Census results, it has been hypothesized that birds on the Missouri River System move to the alkali lakes to breed if river conditions are poor, and vice versa (Plissner and Haig 1996). Comparing the data with the U.S. alkali lakes and the Missouri River (Figure NGP8), there may be a slight relationship between the number of adults counted in the two areas with several caveats. Except in the four census years, only the core area of the alkali lakes was surveyed. The additional areas surveyed in the

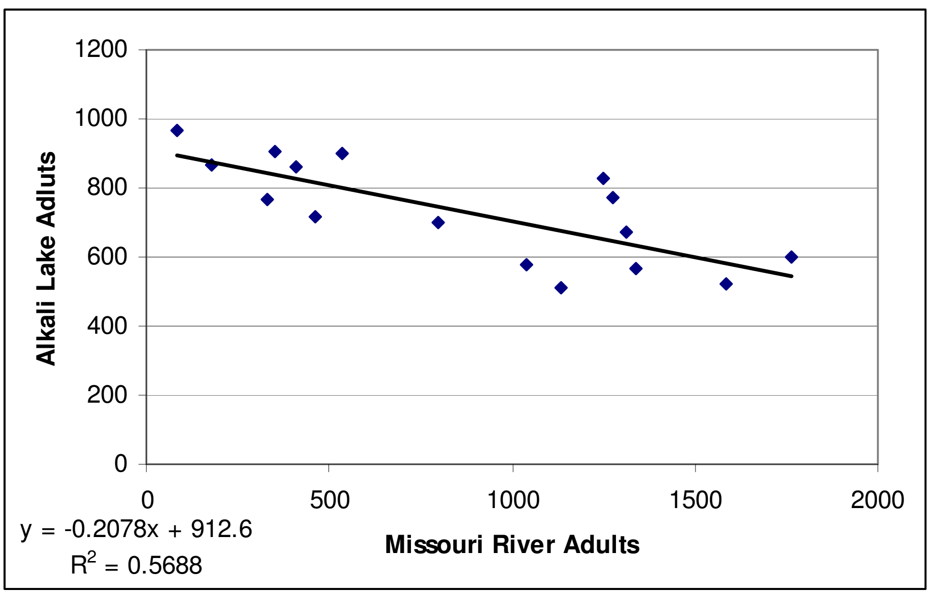

Figure NGP8. The number of adult plovers counted on the alkali lakes, ND and MT, compared with the number of adult plovers counted on the Missouri River in ND and MT, from 1991 and 1994-2008.
Sources: Ferland and Haig 2002, USACE in litt.2008a, USFWS in litt. 2008.

International Piping Plover Census years (and not surveyed in out-years) comprised up to 29% of the adult birds (USFWS 2008a). In fact, the number of birds missed even during International Piping Plover Census years was likely higher, because several new areas supporting plovers were not surveyed until 2008.

NGP 2.4.2.3 Distribution patterns and trends

Missouri River breeding information

The number of adult plovers on the Missouri River system has fluctuated from a low of 86 in 1997 to a high of 1,764 in 2005 (USACE 2008a) as shown in Figure NGP9. The Missouri River accounts for about one-half of the total piping plovers in the U.S. on average (Brown and Jorgensen 2008, Peyton and Wilson 2008, USACE in litt. 2008a, USFWS in litt. 2008). As Figure NGP13 shows, the number of plovers on the Missouri River system is likely inversely related to the amount of water in storage.

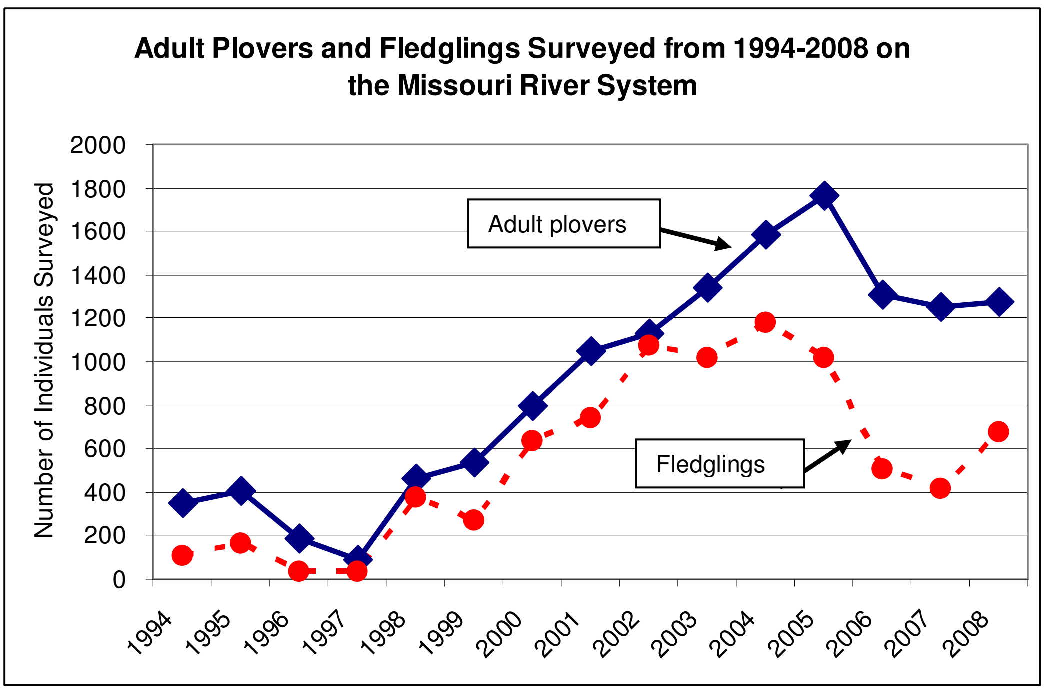

Figure NGP9. Adult plovers and fledged young counted on the Missouri River system, 1994-2008. (USACE in litt. 2008a)

U.S. alkali lakes (North Dakota, Montana, and South Dakota) breeding information

Up to approximately 83% of the plovers in the U.S. Northern Great Plains nest on alkali lakes along the Missouri Coteau from central North Dakota to eastern Montana (Figure NGP10) (Brown and Jorgensen 2008, Peyton and Wilson 2008, USACE in litt. 2008a, USFWS *in litt.* 2008a). Although numbers have varied somewhat annually, the alkali lakes have consistently supported a relatively stable number of plovers (Figure NGP11).

Due to the large area to be covered and access issues (e.g. land in private ownership, limited staff time, time and difficulty in accessing areas), additional areas that are not surveyed also likely support piping plovers. This was illustrated in the Long Lake District, where, as previously mentioned, piping plovers were found during the 2008 season at seven lakes that had not been surveyed previously.

Until recently, piping plovers were thought to use only the Missouri River system in South Dakota, with little to no nesting off of the river. However, in 2007 and 2008, a birder reported a small number of plovers nesting on two alkali lakes in central South Dakota (R. Olson in litt. 2008). While South Dakota does not have the extensive alkali lake system that North Dakota does, there may be other lakes with small populations of nesting piping plovers, at least during some years. These areas are not monitored and may not be visited, even during the International Piping Plover Census years.

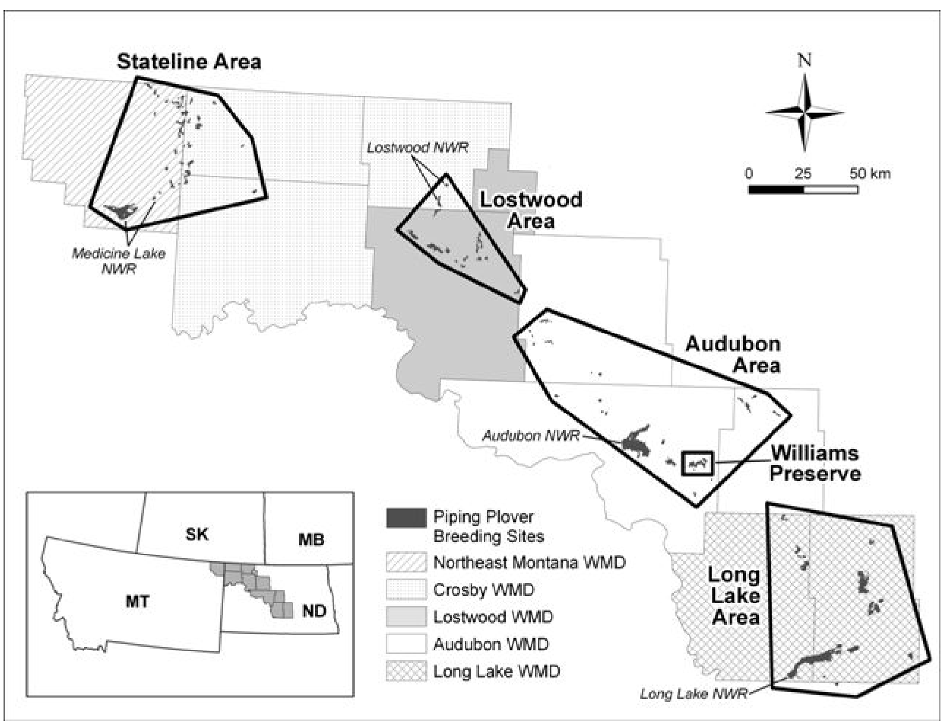

Figure NGP10. The major nesting areas of the U.S. alkali lakes plovers.
(USFWS in litt.2008)

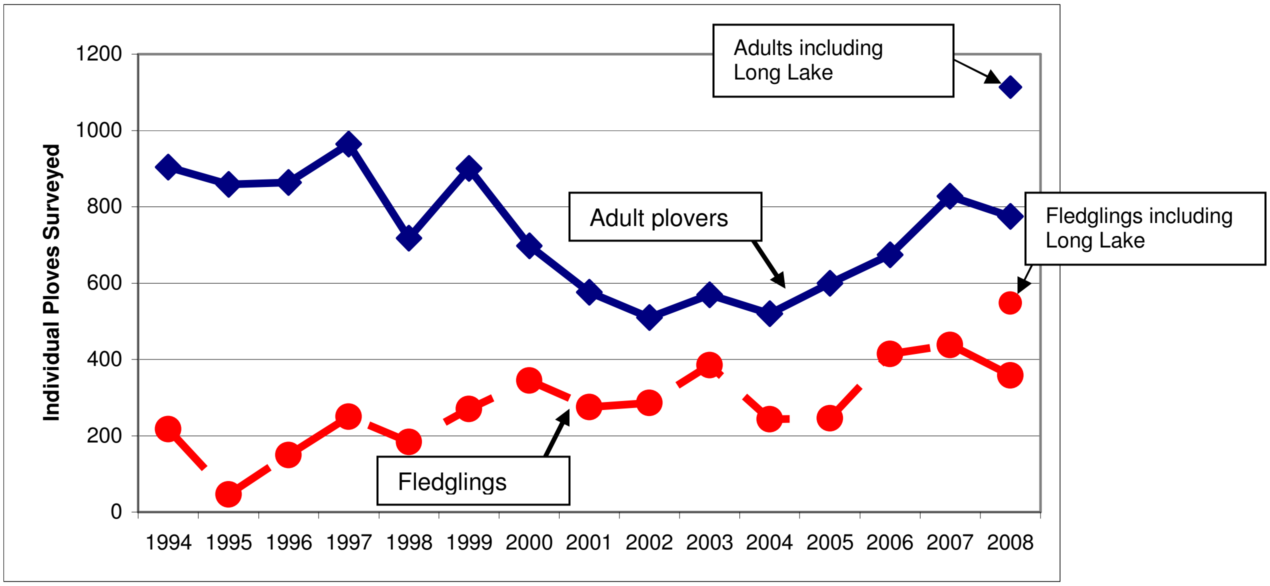

Figure NGP11. The number of adult plovers and fledglings documented on U.S. alkali lakes, North Dakota and Montana 1994-2008.
The number of adults and fledglings including those surveyed at Long Lake Refuge, south of the traditional survey area, are shown for 2008. Since many of the birds at Long Lake were found in areas that had not been surveyed previously, they were not included in the trend lines (USFWS in litt. 2008).

Great Plains Canada

The approximate distribution of piping plovers in Canada is shown in Figure NGP12 (Canadian Wildlife Service 2004). Due to the size of the potential plover habitat and limited resources, much of the potential habitat in Canada is not surveyed annually. During the International Piping Plover Census years, an effort is made to survey all known habitat for adult plovers. As Table NGP2 shows, the numbers have fluctuated considerably. In the 2006 Census, weather conditions interrupted the surveyors, doubling the time it took to do the census. Due to extremely wet conditions, birds may have moved in the middle of the Census period (Elliott-Smith 2009). Thus, it is likely that some of these individuals may have been double-counted. While there was probably a real increase in plover numbers between 2001 and 2006 in Canada, the amount of increase (more than 75%) reported by the International Piping Plover Census is unlikely to be correct.

Parts of the Canadian Great Plains population are surveyed annually. However, due to the large area to be covered, many areas are only surveyed during the International Piping Plover Census years.

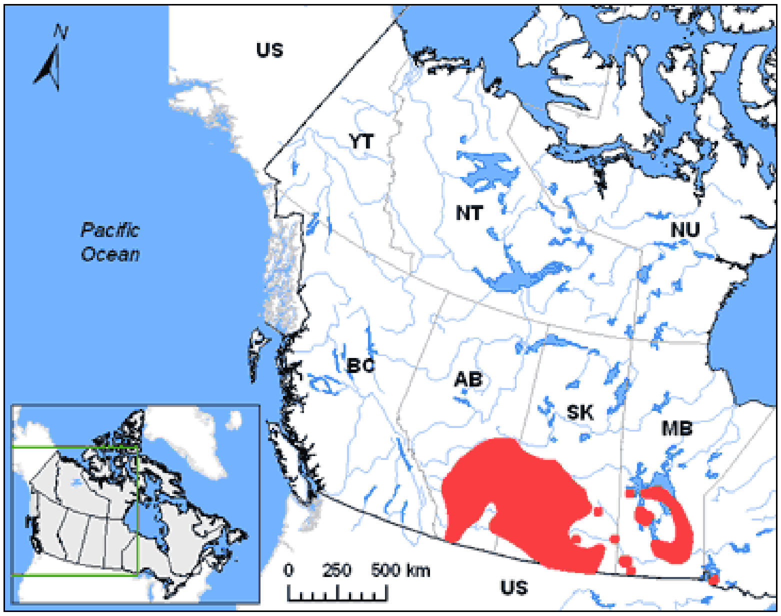

Figure NGP12: Distribution of Northern Great Plains piping plovers in Canada.
Note: Distribution, shown in red, is approximate. Information derived primarily from the COSEWIC Status Report. In many cases additional data sources were used; a complete list will be available in the future. Source: Canadian Wildlife Service, 2004

2.4.2.4 Habitat or ecosystem conditions:

Missouri River

Plover adult numbers seem to be roughly correlated with the amount of suitable habitat available on the Missouri River system. However, there seems to be a time lag between the availability of habitat and population increases. Few birds nested on the system during 1996-1997, when high water inundated most of the suitable habitat. However, the high water also created a great deal of new habitat in the riverine segments, which lasted for a number of years. Following this high water event, the basin entered a prolonged drought that exposed hundreds of miles of suitable nesting habitat along the reservoir shoreline. For these reasons, the population on the river system gradually increased through 2005 (USACE in litt. 2008a).

Conditions on the Missouri River system change drastically depending on the amount of water in storage. In 2000, the USFWS issued a Biological Opinion (USFWS 2000) for the USACE's management of the Missouri River that included Reasonable and Prudent Alternatives to avoid jeopardy to the piping plover. The opinion required flow changes to provide plover habitat over time (USFWS 2000). Several years of high flows, culminating in extremely high water years in 1996-1997, demonstrated that under some flow conditions, habitat could be created through flows. Although there was little habitat available prior to 1998 and few birds on the system (USACE unpubl. data), after 1998 habitat, bird numbers, and breeding success increased. The 2000 Biological Opinion was not implemented, however, and in 2003 the USFWS amended it to allow the USACE to provide sandbar habitat for plover nesting by mechanically building sandbars (through dredging in the river to pile up sand material) or clearing existing sandbars of vegetation to provide habitat (USFWS 2003). The 2003 Amendment to the 2000 Biological Opinion allows the USACE to provide habitat through flow modifications, although this is no longer required (USFWS 2003).

To date, clearing vegetation from existing islands and creating new islands by piling material in the river have been employed to provide addition habitat The USACE has attempted to clear vegetation from approximately 880-980 acres of sandbar habitat on the system, including reservoirs (USACE in litt. 2008a). This was done through a combination of spraying herbicide alone and spraying herbicide followed by clearing the resulting dead vegetation. In general, vegetation treatment has not been considered successful on the Missouri River, with low plover use of treated areas and poor fledge ratios where birds have nested (USACE 2009b). Vegetation removal to provide additional habitat has been successfully performed elsewhere (USACE 2007a).

The 2003 Biological Opinion requires that certain emergent sandbar habitat targets be met (Table NGP3); the targets are the total amount of acreage that must be available. Although the Biological Opinion allows multiple means of meeting these targets, there is only minimal sandbar habitat available under current river management operations, so actions that provide additional habitat have been required. As Table NGP3 shows, there were far fewer acres available in 2005 than required by the 2003 Biological Opinion (USFWS 2003, David Miller and Associates in litt.2006).
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Table NGP3. Emergent sandbar habitat requirements for plovers under the 2003 Biological Opinion (USFWS 2003).

River Segment	**Segment Length (Miles)**	**Required**		**On-the-ground**	**Required**	
		Acres 2005 per river mile	Total Acres by 2005	Total Acres actually available in 2005[1]	Acres 2015 per river mile	Total Acres by 2015
Fort Peck[2]	203.5	N/A	-	239	-	883
Garrison	85.9	25	2,147.5	583	50	4,295
Fort Randall	35.0	10	350	155	20	700
Lewis and Clark Lake	17.0	40	680	131	80	1,360
Gavins Point	58.1	40	2,324	905	80	4,648
Total	**-**	**-**	**5,501.5**	**2,013**	**-**	**11,886**

1 Source: David Miller and Associates (2006)

2 The USACE was required to determine how much habitat was available on the Fort Peck River stretch in 1998 after the habitat-creating flows of 1996-1997. This acreage then became habitat acreage target to be available by 2015. David Miller and Associates (2006) estimated that there was 883 acres of habitat available in 1998.

In order to address this shortcoming, since 2004 the USACE has constructed approximately 605 acres of sandbar habitat at seven different river locations. Five of these were created in the reach below Gavins Point Dam, with two additional islands created above the dam in the headwaters of Lewis and Clark Lake (USACE in litt. 2008a). While plovers have used these islands for nesting (USACE 2009a), the long-term implications of these islands for population recovery are not clear. The birds have generally been very successful at fledging young on the constructed islands during the first breeding season following construction, with slightly less success in the second year and very poor success in the third. Interestingly, in 2008, the four-year-old islands experienced a rebound in reproductive success (T. Fleeger, USACE, in litt. 2008). This may be related to the density of birds on the islands. For three years after the islands were created, bird density increased, possibly attracting more attention from predators. Kruse et al. (2002) suggested that predators key in on islands over time, making them less productive. By the fourth year, the islands were used by fewer birds and the lower density may have made the islands a less attractive target for predators. It has been noted that productivity and density seem to be inversely related (Mayer 1991). One study (Murphy et al. 2001) determined that breeding success was not related to density. However the birds on the Missouri River are likely nesting much more densely than the birds in that study.

The erosion rate of sandbars, whether they are created mechanically or through natural river functions, varies depending on river reach and even the location of an island within a reach. On the reach below Gavins Point Dam, where most island construction has taken place, loss to erosion has been estimated to be approximately 14% annually, and loss to vegetation about 21% (T. Fleeger in litt. 2008). These estimates demonstrate the need for new habitat to be generated regularly to counteract habitat loss.

The 2003 Biological Opinion required the USACE to unbalance the three major reservoirs (Fort Peck, Lake Sakakawea, and Lake Oahe) on a three-year cycle to ensure available habitat on one of the reservoirs annually. The 2003 opinion also required the USACE to identify and implement projects to create plover nesting habitat on the reservoirs by 2020 when system storage allowed. Projects may include removing vegetation from beaches, adding appropriate substrate (e.g., gravel) to attract plovers, or mechanically building up islands in the reservoirs.

Following the high flow years of 1996-1997, the Missouri River basin underwent a drought. During this period, system storage changed from a near-record high of 71.7 million acre feet (MAF) in 1997 to a record low of 33.9 MAF in 2007 (USACE 2009c). The years of declining storage exposed reservoir shoreline habitat, leading to large numbers of plovers successfully nesting on the reservoirs. For example, on Lake Oahe from 1994 (when system-wide plover surveys began) through 1997, there was an average of 42 adult piping plovers and a fledge ratio of just 0.49, whereas from 1998 through 2008, there was an average on 235 adults and a fledge ratio of 1.28.

The reasons for the dramatic increase in both bird numbers and reproductive success following the high flows of 1997 are not clear. It is evident that there is some interaction between available acres, plover abundance, and breeding success, but how these three relate is not known. Although the amount of available acres on reservoir segments decreased by about 75% between 1998 and 2005, the number of adult plovers increased almost three-fold (Table NGP4); furthermore, the fledge ratio declined across the years, but it remained above 1.24, the level thought necessary for population stability (Larson et al. 2002). However, on the Missouri River system as a whole, including reservoir segments, the fledge ratio declined from 1.61 to 1.15 between 1998 and 2005 and has remained below the level thought necessary for population stability through 2008. It is possible that the high water events of 1996-1997 lowered the predator levels along the Missouri River for several years, and also that the large increase in sandbar habitat along river stretches with relatively few nesting birds may have made predators less efficient in the years following the high-flow events.

Table NGP4. Acres available on Missouri River riverine reaches (including Lewis and Clark Lake) in 1998 and 2005, adult plover numbers, and fledge ratios.

River Segment	**Acres Available: 1998**[1]	**Adult Count: 1998**[2]	**Fledge Ratio: 1998**[2]	**Acres Available: 2005**[1]	**Adult Count: 2005**[2]	**Fledge Ratio: 2005**[2]
Fort Peck	883	4	1	239	2	4
Garrison	2,643	74	1.84	583	220	0.83
Fort Randall	584	33	1.33	155	42	0.81
Lewis and Clark Lake	738	82	2.46	131	24	0.17
Gavins Point	3,072	49	2.20	905	340	1.97
Total	**7,920**	**242**	**2.04**	**2,013**	**628**	**1.43**

[1] Source: David Miller and Associates, in litt. 2006
[2] Source: T. Fleeger, USACE, in litt. 2008

The number of plovers using the system seems to show an inverse relationship between the number of birds and system storage (Figure NGP13). As system storage decreases, more habitat along the reservoirs is available. Additionally, as discussed above, the high water in the mid 1990's created sandbar habitat in the riverine stretches. Starting in 2006 under a revised Master Manual (USACE 2006a), flows out of the dams were lowered to conserve water during drought, providing additional habitat as more islands were exposed. As Figure NGP13 shows, storage declined from a high of more than 71,000 cubic feet per second (cfs) in 1997 to a low of 38,997 cfs in 2005 while the plover population increased. From 2006 through 2008, system storage increased through a

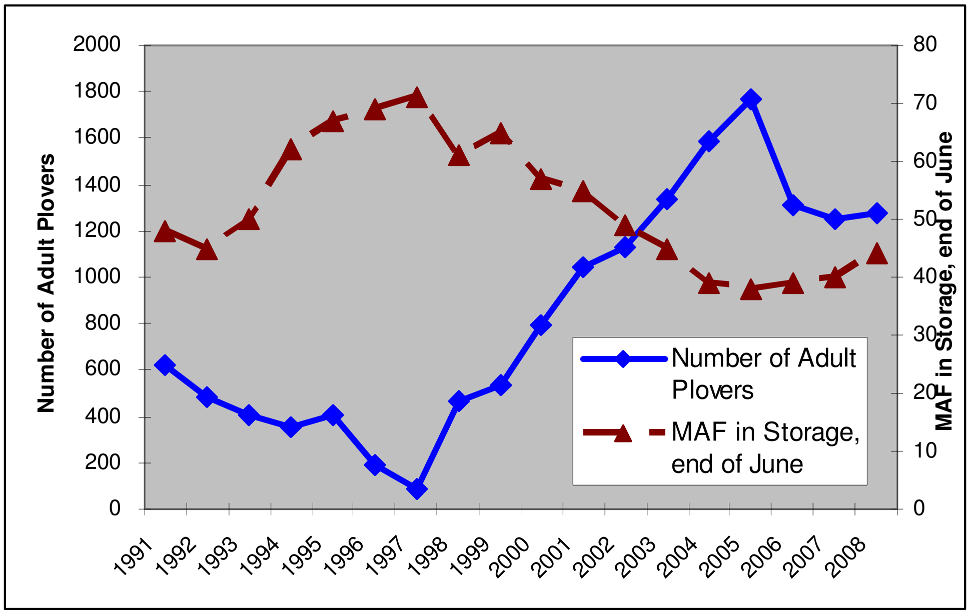

Figure NGP13. System storage on the Missouri River at the end of June (million acre feet) and the number of adult plovers counted annually.
Indicates an inverse relationship between the amount of water in storage and the number of adult plovers using the system is evident (USACE, in litt. 2008a, USACE 2008b).

combination of water-saving measures and increased inflows into the system; at the same time, plover populations began to decline.

Weather in the Great Plains is naturally cyclical (Stockton and Meko 1983), with regular drought periods followed by a number of average or wet years. Thus, habitat conditions on the Missouri River system can be expected to decline in the next few years if the basin is emerging from the eight-year drought of the early 2000s. A revised Northern Great Plains recovery plan will need to address the variation inherent in the population to estimate the minimum number of breeding birds needed to sustain the population over the long term during the downward population swings. Because we know that there will be years when some locations have very low fledge ratios due to weather conditions, habitat will be needed in other areas and years so that correspondingly high fledge ratios can be attained (M. Larson, Minnesota Department of Natural Resources, in litt. 2003).

Additionally, invasive exotic species, such as salt cedar (*Tamarix* spp.), grow very quickly on reservoir shorelines and are difficult to control. These non-natives may make less habitat available in the future since they quickly cover exposed shoreline.

Alkali lakes

As on the Missouri River, habitat availability on the alkali lakes in the U.S. and Canada depends largely on weather conditions, with more or less habitat available depending on natural cyclical weather patterns. A year with above average snowpack in the Missouri River basin is likely to lead to low habitat levels on both the Missouri River and the alkali lakes on the U.S. coteau. However, due to the extensive area used by plovers for nesting, the entire breeding area is unlikely to be wet in the same year. On the alkali lakes, drainage patterns may change somewhat due to nearby land-use patterns, affecting the availability of piping plover nesting habitat. Land-use changes near alkali lakes may also impact piping plover nesting success by drawing predators in to the area (Murphy et al. 2003).

Nebraska – In addition to the Missouri River, plovers in Nebraska nest on the Platte, Elkhorn, Loup, and Niobrara Rivers. Habitat conditions on these systems fluctuate widely depending on flows (Brown and Jorgensen 2008; S. Wilson, National Park Service, pers. comm. 2009). High flows on the Platte in 2008 precluded most nesting but created sandbar conditions that may provide habitat in future years. Plovers in Nebraska also nest along the edges of lakes created by the sand and gravel mining industry, or by lakes created for housing development. Although this habitat is transitory, it has supported from 0 to 200 adult plovers since monitoring began in 1987. Lake McConaughy, a large reservoir in southwestern Nebraska has been monitored for plover nesting since 1992. In recent years, due to drought conditions, the lake has supported a high of 236 plover pairs (M. Peyton, Central Nebraska Public Power Commission, in litt. 2009), although birds and habitat can be affected by flooding and disturbance from recreational uses.

Colorado – In Colorado, an average of six 6 pairs has been monitored annually, mostly at two reservoirs (John Martin and Neegronda). As in other areas, habitat conditions depend largely on weather patterns, with little habitat available under high water levels. However, periodic flooding is necessary to remove vegetation that would otherwise make the habitat unsuitable for nesting, so simply providing stable water levels would not provide stable plover breeding habitat. Both avian and ground predators have been a problem, as has incursion by invasive species, e.g., salt cedar (USACE 2007a).

Minnesota – The only site where plovers have been documented in Minnesota is the Lake of the Woods in the northern part of the state. The number of plovers in Minnesota has sharply declined since surveys began in the early 1980s (see Figure NGP5), with only one pair documented in the state in 2008 (Haws 2008, K. Haws in litt. 2009). This pair nested, but the nest was flooded prior to hatch (K. Haws in litt. 2009). Although the population in Minnesota may have always been small, its location on the periphery of the plover's Northern Great Plains range makes contractions a concern. The nesting habitat on the reservoir has eroded considerably, and a study suggests that these areas are unlikely to naturally accrete again due to less sediment inflow (Haws 2008). In addition, human disturbance appears to be negatively affecting nesting success in remaining habitat areas.

NGP 2.4.3 Five-factor analysis

In the following sections, we provide an analysis of the new information pertinent to the status of the Northern Great Plains piping plover breeding population, including relevant threats within the migration and wintering range. Information has been updated since the 1991 5-year review and the 1988 recovery plan for the population. Continuing threats and new threats, notably climate change, which is identified as a manmade factor affecting the species' continued existence, are discussed.

NGP 2.4.3.1 Factor A. Presence of threatened destruction, modification or curtailment of habitat or range:

Reservoirs, channelization of rivers, and modification of river flows

The 1988 recovery plan identifies reservoirs, channelization of rivers, and modification of river flows as a major threat due to the resulting reduction in sandbar riverine habitat, the flooding of remaining breeding habitat during the nesting season, and vegetation growth on sandbars that are rarely scoured by high flows. All of these are continuing threats.

Prior to colonization, river systems in the Northern Great Plains generally had large rises in the spring as water melted off of the prairie and then the mountains. These spring rises carried sediment down the system, creating sandbar islands as the water slowed and deposited the material. The water levels would then drop throughout the summer, exposing more acres of sandbar as the season progressed (USFWS 2003). After European settlement, attempts were made to make the rivers more predictable and suitable for navigation, and to minimize seasonal flooding. River channels were straightened and channelized, and a number of dams were constructed. These dams greatly reduced sediment inflow into the system, reducing the amount of sand available for sandbar creation (National Research Council 2002). Additionally, the hydrology of the rivers has been drastically altered. On the Missouri river, flows used to generally decline over the summer as tributary flows decreased. Today, they generally increase during the nesting season to provide for downstream needs (USFWS 2003). This means that less sandbar habitat is available over the course of the summer, rather than more, as would have been the case prior to dam construction. By contrast, due to the large number of users on the Platte River, flows are variable and the river often runs dry in the summer, also leading to a reduction in piping plovers on the river (National Research Council 2004).

Conditions on rivers and reservoirs depend on a combination of local and regional weather conditions and water management of the dams. On the Missouri River, a drought from 2001 through 2008 led to low water levels on the largest of the reservoirs (Lake Oahe and Lake Sakakawea) and generally lower releases out of the dams, providing habitat for a relatively large number of birds. However, reservoir levels can rise very quickly due to inflows from weather events or snow-melt. This rise often occurs in the middle of the season, flooding nests. Below dams, flows change according to downstream needs, inundating nests or chicks directly or covering foraging habitat.

On the Missouri River, the USACE has created sandbar habitat mechanically since 2004 and is attempting to identify an effective method of removing vegetation from existing sandbars as required to prevent jeopardy in a Biological Opinion (USFWS 2003). These actions, among others, are described in the reasonable and prudent alternative to system operations in the Biological Opinion. These actions, when implemented, allow the USACE to avoid the likelihood of jeopardizing the long term survival and recovery of the piping plover. However, to date, more sandbar habitat is being lost on the riverine stretches of the Missouri River annually than the USACE is creating (USACE 2009b). Suitable nesting habitat on the reservoirs decreases as they fill, so in years when the system is full, there is very little habitat available.

Managers elsewhere have also manipulated habitat for piping plovers. The USFWS Partners For Wildlife program has worked on the central Platte River in Nebraska to remove vegetation from islands, reshape existing islands, and create mid-channel islands since 2007 (K. Dinan, USFWS, pers. comm. 2009). Piping plovers have successfully raised young on these areas.

The lack of sufficient suitable habitat due to modification of river flows continues to be a major threat to the piping plover. Depending on the year, up to 45% of the birds in the U.S. Northern Great Plains may nest on river systems (Haig and Plissner 1992; Plissner and Haig 1996; Ferland and Haig 2002; USACE 2006b; USACE 2007a; Brown and Jorgensen 2008; D. Mulhern, USFWS, in litt. 2008; D. Nelson in litt. 2008; Peyton and Wilson 2008; USACE 2008b; USFWS 2008b; Elliott-Smith 2009). The lack of sufficient habitat is likely interrelated with other threats to piping plovers, including intraspecific aggression (aggressive interactions between piping plovers, especially adults to non-related chicks) and predation.

Commercial sand and gravel mining

Commercial sand and gravel mining was identified as a threat in the 1988 recovery plan. Mining is ongoing in Nebraska in the lower and central Platte River systems. Mine operators inadvertently create piping plover habitat by depositing waste sand alongside pit lakes. Plovers nest on spoil piles of sparsely or non-vegetated sand and associated lakes at sand and gravel mines. Generally, when production is finished, the mines are turned into housing developments. Some lakes have been constructed for housing developments without first mining the area. As the 1988 plan states, these activities can be problematic because of construction activities in the areas where plovers nest, potentially directly impacting nesting birds or indirectly disturbing nesting or brood rearing activities (Brown and Jorgensen 2008). The 1988 plan also identifies predation as a problem on these mine sites. The Nebraska Tern and Plover Partnership and the USFWS are actively working with the mine operators to try to minimize take.

The Nebraska Tern and Plover Conservation Partnership works with miners and real estate developers to identify areas where mining or construction operations will occur during the nesting season. They then attempt to discourage nesting in some areas using mylar grids in areas where plovers might nest (a mylar grid is made by attaching mylar tape to three-foot tall posts set approximately six feet apart in a grid pattern), planting a grass cover, overtopping with topsoil, or frequently raking the area. In areas which will not be disturbed in a given year, they attempt to attract birds by manipulating the substrate to make it more attractive to plovers (Nebraska Tern and Plover Conservation Partnership 2009). Working with volunteers, the Nebraska Tern and Plover Conservation Partnership then monitors nesting activities throughout the summer and attempts to improve reproductive success by fencing nesting areas to keep out both predators and humans, placing signs to alert people to stay out of the area and placing predator exclosures (cages which keep large predators out while allowing attending adults free access to and from the nest) on nests where possible.

With this intensive program in place, the number of both adult plovers and juveniles fledged has varied annually, but generally seems to be increasing (Figure NGP14). However, this type of habitat is developed or becomes vegetated over time. Thus, it will presumably remain available while sand and gravel mining is ongoing, but will not be available in the long term.

Sandpits provide habitat for piping plover nesting and brood rearing, supplementing the population that breeds on nearby rivers. However, although sandpits can provide suitable breeding habitat, the threat remains high because of a need for intensive ongoing management.

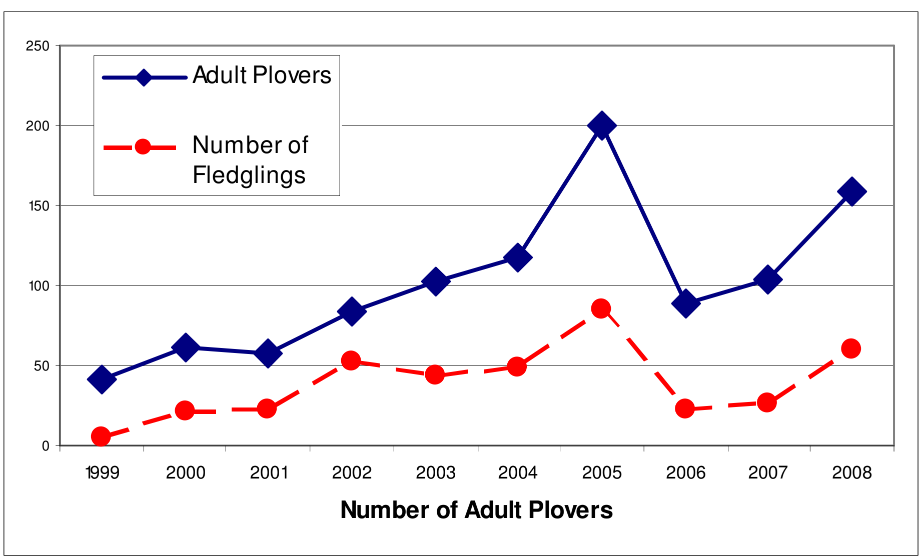

Figure NGP14. The number of adult plovers and fledglings counted on manmade areas in Nebraska since the NTPCP started working in 1999.
Source: M. Brown, NTPCP, in litt. 2009.

Freshening of water on saline wetlands in central North Dakota

The 1988 recovery plan identifies freshening of alkali lakes as a potential threat to piping plovers. Prindiville (1986) referred to two alkali wetlands that had been deepened and freshened to reduce alkalinity, with resulting loss of plover habitat. To our knowledge, this was never a widespread practice and does not appear to be a problem at this time.

Oil and gas development

The 1988 recovery plan notes that oil spills in the wintering range may be a threat, but it does not address the potential impacts of oil and gas development on the breeding grounds. Oil development on the breeding grounds has increased dramatically since the 1988 and remains a threat today.

Although USFWS personnel work with oil producers to avoid impacts to plovers, unless a federal permit is required, the USFWS is not necessarily informed about oil activity, and many wells are put in without any input regarding potential impacts on plovers.

In North Dakota and Montana, oil production near plover nesting habitat has increased substantially since 1988, and many oil wells are near known plover nesting areas. As shown in Figure NGP15, at least in North Dakota and Montana, this activity is concentrated in the alkali lakes area, where up to approximately 83% of the plovers in the U.S. Northern Great Plains nest (Brown and Jorgensen 2008, Peyton and Wilson 2008, USACE in litt. 2008a, USFWS in litt. 2008a,). In 2007, there were 494 drilling permits

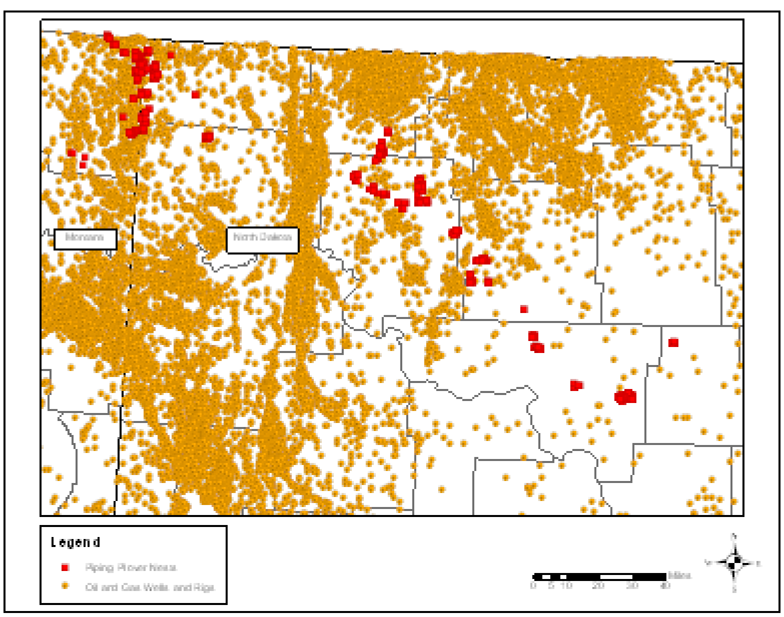

Figure NGP15. Piping plover nests and permitted oil and gas wells and rigs in North Dakota and Montana.
Note that not all of these wells are active.

issued in North Dakota, an increase of 146 from the year before (North Dakota Petroleum Council 2008). The impacts from oil development are largely unknown but potentially substantial. Prior to production, seismic surveys are performed over an extensive area to determine the likely location of oil reserves. This requires large equipment that can leave permanent tracks in plover nesting areas, even under frozen conditions in winter. Plover chicks can have difficulty getting out of vehicle tracks, which may contribute to mortality (Eddings 1991, Howard et al. 1993). If the seismic surveys suggest that there may be oil present, companies will construct oil pads and drill for oil. The pads are generally three to five acres and are located at least every 320 or 640 acres (half section to full section). The pads require new road construction as well as new powerlines for the additional load to run the pumps and other equipment.

The extensive road system built to access oil wells may cause direct mortality of adult plovers. Plovers were documented to be hit by cars on a road between Lake Audubon and Lake Sakakawea (a Missouri River reservoir) in North Dakota (USFWS 2004; M. Shriner, Western Area Power Administration, in litt. 2007). Plover mortality has also been documented from powerline strikes (M. Shriner in litt. 2007). Most roads and powerlines are not surveyed for dead birds, so the impact of these features on plovers is not known.

Oil wells may be placed near to plover nesting areas. Drilling activity is extremely loud and would likely be disruptive to nesting plovers if it is done during the nesting season. The ongoing activity associated with a well in production may continue to cause birds to avoid nesting areas, depending on the proximity of the well to the potential habitat (Thomsen 2006). Additionally, a spill may permanently impact nesting habitat.

Once a well has been constructed, the reserve pits are often not covered with netting to prevent birds from accessing the pit. The USFWS recommends that companies net all pits and federal law enforcement in North Dakota has documented and has fined a number of companies for killing migratory birds in these pits. To our knowledge, no plovers have been found in oil pits, but un-netted pits near plover habitat may cause plover mortality. Contamination from the reserve pit, either while the well is active or over time after the extraction is complete, may permanently impact piping plover habitat.

The long-term impacts of oil and gas production on piping plovers are unknown but potentially large. The Baaken Formation in North Dakota, Montana, and Saskatchewan underlies major piping plover nesting areas on the alkali lakes and Missouri River system (USGS 2008). The oil and gas activity may be placed near to piping plover nesting beaches, impacting reproduction directly. Oil spills may also impact nesting piping plover habitat. Since the piping plovers generally nest at the bottom of watersheds, any spills would likely migrate to the nesting areas.

Wind power

The number of wind farms in the Northern Great Plains is increasing rapidly (American Wind Energy Association 2008). North Dakota has been identified as the top state in the nation for wind energy potential, and Montana is the fifth highest (American Wind Energy Association 2009).

The potential impacts of wind farms on piping plovers are unknown but may be significant. Impacts may occur through direct collision with turbines, or indirectly if plovers avoid previously used areas that now contain wind farms. We do not know how plovers move either during the nesting season or in migration, so the potential impacts of wind farms could be large but are difficult to assess.

Invasive species

While the 1988 recovery plan identified loss of habitat as a threat to piping plovers, it did not specifically identify loss of habitat due to invasive species. Piping plover habitat is by nature ephemeral, with fluctuating water levels periodically clearing vegetation, which then grows back over time during dry periods. However, invasive exotics, particularly salt cedar, which is tolerant of flooding, are a growing problem on plover habitat (USACE 2007a). On the Missouri River reservoirs, changing water conditions provide prime habitat for noxious weeds to become established, with up to 200,000 acres of potential habitat exposed on Lake Oahe alone in dry conditions (USACE 2008c). Salt cedar, leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), and absinth wormwood (*Artemisia absinthium*) have been identified as noxious weeds on Missouri River reservoir shorelines (USACE 2007b). Other invasive species, such as kochia (*Kochia scoparia*) and clover (*Trifolium* spp.) can also rapidly take over plover habitat, precluding nesting (USACE 2007a).

Even native species that are declining overall along channelized rivers such as cottonwoods (*Populus* spp.) and willows (*Salix* spp.) are problematic, because flows are rarely sufficient to scour them from riverine islands where they do regenerate (Johnson 1994). Historically, sandbar islands would have been periodically scoured through ice movement or high spring flows. High flows would also have created bars by carrying sediment downstream that would then drop out as flows declined. These natural flows would continue to decline throughout the summer, exposing large expanses of unvegetated sandbars for nesting and foraging. However, the current regulated water releases are rarely large enough to scour or create sandbars, and much of the sediment is trapped behind the dams and not available to create sandbars. Instead, agencies are trying other methods to provide sandbar habitat as discussed in section NGP 2.4.3.1.

Vegetation encroachment is a major factor in limiting the amount of suitable nesting habitat. Some small-scale projects have successfully removed vegetation using a combination of chemicals, fire, and/or mechanically removing vegetation (USACE 2007a, K. Dinan, pers. comm. 2009). However, the success of larger-scale efforts to clear vegetation for piping plover habitat is not yet clear (USACE 2009a). Invasive exotics may be even more difficult to remove than native species, so this problem may increase over time. Habitat managers are actively attempting to address the problem of encroaching vegetation

Since cyclical wet and dry cycles will presumably continue to expose bare habitat periodically, and since managers are actively attempting to determine methods to clear vegetation, invasive species is considered a moderate threat at this time.

Density leading to intraspecific aggression

Although loss of habitat was identified in the 1988 recovery plan as one of the primary causes of the piping plover's decline, the specific impacts of limited available habitat were not explored. There is some information suggesting that in situations where density may be leading to insufficient forage for chicks, piping plover adults will attack non-related young (D. Catlin in litt. 2009). In the Northern Great Plains, this agonistic behavior is likely related to limited available habitat, as birds are forced to nest in dense concentrations and compete for forage (D. Catlin in litt. 2009). Of five chick carcasses that were in good enough condition to determine the cause of death on the Gavins Point stretch of the Missouri River in 2006, four showed signs of trauma, which may have been caused by intraspecific aggression (Catlin and Fraser 2007). Adults attacking non-related chicks have been observed in other shorebirds in years when food was limiting (Ashbrook et al. 2008). Murphy et al. (2001) documented no relationship between pair spacing and the number of fledglings produced at Appam Lake, an alkali lake in North Dakota, although this lake was probably not as densely occupied by plovers as constructed sandbars on the Missouri River, and food was unlikely to be limiting.

Intraspecific aggression seems to be a symptom of birds nesting too densely resulting in competition for resources. The reduction in suitable nesting habitat due to a number of factors is a major threat to the species, likely limiting reproductive success and thus future recruitment into the population.

Summary

The threat of destruction, modification or curtailment of habitat or range is a serious and ongoing threat to the piping plover. The Missouri and Platte River systems operate under Biological Opinions, which include actions to avoid and minimize impacts on plovers. Because of the plover's threatened status, other entities undertaking projects that may impact plover breeding habitat are willing to take measures to reduce or eliminate impacts within the project area. If the species was not federally listed, the current level of willingness to modify their actions to reduce impacts on plovers and the habitat conditions would likely be curtailed.

NGP 2.4.3.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

Early 20th century accounts report that shorebird hunting caused the first known major decline of the species (USFWS 1988). At the time of the 1988 plan, this factor was not thought to be a meaningful ongoing impact to the species in the Northern Great Plains. The USFWS is not aware of any significant new information regarding this threat.

The 1988 recovery plan suggests the species could be sensitive to impacts associated with scientific research and educational impacts. The original listing (50 FR 50726) does not identify scientific or educational impacts as applicable to the piping plover at that time. Since listing, these impacts have been carefully monitored and managed through the permitting process. The impacts of scientific research on piping plovers should be continued to be monitored closely.

In sum, we do not consider the overutilization for commercial, recreational, scientific or educational purposes to be a major threat to the Northern Great Plains piping plover population at this time. If the species were not listed, it would still be protected by the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703 et seq.), and researchers would have to apply for a permit before undertaking scientific studies.

NGP 2.4.3.3 Factor C. Disease or predation:

Disease

The 1988 recovery plan stated that disease was not known to be problem for piping plovers. However, the recovery plan indicated that botulism (USFWS 1988) had not been carefully investigated and could prove detrimental in the future. Several of the alkali lakes that support plovers have had historical outbreaks of botulism (National Wildlife Health Research Center in litt. 1994). Although botulism may be relatively constrained to a specific lake, it could cause a large local die-off.

Since 1988, West Nile Virus has emerged as a concern for avian wildlife species. Despite the fact that piping plover carcasses are rarely found and those that are found are generally not in good enough condition for the cause of death to be determined, a few piping plovers carcasses have tested positive for West Nile Virus (Sherfy et al. 2007). Presumably, other birds succumbed to this disease that were not found or for which the cause of death could not be positively identified.

Managers should continue to be aware of the potential impacts of disease on piping plovers. However, at this time, we do not have information to indicate that disease is a major threat facing the species.

Predation

The 1988 recovery plan mentions predation as a potential contributing factor to the species' decline in much of the Northern Great Plains. At that time, managers did not appear to think that predation was an important threat to the species. Since 1988, there has been a great deal of research on the potential impact that predation may be having on piping plovers (e.g,, Strauss 1990, Kruse 1993, Ivan and Murphy 2005). Although some predation occurs naturally, researchers have suggested that predation is symptomatic of insufficient or poor quality habitat, often forcing the birds to nest too densely (Mayer 1991, Kruse et al. 2002).

Most areas in both the U.S. and Canada apply nest exclosures to some or most of the plover nests to reduce the impact of nest predation (Brown and Jorgensen 2008, Heyens 2008, Prescott and Engley 2008, Rasmussen 2008, USFWS 2008b, USACE 2009a). Nest exclosures have been shown to improve plover nest success but may increase risks to adults (Murphy et al. 2003a). Additionally, increased nest success may not lead to increased fledging success, since predators may be attracted to areas with a high density of chicks (Neuman et al. 2004).

It is thought that while nest predators tend to be mammalian, chick predators are often avian (Ivan and Murphy 2005). Control efforts to remove avian predators that are thought to prey on chicks has been initiated on the Missouri River starting in 2007, and on the U.S. alkali lakes starting in 2008. A preliminary analysis suggests that removal of five owls along the 59-mile Gavins Point River reach in 2008 significantly improved the survival probability of chicks on those islands where owls were relocated (D. Catlin in litt. 2009).

In some areas, predation appears to be a major impediment to reproductive success, and it possibly removes adults from the population. High predation levels are likely linked with a lack of sufficient high-quality habitat (Kruse et al. 2002, Murphy et al. 2003), so efforts to decrease the impacts of predation should not only focus on removing predators but also on addressing the key underlying factor of nesting habitat.

Overall, predation appears to be a major factor impacting the Northern Great Plains population. Many areas are performing predation control activities (caging nests, removing predators, removing trees from prairie) to improve piping plover productivity. Additionally, projects that provide more habitat for plovers indirectly reduce the predation threat since nesting plovers are more spread out and thus a more difficult target. Without the protection of the ESA, these activities to reduce the impacts of predation would be unlikely to continue.

NGP 2.4.3.4 Factor D. Inadequacy of existing regulatory mechanisms:

Because of the piping plover's threatened status, the species is considered in environmental reviews prior to federal actions (e.g., issuing a permit) that may impact piping plovers or nesting habitat. Formal and informal ESA section 7 consultations are conducted regularly with a number of federal agencies, and the piping plover is considered when the USFWS reviews projects for the National Environmental Policy Act (NEPA). In addition, critical habitat has been identified for the Northern Great Plains breeding area, although the critical habitat designation was remanded in Nebraska (Nebraska habitat conservation coalition v. USFWS 4:03CV3059).

Piping plovers are protected by the Migratory Bird Treaty Act. While this statute protects plover adults, their active nests, and their young, it does not protect habitat when the birds are not there. Since habitat loss is a major threat facing the species (see section NGP 2.4.3.1), the species would likely continue to decline without additional habitat protection.

In addition, the states in which piping plovers breed have all identified the piping plover as a species of conservation concern in their State Wildlife Action Plans (Association of Fish and Wildlife Agencies 2007a). The protections afforded by this designation vary from state to state but are not as comprehensive as protections under the ESA (Association of Fish and Wildlife Agencies 2007a). All states participate in the International Piping Plover Census, and South Dakota, Nebraska, and Minnesota actively engage in annual management activities to improve reproductive success. Long-term agreements would need to be made with states and other federal agencies to ensure continued habitat protection if the species were not protected by the ESA.

The Canadian Species at Risk Act (SARA), enacted in 2001, provides many protections for piping plovers in eastern Canada that parallel those conferred by the ESA. In addition to prohibitions and penalties for killing, harming, or harassing listed species, SARA requires preparation of a Recovery Strategy, measures to reduce and monitor impacts of projects requiring environmental assessments, and protection of Critical Habitat (Environment Canada 2003).

Existing state and federal regulatory mechanisms, including the ESA, play a critical role in continuing to recover the piping plover on the Northern Great Plains breeding range. USFWS, USACE, State, and non-profit organizations spend considerable time and money implementing actions to benefit the species. Because threats are being managed rather than eliminated, removal of the Northern Great Plains piping plover from ESA protections would require institution of adequate alternative regulatory mechanisms.

Missouri River management

The USFWS is engaged in ongoing discussions with the USACE regarding Missouri River management, so that the USACE can provide for multiple users' needs while minimizing impacts on the piping plover. Despite these efforts, piping plover nests are lost each year through incidental take from flooding due to management actions. As discussed in section NGP 2.4.2.4, the Missouri River is managed under a Biological Opinion, which allows the USACE a certain amount of take if they, as the action agency, implement Reasonable and Prudent Alternatives to avoid jeopardy to the species (USFWS 2003).

The Reasonable and Prudent Alternatives include providing 11,866 acres of habitat on the Missouri River as well as performing management on the reservoirs to provide nesting habitat on the shorelines or islands. Although the USACE has been mechanically creating island habitat since 2004 and has been experimenting with ways to remove vegetation, the acreage has fallen far short of the Reasonable and Prudent Alternative (USACE 2009b). Despite this shortfall of available habitat acres, the USACE has documented an average take of 141 plovers (primarily eggs) since 2004 due to operations on the Missouri River (the management of the dams). In 2008, 256 eggs and seven chicks were lost to flooding attributed to USACE system management. We are very concerned over the amount of take on the Missouri River, and are actively engaged with the USACE to develop strategies to provide additional nesting habitat. Without ESA protection, the USACE would be less likely to consider piping plovers in management decisions and impacts on the birds could be much greater.

Oil and gas

In North Dakota and Montana, where oil and gas production coincides with U.S. Northern Great Plains piping plover habitat, mineral rights are largely under private ownership, as are the surface lands. Without a federal nexus, consultation is not required, and the USFWS is not currently notified of oil and gas activities with potential impacts on piping plovers. Further, although the ESA and MBTA are applicable to activities on private lands, there is currently no oversight to ensure that the companies consult with the USFWS or are even aware of their responsibilities to do so. Thus, we do not know how many wells are being constructed near plover habitat. As shown in Figure NGP15, at least in North Dakota and Montana, this activity is concentrated in the alkali lakes, where approximately 83% of the plovers in the U.S. Northern Great Plains nest.

Wind power

Unless they are larger than 100 Megawatts, wind farms do not require a state permit in North Dakota, and no state permit is required in Montana (Association of Fish and Wildlife Agencies 2007b). Wind farms do not require a federal permit unless they are located on federally owned land or federal easements. As with oil and gas activities, while the ESA and MBTA apply, unless the wind farm requires a federal permit, the USFWS may not be aware of the project. The USFWS is currently working with developers on a whooping crane and lesser prairie chicken HCP for the whooping crane migration corridor; this HCP includes avoidance measures for piping plovers.

Summary

Even with protection under the Endangered Species Act, many ongoing activities are taking place that negatively impact piping plovers and their habitat. Because of the ESA's protective mechanisms, agencies and others doing projects that may impact plovers generally attempt to at least reduce impacts on the species. Without federal protection, activities to protect, build or enhance habitat for plovers would be unlikely to continue.

2.4.3.5 Factor E. Other natural or manmade factors affecting the species' continued existence:

Power lines

At the time of listing, the potential threat of power lines to plovers was not known. Additionally, there were many fewer power lines in the Northern Great Plains than there are today. As more power is produced on the prairie, a large number of new power lines are needed to carry this power to population centers (American Wind Energy Association

2009). Overhead power lines have been documented to kill a large number of birds, including plovers (USFWS 2004, M. Shriner in litt. 2007). Since we know very little about plover movements, it is difficult to determine how much of an effect power lines may have on plovers. Marking lines with highly visible reflectors has been shown to be at least partially effective in reducing bird strikes in a number of species (Avian Power Line Interaction Committee 1994). The USFWS has recently (starting in 2008) begun to recommend that power lines in the whooping crane (*Grus americana*) migration corridor be marked. This corridor overlaps nearly all of the plover's range in the United States. The Service does not have information indicating how many lines are marked at this time, but it is likely a relatively low percentage.

Overall, power lines are known to kill piping plovers when located between feeding and nesting areas, but it is unknown whether the increasing number of powerlines across the migration routes impacts plovers. Because of ESA protection, the USFWS can work with companies to mark power lines so that plovers are less likely to collide with them.

Climate change

Climate change was not discussed as a potential threat to the piping plover at the time of listing. However, it is now apparent that climate change has the potential to be a severe threat to the species both on the wintering (section WM2.2.2.5) and breeding grounds.

According to the Intergovernmental Panel on Climate Change (IPCC 2007), "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007, p.1). Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1,300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is also likely that heat waves have become more frequent over most land areas and that the frequency of heavy precipitation events has increased over most areas (IPCC 2007).

The Intergovernmental Panel on Climate Change (2007) predicts that changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century. For the next two decades a warming of about 0.2° C (0.4° F) per decade is projected globally; after this, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6 to 4.0° C (1.1 to 7.2° F) with the greatest warming expected over land. Finally, the Intergovernmental Panel on Climate Change projects a high likelihood that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007).

The average temperature in the Great Plains already has increased roughly 1.5° F relative to a 1960s and 1970s baseline (U.S. Global Change Research Program 2009). By the end of the century, temperatures are projected to continue to increase by 2.5° F (and up to more than 13° F) compared to the 1960–1979 baseline, depending on future emissions of heat-trapping gases (USGS 2009). Across the U.S. range of the Northern Great Plains piping plover, summer temperatures are projected to increase 5° F to 9° F by the end of the century, depending on future emissions (USGS 2009).

Northern areas of the Great Plains are projected (with high confidence) to experience a wetter climate by the end of this century (USGS 2009). Across the U.S. range of the Northern Great Plains piping plover, spring precipitation is expected to increase between zero and 15% under a lower emissions scenario and between zero and 40 percent under a higher emissions scenario. By contrast, in a study looking at how climate change might affect the prairie pothole region, Johnson et al. (2005) suggested that the area in western North Dakota and eastern Montana north to Saskatchewan is likely to become drier, with many of the potholes receiving less moisture in most years. Regardless, conditions are likely to change drastically in the near future as a result of climate change.

This shift in temperature and moisture could have profound effects on piping plover habitat, which is dependant on wet-dry cycles to keep habitat clear of vegetation. Additionally, changing precipitation patterns in the Rockies would likely have profound effects on the amount of inflow into the Missouri River system, also affecting the amount of habitat available there. Although drought starting in 2001 exposed a great deal of reservoir shoreline for plover nesting, over time much of this habitat has become vegetated and is no longer suitable. Thus, long-term low water, like long-term high water on the Missouri River, may eventually provide less nesting habitat for plovers.

Given these projected changes, resource agencies will need to consider the range of possible effects associated with climate change when managing habitat. Recovery efforts will need to be able to monitor conditions and respond to contingencies.

In sum, climate change will likely impact plover habitat, since changes in weather patterns will impact the frequency and duration that suitable breeding habitat is available. Climate change is a global phenomenon, which is not to date impacted by ESA protections.

Human disturbance

Human disturbance was identified as a threat in the 1988 plan and continues to be a threat today. It is a particular problem in popular river or reservoir reaches where up to about 70% of the Northern Great Plains plovers in the U.S. nest, depending on the year (Haig and Plissner 1992, Plissner and Haig 1996, Ferland and Haig 2002, USACE 2006b, USACE 2007a, D. Mulhern in litt. 2008, Peyton and Wilson 2008, USACE 2008b, USFWS 2008b, D. Nelson in litt. 2009, Elliott-Smith 2009, Nebraska Tern and Plover Conservation Partnership 2009). The USACE in Colorado and on the Missouri River, along with the Nebraska Tern and Plover Conservation Partnership, erects signs and fencing in order to try to inform the public to keep away from nesting plovers (USACE 2007a, Brown and Jorgensen 2008, USACE 2009a). The success of these measures is difficult to ascertain, because the areas are not continuously monitored and reproduction may be impeded indirectly if adults do not tend to nests or chicks appropriately because of disturbance.

Off-road vehicle use is not permitted on USACE property. Despite these precautions, reproductive failures are attributed to human disturbance and off-road vehicle use (USACE 2009a).

As the waterfront areas in Nebraska and along the Missouri River become more developed, human disturbance is likely to become more prevalent. USFWS law enforcement agents and South Dakota game wardens patrol plover beaches throughout the summer, especially during busy holiday weekends, but the large area to cover and the few law enforcement personnel mean that enforcement is generally lacking.

Overall, human disturbance is a large and growing threat to breeding piping plovers. As more people recreate on the river systems, they are more likely to use nesting areas, reducing breeding success. Because of the plover's threatened status, plover monitors erect signs prohibiting access within highly used nesting areas. Without ESA protection, there would unlikely be funding for this activity, and states would object to closing off popular areas to the public.

NGP 2.4.4 Synthesis

Here, we consider the status of the Northern Great Plains piping plover population with respect to ESA definitions of threatened and endangered species. Recognizing that (1) the Northern Great Plains piping plover population comprises a DPS of the subspecies *C. m. circumcinctus*, and (2) 23 years of ESA recovery planning and implementation for the Northern Great Plains population has been conducted consistent with the premise of complete demographic independence from other piping plovers (section 2.1), we address the status of Northern Great Plains piping plovers and progress towards recovery of this population. In conducting this evaluation, we considered progress towards the recovery criteria in the 1988 recovery plan; new information about demographic characteristics, distribution, and habitat requirements; and analysis of listing factors and relevant conservation measures for both the breeding and nonbreeding portion of the annual cycle. In section 3 of this review, we further evaluate the status of the Northern Great Plains piping plover in relation to all piping plovers listed as threatened under the ESA.

The International Piping Plover Census numbers indicate that the Northern Great Plains population (including Canada) declined from 1991 through 2001 then increased dramatically from 2001 through 2006. This increase corresponded with a multi-year drought in the Missouri River basin that exposed a great deal of nesting habitat, suggesting that the population can respond fairly rapidly to changes in habitat quantity and quality. Despite this recent improvement, the numeric, distributional, or temporal elements of the population recovery criteria have not been met.

As the Missouri River basin emerges from drought and breeding habitat is inundated, the population will likely decline. The management activities done in many areas during drought have undoubtedly helped to maintain and increase the piping plover population, especially to mitigate for otherwise poor reproductive success during wet years when habitat is limited.

Modeling strongly suggests that the piping plover population is very sensitive to adult and juvenile survival. Therefore, while there is a great deal of effort extended to improve breeding success, to improve and maintain a higher population over time, it is also necessary to ensure that the wintering habitat, where birds spend most of their time, is secure. On the wintering grounds, the shoreline areas used by wintering piping plovers are being developed, stabilized, or otherwise altered, making them unsuitable. Even in areas where habitat conditions are appropriate, human disturbance on beaches may negatively impact piping plovers' energy budget, as they may spend more time being vigilant and less time in foraging and roosting behavior. In many cases, the disturbance is severe enough that piping plovers appear to avoid some areas altogether. Threats on the wintering grounds may impact piping plovers' breeding success if they start migration or arrive at the breeding grounds with a poor body condition.

While the population increase seen in recent years demonstrates the possibility that the population can rebound from low population numbers, ongoing efforts are needed to maintain and increase the population. In the U.S., piping plover crews attempt to locate most piping plover nests and take steps to improve their success. This work has suffered from insufficient and unstable funding in most areas.

Emerging threats, such as energy development (particularly wind, oil and gas and associated infrastructure) and climate change are likely to impact piping plovers both on the breeding and wintering grounds. The potential impact of both of these threats is not well understood, and measures to mitigate for them are also uncertain at this time.

We conclude that the Northern Great Plains piping plover population remains likely to become an endangered species within the foreseeable future throughout all of its range and is correctly classified as a threatened species under the ESA. The Northern Great Plains piping plover is not currently in danger of extinction throughout all or a significant portion of its range (i.e., is not an endangered species), because the population has responded dramatically to an increase in habitat during drought years as well as more than 20 years of recovery efforts. However, the population remains vulnerable, especially due to management of river systems throughout the breeding range. Many of the threats identified in the 1988 recovery plan, including those affecting the Northern Great Plains piping plover population during the two-thirds of its annual cycle spent in the wintering range, are ongoing or have intensified. Increased understanding and management are also needed to provide for rangewide protection against threats from wind turbine generators and climate change. The status of the Northern Great Plains piping plover is consistent with the ESA definition of a threatened species.

NGP 2.4.5 Section references

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AC 2.5 UPDATED INFORMATION AND CURRENT SPECIES STATUS FOR THE BREEDING RANGE OF THE ATLANTIC COAST POPULATION

AC 2.5.1 Recovery criteria

AC 2.5.1.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes, the 1996 revised Atlantic Coast recovery plan contains objective, measurable criteria.

AC 2.5.1.2 Adequacy of recovery criteria:

Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

No. Revision of criterion 3 is needed to account for new information.

Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

The most critical listing factors (habitat loss and degradation, predation, human disturbance, and inadequacy of regulatory mechanisms) known at the time of the 1996 revised recovery plan are addressed in criteria 4 and 5. Oil spills are a continuing moderate threat, but a population that has attained abundance and productivity targets will be less vulnerable to temporary injuries from localized oil spills, especially if restoration is implemented promptly.

Two threats that have emerged since the 1996 revised recovery plan – wind turbine generators and climate change – merit further evaluation to determine if and how recovery criteria should address these threats. Although some measures should be taken immediately to reduce threats from sea-level rise, a better understanding of wind turbine generator and climate change effects on piping plovers and their habitat is required before appropriate recovery criteria (if needed) can be formulated.

The best available information indicates that disease, environmental contaminants, and overutilization are currently minor threats to Atlantic Coast piping plovers. In light of the population's small size, continued vigilance relative to these potential factors is appropriate, but no new recovery criteria are warranted at this time.

List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met.

To delist the Atlantic Coast piping plover population, the following recovery criteria must be met:

Recovery Criterion 1. Increase and maintain for five years a total of 2,000 breeding pairs, distributed among the four recovery units as specified below:

Recovery Unit	*Minimum Subpopulation*
Atlantic (eastern) Canada[1]	*400 pairs*
New England	*625 pairs*
New York-New Jersey	*575 pairs*
Southern (DE-MD-VA-NC)	*400 pairs*

The New England recovery unit population has exceeded (or been within three pairs of) its 625-pair abundance goal since 1998, attaining a post-listing high of 711 pairs in 2008. The New York-New Jersey recovery unit reached 586 pairs in 2007, surpassing its 575-pair goal for the first time; in 2008, however, abundance dipped to 554 pairs. The Southern recovery unit, which attained 333 pairs in 2007 and 331 pairs in 2008, has not yet reached its 400-pair goal. Southern recovery unit population growth between 2003 and 2007 is encouraging.

The Eastern Canada recovery unit has experienced the lowest population growth (9% net increase between 1989 and 2008), despite higher overall productivity than in the U.S. (see discussion under criterion 3, below). The highest post-listing abundance estimate was 274 pairs in 2002, and the 2008 estimate was 253 pairs, placing this recovery unit furthest from its goal (400 pairs). Objectives for the Atlantic (eastern) population in the Canadian Wildlife Service's 2002 National Recovery Plan (Goossen et al. 2002) include a near-term abundance goal of 335 pairs (sustained over three consecutive International Piping Plover Censuses conducted at five-year intervals) and further assessment of the feasibility of attaining a longer-term target of 400 pairs.

Feasibility of reaching the 400-pair Eastern Canada recovery unit target appears uncertain, but periodic rapid declines (e.g., -21% in just three years, 2002-2005) and high productivity needed to just sustain a stationary population underscore the vulnerability of this subpopulation to low numbers. Robust gains in abundance would provide the population with security against variability in productivity. The USFWS maintains an active dialogue with CWS regarding coastwide demographic trends and concurs that potential changes in the 400-pair long-term objective should be deferred at least until the less ambitious target of 335 pairs is attained. In the event that future recovery planning by CWS reduces the long-term objective below 400 pairs, the USFWS must evaluate implications for long-term viability of the coastwide population. Such an evaluation would require in-

[1] Recent CWS documents and published literature refer to piping plovers breeding in Nova Scotia, New Brunswick, Prince Edward Island, Quebec, and Newfoundland as the piping plover *melodus* subspecies or the "eastern Canada population." This subpopulation coincides exactly with the geographic area termed "Atlantic Canada Recovery Unit" in the USFWS 1996 revised recovery plan. To reduce confusion, we refer henceforth in this status review to the Eastern Canada recovery unit. Annual abundance figures for the Eastern Canada recovery unit cited in this status review include 1-5 pairs on the French Islands of St. Pierre and Miquelon, reported by CWS in annual eastern Canada population data summaries.

depth consideration of all vital rates (including abundance, productivity, survival, and movements within the population) and implications for persistence of the four recovery units and the entire Atlantic Coast piping plover (*C. m. melodus*) subspecies.

Attainment of abundance objectives remains fundamental to reducing vulnerability of Atlantic Coast piping plovers to extinction. Although considerable progress has been made toward meeting criterion 1, only the New England recovery unit has met and sustained its subpopulation target for the requisite five years.

Recovery Criterion 2. Verify the adequacy of a 2,000-pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term.

No explicit effort has been made to address this criterion. However, average microsatellite heterozygosity and mitochondrial control region nucleotide diversity of Atlantic Coast piping plovers and lack of evidence of recent genetic bottlenecks indicate that current genetic risks are low (Miller et al. 2009; see section AC 2.5.2.3). In light of the low likelihood of risks – and because conservation genetics is a rapidly-evolving discipline – it is appropriate to defer response to this criterion pending further progress toward other recovery criteria. The appropriate approach to satisfying this criterion should be determined in consultation with conservation geneticists, and it is unlikely to substantially delay delisting of Atlantic Coast piping plovers once other criteria are met.

Recovery Criterion 3. Achieve five-year average productivity of 1.5 fledged chicks per pair in each of the four recovery units described in criterion 1. Data to evaluate progress toward this criterion should be obtained from sites that collectively support at least 90% of the recovery unit's population.

As explained in the 1996 revised recovery plan, modified productivity criteria that are specific to recovery units (rather than the "one-size-fits-all" measure of 1.5 chicks fledged per pair) should be developed in response to anticipated new information about the latitudinal variation in productivity needed to maintain a stationary population. See section AC 2.5.2.2 for new information based on analysis of trends in abundance and productivity from 1986-2006 (Hecht and Melvin 2009a). For example, the breeding population in the Southern recovery unit may be able to increase productivity to recovery levels and then sustain itself with an annual productivity rate of <1.5 chicks fledged per pair (Hecht and Melvin 2009a). In contrast, productivity of >1.5 is likely needed to secure the Eastern Canada recovery unit (Calvert et al. 2006, Hecht and Melvin 2009a). Revision of this recovery criterion will require demographic modeling that explores effects of variation in productivity, survival rates, and carrying capacity of habitat on population viability within individual recovery units and the Atlantic Coast population as a whole.

Recovery Criterion 4. Institute long-term agreements among cooperating agencies, landowners, and conservation organizations to assure protection and management sufficient to maintain the target populations in each recovery unit and average productivity specified in criteria 1 and 2.

> Most Atlantic Coast piping plover recovery partners have demonstrated ongoing commitments to piping plover conservation, and some have developed long-term management plans for their sites. However, ESA provisions are a major underlying motivator for management and protections being implemented by many recovery partners and landowners. Formal long-term agreements are essential to continued conservation of natural habitat formation processes and implementation of management practices that minimize adverse effects of major threats, such as human beach recreation and predation, which cannot be removed. Although many stakeholders profess understanding that continuation of protection (at some level) will be needed in perpetuity, progress toward the written commitments needed to attain this criterion has been very limited.
>
> In sum, this criterion has not been met. Efforts to develop formal mechanisms to provide post-delisting conservation must be substantially increased.

Recovery Criterion 5. Ensure long-term maintenance of wintering habitat, sufficient in quantity, quality, and distribution to maintain survival rates for a 2,000-pair population.

> As evidenced in section WM 2.2 of this document, progress toward understanding and managing threats to migrating and wintering piping plovers and their habitats has accelerated in recent years. However, considerable additional effort will be needed to further refine management needs and techniques and assure their efficacy, let alone securing the long-term implementation commitments required under this criterion.
>
> Increased emphasis on conservation needs during migration and wintering portions of the annual cycle is a very high priority recommended future action for recovery of all piping plover populations, including Atlantic Coast piping plovers (see section 4.1). Efforts to reduce habitat loss and degradation are particularly urgent, as accumulating losses pose the risk of permanently precluding recovery of piping plover populations.

AC 2.5.2 Biology and habitat

A large body of information regarding the biology, habitat, and status of Atlantic Coast piping plovers has become available since the 1985 final rule and 1991 five-year review. Much of this information was incorporated in the 1996 Atlantic Coast recovery plan. Here we summarize information that has become available since 1996, with brief references to a few studies also discussed in the 1996 revised recovery plan.

AC 2.5.2.1 Life history:

Sung et al. (2005) investigated piping plover vocalizations at several sites in eastern Canada, identifying 14 adult and three chick call types and associated behaviors or threats. Breeding males from a small sample were individually distinguishable on the basis of recordings of display-flight calls, suggesting potential application (with further study) of piping plover vocalizations to monitoring of threats and abundance (Sung and Miller 2007).

Majka and Shaffer (2008) found a preponderance of prey species in the 3.2-5.0 mm size range in fecal samples of piping plovers breeding in Quebec. They also noted high prevalence of one beetle species, *Bledius opaculus*, which feeds on algae from sand- and mud-flats.

AC 2.5.2.2 Abundance, population trends, and demography:

Abundance trends

Annual estimates of breeding pairs of Atlantic Coast piping plovers are based on multiple surveys at most occupied sites. Sites that cannot be monitored repeatedly in May and June (primarily sites with few pairs or inconsistent occupancy) are surveyed at least once during a standard nine-day count period (Hecht and Melvin 2009a).

Since its 1986 listing, the Atlantic Coast piping plover population estimate has increased 234%, from approximately 790 pairs to an estimated 1,849 pairs in 2008, and the U.S. portion of the population has almost tripled, from approximately 550 pairs to an estimated 1,596 pairs (Figure AC1 and Appendix B). Even discounting apparent increases in New York, New Jersey, and North Carolina between 1986 and 1989, which likely were due in part to increased census effort (USFWS 1996), the population nearly doubled between 1989 and 2008. The largest population increase between 1989 and 2008 has occurred in New England (245%), followed by New York-New Jersey (74%). In the Southern recovery unit, overall growth between 1989 and 2008 was 66%, but almost three-quarters of this increase occurred in two years, 2003-2005. The eastern Canada population fluctuated from year to year, with increases often quickly eroded in subsequent years; net growth between 1989 and 2008 was 9%.

The overall population growth pattern was tempered by periodic rapid declines in the Southern and Eastern Canada recovery units. The eastern Canada population decreased 21% in just three years (2002-2005), and the population in the southern half of the Southern recovery unit declined 68% in seven years (1995-2001). The recent 64% decline in the Maine population, from 66 pairs in 2002 to 24 pairs in 2008, following only a few years of decreased productivity, provides another example of the continuing risk of rapid and precipitous reversals in population growth.

Productivity

Annual productivity estimates by recovery unit are illustrated in Figure AC1 and are provided by state in Appendix B. The proportion of the population included in annual estimates of productivity (chicks fledged per pair) has continued to improve since 1996, exceeding 90% of breeding pairs coastwide as well as in the New England and Southern recovery units, every year starting in 1998. More than 90% of New York-New Jersey recovery unit pairs were included in productivity estimates in eight of the last 11 years. The percentage of Eastern Canada recovery unit pairs for which productivity estimates were reported in 1998-2008 ranged from 80% to 94%.

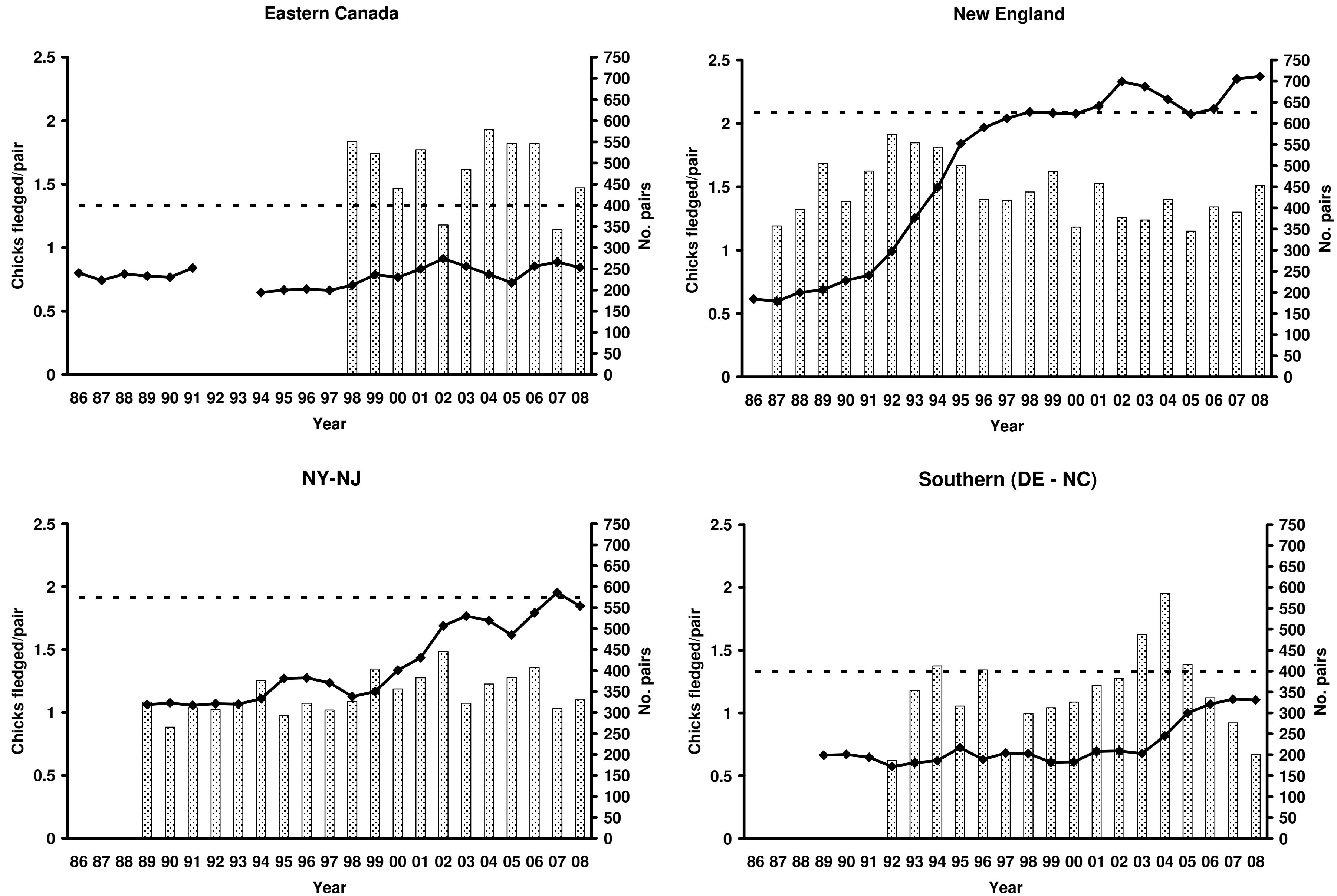
Hecht and Melvin (2009a) evaluated latitudinal trends in Atlantic Coast piping plover productivity and relationships between productivity and population growth. Overall productivity for the Atlantic Coast population 1989-2006 was 1.35 chicks fledged per pair (annual range = 1.16-1.54), and overall productivity within recovery units decreased with decreasing latitude: Eastern Canada = 1.61, New England = 1.44, New York-New Jersey = 1.18, and Southern = 1.19 (Hecht and Melvin 2009a). Within recovery units, annual productivity was variable and showed no sustained trends. There were significant, positive relationships between productivity and population growth in the subsequent year for each of the three U.S. recovery units, but not for Eastern Canada. Regression analysis indicated a latitudinal trend in predictions of annual productivity needed to support stationary populations within recovery units, increasing from 0.93 chicks fledged per pair in the Southern unit to 1.44 in Eastern Canada. Relatively small coefficients of determination ($r^2 = 0.09\text{-}0.59$) for the relationships between annual productivity and population increases in the subsequent year indicate that other factors, most likely annual survival rates of both adults and fledged chicks, also had important influences on population growth rates.

The estimate of productivity needed to maintain a stationary population within New England, 1.21 chicks fledged per pair, based on regression analysis (Hecht and Melvin 2009a), is similar to the value of 1.24 that was estimated through population modeling based on survival estimates derived from 1985-1988 banding studies in Massachusetts (Melvin and Gibbs 1996). Regression analysis estimated productivity of 1.44 chicks fledged per pair needed to maintain a stationary population in eastern Canada (Hecht and Melvin 2009a), while Calvert et al. (2006) estimated 1.63 chicks per pair for eastern Canada exclusive of southern Nova Scotia, based on estimates of survival derived from 1998-2004 banding studies.

Breeding site fidelity and dispersal

Dispersal patterns observed in a 1998-2003 banding study conducted in five eastern Canada provinces were similar to those reported by previous studies from Massachusetts, Maryland, and Virginia that are summarized in the 1996 recovery plan. During the life of the study (including resightings through 2008), 40% of eastern Canada piping plovers

Figure AC1. Trends in abundance (breeding pairs) and productivity (chicks fledged per pair) for Atlantic Coast recovery units, 1986-2008. Abundance data are indicated by lines connecting points, productivity data are indicated by bars. Dashed lines indicate abundance objectives established in the 1996 revised recovery plan. Productivity data are plotted for years when productivity data was reported for ≥60% of pairs.



banded as adults exhibited fidelity to their nesting beaches in every year that they were resighted, and only six of 152 recaptured adults (4%) moved to a different province in a subsequent year (Amirault et al. 2005, updated by D. Amirault-Langlais and F. Shaffer, CWS, pers. comm. 2009). By contrast, 5% of 95 plovers banded in their hatch year nested at their natal beaches and 84% nested in their natal province. Only one of 888 banded birds, however, was detected breeding outside of eastern Canada. That bird, banded as a chick on Prince Edward Island, fledged a chick in Massachusetts after unsuccessfully breeding on Long Island, New York, the previous season.

Site fidelity of banded adults on Long Island in 2002-2004 was 83% (Cohen et al. 2006).

Survival

Estimates of annual adult survival on Long Island (70%; Cohen et al. 2006) and eastern Canada (73%; Calvert et al. 2006) were similar to those reported from late 1980s studies in Massachusetts (74%; Melvin and Gibbs 1996) and Maryland (71%; Loegering 1992). However, apparent survival (34%) for the first year after fledging in eastern Canada (Calvert et al. 2006) was much lower than that from earlier Massachusetts banding studies (48%; Melvin and Gibbs 1996). There is currently no information regarding the distribution of mortality in the annual cycle of Atlantic Coast piping plovers.

Two recent Atlantic Coast population viability analyses conducted by Calvert et al. (2006) and Brault (2007) have confirmed the consistent finding of earlier piping plover PVAs that extinction risk is highly sensitive to small declines in adult and/or juvenile survival rates (see other PVA studies cited in section WM 2.2.1.2). Calvert et al. (2006) found that changes in productivity (% increase in chicks fledged per pair) required to attain long-term growth rates in eastern Canada would be approximately threefold the change required in adult apparent survival (% increase in annual survival of adults). Similarly, modeling by Brault (2007) for the New England and Eastern Canada recovery units indicated that a 1% reduction in annual adult survival would need to be offset by a 2.25% increase in fledglings produced in order to maintain a stable population. Progress toward recovery would be quickly slowed or reversed by even small sustained decreases in survival, and it would be difficult to increase current fecundity levels sufficiently to compensate for widespread long-term declines in survival.

Summary

Increased abundance of Atlantic Coast piping plovers has reduced near-term vulnerability to extinction, but uneven geographic distribution of population growth and sensitivity of persistence probabilities to both survival and productivity engender continuing conservation concern. Reasons for apparent lower rates of survival of birds breeding at higher latitudes merit further study.

AC 2.5.2.3 Genetics, genetic variation, or trends in genetic variation:

Miller et al. (2009) found that rangewide genetic diversity of piping plovers sampled from 23 U.S. states and Canadian provinces appeared comparable to the range of values observed in two snowy plover (*Charadrius alexandrinus*) subspecies from the continental U.S. and Caribbean[1]. Average microsatellite heterozygosity and mitochondrial control region nucleotide diversity within both the Atlantic U.S. and Canada regions fell within the range of values observed for snowy plovers. Miller et al. (2009) also detected no evidence of previous genetic bottlenecks in *C. m. melodus*. Currently available information provides no evidence of loss of genetic variation, genetic drift, or inbreeding within *C. m. melodus*.

AC 2.5.2.4 Taxonomic classification or changes in nomenclature: See section 2.1.2. A recent molecular genetics study, including mitochondrial and microsatellite data, confirmed subspecific status of piping plovers breeding on the Atlantic Coast of North America (Miller et al. 2009). *Charadrius melodus melodus* (AOU 1957) exactly coincides with geographic coverage of the 1996 Atlantic Coast recovery plan.

AC 2.5.2.5 Spatial distribution, trends in spatial distribution, or historic range:

Piping plovers remain sparsely distributed across their Atlantic Coast breeding range. In 2002, one or more pairs bred at 281 different sites and 30% of breeding pairs occurred at 208 sites with 1-5 pairs. In addition to the active sites, surveys were performed at 177 sandy coastal beaches and spits where no breeding was detected in 2002 (Hecht and Melvin 2009b). This pattern reflects the species' territorial behavior, natural and human-induced habitat fragmentation, and continuing gaps between abundance of breeding pairs relative to available habitat in many parts of the Atlantic Coast range.

The latitudinal extent of the breeding population did not change between 1986 and 2006, as piping plovers nested annually from southern North Carolina north to the western coast of Newfoundland. Breeding piping plovers were present each year in all Atlantic Coast states from North Carolina to Maine, except for New Hampshire, where they were reported in 1997 for the first time since ESA listing. One to three pairs were reported nesting in South Carolina in 1986, 1990, 1991, and 1993 (Hecht and Melvin 2009a).

Breeding Atlantic Coast piping plovers became less evenly distributed among the four recovery units between 1989 and 2007. Percentage of the population breeding in New England increased from 22% to 37% and declined in each of the other three recovery units during that period. In particular, the percentage breeding in eastern Canada declined from 24% to 14%, notwithstanding an increase in the absolute number of breeding pairs there.

Continuing vulnerability of the Atlantic Coast population to formation of gaps in the range is illustrated by the sharp decline in abundance of breeding pairs in the southern

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[1] This congener is a species of conservation concern, but only the Pacific Coast DPS is currently listed under the ESA.

half of the Southern recovery unit (south of Cedar Island, Virginia) between 1995 and 2001, when the population there declined from 75 pairs to only 25 pairs, thereby concentrating >85% of the breeding population in the recovery unit along less than 20% of its shoreline (Hecht and Melvin 2009a). With storm-related habitat improvement and predator management at sites where management to minimize human disturbance was ongoing, the population in this part of the range rebounded, reaching 102 pairs by 2008 (Cameron 2008, Smith and Boettcher 2008).

AC 2.5.2.6 Habitat use and conditions:

A growing body of evidence reinforces information presented in the 1996 revised recovery plan regarding the importance of wide, flat, sparsely-vegetated barrier beach habitats for recovery of Atlantic Coast piping plovers. Such habitats include abundant moist sediments associated with blowouts, washover areas, spits, unstabilized and recently closed inlets, ephemeral pools,and sparsely vegetated dunes.

At Cape Cod National Seashore in Massachusetts, Jones (1997) found that significantly more nests were on beaches with access to bayside feeding habitats compared with random points. However, almost two-thirds of Jones’s nests occurred on beaches without chick access to bayside foraging; nest success was significantly greater on beaches without bayside access, while fledging success did not differ significantly. Two logistic regression models indicated that sparse vegetation and distance from pedestrian access points were important indicators of beach suitability, while one of the models also identified bay access as characteristic of nest habitat selection. Beach slope at nests averaged 5.6%, less than the mean slope at random points (8.3%; Jones 1997). Out of 80 piping plover nests observed by Strauss (1990) at Sandy Neck in Barnstable, Massachusetts, no nests were located seaward of “steep foredunes,” where this habitat constituted 83% of the beach front. Many areas in Strauss's study site had been artificially plugged with discarded Christmas trees and/or sand fences. Piping plover distribution and foraging rates during the pre-nesting period (during establishment of territories and courtship) on South Monomoy Island, Massachusetts, indicated that sound and tidal-pond intertidal zones were the most important feeding areas in the period before egg-laying (Fraser et al. 2005).

Goldin and Regosin (1998) found significantly higher chick survival and overall productivity among chicks with access to salt pond “mudflats” than those limited to oceanside beaches at Goosewing Beach, Rhode Island. Goldin and Regosin (1998) also reported that broods on the pond shore spent significantly less time reacting to human disturbance (1.6%) than those limited to the ocean beach (17%). Since ocean beaches are highly attractive to recreational beachgoers, limiting plovers to these habitats may also increase the potential for disturbance from people and pets.

A 1992-1993 study of nest site selection on 90 km (55.8 miles) of beach on Jones Beach Island, Fire Island, and Westhampton Island, New York (Elias et al. 2000) found that all 1-km beach segments with ephemeral pools or bay tidal flats were used for nesting and brood rearing, whereas less than 50% of beach segments without these habitats were used. When the amount of time that plover broods used each habitat was compared with its availability, broods preferred ephemeral pools on segments where pools were present. On beach segments with bay tidal flats, broods preferred bay tidal flats and wrack to other habitats. On segments with neither ephemeral pools nor bay tidal flats, wrack was the most preferred habitat, and open vegetation was the second most preferred. Indices of arthropod abundance were highest on ephemeral pools and bay tidal flats. Chick peck rates were highest on ephemeral pools, bay tidal flats, and the ocean intertidal zone.

Cohen et al. (2008) reported that mean vegetative cover around piping plover nests on a recently re-nourished Long Island beach was 7.5%, and all plovers nested in <47% cover. Although almost 60% of nests were on bare ground, nests occurred in sparse vegetation more often than expected based on availability of this habitat type. Plovers also appeared to favor nest sites with coarse substrate over pure sand. At the same study area, piping plover chicks foraged more than expected and exhibited high peck rates in wrack, where arthropod abundance indices were also high (Cohen et al. 2009).

Following storm-and human-related increases in nesting and foraging habitat, the population at West Hampton Dunes, New York, grew from five pairs in 1993 to 39 pairs in 2000, and then declined to 18 pairs by 2004 concurrent with habitat losses to human development and vegetation growth (Cohen et al. 2009). Distribution of nests was heavily concentrated on the bayside of the barrier island in the early years following inlet formation and closure, but bayside nests decreased precipitously starting in 2001 and disappeared by 2004 as the study area was redeveloped and the bayside revegetated. The chick foraging rate was highest in bayside intertidal flats and in ocean and bayside fresh wrack. Chicks used the bayside more than expected based on percentage of available habitat, and survived better on the bayside before village construction and the initiation of predator trapping, but not after. In most years, density of nesting pairs adjacent to bayside overwash was 1.5 to two times that at an adjacent reference site, where beach nourishment increased nesting habitat but not foraging habitat. Cohen et al. (2009) concluded that local population growth can be very rapid where storms create both nesting and foraging habitat in close juxtaposition. An increase in local nesting habitat via artificial beach nourishment, however, is not necessarily followed by an increase in the local population if nearby intertidal flats are absent. Cohen et al. (2009) also note similarity between their results and observations by Wilcox (1959) of rapid colonization of habitats created on Westhampton barrier beaches by storms in the 1930s and their subsequent decline following revegetation and redevelopment (see the 1996 recovery plan).

At the North Brigantine Natural Area in New Jersey, changes in piping plover nesting numbers have paralleled changing habitat conditions. This area was subject to severe erosion in the early 1990s, and no plovers nested between 1990 and 1994. In the winter of 1994-1995, a series of nor'easters created a short-lived, shallow inlet from the ocean to a tidal lagoon (Widgeon Bay), which later transformed to several meandering channels, overwashing the beach and stripping vegetation. The piping plover population at this site grew from a single pair in 1995 to 15 pairs in 2002. Through 2002, plover breeding activity was concentrated almost entirely in the overwash area, which comprised less than a third of the approximately 2.5-mile-long Natural Area beach (D. Jenkins, New Jersey Division of Fish and Wildlife, pers. comm. 2003). With active management of both predators and off-road vehicle use, the North Brigantine site was also highly productive, fledging an average of 1.74 chicks per pair during the eight-year period. In 2003, the population increased to a total of 17 pairs distributed over a larger portion of the Natural Area, but productivity declined markedly. A subsequent decrease in overwash events at the site resulted in revegetation of the site and improved fox denning and feeding habitat (also coinciding with curtailed fox removal). Abundance dropped to eight pairs in 2004, and then held steady through 2008. Although productivity averaged only 1.17 chicks per pair during 2004-2006, it consistently exceeded the statewide average in each of those years before dropping below the statewide average in 2007 and 2008 (annual reports, New Jersey Division of Fish and Wildlife; T. Pover, Conserve Wildlife Foundation of New Jersey, pers. comm. 2009).

Analysis of piping plover nest site selection in New Jersey by Kisiel (2009) found a strong preference for nesting near inlets, particularly those that were not "shored" (hardened) with jetties or other stabilization features. Sixty- two percent of all pairs nesting in the state between 1987 and 2007 were located <1.6 km from one of 13 inlets along the New Jersey ocean shoreline.

Dramatic increases in plover productivity and breeding population on Assateague Island in Maryland following the 1991-1992 advent of large overwash events corroborated earlier findings and management recommendations by Loegering and Fraser (1995; see also USFWS 1996). Piping plover productivity, which had averaged 0.77 chicks per pair in a five-year period before the overwash, averaged 1.67 chicks per pair from 1992 to 1996 following the overwash events. The nesting population also grew rapidly, doubling by 1995 and tripling by 1996, when 61 pairs nested there. Over the 12 years from 1996-2007, the breeding population held steady at approximately 60 pairs (range = 56-66), but increasing vegetation forced nesting locations further seaward or into atypical vegetated habitats and blocked chick access to bayside foraging habitats (J. Kumer, NPS, pers. comm. 2009). The breeding population declined to 49 pairs in 2008, and productivity matched the previous recorded low of 0.41 chicks per pair (NPS 2008a).

In Virginia, Boettcher et al. (2007) reported that the five islands where piping plover breeding was observed every year from 1986-2005, "… encompass large segments of broad beaches with low discontinuous dunes and expansive sand-shell flats … providing unimpeded access from beach nest sites to the moist-soil ecotones of backside marshes." Cross and Terwilliger (2000) found that chick habitat use, foraging rates, and invertebrate prey abundance on four Virginia barrier islands was highest at moist inner-beach marsh edge and barrier flat habitats.

At Cape Lookout National Seashore, North Carolina, 13-46 pairs of plovers have nested on North and South Core Banks each year since 1992. While these unstabilized barrier islands total 70.4 km (44 miles) in length, nesting distribution is extremely patchy, with all nests clustered on the highly dynamic ends of the barrier islands, recently closed and sparsely vegetated "old inlets," expansive barrier mudflats, or new ocean-to-bay overwashes (NPS 2008b). During a 1990 study, 96% of brood observations at Cape Lookout Seashore were on bay tidal flats, even though broods had access to both bay and ocean beach habitats (McConnaughey et al. 1990).

Summary

Recent research and observations of piping plover distribution in response to habitat changes further buttress the 1996 revised recovery plan assessment that low, sparsely-vegetated beaches juxtaposed with abundant moist foraging substrates are preferred by breeding Atlantic Coast piping plovers.

AC 2.5.3 Five-factor analysis

In the following sections, we provide an analysis of threats to Atlantic Coast piping plovers in their breeding range. We update information obtained since the 1985 listing, 1991 status review, and 1996 revised recovery plan. Previously identified and new threats, including climate change and wind turbine generators, are discussed.

AC 2.5.3.1 Factor A. Present or threatened destruction, modification or curtailment of its habitat or range:

The 1985 final rule cited loss of appropriate sandy beaches and other littoral habitats due to recreational and commercial developments and dune stabilization as a factor contributing to the species' decline on the Atlantic Coast. Actions to discourage new structures or other developments, interference with natural inlet processes, and beach stabilization were accorded "priority 1" (actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future) in the 1996 revised recovery plan. Recent studies and reports, summarized above in section AC 2.5.2.6, reinforce the continued importance of protecting preferred piping plover breeding habitats and the natural coastal processes that form and maintain them. Several papers in the peer-reviewed literature explicitly recommended avoiding beach management practices (e.g., jetty construction, breach filling, dune building, beach nourishment) that typically inhibit natural renewal of ephemeral pools, bay tidal flats, and open vegetation (Elias et al. 2000) and allowing natural storm processes that create habitat to act unimpeded (Cohen et al. 2009).

New England recovery unit

Since completion of the 1996 revised recovery plan, only one formal section 7 consultation has been conducted for a project (at a small site in Maine) involving habitat modification or degradation in New England (USFWS 2008a). Informal consultations[1] with the USACE have resulted in project modifications to avoid direct and indirect

[1] Examples of projects for which consultation has been concluded informally include dredging of Ellisville Harbor channel in Plymouth, Massachusetts (M. Bartlett, USFWS, in litt. 2003) and navigation improvements in Westport Harbor and disposal of dredge material on Westport Beach, Massachusetts (S. von Oettingen, USFWS, in litt. 2007).

adverse effects (including indirect effects from project-induced beach recreation) of beach nourishment or inlet dredging. Projects with potential to degrade habitat have been proposed from time to time, but few have been implemented.[1] Although effects from past habitat loss and modification have diminished the piping plover's habitat base in New England, many high quality habitats remain, and piping plovers breed productively on a wide range of microhabitats (Jones 1997). Continued efforts to conserve high quality habitats are warranted, but overall threats from recent or proposed projects are low in the New England recovery unit.

New York-New Jersey recovery unit

Loss and degradation of habitat remains a prominent threat to piping plovers in the New York-New Jersey recovery unit. Within the New York Bight, which includes the species' entire range in New Jersey and the southern Long Island shoreline, more than half the beaches are classified as "developed" (USFWS 1997). The remaining beaches in the New York Bight, classified as "natural and undeveloped," enjoy some protection from development through the Coastal Barrier Resources Act's (96 Stat. 1653; 16 U.S.C. 3501 *et seq*.) limitations on federal assistance and flood insurance (discussed in the revised recovery plan). However, many of these areas are also subject to extensive stabilization activities that promote the formation of mature dunes, thus preventing overwash, inlet migration, and other natural coastal processes that create and maintain optimal plover habitats, described in section AC 2.5.2.6.

Along the south shore of Long Island, all six inlets from Montauk Point to Rockaway Inlet have been stabilized with hard structures, and multiple groin fields are located between them. Although these structures pre-date the piping plover's ESA listing, modification and maintenance activities (e.g., 2004 rehabilitation of Shinnecock Inlet western jetty) continue. Ongoing and proposed Long Island shoreline stabilization activities affecting piping plover habitats include inlet management, beach nourishment, dune construction, and dune stabilization (Figure AC2).

Inlet dredging impedes formation of flood and ebb tide shoals and back bay tidal flats, and the associated dredged material disposal often hinders overwash processes. Since 1996, maintenance dredging conducted three times at Shinnecock Inlet and four times each at Moriches and Fire Island Inlets has placed more than 4.7 million cubic yards of sand on updrift and downdrift beaches. Dredging at Fire Island Inlet slated for winter 2009-2010 is projected to place more than a million cubic yards of sand along "feeder beaches" west of the inlet or possibly updrift. Other recent navigation channel maintenance projects with beach renourishment include: 15-year Shelter Island, New York, Erosion Control Project (revised biological opinion, 1997); Three-Mile Harbor Dredging Project (1999); East Rockaway Inlet Navigation Project (2002); Porpoise Channel Dredging Project (2002); and Intracoastal Channel Maintenance Dredging

[1] Examples of projects proposed but not implemented include a proposal to build a road across Long Beach in Stratford, Connecticut (M. Bartlett in litt. 1996) and a 2007 proposal to fill a breach in Nauset Beach in Chatham, Massachusetts (NPS 2008c).

Figure AC2. Ongoing and proposed shoreline stabilization projects in the USACE New York District, 2009.

(2002; 2003). Permit conditions restricting timing of on-shore disposal and grading are not always followed (e.g., D. Stilwell, USFWS, in litt. 2007).

Over the last 40 years, all major Long Island barrier island breaches have been artificially closed, most recently at Westhampton Dunes in 1993. A 1995 Breach Contingency Plan, originally conceived to guide interim breach response over 57 miles of barrier island beach pending reformulation of the 83-mile Fire Island Inlet to Montauk Point Project (FIMP), called for initiation of closure activities within 72 hours of a breach (USACE 1996). Studies for the FIMP Reformulation have identified 10 areas vulnerable to breach and estimated that 20-69 acres of intertidal and upland spit habitat might be formed on the bays during a one-month breach, 74-351 acres during a 12-month opening (S. Alfageme, Moffatt and Nichol, in litt. 2006). Although the USACE's 1993 Initial Project Management Plan for the FIMP Reformulation anticipated issuance of a Public Notice for the Reformulation Report in 2002 (USACE 1993), FIMP Reformulation remained in progress as of June 2009.

A 2007 plan developed by the NPS in consultation with the USGS allows for natural development of breaches within Fire Island National Seashore, especially in the Otis Pike High Dune Wilderness Area, but only if it can be determined that the breach is likely to close naturally within some reasonable time frame (approximately three months), is not likely to lead to the development of a semi-permanent tidal inlet, and is not likely to lead to significant increased flooding damage to mainland development. If breaches are closed and ecological benefits thereby reduced, mitigation measures such as sand transfer or nourishment by dredging to create wash over fans and flood-tide deltas on the landward side of the barriers in Great South Bay may be implemented, but only in developed parts of the Seashore (Williams and Foley 2007).

Several ongoing "interim projects" are stabilizing portions of the Long Island south shore barrier islands most susceptible to breaching and overwash, both of which constitute piping plover habitat formation processes (USFWS 2001). Between 2001 and 2009, three renourishments have placed more than 2.3 million cubic yards of sand at the Westhampton Interim Project area (S. Couch, USACE, pers. comm. 2009). The West of Shinnecock Interim Project provided more than 800,000 cubic yards of sand for construction of "dunes" and beach nourishment in 2005, and allowed for two renourishment cycles with approximately 390,000 cubic yards each. Plantings of American beach grass and erection of sand fencing in the project areas also promote the formation of large, steep, heavily vegetated dunes.

Efforts to develop an interim federal shoreline stabilization project for Fire Island were suspended in approximately 2000 due to lack of a nonfederal sponsor. However, the National Park Service has granted special use permits for beach nourishment, beach scraping, dune construction, and beach grass plantings by communities within the Fire Island National Seashore (NPS 2003, USFWS 2003). More than 1.25 million cubic yards of sand were placed in the Fire Island communities in 2003. Three to seven more nourishment projects and 12-15 scraping projects are anticipated under the six-year life of a new plan approved in 2008 (USFWS 2008b).

Along the Atlantic coastline in New Jersey, five of 11 inlets (not including New York Harbor and Delaware Bay) are armored with jetties or other hard structures on both sides, and the shoreline is hardened on one side of three other inlets (Kisiel 2009). A permit has recently been issued for installation of steel sheet-piling and rock revetments at one of the three inlets currently without hard structures on either side (New Jersey Division of Land Use Regulation File #0511-08-0011.1, Jenkins in litt. 2009a). Maintenance dredging (conducted periodically at Manasquan, Barnegat, and Cape May Inlets) and repairs of existing hard structures are conducted in accordance with measures to avoid disturbance to piping plovers, but they perpetuate existing habitat loss.

All but approximately 13 of the 125 miles of Atlantic coastline in New Jersey (from Sandy Hook to Cape May) are encompassed in USACE beach nourishment and/or dune stabilization shore protection project areas. Two programmatic Biological Opinions (PBOs) address impacts of the projects along 112 miles of shoreline (USFWS 2002, 2005). The 2002 PBO addresses beach nourishment projects from Sea Bright to Manasquan Inlet in Monmouth County under the jurisdiction of the USACE New York District, and the 2005 PBO treats projects in the USACE Philadelphia District, from Manasquan Inlet to Cape May in Ocean, Atlantic, and Cape May Counties. Since the issuance of the 2002 and 2005 PBOs, 16 Tier 2 (i.e., project-specific) consultations covering >22 miles of shoreline have been completed (Table AC1). Since 1996, but prior to the 2002 and 2005 PBOs, the Service had engaged in at least six formal consultations for beach nourishment projects covering 11.14 linear miles and more than seven million cubic yards of fill. Other federal beach nourishment projects during this time were addressed in several Fish and Wildlife Coordination Act reports, but projects have been stalled due to lack of funding. In addition, the Regulatory Branch of the USACE Philadelphia District has active permits for beach nourishment activities at the south end of Ocean City (expires in 2010), and Strathmere, Upper Township (maintenance authorized through 2011).

Even within the 13 miles of New Jersey shoreline excluded from the USACE's nourishment programs, an approximately 3,000-foot section of the Sandy Hook Unit of the Gateway National Recreation Area, known as the Critical Zone, is regularly nourished by the NPS. Formal consultation on a permanent sand slurry pipeline to move sand from other portions of the Sandy Hook shoreline to the Critical Zone was completed in 2005, but the project is still under construction.

Singly and collectively, the projects described above accelerate the formation of mature dunes, substantially reducing inlet creation and overwash that would otherwise form and perpetuate the sparsely vegetated, low-lying, early-successional barrier beach habitats important to breeding piping plovers.

In addition to preclusion of natural habitat formation and creation of suboptimal beach and dune habitats, other direct and indirect adverse effects of artificial shoreline stabilization include disturbance by construction activities, burial of piping plover prey base, increased human recreation activity, intensified conflicts with human recreation induced by loss of alternative (overwash and bayside) plover habitats, and exacerbation

Table AC1. Tier 2 (project-specific) consultations with the USACE in New Jersey under the 2002 and 2005 Programmatic Biological Opinions, through August 2009.

Tier 2 Consultations in the NY District since 2002	**Consultation Completion Date**	**Estimated Fill Quantity (cubic yards)**	**Length of Fill (Linear Miles)**
City of Long Branch	2007	1,000,000	3
Tier 2 Consultations in the Philadelphia District since 2005			
City of Brigantine (14th Street North - 18th Street South)	2005/2006	500,000	1.57
City of Brigantine (Dredging of St. Georges Thorofare, sand placed on Absecon Inlet Beach Area)	2006	60,500	unknown (likely <0.5)
Borough of Surf City – Long Beach Island	2007	500,000	1.48
Cape May Inlet – Lower Township (U.S. Coast Guard)	2007	250,000	1.33
Borough of Avalon (9th-18th streets) – informal	2007	183,000	0.47
Borough of Avalon (9th-18th streets) – informal	2008	183,000	
City of Ocean City	2008	600,000 – 800,000	2.17
City of Ocean City (North End)	2008	50,000	0.37
Cape May Inlet – Lower Township and Lower Cape May Meadows – Cape May Point	2008	575,000 – 675,000	1.69
Borough of Harvey Cedars – Long Beach Island	2008	525,000	1.98
Borough of Avalon (9th-18th streets for 2009)	2008	150,000 – 200,000	0.38
City of North Wildwood/ City of Wildwood	2008	1,438,055	1.5
Upper Township/Sea Isle	2009	1,286,000	3.16
Stone Harbor (98th St. to 111th St.)	2009	245,000	0.66
Great Egg Harbor Inlet and Peck Beach	2009	1,500,00	2.65
Total (2002 PBO)			**3**
Total (2005 PBO)			**19.41**
Statewide total			**22.41**

of predation threats (USFWS 2001, 2002, 2003, 2005). Project descriptions for many of the consultations listed above include commitments to avoid or minimize construction during the piping plover breeding season and to implement USFWS (1994) *Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast (Guidelines for Managing Recreation).* Although these conservation measures play an important role in maintaining piping plovers on nourished beaches in the New York-New Jersey recovery unit, they cannot fully compensate for loss of overwash and bayside habitats that are both preferred by the plovers and less attractive to human beach recreationists.

Southern recovery unit

Piping plovers in the Southern recovery unit are almost completely restricted to low-lying, unstabilized barrier island flats and spits (see Maryland, Virginia, and North Carolina studies and reports cited in section AC 2.5.2.6). Piping plovers remain absent from barrier beaches adjacent to roads along most of the Delaware coast. With very few exceptions, breeding piping plovers have not yet recolonized sections of Assateague Island in Maryland and Virginia south of Maryland State Road 611, where artificial "dunes" were constructed in the 1960s (USFWS 2007, NPS 2008a). This increases sensitivity of Southern recovery unit populations to frequency and magnitude of storms overwashing the remaining undeveloped habitats.

Boettcher et al. (2007) credited Hurricane Isabel in 2003 with creating favorable habitat conditions that facilitated expansion of the Virginia population. Conversely, piping plover habitat on the northern section of Assateague Island National Seashore in Maryland has declined in recent years due to the lack of sufficient washover events. A 1.6 mile-long storm berm, constructed in 1998, has accentuated the loss of chick foraging habitat, believed to be a major factor in recent declining plover productivity and abundance on the Maryland end of Assateague Island. Successive attempts to modify this berm and restore overwash have not yet proven successful (NPS 2008a), although the NPS remains optimistic that this will happen when larger storms occur there (J. Kumer pers. comm. 2009). In 2003, the Secretary of Homeland Security declared a new inlet that formed during Hurricane Isabel between Frisco and Hatteras Village in North Carolina to be a national security issue and instructed Federal Emergency Management Service and the USACE to fill the inlet (USFWS 2006). Piping plovers in North Carolina remain confined to undeveloped and unstablized portions of barrier islands, most notably within the Cape Lookout National Seashore, Lea and Hutaff Islands, and spits adjacent to inlets (and Cape Point) within the Cape Hatteras National Seashore and Pea Island National Wildlife Refuge. Reductions in habitat quality due to recent revegetation of habitat created by Hurricane Isabel were noted at Cape Lookout National Seashore in 2008, but this was at least partially offset by formation of new habitats elsewhere within that Seashore (NPS 2008b).

Habitat restoration efforts

Efforts to create and enhance piping plover nesting and foraging habitats, as provided in Atlantic Coast revised recovery plan task 1.24, have been incorporated into a number of shoreline stabilization projects (e.g., USFWS 2001, 2005) and implemented by other recovery cooperators (see, for example, Suffolk County Department of Parks, Recreation, and Conservation 2004). With the exceptions of the Lower Cape May Meadows and Stone Harbor restoration projects in New Jersey (USFWS 2005, B.E. Brandreth *in* Guilfoyle et al. 2007), however, most efforts to date have been small-scale. Monitoring and evaluation of restoration project effects on piping plovers and habitat indicators (e.g., habitat availability-use ratios, predator track indices) have been nonexistent or extremely limited (Maslo 2009). Preliminary review of 10 projects in Rhode Island, New York, New Jersey, and Virginia by Maslo (2009) suggested that increases in abundance of nesting pairs followed some vegetation removal and foraging habitat enhancement projects, but that the projects that improved foraging opportunities away from the ocean intertidal zone were more likely to also be associated with increased productivity.

Summary

Habitat loss and degradation remains very serious threats to Atlantic Coast piping plovers, especially in the New York-New Jersey and Southern recovery units. Artificial shoreline stabilization projects perpetuate conditions that reduce carrying capacity and productivity and exacerbate conflicts between piping plovers and human beach recreation. As discussed in section AC 2.5.3.5, many activities that artificially stabilize barrier beaches will further exacerbate threats from projected sea-level rise.

AC 2.5.3.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

Although it discussed severe depletion of piping plover populations due to uncontrolled hunting in the late 1800s, the 1985 final listing rule stated that this factor was not an current threat to the piping plover. The 1996 revised recovery plan does not explicitly address overutilization as a threat to Atlantic Coast piping plovers, but it does briefly mention concerns about safety of piping plover marking techniques for use in research.

The only utilization-related threat identified post-listing is that of leg injuries associated with banding for scientific studies. Although injuries have been reported in all breeding populations, 78% of 54 injuries (seen 1985-1989) reviewed by Lingle et al. (1999) involved the Atlantic Coast population. Seventeen apparent band-related injuries, ranging from abrasion to foot loss, were observed from 361 recaptures of banded piping plovers in eastern Canada, 1998-2004. All but two of these injuries were related to the use of novel aluminum bands (Amirault et al. 2006). Although band-related mortality may have gone undetected, breeding was confirmed for many of the birds with foot loss (Amirault et al. 2006). Since 1989, banding of U.S. Atlantic Coast piping plovers has only been authorized in very limited circumstances (i.e., one study involving a relatively small number of birds, and birds released following treatment to remove oil). No banding has been conducted in eastern Canada since 2003 (D. Amirault-Langlais pers. comm. 2008a). Threats to Atlantic Coast piping plovers from band-related injuries are fully regulated by the USFWS and CWS and are, therefore, of low concern. Furthermore, awareness of the history of banding injuries to Atlantic Coast piping plovers among the research community and federal and State wildlife agencies makes it unlikely that this threat would pose more than a low risk to Atlantic Coast piping plovers if the species were to be removed from ESA protections.

AC 2.5.3.3 Factor C. Disease or predation:

Disease

The final listing rule stated that disease was not known as a problem for piping plovers, and the revised Atlantic Coast recovery plan contained no mention of disease. The USFWS and CWS receive occasional reports of disease-related mortality on the Atlantic Coast (e.g., three post-fledging mortalities in Atlantic Canada; D. Amirault-Langlais, pers. comm. 2008b), but it is not known whether the role of disease is primary or secondary to some other stressor. Diseases detected in the U.S. Atlantic Coast breeding range include aspergillosis, avian cholera, and salmonella (J. Hoeh, USGS, pers. comm. 2009), all isolated cases. There is no evidence that disease is a current threat to Atlantic Coast piping plovers. In light of the Atlantic Coast population's relatively small size, however, continued vigilance is appropriate to detect any emerging diseases.

Predation

The final rule identified predation by pets, feral dogs and cats, skunks, and raccoons as threats on the plover's Atlantic Coast range. The 1996 revised recovery plan provides a more thorough discussion of predation threats, and recommends specific tasks to be implemented in an integrated approach to predator management employing a full range of management techniques (see task 1.4 and related sub-tasks).

Recent research and reports indicate that predation poses a continuing (and perhaps intensifying threat) to Atlantic Coast piping plovers. Erwin et al. (2001) found a marked increase in the range of raccoons and foxes on the Virginia barrier islands between the mid-1970s and 1998, and concurrent declines in colonies of beach-nesting terns and black skimmers. Boettcher et al. (2007) identified predation as "the primary threat facing plovers in Virginia." Review of egg losses from natural and artificial nests at Breezy Point, New York, found that gulls, crows, and rats were major predators (Lauro and Tanacredi 2002). Recommendations included removal of crow nests to complement ongoing removal of gull eggs and nests. Modeling by Seymour et al. (2004) using red fox movement data from northern England indicated that risk of fox predation on ground-nesting bird species in long, linear habitats increased with narrowing habitat width, and was sensitive to changes in habitat width of even a few meters.

Free-roaming domestic and feral cats, particularly those associated with human-subsidized feral cat colonies, appear to be an increasing threat to piping plovers and other beach-nesting birds. Examples of sites where feral cats have been identified as substantial threats to piping plovers just since 2006 include Seabrook, New Hampshire; Brookhaven and Southampton, New York; Cape May City and the Borough of Stone Harbor, New Jersey; Cape Hatteras and Cape Lookout National Seashores, North Carolina (M. Amaral, USFWS, in litt. 2006; E. Davis, USFWS, in litt. 2007a; A. Scherer, USFWS, pers. comm. 2007; NPS 2007a, 2008b; S. Papa, USFWS, pers. comm. 2008; D. Stilwell, USFWS, in litt. 2009;). USFWS biologists, state wildlife agencies, and conservation groups such as American Bird Conservancy and National Audubon Society are devoting extensive efforts to work with local authorities and feral cat advocates to prevent and remove free-roaming cats in proximity to piping plover breeding areas.

Although predator numbers are undiminished or increasing, effectiveness of predator exclosures (wire cages placed around nests, a key management tool in the early years of the recovery program) has declined. Episodes of systematic harassment of incubating piping plovers (primarily by foxes, coyotes, and crows) and depredation at exclosures, elevated rates of nest abandonment, and incidents of adult mortalities associated with exclosed nests on the Atlantic Coast (USFWS 1996, Mostello and Melvin 2002, Melvin and Mostello 2003, 2007) and elsewhere (Murphy et al. 2003) have caused managers to use exclosures more selectively. Cohen et al. (2009) found that exclosures improved nest survival, but not overall reproductive output on Westhampton Island, New York study sites, a result that has been echoed by studies of other plover species and of piping plovers in their Northern Great Plains breeding range (e.g., Neuman et al. 2004).

As effectiveness of exclosures has declined, managers have increased selective predator removal activities at many sites throughout the U.S. Atlantic Coast range (e.g., USDA 2006, NPS 2007b, Cohen et al. 2009). Most predator removal efforts have focused on mammalian predators, but gulls and crows have been targeted at some sites (e.g., Brady and Inglefinger 2008, USFWS 2007, USDA 2008,). Boettcher et al. 2007 state that predator management is “one of the most important and expensive avian conservation measures being implemented on Virginia’s barrier islands.” Cohen et al. (2009) found that the number of chicks fledged per pair at Westhampton, New York increased with the annual number of cats and foxes trapped. Mean productivity at Maine sites where predator management was conducted was approximately double productivity at sites without predator management in both 2007 and 2008 (USDA 2008). Productivity of piping plovers at Plymouth Beach, Massachusetts, averaged 1.67 fledged chicks per pair during three years when foxes were removed, compared with 0.86 chicks per pair during the preceding seven years (S. Melvin, Massachusetts Division of Fisheries and Wildlife, pers. comm. 2009). Following selective crow removal at Crane Beach in Ipswich, Massachusetts, in 2008, piping plover productivity was the highest since 1999 and exceeded 1.25 fledglings per pair for first time since 2002 (Brady and Inglefinger 2008).

Implementation of conservation measures for addressing predation threats is time-consuming and costly. Although site-specific predator pressures vary from year-to-year, predator management is a recurring need. Furthermore, logistical constraints and difficulties obtaining authorizations often delay or prevent managers from implementing alternative management approaches when predator exclosures fail, resulting in substantial losses of eggs, chicks, and breeding adults. See section AC 2.5.3.5 for further discussion of expenditures and effort associated with implementing these conservation measures and threats posed by lack of reliable funding.

Predation is a pervasive, persistent, and serious threat to breeding Atlantic Coast piping plovers.

AC 2.5.3.4 Factor D. Inadequacy of existing regulatory mechanisms:

The 1985 final listing rule contained brief mention of a few limited legal protections for piping plovers, but noted that ESA listing would offer additional safeguards.

Many continuing regulatory protections for breeding Atlantic Coast piping plovers afforded by the ESA, other federal authorities (including the Migratory Bird Treaty Act and the Coastal Barrier Resources Act), and state laws are summarized on pages 46-49 in the 1996 revised recovery plan. Formal and informal ESA section 7 consultations are conducted with the USACE, seven units of the NPS that collectively hosted 17% of U.S. Atlantic Coast breeding pairs in 2007, the U.S. Coast Guard, the Minerals Management Service, the National Aeronautics and Space Administration, USFWS National Wildlife Refuges, and other agencies. The *Guidelines for Managing Recreation* (USFWS 1994) provide consistent guidance to landowners and other groups about proven practices for ESA compliance. Several regulatory mechanisms enacted since 1996 or that were omitted from the revised recovery plan are summarized below.

The Canadian Species at Risk Act, enacted in 2002, provides many protections for piping plovers in eastern Canada that parallel those conferred by the ESA. In addition to prohibitions and penalties for killing, harming, or harassing listed species, SARA requires preparation of a recovery strategy for listed threatened and endangered species, measures to reduce and monitor impacts of projects requiring environmental assessments, and protection of critical habitat (Environment Canada 2003). The *melodus* subspecies of piping plovers is listed as endangered (Department of Justice Canada 2002). Posting of a proposed recovery strategy on the Species at Risk Public Registry is anticipated following notifications to landowners and will include identification of eastern Canada critical habitat sites (D. Amirault-Langlais pers. comm. 2009).

In Maine, protections described in the 1996 recovery plan have been expanded. Three more sites were designated as Essential Habitat in 1998, bringing the state total to twelve (Maine Department of Inland Fisheries and Wildlife 2000). As of 2007, 10 piping plover nesting beaches are also designated as Significant Wildlife Habitat (shorebird feeding and roosting areas) under Maine's Natural Resource Protection Act, which requires special review and permits from the Maine Department of Environmental Protection (ME DEP 2007). Maine Sand Dune Rules require that Essential and Significant Wildlife Habitats cannot be unreasonably harmed. These rules also require that owners of property on a beach that will be nourished enter legally binding agreements that allow for the management of piping plovers and other wildlife habitat on the beach portion of their properties (ME DEP 2006).

New Jersey state regulations protecting piping plover habitats were not specifically mentioned in the 1996 recovery plan. New Jersey's Coastal Zone Management (CZM) Rules, which receive their authority under several different statutes including the Coastal Area Facility Review Act (CAFRA), regulate development and other activities along New Jersey's Coastal Zone. Under 1994 CZM rules, beach raking is restricted in documented piping plover habitat from April 1 to August 15. Amendments to CAFRA enacted in 1993 also regulate single family homes near the water's edge; a general permit cannot be issued if the development would adversely affect habitat for any state-listed endangered or threatened species through primary or secondary impacts (D. Jenkins, pers. comm. 2009b). Furthermore, efforts by USFWS and New Jersey Endangered and Nongame Species Program have produced (as of August 2009) 10 MOUs with local governments implementing formal beach management plans for the protection of federally and state-listed species; nine additional plans are under development.

Although they are uncommon, some regulatory mechanisms can impede piping plover conservation activities. The USFWS has recommended modifications to New Jersey CZM Rules to allow beach and dune manipulation and vegetation management for piping plover habitat restoration or enhancement projects (J.E. Davis, USFWS, in litt. 2007b). Efforts by advocacy groups to institute legal prohibitions on trapping and removing feral cats (Longcore et al. 2009), even at sites where they pose a significant threat to imperiled native wildlife, are an example of a potential regulatory threat that could substantially adversely affect breeding piping plovers.

Existing state and federal regulatory mechanisms, including the ESA, play a critical role in progress toward piping plover recovery in their Atlantic Coast breeding range. Their effective implementation, however, requires copious time and effort on the part of USFWS and state wildlife agency biologists and other important recovery cooperators. Furthermore, these efforts are contingent on immense amounts of information collected annually to determine the abundance, location, and productivity of nearly every breeding pair. Because threats are being managed, not eliminated, removal of the Atlantic Coast piping plover from ESA protections will require institution of adequate alternative regulatory mechanisms or contractual agreements that do not currently exist.

In the absence of the ESA, other existing regulatory mechanisms are currently inadequate to protect breeding Atlantic Coast piping plovers.

AC 2.5.3.5 Factor E. Other natural or manmade factors affecting its continued existence:

Disturbance by humans and dogs

Threats from human beach-users were cited in the final listing rule and described in detail in the revised Atlantic Coast recovery plan. Threats to breeding piping plovers from both motorized and non-motorized beach recreation activities are relatively well understood, and recommended management options are described in the *Guidelines for Managing Recreation* (USFWS 1994).

Emerging threats include the increasing popularity of "extreme sports," such as kite-buggies and surf kites (also called "kite boards"), which accidentally land in and near breeding habitat. Examples of places where limitations on surf kites have been instituted include Sandy Hook and Stone Harbor in New Jersey, Cape Cod National Seashore in Massachusetts, and Long Beach in Stratford, Connecticut.

Sufficiency of restrictions on dogs in piping plovers nesting areas and consistency of enforcement are continuing concerns of biologists monitoring Atlantic Coast piping plovers (e.g., M. Bartlett in litt. 2008; E. Jedrey and B. Harris, Massachusetts Audubon Society, pers. comm. 2008 *in* USFWS 2008a; NPS 2008b). Recent literature on closely related beach-nesting plover species provides additional evidence of adverse effects on breeding activities from both leashed and unleashed dogs (Lord et al. 2001, Weston and Elgar 2007).

Management activities to protect habitat, nests, and unfledged chicks from impacts of pedestrian recreation include symbolic fencing of courtship and nesting habitat, informational and interpretive signing, public education, and law enforcement patrols. On sites where off-road vehicles are allowed to operate during the breeding season, protection requires additional closures of the lower beach and intertidal zone during periods when unfledged chicks are present. These management activities are predicated on frequent monitoring of individual breeding pairs during territory establishment and courtship, nesting, and chick-rearing periods. For example, periodic adjustment of buffers established with warning signs and symbolic fencing to protect piping plover courtship habitat, nests, and incubation behavior requires regular observations of breeding activity. Minimizing the spatial extent and duration of restrictions on use of off-road vehicles is contingent on precise hatching date predictions and daily verification of brood locations (USFWS 1996). All of these labor-intensive actions require continued implementation to counter threats that are present every year.

Disturbance by humans and dogs is a continuing widespread and severe threat to Atlantic Coast piping plovers. See also discussion below regarding expenditures and effort associated with implementation of these conservation measures and threats posed by lack of reliable funding.

Beach-raking

As described in the revised recovery plan, beach-raking machines remove the plovers' wrackline foraging habitat and pose mortality risks due to crushing or sweeping up eggs and chicks. Several recent studies (Elias et al. 2000, Cohen et al. 2009; see section AC 2.5.2.6) have confirmed the importance of wrack as a foraging habitat. Jones (1997) suggested presence of wrack as a primary factor explaining breeding success of piping plovers without bayside access at Cape Cod Seashore in Massachusetts. Jones (1997) also cited potential for beach-cleaning operations to degrade habitat, since piping plovers often place their nests near cobble, wrack, or other natural debris. Indiscriminant use of beach-raking machines is a continuing threat to Atlantic Coast piping plovers.

Oil spills

Neither the 1985 final listing rule nor the 1988 recovery plan identified oil spills as a threat to breeding Atlantic Coast piping plovers, but this threat was recognized in the 1996 revised recovery plan (see task 1.5). Since the 1986 listing, six oil spills of known origin affecting Atlantic Coast piping plovers have included the World Prodigy (RI, 1989), B.T. Nautilus (NY and NJ, 1990), North Cape (RI, 1996; oiled piping plover habitat), T/B Rhode Island (NY, 2001), Anitra (NJ/DE, 1996), and Bouchard No.120 (MA and RI, 2003). More than 50 oiled adult piping plovers were observed in both the Anitra and Bouchard No. 120 spill areas, and 27 adults were oiled by the B.T. Nautilus spill (Mierzykowski 2009).

Implementation of piping plover restoration plans using funds collected from the responsible party have been completed or are in progress for the World Prodigy, B.T. Nautilus, North Cape, and Anitra spills. The natural resource damage assessment and restoration planning are still in progress for the 2003 Bouchard No.120 spill.

Sporadic incidents of oiling of unknown origin also affect piping plovers and breeding sites. Examples include Newfoundland and Nova Scotia, 2000(reported *in* Amirault-Langlais et al. 2007); Cape Cod National Seashore, Massachusetts, 2003 (USFWS files); and Assateague and nearby barrier islands in Virginia, 1997 (Mierzykowski 2009).

Oil spills may have a direct or indirect impact on birds. Adult piping plovers may become oiled as they feed in the intertidal zone and wrack line. Oiled adults may spend more time preening and less time foraging, tending their young, or incubating. Toxic effects may occur in adults from oil ingested during feather preening. Eggs may be coated with petroleum products from stained or coated adults (Mierzykowski 2009). Even if spills occur prior to the arrival of birds on the beaches, the habitat may be degraded for plovers. After the January 1996 North Cape oil spill in Rhode Island, lower prey abundance was recorded in piping plover habitat (Donlan et al. 2003). Finally, spill response operations on beaches typically involve many responders with potential to disturb piping plover breeding activities.

Oil spills pose a continuing moderate threat to breeding Atlantic Coast piping plovers. Restoration programs funded by responsible parties can help mitigate losses, but piping plover populations are at higher demographic risk during the many years that commonly occur between spill-associated mortality and completion of restoration.

Other environmental contaminants

Environmental contaminants have not been identified as a limiting factor in the Atlantic coast piping plover population. Contaminant investigations of piping plovers in the Atlantic coast population (summarized by Mierzykowski 2009), however, have been extremely limited. Since 1990, 33 opportunistically-collected composite or individual piping plover egg samples from Maine, New York, New Jersey, and Delaware have been analyzed for residues of organochlorine compounds and trace elements. No contaminant egg data are known to exist for piping plovers from Massachusetts, Rhode Island, Connecticut, Maryland, Virginia, or North Carolina.

Average concentrations of total polychlorinated biphenyl, dichloro diphenyl dichloroethylene (DDE), and mercury in Atlantic Coast piping plover eggs analyzed since 1990 did not exceed suggested toxicity threshold effect levels, but too few samples were analyzed to adequately characterize contaminant burdens in the population. Although average PCB, DDE, and mercury concentrations were not highly elevated, the maximum reported PCB and mercury concentrations in these composite egg samples were at toxic levels. Polybrominated diphenyl ether (PBDE) and perfluorooctane-sulfonate (PFOS) have been detected in 2007 and 2008 samples of piping plover eggs from Maine (Goodale 2008, 2009). Avian egg threshold effect levels for these two compounds are still in development. One piping plover egg sample from Maine in 2007 had a PFOS level that was two-fold higher than a concentration that reduced hatching success in PFOS-dosed chicken eggs (Mierzykowski 2009).

The USFWS has secured funding for analysis of a few additional samples of opportunistically collected non-viable or abandoned piping plover eggs in 2009 to establish concentration baselines, particularly in the states where no information is currently available. Results are anticipated in 2010 (S. Mierzykowski, USFWS, pers. comm. 2009).

Currently available information (subject to revision if indicated by new information) indicates that environmental contaminants pose a low threat to breeding Atlantic Coast piping plovers.

Wind turbines

Wind turbine generators have emerged as a potential threat to piping plovers since the 1996 revised recovery plan.

Five wind turbine generators have been constructed on Sable Island, Nova Scotia, where migrating piping plovers are occasionally reported (D. Amirault-Langlais pers. comm. 2008c); 18 bird corpse surveys between August 2006 and September 2008 detected only one shorebird, a greater yellowlegs (Z. Lucas, Green Horse Society, pers. comm. 2008). Two wind turbine projects (one with 16 turbines, the other with ten) are also located near piping plover breeding sites on Prince Edward Island. The only proposed wind turbine generator project reviewed by CWS in Atlantic Canada as of March 2009 that raised concerns about piping plovers is on Cape Sable Island, Nova Scotia; this project has not yet proceeded to construction (A. Boyne, CWS, pers. comm. 2009).

In late 2008, the USFWS completed consultation with the Minerals Management Service on a proposal by Cape Wind Associates to construct 130 wind turbine generators

approximately five miles off the coast of Cape Cod, Massachusetts (USFWS 2008a), but (as of August 15, 2009) Minerals Management Service has not yet issued a Record of Decision for this project.
Since 2008, the USFWS has provided technical assistance and preliminary comments regarding proposals (in various stages of development) for one-two wind turbine generators to USDA in Maine, U.S. Coast Guard and National Guard Training Center in New Jersey, and National Aeronautics and Space Administration in Virginia (Appendix C). The USFWS has also concurred with Minerals Management Service's determination that leases for single meteorological towers in seven potential wind turbine generator lease blocks located 8-17 miles off the coast of Delaware and New Jersey are not likely to adversely affect piping plovers. Comments regarding seven potential off-shore wind power demonstration sites have been submitted to the Maine State Planning Office's Ocean Energy Task Force (L. Nordstrom, USFWS, in litt. 2009). Several other wind turbine generator projects that have been the subject of media reports or regulatory review by State agencies, but for which no formal communication with the USFWS regarding potential impacts to piping plovers has been initiated, are also listed in Appendix C.

The major potential threat to piping plovers posed by wind turbine generators is that of collisions. In the off-shore environment, the primary risk occurs during migration, when routes and flight altitudes are largely unknown. While analysis of the best available information indicates that risk from the Cape Wind project is low (USFWS 2008a), the prospect of multiple large wind turbine generator projects along potential migration routes poses greater concern. Studies to determine the most effective methods to assess wind turbine generator risks to piping plovers (and other listed and candidate bird species) on the Outer Continental Shelf are currently in planning stages under the auspices of Minerals Management Service (M. Boatman, MMS, pers. comm. 2009). Risk from wind turbine generators sited nearshore, on nesting beaches, or in the vicinity of intertidal flats landward of barrier islands or spits has not been assessed. Impacts may vary with the specific size, number, and configuration of proposed wind turbine generators and site-specific factors such as juxtaposition of nesting and foraging habitats and weather patterns.

Wind turbine generators pose a threat to piping plovers in the foreseeable future, but the magnitude of this threat cannot be assessed without better information about piping plover movements. Information needs include migration routes and altitude, flight patterns associated with breeding adults and post-fledged young of the year foraging at nearby sites that are not contiguous with nesting habitats, and avoidance rates under varying weather conditions.

Climate change

An accumulating body of evidence has led most scientists to agree that human-induced warming is changing the global climate (e.g., IPCC 2007). Neither the final rule listing the piping plover (USFWS 1985) nor the 1996 revised Atlantic Coast recovery plan mentioned climate change-related threats to piping plovers. Here we briefly address two climate change-related concerns for coastal regions: accelerated sea-level rise and potential for more frequent and energetic storms (IPCC 2007). Although not discussed further, we do not discount the potential for other climate change related effects on piping plovers (e.g., changes in predator communities, emergence of new diseases, increases in competition for nesting territories with other beach-nesting bird species on a reduced habitat base).

Potential effects of accelerating sea-level rise on coastal beaches, including piping plover nesting and foraging habitats, may be highly variable and potentially severe. Important factors influencing future habitat losses and gains include the amount of sea-level rise, which may vary regionally due to subsidence or uplift and the specific landforms occurring within a region (Galbraith et al. 2002, Gutierrez et al. 2007). Gutierrez et al. (2007) predicted varying responses of spits, headlands, wave-dominated barriers, and mixed-energy barriers for four sea-level rise scenarios in the U.S. mid-Atlantic region (overlapping most of the piping plover's New York-New Jersey and Southern recovery units). Human responses, especially coastal armoring, will also play key roles in the effects of sea-level rise on the quantity, quality, and distribution of piping plover habitats. The U.S. Climate Change Science Program (CCSP 2009), for example, stated that, "To the degree that developed shorelines result in erosion of ocean beaches, and to the degree that stabilization is undertaken as a response to sea-level rise, piping plover habitat will be lost. In contrast, where beaches are able to migrate landward, piping plovers may find newly available habitat." A review of impacts of sea-level rise and climate change on the coastal zone of southeastern New Brunswick reached similar conclusions, stating that, "…coastal ecosystems have a natural capacity to respond to climate and water-level variability … [but] future impacts of sea-level rise and climate change could be exacerbated by development pressures or infrastructure protection projects." (Environment Canada 2006). Timing and spatial distribution of habitat gains and losses will also be critical (Galbraith et al. 2002); demographically vulnerable species such as piping plovers will be especially susceptible to lags between habitat loss and formation.

Increased coastal storm activity is a second climate change-related threat to piping plovers in their Atlantic Coast breeding range. Although there is uncertainty about whether and how storm frequency or intensity will change relative to 20th century trends (CCSP 2008), sea level rise alone will increase coastal flooding during storm surges and amplify rates of habitat change on coastal beaches. If coastal storm activity also increases, these effects are likely to be exacerbated (CCSP 2009). Furthermore, increased numbers and intensity of storms during the breeding season could directly affect piping plover breeding success by increasing long-term rates of nest inundation, nest abandonment, or chick mortality due to harsh weather.

Sea-level rise and coastal storm activity pose significant threats to Atlantic Coast piping plovers. Although the current impacts on habitat availability and breeding success are undetermined, they are expected to increase within the next 10 to 20 years. Furthermore, ongoing and near-term human coastal stabilization activities may strongly influence the mid- and long-term effects of climate change on piping plovers and their habitat. It is urgent, therefore, that we improve understanding of threats from sea-level rise and increased coastal storm activity and develop scientifically-sound strategies to address them.

Reliability of effort and expenditures for conservation measures

The magnitude of conservation efforts, described in the 1996 recovery plan, remains high. In 2002, 73 federal, state, and local governmental agencies and private organizations played key roles in conservation efforts at 281 U.S. Atlantic Coast plover breeding sites. Total inflation-adjusted estimated expenditures increased by 51% between 1993 and 2002, from $2.28 million to $3.44 million, but annual per-pair expenditures declined 4% from $2,459 to $2,350, and hours of paid-staff effort were similar (93 hours per pair in 1993, 95 hours in 2002; Hecht and Melvin 2009). Per-pair staff hours devoted to conservation of piping plovers in eastern Canada in 2002 and 2003 were higher or similar to the U.S. portion of the range (Recovery of Nationally Endangered Wildlife 2003, 2004).

The greatest impediments to reducing management costs for breeding Atlantic Coast piping plovers are the species' widespread distribution at relatively low densities and the unrelenting threats posed by human recreation, coastal development, shoreline stabilization projects, and predators. However, landowner choices regarding management options exert a strong influence on expenses. For example, in both 1993 and 2002, per-pair spending at seven National Park Service units, where public use was allowed but intensively managed, were more than double expenditures at National Wildlife Refuges that prohibited public access to beaches during the piping plover breeding season (Hecht and Melvin 2009b). The 1996 Atlantic Coast recovery plan presents alternative strategies for managing off-road vehicle use to avoid killing or injuring piping plovers, their eggs, or chicks. Some alternatives require very little monitoring and hence, lower costs (for example, complete closure to vehicles for the entire nesting season), but many beach managers have elected options with more labor-intensive monitoring requirements that allow them to minimize the extent and duration of vehicle closures. Per-pair expense of deploying predator exclosures declines very little as the number of pairs on a site increases, as this technique requires intensive monitoring, but potential public controversy has deterred some landowners from adopting lethal predator removal, despite the fixed costs per site and potentially larger benefits of reducing predation on both eggs and precocial chicks.

Cooperating agencies and landowners struggle to maintain staff and budgets to implement Atlantic Coast piping plover conservation programs[1]. Even temporary interruption of funding would risk steep declines, as well as lingering effects that would result from the loss of experienced, skilled staff at government and nongovernmental organizations. Veteran biologists play key roles in training novice monitors and rapidly responding to difficult or controversial situations and new problems. Other at-risk beach-dwelling species (e.g., least tern (*Sternula antillarum*), seabeach amaranth (*Amaranthus*

[1] The USFWS Northeast Region recently identified piping plover management as the highest regional priority for incorporation into base budgets of refuges that host breeding piping plovers (J. Kennedy, USFWS, pers. comm. 2009).

pumilus)) would also be adversely affected by diminished funding for protection of Atlantic Coast piping plovers. Lack of reliable funding to maintain annual implementation of intensive management programs constitutes a serious continuing threat to Atlantic Coast piping plovers, and this threat would likely be exacerbated in the absence of ESA listing.

AC 2.5.4 Synthesis

Here we consider the status of the Atlantic Coast piping plover population with respect to ESA definitions of threatened and endangered species. Recognizing that: (1) the Atlantic Coast piping plover population constitutes the subspecies *C. m. melodus*, and (2) 23 years of ESA recovery planning and implementation for the Atlantic Coast population have been conducted consistent with the premise of complete demographic independence from other piping plovers (section 2.1 of this review), we address the status of Atlantic Coast piping plovers and progress toward recovery of this population. Pertinent considerations include progress towards meeting Atlantic Coast recovery criteria 1, 4, and 5; new information about demographic characteristics, distribution, and habitat requirements; and analysis of listing factors and relevant conservation measures for both the breeding and nonbreeding portions of the annual cycle. In section 3 of this review, we further evaluate the status of Atlantic Coast piping plover in relation to all piping plovers listed as threatened under the ESA.

Substantial population growth, from approximately 790 pairs in 1986 to an estimated 1,849 pairs in 2008, has decreased the Atlantic Coast piping plover's vulnerability to extinction since ESA listing. Thus, considerable progress has been made toward the overall goal of 2,000 breeding pairs articulated in recovery criterion 1. As discussed in the 1996 Atlantic Coast recovery plan, however, the overall security of the Atlantic Coast piping plover is fundamentally dependent on even distribution of population growth, as specified in subpopulation targets, to protect a sparsely-distributed species with strict biological requirements from environmental variation (including catastrophes) and increase the likelihood of interchange among subpopulations. Although the New England recovery unit has sustained its subpopulation target for the requisite five years, and the New York-New Jersey recovery unit reached its target in 2007 (but dipped below again in 2008), considerable additional growth is needed in the Eastern Canada and Southern recovery units (recovery criterion 1).

Productivity goals (criterion 3) specified in the 1996 recovery plan must be revised to accommodate new information about latitudinal variation in productivity needed to maintain a stationary population. Population growth, particularly in the three U.S. recovery units, provides indirect evidence that adequate productivity has occurred in at least some years. However, overall security of a 2,000 pair population will require long-term maintenance of these revised recovery-unit-specific productivity goals concurrent with population numbers at or above abundance goals.

Twenty years of relatively steady population growth, driven by productivity gains, also evidences the efficacy of the ongoing Atlantic Coast piping plover recovery program.

However, all of the major threats (habitat loss and degradation, predation, human disturbance, and inadequacy of non-ESA regulatory mechanisms) identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive. Indeed, recent information heightens the importance of conserving the low, sparsely vegetated beaches juxtaposed with abundant moist foraging substrates preferred by breeding Atlantic Coast piping plovers – development and artificial shoreline stabilization pose continuing widespread threats to this habitat. Severe threats from human disturbance and predation remain ubiquitous along the Atlantic Coast. Expensive labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, are implemented every year by a network of dedicated governmental and private cooperators. Because threats to Atlantic Coast piping plovers persist (and in many cases have increased since listing), reversal of gains in abundance and productivity would quickly ensue from diminishment of current protection efforts. Insufficiently reliable funding to support annual protection efforts poses a current threat. Considerable additional progress is required to accomplish recovery criterion 4, institution of long-term agreements among cooperating agencies, landowners, and conservation organizations to ensure sufficient protection and management to maintain population targets and average productivity in all recovery units.

Piping plover populations are inherently vulnerable to even small declines in their most sensitive vital rates, survival of adults and fledged juveniles. Therefore, assuring the persistence of the Atlantic Coast piping plover also requires maintenance and protection of habitat in their migration and wintering range, where the species spends more than two-thirds of its annual cycle. As discussed in the Wintering-Migration section of this review, habitat degradation and increasing human disturbance are particularly significant threats to nonbreeding piping plovers. Although progress toward understanding and managing threats in this portion of the range has accelerated in recent years, substantial work remains to fully identify and remove or manage migration and wintering threats. Efforts to stem habitat loss and degradation are particularly urgent, as accumulating losses pose the risk of permanently precluding recovery.

Finally, two emerging potential threats, wind turbine generators and climate change (especially sea-level rise) are likely to affect Atlantic Coast piping plovers throughout their life cycle. These two threats require further study to ascertain effects on piping plovers and/or their habitat, as well as the need for specific protections to prevent or mitigate impacts that could otherwise increase overall risks to the species.

We conclude that the Atlantic Coast piping plover remains likely to become an endangered species within the foreseeable future throughout all of its range, and is therefore a threatened species. The Atlantic Coast piping plover is not currently in danger of extinction throughout all or a significant portion of its range (i.e., an endangered species), because more than 20 years of intensive recovery efforts have reduced its near-term extinction risk by increasing the population and managing the continuing threats, especially in the breeding range. However, the Atlantic Coast piping plover remains vulnerable to low numbers in the Eastern Canada and Southern (and, to a lesser extent, New York-New Jersey) recovery units. Furthermore, the factors that led to the piping plover's 1986 listing remain operative rangewide (including in New England), and many of these threats have increased. Interruption of costly, labor-intensive efforts to manage these threats would quickly lead to steep population declines. Therefore, the species remains likely to become an endangered species within the foreseeable future throughout all of its range until mechanisms are established to assure long-term conservation of habitat and continuation of the intensive annual management activities to reduce human disturbance and predation. Increased understanding of threats and management are also needed to protect the species during the two-thirds of its annual cycle spent in the migration and wintering range and to provide for rangewide protection against threats from wind turbine generators and climate change. The status of the Atlantic Coast piping plover is consistent with the ESA definition of a threatened species.

AC 2.5.5 Section references

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3.0 RESULTS

ESA section 4(c)(2) requires the USFWS to review the status of listed species at least once every five years and to determine, in accordance with ESA sections 4(a) and (b), whether each species should be removed from the list or reclassified.

3.1 Recommended Classification

We recommend retaining the piping plover's current classification, i.e., endangered in the watershed of the Great Lakes and threatened in the remainder of its range. We believe this accurately reflects the species' status across its range.

Rationale: At a current population of 63 breeding pairs, the Great Lakes piping plover has attained approximately 40% of the 150 breeding-pair recovery goal. Although there has been progress toward many of the recovery goals established for the population, Great Lakes piping plovers remain in danger of extinction due to their low abundance, limited distribution, and persistent threats from habitat degradation, human disturbance, and predation. Recent disease outbreaks and an increase in raptor predation highlight the population's precarious status. Long-term agreements and funding are needed to maintain the annual management activities aimed at reducing human disturbance and predation threats. See section GL 2.3.4 for a more detailed discussion of the status of the Great Lakes population.

As explained in more detail in section NGP 2.4.4, the Northern Great Plains piping plover estimated population size has increased in this decade, but it remains below the recovery goals set out in the 1988 recovery plan. Furthermore, the factors that led to the species' listing (i.e., habitat loss and degradation due to water management on the river systems, predation, and human disturbance), as well as other activities (e.g., growing oil and gas production) continue to threaten piping plovers on the Northern Great Plains.

The Atlantic Coast piping plover remains vulnerable as a result of low abundance in the Eastern Canada and Southern (and, to a lesser extent, the New York-New Jersey) recovery units. All of the factors that led to the piping plover's 1986 listing remain operative on the Atlantic Coast, and many of these threats have increased. Reliable funding and long-term agreements are needed to assure conservation of habitat and continuation of the intensive annual management activities to reduce human disturbance and predation. A more detailed discussion of the status of the Atlantic Coast population is provided in section AC 2.5.4.

In addition to the considerations pertinent to each breeding population, all piping plovers remain at risk due to continuing habitat loss and increasing human disturbance during the two-thirds of their annual cycle spent in the migration and wintering range. Immediate efforts are needed to reduce threats from sea-level rise throughout the species' coastal range. Actions may also be required to provide protection against other effects of climate change and from potential rangewide threats posed by wind turbine generators.

3.2 Recommended Recovery Priority Number

Retain as 2C. This recovery priority number is indicative of a species that faces a high degree of threat, has a high recovery potential, and is in conflict with construction or other development projects or other forms of economic activity.

***Rationale*:**

Degree of threat - As described in section 3.1, all piping plovers continue to face intense, pervasive, and persistent threats throughout their range, albeit the risk of imminent extinction is intrinsically highest for the Great Lakes breeding population due to low abundance levels. Intensive management of threats, especially in the breeding portions of the species' range, has facilitated population growth since listing; however, any interruption of these efforts would rapidly lead to steep population declines in the Great Lakes and Atlantic Coast portions of the range. Likewise, the Northern Great Plains population remains highly susceptible to immediate effects of ongoing management of water levels, flows, and habitat on the rivers and reservoirs. Accelerated efforts to stem accumulating loss and degradation of coastal migration and wintering habitat are needed to avoid adverse effects on survival rates that (if realized) would significantly, and perhaps irreversibly, increase the species' extinction risk. Thus, priority for future recovery efforts must reflect the danger of rapid declines in abundance that would certainly result from interruption of the current recovery program, as well as the pressing need to more fully address threats in the species' wintering and coastal migration range.

Recovery potential - Although intensive management must be sustained to ensure continued population growth and stability, the biological limiting factors and many threats affecting piping plovers are well understood. Furthermore, proven management techniques have shown to have a high degree of success in alleviating the effects of ongoing threats to the species. The Great Lakes and Atlantic Coast populations have a high potential for recovery if protection efforts can be sustained and long-term agreements established to continue management of threats after removal from ESA protections. The Northern Great Plains population also has a high recovery potential, based on resiliency demonstrated by population growth during a drought in the early 2000s as well as by cooperative conservation efforts for breeding piping plovers by the USFWS, the USACE, state governmental agencies, non-governmental organizations, and landowners. Although threats from climate change entail many uncertainties for all species listed under the ESA, the most widely and consistently predicted climate change-related threat to piping plovers is sea-level rise affecting the Atlantic Coast breeding range and all populations in their coastal migration and wintering ranges. While there are also substantial unknowns associated with sea-level rise predictions, scientific information summarized in this status review indicates that there are important current and near-term opportunities to reduce adverse effects of sea-level rise on piping plovers and their coastal habitats. Thus, with staunch continuation of recovery actions on the breeding grounds and accelerated efforts to reduce habitat loss and degradation and manage human disturbance in the migration and wintering range, recovery of this species is attainable.

Conflict rating – Ubiquitous conflicts with development and tourism in the Atlantic Coast, Great Lakes, and coastal migration and wintering range are managed through ESA section 7 consultations and use of other regulatory and non-regulatory recovery mechanisms. On the Northern Great Plains, the conflict rating is related to economic activities including water management on the rivers and reservoirs, oil and gas production, and sand and gravel mining.

Taxonomy – The current listing assigns endangered status to piping plovers in the watershed of the Great Lakes and threatened status in the remainder of its range. As such, all populations of *Charadrius melodus* continue to require protection under the ESA. The taxonomy component of the recovery priority number reflects the significance associated with potential loss of more genetically distinct taxa. Therefore, the piping plover recovery priority number should be consistent with risk connoted by ESA listing of all piping plover populations across the entire range of the full species.

3.3 Recommended Listing Priority Number

We acknowledge the merits of clarifying the listing to recognize the subspecies *Charadrius melodus melodus and C. m. circumcinctus*, and, within *C. m. circumcinctus*, two DPSs (as outlined in section 2.1 above). Priority for formal recognition of three entities (as described in 48 FR 43098) is 6 on a scale of 1 to 6, indicating that (1) the proposed change would have low management impact, and (2) the action is not petitioned. Formal recognition of these three units would change little in terms of regulatory impact, as the best scientific information available continues to indicate that both the Atlantic Coast and Northern Great Plains populations should remain classified as threatened, and that the Great Lakes population should continue to be listed as endangered.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Below are recommendations for future recovery actions, organized by the geographic regions as reviewed in section 2 of this review. Continuing implementation of many recovery actions specified in the three operative recovery plans is a mainstay of piping plover recovery programs. Actions listed in this section include activities identified in the recovery plans that warrant additional emphasis, as well as new needs that have been recognized during this status review. Recovery task numbers are indicated for action items identified in the 2003 Great Lakes recovery plan, 1988 Northern Great Plains recovery plan, and the 1996 revised Atlantic Coast recovery plan.

4.1 Recommendations for Wintering and Migration Range

Piping plover populations are highly vulnerable to even small declines in survival rates of adults and fledged juveniles. Population growth gained through high productivity on the breeding grounds will be quickly reversed if survival rates or breeding fitness decline due to stressors experienced during the two-thirds of the annual cycle spent in migration and wintering. Although management of threats in the nonbreeding range has begun to increase in recent years, considerably more attention and effort are required, as outlined in Great Lakes recovery tasks 2.0, 3.0, and 4.4, Atlantic Coast recovery tasks 2.0 and 3.1. and Northern Great Plains recovery tasks 1.12, 1.13, 2.22, 2.23, 3.32, 4.42, and 4.43. The conservation actions and research needs outlined below are primarily designed to address the two most important threats to non-breeding piping plovers, as identified in section WM 2.2.2 of this status review: habitat loss and degradation, and increasing disturbance by people and pets. Accelerated implementation of these actions is a very high priority for recovery of all three breeding populations.

Recommendations for conservation planning, coordination, and implementation in the migration and winter range:

1. Develop a comprehensive conservation plan for piping plovers in the U.S. portion of their migration and wintering range.

   a. Acquire funds to develop a concise, cohesive plan that will address the migration and wintering needs of the three breeding populations. This is most efficiently accomplished by a qualified contractor working in close coordination with USFWS biologists.

   b. Develop a state-by-state wintering and migration habitat use atlas (GL tasks 2.12, 2.13, 2.16; AC task 2.1; NGP task 1.13).

      i. Quantify amount and distribution of currently existing habitat.

      ii. Determine the condition of each site, including the type and level of alteration, presence and threat level from invasive species, and whether natural coastal processes are impeded. Compare with historic habitat availability using aerial photography or other records.

iii. Determine the temporal abundance and distribution of piping plover activity at sites with suitable habitat. Where appropriate data are currently lacking, conduct multiple surveys by qualified personnel across several migration and wintering seasons. Examples of reports summarizing methods and results of such surveys are available on request to the USFWS.

iv. Evaluate likelihood of future actions, including human development and recreational uses, and natural events that could potentially affect habitat quantity and quality at each site.

v. Evaluate factors at each site that will affect the response of habitat to accelerating sea-level rise and identify potential actions to minimize its adverse effects.

c. Conduct a systematic review of recreational policies and beach management. Identify gaps in management and enforcement of regulatory mechanisms by state. Develop recommendations to improve management and enforcement of piping plover protections where warranted (AC task 2.24).

d. Develop an education/outreach strategy to work with state, county, and municipal governments to develop and implement ordinances and other strategies reducing effects of habitat stabilization, beach cleaning practices, human uses, and pets in beach and bayside habitats (GL task 5.2, AC task 2.24, NGP task 5.2).

e. Develop an education/outreach strategy to work with private landowners with regard to habitat stabilization, beach-cleaning practices, human uses, and pets.

2. Develop, in coordination with land managers, management plans for critical habitat sites or other sites that support or could support nonbreeding piping plovers. This may be accomplished concurrently with development of the atlas described under action 1b above or as a follow-up task (GL tasks 2.14, 2.22; AC tasks 2.13, 2.2; NGP tasks 4.42, 4.43).

a. Develop and implement a conservation plan tailored to the site's conditions. A range of management measures may include, as appropriate, leash laws and dog-free zones, off-road vehicle management, and symbolic fencing of key habitats during periods of high plover use.

b. Develop a recommended piping plover monitoring protocol for each site that includes suggested frequency and intensity of monitoring.

c. Monitor the effectiveness of management measures (2.a above).

3. Improve consistency in the approach used, and recommendations generated for, piping plover conservation in ESA section 7 consultations and Coastal Barrier Resources Act review across all USFWS field offices throughout the species' U.S. coastal migration and wintering range.

   a. Regularly update USFWS field office staff regarding latest information on piping plovers and habitat use.

   b. Emphasize importance of maintaining natural coastal processes to perpetuate high quality piping plover migrating and wintering habitat (AC task 2.21).

   c. Discourage projects that will degrade or interfere with formation or maintenance of high quality piping plover habitat (GL task 2.22, AC task 2.21, NGP task 4.43).

   d. Encourage project features to minimize adverse effects on piping plovers and their habitat, including creation and enhancement of habitat in the vicinity of existing stabilization projects. .

   e. Develop a comprehensive monitoring and management plan template for shoreline stabilization projects on the wintering and migration grounds.

   f. Consider effects of climate change when determining long-term impacts. Include measures to conserve and enhance the capacity of piping plover habitats to adapt to sea-level rise.

4. Develop a website specifically for wintering and migrating piping plover issues (GL task 5.2 and AC tasks 4.1, 4.2).

   a. Develop a piping plover contact list of all individuals in each state and other countries (Canada, Mexico, Bahamas, etc.).

   b. Link to other plover websites.

   c. Upload all pertinent literature, including research and monitoring reports not protected by copyright, to the website.

   d. Upload summarized section 7 consultations, conservation measures, reasonable and prudent measures, and terms and conditions.

Recommended research and data needs in the migration and wintering range:

5. Focus the non-breeding portion of the International Census on enhancing understanding of piping plover abundance, distribution, and threat levels in seasonally emergent habitat (seagrass beds, oyster reefs, and mud flats) in Texas bays, and in Mexico and the Caribbean (GL task 2.13 and NGP task 1.13).

a. Continue to encourage and improve International Census efforts at priority sites in Texas.

b. USFWS regional coordinators for the International Census should establish contacts in Mexico, Bahamas, Cuba, and other appropriate Caribbean countries at least a year in advance of the 2011 International Census.

   i. Increase efforts to maximize survey coverage.

   ii. Encourage collection of information describing types and levels of threats at each International Census site in addition to physical and biological attributes of the site.

   iii. Provide information about color-banded birds and encourage surveyors to look for and report these marked piping plovers.

6. To further enhance understanding of spatial partitioning of the breeding populations (as well as the impacts of some threats) on the migration/winter grounds, USFWS should facilitate and encourage all efforts dedicated to (or incorporating) monitoring of color-banded piping plovers. There is urgency associated with this data collection since several large breeding grounds banding studies have recently ended or are slated for completion in the near future, and opportunities to glean information will decline as banded piping plovers die off (GL task 2.12, NGP task 1.133).

7. Further investigate the partitioning of survival within the annual cycle, and determine whether winter habitat quality influences reproductive success and survival (GL task 4.1 and AC task 3.6). Explore opportunities for further comparison of survival rates among breeding populations to inform these issues.

8. Continue to refine characterization of optimal winter habitat and understanding of factors affecting piping plover use of different microhabitats (e.g., ocean intertidal zones, wrack, inlet shoreline, soundside flats) (GL task 4.4; AC tasks 3.11, 3.12, 3.13; NGP tasks 2.22, 2.23). Research approaches should recognize that piping plovers may move among relatively nearby habitat patches. Plover habitat use patterns and needs may also vary geographically (across their nonbreeding range) and seasonally.

   a. Determine how habitat modification or complete loss of a site on migration and wintering grounds affects survival given documented site fidelity.

   b. Develop design specifications for creating roosting and foraging habitat.

   c. Quantify the amount and distribution of habitat needed for recovery of each breeding population, giving due consideration to intra- and inter-species competition for use of similar habitats.

9. Develop strategies to reduce threats from accelerating sea-level rise.

a. Identify human coastal stabilization practices that increase or decrease adverse effects of sea-level rise on coastal piping plover habitats.

b. Identify sites most likely to maintain (or increase) characteristics of suitable piping plover breeding and/or migration habitat as sea-level rises.

c. Evaluate projected effects of sea-level rise on the regional distribution of piping plover habitats over time. Facilitate use of LIDAR (a remote sensing system used to collect topographic data) mapping of coastal elevations, development of models, and timeframe analysis throughout the species wintering and migration range in the U.S. to generate projections regarding areas most likely to be inundated within given time frames.

10. Determine the extent that human and pet disturbance limits piping plover abundance and behavioral patterns in the wintering and migration habitats (GL task 2.14, AC task 3.14, NGP task 3.221).

11. Determine the effect of human and pet disturbance on survival and reproductive fitness (GL task 4.1, AC task 3.14, NGP task 3.221).

12. Support research to ascertain impacts of predation on wintering/migrating piping plovers, as well as to determine the effectiveness of predator control programs.

4.2 Recommendations for Great Lakes Population Breeding Range

Recommended conservation actions

1. Identify and secure reliable funding for various recovery program partners aimed at continued coordination and management of threats from human disturbance and predation, as described in recovery plan tasks 1.22, 1.34, and 1.36.

2. Continue to build partnerships and increase participation of non-governmental groups and volunteers in conservation efforts (recovery task 6.0).

3. Closely monitor the population for disease outbreaks and prepare response plans to address disease outbreaks, with emphasis on Type E botulism.

4. Pursue development of agreements needed to assure long-term protection and management to maintain population targets and productivity (recovery task 1.18). Prototype agreements should be pursued at sites where there is a history of intensive and successful piping plover protection and a high degree of commitment to the piping plover protection program.

5. Continue efforts to purchase habitat and increase protection through conservation easements, deed restrictions, and other mechanisms (recovery task 1.362).

Recommended research and data needs

6. Conduct further research on the genetic fitness and adequate effective size of the population through molecular genetic and pedigree analysis (recovery task 4.6).

7. Update and refine population viability models to assess and potentially modify recovery goals for the population (recovery task 4.7).

8. Develop strategies to reduce threats from the potential for water level decreases in the Great Lakes associated with climate change. Identify sites most likely to maintain (or increase) characteristics of suitable piping plover breeding and/or migration habitat.

9. Undertake studies addressing merlin foraging ecology and the relationship between merlins and piping plovers breeding areas in the Great Lakes.

10. Conduct studies to understand potential effects of wind turbine generators that may be located or proposed for the Great Lakes, nearshore, and within or between nesting or foraging habitats. Information needs include migration routes and altitude, flight patterns associated with breeding adults and post-fledged young of the year foraging at nearby sites that are not contiguous with nesting habitats, and avoidance rates under varying weather conditions.

4.3 Recommendations for Northern Great Plains Population Breeding Range

Recommendation for conservation planning

1. A draft and final revised recovery plan (or, alternatively, an interim conservation strategy) for the Northern Great Plains piping plover population should be developed. The Northern Great Plains recovery plan is over 20 years old, does not discuss several threat factors, and includes numeric recovery goals that may not provide for the population's long-term conservation.

   At the time that the 1988 plan was completed, there were significant gaps in knowledge about the species' biology. Many of the numerical population criteria were based on "best professional judgment" rather than how many piping plovers were necessary to secure the population given empirical estimates of vital rates such as productivity, survival, and dispersal, the reproduction level needed for stability, and the habitat needed to sustain this population level over time. Since that time, substantial new information has become available to inform recovery needs. An updated recovery plan would allow managers to re-examine the population's conservation needs in light of this new information.

   While many of the listing factors discussed in the 1988 recovery plan remain pertinent today, many new threats have come to light. The revised recovery plan would contain objective and measurable recovery criteria addressing all threats meaningfully impacting the population. It would also estimate the time required and the cost to carry out those measures needed to achieve recovery and delisting.

Recommended management actions

2. Continue to construct habitat on the Missouri River system while exploring ways that flows could be altered to provide additional habitat for piping plover nesting and brood rearing.

3. Actively explore ways that the Missouri River reservoirs and shorelines can be manipulated to provide breeding habitat under a variety of water conditions.

4. Ensure habitat availability. Identify how much habitat is needed over time on river systems to provide for a secure Northern Great Plains piping plover population. The Missouri and Platte rivers in particular are highly altered systems, leading to flooding of breeding habitat and suppressed reproduction. To date, sandbar creation efforts on the Missouri River have not kept pace with habitat loss. See recovery plan tasks 4.416 and 4.417.

5. Continue to perform monitoring and recovery actions annually throughout the U.S. Northern Great Plains population.

6. Identify and secure consistent funding for management, monitoring, and recovery efforts for the U.S. alkali lakes population.

7. Public outreach:

    a. Increase public outreach and education in areas where there is the potential for human/plover interactions. See recovery plan tasks 5.51 and 5.52.

    b. Increase law enforcement activities in areas where human disturbance may be impacting reproductive success.

8. Habitat protection:

    a. Continue to work with landowners on the alkali lakes to ensure protection of piping plover alkali lakes and surrounding uplands. Where possible, obtain long-term agreements with landowners to protect these habitats. Increase efforts to remove trees, rockpiles, etc., that may harbor predators. See recovery plan tasks 4.417 and 4.418.

    b. On the river systems, obtain easements or fee-title on undeveloped land to reduce current and future pressure from human activities on nearby piping plover habitat. Keep as much of the river bank as possible from being stabilized, since this increases flow velocity and thus sandbar erosion rates and encourages development. See recovery plan task 4.416.

c. Restrict public use of sandbar and shoreline areas as needed to provide for piping plover nesting and brood-rearing needs.

Recommended research and information needs:

9. Explore the movement of birds within the Northern Great Plains. It has been postulated that if there is not much habitat on the Missouri River system, birds will nest on the alkali lakes and vice versa. Sightings of banded birds have established that birds do move among the Missouri River, Nebraska, and the alkali lakes. There have been some sightings of birds hatched in Saskatchewan that apparently breed on the alkali lakes in Montana. However, it is not known if there are large-scale movements of piping plovers from one habitat type to another, in particular between the alkali lakes in the U.S. and Canada and the Missouri River system. A study of large-scale piping plover movements over time would help to identify where to focus management actions to ensure that there is habitat available in areas where birds may go if habitat in one area is not suitable in a given year.

10. Predation control efforts are ongoing on the Missouri River system and the U.S. alkali lakes. However, predation control may not always have the intended effect. For example, caging nests may increase adult mortality if predators learn to key in on cages. Increasing the number of chicks hatched may not lead to a higher fledging success, since predators may key in on densely occupied areas. Research is needed to determine if predation control is actually improving reproductive success in all areas where it is taking place. See recovery plan tasks 3111 and 3112.

11. The International Census is an extremely useful tool in the Northern Great Plains. Therefore, we recommend continuing the International Census for this population (recovery plan tasks 111 and 112). It may also be worth exploring additional sampling techniques between International Censuses to better track piping plover population trends on the Northern Great Plains. A well-designed sampling approach in which a subset of sites is surveyed more frequently may supplement the International Census by providing information on population trends and bird movements. Therefore, sub-sampling is unlikely to completely replace efforts to periodically survey the entire region. However, a combination of attempting to survey the entire area coupled with more frequent sub-sampling may provide more accurate and timely information about population trends.

12. Wind power is rapidly expanding in the Northern Great Plains. Research is needed to assess the threat this poses to piping plovers at breeding sites and in migration corridors. Special focus should be placed on the impact of associated power transmission lines.

13. Oil and gas exploration and production is rapidly expanding throughout Northern Great Plains breeding grounds. Work is needed to determine the short and long-term impacts of oil exploration and production, including short-term impacts such as seismic work or drilling, ongoing impacts of extraction, potential impacts of spills or leakage, and long-term, cumulative changes as more habitat is disturbed for well pads and roads.

14. Piping plover adult numbers appear to fluctuate in response to the quantity of water in the river system (see Figure NGP13 in this review). A historical analysis of system storage and flows compared with adults surveyed and reproductive success may help in future river management. See recovery plan tasks 4161 and 4162.

15. There is very limited evidence suggesting that forage on alkali lakes may be generated from nearby prairies. Changes in surrounding habitat may impact plovers in other ways as well. Examining forage on alkali lakes in relation to surrounding land use may help to focus alkali lake management priorities over the long term. See recovery plan task 211.

4.4 Recommendations for Atlantic Coast Population Breeding Range

Recommended conservation actions

1. Increase efforts to restore and maintain natural coastal formation processes in the New York-New Jersey recovery unit, where threats from development and artificial shoreline stabilization are highest, and in the Southern recovery unit, where the plover's habitat requirements are the most stringent (recovery task 1.2). This action is also critical to reducing adverse effects of accelerating sea-level rise.

2. Identify and secure reliable funding to support continuing management of threats from human disturbance and predation, as described in recovery plan tasks 1.1, 1.3, and 1.4.

3. Accelerate development of agreements needed to assure long-term protection and management to maintain population targets and productivity (recovery task 1.6). Prototype agreements should be pursued at sites where there is a history of intensive and successful piping plover protection, a high degree of commitment to the piping plover protection program, and experienced on-site shorebird biologists who can provide expertise to devise and test alternative types of agreements (recovery task 1.62).

Recommended research and data needs

4. Develop strategies to reduce threats from accelerating sea-level rise. Identify sites most likely to maintain (or increase) characteristics of suitable piping plover breeding and/or migration habitat. Identify human coastal stabilization practices that increase or decrease adverse effects of sea-level rise on coastal piping plover habitats.

5. Conduct studies to understand potential effects of wind turbine generators that may be located or proposed for the Outer Continental Shelf, nearshore, and within or between nesting and foraging habitats. Information needs include migration routes and altitude; flight patterns associated with breeding adults and post-fledged young of the year foraging at nearby sites that are not contiguous with nesting habitats, and avoidance rates under varying weather conditions.

6. Conduct studies, including meta-analyses of local studies, to understand factors that affect latitudinal variation in productivity needed to maintain stationary populations of Atlantic Coast piping plovers.

7. Conduct demographic modeling to explore effects of latitudinal variation in productivity, survival rates, and the carrying capacity of habitat on population viability within individual recovery units and the Atlantic Coast population as a whole. Use this information to revise recovery criterion 3 to provide recovery unit-specific productivity targets sufficient to assure secure populations (recovery plan task 3.5).

8. Review state laws within the Atlantic Coast piping plover's breeding and wintering range to assess protections that would be afforded if the species were removed from ESA listing.

9. Support effective integrated predator management (recovery plan task 1.4) through studies of ecology and foraging behavior of key predators; for example, studies assessing the adequacy of buffers between feral cat colonies and piping plover nesting sites would be useful.

4.5 Rangewide Recommendations

1. Clarify the piping plover ESA listing to recognize the subspecies *Charadrius melodus melodus and C. m. circumcinctus*, and, within *C. m. circumcinctus*, two DPSs.

2. The International Piping Plover Census has fostered widespread involvement in survey efforts and provided extensive data. However, as piping plover conservation efforts mature, it may be beneficial to shift the Census effort to address specific questions that are not answered by other ongoing efforts.

   Given ongoing recovery programs on the breeding grounds, the most important future International Census contribution to ESA recovery implementation and monitoring for all piping plovers is the abundance estimate for the Northern Great Plains breeding population (including Prairie Canada). The highest benefit can be realized by emphasizing completeness and quality control of this portion of the census and by expediting synthesis and reporting, so that managers can make timely use of this information (see recommendation 11 for the Northern Great Plains breeding range). Trends in abundance of Great Lakes and Atlantic Coast breeding populations (at least for the U.S. portion of their ranges) and progress toward their recovery are most effectively monitored through the annual surveys conducted in accordance with their recovery plans (see sections GL 2.3.2.2 and AC 2.5.2.2). During International Census years, Atlantic and Great Lakes population estimates based on the nine-day U.S. Atlantic Coast window census[1] (see Atlantic Coast recovery task 1.11) and standard Great Lakes survey methods with special emphasis on complete coverage of all suitable habitat (see Great Lakes recovery task 1.12) can be used to provide a species-wide context.

The most valuable potential contribution from future winter censuses is improved understanding of the species' range in the Caribbean, Mexico, and other areas that may not have been fully covered in the past (e.g., seasonally emergent habitats within bays lying between the mainland and barrier islands in Texas). See recommendation 5 for the migration and wintering range. In other portions of the continental U.S., the winter census continues to provide beneficial information in the form of a fairly complete one-time survey coverage of wintering habitats, but it does not provide a true wintering "census." In some areas, participation in wintering census by a broad-based group of cooperators also fosters attention to piping plover conservation needs and collects data that otherwise would not exist. However, constraints associated with single, infrequent, mid-winter counts (section WM 2.2.1.3) limits inference from the International Census to the value of particular wintering sites for recovery of the species and to detect trends.

[1] The Atlantic Coast window census uses different methods than the International Census.

U.S. FISH AND WILDLIFE SERVICE FIVE-YEAR REVIEW
Species: Piping Plover *(Charadrius melodus)*

Current Classification: Endangered in the watershed of the Great Lakes
Threatened in the remainder of the species' range

Recommendation Resulting from the Five-Year Review: No change

Review Conducted by: Anne Hecht, Northeast Regional Office
Jack Dingledine, East Lansing Field Office
Carol Aron, North Dakota Field Office
Patty Kelly, Panama City Field Office
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FIELD OFFICE APPROVAL:

Approve [signature] Date 09/15/09
East Lansing, Michigan Field Office Supervisor, U.S. Fish and Wildlife Service

REGIONAL OFFICE APPROVAL:

Acting Approve James G. Geiger Date 9/22/09
Regional Director, U.S. Fish and Wildlife Service Region 5

Approve Lynn M Lewis Date 9/22/09
Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 3

REGIONAL CONCURRENCE:

Concur Elizabeth [signature] Date 9/22/09
for Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

for Concur Franklin Arnold III Date 9/28/2009
Regional Director, U.S. Fish and Wildlife Service Region 4

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Appendix A

The outside experts and USFWS biologists listed below generously provided technical review of draft sections of this document:

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Appendix B

Estimated abundance of breeding pairs of Atlantic Coast piping plovers, 1986–2008

State/RECOVERY UNIT	Pairs																						
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Maine	15	12	20	16	17	18	24	32	35	40	60	47	60	56	50	55	66	61	55	49	40	35	24
New Hampshire												5	5	6	6	7	7	7	4	3	3	3	3
Massachusetts	139	126	134	137	140	160	213	289	352	441	454	483	495	501	496	495	538	511	488	467	482	558	566
Rhode Island	10	17	19	19	28	26	20	31	32	40	50	51	46	39	49	52	58	71	70	69	72	73	77
Connecticut	20	24	27	34	43	36	40	24	30	31	26	26	21	22	22	32	31	37	40	34	37	36	41
NEW ENGLAND	184	179	200	206	228	240	297	376	449	552	590	612	627	624	623	641	700	687	657	622	634	705	711
New York	106	135	172	191	197	191	187	193	209	249	256	256	245	243	289	309	369	386	384	374	422	457	443
New Jersey	102	93	105	128	126	126	134	127	124	132	127	115	93	107	112	122	138	144	135	111	116	129	111
NY-NJ	208	228	277	319	323	317	321	320	333	381	383	371	338	350	401	431	507	530	519	485	538	586	554
Delaware	8	7	3	3	6	5	2	2	4	5	6	4	6	4	3	6	6	6	7	8	9	9	10
Maryland	17	23	25	20	14	17	24	19	32	44	61	60	56	58	60	60	60	59	66	63	64	64	49
Virginia	100	100	103	121	125	131	97	106	96	118	87	88	95	89	96	119	120	114	152	192	202	199	208
North Carolina	30	30	40	55	55	40	49	53	54	50	35	52	46	31	24	23	23	24	20	37	46	61	64
South Carolina	3		0		1	1		1			0					0						0	
SOUTHERN	158	160	171	199	201	194	172	181	186	217	189	204	203	182	183	208	209	203	245	300	321	333	331
U.S. TOTAL	550	567	648	724	752	751	790	877	968	1150	1162	1187	1168	1156	1207	1280	1416	1420	1421	1407	1493	1624	1596
EASTERN CANADA*	240	223	238	233	230	252	223	223	194	200	202	199	211	236	230	250	274	256	237	217	256	266	253
ATLANTIC COAST TOTAL	790	790	886	957	982	1003	1013	1100	1162	1350	1364	1386	1379	1392	1437	1530	1690	1676	1658	1624	1749	1890	1849

* includes minor revisions to 1990-2002 Eastern Canada estimates made by CWS in 2005; includes 1-5 pairs on the French Islands of St. Pierre and Miquelon, reported by CWS

Estimated productivity of Atlantic Coast piping plovers, 1987–2008

State/RECOVERY UNIT	Chicks fledged/pair																					
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Maine	1.75	0.75	2.38	1.53	2.50	2.00	2.38	2.00	2.38	1.63	1.98	1.47	1.63	1.60	1.98	1.39	1.28	1.45	0.55	1.35	1.06	1.75
New Hampshire											0.60	2.40	2.67	2.33	2.14	0.14	1.00	1.00	0.00	0.67	0.33	2.00
Massachusetts	1.10	1.29	1.59	1.38	1.72	2.03	1.92	1.81	1.62	1.35	1.33	1.50	1.60	1.09	1.49	1.14	1.26	1.38	1.14	1.33	1.25	1.41
Rhode Island	1.12	1.58	1.47	0.88	0.77	1.55	1.80	2.00	1.68	1.56	1.34	1.13	1.79	1.20	1.50	1.95	1.03	1.50	1.43	1.03	1.48	1.68
Connecticut	1.29	1.70	1.79	1.63	1.39	1.45	0.38	1.47	1.35	1.31	1.69	1.05	1.45	1.86	1.22	1.87	1.30	1.35	1.62	2.14	1.92	2.49
NEW ENGLAND	1.19	1.32	1.68	1.38	1.62	1.91	1.85	1.81	1.67	1.40	1.39	1.46	1.62	1.18	1.53	1.26	1.24	1.40	1.15	1.34	1.30	1.51
New York	0.90	1.24	1.02	0.80	1.09	0.98	1.24	1.34	0.97	1.14	1.36	1.09	1.35	1.11	1.27	1.62	1.15	1.46	1.44	1.55	1.15	1.21
New Jersey	0.85	0.94	1.12	0.93	0.98	1.07	0.93	1.16	0.98	1.00	0.39	1.09	1.34	1.40	1.29	1.17	0.92	0.61	0.77	0.84	0.67	0.64
NY-NJ	0.86	1.03	1.08	0.88	1.04	1.02	1.08	1.25	0.97	1.07	1.02	1.09	1.35	1.19	1.28	1.49	1.07	1.23	1.28	1.36	1.03	1.10
Delaware		0.00	2.33	2.00	1.60	1.00	0.50	2.50	2.00	0.50	1.00	0.83	1.50	1.67	1.50	1.17	2.33	1.14	1.50	1.44	1.33	0.30
Maryland	1.17	0.52	0.90	0.79	0.41	1.00	1.79	2.41	1.73	1.49	1.02	1.30	1.09	0.80	0.92	1.85	1.56	1.86	1.25	1.06	0.78	0.41
Virginia		1.02	1.16	0.65	0.88	0.59	1.45	1.66	1.00	1.54	0.71	1.01	1.21	1.42	1.52	1.19	1.90	2.23	1.52	1.19	1.16	0.87
North Carolina			0.59	0.43	0.07	0.41	0.74	0.36	0.45	0.86	0.23	0.61	0.48	0.54	0.50	0.17	0.46	0.65	0.92	0.87	0.26	0.30
SOUTHERN	1.17	0.85	0.88	0.72	0.68	0.62	1.18	1.37	1.05	1.34	0.68	0.99	1.04	1.09	1.22	1.27	1.63	1.95	1.38	1.12	0.92	0.67
U.S. average	1.04	1.11	1.28	1.06	1.22	1.35	1.47	1.56	1.35	1.30	1.16	1.27	1.45	1.17	1.40	1.34	1.24	1.43	1.24	1.30	1.13	1.19
EASTERN CANADA		1.65	1.58	1.62	1.07	1.55	0.69	1.25	1.69	1.72	2.10	1.84	1.74	1.47	1.77	1.18	1.62	1.93	1.82	1.82	1.14	1.47

Appendix C

Wind turbine generator (WTG) projects built or proposed in the Atlantic Coast piping plover breeding range

Project name or sponsor and location	#WTGs built or proposed	Location relative to piping plovers	Lead federal agency	Project stage as of 2009	Reference document(s)
North Cape, Prince Edward Island	16	near a nesting site and on potential migration path to/from Magdalen Islands and Newfoundland	NA	constructed 2001 and 2004	D. Amirault-Langlais, pers. comm. 7/30/09 to A. Hecht; http://www.canwea.ca/farms/wind-farms_e.php
Eastern Kings Wind Farm, Prince Edward Island	10	near several nesting sites	NA	constructed 2007	D. Amirault-Langlais, pers. comm. 7/30/09 to A. Hecht http://www.canwea.ca/farms/wind-farms_e.php
Sable Island, Nova Scotia	5	land-based; unconfirmed reports of historic nesting; occasional reports during migration	NA	constructed 2006	D. Amirault-Langlais, 9/16/08 email to S. von Oettingen; http://www.greenhorsesociety.com/Wind-Energy/Windfarm.htm
Pubnico, Nova Scotia	17	inside harbor and few sandy beaches nearby; limited concern per Amirault, 3/18/09 email to A. Hecht	NA	constructed 2004-05	http://www.gov.ns.ca/nse/ea/pubnicowind.asp
Cape Sable Island, Nova Scotia		likely NS landfall site, per Amirault 3/18/09 email	NA	reviewed by CWS, but not yet moved forward	3/18/09 emails from A. Boyne and D. Amirault-Langlais
Vinalhaven Island, ME	3	island in Penobscot Bay, possible migration corridor	USDA	pre-construction surveys nearly complete	USDA consultation with Maine Field Office, Fox Island electric cooperative
Monhegan Island, ME	1 or 2	island in outer Penobscot Bay, possible migration corridor		unknown	none; no communications with USFWS
State Planning Office, Ocean Energy Task Force, ME		1-3 miles off-shore		considering 7 sites for potential testing and possible development of facilities	4 August 2009 technical assistance letter from Maine Field Office

Project name or sponsor and location	#WTGs built or proposed	Location relative to piping plovers	Lead federal agency	Project stage as of 2009	Reference document(s)
Ocean Energy Institute - Gulf of Maine, ME	five 9.2-sq mi floating platforms	off-shore		UMaine working on technology	no direct communications with USFWS; many media reports
Cape Wind, Nantucket Sound, MA	130	>4 mi off-shore	MMS	formal consultation and FEIS completed; record of decision pending	USFWS Biological Opinion, 21 Nov 2008; FEIS (MMS), 16 January 2009
South Coast Off Shore Wind project, Buzzards Bay, MA	90-120 in 3 areas	1 - 3 mi off-shore		unknown	informal requests to New England Field Office on avian risk; T. French, MA Division of Fisheries and Wildlife, in litt., 2008; http://www.southcoastwind.org/maps.html
U.S. Coast Guard Training Center, Cape May, NJ	2	land based, approximately 0.5 mi landward of nesting habitat; very close to potential adult foraging habitat	USCG	draft EA completed	February 2009 Draft EA US Coast Guard Training Center
National Guard Training Center, Sea Girt, NJ	1 or 2	land based, between current nest site (~0.25 mi landward) and potential adult foraging habitat	NGTC	pre-construction surveys in planning but not yet initiated	23 Feb 2009 technical assistance letter from USFWS to NGTC regarding pre-constructions surveys
Seven lease areas on OCS off DE and NJ	7 met towers	potential wind parks are 8-17 mi off-shore NLAA determination	MMS	construction of meteorological towers expected spring/summer 2009	16 March 2009 letter from Chesapeake Bay Field Office stating meteorological towers not likely to adversely affect listed species
NASA Wallops Flight Facility, VA	up to 2	bay side of Wallops Island	NASA	pre-construction surveys in planning	8 July 2008 technical assistance letter from USFWS to NASA