# Piping Plover
## (*Charadrius melodus*)

## 5-Year Review:
## Summary and Evaluation

*Piping plover in breeding plumage, photographed June 2016 at North Manitou Island, Michigan by Vince Cavalieri, USFWS.*


**U.S. Fish and Wildlife Service**

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*with major contributions from*
Missouri River Coordinator's Office
Panama City, Florida Field Office
Corpus Christi, Texas Field Office
South Carolina Field Office


**March 2020**

**5-YEAR REVIEW**
**Species reviewed:** Piping Plover (*Charadrius melodus*)

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# 1.0 GENERAL INFORMATION

## 1.1 Reviewers

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## 1.2 Methodology Used to Complete the Review

Sources of data informing this review include recovery plans, the 2012 Comprehensive Conservation Strategy for the Piping Plover in its Coastal Migration and Wintering Range, published literature, unpublished reports, and other communications (see References sections).

Many experts and field office biologists generously provided information and technical review of draft sections of this document.

### 1.3 Background

#### 1.3.1 Federal Register Notice citation announcing initiation of this review

July 8, 2014 (79 FR 38560-38562).

#### 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 62816-62841).

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 23476-234524).

### 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). The first 5-year species-specific review was initiated in 2008 (73 FR 56860) and completed in 2009. Substantial information developed since listing was incorporated into the review, however, no change in listing status was recommended.

### 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]
**Name:** Draft Revised Recovery Plan for the Northern Great Plains Piping Plover (*Charadrius melodus*)
**Date issued:** 2016

## 2.0 REVIEW ANALYSIS

2.1 Updates to the Classification and Application of the 1996 Distinct Population Segment (DPS) Policy

WM 2.2 Updated Information to the 2012 Comprehensive Conservation Strategy for the Piping Plover in its Coastal Migration and Wintering Range

GL 2.3 Updated Information and Current Species Status for the Breeding Range of the Great Lakes Population

NGP 2.4 Updated Information and Current Species Status for the Breeding Range of the Northern Great Plains Population

AC 2.5 Updated Information and Current Species Status for the Breeding Range of the Atlantic Coast Population

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[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.*

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

**2.1.1 Is the species under review a vertebrate?** Yes.

**2.1.2 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?** Yes. A thorough review of the DPS classification was performed and recorded in the 2009 Piping Plover 5 Year Review.

**2.1.3 New information pertinent to taxonomic classification and the application of the DPS policy** .

For a more in-depth discussion on the application of the 1996 DPS policy to piping plovers, see 2.1 of the 2009 5-year Piping Plover Review.

The best available scientific information supports recognition of two separate subspecies of piping plover, and three separate entities consistent with the ESA definition of "species." Genetic analyses including both the use of mitochondrial DNA sequence analyses as well as an analysis of variable microsatellite markers have shown that piping plovers that breed on the Atlantic Coast of the U.S. and Canada belong to the subspecies *C. m. melodus* and that a second subspecies, *C. m. circumcinctus,* breeds on the Northern Great Plains of the U.S. and Canada, as well as on the Great Lakes (Miller et al. 2010). Within the interior subspecies *C. m. circumcinctus*, the 2009 5-year review found that the Northern Great Plains and Great Lakes populations constitute distinct population segments due to both marked separation due to breeding behavior, as well as habitat differences and differences in wintering distribution.

Since the 2009 5-year review, observations of banded individuals have shown a very low level of interchange between the three piping plover populations, including Great Lakes plovers seen breeding on the Atlantic Coast in Massachusetts (Jeff Denoncour pers. comm.) and North Carolina (Jon Altman pers. comm.), and a small number of Great Plains plovers breeding in the Great Lakes. The genetic significance of these interchanges is unknown. At least one of these birds is known to have returned to its source population. Table 1 conveys all known interchanges between the three populations since the 2009 five-year review.

More than 10,000 piping plover adults and chicks have been banded in the last 30 years. Nearly the entirety of the Great Lakes piping plover population is banded (> 90%) and monitored closely each year and large portions of the Great Plains population are also banded and counted annually. Despite these intense efforts only three Great Plains birds have been detected to have attempted breeding in the Great Lakes since the 2009 5-year review (and only 1 prior), and no

Great Lakes birds have been detected breeding in the Great Plains (though an unconfirmed sighting of a Great Lakes piping plover at Lake of the Woods, Minnesota in 2017, could have been a breeding individual). Similarly, there have been no Atlantic Coast birds detected breeding in the Great Lakes and only four Great Lakes piping plovers have been observed breeding on the Atlantic Coast despite very high survey efforts. No Great Plains piping plovers have been found breeding on the Atlantic Coast and no Atlantic Coast piping plovers have been found breeding in the Great Plains.

**Table INTRO1**. Known interchanges between the three piping plover populations since the 2009 five-year review.

| Band Combination | Source population | Sex | Breeding years & locations |
|---|---|---|---|
| Gf,GL:Y,B | Great Plains | Male | 2015; Long Island, WI<br>2016; Long Island, WI |
| b,-: Gf,LY | Great Plains | Female | 2015; Illinois Beach State Park, IL |
| L,-:X,R/L | Great Plains Manitoba | Male | 2011-2015; Port Inland, MI |
| Of,YY: X,R | Great Lakes | Female | 2011; Cape Lookout National Seashore, NC |
| X,G/O/G:O,- | Great Lakes | Female | 2015; Seawall Beach, ME<br>2016; Popham Beach, ME |
| X,G/O/G:O,- | Great Lakes | Female | 2014; Crane Beach, MA |
| O,b:X,b/O | Great Lakes | Female | 2017-2018; Crane Beach, MA |

The DPS policy does not require complete reproductive isolation, and it allows for some limited interchange among population segments considered discrete (61 FR 4722). A very low rate of interchange in banded individuals between the three breeding populations provides evidence of a marked separation due to breeding behavior and is consistent with the subspecies differentiation between Atlantic coast and interior piping plovers (see, for example, Haig et al. 2006). Other findings of the application of the DPS policy in the 2009 5-year review, including the unique ecological setting of the Great Lakes population, and marked differences in winter distribution of the three populations continue to hold true. It is important that recovery planning and implementation continue to respect the biological integrity of the three entities meeting the ESA definition of "species (Figure INTRO 1.)."

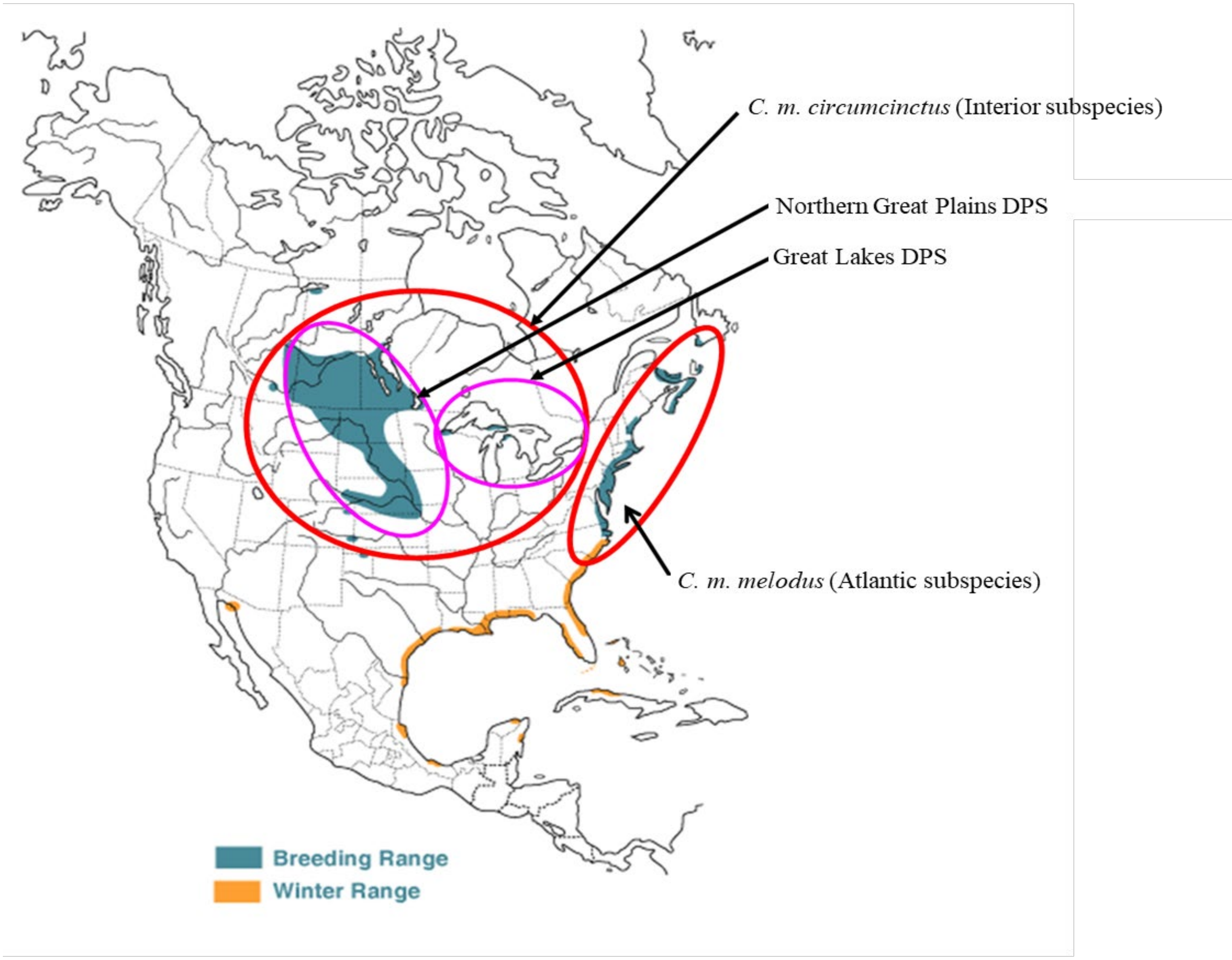


**Figure INTRO1.** Distribution and range of *C. m. melodus*, Great Lakes DPS of *C. m. circumcinctus*, Northern Great Plains DPS of *C. m. circumcinctus* (base map from Elliott-Smith and Haig 2004 by permission of Birds of North America Online, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology) [1].

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

### 2.1.4 Section references

Miller, M. P., S. M. Haig, C. L. Gratto-Trevor, and T. D. Mullins. 2010. Subspecies status and population genetic structure in piping plover *(Charadrius melodus). Auk.* 127:57-71.

USFWS. 2009. Piping Plover (*Charadrius* melodus). 5-Year Review: Summary and Evaluation. Hadley, Massachusetts and East Lansing, Michigan.

Haig, S.M., E. A. Beever, S. M. Chambers, H. M. Draheim, B. G. Dugger, S. Dunham, E. Elliott-Smith, J. B. Fontaine, D. C. Kessler, B. J. Knaus, I. F. Lopes, P. Loschl, T. D. Mullins, and L. M. Sheffield. 2006. Taxonomic considerations in listing subspecies under the U.S. Endangered Species Act. Conservation Biology: 20:1584-1594.

***Correspondence, Electronic Communications, and Conversations***

Jeff Deconcour– Northeast Ecology Assistant, The Crane Estate. Email Correspondence, August 14, 2014.

Jon Altman – Wildlife Biologist, National Park Service. Email Correspondence, February 25, 2013.

## WM 2.2 UPDATED INFORMATION TO THE 2012 COMPREHENSIVE CONSERVATION STRATEGY FOR THE PIPING PLOVER IN ITS COASTAL MIGRATION AND WINTERING RANGE

### WM 2.2.1 Biology, ecology, and habitat preferences of nonbreeding piping plovers

A large body of information regarding the biology, ecology, habitat, and status of the piping plover in its coastal migration and wintering range has become available since the publication of the 1985 final rule, the 1988 Northern Great Plains recovery plan, the 1991 5-year review, the 1996 revised Atlantic Coast recovery plan, the 2003 Great Lakes recovery plan, and the 2009 Piping Plover 5-year Review. Much of this information is contained in the 2012 Comprehensive Conservation Strategy for the Piping Plover (*Charadrius melodus*) in its Coastal Migration and Wintering Range in the Continental United States (CCS) (USFWS 2012). Here we summarize new information that has become available since 2012.

#### WM 2.2.1.1 Temporal and spatial distribution:

***Distribution***

Piping plover abundance and distribution continues to be better documented throughout coastal migration and wintering range within and outside of the U.S. Outside of the U.S., the 2011 International Piping Plover Winter Census (Census) helped confirm the importance of the Bahamas to piping plovers (Gratto-Trevor et al. 2016). Individuals from the Great Lakes and Atlantic Coast populations use the Bahamas as a winter site, but the vast majority are from the Atlantic Coast population (Gratto-Trevor et al. 2016, 2019). Twenty-seven percent of the total number of piping plovers counted during the 2011 Census were seen in the Bahamas. Based on band resights, Grato-Trevor et al. (2016) were able to conclude that the Bahamas are home to at least 32% of the Atlantic Coast breeding population in the winter, and as much as 19% of the global piping plover population for up to 9 months of the year. The 2016 Census was the largest effort in the Caribbean to date to document piping plovers, which resulted in over 1,500 plovers counted (Elliott-Smith 2016) (Figure WM 1). Over 1,400 piping plovers were seen in the Bahamas (NAS 2016), 96 were seen in the Turks and Caicos Islands, and 105 were seen in Cuba (Rock et al. 2019). Band resights confirmed that all three breeding populations use Cuba as a winter site, but the majority are from the Atlantic Coast population (Rock et al. 2019). All banded birds resighted in the Turks and Caicos were from the Atlantic Coast population (Rock et al. 2019).

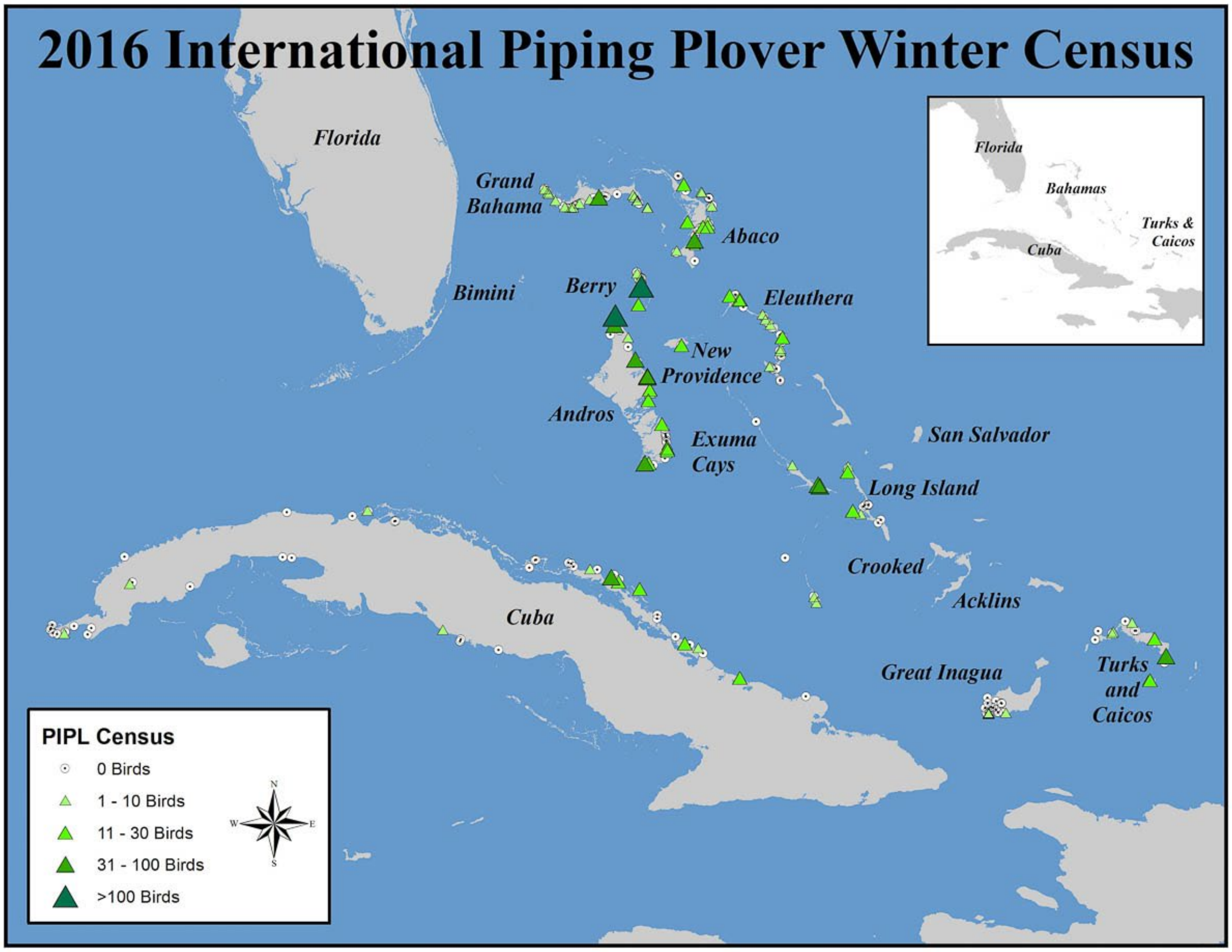


**Figure WM 1.** Location and numbers of Piping Plovers seen in the Bahamas, Turks and Caicos Islands, and Cuba during the 2016 International Piping Plover Winter Census (from Audubon 2016; reproduced by permission).

Within the U.S. in Texas, where a large proportion of the Northern Great Plains population winters (Gratto-Trevor et al. 2012), Christmas Bird Counts (CBC) have documented piping plovers in new areas that are not easily accessible or surveyed often (B. Ortego pers. comm. 2015). In 2014, 363 piping plovers were observed on an area called the Land Cut, in the Laguna Madre and in 2015, ~50 piping plovers were found on flats in east Matagorda Bay(B. Ortego pers. comm. 2015). In South Carolina, where a large proportion of the Great Lakes population winters along with the Atlantic Coast population (Gratto-Trevor et al. 2012, Chaplin pers. comm. 2019), piping plover surveys are often required in conjunction with shoreline stabilization projects at key sites subject to ESA section 7 consultation. Surveys are required for a minimum of five years, all unbanded and banded plovers are counted, and bands are resighted and reported. Most of the current information, including two recent publications (Cohen et al. 2018, Gibson et al. 2018), on nonbreeding piping plovers in the Southeast has been gleaned from these ongoing surveys because the minimum survey period lasts as long as the bird's average lifespan (Wilcox 1959) and more birds are uniquely banded, making local resident and passage population estimates possible. These surveys have documented arrival and departure dates for migrant and wintering plovers based on band resightings. Cohen et al. (2018) documented an entry probability of ~50% by the end of July for the fall migrant and wintering populations. These results are supported by Weithman et al. (2018) and Loring and Paton (2019) highlighting the need for nonbreeding plover protections, such as posting temporary closures for high tide roosts, to be in place by July (Cohen et al. 2018). The entry probability increased to 95% for both populations by October indicating that the majority of plovers wintering in South Carolina arrive by October (Cohen et al. 2018). These results are the basis for the USFWS nonbreeding piping plover protocol that calls for using survey counts only from the core winter months of December and January to estimate local winter population numbers (Chaplin pers. comm. 2019).

***Migration***

Migration is the least understood part of the piping plover annual cycle, but technology such as nanotags, banding, and intensive survey efforts have begun to shed some light on the subject. Important stopover sites have been identified and fall migration arrival and departure timing is now better understood. Loring and Paton (2019) conducted a study on Atlantic Coast breeders in Massachusetts and Rhode Island that showed plovers flew over offshore waters during migration and numbers peaked at sunset and when winds blew out of the southwest providing a tailwind. Loring and Paton's (2019) study also confirmed that the majority of birds depart in July to head south to their wintering grounds. These results are supported by Cohen et al. (2018), which documented piping plovers arriving in South Carolina in July, and Weithman et al. (2018), which documented plovers arriving in July at South Point on Ocracoke Island in North Carolina. South Point was discovered to be a significant stopover site in 2016 because results of abundance and resighting surveys documented 14.7% of Atlantic Coast breeders and 9.9% of the global population of plovers migrated through South Point between July and October (Weithman et al. 2018). The peak of migration occurred between late July and early August and the highest estimate of a survey specific peak of 292 individuals occurred on August 1, 2016 (Weithman et al. 2018). Piping plovers from all three breeding populations were resighted at South point, but 96% of the resights were from the Atlantic Coast population. Unbanded birds counted during this study were also likely from the Atlantic Coast breeding population based on the results of a banding project in Georgia and South Carolina where the majority of plovers banded were resighted in following breeding seasons within the Atlantic Coast breeding range (Chaplin pers. comm. 2019). This suggests that the significance of South Point as a stopover site for Atlantic Coast breeders may be even greater. Individuals from all three breeding populations were also observed at two inlet beaches in North Carolina between 2009 and 2014 (Addison and McIver 2014a, 2014b). Masonboro Inlet and Rich Inlet are used more as stopover sites, but small populations remain throughout the winter (Addison and McIver 2014a, 2014b). Kiawah Island in South Carolina is an important stopover site during spring migration. On 3/17/2015, Aaron Given, a biologist with the Town of Kiawah Island, counted 71 piping plovers during a survey (Chaplin, pers. comm. 2019).

A migratory stopover site was discovered at South Point, Ocracoke Island, North Carolina in 2016 (Weithman et al. 2018). Birds from all three breeding populations were observed using South Point as a stopover location, with 96% of the birds observed being from the Atlantic Coast breeding population. By conducting abundance and resighting surveys, researchers were able to determine that 14.7% of the Atlantic Coast breeding population and 9.9% of the global population of plovers had migrated through South Point between July and October of 2016 (Weithman et al. 2018). Since piping plovers are known to show strong site fidelity, it is likely that South Point is a key stopover site for the species.

#### WM 2.2.1.2 Survival:

Demographic analyses have revealed wintering range effects on individual piping plover annual survival. Analysis of data collected in the Carolinas and Georgia in 2010-2017 found that plovers using recreationally disturbed habitats with significant modifications to their habitat have lower survival rates (10% less) and lower body condition (7% lower mass) than birds that use less disturbed habitat without modifications (Gibson et al. 2018). Further, birds that emigrated from disturbed sites had higher survival (0.80) than birds that stayed (0.67); but because of their strong site fidelity, birds were more likely to die than leave because of disturbance (Gibson et al. 2018). The model used in Gibson et al. (2018) found little support that an individual's breeding population influenced annual survival. This study further supports findings in Roche et al. (2010) that annual survival is influenced by where individuals overwinter rather than association with a breeding population. Roche et al. (2010) found that after-hatch-year apparent survival declined in four of their seven study populations. They found evidence of correlated year-to-year fluctuations in annual survival among populations wintering primarily along the southeastern U.S. Atlantic Coast, as well as indications that shared overwintering or stopover sites may influence annual variation in survival among geographically disparate breeding populations.

Adult survival is also being explored in other parts of the coastal migration and wintering range. Gratto-Trevor et al. (2016) estimated true survival of 0.71 from 57 marked birds in the Bahamas that were banded between 2009 and 2010 and resighted through 2013.
Along the Florida panhandle, annual apparent survival for wintering piping plovers ranged from 58% to 76% (M. Tuma pers. comm. 2019). In Texas, there is an ongoing effort to determine piping plover survival after Hurricane Harvey hit the Texas coast in August 2017 (D. Newstead pers. comm. 2018).

#### WM 2.2.1.3 Habitat use:

The CCS noted that migrating and wintering piping plovers use a mosaic of ephemeral habitats in response to local weather and tidal conditions throughout the coastal migration and wintering range. Piping plovers along the Texas coast tend to increase in abundance on beaches when back bay flats are inundated with water (Newstead and Vale 2014, Anderson and Heath 2017,). Tide levels in the Laguna Madre on the southern Texas coast are driven by wind. During fall and spring when tides are seasonally higher, water levels within the bay systems may be too high to expose flats and thus preclude piping plover use. The water level in the Laguna Madre is a key driver of whether piping plovers were found in bay or beach habitats. Data show that piping plovers prefer bay side habitats when available, at least during fall through spring, but become dependent on beach habitats when bay water levels are high (Newstead 2014, Newstead and Vale 2014).

Prey availability and distribution is a key factor in piping plover foraging habitat use. In 2011, a South Carolina study strongly linked plover habitat use to the abundance of key invertebrate taxa (SCDNR 2011). Following the study, the South Carolina Department of Natural Resources (SCDNR) identified an Intertidal Marine Invertebrates Guild made up of amphipod crustaceans, bivalve mollusks, polychaete worms, and chelicerate arthropods based on the presence of dominant taxa from sediment cores and plover fecal samples (SCDNR 2015a). Piping plover presence in foraging areas was correlated with the highest prey availability. Cisek (2013) found that winter piping plover foraging behavior at Harbor and Hilton Head Islands in South Carolina was associated with high macroinvertebrate density, amphipod abundance, and temperature. SCDNR (2017) found plover occupied foraging areas were significantly correlated to haustorid amphipod abundance, which is a known preferred prey item. Large errant polychaetes, the most preferred plover prey items, were associated with more sheltered areas such as ephemeral lagoonal depressions. Finer substrates that accumulate in these types of sheltered environments provide substrate for polychaetes and although they tend to be less abundant, they provide a greater caloric reward per individual than smaller taxa found in more exposed intertidal areas (SCDNR 2015b, 2017).

#### WM 2.2.1.4 Winter site fidelity:

Piping plovers exhibit a high degree of intra- and inter-annual fidelity to wintering areas, which often encompass several nearby sites (Drake et al. 2001, Noel and Chandler 2008, Stucker et al. 2010 *in* USFWS 2012). Gratto-Trevor et al. (2016) found that 100% of the piping plovers they observed wintering in the Bahamas were resighted either on or within 6 km of the same beach where they were originally banded between August 2010 and December 2014.

Winter site fidelity does not appear to be influenced by disturbance, and is overall similar to breeding site fidelity. Individuals are more likely to remain at a site, regardless of site quality or disturbance, than emigrate to a new site thereby resulting in lower survival (Gibson et al. 2018). For example, during the Deepwater Horizon oil spill, marked piping plovers rarely moved between sites, and researchers observed high detection rates, even in oil-impacted sites that were heavily disturbed due to clean up efforts (Gibson et al. 2017).

### WM 2.2.2 Five-factor analysis

In the following sections, we provide an analysis of threats to piping plovers in their coastal migration and wintering range. We provide updated information obtained since the completion of the 2012 CCS. Previously identified and new threats are both discussed.

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

Destruction, modification, and loss of habitat continues to be an ongoing threat to the piping plover coastal migration and wintering range. The 1985 final rule 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 also stated that shoreline development throughout the wintering range poses a threat to all populations of piping plovers. The CCS concluded that the migration and wintering range showed continued loss and degradation of habitat due to shoreline and inlet stabilization efforts and these losses continue to be documented in parts of the range (Rice 2016, 2017).

Developed shorelines within the piping plover coastal migration and wintering range have caused and continue to cause the majority of habitat loss, modification, and degradation due to the perpetual maintenance of infrastructure as well as permanent structures previously placed on or adjacent to shifting shorelines. Shoreline stabilization projects aimed at protecting existing development and infrastructure can cause temporary or lasting effects depending on the type of project, location, timing, and quality of sand source. Sand placement projects can have beneficial effects by creating unvegetated, open areas, which make optimal roosting habitat, and create more space for birds on the beach, but these effects are short-lived, often lasting only a few years before vegetation encroaches again (Chaplin 2019). Sand placement projects and inlet relocation projects have more of an impact on foraging habitat by directly impacting benthic invertebrates or altering substrates, which indirectly influences the distribution and abundance of the benthic community (USFWS 2012, SCDNR 2015a, b, Wooldridge et al. 2016, SCDNR 2017). Wooldridge et al. (2016) found that replenished sections of beach had half as many invertebrates as control sections after 15 months. Polychaete density was also reduced to one third of control levels after 15 months. Although no overall effect of total invertebrate abundance was detected, Wooldridge et al. (2016) indicated that replenishment affects taxon within the community differently, such as polychaete worms, which are the preferred prey item of piping plovers. Another consequence of developed shorelines is human recreational disturbance, which can be functionally equivalent to habitat loss if the disturbance prevents birds from using the area or extends the time and energy needed to feed and rest (Goss-Custard et al. 2006). The presence of people has been documented to displace shorebirds and influence habitat use (Pfister et al. 1992, Fitzpatrick and Bouchez 1998, McCrary and Pierson 2000, Cornelius et al. 2001, Mizrahi 2002, Hvenegaard and Barbieri 2010, Forys 2011, Burger and Niles 2013, Lafferty et al. 2013, Burger and Niles 2014, Cestari 2015, Martín et al. 2015, Drever et al. 2016, Watts 2017, Hunt et al. 2019, Mengak et al. 2019).

***Efforts to avoid and reduce adverse effects on habitat***

Through the ESA 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. Numerous Biological Opinions (BO) have been written for projects occurring within the coastal migration and wintering range, which include non-discretionary Reasonable and Prudent Measures to reduce impacts and minimize take. Habitat Management Plans, which include long term management techniques such as seasonally posting high tide roosting habitat, are often incorporated into BOs for recurring projects (Chaplin pers. comm. 2019).

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

Based on the current information, overutilization is not a threat to piping plovers within their coastal migration and wintering range because the 1985 final listing rule found no evidence to suggest that this factor is a current threat. The recovery plans state that hunting in the late 1800s may have severely reduced piping plover numbers, but there is no information indicating that hunting is currently a threat to piping plovers in the U.S. or in other countries.

#### WM 2.2.2.3 Factor C. Disease or predation:

***Disease***

The CCS concluded that disease poses a minor threat to nonbreeding piping plovers (USFWS 2012). We do not have any additional information at this time to indicate the threat level has changed.

***Predation***

The CCS concluded that the extent of predation on nonbreeding piping plovers is unknown, but it could be a potential threat. Predation is often difficult to document, but between December 2012 and September 2017, five mortalities likely due to avian predation were reported along the Texas Coast. In the Florida panhandle, higher counts of raptors coincided with the piping plover nonbreeding season as well as with sites with high piping plover use (Tuma pers. comm. 2018).

#### WM 2.2.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

Existing regulatory protections, absent the ESA, are currently insufficient to adequately protect piping plovers within their coastal migration and wintering range. Federal regulatory protections for wintering and migrating piping plovers are inherent in the Coastal Barrier Resources Act

(CBRA), however, not all occupied piping plover areas are included. The MBTA addresses the bird itself, but only from intentional acts of harm. Formal and informal ESA section 7 consultations with Federal agencies or state and private entities receiving Federal funds, permits, or undertaking Federal projects within the coastal migration and wintering range continue to play a critical role in piping plover conservation. Therefore, removal of ESA protections is likely to require institution of alternative regulatory mechanisms or contractual agreements that currently do not exist.

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

#### WM 2.2.2.5.1 Recreational disturbance

The CCS identified human recreational disturbance as a major threat to piping plovers in their coastal migration and wintering range (USFWS 2012). The Atlantic Flyway Shorebird Initiative has also identified human recreational disturbance at stopover sites as a major threat to migrating shorebirds (Mengak et al. 2019, Hunt et al. 2019). Additional studies have documented the effects of disturbance since the CCS was completed in 2012 (Burger and Niles 2013, Lafferty et al. 2013, McLeod et al. 2013, Schlacher et al. 2013, Burger and Niles 2014, Koch and Paton 2014, Weston et al. 2014, Cestari 2015, Glover et al. 2015, Martin et al. 2015, Vas et al. 2015, Allport 2016, Drever et al. 2016, McEvoy et al. 2016, Murchison et al. 2016, Stigner et al. 2016, Ramli and Norazlimi 2017, Watts 2017, Gibson et al. 2018, DeRose-Wilson et al. 2018, Hunt et al. 2019). A 2017-2018 literature review documented 632 citations published between 1974 and 2018 on disturbances to shorebirds, their habitats, and their prey base in addition to management recommendations for reducing disturbance (Comber et al. 2019). This literature review highlights that this threat is well documented, but not well managed.

Human disturbance is often associated with developed shorelines (Bimbi 2016) and 40% of the shoreline within the coastal migration and wintering range is developed (Rice 2012). Gibson et al. (2018) found piping plovers using disturbed sites across North Carolina, South Carolina, and Georgia had lower true annual survival rates than those using undisturbed sites. The study also found that plovers using more disturbed sites weighed an average of seven percent less than those using less disturbed sites (Gibson et al. 2018). Due to their strong site fidelity, plovers that have previously used disturbed habitat are likely to return to that same location instead of finding more suitable habitat elsewhere (Gibson et al. 2018). Plovers foraging in disturbed areas spend less time foraging, and more time alert, than those in undisturbed areas. This leads to lower body condition, due to the plover's increased stress levels and reduced time feeding (Rutter 2016). Limiting the amount of interactions between humans and piping plovers would reduce the negative impacts of disturbance. This can be accomplished by designating bird only areas in important habitats with higher levels of disturbance (Hunt et al. 2019). However, bird only areas need to incorporate appropriate buffers to ensure the designated areas minimize disturbance (Glover et al. 2011, Burger and Niles 2014, Koch and Paton 2014). Plovers and other shorebird species have been documented using temporary closures of high tide roosts on Hilton Head

Island in South Carolina (Chaplin pers. com. 2017). During surveys on Mustang Island in Texas from 2011-2012, piping plover distribution was concentrated within Mustang Island State Park, which uses bollards to limit vehicle traffic (Newstead and Vale 2014). Similarly, piping plover distribution was lowest in the highest human use area at Padre Island National Seashore in Texas (Newstead and Vale 2014). All of these examples indicate that plovers prefer lower disturbance areas within their winter sites.

Interactions between dogs (*Canis lupus familiaris*), particularly dogs running off leash, and shorebirds elicit the strongest response from shorebirds. Shorebirds are more likely to flush from the presence of dogs than people, and breeding and nonbreeding shorebirds react to dogs from distances farther than the distance to people (USFWS 2012, Murchison et al. 2016, Stigner et al. 2016, Ramli and Norazlimi 2017, Mengak et al. 2019). Unleashed dogs often chase birds, and can elevate a piping plover's stress enough to impact individual survival (Rutter 2016). Elevated stress levels in the nonbreeding season can carry over into the breeding season and impact future reproductive success by reducing survival and fecundity rates (Rutter 2016). The Comber et al. (2019) literature review identified 61 citations published between 1991 and 2017 on disturbances to shorebirds from dogs. Although this threat is well documented, the public's perception of dogs disturbing shorebirds is that it's not harmful, which does little to encourage dog owner behavioral changes or compliance with leash laws or closed areas in shorebird habitats (Rutter 2016). For example, 21% of dogs occurring at Cape Lookout National Seashore from 2007-2013 were unleashed despite leash laws (NPS 2015). From 2011-2015, dog owners visiting the seashore have been given a total of 125 off leash citations, 1 dog harassing wildlife citation, 51 written warnings, and 552 recorded verbal warnings (NPS 2011, 2012, 2013, 2014, 2015).

Outreach and education efforts are a conservation tool that is often used to increase awareness in hopes of minimizing human recreational disturbance to shorebirds. Some studies have indicated that education and awareness hasn't translated into positive conservation attitudes or behavioral changes (Jorgensen and Brown 2015, Rutter 2016). This may be significant since it is becoming more apparent that conservation efforts for birds in public spaces are reliant on human behavioral change (Jorgensen and Brown 2015). The USFWS convened an Atlantic Coast Piping Plover Human Disturbance Communication Team to develop a strategic communications plan aimed at making outreach-related recommendations to reduce effects of human recreational disturbance on piping plovers (USFWS 2017). The plan is designed to be a communications tool for conservation partners, but it is up to the partners to implement the strategies and recommendations outlined. Therefore, USFWS and conservation partners will need staff, time, and funding to effectively implement this important resource.

In summary, human recreational disturbance is an increasing threat with survival implications. This threat should be reprioritized within the coastal migration and wintering range due to the findings of Gibson et al. (2018). Habitat loss within the range remains a serious threat and human recreational disturbance further reduces the amount of habitat available. Even remote, boat only access sites have been subject to disturbance. A multi-faceted approach including a communications strategy, bird only areas with appropriate buffers, site stewardship and management, and enforcement, is needed to effectively minimize this increasing threat.

### WM 2.2.2.5.2 Military actions

***Military Operations***

The CCS concluded that military operations pose a minimal threat to nonbreeding piping plovers (USFWS 2012). We do not have any additional information at this time to indicate the threat level has changed.

### WM 2.2.2.5.3 Contaminants

***Oil spills***

The CCS documented how oil spill response activities associated with the Deepwater Horizon (DWH) spill had disturbed piping plovers and other shorebirds and had short- and long-term effects on habitat. On April 20, 2010, an explosion on the DWH oil drilling rig triggered a well blowout on the seafloor, 45 mi off the coast of Louisiana. The well was sealed 87 days later after an estimated 4.9 million barrels of oil were released into the Gulf of Mexico (McNutt et al. 2012). Some level of oiling was detected on approximately 650 mi of shoreline throughout the Gulf Coast states (Nixon et al. 2016), and approximately 50% of the shorelines impacted were beach ecosystems (Michel et al. 2013). Clean-up and recovery operations began immediately after the initiation of the spill and clean-up operations continued for five years.

Beach ecosystems along the Gulf of Mexico are important overwintering areas for at least two of the breeding populations of piping plovers. While the number of undetected birds is unknown, <1% of all direct recoveries of live or dead birds from the DWH-impacted areas were oiled shorebirds (Henkel et al. 2012). Of the 7,258 birds recovered alive or dead, 85 were shorebirds and of those, 23 were identified as visibly oiled (USFWS 2011). Another 8.6% of shorebirds captured the year following the spill were oiled (Henkel et al. 2012). It is possible that more shorebirds were affected, but not recovered or that the population-level effects have not yet been determined (e.g., decreased reproductive success due to a decline in invertebrate prey on the overwintering beaches; Henkel et al. 2012). In addition to direct oiling, piping plovers were also at risk of ingesting oil given their foraging strategy or through preening of oiled feathers.

Based on the timing of the explosion and subsequent spill, there were likely very few, if any, piping plovers in the impacted area. However, some piping plovers return to the nonbreeding grounds in July, when oil was still actively spilling into the Gulf of Mexico and very early on in the recovery and clean-up process. Gibson et al. (2017) started surveys for piping plovers as soon as logistically possible after the spill started (August 29, 2010) at four sites in the affected area and three reference sites away from the oil spill. In addition to surveying for birds at these seven study areas, they captured and marked piping plovers with unique color band combinations.

Gibson et al. (2017) found no effect on apparent survival from oiling or clean-up efforts. Apparent survival through the 2011 breeding season was similar among impacted and reference sites and between oiled and non-oiled birds (Gibson et al. 2017). In contrast to these results, the Natural Resources Damage Assessment (NRDA) team estimated that 26-41 piping plovers either died or failed to reproduce as a result of the oil spill (Deepwater Horizon NRDA Trustees 2016). Long-term population-level effects of the DWH are not known.

On March 22, 2014, 168,000 gallons of intermediate fuel oil spilled in Galveston Bay, TX. Oil was observed on a remote stretch of Matagorda Island a few days later and some oil came ashore on Galveston Island. After winds shifted, oil was pushed onto the shoreline of Matagorda Island National Wildlife Refuge and San Jose Island. Tar balls washed ashore further south on Mustang and North Padre Islands. Oiled piping plovers were observed at Bolivar Flats and along several stretches of beach to the south. While no oiled birds were captured, no carcasses were observed or retrieved. Best Management Practices (BMPs) for protecting listed species were implemented during the oil spill response.

***Pesticides and Other Contaminants***

The CCS concluded that pesticides and other contaminants pose a low threat to nonbreeding piping plovers (USFWS 2012). We do not have any additional information at this time to indicate the threat level has changed.

#### WM 2.2.2.5.4 Accelerating sea level rise

The CCS concluded that accelerating sea level rise (SLR) poses a threat to piping plovers within their coastal migration and wintering range. The CCS also noted that the magnitude of threats from SLR is closely linked to threats from developed coastlines because sites that are able to adapt to SLR are likely to become more important to plovers as habitat at developed or stabilized sites degrades. Von Holle et al. (2019) investigated the effect of local and eustatic SLR on important sea turtle, seabird, and shorebird habitat across the South Atlantic Bight (SAB) and found a substantial increase in the coastal erosion vulnerability under a modest increase in SLR by 2030. Fifty percent of the winter piping plover habitat within the SAB will have an increased vulnerability by 2030 as compared to year 2000 vulnerability levels (Von Holle et al. 2019). Habitat within the SAB with high piping plover wintering densities is projected to have an even higher (66% )increased vulnerability due to accelerating SLR as compared to the 2000 levels (Von Holle et al. 2019). This is significant since 40% of the coastal migration and wintering range beaches is already developed (Rice 2012) and developed beaches are predicted to be more vulnerable to SLR due to their limited ability to adapt. The remaining 60% of undeveloped beaches within the coastal migration and wintering range is also vulnerable to SLR. Von Holle et al. (2019) suggests that available piping plover habitat could become much more vulnerable to SLR impacts in the next ten years.

### WM 2.2.2.5.5 Weather events

***Storms***

Storms are a component of the natural processes that form coastal habitats and can benefit or adversely affect piping plovers at all life stages (Saunders et al. 2014, Bourque et al. 2015). Storms can eliminate local roost sites, lead to decreases in food supply within foraging habitat, and even directly kill birds (Saunders et al. 2014). Saunders et al. (2014) found that adult piping plover survival was negatively correlated with hurricane frequency. Some birds may have resiliency to storms and move to unaffected areas without harm, while other reports suggest birds may perish from storm events. In 2014, Hurricane Arthur was responsible for the loss of 15 chicks (63%) along Cape Lookout National Seashore in North Carolina (NPS 2014). Between 2011 and 2016, 25% of all nest losses were due to flooding or high winds (NPS 2011, 2012, 2013, 2014, 2015, 2016). In 2017, following Hurricane Mathew, all known banded piping plovers observed before the storm at regularly surveyed sites in South Carolina were observed during surveys following the storm (Chaplin pers. comm. 2019).

Storms are important natural processes that create or enhance habitat (Bourque et al. 2015, Rice 2016). Bourque et al. (2015) analyzed a 27 year dataset and found that the number of chicks fledged increased three years after a major storm in New Brunswick, Canada. The lag time between storm events and colonization of new habitat was not surprising given low-density populations, high site fidelity in adults, and high variability in juvenile survival rates (Bourque et al. 2015). In 2012, Hurricane Sandy opened 33 coastal inlets along the U.S. Atlantic Coast breeding range, 9 of which were still open in 2015 (Rice 2016). After Hurricane Sandy, other storm events opened an additional 23 inlets, creating valuable coastal habitat. Conversely, these storms have also accounted for the natural closures of 47 inlets between 2012 and 2015 (Rice 2016). Hurricane Ike severely damaged Bolivar Flats in Texas in 2008, but the number of piping plovers using the flats has steadily increased. As of 2014, the flats were supporting numbers of plovers close to counts from multiple years preceding the hurricane (Newstead and Vale 2014). In 2017, Hurricane Harvey hit the central and upper Texas coast as a Category 4 storm and provided another example of how storms can benefit plover habitat. At Charlie's Pasture in Port Aransas, Texas, Harvey caused two significant breaches, which changed the water flow on the flats and increased the amount of available habitat for wintering piping plovers. While the hurricane washed away the algal flats, it left sand flats with regular flow in and out from the adjacent shipping channel. More piping plovers were observed at Charlie's Pasture during surveys in the fall and winter after the hurricane than before the major disturbance (Macaulay 2018). In 2018, Hurricane Michael, a category 5 storm impacted Tyndall Air Force Base (AFB) and T.H. Stone Memorial St. Joseph Peninsula State Park in Florida. At least one marked bird was seen on Tyndall AFB pre- and post- hurricane. Continuing surveys by Florida Audubon and Florida Wildlife Research Institute may provide greater insight on post-storm survival (Pruner pers. comm. 2019).

Other storm-induced adverse effects include post-storm acceleration of human activities such as beach nourishment, sand scraping, and berm and seawall construction. Storms can accelerate these activities because coastal habitat is especially vulnerable to degradation from natural erosion, sea level rise, recreation, and coastal development (USGS 2018a). The Atlantic Coast breeding range has had close to 80 km of sediment placement projects permitted to modify beach habitat following Hurricane Sandy. This was a 15% increase in the amount of modified shoreline prior to Hurricane Sandy (Rice 2017).

***Severe cold weather***

Several sources suggest the potential for adverse effects of severe winter cold on survival of piping plovers. Cold weather can directly lead to reductions in survival, as seen in a population of piping plovers in Georgia that declined by 52% concurrent with a 4-week period of cold weather (Gibson et al. 2017). Unusually cold temperatures can also effect survival indirectly by reducing the amount of food available. Reduced food availability causes piping plovers to expend valuable energy foraging and results in lower body conditions that reduce chances of survival (Saunders et al. 2014).

### WM 2.2.2.5.6 Energy Development

***Land-based Oil and Gas Exploration and Development***

The CCS concluded that land-based oil and gas extraction activities pose a very low threat to nonbreeding piping plovers (USFWS 2012).  We do not have any additional information at this time to indicate the threat level has changed.

***Wind Farms***

While there is no current evidence of onshore wind farms impacting piping plovers, either directly or indirectly on the coastal migration and wintering range, they are becoming an increasing concern in Texas (Nareff pers. comm. 2018). Onshore wind farms currently exist or are proposed over much of south Texas, including areas along the coast near critical habitat (USGS 2018b). Piping plovers are not likely to come into contact with wind turbines, or associated infrastructure, while foraging or roosting, but may during migration. In addition to the threat of collision with turbine blades, wind farms may result in habitat loss or modification and as well as changes in behavior due to avoidance. Wind Farm infrastructure may also support avian predators. Some detections of tagged piping plovers have occurred within 2.5 km of a turbine (Newstead 2014).

### WM 2.2.3 Ongoing Conservation Efforts

Conservation efforts focusing on habitat protection continue within and outside of the U.S. in the piping plover migration and wintering range. In 2015, the Bahamas National Trust and Bahamian government announced that Joulter Cays would be designated as a national park. Joulter Cays, covering 92,000 acres of land and water, is a series of mangrove covered cays connected by miles of sand flats. It is recognized as a critical wintering area for 13 shorebirds species, including the piping plover (Saha 2015, NAS 2018). In NW Florida, a partnership between USFWS, NPS, and Audubon resulted in an area being posted to protect piping plovers within the Gulf Islands National Seashore. In SE Florida, a private landowner donated Ballast Key to the USFWS Refuge System in 2019. It protects part of piping plover critical habitat Unit FL-29 and is now part of the Key West NWR. NRDA funds for coastal species protection are directing the acquisition of an eight acre parcel located adjacent to critical habitat Unit FL-3 Navarre Beach, in Santa Rosa, Florida. This tract will be added to the encompassing Santa Rosa County Navarre Beach Marine Park.

Outreach and education efforts in addition to research and management continue throughout the range. In Texas, the Gulf Coast Bird Observatory, Coastal Bend Bays and Estuaries Program, and the American Bird Conservancy have continued educational efforts along the Texas coast. All have conducted outreach events including bird walks, booths at local events, and presentations at local conservation organization meetings and festivals. New signs, fencing, and bollards have been erected at important shorebird sites along the coast. In the Carolinas and Georgia, local volunteers and partners from USFWS, NC Wildlife Resources Commission, Department of Defense, NC National Estuarine Research Reserve, NC State Parks, NPS, Audubon NC, SCDNR, SC Audubon, SC Shorebird Project, SC Parks and Recreation Commission, local municipalities, Virginia Tech, Georgia Shorebird Alliance, Manomet, and GA DNR continue to work on shorebird conservation through research, management, and outreach and education. In Florida, $16,000 is contributed to the USFWS Panama City Field Office's piping plover contribution fund account annually. These funds are a conservation measure associated with a consultation with Panama City for beach renourishment and are currently directed to the University of Florida's Cooperative Fish and Wildlife Research Unit to analyze the winter survival and habitat use of piping plovers in NW Florida. Two new conservation tools have also been compiled and are now available including the *Atlantic Coast Piping Plover Strategic Communications Plan* (USFWS 2017) and *Guidance and Best Practices for Evaluating and Managing Human Disturbances to Migrating Shorebirds on Coastal Lands in the Northeastern United States* (Mengak et al. 2019).

### WM 2.2.4 Synthesis

A review of threats from 2012 to present indicates that losses and degradation of habitat continues and that levels of recreational disturbance are increasing. As a result, cumulative losses of habitat and habitat function throughout the coastal migration and wintering range continues to be the primary threat. Since the completion of the CCS, more information documenting continued impacts to habitats, individual survival, and negative effects from recreational disturbance has become available, indicating current conservation efforts aimed at protecting habitat and minimizing recreational disturbance are not adequately addressing the threat. Effective conservation efforts need to be implemented and enforced immediately throughout the range to offset the increasing threat level. Other threats were also identified, but they were considered lower priorities due to the ongoing cumulative loss of area and function of coastal migration and wintering habitat. After reviewing new information, oil spills, predation, storms, and severe cold weather are of concern, but they remain lower threats when considered independently. Cumulatively, oil spills, due to the associated clean-up response, and storms, due to the shoreline stabilization efforts that tend to follow, have the potential to exacerbate ongoing threats from habitat loss and disturbance locally and regionally. This is particularly significant for the Great Lakes population because the population is already more vulnerable due to low numbers; therefore, affected areas where Great Lakes birds occur could have population level effects. Accelerating SLR is a growing concern because the magnitude of threats from SLR is closely linked to threats from developed coastlines since those shorelines have less adaptability. Shoreline stabilization efforts in response to SLR and the increase in storm frequency are likely to compound ongoing habitat losses throughout the coastal migration and wintering range. Cumulatively, all of these threats will likely limit the recovery potential of all three breeding populations, particularly the Great Lakes population, unless habitat within the coastal migration and winter range is effectively managed to minimize recreational disturbance and habitat loss and degradation.

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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 and most up-to-date information on the biology of the species and its habitat?***

For the most part, yes. The recovery criteria described in the 2003 recovery plan for the Great Lakes piping plover generally reflects the best available information on the biology of this breeding population. However, there has been some new information on biology and habitat in the Great Lakes.

Recent advances in our knowledge of population genetics along with remote sensing should facilitate future research into sustainable long term population needs. Additional demographic, habitat, and genetic data should become available as the population increases, and we anticipate the criterion calling for 150 breeding pairs will warrant reconsideration when the population approaches 100-125 breeding pairs.

***Are all of the 5 relevant listing factors addressed in the recovery criteria?***

The most important listing factors evaluated in the 2003 recovery plan and the 2009 Piping Plover 5 Year-Review (73 FR 56860) are addressed in the individual criterion. Section GL 2.3.3 of this document discusses these factors and includes additional threats not addressed in the 2003 recovery criteria or the 2009 Piping Plover 5-Year Review. Two factors not addressed in the criteria are overutilization and environmental contaminants, both of which are still present but remain minor threats to Great Lakes piping plovers. Disease has become a greater threat since 2009. Specifically, Type E Botulism in Lake Michigan has resulted in at least 9 plover deaths during 2007 – 2018 (4 in 2007, 1 in 2008, 2 in 2010, 1 in 2013, 1 in 2014). This threat should continue to be monitored to determine if additional recovery actions are needed (refer to section GL 2.3.3.3 of this document). Since 2009, oil spills in the winter range have continued as a threat, with the 2010 Deepwater Horizon oil spill being especially notable. Fall migration surveys following the spill found that oil was regularly distributed both in and near piping plover habitat (Gibson et al. 2017). This threat should also continue to be monitored to determine if additional recovery actions are needed (refer to section GL 2.3.3.5).

The range wide threat from wind turbine generators and climate change were discussed in the 2009 5-year review. The effects of wind turbine generators on Great Lakes piping plovers during the migratory period are still unknown, as our knowledge of this period of the plover's life cycle remains poorly understood. To date, however, no piping plovers have been discovered in the course of post-construction fatality monitoring of wind energy facilities in Michigan. Similarly, the effects of climate change on piping plovers in the Great Lakes remain unknown as model predictions on the level of increase or decrease in Great Lakes water levels vary (GLERL 2018). Great Lakes water levels directly affect the amount and distribution of piping plover habitat. Neither wind energy development nor climate change requires new recovery criteria to address these issues, however, additional research on the effects of these factors is recommended.

***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 and 2009 five-year review describes five recovery criteria. The population will be considered for reclassification to threatened when the first four criteria are accomplished, and will be 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 2017, the Great Lakes piping plover population reached a high since listing, at 76 breeding pairs (152 breeding individuals). Of these, 52 pairs were found nesting in Michigan and 24 were found in other Great Lakes states (and provinces) - including eight pairs in Wisconsin and fourteen in Ontario, Canada. The 52 nesting pairs in Michigan represent 52% of the recovery criterion, and the twenty-four breeding pairs outside Michigan represent 48% of the goal. The number of birds outside of Michigan has grown since the last review. However, in 2018, the population declined to 67 pairs, only 45% of the recovery goal. The single breeding pair found in 2007 in the Great Lakes region of Canada represented the first confirmed piping plover nest in that area in over 30 years. By 2009, the number of nesting pairs in Canada had increased to seven, but subsequently decreased to five in the 2011-2013 nesting seasons. The pair count in Canada increased again during the 2014 – 2017 seasons with 8, 11, 16, and 14 pairs initiating nests, respectively before dropping to 8 pairs in 2018. Outside the core Great Lakes piping plover breeding areas in Michigan, Wisconsin and Ontario, a pair was discovered at Illinois Beach State Park, Lake County, Illinois in 2009 but unfortunately was unsuccessful. However, birds returned to Illinois, breeding successfully in 2015. Great Lakes piping plovers returned to New York in 2015 and 2016 as well but had limited breeding success. Breeding pairs of Great Lakes piping plovers returned to Pennsylvania in 2017 and nested again in 2018.

**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 2009-2018 except for the years 2011 and 2017. During this time, the annual fledgling rate ranged from a low of 1.26 in 2017 to a high of 2.09 in 2012, with an overall average rate of 1.67 (Cuthbert and Roche 2009; Cuthbert et al. 2010, 2014; Cuthbert and Rutter 2015, 2016; Cuthbert and Saunders 2011, 2012, 2013, 2017, 2018). This average is well within the goal of 1.5 to 2.0 fledglings per pair per year.

Recent population trends indicate the population is slowly increasing, but is highly sensitive to loss of nesting adults on the breeding grounds and during other segments (e.g. migration, winter) of the annual cycle (Cuthbert and Roche 2009; Cuthbert et al. 2010; Cuthbert and Saunders 2011, 2012, 2013). Between 2009 and 2011 the population decreased 24% from 71 to 54 breeding pairs, but then rose again, reaching a high of 76 pairs in 2017. The long-term trend, from 1986-2009 and 2011-2017, indicates a slowly increasing population size, followed by a stagnant population trend during 2015-2017, at around 75 breeding pairs and then another decrease to 67 pairs in 2018. Because of the decrease between 2009-2011 and the fact that current levels are not at or above the recovery goal of 150 breeding pairs, all elements of this criterion have not yet been achieved.

**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.

Major issues related to habitat degradation on the breeding grounds include but are not limited to; development, construction, beach grooming, break wall developments, and vegetative encroachment. On the wintering grounds degradation concerns include the former list with addition of: wrack removal, shoreline stabilization, sand placement projects, groins, seawalls, revetments, dredging, sand mining, inlet stabilization and relocation.

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.

On the wintering grounds, revisions to the critical habitat units has occurred. A revised designation for four North Carolina critical habitat units was published in 2008. Redesignation of 18 Texas critical habitat units in 2009 substantially increased the proportion of critical habitat in that State that is classified as state-owned. However, this is primarily attributable to a change in mapping methods that included intertidal areas in the 2009 land ownership estimates, whereas intertidal lands had been excluded from the estimation of critical habitat acreage and ownership in 2001 (F. Weaver, USFWS, pers. comm. 2012). Overall, the estimated proportion of federal land comprising the critical habitat has remained relatively constant through the redesignations in North Carolina and Texas (USFWS 2008, 2009b).

In 2012, the Whitefish Point Unit of Seney National Wildlife Refuge (NWR) acquired an additional 20 acres, including 1,000 feet of shoreline important for nesting piping plovers. A habitat restoration project was started at Wilderness State Park in 2012 that included invasive species removal and control, as well as native species removal to mimic natural beach scour. These activities resulted in piping plovers returning to breed on Waugoshance Point in 2016 (Cuthbert and Rutter 2016).

In 2011, the St. Louis River Alliance began work on a five-year project to restore piping plover nesting habitat to Wisconsin Point and the St. Louis River Estuary. The project is funded by a grant from the U.S. Fish and Wildlife Service Coastal Program. As of 2012 and 2013, plovers have been seen utilizing the restored habitat as a migration stopover site.

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.

Further information can be found in the 2003 Recovery Plan and the 2009 Piping Plover 5-Year Review, which discuss designation of critical habitat and how the multi-partner recovery program works towards long-term habitat goals.

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

It is unclear whether this criterion has been met. As discussed in section GL 2.3.3.5 of the 2009 USFWS Piping Plover 5-Year Review, Miller et al. (2009) 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. 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 criterion has not been met. The primary goal 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, cannot be completely defined at this time, as the population is likely to continue its geographic expansion in the Great Lakes basin.

As indicated in section WM 2.2.2 of the 2009 USFWS Piping Plover 5-Year Review, progress towards understanding and managing threats to migrating 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. Conservation needs and techniques are identified in the 2012 U.S. Fish and Wildlife Service Comprehensive Conservation Strategy for the Piping Plover (*Charadrius melodus*) in its Coastal Migration and Wintering Range in the Continental United States (CCS).

Monitoring of nonbreeding piping plovers to assess regional abundance and distribution continues to be a priority. Along with monitoring, coordinated efforts have gone into the reporting and recording of nonbreeding piping plovers. Through these efforts, a database has been created in which wintering ground sightings are recorded and updated. These activities will be crucial for continued identification of important wintering habitats that need long-term protection.

### GL 2.3.2 Biology and habitat

Since the 2009 five-year review, new information has been developed on the biology and habitat use of the Great Lakes population. This review provides additional information obtained since 2009.

### GL 2.3.2.1 Life history:

There has been new information regarding the life history of the Great Lakes piping plover. Roche et al. (2010a) found that most early-season nest abandonment in piping plovers results from the death of attendant adults. The authors found abandonment as the main cause of nesting failure in Great Lakes piping plovers from 1993-2007, and that from 2002-2007, annual mortality associated with disappearances averaged 5.7% of the marked population. The study found disappearances primarily occur from 16 May to 19 June, are more common in older females than average age females, and were most frequently attributed to merlin predation. Approximately 16% of monitored clutches laid by Great Lakes piping plovers from 1993-2007 were lost before hatching. Abandonment was discovered to be the most common cause of nest loss (50% of all nest losses), but predation (31%) and flooding (19%) were also important. Among abandoned nests, Roche et al. (2010a) determined that 70% were abandoned concurrently with the disappearance of one or both members of the nesting pair, whereas 30% of abandonments appeared to be desertions, as both adults were later resighted. The study shows that most nest failures of Great Lakes piping plovers attributed to abandonment from 1993–2008 were actually cases of unrecognized adult mortality. Roche et al. (2010a) mentioned the frequency of these events has increased dramatically since 2002 (concurrent with an increase in regional merlin abundance), and currently accounts for approximately one fifth of annual adult mortality.

The frequency of merlin predation events on piping plover coincides with an apparent increase in merlins in the Great Lakes Region. Breeding Bird Survey trends indicate a 12.85% annual increase in merlins in Michigan between 2002 and 2012 (Sauer et. al 2014). Additionally, data from the Michigan Breeding Bird Atlas results show a widespread comeback in the state, with only 54 townships showing merlin presence in MBBA I, as compared with 193 townships in MBBA II, as well as many more confirmed nesting attempts during this more recent period (Haas 2011). Further, a recent study has confirmed that merlins have dramatically expanded their range in Wisconsin, reflective of similar changes across the continent (Cava et al. 2014). A new study by Saunders et al. (2018) estimated that merlin abundance in the Great Lakes region is predicted to increase from an index of 126 individuals (CI: 94 – 168) in 2017 to 166 individuals (CI: 63 – 379) by 2026. This is following the trend of an increase in their population size from 82 individuals (CI: 55 – 109) to 126 individuals (CI: 95 – 168) over a 24-year period from 1993 to 2016. Further, the authors found that regional merlin abundance (as measured by an index of merlin observations at two raptor observatories) had a strong negative association with adult plover survival, as has been demonstrated in other studies in the Great Lakes region (Roche et al. 2010, Saunders et al. 2014).

A study done by Claassan et al. (2014) investigated variation in nest initiation date, clutch size, daily nest survival, renesting propensity, and renesting intervals of federally endangered Great Lakes piping plovers from 1993-2010. They found that nests were initiated earlier by older adults (i.e. previous breeders), and that nest initiation date was more strongly associated with age of the female than age of the male. In the study, piping plovers that nested later in the season had smaller clutch sizes. Nest survival decreased with later nest initiation dates, increased with male age, and increased with nest age until close to hatching. Piping plovers replaced 49% of failed nests. However, the propensity to renest decreased later in the season and varied according to cause of failure. The most common occurrence of renesting was seen following flooding and was least common when clutches were inviable. The authors observed that the closer a nest was to the estimated hatch date when it failed, the greater the time lag before renesting. Claassan et al. (2014) also found renesting intervals averaged 4.2 days longer for birds that changed mates.

An analysis of 10 years of banded bird sightings by Stucker et al. (2010) found that the winter range of Great Lakes piping plovers extends from North Carolina to Texas, and the Bahamas, with the majority (75%) of reported individuals wintering in Georgia and Florida. About 95% of sightings were near or within federally-designated winter Critical Habitat for piping plovers. Stucker et al. (2010) confirmed that female plovers leave for, and reach, the wintering grounds before males, arriving in July and staying through April. Although breeding pairs do not winter in close association, the authors stated there is some evidence which suggests that offspring winter closer to the male rather than the female. Through repeated observations over several winters, Stucker et al. (2010) also determined that 52% of individuals from the Great Lakes showed apparent site fidelity. In particular, intra- and inter- annual non-breeding site fidelity was demonstrated at local and extra-local spatial scales (Stucker et al. 2010). See section WM 2.2.1.3 for additional information on wintering ground habitat use.

New information on differences in age at first breeding by Great Lakes piping plovers was published by Saunders et al. (2014). The authors determined that females had a higher probability ($0.557 \pm 0.066$) of initiating breeding at age one than did males ($0.353 \pm 0.052$), but almost all plovers began breeding by age three. The same study also estimated first-year survival rate of Great Lakes piping plovers as $0.284 \pm 0.019$ (SE) from mean banding age (9 d old) and $0.374 \pm 0.023$ from fledging age (23 d). Earlier hatching dates improved first-year survival estimates, indicating that chicks hatching earlier in the season not only have higher survival rates prior to fledging, but this advantage carries over to survival to age one as well. Thus, protecting early nests to ensure hatching success may increase recruitment in this population.

A study by Saunders et al. (2013) used visual and auditory stimuli to test whether captive-reared piping plover chicks lack the ability to recognize predators. The authors found average vigilance increased by 56.4% during predator treatments compared to non-predator treatments; however, chicks did not appear to differentiate between specific predators or non-predators. The authors indicated that captive-reared chicks innately recognize avian predators, which suggests that decreased post-release survival in captive-reared piping plovers is most likely caused by some other captivity-induced difference or by the lack of a parentally-taught behavior.

### 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 2016, approximately 81% of breeding adults were uniquely color banded (and 98% carried at least a partial band combination), which greatly increases the accuracy of breeding pair estimates (Cuthbert and Saunders 2013).

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 *in* USFWS 2009a). However, it is important to note that the number of breeding pairs decreased from 2009 -2011 by 24% (71 to 55 pairs), and then decreased again from 76 pairs in 2017 to 67 pairs in 2018.

Low first year survival rates are a likely factor in that decline. Great Lakes piping plovers were found to have a first-year survival rate of 0.375±0.023, with early-hatching chicks more likely to survive than late-hatching chicks (Saunders et al. 2014). The lower survival rates of late-hatching chicks may have influenced the number of breeding pairs returning to the Great Lakes from 2009-2011. The decrease in pairs between 2009 and 2011 does not indicate the Great Lakes piping plover population is in decline, but simply reflects the high sensitivity of the population to the loss of nesting adults both on the breeding grounds and during the remainder of the year (Cuthbert and Roche 2009; Cuthbert et al. 2010; Cuthbert and Saunders 2011, 2012, 2013). In 2012, the breeding pair numbers increased again from 54 pairs in 2011 to 58 pairs in 2012, followed by 66 pairs in 2013, 70 in 2014, 75 pairs in both 2015 and 2016, 76 pairs in 2017 before again declining to 67 pairs in 2018 (Cuthbert and Saunders 2018). The Great Lakes piping plover recovery plan documents the 2002 population at 51 breeding pairs (USFWS 2003).

In addition, the number of non-nesting individuals has increased annually since 2009. Between 2011 and 2016, an average of approximately 25 non-nesting piping plovers were observed annually, based on limited data from years 2011-2016 (S. Saunders, pers. comm. 2017). Although there was some fluctuation in the total population from 2009-2018, the increase in number of pairs, combined with the increased observance of non-breeding individuals, indicates the population continues to increase long-term but has been fairly static since 2009 (Figure GL1).

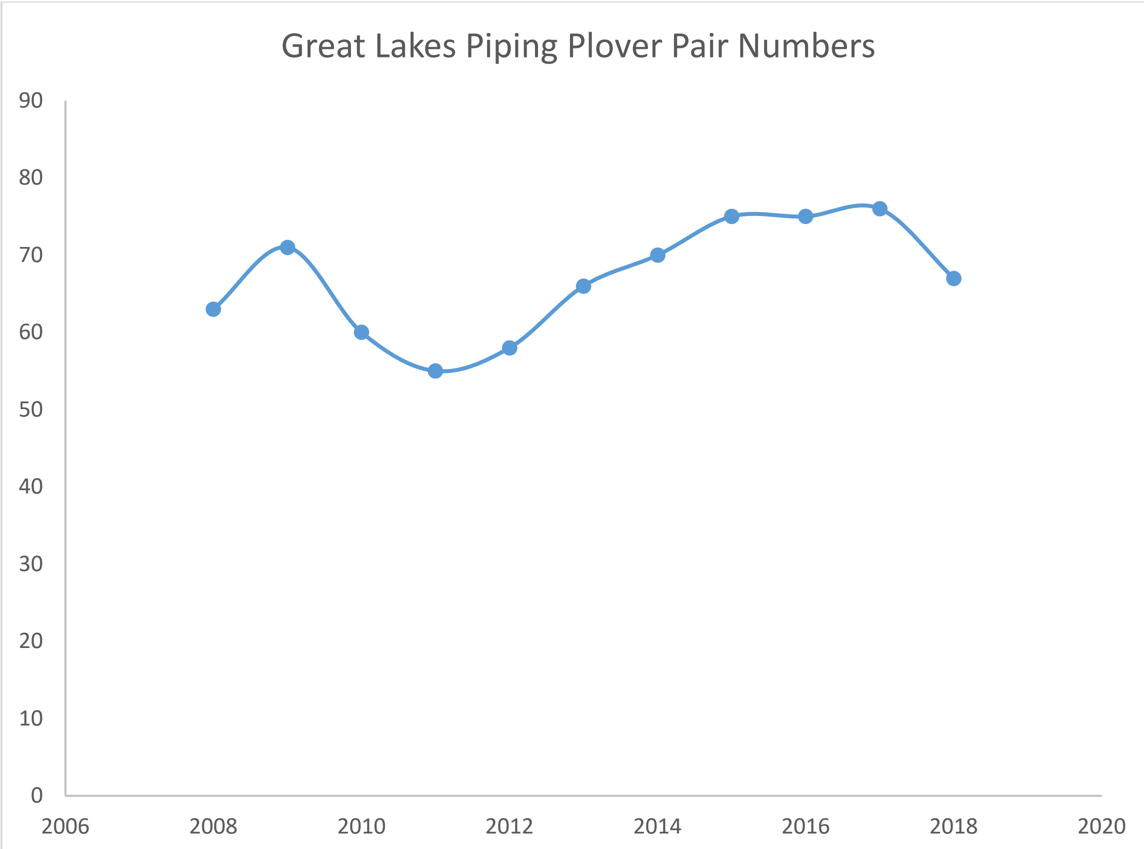


**Figure GL1.** Annual number of Great Lakes piping plover breeding pairs (2008-2018).

***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, which include: a USFWS aluminum leg band above the tibiotarsal joint on one leg, an orange plastic flag above the tibiotarsal joint on another leg, a unique combination of three plastic color bands on the tarsi. Wild-reared chicks receive brood-specific color combinations consisting of: a USFWS aluminum leg band above the tibiotarsal joint on one leg, an orange band above the tibiotarsal joint on the other leg, one or two colored plastic bands on the tarsi to indicate brood. The colored bands on the chicks also contain a colored dot and/or numbers; this allows for recognition of individual chicks and thus more accurate count of individual chick survival within broods. Nesting adults are trapped on the nest using a single-chambered Potter trap (Lincoln 1947); chicks are caught by hand with the help of small circular mesh devices. 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).

***Sex ratio***

There is an observed male-biased adult sex ratio in the Great Lakes piping plover population. A study by Saunders and Cuthbert (2015) collected feathers to determine the population sex ratios at hatching, banding (9 days old), and fledging (23 days old) to determine if the bias arises during the pre-fledging period, and if so, at what stage. During 2012-2014, Saunders collected feathers, determined the sex of 307 piping plover chicks, and followed individuals to a stage where survival to fledging could be inferred. Within fully-sexed broods at hatching, the average proportions of male chicks during the three years of the study were 0.47, 0.58, and 0.54, respectively. At banding, the sex ratio remained unbiased in 2012, but was male-biased in 2013 and 2014. Overall, the sex ratio was 1:1 at fledging in 2012, but significantly differed from parity in 2013 and 2014. They also found strong support for a sex effect on chick survival to fledging age, with higher male ($\mu = 0.83$) than female ($\mu = 0.71$) survival. Thus, the male-biased sex ratio arises, in part, due to differential survival during the pre-fledging period. The authors determined that this difference did not result from female chicks hatching later in the season or weighing less at banding than male chicks. Future investigations into possible behavioral- or weather-related influences on sex-specific survival are needed.

***Productivity***

The reproductive success of the Great Lakes piping plover, traditionally called the fledging 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 during 1984-2002. The 2009 Piping Plover 5-Year Review covers the fledging rates of 2003-2008. From 2009-2017, the annual fledging rate ranged from a low of 1.26 in 2017 to a high of 2.09 in 2012, with an overall average of 1.67 (Cuthbert and Roche 2009; Cuthbert et al. 2010, 2014; Cuthbert and Rutter 2015, 2016; Cuthbert and Saunders 2011, 2012, 2013, 2017) (Figure GL2). Productivity once again rose to 1.85 chicks per pair in 2018 (Cuthbert and Saunders 2018).

Despite the apparent increase in recent years (2014 – 2016), 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. Exposure to consistent cold or rain leaves chicks dependent on their parents for brooding, which reduces the amount of time available for foraging (Flemming et al. 1988). For example, it has been shown that precipitation during the first 3 days of life is related to lower chick survival (Brudney et al. 2013). Other stochastic factors such as predation and human encroachment have a significant impact on annual fledging rates as well. Further, Saunders and Cuthbert (2015) suggest that differential survival of female chicks during the pre-fledging period (i.e. lower survival rates than male chicks) may be contributing to lower fledging rates, although the cause(s) of female-biased chick mortality have not been identified.

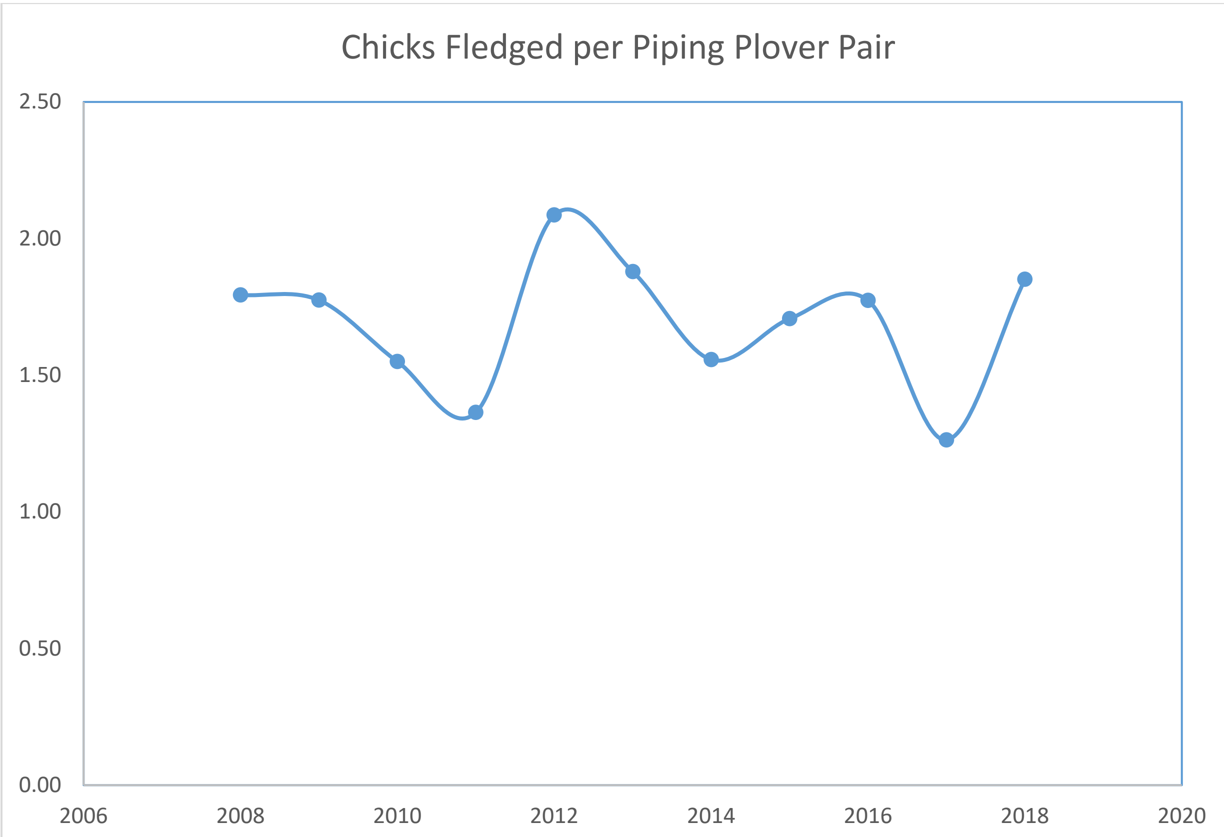


**Figure GL2.** Average productivity of Great Lakes piping plovers (2008–2018).

Brudney et al. (2013) recently reported on several key factors that influenced fledging rates during 1992 – 2011. They estimated high chick survival rates at sites with public beaches and buildings within 500 m of a nest. They concluded that public beaches have more intensive monitoring, possibly reducing predation and direct human disturbance. Additionally, the authors found several factors that negatively influenced fledgling rates. Piping plovers that nested close to forested areas had lower chick survival, which was likely due to increased availability of perches for avian predators. Early-hatching piping plover broods had greater survival than late-hatching broods, especially during the later years of the study. Because late broods are often the product of re-nesting efforts, parents of late broods may be in poorer condition if they have laid and incubated multiple clutches (Brudney et al. 2013). Female piping plovers are also more likely to desert late broods than early broods; therefore, late broods are more likely to be tended by only one parent. The authors discovered that chick survival has increased over the past two decades, and a large part of this improvement seems to be related to enhanced survival among early-season nests (due to increased efforts for nest protection via exclosures early in the season). Finally, mean calendar hatch date has advanced by 4 days over the past 20 years, possibly as a result of climate change and warmer spring conditions earlier in the breeding season (Brudney et al. 2013).

Additional new information on fledging rates was published by Saunders et al. (2012). Their results suggest that reproductive success improves with age, female site familiarity, and timing of nesting. In corroboration with the results of Brudney et al. (2013), Saunders et al. (2012) found that piping plover fledgling success is higher when nests are established earlier, usually by older individuals (i.e. experienced breeders). The authors also state that success increases when females nest at the same location during consecutive years, and decreases when females move to new sites. This suggests that maintenance of high-quality nesting habitat at frequently-used sites will allow for maximization of reproductive effort in this population. Saunders et al. (2012) found no added effect on success of male age, male experience, or pair experience.

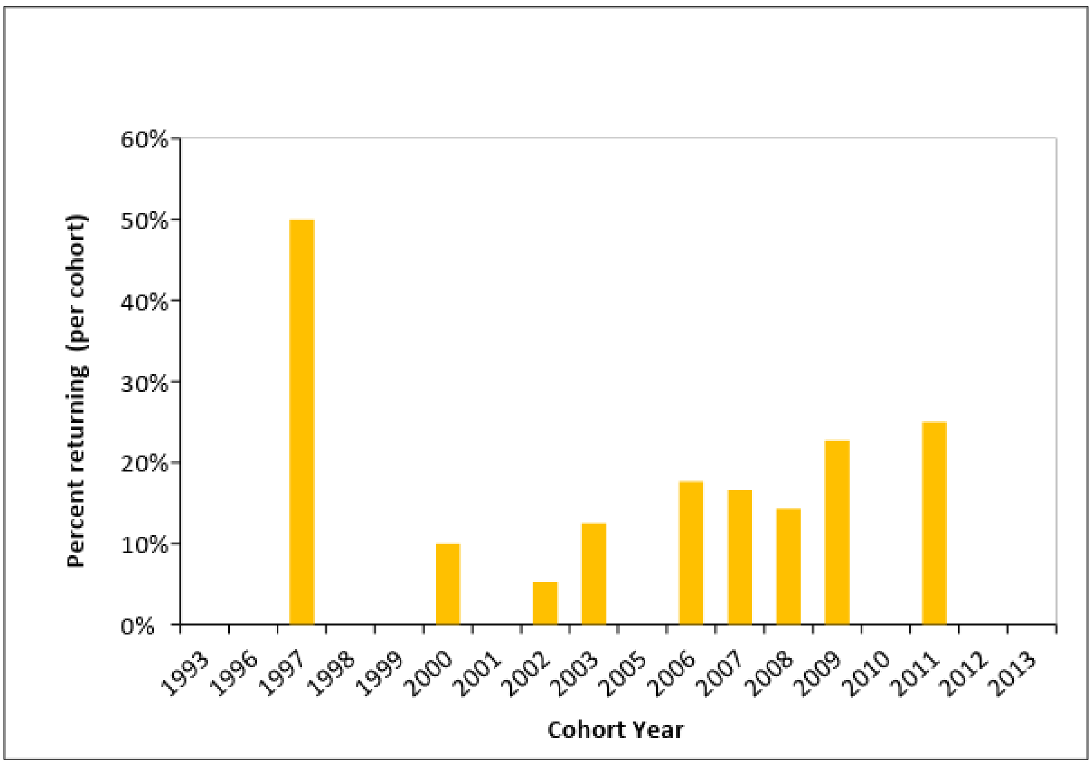


**Figure GL3.** Percentage of returning captive-reared Great Lakes Piping Plovers per cohort. Data come from poster presentation by University of Minnesota undergraduate student E. Wiley in 2013.

In response to potential nest losses from storms and other factors, a salvage captive-rearing program was initiated in 1997 by the University of Minnesota and subsequently managed by the Detroit Zoological Society along with other partners. Under this program, abandoned eggs are collected and artificially incubated. Chicks are hand-reared and subsequently released once they have reached fledging age, typically around 30-35 days of age. Since its beginning, the captive rearing program has increased the annual number of chicks fledged by an average of approximately 12% (Cuthbert and Saunders 2017).

Through 2018, 289 captive-reared piping plovers have been released. In 2013, University of Minnesota researchers calculated a total of 23 captives have returned to breed, an 11.7% return rate. The greatest number of captive-reared individuals returned from the 2009 cohort, but the highest percent return was from the 1997 cohort (Figure GL3). The majority of returning captive-reared individuals nested at two sites: Sleeping Bear Dunes in Benzie and Leelanau Counties, and Ludington State Park in Mason County. An analysis comparing return rate and reproduction in captive- and wild-reared piping plovers found no significant difference in clutch size, but there was a significant difference found in both hatching and fledging rates, with wild-reared plovers hatching significantly more eggs (3.10 vs. 2.28 mean eggs hatched; $p = 0.014$) and fledging significantly more chicks (1.80 vs. 1.20 mean chicks fledged; $p = 0.015$) per breeding season than did captive-reared plovers (E. Wiley et al., unpubl. data).

***Survival***

The 2003 recovery plan reported a piping plover hatch year survival rate (fledging to 1 yr) of 28%, and an after-hatch year survival rate (1 yr +) ranging from 73% to 83% (Wemmer 2000 *in* USFWS 2003). Cuthbert and Roche (2007) found an average hatch year survival rate of approximately 24% and an after-hatch year survival rate of 77% (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 *in* USFWS 2009a) and/or difficult to mitigate.

Saunders et al. (2014) used multi-state capture-recapture models to estimate age-specific survival and recruitment probabilities of Great Lakes piping plovers during 1993-2012. They found first-year survival (i.e. to 1 yr old) averaged $0.284 \pm 0.019$ from mean banding age (9 days) and $0.374 \pm 0.023$ from fledging age (23 days). Factors that increased first-year survival during the pre-fledging period (9 – 23 days) included earlier hatching dates, older age at banding, greater number of fledglings at a given site, and better body condition at time of banding. Adult survival was reduced by increased hurricane activity on the southeast U.S. Atlantic coast where Great Lakes piping plovers winter and by higher populations of merlins. Mean annual adult survival declined from 1993 to 2012, and did not differ between males and females (males: $0.742 \pm 0.022$; females: $0.725 \pm 0.024$). Enhanced body condition led to higher survival to fledge and early breeding led to improved first-year survival.

In an updated analysis, Saunders et al. (2018) used an integrated population model to estimate adult and juvenile (banding age to 1 y old) survival probabilities. The mean annual estimates of adult plover apparent survival ranged from 0.71 to 0.86 during 1993 – 2016, with mean adult survival over the study period at 0.78 (CI: 0.72 – 0.83). Mean annual estimates of juvenile apparent survival ranged from 0.17 to 0.29, with a mean value of 0.22 (0.19 – 0.25) over the 24-year study period. These estimates are very similar to those reported in Saunders et al. (2014).

### *Population viability*

Saunders et al. (2018) conducted a Bayesian population viability analysis for Great Lakes piping plovers and found that the projected average plover population growth rate during 2017 – 2026 was predicted to be 0.95 (CI: 0.72 – 1.12), leading to a projected decline from 75 pairs (CI: 72 - 78) in 2016 to 67 pairs (CI: 4 – 201) by 2026. The credible intervals surrounding these estimates are wide because the authors included an effect of regional merlin abundance on adult survival, thus increasing uncertainty around estimations of population growth and viability. The authors also calculated the percent of the time in which the plover population was predicted to grow, decline, or remain stationary by 2026 compared to the 2016 estimate. Their model projected that the population has a 32% probability of increasing in abundance (> 78 pairs), a 63% probability of decreasing (< 72 pairs), and a 5% probability of remaining the same (72 pairs $\geq N_{2026} \leq 78$ pairs). For comparison, the model without the merlin index projected that the plover population has a 60% probability of increasing, a 30% probability of decreasing, and a 10% probability of remaining the same size as in 2016. Despite a projected increase in the index of merlin abundance, the probability of quasi-extinction (≤ 15 breeding pairs remaining) of Great Lakes piping plovers, under current levels of management, by 2026 was estimated at an average of 11.9%.

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

No new information. See section GL 2.3.3.5 of the USFWS 2009 Piping Plover 5-Year Review.

#### GL 2.3.2.4 Taxonomic classification or changes in nomenclature:

Miller et al.'s (2009) 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 of the USFWS 2009 Piping Plover 5-Year Review.).

#### 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 stated in the 2009 5-year review, the population 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. Since the 2009 review, the Great Lakes population has continued to expand, breeding at historic sites farther south in Michigan (Muskegon State Park), nesting again in Illinois, New York, and Pennsylvania, and expanding to additional sites in Ontario (Figures GL4 and GL5). At the same time there has been a decrease in pairs in the Upper Peninsula of Michigan and at some locations in the Lower Peninsula including Ludington State Park.

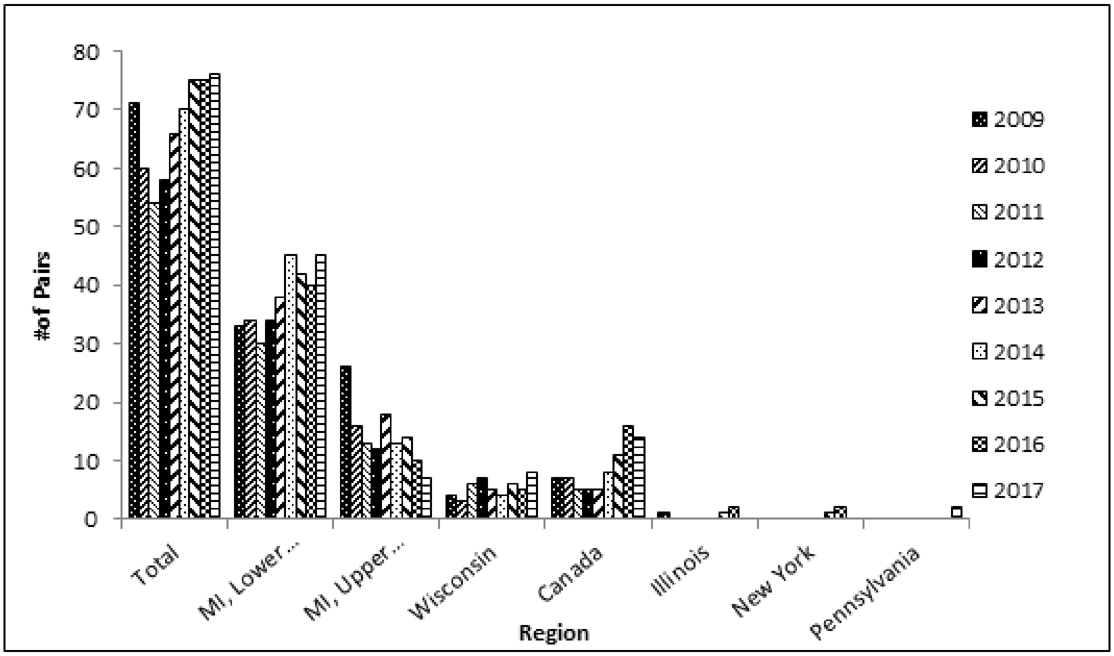


**Figure GL4.** Annual abundance estimates, per region, for Great Lakes piping plovers (2009-2017).

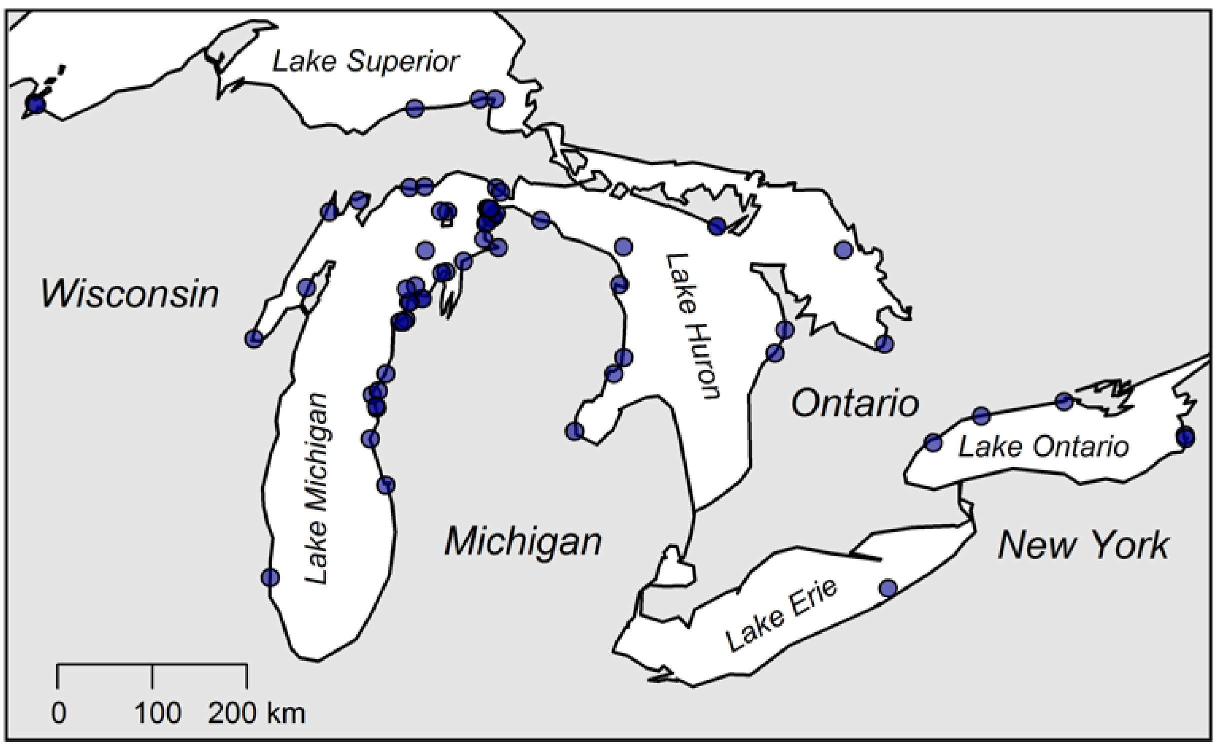


**Figure GL5.** Piping plover nesting locations in the Great Lakes region during 1993–2018.

### *Michigan*

During 2009-2018, nests were found on Michigan beaches in Bay, Iosco, Oceana and Muskegon counties, as well as on South Manitou Island; all of these locations were previously unoccupied from 1986-2008, though some had been used historically (Cuthbert and Roche 2009, Cuthbert et al. 2010). Between 1986 and 2008, several sites in Alpena, Delta, and Emmett counties were routinely used for nesting; however, from 2009-2013, none of these beaches were found to be used by nesting piping plovers (Cuthbert and Roche 2009; Cuthbert et al. 2010; Cuthbert and Saunders 2011, 2012, 2013). The reason for the shift away from most of these sites is unclear; however, nesting habitat at Cross Village, Waugoshance Point, and Sturgeon Bay in Emmett County has become increasingly vegetated making it largely unsuitable, though habitat restoration work at Wilderness State Park resulted in successful nesting in 2016 (Cuthbert and Saunders 2017).

Additional sites along the southern shore of Lake Superior traditionally utilized as nesting areas in the 1980s have experienced increased use by nesting piping plovers in recent years. During the years of 2009 – 2013 several unused sites in Chippewa, Iosco, Leelanau, Mackinac, and Mason counties have been reutilized. The change in range along the shorelines of Lakes Huron, Michigan and Superior appears to indicate there is no longer a distributional trend toward the Lake Michigan basin.

In relation to land use, there continues to be a growing trend towards plover use of public land. From 2009-2018, an average of 79% of nests have been located on publicly owned lands. In 2013, 35% of these nests were found at Sleeping Bear Dunes National Lakeshore in Benzie and Leelanau counties. The relatively high nesting density at Sleeping Bear Dunes may partly 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 Island. During 2005-2013, there was an average of 10 nesting pairs found on the island, which has since increased to an average of 15 nesting pairs during 2014-2018. 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*

There has been an average of 5 nesting pairs a year in Wisconsin since 2009 (Cuthbert and Roche 2009; Cuthbert et al. 2010, 2014; Cuthbert and Rutter 2015, 2016; Cuthbert and Saunders 2011, 2012, 2013, 2017, 2018). Surveys in 2011 and 2012 found a record high of six nesting pairs scattered across the Apostle Islands National Lakeshore, on public and private land. In 2012, one of the state’s 7 breeding pairs was found on Lake Michigan in Door County, but none of the chicks survived to fledge. Non-nesting plovers were reported at Seagull Bar in Marinette, Cat Islands in Green Bay, and Wisconsin Point. A nesting pair returned to Marinette in 2015, but was unable to fledge any chicks. In 2016, a pair of breeding plovers was observed nesting at Bad River Mouth, but no eggs were hatched. The Cat Island chain has been undergoing reconstruction efforts since 2012 (Cawdrey 2016). The restoration of lost habitat on the island chain has been successful in encouraging one pair of piping plovers to nest on the islands in 2016, four pairs in 2017 and three pairs in 2018 (Cuthbert and Rutter 2016, Cuthbert and Saunders 2017, 2018).

***Ontario***

From 2009- 2018, an average of 9 nesting pairs have been found on Lake Huron shoreline in Ontario, Canada. The nesting pairs were found on Sauble Beach, Wasaga Beach, Manitoulin Island, Port Elgin, Toronto Island, Darlington Provincial Park, Presqu'ile Provincial Park, South Limestone Island, and North Beach. Manitoulin Island and South Limestone Island are new sites, and were first used by piping plovers in 2009 and 2016, respectively. The nest found on Toronto Island in 2015 was the first nest observed at that location since 1934 (Cuthbert and Rutter 2015). All of the recent observations of nesting piping plovers in Ontario, Canada, indicate that these individuals are part of the Great Lakes population, as indicated by leg band combinations.

***Other Great Lakes states and provinces***

In 2009, a pair was found nesting at Illinois Beach State Park in Illinois. The pair laid four eggs, but shortly thereafter the nest was abandoned. Nesting piping plovers returned to Illinois in 2015, 2016 and 2018. One nesting pair laid four eggs and successfully fledged two chicks in 2015. In 2016, two pairs each laid four eggs; both pairs failed to fledge any chicks. In 2018 a pair laid 4 eggs in Waukegan, Illinois but did not fledge any chicks in the wild. Montario Point in New York had two pairs of nesting piping plovers in 2015 and one pair in 2016. All three pairs in NY laid four eggs, with only one chick surviving to fledge in 2015. In 2018 a pair fledged 4 chicks at Sandy Pond, New York. In 2017, two pairs of plovers had established nests within Presque Isle State Park, Pennsylvania. The first PA pair laid 3 eggs and was able to fledge 2 chicks. The second PA pair laid four eggs before abandoning the nest; the eggs were collected and two captive-reared chicks were released into the wild at Whitefish Point, MI. In 2018 one of the same pairs returned to Presque Isle State Park and fledged 4 chicks. Other than the nests in Illinois, New York, and Pennsylvania, 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, Minnesota Point in Minnesota, and Point Pelee and Long Point in Ontario.

### GL 2.3.2.6 Habitat or ecosystem conditions:

***Habitat changes***

Changes in the amount and suitability of breeding habitat in the Great Lakes have occurred since the 2003 recovery plan and 2009 five year review. From 2009-2013, the Great Lakes continued to experience a period of lower than average water levels. The U.S. Army Corps of Engineers (USACE)(Detroit District) reported a new record low water level for Lake Michigan-Huron for December 2012 and January 2013. The new record low of 576.02 feet was not only the lowest January monthly average water level ever recorded, but also the lowest monthly average ever recorded for any month over the official period of record for Great Lakes water levels, which extends back to 1918 (USACE, 2014). As of February 2014, Lake Superior's water was now only 2 inches below average (USACE, 2014). Following the period of low water, 2013 started a record setting rise in Great Lakes water levels over the next two years, with Lake Michigan-Huron rising 1.0 meter by 2015 (GLERL 2017). In 2017, water levels on all five Great Lakes were above average and Lake Michigan-Huron was only 0.5 meters (m) below the record high level (GLERL 2017). Levels continued to rise in 2018 with record water levels in all five Great Lakes (GLERL 2018).

The extended period of lower than average water levels in the Great Lakes from 2009-2013 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. Lake Superior had been at historic low water levels for a period of several years, in 2009 there was a combined total of two pairs at Vermillion and Whitefish Point two sites located along the Lake Superior shoreline in Chippewa County, MI. In 2012 there were 5 and in 2013 that number increased to 9 nests between the two sites (Cuthbert and Saunders 2012, 2013). However, 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 of this document). The period of rising water levels in the Great Lakes following 2013 resulted in habitat loss. High water levels reduce beach width and decrease the amount of available habitat along the shoreline (USFWS 2003). The number of pairs nesting at Vermillion and Whitefish had dropped down to 4 in 2014 and 2 in 2016 (Cuthbert et al. 2014, Cuthbert and Rutter 2016).

***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, the critical habitat currently used for nesting is located mostly in Michigan but also includes locations in Pennsylvania, New York and Wisconsin. 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 piping plovers occur in these areas during periods of migration; thus, this indicates the continued importance of these sites 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 2009 5-year review. Existing and new threats are discussed.

#### 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 of 2017, 13% of U.S. nests lie on private lands that are particularly vulnerable to development (Cuthbert and Saunders 2017). 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. These activities continue to threaten piping plover habitat to varying degrees. Development of occupied sites is controlled, in part, through the section 10 permit process under the ESA. However, 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.

A variety of beach maintenance practices (often simply referred to as "beach grooming") are regularly conducted on heavily developed beaches where the primary intent is residential and recreational use. Some of these have a practical motive and others are for aesthetic purposes. Beach grooming and stabilization with "snow-fencing" are examples of common beachside community practices which have the potential to negatively impact plover habitat. Without early season surveys, nests may go unnoticed and become lost due to beach grooming practices.

An example of beach maintenance was observed in 2013 in front of a housing development near Ludington, Michigan on a beach were plovers had nested the previous season. During an early season survey, a member of the University of Minnesota Piping Plover Research Team observed a potential pair near the location of the 2012 nest, but when the team returned to the area a week later, the beach had been groomed and they were unable to relocate the plovers.

Other instances of beach maintenance have occurred near plover nesting sites with varied effects on nesting. In some instances, cooperation has occurred in order to delay beach grooming until the end of the breeding season or else beach grooming has been moved to an area not used for nesting. Au Sable in Iosco county and Manistee, in Manistee county, MI are two sites in which cooperation between public and private agencies has led to successful outcomes. In Manistee,

MI, beach grooming has been kept to an area of the beach where plovers have not been seen nesting. The ungroomed area in Manistee has continued to support nests from 2009-2016. In Au Sable, MI, USFWS worked with locals to halt beach grooming and move the scheduled Fourth of July fireworks display in order to avoid disturbing piping plover chicks.
Loss of habitat due to pressure from development also occurs to a limited degree on federal lands, which supported approximately 75% of the breeding sites in 2017. Informal and formal consultations under section 7 of the ESA have been conducted at a number of sites throughout the Great Lakes basin. Recently completed or ongoing formal consultations include: navigational and shoreline stabilization projects with the USACE, Forest Management Plans with the U.S. Forest Service, and shoreline habitat restoration projects with the National Park Service. In 2013, USACE finished work on a break wall development in Grand Marais located near a frequently used nesting site. Other projects with federal jurisdiction subject to previous consultation include boat ramps and launches, and also hazardous waste remediation.

Disturbance in the form of recreational use 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 actions 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 have gone unused in recent years (Stucker et al. 2003; Stucker and Cuthbert 2004; Westbrock et al. 2005; Cuthbert and Roche 2006, 2007a *in* USFWS 2009a). These include several sites in northern Michigan, such as Wilderness State Park in Emmet County. As recently as 2001, Wilderness State Park supported 12 pairs, which represented over 35% of the entire Great Lakes population at that time. By 2010, there were no plovers nesting in the park. 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 cobbled 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 *in* USFWS 2009a). Thanks to vegetation removal efforts started in 2012, non-breeding plovers were observed near habitat restoration areas in 2015 (Cuthbert and Rutter 2015). The following year, a pair was discovered nesting at Waugoshance Point, Wilderness State Park, for the first time in 10 years and was able to successfully fledge 3 chicks (Cuthbert and Rutter, 2016).

The trend of extirpation from traditionally occupied sites seems to be occurring in several other nesting areas, such as Platte Point in Benzie county, Cross Village in Emmet county, Vermilion in Chippewa county, and Pointe Aux Chenes in Mackinac County. All of these locations have experienced extended periods of vegetation encroachment.

***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. The Nature Conservancy, the National Park Service, and the Manistee National Forest Service have conducted invasive species plant removal and control on some of their properties. Since 2006, the Rapid River district of the Hiawatha National Forest has undertaken efforts to reduce infestations of invasive plants in two locations at Indian Point: 1) in a two acre area of National Forest at the point itself, and 2) along a 1½ mile stretch of National Forest land between Indian Point and the Sturgeon River (J. Ekstrum, Wildlife Biologist, USFS, pers. comm., 2014). This type of management helps maintain the natural coastal ecosystem that plovers require for breeding. Also habitat improvement projects have begun at Wilderness State Park in Emmett County, MI (see above), Wisconsin Point, WI, and Cat Islands, WI. As early as 2012 and 2013, plovers have been observed utilizing the Wisconsin Point area as a migratory stop. Ongoing efforts to restore the barrier island chain at Cat Island have resulted in breeding plovers using the islands for nesting in 2016, and again in 2017 (Cawdrey 2016) Non-breeding plovers have also been observed in the Cat Island chain. Thanks to the recent breeding successes and improved habitat availability, it is likely that nesting plovers will continue to return to the islands in years to come (Cuthbert and Saunders 2017).

***Habitat protection through acquisition***

Habitat protection through acquisition has occurred in Michigan. In 2012, the Whitefish Point Unit of Seney National Wildlife Refuge (NWR) acquired an additional 20 acres, which included 1,000 feet of shoreline important for nesting piping plovers. The following year, the Nature Conservancy purchased a property in Grand Marais, that has been an active plover nesting site from 2009-2017.

***Summary***

Shoreline development which includes management activities such as beach grooming, continues as a leading cause of habitat destruction in the Great Lakes. Vegetation encroachment and rising water levels are additional factors effecting habitat availability. Habitat improvement and protection through acquisition has occurred, but not at rates which appear to offset the impacts.

### 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. In the 1985 listing rule, year-round shooting was identified as a factor that greatly reduced the numbers of piping plovers along the Atlantic Coast, causing the species to be nearly extirpated from some areas. Today, 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. From 2005 – 2017, 24 individuals 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. Of the 24 reported injuries, only 12 are thought to be related to leg bands, 4 are thought to be unrelated, and the remaining 8 reports are from unknown causes.

An investigation by Roche et al. (2010b) examined the potential deleterious effects of capturing and marking piping plover chicks with colored and metal leg bands during their first 24 days post-hatching. The study found no evidence of an adverse effect of bands, or banding-related disturbance, on survival of piping plover chicks prior to fledging. Further, their results showed an increase in daily survival rates during the 3 days following banding. The authors hypothesized that this was due to increased post-banding vigilance on the part of chicks and adults. Further research in this area is needed. A study by Hunt et al. (2013) also found that handling and banding have limited adverse impact.

In summary, with enforcement of ESA protections, any threats posed by commercial, recreational, scientific, or educational purposes remain low and unchanged from the 2003 recovery plan. Loss of the ESA protections under current population status could result in an increase in threats posed by these activities.

### GL 2.3.3.3 Factor C. Disease or predation:

***Disease***

While not discussed in the 1985 listing rule, the 2003 recovery plan describes the impacts of disease as insignificant. However, disease-related mortality events have occurred in the Great Lakes population since 2003. Beginning in 2007, outbreaks of Type-E botulism in the Great Lakes have caused extensive mortality in fish-eating species of waterbirds. An epidemiological analysis conducted at three sites on the Lake Michigan shoreline from 2010-2013 found an average of 2000 waterbird deaths a year, with 63% of the carcasses (n=102) testing positive for Type-E Botulism (Chipault et al. 2015). Type-E Botulism has resulted in at least 9 piping plover deaths from 2007-2017, and is suspected in two more. For a discussion of the toxin and possible routes of exposure to birds see GL 2.3.2.3 of the 2009 Piping Plover 5- year Review.

The 9 confirmed, and 2 suspected, piping plover Type-E Botulism deaths all occurred at Sleeping Bear Dunes National Lakeshore in Benzie and Leelanau counties, MI. The Sleeping Bear Dunes National Lakeshore is an area with a relatively high nesting density of piping plovers. Currently, attempts at controlling the spread of the disease focus on removing and disposing of carcasses found along the shoreline. Actions have also been taken at the Sleeping Bear Dunes National Lakeshore to secure the Type-E botulism antitoxin with local veterinarians, as close proximity of the antitoxin would allow for a rapid response if an outbreak were to occur.

Overall, disease continues to be a threat to the Great Lakes population, especially Type E Botulism; however, the threat level currently remains low. This could change rapidly, as disease outbreaks in the vicinity of high density piping plover breeding areas are increasing. Further research into the cycle of Type E botulism and its exposure to birds is needed.

***Predation***

Predation remains one of the most significant threats to the Great Lakes population, as discussed in the 2003 recovery plan and the 2009 Piping Plover 5-Year Review. A wide variety of predators are known to take piping plovers in the Great Lakes. The routine use of predator exclosures has reduced egg predation and increased hatching success substantially. Consistent use of exclosures and psychological fencing increased hatching success from 37% to 72% between 1984 and 1999 (Cuthbert and Wemmer 1999; Wemmer 2000 *in* USFWS 2003). Classen et al. (2014) found nest success to have increased even more, to 76%, by 2010. Nest exclosures are used at nearly 100% of nesting sites throughout the Great Lakes. However, there is still some concern regarding increased adult predation from predators “keying” in on exclosures.  In such cases, nests are heavily monitored to determine if exclosures should be removed. The use of ‘dummy’ exclosures has also been enacted at several nesting locations in an attempt to avoid predators associating exclosures with plovers.

Chicks and adults continue to remain vulnerable to a variety of terrestrial and avian predators (Melvin et al. 1992 *in* USFWS 2009a). 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. In 2017, 55% of all Great Lakes piping plover nests were found within the Lakeshore.  Presumably, an increase in the number of nesting pairs within the park and on the islands reflects, in part, the relative success of the predator control program (Cuthbert and Saunders 2017).

The number of piping plovers taken by merlins is of marked concern, as they are suspected to have killed 40 adult plovers since 2005 (Cuthbert and Saunders 2017; Saunders et al. 2018). Roche et al. (2010a) found annual mortality of adults associated with disappearances averaged 5.7% from 2002 to 2007, and that the disappearances were most frequently attributed to merlin predation. The authors mentioned the frequency of these events has increased dramatically since 2002, and currently accounts for approximately one fifth of annual adult mortality (Roche et al. 2010a). Since regional merlin abundance is likely to increase (Saunders et al. 2018), studies addressing merlin foraging ecology and the relationship between merlins and piping plovers should be examined.
In conclusion, predation remains a major threat to the Great Lakes population, particularly as a result of a recent increase in predation of piping plover adults by predatory birds.

#### 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, 2003 recovery plan, and 2009 5 Year Review. (See the discussion of Factor D in section 2.3.3.4 of USFWS 2009 5-Year Review.)

#### 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. An update on these threats (human-associated pet disturbance in nesting areas, wind power, oil spills, and climate change) is 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 *in* USFWS 2009a). 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. In 2011, in Schoolcraft County, MI, a piping plover chick was confirmed dead from an off-road vehicle on the beach. In another example, a breeding female was found dead in Leelanau County in 2017 from injuries suspected to have been caused by a domestic dog. The presence of dogs on beaches utilized by plovers can lead to nest abandonment, decreased foraging time, and mortality across all age classes. Dog feces has been found to contain high concentrations of microbes, which can alter the microbial community present in shoreline substrates. This can lead to an increase of disease and infection rates in piping plovers that forage in those areas. Since people enjoy traveling with their pets, the density of dogs on beaches is highest in the same areas that beach visitors are congregated. Thus, dog related concerns are of increasing importance in management strategies because the number of households with at least one pet dog is rising

(Rutter 2016). Human disruption, and therefore pet disruption, of piping plover nesting areas is likely to increase, as the shoreline of the Great Lakes is an increasingly popular vacation destination. For instance, Sleeping Bear Dunes Biologist S. Jennings reported that between fiscal years 2009 and 2018, park visitation has increased by 42%, concurrent with a 67% increase in the number of pairs nesting at Sleeping Bear Dunes. It is important to understand the impacts of increased recreational use on plover breeding success, and to ensure that appropriate management actions are in place that will help minimize the effects of anthropogenic disturbance in plover nesting areas.

There have been additional instances of threats to piping plovers due to recreational purposes since the 2009 Piping Plover 5-Year Review. In 2011, in Schoolcraft County, MI, a piping plover chick was confirmed dead from ATV use on the beach. Another incident occurred in 2013 in Iosco County, MI, when piping plover eggs went missing from an exclosure. Human footprints leading to the exclosure, as well as apparent human manipulation of the exclosure, suggest the eggs were taken by a beachgoer. In 2017 an exclosure was destroyed at Silver Lake State Park and signs were taken down, however this occurred post fledging. Multiple Great Lakes communities have fireworks shows that bring many recreationists to piping plover nesting beaches at a critical time in the plover nesting cycle, which has potentially lead to the loss of plover chicks.

***Wind power***

Increasing demand for alternative energy sources is likely to increase the number of wind energy developments in and around the Great Lakes. 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. In some cases wind energy developers have limited wind energy development within 3 miles of the Great Lakes. In 2009, the USFWS, a coalition of eight states, the Conservation Fund, and representatives of the wind energy industry began preparing a Multi-Species Habitat Conservation Plan (MSHCP). The aim of the MSHCP is to avoid and reduce impacts of wind turbine facilities by thoughtful siting, design, research, and mitigation (USFWS 2018). If the MSHCP is adopted, close monitoring, and planning may make it possible to limit negative impacts on the Great Lakes piping plover as the demand for wind power increases.

***Oil spills***

Oil drilling continues to be a major activity along the wintering grounds of the piping plover, posing a continued potential threat. Protective measures and contingency plans should be in place and followed in order to minimize the negative impacts of oil spills on the Great Lakes piping plover and its habitat. There remains limited oil drilling in the Great Lakes region however threats association with pipeline rupture and transportation are present but at unknown levels. See section WM 2.2.2.5.3 for additional discussion of oil spills and potential impacts on piping plovers on the wintering grounds.

***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 approximately 2° F per decade since 1980 (Austin and Colman 2007 *in* USFWS 2009a). 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 *in* USFWS 2009a). Despite projected increases in precipitation, increased air temperatures and reduced ice cover are were originally expected to result in lake level decreases of 1.5 to as much as 8 feet. Recent projections suggest a slight decrease or even a small rise in levels (IUGLSB 2012). Other model-based projections for lake level changes show relatively small trends with high variability (Wuebbles et al. 2019).

Expected changes due to climate change could have both positive and negative effects on piping plovers and their habitats in the Great Lakes region. Reductions in lake levels could potentially increase the amount of available habitat by increasing the width and length of open beach. 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. If the long-term trend is for increasing water levels, direct loss of shoreline habitat is likely. 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.

Climate change studies indicate a trend toward increasing numbers and intensity of storm events such as hurricanes (Emanuel 2005, Webster et al. 2005 *in* USFWS 2012). Saunders et al. (2014) stated one cause of declining adult survival in the Great Lakes Piping Plover from 1993 – 2012 was increased hurricane activity on the southeast U.S. Atlantic coast where Great Lakes piping plovers winter. Severe storm events may erode piping plover habitat in certain locations while creating new habitat in other place, thus having variable effects on the population. Overall, the magnitude of the threats from 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 of this document); new information about demographic characteristics, genetics, distribution, and habitat conditions (section GL 2.3.2 of this document); and analysis of listing factors and relevant conservation measures (section GL 2.3.3 of this document) were all considered in this review. Other pertinent considerations include analysis of threats facing Great Lakes piping plovers in their coastal migration and wintering range (section WM 2.2.2 of this document).

The population has shown significant growth, from approximately 17 pairs at the time of listing in 1986 to 76 pairs in 2017. The total of 76 breeding pairs represents just over 50% of the current recovery goal of 150 breeding pairs for the Great Lakes population. As a result of intensive management the productivity goals specified in the 2003 recovery plan have been met over the past five years. During this period, the average annual fledging rate has been 1.7, well above the 1.5 fledglings per breeding pair recovery goal. However, recent analyses of banded piping plovers in the Great Lakes suggest that after-hatch year survival (adult) rates may be declining (Saunders et al. 2014, Saunders et al. 2018). 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.

The increase from 55 pairs in 2011 to 76 pairs in 2017 is 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. The drop to 67 pairs in in 2018 is proof that the population remains vulnerable. 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 non-governmental 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 document, habitat degradation and increasing human disturbance are particularly significant threats to nonbreeding piping plovers. Progress towards understanding and managing threats in this portion of the range has accelerated in recent years, especially with the development of the 2012 Winter CCS. However, substantial work remains to fully 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, oil spills, an increasing predator threat from a rise in merlin numbers and, potentially, climate change. Outbreaks of Type E botulism in the northern Lake Michigan basin have resulted in 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 specific protections and continued monitoring to prevent or mitigate impacts. Climate-change is projected to cause accelerated sea level rise, more frequent intense storms and severe cold events. The degree to which climate change will affect piping plover habitat is unknown; however, several of components of climate predictions are likely to alter habitat conditions and distribution, and severe cold events could negatively impact survival rates.

We conclude that the Great Lakes piping plover remains in danger of extinction throughout its range, and is therefore properly classified as endangered under the ESA. Although more than 30 years of intensive recovery efforts have reduced near-term extinction risks, the population remains susceptible to extinction (i.e., 12% quasi-extinction [defined as ≤ 15 breeding pairs] probability within the next 10 years; Saunders et al. 2018) 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 funding assurances are needed to ensure long-term conservation of habitat and continuation of intensive annual management activities. 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?

The 1988 Great Lakes and Northern Great Plains Piping Plover final recovery plan contains recovery criteria that measures progress towards recovery but all criteria are not objective or measurable. In 2016, the Service published draft criteria in the "Draft Revised Recovery Plan for the Northern Great Plains Piping Plover (*Charadrius melodus*)" (USFWS 2016) and is currently in the process of revising the recovery plan and the associated recovery criteria. The revised recovery plan will contain objective, measurable criteria.

#### NGP 2.4.1.2 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?***

The recovery criteria in the 1988 recovery plan does not reflect best available information. The revised recovery criteria currently being drafted will reflect best available information on the biology of the species and its habitat.

***Are all of the 5 relevant listing factors addressed in the recovery criteria?***

No, the threats associated with the factors identified in the 1988 plan need to be updated and will be addressed in the revised recovery criteria. Energy development on the breeding grounds, loss of habitat due to invasive species, and climate change were not addressed in the 1988 plan.

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

**Recovery Criterion A in the 1988 plan.** Number of birds in the Northern Great Plains states will increase to 1,300 pairs.

**Recovery Criterion C in the 1988 plan.** The Canadian Recovery Objective of 2,500 birds for the prairie region will be attained.

**Recovery Criterion D in the 1988 plan.** 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).

Despite the significant level of effort invested in breeding surveys for many years, there remains no reliable means to estimate the current range-wide abundance or population trends over time of the Northern Great Plains (NGP) population. As a result, we cannot determine whether the recovery criterion have been met. The lack of an integrated and standardized surveillance and monitoring program to account for multiple scales has resulted in data that cannot be readily scaled to the metapopulation level. Thus, inference of the annualized status and trend of the habitat or plover breeding population over time and space has not been possible. While it is plausible that the various monitoring efforts could be linked under an overarching framework, there are no means currently available to estimate the overall trends in abundance or population performance over time of piping plovers in the NGPs. Section NGP 2.4.2 of this document provides additional details on this issue.

### NGP 2.4.2 Biology and habitat

#### NGP 2.4.2.1 New information on the species' biology and life history:

***Nest site fidelity***

Fidelity to natal rearing habitat for first-year breeding adults is comparatively high, with reported natal-site fidelity as high as 50 percent (Cohen and Gratto-Trevor 2011, Anteau 2018).

***Nest pair density, fecundity and recruitment***

Typically, high habitat quality leads to higher nest density and overall success compared to when habitat conditions are poor (Kruse et al. 2002, Muir and Colwell 2010). However, at times high nest density can trigger intra-specific competition that can decrease overall fecundity which could lead to demographic consequences (Ryan 2004, Catlin et al. 2019, Anteau et al. 2014).

***Survival and reproduction***

Numerous efforts have been untaken to estimate the productivity and survival of piping plovers breeding in the NGP. The findings of these studies are summarized in Table NGP1.

### NGP 2.4.2.2 Abundance, population trends, and demography:

***Current distribution***

With the exception of a few individuals (33 plovers reported in the 2006 International Census) that breed in Colorado, Iowa, Kansas and Minnesota (Elliott-Smith et al. 2009), the key NGP piping plover breeding habitat occurs in Montana, North and South Dakota, and Nebraska (Figure NGP1). There are four local populations within the NGP (Figure NGP2). The observed spatial and behavioral aspects of each local population conform reasonably well to the general criteria of a metapopulation described by Hanski (1999): discrete geographic distributions of local populations; the presence of ecological processes occurring at two scales (local and metapopulation scales); and the breeding habitat within each discrete area is sufficiently large and stable to enable the local populations to persist for multiple generations. We thus, hereafter, collectively refer to the local populations as a metapopulation. For the purposes of recovery planning, one management region for each local population was established as follows:

- Northern Rivers Management Region (NRMR: Missouri River system on Fort Peck Lake, Montana to Pierre, South Dakota);
- Alkali Lakes Management Region (ALMR in North Dakota and Montana);
- Southern Rivers Management Region (SRMR: Missouri River system from Fort Randall Dam, South Dakota to Ponca, Nebraska, the Niobrara River, the Loup River system and the Platte River system in Nebraska); and
- Prairie Canada Management Region (PCMR; all river, reservoir and wetland habitats in Prairie Canada)

**Table NGP1.** Summary of the vital rates associated with breeding piping plovers in the Northern Great Plains.

| | **SURVIVAL**[1] | |
|---|---|---|
| | Estimate | Citation |
| Adult | 0.76-0.82, (SE = 0.08 – 0.22) | Catlin 2009, p. 67-70 |
| | 0.73, SE = 0.09 | Larson et al 2000, p. 725 |
| | 0.69-0.81, CI = 0.62-0.87 (Canadian Provinces)<br>0.80, CI = 0.74-0.84 (Northern Rivers) | Roche et al 2010, p. 1788 |
| | 0.80, SE = 0.03 | Cohen and Gratto-Trevor 2011, p. 385 |
| | 0.78, SE = 0.03 | McGowan et al. 2014, p. 222 |
| | 0.76 – 0.98, SE ± 0.02 – 0.05 [2] | Hunt et al. 2018, p. 156-157 |
| | 0.60 – 0.84, CI: age and sex dependent | Weithman et al. 2017, p. 11050 |
| Juvenile | 0.32, SE = 0.08 | Larson et al 2000, p. 725 |

| | | |
|---|---|---|
| | 0.57, SE = 0.05 | Cohen and Gratto-Trevor 2011, p. 385 |
| | 0.52, SE = 0.12 | McGowan et al. 2014, p. 222 |
| | 0.15 – 0.70, SE ± 0.02 - 0.05 [3] | Hunt et al. 2018, p. 156-157 |
| | 0.06 – 0.49, SE ± 0.02 – 0.04[4] | |
| | 0.21 – 0.71, SE ± 0.02 – 0.07[5] | |
| | **REPRODUCTION** | |
| # fledged chicks per pair | 0.27 – 0.96, CI = 0.05 -1.77[6]<br>0.32 – 1.12, CI = 0.06 – 2.06[7] | Shaffer et al 2013, p. 43 (data pooled) |
| # female fledglings per pair | 0.60, SE = 0.47 | McGowan et al. 2014, p. 222 |
| | 0.77, SE = 0.24 | D. Catlin, unpublished data derived usin methods published by Noon and Sauer 1992, as reported in McGowan et al. 201 222) |
| | 0.52, SE = 0.40 | Unpublished data of C. Gratto-Trevor; reported in McGowan and Ryan 2009, p. 222 |

[1]Adult and sub-adult survival estimates derived from the Northern Great Plains breeding areas are reported here without respect to the recovery region where data were collected.
[2]True survival, after hatch-year (adults)
[3]Apparent prefledging chick survival
[4]True survival, hatch-year (juveniles)
[5]Postfledging survival (juveniles)
[6]Assumes a low-renesting rate.
[7]Assumes a high-renesting rate.

The management regions as described above represent the scale at which local breeding populations of the species have been recorded and studied (Catlin 2009, McGowan et al. 2014, Catlin et al. 2015, Catlin et al. 2016). While breeding piping plovers in the NGP clearly have spatial separation from each other (Figure NGP1), connectivity and exchange of breeding adults transitioning between breeding areas has been well documented (Licht 2001, U.S. Geological Survey unpublished data, Anteau 2018).

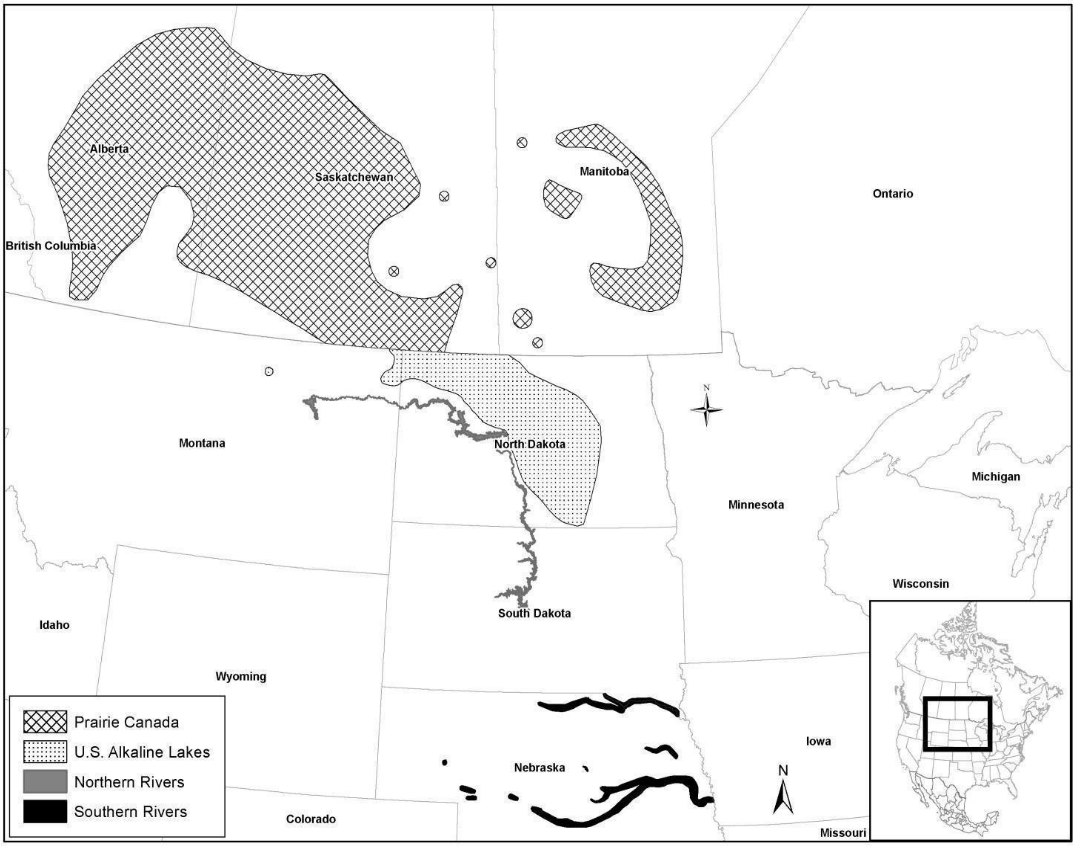


**Figure NGP1.** Map depicting the four primary geographical management regions encompassing the local breeding populations of the NGP piping plover metapopulation.

Preliminary analyses of data from a study initiated in 2012 (Anteau 2018) suggest the rate of dispersal among breeding areas has high inter-annual variability for known breeding adults, but overtime has averaged 14 percent. Marked first year breeding plovers dispersed from their natal breeding habitat at an average rate of 50 percent among metapopulations in the NGP (Anteau 2018). In some instances, piping plovers have dispersed considerable distances from their natal habitat to breed.

***Current status of populations***

At the time of listing, the NGP breeding metapopulation was estimated to be approximately 1,439 pairs (50 FR 50726:50727 [December 11, 1985]). Most of the NGP metapopulation (868 pairs; 60 percent) occurred in Canada at the time of listing. The breeding population within the U. S. (571 pairs) was distributed in six states (Iowa, Minnesota, Montana, Nebraska, North Dakota, and South Dakota), but most occurred in Nebraska and North Dakota (487 pairs; 85 percent) in 1985 (50 FR 50726:50727 [December 11, 1985]).

The breeding conditions and overall fecundity of the NGP piping plover breeding metapopulation has substantial inter-annual variation, making trend tracking difficult. In addition, the breeding areas occur in a patchy array of habitats, widely dispersed in rural landscapes, especially in the alkaline lakes regions of the United States (U.S.) and Canadian provinces. These conditions at a large geographic scale contribute to surveying difficulties and increased uncertainty in trend estimation. Given these inherent complexities, monitoring and surveying efforts at the scale of the metapopulation have generally proven to be unreliable over time. Nonetheless, below we describe the scope and limitations of the metapopulation survey efforts to enumerate breeding plovers over time.

The International Piping Plover Census (Census) is the only monitoring effort in the NGP at the scale of the metapopulation. The Census began in 1991 and implemented a comprehensive, range-wide survey every five years. During a two-week window, surveyors attempted to visit every known breeding area as well as to search for new breeding areas. The relatively short survey window was designed to minimize error associated with double counting.

This ambitious survey has yielded important information on new locations of breeding adults within each local population (K. Brennan 2018), likely a result of the strong support and participation (Elliot-Smith 2009). However, researchers and managers have learned to be cautious in drawing inferences from Census estimates of abundance over time due to data limitations.

For example, Figure NGP2 depicts the number of adult plovers in the NGP (U.S. and Canada) recorded during the five International Census periods since 1991 (the 2016 census data have not yet been published). Based on the survey results in 2011, the overall abundance of the NGP metapopulation decreased by 50 percent since 2006. However, the apparent reduction in abundance was likely due to a decrease in the detection rates caused by widespread flooding in the Missouri River basin in 2011. The precipitation and spring runoff were near historic highs in 2011, causing breeding plovers to widely disperse. The high precipitation also caused searcher efficiency to decline (limited access and flooded nesting habitat).

Thus, 2011 results more likely reflect a decline in observer detection rates, rather than a decline in abundance. In this instance, the Census methodology may not be sufficiently robust in design to accommodate such a shift in detection rates. Given that the Census methodology assumes the same detection rates between years, we conclude abundance estimates from Census data for the NGP metapopulation are not credible in all years for tracking abundance over time. However, some inference is useful for context.

The Census data for the period 1991-2011 suggest a highly variable trend subject to stochastic risks (Figure NGP2). The estimated metapopulation abundance of over 4,500 adult plovers (ca. 2,250 pairs) in 2006, however, represents an increase of approximately 40 percent when compared to the abundance estimates of 3,000 to 3,500 adults for the period 1991 to 2001 (and an increase of approximately 60 percent from the 1985 estimate of 1,439 pairs at the time of listing; 50 FR 50726:50727 [December 11, 1985]).

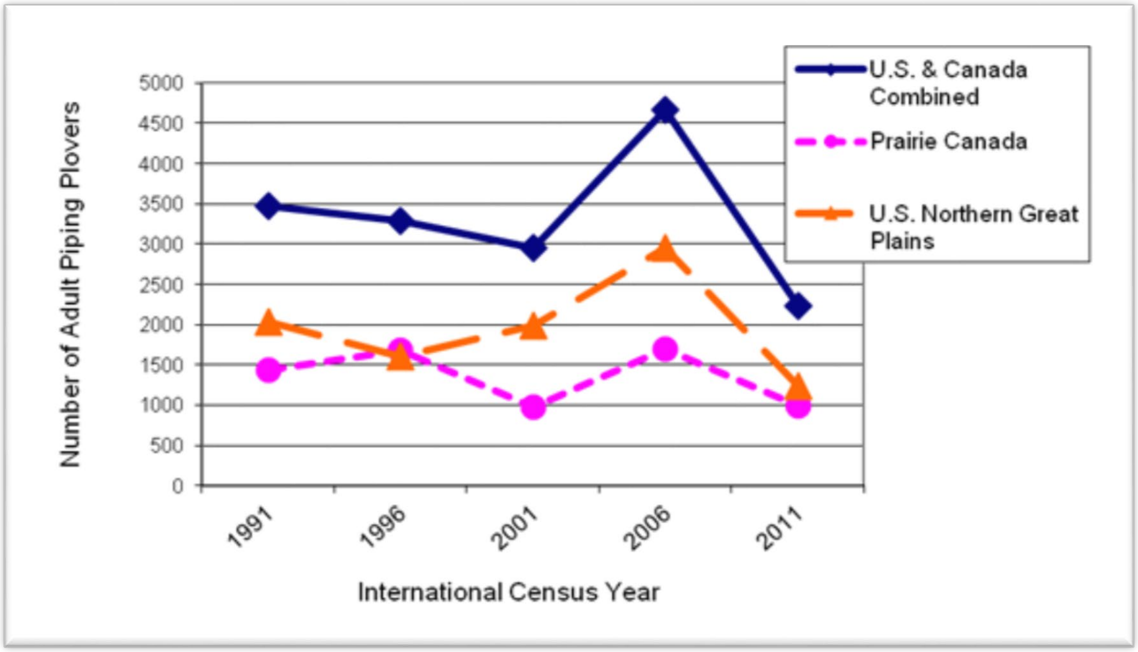


**Figure NGP2.** The number of adult piping plovers reported from the International Piping Plover Census for Canada and the United States from 1991–2011. Unpublished data

Although the Census is the only international standardized approach aimed at estimating abundance at the metapopulation scale, there are many independent but more localized monitoring efforts undertaken each year by governmental agencies and research entities in the United States. Survey results compiled from 1993-2013 annual reports were paired with Census data only from Prairie Canada (1996, 2001, 2006, and 2011) from the same period to provide an overall estimate of abundance for the entire NGP breeding range (Figure NGP3).

Abundance estimates exclusively from the Census data (Figure NGP3) and those from combined data sets (Figure NGP3) compare favorably. These data suggest the NGP metapopulation abundance has varied considerably, between a low of approximately 2,000 individuals (2011) to a high of 4,500 individuals (2004 – 2008). The estimated arithmetic mean of the abundance during the period has been approximately 3,086 individuals[2].

[2] The arithmetic mean was calculated using Census data from Prairie Canada and US data for 1991, 1996, 2001, 2006, and 2011.

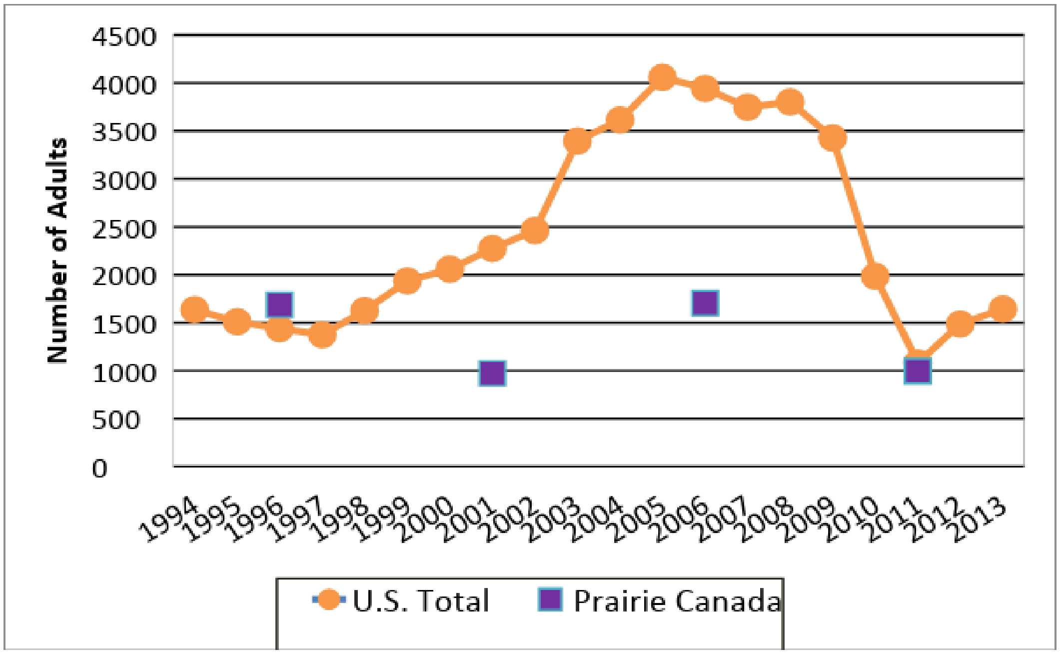


**Figure NGP3.** The number of adult piping plovers reported in the Northern Great Plains from the International Piping Plover Census for Prairie Canada (1996, 2001, 2006, and 2011) and from annual surveys conducted in each management region in the United States, (1993–2013; USACE 2014).

***Local population trends***

*Northern Rivers Management Region (NRMR)*

The USACE has implemented an annual census and monitoring program for piping plovers adults, nest fate, and fledging success in the NRMR since the early-1990s (on the Missouri River from Lake Sakakawea, North Dakota to Lake Oahe, South Dakota). Figure NGP5 depicts the annual number of adult-aged plovers encountered in breeding habitat for the last 24-years (1993-2017) within the NRMR (USACE 2018). Also included in Figure NGP4 is the calculated 3-yr running arithmetic mean of the number of adult plovers observed in breeding habitat. The running 3-yr mean is presented here to incorporate the average number of adults for each generation (assumes a 3-year generation time) which may be more informative when assessing the resilience of the NRMR.

A recent review by Shaffer et al. (2013) to assess the accuracy of the Missouri River census results found that the detection rates of piping plovers were generally low which led to underestimating plover abundance (Shaffer et al. 2013). The study included two riverine segments (Garrison Dam to Bismarck, North Dakota in the NRMA and Gavins Point Dam to Sioux City, Iowa in the SRMA) and one reservoir (Lake Sakakawea, North Dakota in the NRMA). The authors expected the USACE estimates to be lower than the study results because of differing survey methods - the USACE survey methods have longer search intervals and are initiated later in the breeding season (Shaffer et al. 2013). Thus, the estimates in Figure NGP4 under-estimate the actual population size. We are not aware of any effort to approximate the detection probability of the species so we are unable to estimate actual abundance.

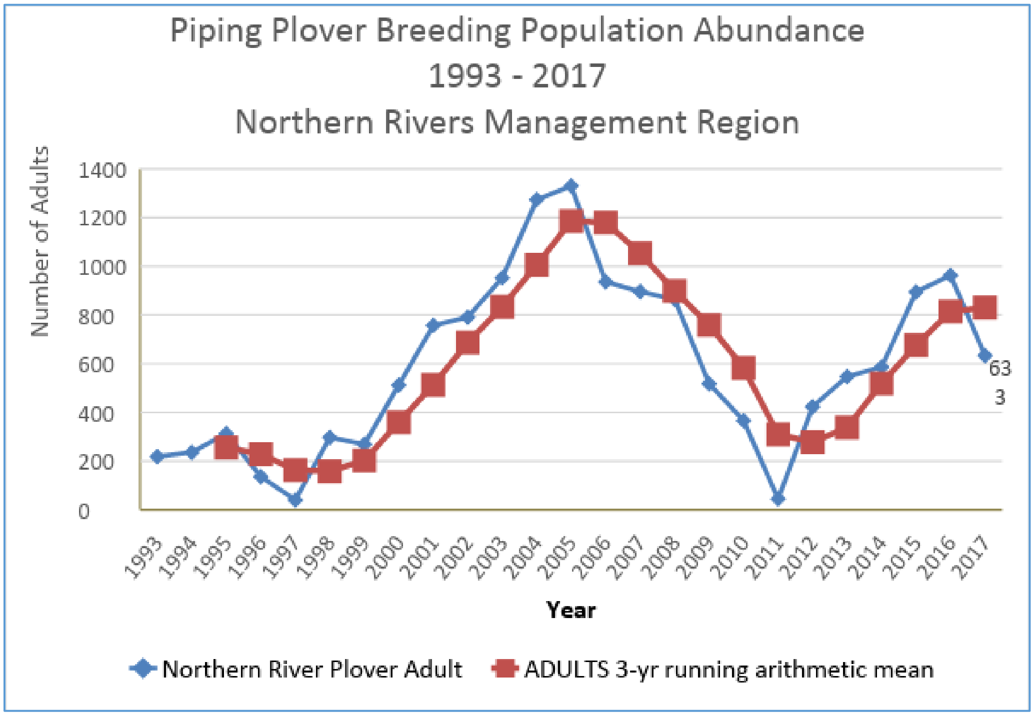


**Figure NGP4.** The annual abundance and 3-year running arithmetic mean of the annual abundance for piping plover breeding adults in breeding habitat from 1993 to 2017 within the Northern Rivers Management Region (USACE 2018).

*Alkali Lakes Management Region (ALMR)*

Monitoring of breeding piping plover abundance has been ongoing on private and public land in the ALMR (Figure NGP5) since 2000 under a collaborated effort between the Service and The Nature Conservancy (K. Brennan 2018). The purpose and scope of this annual effort (during June) is to provide abundance estimates for adult piping plovers and nests; and provide an estimate of fledging rates from brood monitoring. Nest and fledging success is routinely enhanced through the placement of nest exclosures to reduce predation rates (K. Brennan 2018). The mean number of adult plovers encountered during breeding surveys in the ALMR since the species was listed in 1988 is ca. 746 individuals and has varied from a low of 446 (1989) to a high of 1,216 (1999). The overall average is approximately 750 (Figure NGP6).

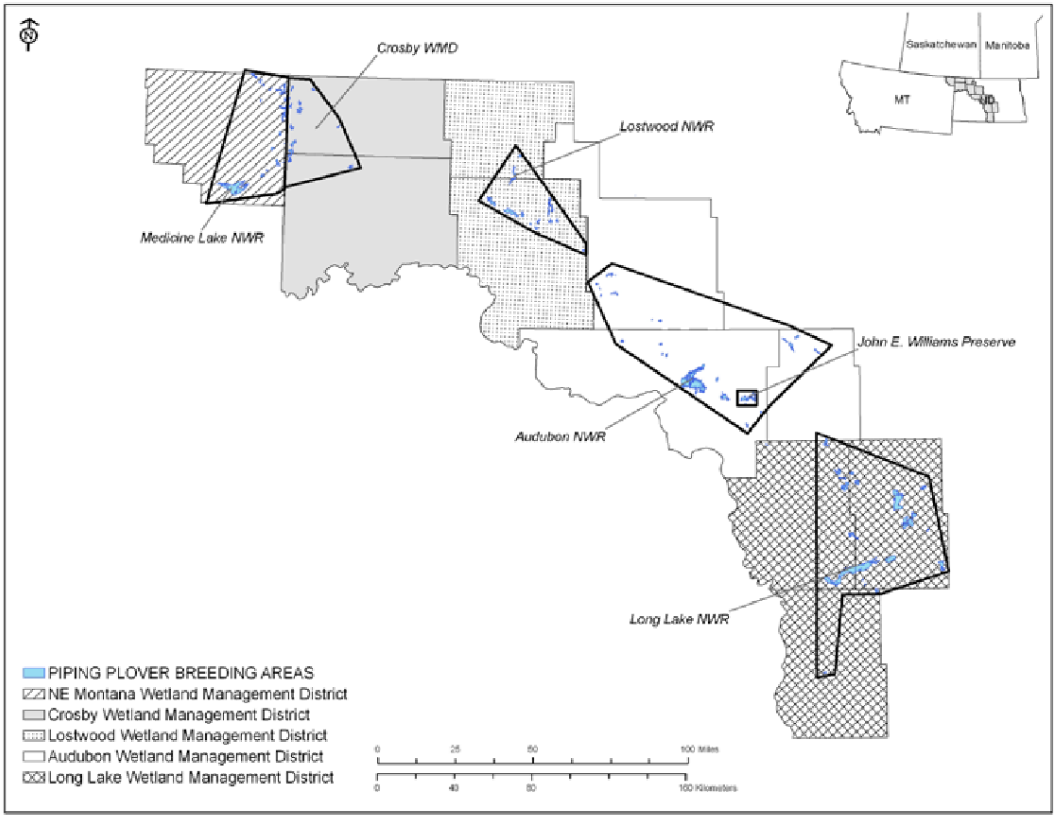


**Figure NGP5**. The U.S. Alkali Lakes Core Area of the Northern Great Plains: sites annually surveyed for piping plover adults, nesting, fledging and band resighting.

When comparing the change over time (1994-2013) of the abundance estimates from the ALMR (as a proportion of the total US abundance), the results suggest the abundance of adults in the ALMR has been somewhat more stable than in other management regions (Figure NGP6). The ALMR represents more than half of the total NGP population during periods when the total NGP abundance is below 1,500 (except in 2012; Figure NGP6).

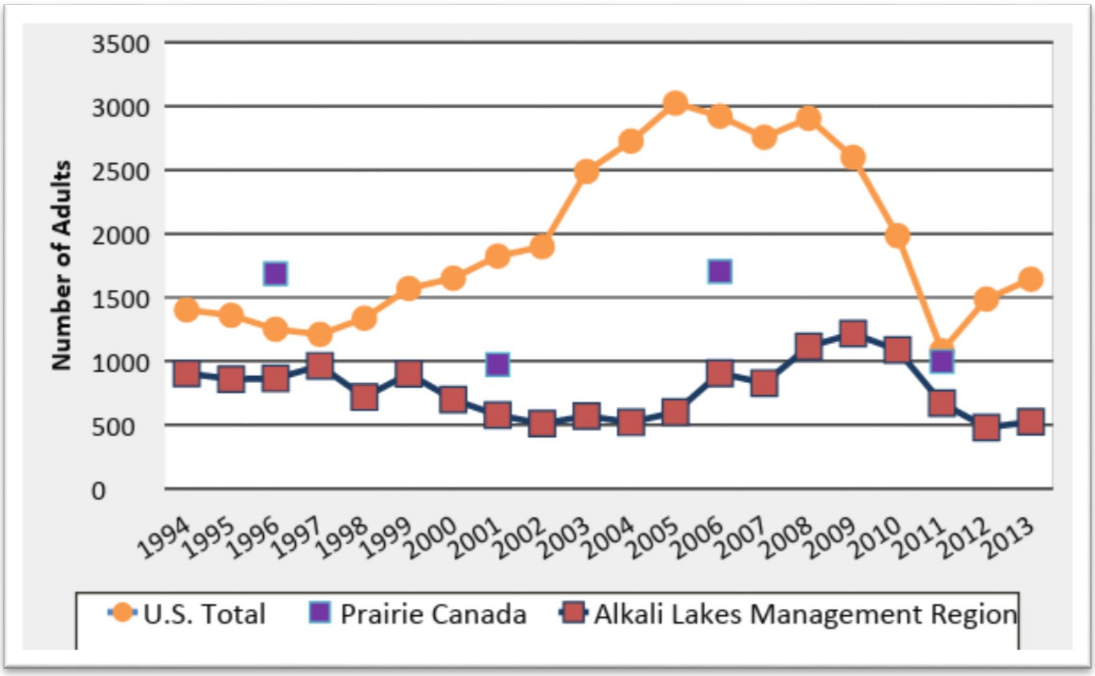


**Figure NGP6.** The estimated abundance of piping plover adults counted during the annual June breeding census within ALMR compared to Prairie Canada[3] and compared to the total estimated abundance summed from all the management regions in the U. S. from 1994–2013.[4]

*Southern Rivers Management Region (SRMR)*

The SRMR is entirely encompassed within the State of Nebraska or within states bordering Nebraska along the Missouri River. Through the collaboration with federal, state, private, and environmental non-governmental organizations, annual monitoring of breeding plovers is conducted in the SRMR with a general focus on the number and location of adults, chicks, and nests and, in some cases, the fate of nests. Piping plover surveys occur annually during the breeding season in the following river systems: 1) the Niobrara, Loup, and Platte Rivers; 2) Lake McConaughy in the North Platte River basin; 3) off-river sites throughout Nebraska; and 4) Missouri River segments within the SRMR (Figure NGP7). Missouri River segments located

[3] Managers in Canada rely on the International Census every 5 years as the only means of estimating abundance.

[4] Annual monitoring by the Service is being curtailed in favor of providing logistical support for a large-scale metapopulation study. By 2019, the Service anticipates discontinuing all piping plover monitoring activities on private lands. Monitoring on public lands will vary depending on the station, staffing levels, and management activities (K. Brennan, *in litt.* 2018).

within the SRMR include Gavins Point, Lewis and Clark, and Fort Randall Reach.

Since 2003, surveys on the Niobrara River have been conducted annually by NPS within the designated Niobrara National Scenic River boundary (NNSR). Surveys are scheduled at the onset of the breeding season to assess potential nesting habitat, locate nesting colonies in the early stages of nesting, and record numbers of adult plovers. Subsequent surveys emphasize documenting nest fate and counting chicks and fledglings (Warrick and Whiting 2017). NPS also monitors the Niobrara River downstream of Spencer Dam including a river segment within the designated Missouri National Recreational River boundary (MNRR). Data collection is similar to the NNSR. There is yet another monitoring effort conducted in the middle reaches of the Niobrara River by the Nebraska Public Power District (NPPD) from the NNSR boundary downstream to Spencer Dam. NPPD surveys have traditionally been conducted once in June and July. Surveys consist of recording colony locations and number of adults, nests, and chicks (Jenniges 2016).

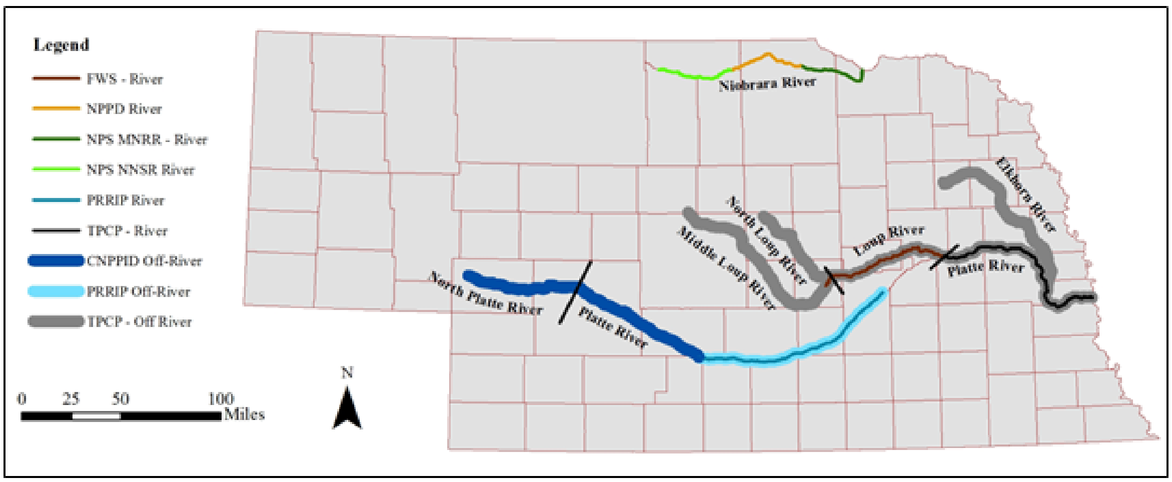


**Figure NGP7**. Map depicting the annual monitoring locations and monitoring entities of piping plovers during the breeding season in Nebraska (USFWS: U. S. Fish and Wildlife Service; NPPD: Nebraska Public Power District; NPS: National Park Service; PRRIP: Platte River Recovery Implementation Program; TPCP: Tern and Plover Conservation Partnership; CNPPID: and Central Nebraska Public Power and Irrigation District).

At Lake McConaughy, (Keith County, NE) piping plover nest surveys and monitoring are conducted by the Central Nebraska Public Power and Irrigation District (Central). Since 1992, Central has assessed nest fate and worked to minimize nest and chick loss due to the effects of operations at Lake McConaughy. Central personnel begin annual searches on approximately 20 April. Nest locations and the distance to the nearest vegetation and water are recorded (Zorn and Wilson 2017). Each nest is revisited at least twice weekly to determine if and when nests may need to be moved due to the rising waters from operational impacts at Lake McConaughy. In addition to monitoring at Lake McConaughy, Central manages and monitors three off-river nesting habitat areas in Platte River basin and has opportunistically surveyed the South Platte River in 2016 (Zorn and Wilson 2016, 2017).

From 1992 to 2006, NPPD surveyed the Platte River from Columbus, NE to Lexington. Surveys were conducted by airboat and completed in mid-June. In addition, from 1992-2017, NPPD managed six nesting sites, three of which were outside the channel of the river. Monitoring at these sites was conducted at least twice weekly (Jenniges 2017).

The Platte River Recovery Implementation Program (PRRIP) was initiated on 1 January, 2007 as a result of a cooperative agreement negotiating process that started in 1997 between the states of Colorado, Wyoming, and Nebraska; the U.S. Department of the Interior (DOI); water users; and conservation groups. The PRRIP monitoring focuses on: 1) piping plover use and productivity on midstream-river sandbars and sand and gravel mines; and 2) document habitat characteristics that are believed to influence nest site selection and nest and brood success along the central Platte River between Lexington and Chapman, Nebraska (Baasch and Keldsen 2017). The PRRIP conducts research on the central Platte to:

> 1) quantify dispersal of adults between units of nesting habitat on the central Platte River among years;
> 2) quantify colonization rate of newly constructed or managed nesting habitat by local versus immigrant adults; and
> 3) quantify frequency and location of renesting attempts by adults with failed nests (Baasch and Keldsen 2017).

The Tern and Plover Conservation Partnership (TPCP; University of Nebraska-Lincoln School of Natural Resources and Nebraska Game and Parks Commission), works with cooperators on piping plover monitoring, research, management, and outreach activities in Nebraska at off-river sites in the Elkhorn, Loup, and lower segment of the Platte River basin (lower Platte River; Brown et al. 2017). The TPCP, with assistance from the Service, surveys selected river segments within the lower Platte River. Survey reports summarize the location of colonies and number of nests and chicks.

The Service conducts surveys annually on the Loup River and a limited segment of the Middle Loup River (USFWS 2017). Surveys have been conducted by the Service from 2010 to present while NPPD conducted a single survey in 2009. Survey reports summarize the location of colonies and number of adults, nests, and chicks.

*Summary of trends and occurrence within the SRMR*

The 2016 International Piping Plover Census was the last coordinated effort to assess the piping plover status and trends within the SRMR. Current survey efforts focus on piping plover status and trends within river basins or sub-river basins to support local goals, objectives, and decision making such as those defined by the PRRIP or the Missouri River Recovery Program. The types of data collected and the frequency of data collected by organizations also vary based on available resources to conduct surveys. The differences in data collected by organizations limit the Service's ability to uniformly assess status and trends within the SRMR.

A number of agencies/organizations provide a summary of annual piping plover occurrence; however, indicators of occurrence vary by organization. For example, the MNRR, NNSR, and USACE provided annual summaries of use while the USFWS and NPPD reported information on the maximum number of individuals observed during surveys. In some cases, historically reported data were transformed to estimate species abundance. Specifically, data estimating the number of pairs (e.g., CNPPID and PRRIP) or number of nests (e.g., TPCP) were multiplied by two and then combined to estimate total number of individuals observed within a nesting season within the SRMR.

These data where then summarized in terms of annual species occurrence (i.e., number of individuals) in the SRMR from 2008 through 2017 (Figure NGP8). Species occurrence was not calculated prior to 2008 because of limited data availability and/or inconsistency in data collected. Prior to 2007, monitoring in the central Platte River was conducted by several organizations. The establishment of the PRRIP in 2007 facilitated an organized level of survey at river and off-river sites in the central Platte River.

Additionally, uniform reporting by the TPCP for river and off-river sites in the lower Platte River (and adjacent tributaries) started in 2008 and has continued through 2017. Since 2008, the number of sites surveyed in the lower Platte River also increased. Since 1995, there was an inconsistent survey effort in the Loup River until surveys were reinitiated in 2009 which continued through 201 (FERC 2016) (Brown et al. 2017). Because of the above considerations, 2008 represented an appropriate starting point for evaluating trends in species occurrence within the SRMR. We acknowledge that species occurrence displayed in Figure NGP8 uses data that is not standardized (see previous paragraph), and thus, there is an undefined level of uncertainty in species occurrence estimates.

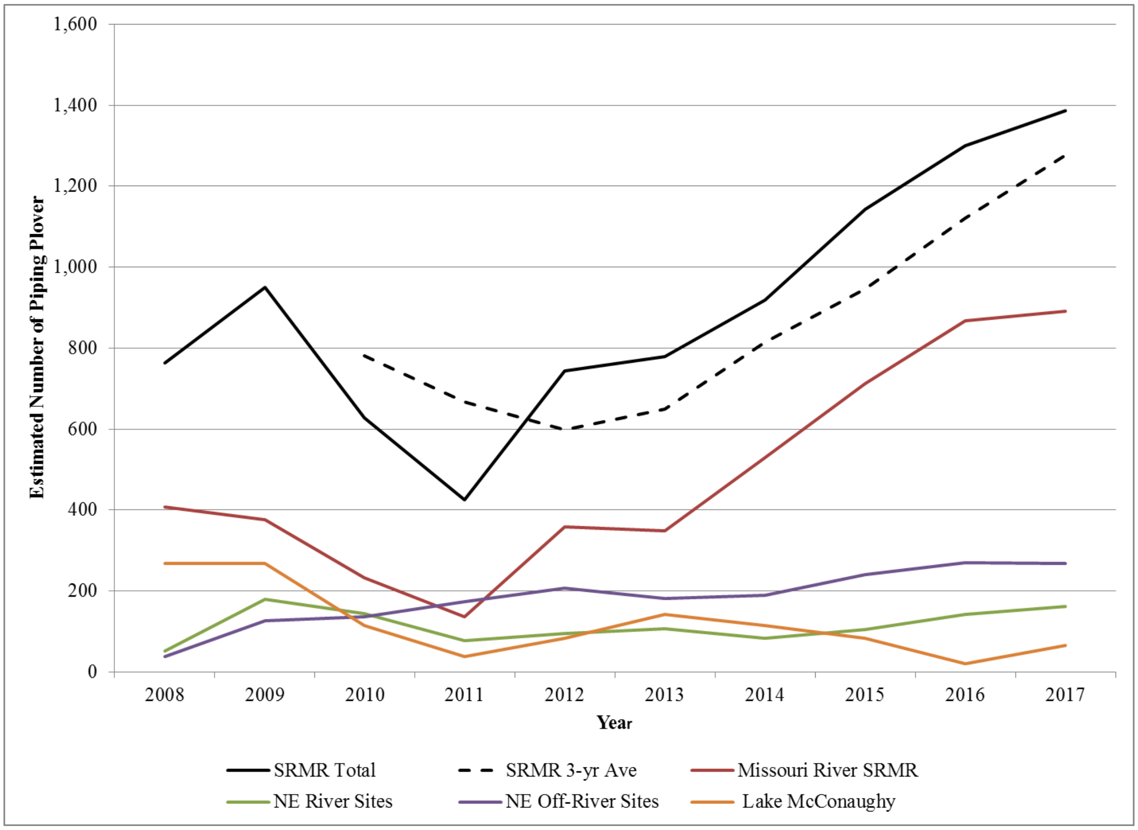


**Figure NGP8**. Estimated piping plover occurrence within the SRMR and three-year moving average for species occurrence. Species occurrence is also subdivided by occurrence within: 1) Nebraska rivers, 2) off-river sites, 3) Lake McConaughy, and 4) segments of Missouri River within the SRMR.

***Conclusions of plover population monitoring in the breeding range***

At the time of listing, the NGP breeding metapopulation was estimated to be approximately 1,439 pairs (50 FR 50726:50727 [December 11, 1985]) and most (868 pairs; 60 percent) occurred in Canada. Within the U. S. (571 pairs), most pairs occurred in Nebraska and North Dakota (487 pairs; 85 percent; 50 FR 50726:50727 [December 11, 1985]). Through collaboration and investment of many organizations over several decades of monitoring, information on the conservation needs of the species has improved. In particular, data on the distribution, location, reproductive success at many breeding areas, has greatly improved. However, monitoring and research efforts have been largely designed to address site or local objectives under a variety of survey methods.

Despite the significant level of effort invested in breeding surveys for many years, there is currently no reliable means to estimate the current range-wide abundance nor population trends over time. Thus, results cannot be readily evaluated for inference towards the annualized status and trend of the piping plover breeding population in the NGP. While it is plausible that the various monitoring efforts could be linked under an overarching framework, there are no means currently available to estimate the overall trends in abundance or population performance over time of piping plovers in the NGP.

### NGP 2.4.2.3 Genetics, genetic variation, or trends in genetic variation:

See section 2.1.

The NGP piping plover breeding population is considered a separate population and there is an intent to eventually delist the NGP piping plover population as a Distinct Population Segment, if and when the data supports such an action. The 2009 5-year review (USFWS 2009a) evaluated the distinctness and significance of each breeding population and concluded the NGP piping plover population satisfies the criteria of a Distinct Population Segment, allowing this segment to be delisted separately from the remaining piping plover populations (USFWS 2009).

### NGP 2.4.2.4 Spatial distribution:

***NGP historic distribution***

A summary of the historical breeding records in the U. S. portion of the NGP was provided in the 1988 Great Lakes and Northern Great Plains Piping Plover Recovery Plan (USFWS 1988b). The excerpt is included below for reference:

*"Past inland breeding records are available for Piping Plover in <u>Montana</u>, <u>Wyoming</u>, <u>New Mexico</u>, <u>North Dakota</u>, <u>South Dakota</u>, <u>Nebraska</u>, and <u>Iowa</u>. In <u>Montana</u>, records included the following counties: Phillips, Sheridan, and McCone (Carlson and Skaar 1976). <u>Wyoming</u> records are limited to Laramie County (Cheyenne), Lincoln County (LeBarge, Fontanelle), and Oneida Lake (county unknown). Likewise, piping plovers have been irregular summer residents and migrants in Adams, Yuma, Washington, and Boulder counties in <u>Colorado</u>. One record exists for Eddy County, <u>New Mexico</u> (Bailey and Niedrach 1965).*

*Piping plovers have bred in the following <u>North Dakota</u> counties: McLean, Benson, Bottineau, Burke, Burleigh, Cass, Emmons, Sioux, Mercer, Oliver, Kidder, Divide, Eddy, Grand Forks, Ward, Logan, McHenry, McIntosh, McKenzie, Mountrail, Morton, Nelson, Pierce, Ramsey, Renville, Sheridan, Stutsman, and Williams (Stewart 1975, Haig 1986a). Breeding in <u>South Dakota</u> occurred in the Missouri Trench counties of: Clay, Hughes, Stanley, Sully, Union, and Yankton, with additional records from Codington, Day, and Miner counties in the Missouri Coteau (Visher 1915, Whitney et al. 1978). <u>Nebraska</u> records exist for counties along the Missouri, Loup, Niobrara, and Platte rivers (Bruner et al. 1904, Bent 1929, Tout 1947, Moser 1940, Heinemann 1944). In <u>Iowa</u>, piping plovers were regular migrants and summer residents. Channelization of the Missouri River below Sioux City eliminated use of all riverine sandbar habitat and resulted in loss of nest sites in Pottawattamie and Harrison counties, the only known nesting in the State (Dinsmore et al. 1984)."*

*NGP current distribution*

With the exception of a few individuals (33 plovers reported in the 2006 International Census) that breed in Colorado, Iowa, Kansas and Minnesota (Elliott-Smith et al. 2009), the key NGP piping plover breeding habitat occurs in Montana, North and South Dakota, and Nebraska (Figure NGP1). The species is comprised of four local populations within the NGP (Figure NGP1). The observed spatial and behavioral aspects of the species within each local population conform reasonably well to the general criteria of a metapopulation described by Hanski (1999): discrete geographic distributions of local populations; the presence of ecological processes occurring at two scales (local and metapopulation scales); and the breeding habitat within each discrete area is sufficiently large and stable to enable the local populations to persist for multiple generations. We thus, hereafter, collectively refer to the local populations as a metapopulation and for the purposes of recovery planning, we established one management region for each local population as follows:

### NGP 2.4.2.5 Habitat or ecosystem conditions:

Piping plovers primarily breed in four habitat types in the NGP—alkali lakes and wetlands; large inland lakes; reservoirs; and rivers. Piping plovers breed in open, sparsely vegetated sand and gravel habitats associated with these habitat types.

Piping plovers nesting on the shorelines of alkaline (naturally salty) lakes occur primarily in North Dakota, Montana, and Canada. Nesting on the shorelines of sand and gravel mines occurs primarily in Nebraska. Within the Canadian breeding range, piping plover nesting habitat includes both alkaline and freshwater lakes and reservoirs in Alberta, Saskatchewan, Manitoba, and Ontario (Environment Canada 2006).

In 1991, approximately 38 percent of the NGP population was observed on reservoirs, river shorelines, and sandbars. In 1996, 15.1 percent was observed at those areas; although 1996 was a high-water year and much of the habitat along rivers was inundated, likely forcing birds to nest elsewhere. This suggests that habitat use by piping plovers is dynamic and that the habitat necessary to support the northern Great Plains population is diverse.

Piping plovers nesting on the Missouri, Platte, Niobrara, Loup Rivers, and other rivers, use reservoir shorelines and large dry, barren sandbars in wide, open channel beds. Vegetative cover on nesting islands is usually less than 25 percent (Ziewitz et al. 1992) and a blend of sand and gravel is more often selected as nesting substrate compared to sites dominated by either sand or gravel (Whyte 1985). Twenty-eight Platte River sandbars, occupied by nesting piping plovers, averaged 938 ft (286 m) in length and 180 ft (55 m) in width (Faanes 1983). Vegetative cover on those sandbars averaged 25.4 percent. Armbruster (1986) estimated the optimum range for vegetative cover on nesting habitat from 0–10 percent, and Schwalbach (1988) found that 89 percent of the plovers nested in areas of less than 5 percent vegetative cover. On the Missouri

River, the majority of the plovers (63 percent) nested in areas where vegetation was less than 4 in (10 cm), with the average vegetation height ranged from 2 to 11 in (6 to 29 cm; Schwalbach 1988).

Plovers may select higher nest sites and farther away from the water's edge, when available. Average elevation of plover nests above river level ranges from 7.4 in (19 cm) below Gavins Point Dam (NRMR) to 12 in (30 cm) below Garrison Dam (SRMR; Schwalbach 1988, Dirks 1990). Beach width (the distance from the water to edge of the upland vegetation) and elevation above the water may also influence use by breeding plovers (Lamber and Ratcliff 1981; Whyte 1985; Weseloh and Weseloh 1983; Prindiville 1986; Faanes 1983; North 1986).

Wider and topographically diverse (raised) beaches likely provide multiple benefits for nesting – greater horizontal visibility, early detection of terrestrial predators, isolation from human disturbance, low likelihood of inundation, and proximity to feeding habitat. Greater line-of-sight distances for enhanced predator detection by adults (Prindiville 1986) may be especially important during the rearing stage for flightless offspring. Wider bands of nesting habitat also provides added buffer against rising water levels and wave actions (Haig and Oring 1986). Distance to water is typically less in nesting habitat associated with rivers (mean = 16 m, n = 39; Faanes 1983) than reservoir or lake habitat (mean = 46.2 m, North 1986). Adult plovers and broods typically forage within unvegetated beach habitat, searching for invertebrates at or near the wetted margin of beaches and sandbars.

## NGP 2.4.3 Five-factor analysis

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

***Reservoirs, channelization of rivers, and modification of river flows***

Prior to settlement by Europeans, the Missouri River basin rivers generally had large discharges in the spring from prairie and mountainous snowmelt that often led to overbank flows. The spring river rises moved sediment through the waterways that resulted in sandbar formation following the reduction of flows throughout the summer (USFWS 2003b). After European settlement, river management focused on modifying flows to obtain better predictability for navigation, agriculture, commercial and residential development, industrial water, electricity (especially hydropower operations aimed at peaking energy delivery), and other development that was hampered by seasonal flooding. River channels were straightened, channelized, and flooded (reservoirs) with the construction of five main-stem Missouri River dams in the mid-twentieth century in the NGP. These modifications exposed plovers to several stressors in NRMR and SRMR.

The dams reduce sediment transport in the system which has a particularly negative effect on habitat by reducing the amount of sand available for sandbar creation (National Research

Council 2002). The operation of the dams results in flow increases during the breeding season to provide for downstream human needs (USFWS 2003b). This results in less sandbar habitat availability over the course of the summer, rather than more, as was the case prior to dam construction. Modified flows in the central Platte River has changed both the timing and volume of water, causing decreased channel widths and overall less sandbar habitat (National Research Council 2005).

Reservoir water levels typically follow regional climate cycles, experiencing drawdowns during dry periods and reaching full pool during wet years. Large areas of habitat often becomes available for nesting plovers during long-term drawdowns. Habitat availability is dependent on these reservoir cycles, as beach areas around reservoirs with stable water levels become encroached by vegetation.

Reservoirs where the exposed-inundated shoreline dynamic occurs and where plovers breed include Lake Oahe and Lake Sakakawea on the Missouri River and Lake McConaughy on the North Platte River (USFWS 2009a). From 1993 to 2012, reservoirs accounted for 44 percent of piping plovers recorded on the Missouri River (USACE 2014), and 29 percent of all observations within the entire NGP including Canada (2006) were on reservoirs (Elliott-Smith et al. 2009). Thus, a significant proportion of the NGP breeding metapopulation is exposed to reservoir water level fluctuations.

Water-level rises on reservoirs are common during summer when plovers are nesting. Nest inundation is the greatest threat to plover nest success on Lake Sakakawea and probably other reservoirs (Anteau et al. 2012b). Those authors found that observed and model-predicted annual nest success estimates for plovers on Lake Sakakawea from 1985 – 2012 were markedly lower than those observed at other breeding areas. They concluded that heavy use of Lake Sakakawea by plovers represents a potential threat to population persistence because of potential negative impacts to recruitment (Anteau et al. 2012b).

The abundance of nesting habitat on the reservoirs generally declines as the reservoirs fill, and there is a corresponding increase in releases through the dams which inundates sandbar habitat downstream in the riverine reaches. Thus, there is generally an inverse relationship between the amount of water in the Missouri River system and the abundance of nesting habitat for piping plovers (USACE and USFWS 2010).

Because the documented loss of habitat, caused by the modification of river flows, continues to negatively impact the piping plover at a substantial scale in the NRMR and SRMR, we consider this as a threat. Depending on the year, up to 45 percent of the plovers nests in the NGP are associated with the river system (Haig and Plissner 1992; Plissner and Haig 1996; Ferland and Haig 2002; Elliott-Smith et al. 2009; USFWS 2009a, 2009b; USACE and USFWS 2010, 2011, 2012; Brennan et al. 2011; Nelson 2011; Brown et al. 2012; USACE 2012; Brennan 2013; Peyton and Wilson 2013).

***Commercial sand and gravel mining***

This stressor is currently limited to the SRMR. Surface aggregate mining is ongoing in Nebraska in the lower and central Platte River systems, including the Loup and Elkhorn Rivers. Dredging operations can attract piping plovers by creating nesting habitat from deposited waste sand resulting in nests on spoil piles. Often, when aggregate production is finished, real estate developers convert the periphery of the sandpit lakes into housing developments (D. Baasch, pers. comm., 2012; M. Brown, pers. comm., 2012). The human disturbance associated with the residential developments introduces pets (dogs and cats), which has shown to interfere with piping plover nesting if left unmanaged (M. Brown, pers. comm., 2012).

In other cases, sandpit lakes are filled in and the topsoil replaced, returning the area to agricultural crop production. Some sandpit lakes have been constructed for housing developments without first mining the area J. Jorgensen, pers. comm., 2012). Other, more conservation-minded undertakings for sandpit lakes have been specifically designed to promote and manage plover nesting habitat (D. Baasch, pers. comm., 2012).

The Nebraska-based Tern and Plover Conservation Partnership, the Nebraska Game and Parks Commission, and the Service collaboratively provide technical support to entities (industrial operations, real estate developers, utility companies, dredge operators and others) towards designing and implementing site-specific management plans aimed at avoiding/minimizing adverse effects to plovers, improve reproductive success, and increase recruitment of birds into the breeding population. With active management, reproductive success has improved, but reproductive success remains largely a function of the amount and quality of breeding habitat.

With active management, commercial aggregate mining can be performed so that it has a minimal risk to the species. Ongoing work by the industry, state, and non-profit has shown that the bare habitat created in the mining process can actually provide habitat to nesting plovers. Therefore, commercial aggregate mining is considered a low magnitude stressor and not a major threat at this time.

***Oil and gas development***

In North Dakota and Montana, oil production within and adjacent to piping plover nesting habitat has increased substantially since the 1986 listing of the species due to development of the Bakken oil shale formation. Significant development activity in North Dakota and Montana is concentrated in the alkaline lakes area, where approximately 20 to 30 percent of the NGP piping plovers nest (Haig and Plissner 1992, Plissner and Haig 1996, Ferland and Haig 2002, Elliott-Smith et al. 2009, Unpublished data from 2011 International Census). For instance, of the 6,347 oil and gas producing wells operating in January of 2012, more than 1,000 were established in 2011. These figures represent nearly a doubling of producing wells since 2007 (3,449 producing wells in January 2007; North Dakota Industrial Commission 2012; Figure NGP9). However, the actual impacts from oil development are largely unknown and are limited to the NRMR and

ALMR.

When exploration efforts indicate the presence of oil, companies may construct oil pads and drill for oil. This development decision triggers a series of construction and operational activities that could result in an adverse behavioral responses by piping plovers (such as habitat avoidance, flushing, or increased vigilance) due to: habitat removal (well pads are generally three to twelve acres with one pad for every 320 or 640 acres and road construction); permanent infrastructure (anthropogenic disturbance associated with roads/gravel pits and mortality from power line strikes (M. Shriner, pers. comm., 2007); and additional industrial development (the demand for gravel and water has fueled a spike in gravel mines and water pumping operations, several in close proximity to nesting basins; Brennan 2012). Although the actual impacts from this stressor is not known, the year-around presence of industrial activities in close proximity to several active nesting sites within the NRMR and ALMR represents a potential threat.

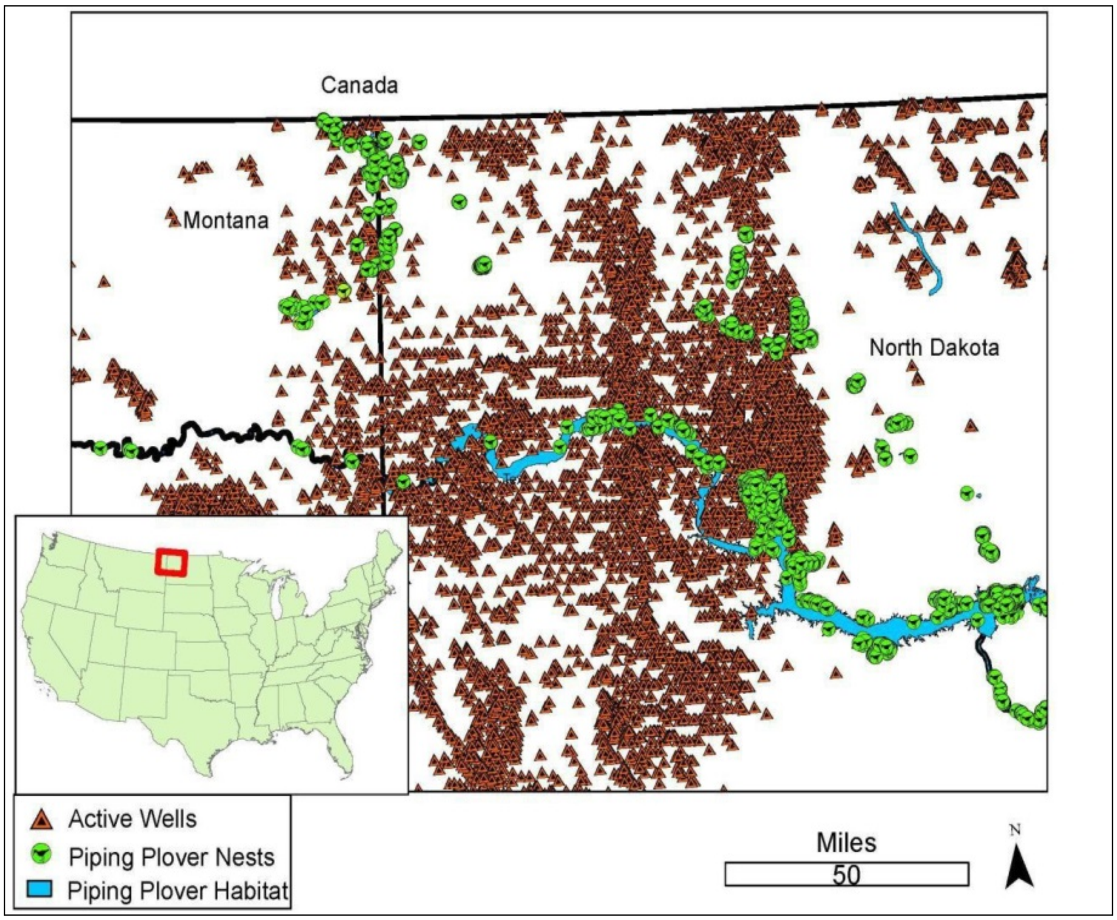


**Figure NGP9.** The proximity of piping plover nests to active oil and gas wells in North Dakota and Montana in 2012. *Source: DNRC Montana Board of Oil and Gas 2011, North Dakota Oil and Gas Commission 2011, USACE 2012, USFWS 2012*

### *Agricultural practices*

Agricultural practices occur in the NRMR, SRMR, and ALMR. Alkaline wetlands of the Prairie Pothole Region lie within an agricultural landscape and are subject to siltation, premature filling and other impacts (Gleason and Euliss 1998). Wetlands in agricultural fields receive more sediment from upland areas than wetlands in grassland landscapes. Cultivation of the wetland catchment areas, where surface water runs off to the wetland basin, alters the dynamics of surface runoff and hydrologic inputs to groundwater. Discharges can mobilize agricultural pollutants and when conveyed through drainage tile, serves as a point source for sediments and pollutants and can alter the aquatic food web and other basic wetland functions. Retaining grasslands or restoring grassland buffers around plover nesting basins may reduce siltation and other contaminant impacts.

Neonicotinoid insecticides are registered for agricultural use as seed treatments, soil amendments, and foliar sprays for a variety of crops, including rapeseed, sunflowers, corn, wheat, barley, oats, field peas, beets and potatoes (Health Canada 2009; Goulson 2013; Main et al. 2014). While the insecticide is often applied to the seed prior to planting, the chemical becomes systemic throughout the plant, making it very popular with farmers because no further treatment may be necessary for several months (Goulson 2013). Since their introduction in 1991, neonicotinoid use has been increasing dramatically (Goulson 2013; Hopwood et al. 2014). Neonicotinoids are used on nearly all of the 8.5 million ha of canola (rapeseed) planted in the Prairie Pothole Region of Canada (Main et al. 2014) and are also routinely applied to more than 80 percent of corn seed planted in North America (Alford 2017). Because neonicotinoids are highly water soluble, have a low soil binding affinity and have a limited translocation efficacy into crops, they are likely to be transported to aquatic habitats (Alford 2017). In the environment, neonicotinoids can degrade quickly by photolysis but are otherwise stable in water, not easily biodegradable and can accumulate in sediments or soil where they have half-lives ranging from 200 to more than 1,000 days (Goulson 2013; Mason et al. 2013).

Fish, amphibians and other vertebrate species tend to be tolerant to neonicotinoid toxicity relative to insects because neonicotinoids are designed to strongly bind to nicotinic acetylcholine receptors, which provide the majority of neurotransmission in insects (Moffat et al. 2016). Neonicotinoids are highly lethal to insects and can also result in a variety of sublethal effects to aquatic invertebrates including altered emergence, growth, sex ratios, feeding, swimming, burrowing behavior, and immobility (Roessink et al. 2013; Pisa et al. 2015; Nyman et al. 2016). However, neonicotinoid toxicity to aquatic invertebrates is also highly variable depending on both the species and neonicotinoid compound.

Toxicity testing indicates that snails and cladocerans (water fleas) are relatively tolerant to neonicotinoids whereas, Ephemeroptera (mayflies) and Trichoptera (caddisflies) are more sensitive (Morrissey et al. 2015; Miles et al. 2018). Neonicotinoid toxicity to Chironomidae (midges) in the laboratory appears to also be variable, with some species (e.g., *Eristalis tenax*) being relatively tolerant and other species (e.g., *Chironomus riparius* and *C. dilutes*) being highly sensitive (Morrissey et al. 2015; Saraiva et al. 2017; Basley et al. 2018).

Differences in seasonality for when aquatic invertebrates are collected for laboratory toxicity testing can also be a factor that affects neonicotinoid toxicity. The chronic toxicity of imidacloprid to the summer generation of a mayfly species (*Cloeon dipterum*) was 5 times more toxic than the overwintering generation (Roessink et al. 2013; Van den Brink et al. 2016). Temperature effects were also tested and had a slight effect on sensitivity but could not fully explain the differences. Differences in sensitivity between summer and overwintering generations were also found for 3 other insect species (Van den Brink et al. 2016).

Direct exposure of piping plovers to harmful concentrations of neonicotinoids seems unlikely in the NRMR and ALMR, but the wide extent and intensity of agricultural practices occurring adjacent to and within the flood plains of the SRMR suggests the potential for adverse effects within the SRMR. However, less is known about indirect effects to insectivorous birds from potential prey loss associated with widespread neonicotinoid use.

In the Netherlands, insectivorous bird populations tended to decline by 3.5 percent on average annually in areas with surface water concentrations of imidacloprid greater than 20 nanograms per liter (Hallmann et al. 2014). Others have also hypothesized that neonicotinoids act indirectly on bird populations by suppressing their immune system and reducing their insect prey (Gibbons et al. 2016). We are not aware of any studies that evaluated the risk of secondary poisoning (i.e., impact to plovers from eating contaminated insects).

However, given the widespread use of neonicotinoids and their potential to persistence in the environment, neonicotinoids may have a negative effect on the piping plover population particularly in alkaline lake breeding areas that receive substantial surface or subsurface agricultural runoff.

***Wind energy production***

Wind energy generation in the Northern Great Plains has increased in recent years (American Wind Energy Association 2012) and active energy facilities are operating within or immediately adjacent to the NRMR, SRMR, and ALMR. North Dakota has been identified as having the greatest wind energy potential in the U.S., and Montana having the fifth highest potential (American Wind Energy Association 2009). Wind energy development is closely tied to federal tax incentives, with development anticipated to increase in years when incentives are available and dropping sharply in years when incentives are not available (American Wind Energy Association 2007).

Possible impacts include direct collision with turbines or with the associated power lines, and avoidance of previously used areas where turbines have been constructed. Flight patterns (altitude or routes) used by piping plovers during the breeding season or migration period, however, are largely unknown. There has been no piping plovers reported from post construction mortality monitoring of operating wind energy facilities to date, suggesting wind energy may pose a minimal risk.

***Invasive species and vegetation growth***

The 1988 Recovery Plan (USFWS 1988) identified habitat loss as a threat to piping plovers, but habitat loss due to invasive species was not specifically mentioned. However, invasive plant species regularly occur in the NRMR, ALMR, and SRMR.

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 tolerant species, salt cedar and *phragmites spp.* (common reeds), which are tolerant of flooding, are a growing concern in plover nesting habitat whose impact may be increasing (Root and Ryan 2004; USACE 2010; Nelson 2011).

On the Missouri River system reservoirs, changing water conditions provide optimum conditions for noxious weeds to become established, with up to 200,000 ac of potential habitat exposed on Lake Oahe alone in dry conditions (USACE 2010). Salt cedar (*Tamarix* spp.), 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 2010). Other invasive species, such as kochia (*Kochia scoparia*) and clover (*Trifolium* spp.) have also been reported to rapidly take over plover habitat, precluding nesting (USACE 2010).

Cottonwoods (*Populus* spp.) and willows (*Salix* spp.), are generally the first species to colonize bare sandbars (Scott et al. 1997). While these species are native, they are problematic, because flows are rarely sufficient to scour them from riverine sandbars (Johnson 1994).

Some small-scale projects have successfully removed vegetation using a combination of chemicals, fire, and/or mechanically removing vegetation (Dinan 2009; pers. comm., Nelson 2011). A recent before-after-control-impact study suggests that spraying is effective at reducing the establishment of emergent vegetation, but additional evidence regarding habitat quality and bird use and productivity is necessary. Experimental spraying, mowing, and burning of *Phragmites* on sandbars in the Lewis and Clark Lake delta within the SRMR is underway to evaluate the ability to remove predator cover. Preliminary analyses of vegetation management practices in the Garrison reach of the Missouri River within the NRMR suggests that herbicide application is effective at retaining emergent sandbar habitat (ESH) (i.e. preventing vegetation establishment), and up to 50% effective when used alone for converting vegetated areas to ESH (USACE 2018).

A study of alkaline shoreline habitat over a 60-year period from 1938-1997 found that average beach width had narrowed during that period because of vegetation growth, leading to less available habitat for plovers (Root and Ryan 2004). The authors speculate that construction of reservoirs and water withdrawals for irrigation may be changing the hydrology of the alkali lakes region, affecting habitat availability. Consolidation drainage in which large wetland basins receive inflows from surrounding basins that have been drained has also altered the hydrology of alkali lakes, making them more persistent with larger water surface area thus contributing to a reduction in the abundance of nesting and foraging habitat (Anteau 2012, McCauley et al. 2015).

Due to the documented scope and magnitude of this stressor, direct causation of habitat loss has been sufficiently established to consider this as a threat. In the absence of amelioration, this potential threat may affect NRMR, ALMR, and SRMR populations.

***Intraspecific competition***

The overall availability of high quality nesting habitat within the NGP continues to be a dominant constraint in the recovery of the piping plover. At a local scale, there is growing evidence suggesting that the territorial behavior among breeding adults for food resources (i.e., adults attacking non- related young; Catlin and Fraser 2007, Catlin 2009) may be amplified by habitat loss. Although competition is a natural stressor, the occurrence of this agonistic behavior at a large scale could be exacerbated by limitations on high quality nesting habitat; resulting in adults being attracted in high concentrations to patches of exceptional nesting habitat (Catlin 2009, Catlin et al. 2015).

Attacks by adult plovers against other (competing) plover broods have been observed in other shorebirds and is likely more frequent in years when food is limiting (Ashbrook et al. 2008) (See Section 2.4.3.1). This behavior is not expected to be a widely occurring in the NGP breeding population, however, (Murphy et al. 2001), so its impact on population demographics is largely unknown.

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

Human disturbance was identified as a threat in the 1988 (USFWS 1988). In localized areas within the NRMR and SRMR, high human disturbance can occur. Anthropogenic disturbance from boating and other recreational activities causes plovers to spend less time foraging and brooding, and more time in alert, vigilant behaviors (Cairns 1982, Flemming et al. 1988, Burger 1994, Gratto-Trevor and Abbott 2011). Evidence suggests that chicks that grow more slowly fledge later, and unfledged chicks are at a greater risk of predation (Catlin et al. 2014). Human disturbance may (indirectly) be a contributor to a reduced fledging rate. Piping plovers may avoid areas with high human activity, instead using less optimal habitat as demonstrated on the wintering grounds in Cohen et al. 2008.

Human disturbance is a particular concern in river or reservoir reaches near cities. An estimated 20 - 80 percent of the NGP plovers in the U.S. nest in riverine sandbar habitat (Haig and Plissner 1992; Plissner and Haig 1996; Ferland and Haig 2002; USACE 2006, 2012; Elliott-Smith et al.

2009; Nelson 2011; Brown et al. 2012; Peyton and Wilson 2013). Sandbar habitat also often attracts human recreation, including sandbars on the Missouri River, and reservoirs in Nebraska and Colorado (USFWS 2003b, Nelson 2012).

In Colorado and Nebraska, as well as on the Missouri River, the USACE erects signs and fencing in order to raise public awareness about the importance of avoiding plover nesting areas (USACE and USFWS 2011, 2102; Brown et al. 2012; Central Nebraska Public Power and Irrigation District 2012; Nelson 2012). The success of these measures is difficult to measure because the closed sites are not continuously monitored.

Off-road vehicle use is not permitted on lands managed by the USACE. Despite these protections, reproductive failures have been attributed to human disturbance and off-road vehicle use is common, especially along rivers and reservoirs throughout the range (USACE and USFWS 2011).

As the waterfront areas in Nebraska, along the Missouri River, and on the shorelines of alkaline lakes become more developed, human disturbance is likely to become more prevalent. South Dakota wildlife conservation officers patrol Missouri River locations in South Dakota where humans are likely to recreate on sandbars and beaches used by plovers. U.S. Fish and Wildlife Service law enforcement agents also patrol throughout the U.S. range, especially during busy holiday weekends, but the large area to cover and the few law enforcement personnel mean that enforcement may not always needs. These patrols are unlikely to persist in the absence of ESA protections.

Overall, human disturbance is a localized stressor currently, but as the human population increases and recreates on the river systems increase, human interactions with nesting and rearing plovers are likely to increase. However, given the extent of this stressor is generally localized, human disturbance is not a significant threat at this time.

### NGP 2.4.3.3 Factor C. Disease or predation:

***Disease***

Disease was not considered as a potential threat to piping plovers at the time of listing (USFWS 1988b). However, botulism had not been investigated and this disease could prove detrimental in the future. Several of the alkaline lakes that support plovers have had historical outbreaks of botulism (National Wildlife Health Research Center *in litt.* 1994). Although botulism may be a localized risk, it has lethal effects.

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, piping plovers carcasses (10-20) have tested positive for West Nile Virus in the last decade (Sherfy et al. 2007; USFWS 2016).

However, based upon available information, disease is not a significant threat at this time.

***Predation***

Predation was not considered as a potential contributing factor to the species' decline at the time of listing (USFWS 1988b). Since 1988, there has been considerable research on the potential impact that predation may be having on piping plovers on the breeding grounds (Strauss 1990, Kruse 1993, Ivan and Murphy 2005, White et al. 2010, Catlin et al. 2011). Although predation is obviously a natural component of the species' life history, researchers have suggested that high rates of predation are symptomatic of high nest densities caused by limited or poor quality habitat (Mayer 1991, Kruse et al. 2002, Catlin 2009) but it is not ubiquitous in the NGP (Anteau et al. 2012b).

The use of nest exclosures is a common management practice in the NGP to reduce the impact of nest predation (Prescott and Engley 2008, USFWS 2009b, Gratto-Trevor and Abbott 2011, Brown et al. 2012, Heyens et al. 2012, USACE and USFWS 2012, White 2012, Smith et al. 2011). Nest exclosures have been shown to improve plover nest success but increased nest success may not lead to increased fledging success if predators are attracted to areas with a high density of chicks (Neuman et al. 2004). Furthermore, nest exclosures pose a risk to the adults when predators become adapted to cages and prey upon adults (Murphy et al. 2003).

Research suggests that predation vulnerability varies with life stage – mammals are the more typical nest/egg predators and birds are the more typical chick predators (Ivan and Murphy 2005). Control efforts to remove avian predators that are thought to prey on chicks were initiated on the Missouri River in 2007 and on the U.S. alkaline lakes in 2008.

California (*Larus californicus*) and Ring-billed gulls (*Larus delawarensis*) have increased by more than 1.5 percent annually throughout most of the piping plover's breeding range from 1966-2011(Sauer et al. 2012). Gulls have been documented nesting on islands which had previously supported nesting piping plovers (Beyersbergen et al. 2004). The islands that now have gull nesting originated from a variety of causes. Some of these islands are natural. Some are high points that became islands when Lake Audubon was created. In Lake Audubon, some islands have been protected from erosion to benefit nesting waterfowl and plovers by placing rip-rap around them. Still other islands were created in Lake Audubon specifically for piping plover or duck nesting (Frerichs 2014). The alkali lakes region has performed gull control at selected sites where gulls have taken over islands previously used by nesting piping plovers since 2008 (Brennan 2008). Anecdotally, gull control has been effective, with piping plovers successfully nesting in areas where gull colonies had formerly been (Mueller 2010).

A recent analysis suggested that removal of five great horned owls (*Bubo virginianus*) along the 59-mile Gavins Point River reach in 2008 significantly improved the survival probability of chicks after owls were removed (Catlin et al. 2011). While the increase was statistically significant, the number of additional chicks fledged was marginal for a relatively large amount of effort (Catlin et al. 2011, USACE and USFWS 2011). Predation control efforts are not always successful at increasing productivity to a level that would stabilize the population (USACE and USFWS 2012).

In some areas, predation appears to be a major impediment to reproductive success, as it 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). Targeted predator control may be necessary in the short term, but long-term efforts should focus on the key underlying factor of providing sufficient nesting habitat.

Many cooperators perform predation control activities (caging nests, removing predators, removing trees from prairies) to improve piping plover productivity. Projects that provide more habitat for plovers indirectly reduce the predation threat since nesting plovers are more spread out and thus more difficult to target. However, we conclude that predation is a widespread stressor in the NGP breeding range based upon expert opinion of research and management professionals where consensus was reached that predation is a potential threat only within the SRMR (USFWS 2015).

#### NGP 2.4.3.4 Factor D. Inadequacy of existing regulatory mechanisms:

Because of its federally threatened status, the piping plover 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 on federal actions pursuant the National Environmental Policy Act (NEPA). In addition, critical habitat has been designated for the most of the NGP breeding area (67 FR 57638 [September 11, 2002]).[5]

Piping plovers are also protected by the Migratory Bird Treaty Act (MBTA) for cases of purposeful take. Non-purposeful take, referred to as incidental take, is currently not considered prohibited for any activity that is otherwise fully legal. While this statute protects plover adults, their active nests, and their young, it does not protect habitat when the plovers are not there. Thus the MBTA does not provide protection from the threat of habitat loss.

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 2007). Wildlife Action Plans are generally voluntary, comprehensive strategic plans that focus attention and funding on rare species, unique habitats and partnership opportunities to benefit both.

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[5] A portion of the critical habitat designation was remanded back to the USFWS (Nebraska Habitat Conservation Coalition v. USFWS 2005).

The protections afforded by designation as species of greatest conservation need vary from state to state, but are not as comprehensive as protections under the ESA (Association of Fish and Wildlife Agencies 2007). All states within the breeding range participate in the International Piping Plover Census, and North Dakota, South Dakota, Nebraska, and Minnesota actively engage in annual management activities to improve reproductive success. The piping plover is a state endangered species in Minnesota and a state threatened species in Colorado, Nebraska, and South Dakota.

The Canadian Species at Risk Act (SARA), enacted in 2001, provides many protections for piping plovers in 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. The USFWS, USACE, State, and non-profit organizations spend considerable time and money implementing actions to benefit the species, which may not occur in the absence of ESA listing. Because threats are being managed rather than eliminated, these entities would need to continue to manage for the Northern Great Plains piping plover population as described in Recovery Criterion D (See section NGP 2.4.1.2 of this document).

***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. Section 7 consultation is not required when there is no federal nexus and there is no regulatory requirement for companies to notify the USFWS of oil and gas activities that may have potential to adversely affect piping plovers. Some regulatory protections of the ESA and MBTA for piping plovers are applicable to activities on non-federal lands. Thus, we know very little about many wells that have the potential to impact plover habitat.

As depicted in Figure NGP9, oil and gas development is in close proximity to active breeding areas in the ALMR and NRMR (DNRC Montana Board of Oil and Gas 2011, North Dakota Oil and Gas Commission 2011, USACE 2012, USFWS 2012c). An Executive Order, issued on April 3, 2012 (Obama 2012) requires federal agencies to ensure the safety of gas production, but it is unclear if the order includes piping plovers. Some pipelines are regulated by federal agencies (e.g., the Federal Energy Regulatory Commission or the State Department), and in these cases the USFWS can provide input into the design and placement of the pipe to avoid and minimize impacts to plovers.

Nonetheless, we conclude the existing regulatory mechanisms are inadequate to ameliorate stressors arising from oil and gas production, and would only increase in the absence of ESA protections.

***Wind power***

Wind energy facilities do not require a federal permit unless they are located on federally owned land or on federal easements. Facilities less than 100 megawatts do not require a state permit in North Dakota or South Dakota. No state permit is required in Montana regardless of facility size (South Dakota Energy Infrastructure Authority et al. undated, Association of Fish and Wildlife Agencies 2007, Montana Department of Environmental Quality 2011, South Dakota Codified Laws 2012). The Nebraska Power Review Board permits wind projects greater than 80 megawatts in Nebraska - a process which triggers a review by Nebraska Game and Parks Commission (Nebraska Legislature 2010). However, the exposure risk of the species to the operational stressors of wind energy development is largely unknown, but to date, no piping plover fatalities have been encountered during fatality monitoring anywhere in the NGP.

#### NGP 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 NGP than there are today (Harris Williams and Co. 2010). As more power is produced in the NGP, a large number of new power lines are needed to carry this power to population centers (American Wind Energy Association and Solar Energy Industries Association 2009). Overhead power lines have been documented to pose a strike risk to numerous bird species, including plovers (USFWS 2004, M. Shriner, pers. comm., 2007). Because little is known about piping plover dispersal patterns, it is difficult to assess the overall risk power lines may pose to the species. Marking lines with highly visible reflectors has been shown to be partially effective in reducing bird strikes in a number of species (Avian Power Line Interaction Committee 1994).

The USFWS recommends that power lines in the whooping crane (*Grus americana*) migration corridor be marked near wetlands that may be used by whooping cranes. This recommendation would overlap nearly all of the piping plover's range in the United States. The USFWS does not have information indicating how many lines are marked at this time. Nonetheless, power lines have been documented to kill piping plovers when located in the flight path of two nesting/foraging areas, but it is unknown as to whether the increasing number of power lines across the migration routes impact plovers.

### *Climate change*

Climate change has the potential to be a severe threat to the species. According to the Intergovernmental Panel on Climate Change (IPCC) (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). Average temperatures in Northern Hemisphere 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). The past 50 years, cooler temperatures and frosts have become less frequent over most land areas (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 IPCC (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 trend 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 IPCC 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 (U.S. Global Change Research Program 2009). Across the U.S. range of the NGP piping plover, summer temperatures are projected to increase 5° F to more than 10° F by the end of the century, depending on future emissions (U.S. Global Change Research Program 2009).

Northern areas of the Great Plains are projected to experience a wetter climate by the end of this century (U.S. Global Change Research Program 2009). Across the U.S. range of the NGP piping plover, spring precipitation is expected to increase between zero and 15 percent under a lower emissions scenario and between zero and 40 percent under a higher emissions scenario.

This shift in temperature and moisture could have profound effects on piping plover habitat, which is dependent on wet-dry cycles to keep habitat clear of vegetation. Additionally, changing precipitation patterns in the Rockies would likely have effects on the amount of inflow into the Missouri River system, also affecting the amount of habitat available there. Precipitation data from 1901 through 2012 show an increase in average precipitation over the time period (NRCS 2012).

Given these projected changes, resource agencies will need to consider the range of possible effects associated with climate change when managing habitat. At this time, it is unknown as to whether climate change is a significant future threat, but recovery efforts should monitor conditions and have a plan for contingencies.

***Summary***

A variety of stressors are known to affect piping plovers in the NGP. Yet, not all stressors occur at a sufficient geographic scope and/or magnitude such that we would anticipate measureable/detectable demographic consequences at either the local or metapopulation scales. The SRMR was determined to have the most threats (5) followed by the NRMR (4) and ALMR (3). One threat (invasive vegetation) was common to all.

**Table NGP2.** Summary of stressors and identification of threats† occurring within each piping plover management region.

| Stressor | Southern Rivers | Northern Rivers | Alkali Lakes | Prairie Canada‡ |
|---|---|---|---|---|
| **Factor A<br>Destruction, modification, or curtailment of habitat or range** | | | | |
| Modified river flows/power peaking; reservoirs, and channelization | ✔ | ✔ | | |
| Sand and gravel mining | | | | |
| Oil and gas production | | ✔ | ✔ | |
| Agricultural development | ✔ | | | |
| Neonicotinoids | ✔ | | | |
| Wind energy production | ? | ? | ? | |
| Invasive vegetation | ✔ | ✔ | ✔ | |
| Density leading to intraspecific aggression | | | | |
| **Factor B<br>Overutilization for commercial, recreational, scientific, or educational purposes** | | | | |
| Human Disturbance | | | | |
| **Factor C<br>Disease or predation – Moderate Overall** | | | | |
| Disease | | | | |
| Predation | ✔ | | | |
| **Factor D<br>Inadequacy of existing regulatory mechanisms** | | | | |
| Oil and gas production | | ✔ | ✔ | |
| Wind energy production | ? | ? | ? | |
| **Factor E** | | | | |

| Other natural or anthropogenic factors | | | | |
|---|---|---|---|---|
| Power lines | **?** | **?** | **?** | |
| Climate change | ? | ? | ? | |

†Stressors within each management region denoted by checkmarks represent potential threats because of the higher likelihood for demographic consequences at the local population scale. Stressors with an unknown effect on demography are identified with a question mark.

‡The Prairie Canada local population was not included in this threat assessment due to a limited availability of information.

MRs in the U. S. and 9 of the 12 potential threats were associate with Factor A (habitat loss, degradation, or modification). Table NGP2 provides an overall summary of the stressors identified as being a potential threat to the viability of breeding piping plovers within each MR.

### NGP 2.4.4 Synthesis

Here, we consider the status of the NGP piping plover population with respect to ESA definitions of threatened and endangered species. In conducting this evaluation, progress towards the recovery criteria in the 1988 recovery plan was considered along with new information about demographic characteristics, distribution, and habitat requirements; as well as an analysis of listing factors and relevant conservation measures for both the breeding and nonbreeding portion of the annual cycle. As the "Draft Revised Recovery Plan for the Northern Great Plains Piping Plover (*Charadrius melodus*)" (USFWS 2016) and associated objective, measurable criteria continue to develop, further evaluation will be necessary.

While the population increase seen since 2011 demonstrates the possibility that the population can rebound from low population numbers, ongoing efforts are needed to maintain and ensure growth within the population. To achieve these efforts, there will be a need to continue to rely on the consistent efforts of our current partners, as well as a need to expand efforts through relationships with other entities. Continued collaboration will be key to species recovery.

Emerging threats, such as energy development (particularly wind, oil and gas and associated infrastructure) and climate change may 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 NGP piping plover population remains correctly classified as a threatened species under the ESA definition. The NGP 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 25 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 NGP 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 range-wide protection against threats from wind turbine generators and climate change.

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## AC2.5 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. As stated in the 2009 Piping Plover 5-Year Review, revision of criterion 3 is needed to account for new information. See further discussion and consideration of new information under criterion 3, below.

***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 – climate change and wind turbines – merit further evaluation to determine if and how recovery criteria should address these threats. Because habitat modifications strongly affect the ability of sandy ocean beaches to adapt to accelerating sea level rise (see pertinent discussion under Factors A, D, and E), criteria 4 and 5 may partially address that climate change related threat. However, a better understanding of all climate change effects on piping plovers and their habitat is required before appropriate new recovery criteria can be formulated (if needed). Likewise, sufficient information about piping plover flight behavior and the likelihood of wind turbine construction in areas used by piping plovers is not yet available to assess the need for a recovery criterion pertinent to threats from wind turbines.

The best available information indicates that disease, environmental contaminants, and overutilization are not current threats to Atlantic Coast piping plovers. 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 5 years a total of 2,000 breeding pairs, distributed among the four recovery units as specified below[6]:

| *Recovery Unit* | *Minimum Subpopulation* |
|---|---|
| *Atlantic (Eastern) Canada*[7] | *400 pairs* |
| *New England* | *625 pairs* |
| *New York-New Jersey* | *575 pairs* |
| *Southern (DE-MD-VA-NC)* | *400 pairs* |

[6] These subpopulation abundance and distribution targets will ensure representation, redundancy, and resiliency for Atlantic Coast piping plovers in their breeding range (USFWS 2019). Maintaining geographically well-distributed populations across the four recovery units serves to conserve representation of genetic diversity and adaptations to variable environmental selective pressures evidenced by the population's genetic structure (Miller et al. 2010), variable habitat requirements (USFWS 2019), differences in vital rates (Hecht and Melvin 2009a) and morphometric differences (Gibson et al. 2019). The ability of piping plovers in each recovery unit to rebound from events that depress unit-wide productivity or survival and to colonize newly formed or improved habitat (e.g., after storms or artificial habitat enhancement projects) depends on within-unit redundancy that is measured via progress towards abundance targets. Distribution of robust numbers of breeding pairs across the four recovery units will also provide Atlantic Coast piping plovers with a buffer against stressors (e.g., weather, habitat degradation, disturbance) in their migration and wintering range that may depress survival rates (USFWS 2019; see also Gibson et al. 2018).

[7] Canadian Wildlife Service (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, the 2009 Piping Plover 5-Year Review referred to the Eastern Canada recovery unit, a convention that we continue in this document. 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.
The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) currently recognizes piping plovers breeding in Eastern Canada as *Charadrius melodus melodus* and designates the subspecies as "Endangered" (Department of Justice Canada 2002). This supersedes 1978 and 1985 designations assigned to the entire Canadian population of piping plovers (COSEWIC 2001). The Canadian piping plover recovery strategy recognizes the importance of conserving migration and wintering habitat in the U.S. and other countries (Environment Canada 2012).

This criterion has not been met. As illustrated in Figure AC1 (in section AC 2.5.2.2), only the New England recovery unit population has met and sustained its recovery target. The New York-New Jersey recovery unit surpassed its 575-pair goal in 2007, but decreased 35 percent to 378 pairs in 2014 before rebounding to 497 pairs in 2017 and then declining to 486 pairs in 2018. The Southern recovery unit attained a post-listing high of 386 pairs (97 percent of its target) in 2016; however, it then decreased 24 percent to 295 pairs in 2018. The 2017 Eastern Canada recovery unit population estimate of 169 pairs is the lowest listed since piping plover's 1986 listing under the ESA. It rebounded slightly to 181 pairs in 2018.

**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 (see information presented in the 2009 5-year review and results of Miller et al. (2010)). In light of the low likelihood of risks, response to this criterion has been considered a low priority relative to efforts to attain other recovery criteria. The appropriate approach to satisfying this criterion should be determined in consultation with conservation geneticists. Genetic samples (feathers collected during some banding projects and tissue from individuals submitted to the National Wildlife Health Center) have been archived, although they have not been earmarked for this sole purpose.

**Recovery Criterion 3.** Achieve 5-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.

Revision of this criterion is needed. 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) may be developed in response to anticipated new information about the latitudinal variation in productivity needed to maintain a stationary population. On the basis of trends in abundance and productivity from 1986-2006 (Hecht and Melvin 2009a) and recognition that productivity needed to sustain recovery unit populations may be lower than that needed to attain targets, the 2009 5-year review recommended revision of this criterion. The recovery plan and the 2009 5-year review specified that revision of this recovery criterion will require demographic modeling that explores effects of variation in productivity, survival rates, and breeding propensity on population viability within individual recovery units and the Atlantic Coast population as a whole. New and emerging information demonstrates the importance of full life-cycle modeling, as well as consideration of density-dependent regulation to define and understand relationships among all vital rates and habitat availability and condition. See summaries of new publications and ongoing studies of survival, breeding site fidelity, dispersal, and demographic responses to habitat changes in sections AC 2.5.2.2 and AC 2.5.2.6, as well as recommended future recovery action 11 for the Atlantic Coast population breeding range in section 4.4.

**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 3.

As discussed under Factor D (section AC 2.5.3.4), ESA sections 7 and 9 currently play major roles in ongoing efforts to reduce widespread continuing threats from habitat loss and degradation and human disturbance. Many section 7 consultations also address Federal activities that will affect the long-term ability of habitats to adapt to sea level rise. Many Atlantic Coast piping plover recovery partners have demonstrated ongoing commitments to piping plover conservation, and a few 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 in the U.S. portion of the range. Although a population that has reached the abundance and distribution targets provided in criterion 1 may require slightly less protection than needed to achieve growth, Atlantic Coast piping plovers are conservation-reliant. They require continuing management of threats that cannot be removed.

The 11 State wildlife agencies play a key role in current conservation efforts, and they are logically appropriate entities to lead post-ESA conservation. The exact nature of each State agency's role, however, must reflect its regulatory authorities and ability to assume primary responsibility for specific protections. Section 7 consultations are the primary current mechanism for reducing threats from habitat modification projects, and sufficient alternative mechanisms, whether under the auspices of State laws or other authorities of the Federal agencies, have not yet been identified. Furthermore, the willingness of landowners and other partners to conduct predation management activities if piping plovers are no longer classified as a threatened species under the ESA must be determined. In summary, 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.

This criterion has not been met. Piping plovers spend up to 10 months of their annual cycle on their migration and wintering grounds. As discussed under survival in section AC 2.5.2.2., a 2018 publication demonstrates the effect of anthropogenic disturbance in the wintering range on true annual survival rates. Progress toward understanding and managing threats to migrating and wintering piping plovers and their habitats (discussed in the 2009 5-year review and updated in section WM 2.2 of this document) is accelerating. 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 for recovery of Atlantic Coast piping plovers (see section 4.1). Efforts to reduce habitat loss and degradation are particularly urgent, as habitat modifications to sandy beaches in the wintering range may also reduce their capacity to adapt to accelerating sea level rise.

***Summary***

Although important population growth has occurred under the auspices of an active network of recovery partner organizations, none of the Atlantic Coast piping plover recovery criteria has been met.

### AC 2.5.2 Biology and habitat

A large body of information regarding the biology, habitat, and status of Atlantic Coast is contained in the 1996 Atlantic Coast recovery plan and the 2009 Piping Plover 5-Year Review. Here we summarize new information that has become available since 2009.

#### AC 2.5.2.1 Life history:

***Diet***

A study of opportunistically-collected stomach contents from dead Atlantic Coast piping plovers found only arthropods (primarily insects) in six chick samples, while three adult samples contained both terrestrial and intertidal prey; the authors note that stomach contents may over-represent insects and other arthropods in comparison to soft-bodied taxa (Sanger and Levison 2016). Monk et al. (2016) report four observations of adult and fledgling piping plovers consuming fish, a behavior that they characterize as possible evidence of dietary flexibility, albeit opportunistic and infrequent.

### *Phenology*

Since 2011, the USFWS has received occasional reports of unusually delayed fledging periods, early hatch dates, and other phenological "anomalies" that depart from information summarized in the 1996 Atlantic Coast recovery plan. Piping plovers older than 35 days that are incapable of flight have been reported from several widely distributed sites in Massachusetts, New York, and Maryland (USFWS 2015). A few hatch dates prior to May 15 have been reported from New Jersey, Virginia, and North Carolina (USFWS 2015). The USFWS has solicited information about potential contributing factors (e.g., evidence that prey is limited, harsh weather, unusual disturbance), but rare events are inherently difficult to interpret. A 2015 addendum to the 1994 *Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take under Section 9 of the Endangered Species Act* provides revised advice regarding the timing of management to protect unfledged chicks (USFWS 1994, 2015).

### *Flight behavior at and near nest sites*

Estimated non-courtship flight heights of breeding piping plovers at six New Jersey and Massachusetts sites ranged from 0.25 to 40 m (mean = 2.6 m; 97 percent were less than 10 m) and average calculated flight speed was 9.30 m/second (Stantial and Cohen 2015, M. Stantial, State University of New York, pers. comm. 2018a). Flight frequency increased during low tidal stages and during the chick-rearing phase, was higher where nesting and foraging habitat were separate than when they were contiguous, and increased with air temperature at some locations. The center points of piping plover flight paths were clustered by territory, indicating that birds tended to commute to foraging areas using pair-specific routes, and habitat configuration was found to be the most important consideration when conducting assessments of collision risk at or near piping plover breeding areas (Stantial and Cohen 2018a). Automated telemetry found that female piping plovers with nests spent almost two-thirds of their time out of receiver range at night, suggesting that piping plovers may make frequent flights at night (Stantial 2014).

### *Post-breeding activity*

Studies on Long Island and New Jersey using (respectively) nanotag and GPS transmitter technology may provide new insights into habitat use by chicks and adults during the post-breeding period, as well as factors affecting survival of young of the year (Walker et al. 2018, Stantial and Cohen 2018b). Observations continue to support the belief that southward migration of piping plovers from their Atlantic Coast breeding grounds primarily occurs from July to September, with the majority of birds initiating migration by the end of August (USFWS 1996). However, 7 years of surveys by New Jersey Division of Fish and Wildlife and Conserve Wildlife Foundation of New Jersey document sustained presence of low numbers of piping plovers at several sites through October (C. Davis, New Jersey Division of Fish and Wildlife, pers. comm. 2018a).

Although there is no corresponding information specific to the Atlantic Coast, analysis of data from the Northern Great Plains found that second-year plovers selected nest sites that they had prospected as post-fledglings more often than would have been expected if nest site selection were random. They also selected sites where other plovers experienced higher average nesting success than at random nesting locations (Davis et al. 2017).

***Migration***

Migratory southbound departures of 65 piping plovers breeding in Massachusetts and Rhode Island in 2015 to 2017 occurred between July 4 and September 4, peaking in late July and when winds were blowing to the southwest. Piping plovers migrated nocturnally, with most birds departing within 4 hours of local sunset. Piping plovers migrated offshore directly across the mid-Atlantic, from breeding areas in southern New England to stopover sites spanning from Long Island, New York to North Carolina. During offshore migratory flights, piping plovers flew at mean flight speeds of 42 km/hr and altitudes of 288 m (interquartile range of model uncertainty = 36 to 1031 m above sea level; Loring et al. 2019a).

See section WM 2.2.1.1 of this document and Weithman et al. (2018) for estimates of the number of piping plovers and stopover duration at a North Carolina site during fall migration in 2016.

***Adaptive variation***

Analysis of a long-term data set found that both body mass of Atlantic Coast (and Northern Great Plains) piping plovers varied with latitude and environmental temperature in both their breeding and wintering ranges, while wing length correlated only with breeding range latitude and temperature. Differences in wing length are most likely driven by breeding season conditions or tradeoffs related to migration, a pattern that may have microevolutionary consequences (Gibson et al. 2019).

### AC 2.5.2.2 Abundance, population trends, and demography:

***Abundance and productivity***

We summarize information reported in USFWS (2019), *Abundance and Productivity Estimates – 2018 Update: Atlantic Coast Piping Plover Population*.

Since 2008 (the last estimate that was available for the 2009 5-year review), the total Atlantic Coast piping plover population estimate increased 2 percent, from 1,849 pairs to 1,879 pairs in 2018. However, uneven distribution of population growth became even more pronounced between 2008 and 2018, with the New England population increasing while net abundance decreased in the other three recovery units (see Figure AC1). See section AC 2.5.2.5 for further information about changes in distribution since the 2009 5-year review.

The largest and most sustained population increase has occurred in New England, where the recovery unit population has exceeded (or been within 3 pairs of) its 625-pair abundance goal since 1998. Despite experiencing small inter-annual dips (e.g., in 2013 and 2016), the New England population reached a post-listing high of 917 pairs in 2018, for a net increase of 29 percent between 2008 and 2018. Abundance in the New York-New Jersey recovery unit attained a post-listing peak of 586 pairs in 2007, then declined 35 percent to 378 pairs in 2014 following 7 years of low productivity (including 4 years when it was less than 1.0 chick per pair). Improved productivity in 2014 and 2015 fueled a partial rebound to 496 pairs in 2016, but the New York-New Jersey population estimate increased by only 1 pair in 2017 and declined slightly in 2018, despite high productivity in both 2016 and 2017. The Southern recovery unit piping plover population attained a post-listing high of 386 breeding pairs in 2016, but declined almost 24 percent to 295 pairs in 2018 (6 pairs less than in 2008). The Southern population responded positively to habitat creation events such as the 1992-1993 Nor'easters, Hurricane Isabel in 2003, Hurricane Ophelia in 2005, and Hurricane Irene in 2011 (Boettcher et al. 2007, NPS 2008, Schupp et al. 2013, USFWS 2014). However, low productivity years (especially successive years of low productivity such as occurred in 2007-2008 and 2016-2017) have been followed by marked declines in breeding abundance. The 2017 piping plover population estimate of 173 pairs in Eastern Canada was the lowest estimate reported since the species was listed under the United States ESA. Although the Eastern Canada subpopulation rebounded slightly to 181 pairs in 2018 and fluctuated between 1986 and 2007 (when it reached 266 pairs), the 2007-2017 decline was the largest (35 percent) and most prolonged, despite much higher long-term average productivity than in the other recovery units. In summary, one recovery unit population increased between 2008 and 2018, while three experienced net population decreases.

Regression analysis by Hecht and Melvin (2009a) found that annual productivity is a partial predictor of recovery unit population trends in the subsequent year, but relatively small coefficients of determination indicated that other factors (e.g., annual survival rates of adults and fledged chicks) also had important influences on population growth rates. Demographic analysis of data collected in 2013-2017 by Weithman et al. (2019) reported that average productivity rates necessary for a stationary population were similar in New York and North Carolina but that other factors, such as immigration (most likely from Virginia) may contribute to the persistence of the North Carolina breeding population. In some parts of the range, habitat availability may also be constraining recruitment into the breeding population (USFWS 2019, Robinson et al. 2019). Exploration (via demographic modeling) of information regarding survival, dispersal, and the response of piping plovers to habitat formation events (see section AC 2.5.2.6), including annual and latitudinal demographic variability, may shed further light on the relationship between productivity and population growth.

### *Breeding site fidelity and dispersal*

Several studies concluded since 2009 or that are in progress provide quantitative estimates of dispersal distances. Rioux et al. (2011) compared effects of prior-year hatching success on the inter-annual dispersal movements of adult piping plovers in eastern Canada (n=86, range=0.01 – 217.33 kilometers). The mean for 15 plovers experiencing hatching failure the previous year was 17.8 kilometers versus 5.8 kilometers for 71 birds hatching at least one egg. Stantial (pers. comm. 2016) reported a mean dispersal distance of 1.84 kilometers between breeding years for adults banded in Massachusetts, 1.35 kilometers in New Jersey (n =19 and 12, respectively). Dispersal from natal site to first breeding location for a small sample (n=6) included one long distance movement (582.32 kilometers) and a mean dispersal distance of 20.64 kilometers for the other five birds (Stantial, pers. comm. 2016). Although ongoing studies have detected a few large movements of marked piping plovers (e.g., A. DeRose-Wilson, Virginia Tech, pers. comm. 2016; Stantial, pers. comm. 2016, 2018b), fidelity to natal regions remains prevalent. Detailed analyses of the overall dispersal patterns are pending.

Currently available information corroborates earlier findings (see USFWS 2009) that most adult piping plovers demonstrate nest site fidelity, returning to the same breeding beach or a nearby beach in consecutive years. Established males make smaller interannual movements than females and first-time breeders disperse more than adults (Wilcox 1959, MacIvor et al. 1987, Loegering 1992, Cohen et al. 2006; see also results from Missouri River piping plovers in Catlin et al. 2015 and Friedrich et al. 2015), but their fidelity to their natal region is very high. Genetic evidence (Miller et al. 2010) is consistent with observed dispersal patterns. Notwithstanding occasional long-distance movements, population growth and stability are heavily dependent on survival and productivity of regional populations.

### *Survival*

Weithman et al. (2019) reported similar average adult true survival of piping plovers breeding at study areas in New York and North Carolina; true annual survival of hatch year birds was variable at both study areas and lower in North Carolina. Continuing research at these sites, as well ongoing studies in eastern Canada, Massachusetts, Rhode Island, New Jersey, and Virginia may shed light on the role of survival rates in explaining apparent differences among productivity rates needed to sustain stationary breeding populations of Atlantic Coast piping plovers that were previously noted by Calvert et al. (2006) and Hecht and Melvin (2009a). As discussed below, however, survival rates and their drivers may include environmental factors in the migration and wintering portions of the annual cycle, as well as chick-rearing conditions.

Findings of Gibson et al. (2018) demonstrate the important role of anthropogenic disturbance at eight geographically proximate North Carolina, South Carolina, and Georgia wintering sites on piping plover body condition, survival, and site fidelity. Piping plovers using recreationally disturbed sites with significant modifications to their habitat had approximately 10 percent lower true annual survival rates (i.e., survival corrected for permanent emigration from the study area) and were 7 percent lighter than those in less disturbed sites. Movements away from specific wintering sites were uncommon, regardless of disturbance regime, but individuals that moved to new wintering locations had higher probabilities of annual survival relative to their site-faithful counterparts. Despite substantial variation among the wintering sites, Gibson et al. (2018) found little support for the hypothesis that an individual's breeding population influenced annual survival.

Gibson et al. (2018) were not able to identify the mechanism that drove the differences in body condition and annual survival because study sites that experienced major shoreline modifications also experienced greater rates of recreational beach use. Thus, worse body condition of piping plovers at disturbed sites may have been due to decreases in invertebrate numbers following coastal modifications, reduced foraging efficiency due increased disturbance, or because lower condition birds are more common at disturbed sites. Since the most consistent finding of population viability analyses for piping plovers is that extinction risk is highly sensitive to small declines in adult and/or juvenile survival rates (e.g., Melvin and Gibbs 1996, Calvert et al. 2006, Brault 2007), the results of Gibson et al. (2018) point to the importance of wintering range studies to elucidate environmental drivers of adult and juvenile survival.

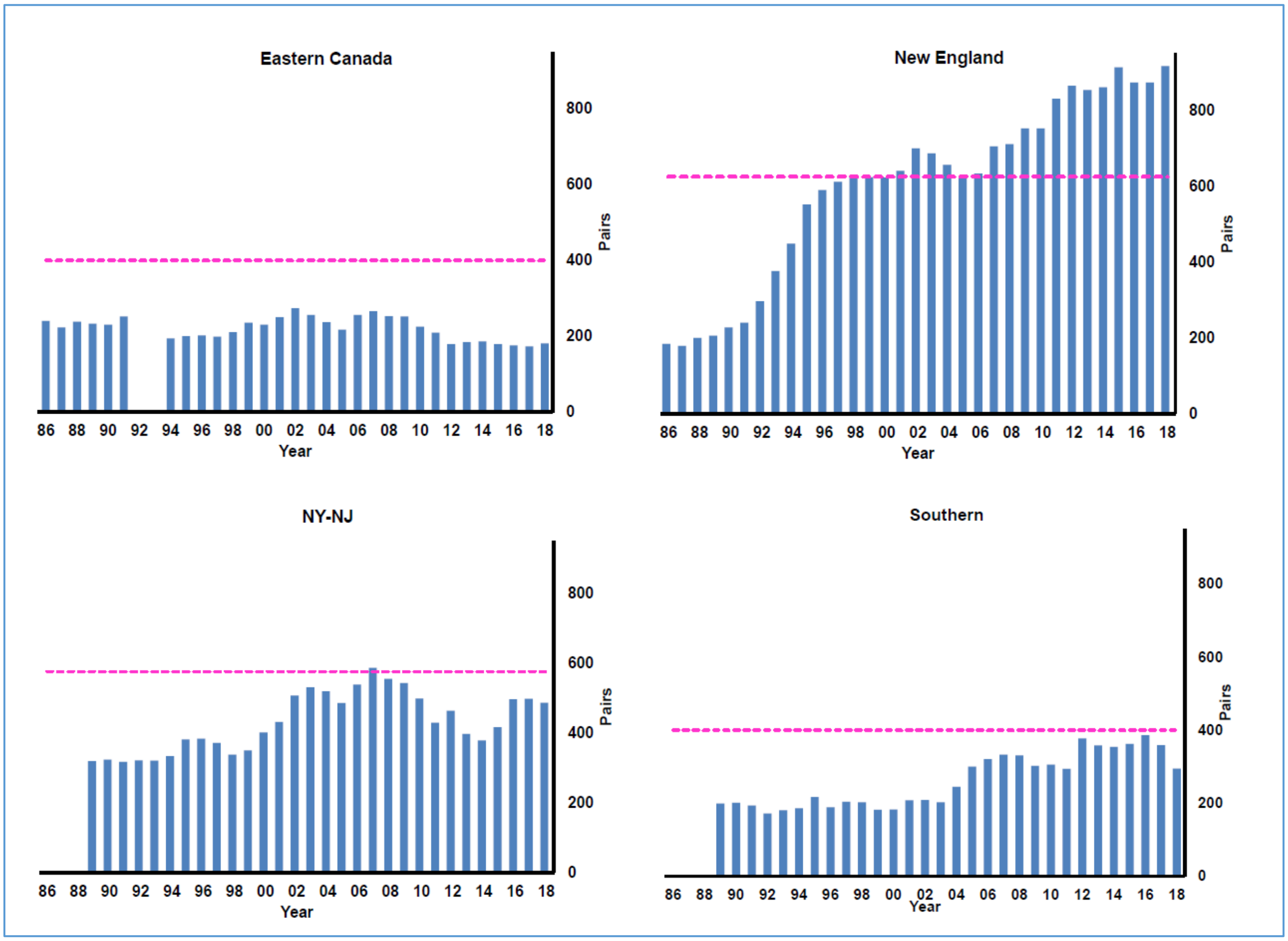


**Figure AC1**. Abundance of Atlantic Coast piping plover breeding pairs by recovery unit, 1986–2017. Blue bars denote the annual pair estimate. Dashed pink lines indicate abundance objectives established in the revised recovery plan.

Although there is, as yet, no evaluation of the long-term effect of nesting and chick-rearing conditions on Atlantic Coast piping plover survival rates, a Missouri River study further illustrates the importance of full life-cycle modeling to understand this important vital rate. Catlin et al. (2014) found that piping plover chicks on the Missouri River that were heavier at fledging had a higher survival rate (as much as 9 percent) than lighter plovers during their first year as well as in subsequent years, which could make a significant impact on population viability and an individual's lifetime fitness. The chicks grew faster and achieved larger body size if they hatched earlier in the season, were exposed to lower nesting densities, and were hatched in higher quality habitat compared to other chicks.

***Summary***

Since ESA listing in 1986, increased abundance of Atlantic Coast piping plovers has reduced near-term vulnerability to extinction, but only the New England recovery unit has been able to reach and sustain its abundance target. Breeding abundance in the Eastern Canada, New York-New Jersey, and Southern recovery units was lower in 2018 than in 2008.

New information regarding factors affecting Atlantic Coast piping plovers throughout the annual cycle, including the effect of anthropogenic disturbance in the wintering range on annual survival rates, shows that demography is more complex than previously understood. Demographic modeling using this new information has the potential to better inform the relationships among vital rates and could facilitate more effective conservation efforts.

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

No new information. See section AC 2.5.2.3 of the 2009 Piping Plover 5-Year Review.

#### AC 2.5.2.4 Taxonomic classification or changes in nomenclature:

No new information. See sections 2.1.2 and AC 2.5.2.4 in the 2009 Piping Plover 5-Year Review.

#### 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. This pattern reflects natural and human-induced habitat fragmentation as well as the species' territorial behavior.

Breeding Atlantic Coast piping plovers became less evenly distributed among the four recovery units between 2008 and 2018. The percentage of the population breeding in New England increased from 37 to 49 percent, but declined in the other three recovery units during that period.

The percentage breeding in Eastern Canada declined to 10 percent in 2018, contrasting with 14 percent in 2008 and 24 percent in 1989 (USFWS 2019).

As discussed in section AC 2.5.2.6 (below), piping plovers increased in areas where Hurricane Sandy and other storms created habitat. In addition, piping plovers have established and increased at Fowler Beach on Prime Hook National Wildlife Refuge, a site on Delaware Bay that was created in 2015 as part of a wetland restoration project. Two patterns of concern, however, include a recently declining population in North Carolina and changes in the distribution of piping plovers in New Jersey. The North Carolina population declined 59 percent between 2012 and 2018, following extremely low productivity in 2014, 2016, and 2017 (Schweitzer 2018). Between 2002 and 2018, the number of breeding pairs in Cape May County, New Jersey has declined from 43 pairs (31 percent of the state population) to only 3 pairs (3 percent of the statewide total) (C. Davis, pers. comm. 2018b, Heiser and Davis 2018).

### AC 2.5.2.6 Habitat use and conditions:

Information that has become available since 2009 continues to support the importance of low, sparsely-vegetated beaches juxtaposed with abundant moist foraging substrates for recovery of Atlantic Coast piping plovers (USFWS 1996, 2009). Consistent with previous site-based studies, piping plovers at 83 subsites in 8 states from Maine to North Carolina established the most nests on washovers (despite their relative rarity) in 2014 and 2015 (Zeigler et al. 2017). To a lesser extent, nests were also located within backshore areas and dune complexes (“low mounds … of loose, windblown granular material, capable of movement from place to place but retaining its characteristic shape … [as well as] low-lying areas between dunes”). Nests were established in areas with less than 20 percent herbaceous vegetation on substrates consisting of sand and shell fragments, gravel, or cobble as well as predominantly sandy substrates. Analyses in progress (S. Zeigler, USGS, pers. comm. 2019) are examining commonalities, as well as latitudinal differences in nest site selection patterns within the U.S. Atlantic Coast range, including apparent increasing reliance of breeding piping plovers on washover habitats with decreasing latitude (Sturdivent et al. 2016, 2018). In eastern Canada, Boyne et al. (2014) found fine-scale differences between nest sites on the Gulf of St. Lawrence and the Atlantic Coast. While width and slope were identified as key factors in site-level selection in both areas, piping plovers along the Gulf of St. Lawrence nested in flatter sections of beach with a high proportion of mixed substrate and less wrack.

Several new studies illustrate the response of piping plovers to storm events that create habitat and to anthropogenic activities that accelerate habitat degradation. Schupp et al. (2013) document a rapid population increase on northern Assateague Island, Maryland in response to habitat formed and maintained by a series of strong storms during the period 1991-1998 and a decline following construction of a low foredune and subsequent vegetation encroachment. Granger et al. (2018) found that 83 percent of immigrants and 80 percent of local recruits nested in newly created habitats (i.e., overwashes, breach fill, or restoration areas) on Fire Island and the western end of Westhampton Island, New York in the years following Hurricane Sandy. In the breeding season immediately following Hurricane Sandy, 57 percent of all new nesting locations on Long Beach Island, New Jersey; 52 percent of new nesting locations on the Rockaway Peninsula, New York; 36 percent of nests on Pullen Island, New Jersey; and 14 percent of nests on Cedar Island, Virginia were established in newly suitable habitat (Zeigler et al. 2019). At the New Jersey sites—where habitat continued to increase during the 2 years post-Sandy—a high percentage of nests were also established in new habitat in the 2014 breeding season, with 57 percent and 65 percent of all nests occurring in newly created habitat on Long Beach and Pullen islands, respectively (Zeigler et al. 2019). Case studies of eight piping plover irruptions (six on the U.S. Atlantic Coast and two on the Northern Great Plains) following habitat creation events underscore the important role of habitat in piping plover demography (Robinson et al. 2019; see also Fraser and Catlin 2019, Hunt et al. 2017, 2018a). In eastern Canada, Bourque et al. (2015) found that the number of fledged piping plover young increased 3 years after a major storm, suggesting that storm occurrence is a factor affecting habitat quality for chicks. However, the relationship was much weaker for the number of nesting pairs, indicating that storms may exert less influence on breeding abundance in eastern Canada than elsewhere in the species' range. The responses of plover abundance and distribution to habitat changes, summarized above, suggest that the effects of density may affect the full suite of demographic rates of Atlantic Coast piping plovers, as Catlin et al. (2019) have demonstrated with respect to piping plovers breeding on the southern Missouri River.

Maslo et al. (2016) compared habitat models and niche overlap for four beach-nesting birds in New Jersey. Sixty-six percent of piping plover nesting habitat in New Jersey also provided suitable habitat for least terns (*Sterna antillarum*), black skimmers (*Rynchops niger*), and American oystercatchers (*Haematopus palliates*), and another 28 percent of the piping plover habitat was suitable for two of the three other species. While piping plover habitat (649 ha) encompassed 86 percent of least tern habitat (totaling 592 ha), it only overlapped 15 percent of the more broadly distributed black skimmer habitat and only 13 percent of American oystercatcher habitat (3606 and 4920 ha, respectively).

### AC 2.5.3 Five-factor analysis

In the following sections, we update information contained in the 1985 final rule, 1996 recovery plan, and the 2009 5-year review about factors affecting the piping plover in its Atlantic Coast breeding range. We also consider how risks to Atlantic Coast piping plovers from the major ongoing and reasonably foreseeable future threats would be affected if ESA protections were removed.

Unmanned aerial systems (UAS, commonly called drones and discussed under Factor E) are the only new category of potential threats that has been identified since 2009, but new information provides increased understanding and elucidates interactions among many previously identified threats. This information also compliments the assessment of factors affecting all three breeding populations in their shared coastal migration and wintering range (see section WM 2.2.2)

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

The wide, flat, sparsely vegetated barrier beaches, spits, sandbars, and bayside flats preferred by piping plovers in the U.S. are formed and maintained by natural forces and are thus susceptible to degradation caused by development and shoreline stabilization activities. Dredging of inlets can affect spit formation adjacent to inlets, as well as ebb and flood tidal shoal formation. Jetties stabilize inlets and cause island widening and subsequent vegetation growth on the updrift inlet shores; they also cause island narrowing and/or erosion on the downdrift inlet shores. Seawalls and revetments restrict natural island movement and exacerbate erosion. Although dredge and fill projects that place sand on beaches and dunes may restore lost or degraded habitat in some areas, in other areas sediment placement, installation of sand fences, and beach scraping degrade habitat quality by altering the natural topography and sediment composition, depressing the invertebrate prey base, and hindering habitat formation and maintenance that would otherwise occur during storms. Detailed summaries of scientific literature describing the effects of habitat modifications to tidal inlets and sandy ocean beaches are provided by Rice (2016, 2017) and ratified by Guilfoyle et al. (2019).

Rice (2016) presents a systematic inventory of habitat modifications to tidal inlets in the piping plover's Atlantic Coast breeding range. Over two-thirds (68 percent) of the 412 sandy tidal inlet habitats from Georgetown, Maine, to North Carolina that were open in 2015 have been modified within the last century or so by human actions, including the construction of hard stabilization structures, dredging activities, sediment mining, and the artificial opening and closing of inlets. The proportion of modified inlets is highest in New York – New Jersey (73 percent) and lowest in the Southern recovery unit (51 percent). Fifty-nine percent of inlets are modified with hard structures, and 44 percent have been dredged. Nine of the inlets that were open in 2015 have been relocated, and 45 inlets have been artificially opened. Forty-eight inlets (not included in the inventory of inlets open in 2015) have been artificially closed. New England has the greatest number of unmodified inlets (71 inlets), but inlets in New England and along the north shore of Long Island and Peconic Bay in New York tend to be much smaller (and provide less habitat) than those from Montauk Point (at the eastern end of the south shore of Long Island) to North Carolina. There are only 2 unmodified inlets (out of 23) from Montauk, New York, to Chincoteague, Virginia. In contrast, 15 contiguous unmodified inlets are located south of Chincoteague, Virginia.

A concurrent inventory of modifications to sandy ocean beaches (Rice 2017) found that 45 percent of the sandy beaches in the U.S. breeding range of the Atlantic Coast piping plover were developed in 2015. Twenty-seven percent of the sandy shoreline has been modified with armor (hard structures). Twenty-four percent of sandy ocean beaches have been modified with sediment placement, including 62 percent on the south shore of Long Island, 63 percent in New Jersey, and 100 percent in Maryland.

Sandy beach development and modification are continuing threats. A comparison of the levels of development modifying sandy beaches from Maine to Virginia in the 1970s (reported by the Heritage Conservation and Research Service) and 2015, found substantial increases in every state except Maine, Rhode Island, and New York (Rice 2017). Forty-two percent of overwash that occurred between Connecticut and Maryland during Hurricane Sandy occurred on developed shoreline where it could not create habitat; this includes 48 and 71 percent of the overwash that occurred on the south shore of Long Island and New Jersey, respectively (Rice 2015). Zeigler et al. (2019) found that the amount and longevity of habitat created by Hurricane Sandy, especially the proportion of high quality overwash habitats, was inversely related to the amount of development in their study areas.

In the 3 years after Hurricane Sandy (2012 to 2015), the USACE placed more than 26 million cubic yards of sediment along 165 miles of sandy ocean beaches from Rhode Island to Virginia, including 50 miles of previously unmodified sandy beach habitat. Another 76 miles of sediment placement was planned for implementation in 2016-17 or proposed (Rice 2017). During the same time period (2012 to 2015), sand fences were present on 15 percent of the sandy ocean beach shoreline from Maine to North Carolina, including 46 percent, 47 percent, and 60 percent, respectively, of the south shore of Long Island, New Jersey, and Delaware. In addition, 4 percent of sandy beaches, including 18 percent of the south shore of Long Island and 20 percent of New Jersey, were modified by scraping between 2012 and 2015 (Rice 2017). As of 2015, only 31 percent of sandy beach habitat in the piping plover's U.S. Atlantic Coast breeding range remained unmodified (T. Rice, Terwillinger Consulting, pers. comm. 2018).

Indirect effects of sediment placement projects include changes in the abundance and composition of invertebrates that comprise piping plover prey. A comparison of nourished and control sections of eight southern California beaches found major declines in almost all taxa following sediment deposition. Mole crabs (*Emerita analogia*) bloomed at half the beaches 4 months after replenishment (then declined to baseline), but polychaetes showed a strong nourishment-induced reduction in abundance that resulted in a more than twofold reduction in overall invertebrate abundance 15 months after placement of the sediment (Wooldridge et al. 2016).

In addition to physical habitat loss and degradation due to development and modification of sandy ocean beaches and tidal inlets, functional loss of habitat occurs when habitat is insufficiently protected from human disturbance that can include unrestricted motorized and nonmotorized recreation, beach-raking, and similar activities. Under a scenario of protections that include symbolic fencing of anticipated nesting area, and prohibitions on beach-rakes, vehicles, and dogs, Hurricane Sandy resulted in a net increase of 289 ha of habitat in New Jersey. Because management agreements were based on pre-storm habitat distributions, however, actual gains were reduced to 16 ha (Maslo et al. 2019). On Fire Island and Cupsogue County Park, New York, only 58 percent of suitable habitat was protected from recreational use in 2015, and only 6 of 151 piping plover nests were initiated in unprotected areas in 2015-2017 compared to an expected 83 if nests had been placed randomly with respect to protection (Walker et al. 2019). At the same study area, analysis indicated that recreational activities in some areas pushed plover chicks into foraging habitats with lower food availability, resulting in lower feeding rates, slower growth, and decreased survival (DeRose-Wilson et al. 2018). See additional information about disturbance by humans and dogs under Factor E (below).

New information documents that habitat loss and degradation, including functional habitat loss due to insufficient protection from human disturbance, are widespread continuing threats to breeding Atlantic Coast piping plovers that reduce carrying capacity and productivity. As discussed further under other factors, beach modifications may also force piping plovers into sections of the beach where they are most likely to conflict with human recreation activities (Abouelezz 2013, USFWS 2014, Gieder et al. 2014) and human-abetted dunes may increase the birds' exposure to key predators (Stantial and Cohen 2016). However, the most serious long-term threat from current and continuing artificial beach stabilization likely lies in reducing the natural mechanisms by which beaches adapt to sea-level rise (FitzGerald et al. 2008, Seavey et al. 2011, Sims et al. 2013, and Lentz et al. 2016, discussed under Factor E).

As discussed further under Factor D, avoidance and reduction of some adverse effects to Atlantic Coast piping plovers and their habitat from activities of federal agencies that modify tidal inlets and sandy beaches has been accomplished through formal and informal ESA section 7 consultations with the USACE, the Federal Emergency Management Agency (FEMA), and other agencies. Alternative mechanisms to address widespread and important continuing threats from habitat modification activities -- including direct disturbance from construction projects, indirect effects of habitat loss and degradation, and impeding natural mechanisms by which beaches adapt to sea level rise – have not yet been identified. Hence, habitat loss and degradation are likely to worsen in the absence of ESA protections.

### *Habitat protection and restoration tools and efforts*

(Maslo et al. (2011) provide target values for design of nesting habitat in New Jersey (less than 10 percent vegetative cover on the backshore, 13 percent vegetative cover on the primary dune, 17-18 percent shell/pebble cover, dune height less than or equal to 1.1 m, and dune slope less than or equal to 13 percent), as well as trigger values signaling the need for adaptive management to maintain suitable conditions, and threshold values after which the habitat becomes unsuitable. At Lower Cape May Meadows, New Jersey, Maslo et al. (2012) found that three artificial tidal ponds were a valuable foraging habitat that supported high foraging rates of both adults and chicks and that high productivity relative to reference sites during the first 5 years post-construction could be linked to the presence of the ponds. Unfortunately, the project failed to sustain early benefits, including numbers of breeding pairs, pointing to the need for further study of factors such as placement of ponds within the landscape, the target density for vegetation, and the thresholds at which predation is likely or chick mobility is restricted (Maslo et al. 2012). Other restoration efforts in New York and New Jersey have produced limited and short-lived benefits for piping plovers (USACE 2008, McIntyre and Heath 2011, New Jersey Audubon Society et al. 2018). The number of breeding pairs at one of two habitat restoration areas created on Fire Island in 2015 increased from one to eight in 2018, but an increase at the second restoration area was very short-lived (Walker et al. 2019). Fraser and Catlin (2019) note that human-placed substrates and vegetation management attract many *Charadrius* species, but that the results are often fleeting or dependent on frequent maintenance.

Habitat enhancement for Atlantic Coast piping plovers must be regarded as experimental. Most projects implemented to date have, at best, produced benefits of limited scope and duration. Adaptive management may be a useful tool for improving the results of habitat enhancement projects if it is grounded in testable hypotheses, multiple performance criteria, and both spatial and temporal controls (McIntyre and Heath 2011, Catlin et al. 2015). Furthermore, the demographic effects will require evaluating the fitness of birds using restored vs. pre-existing habitat by comparing a suite of vital rates (e.g., nest success, chick survival, reproductive output, adult survival, immigration, and emigration) over the life cycle of the created habitat (Fraser and Catlin 2019). These challenges highlight the importance of protecting naturally created habitats. Maslo and Pover (2018) provide a *Protocol for Assessing Beach Nesting Bird Habitat Following Coastal Storms*.

Guilfoyle et al. (2019) articulate the potential benefits of a section 7(a)(1) conservation planning approach to implementation of best management practices for coastal engineering projects that benefit Atlantic Coast shoreline-dependent species, including piping plovers. To date, however, consultations under section 7(a)(2) of the ESA are the primary mechanism for consideration of conservation measures to protect, manage, and enhance piping plover habitat and for their incorporation into projects that are implemented, authorized, or funded by federal agencies such as the USACE and FEMA. Absent ESA requirements, we are aware of few alternative mechanisms[8] for implementing, monitoring, and refining piping plover habitat conservation projects and practices.

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

Although piping plover populations were severely depleted by uncontrolled hunting in the late 1800s (USFWS 1985, 1996), there is no information indicating that overutilization is a recent or current threat to the piping plover. The *Atlantic Flyway Shorebird Business Plan* (AFSI 2015) describes shorebird hunting as a threat, but extremely few piping plovers have been observed in

[8] The Massachusetts Endangered Species Act and Wetlands Protection Act provide for review of some types of activities that take or adversely modify habitat of State-listed wetland species. As long as the species remains State-listed, these protections should remain.

the countries where the hunting pressure has been identified (B. Andres, USFWS, pers. comm. 2018; Watts and Turrin 2016).

Cautious expansion of Atlantic Coast piping plover banding efforts in support of clearly defined research projects beginning in 2001 has occurred without observation of injury rates that occurred in the 1980s (see Lingle et al. 1999 and section AC 2.5.3.2 in the 2009 Piping Plover 5-Year Review). Recovery permits specify placement locations (upper legs only), materials, and sealing methods and require close monitoring and prompt reporting of observed leg injuries. Attachment of glued radio transmitters to breeding piping plovers in Massachusetts, Rhode Island, and New Jersey did not affect the apparent survival rates of the adults (Stantial et al. 2019) or the survival of their nests or chicks (Stantial et al. 2018a).

Capture and marking of Atlantic Coast piping plovers for scientific purposes are carefully regulated and monitored by the USFWS and Canadian Wildlife Service and are, therefore, of low concern. Furthermore, awareness of the history of banding injuries to Atlantic Coast piping plovers among the research community, the U.S. Geological Survey Bird Banding Lab, 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 2009 Piping Plover 5-Year Review stated that there is no evidence that disease is a current threat to Atlantic Coast piping plovers. New information about the occurrence of disease includes an August 2016 case of 4 piping plovers among 15 sick or dead shorebirds collected on the Cape Cod National Seashore in Massachusetts (National Wildlife Health Center 2016). No cause was determined and requests for observations of sick, weak, or dead shorebirds at other Cape Cod beaches resulted in no further reports. In 2019, a fledged young of the year at the Cape Cod National Seashore died from a combination of emaciation and a large mass caused by infection with avian poxvirus (National Wildlife Health Center 2019). Avian pox may have been the cause of lesions observed on the feet of an adult piping plover at Revere Beach, Massachusetts in 2019 (S. Riley, Massachusetts Department of Conservation and Recreation, pers. comm. 2019). Notwithstanding the isolated cases described above, current evidence indicates that disease is not a threat to Atlantic Coast piping plovers, but continued vigilance is appropriate to detect any emerging diseases.

***Predation***

Predation remains a pervasive, persistent, and serious threat to breeding Atlantic Coast piping plovers, and implementation of conservation measures for addressing predation threats is time-consuming and costly (USFWS 2009). Recent and ongoing studies described below supplement earlier information about the nature of this threat and related management efforts.

At Cape Hatteras National Seashore, North Carolina, Kwon et al. (2018) found that daily survival rates of piping plover nests with evidence of ghost crab presence were significantly lower than nests without ghost crabs, suggesting that an earlier study by Wolcott and Wolcott (1999) may have underestimated ghost crab predation on piping plover nests. While relevance to the Atlantic Coast population is unknown, we also note new information regarding the potential of increasing merlin populations to significantly affect recovery rates of Great Lakes piping plovers (Saunders et al. 2018, see also sections GL 2.3.3.3 of this document).

As mentioned under Factor A, modifications to beach habitat may increase exposure of piping plovers to key predators. Preliminary results of predator occupancy surveys in southern New Jersey found that the probability of habitat use by red foxes decreased as distance to the primary dune increased (Stantial and Cohen 2016, Stantial 2017). Additional analyses are currently in progress (Stantial, pers. comm. 2018c).

A decision support tool has been developed to evaluate the benefits and risks of predator exclosures. Cohen et al. (2016, 2019) describe methods to examine trade-offs between decreased nest predation and increased probability of nest abandonment in light of evidence from the Great Lakes and eastern Canada (Roche et al. 2010, Barber et al. 2010) that apparent nest abandonment is caused by breeding season mortality of incubating adults. Comparison of model results by Darrah et al. (2018) found that a fixed-effects model was less well-supported than a model that included the random effect of site, and the fixed-effect model underestimated the risk of exclosure use by 16 percent. The random-effects model estimated a range of 1–6% probability of abandonment for nests not protected by exclosures across sites and 5–41% probability of abandonment for nests with exclosures, suggesting that the magnitude of exclosure-related abandonment is site-specific. No nest or site-level environmental covariates predicting effects of exclosures on predation or abandonment probability nest success have been identified, but site-specific predation and abandonment risk can be predicted using early-season data (Darrah and Cohen 2016). Tests of data from three sites indicated that pooled multi-year data from past years can improve the reliability of exclosure performance predictions for the next season (Cohen et al. 2019).

A study of behavioral ecology and population characteristics of striped skunks (*Mephitis mephitis*) on piping plover nesting beaches on Martha's Vineyard, Massachusetts recommends reducing anthropogenic shelter and food subsidies to reduce overall carrying capacity of coastal skunk populations (Johnson 2016). At beaches where exclusion fencing is not an option for protecting eggs of rare and threatened birds, spring trapping could be effective in reducing skunk densities for most of the nesting season because Johnson's data indicates that female territories would remain vacant until late summer. A study of red fox (*Vulpes vulpes*) movements, habitat selection, and demography on Fire Island, New York is underway with a goal of improving the efficacy and efficiency of management to protect piping plovers and other beach-nesting birds (Granger et al. 2018).

Several projects illustrate the complexity of implementing effective predation management in dynamic environments. In 2017, a structured decision-making workshop developed a framework for using expert opinion to guide predator removal decisions for piping plovers and least terns (Stantial et al. 2018b). In a subsequent analysis, Stantial and Cohen (2018c) used historical nesting data from 22 Massachusetts sites to evaluate the effectiveness of predator removal and make recommendations to adaptively manage predator removal to benefit plover reproductive success in the future. Guidance and best practices for coordination of predation management for piping plovers and three other temperate breeding Atlantic Coast shorebirds were developed under the auspices of the AFSI (Hunt et al. 2018b).

Research and decision support tools provide important information to beach managers working to reduce adverse effects of predation pressure on survival of piping plover nests, chicks, and adults. The ESA has been and continues to be a major impetus for funding this research. Furthermore, as discussed further under Factor D, the ESA plays an important role in implementation of predator management via section 7 consultations and via a statewide habitat conservation plan (HCP) for piping plovers in Massachusetts. Although threats from continuing human-abetted predation pressure remain widespread, there are no alternative mechanisms to assure continuation and future refinement of ongoing efforts. Furthermore, the willingness of state and private partners to continue predation management efforts in the absence of ESA status is uncertain.

### AC 2.5.3.4 Factor D. Inadequacy of existing regulatory mechanisms:

Since the purpose of this 5-year review is to determine whether Atlantic Coast piping plovers continue to warrant protection under the ESA, we focus here on the sufficiency of other (i.e., non-ESA) existing regulatory mechanisms to address the continuing and foreseeable threats discussed under Factors A, C, and E (in the absence of the ESA. Implementation of ESA protections since 1986 has resulted in substantial progress towards Atlantic coast piping plover recovery since the species' 1986 listing, although it has not been sufficient to attain abundance and productivity criteria established in the recovery plan. We start by summarizing ongoing applications of ESA protections to shed light on how the species' status might be affected by the absence of those protections. We then consider available information regarding the extent of alternative mechanisms providing protection to piping plovers and their habitat.

***Role of ESA protections***

The *Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take under Section 9 of the Endangered Species Act* (USFWS 1994, 2015) provide consistent and widely (albeit sometimes insufficiently) implemented guidance to landowners and other groups regarding practices for avoiding take. Likewise, *Guidelines for Managing Fireworks in the Vicinity of Piping Plovers and Seabeach Amaranth on the U.S. Atlantic Coast* (USFWS 1997) are grounded in a presumption of compliance with ESA section 9 protections against killing, wounding, harming, and harassing listed species. Maslo et al. (2018) estimate that, absent current management of human disturbance, less than 3 percent of habitat currently available to piping plovers in New Jersey would be suitable.

Many beneficial activities, as well as avoidance and reduction of adverse effects to Atlantic Coast piping plovers have been implemented through formal and informal ESA section 7 consultations conducted with the USACE, the FEMA, the NPS, the U.S. Coast Guard (USCG), the Bureau of Ocean Energy Management (BOEM), the National Aeronautics and Space Administration (NASA), USFWS National Wildlife Refuge System (NWRS), and other Federal agencies. In the 5 years between October, 2013 and September 2018, the USFWS has engaged in 382 informal consultations and 32 formal consultations for piping plovers in the portion of the breeding range from Maine to Virginia (S. Nystrom, USFWS, pers. comm. 2018). Modification of tidal inlets and sandy beaches, including construction of hard stabilization structures, dredging of inlets, and sediment placement (discussed under Factor A) are conducted or authorized by the USACE, while the FEMA receives applications to fund purchase and placement of sand fences. As described in the section on threats from climate change under Factor E (section AC 2.5.3.5, below), ongoing and near-term habitat modifications are reducing the mid- and long-term resiliency of piping plover habitat to adapt to accelerating sea level rise. Hence, ESA section 7 consultations on habitat modification proposals play an important role in progress towards piping plover recovery and maintenance of habitat formation processes.

Recognition of the threats to piping plovers from human-abetted predation pressure is often reflected in the commitments and activities of beach managers and other agencies and organizations. Although not directly mandated by ESA requirements, predation management (including the use of exclosures and targeted predator removal) is provided as a conservation measure in many section 7 biological opinions, and predation management is the primary mechanism for mitigation of take authorized under a statewide HCP for beach recreation in Massachusetts (discussed further below). Predation management is also conducted outside the framework of ESA mandates, but it is uncertain whether landowners and other partners will be as willing to conduct these activities if piping plovers are no longer classified as a threatened species under the ESA. For example, Messmer et al. (1999) found greater public support for predator removal when the beneficiary species is classified as threatened. Thus, ESA listing plays an important role in current activities to reduce predation threats.

Recent and ongoing development of tools such as an inventory and monitoring protocol (King et al. 2018), a decision support tool for use of predator exclosures (Darrah and Cohen 2017), and a protocol for assessing beach-nesting bird habitat following coastal storms (Maslo and Pover 2018) can improve and streamline piping plover conservation. Development of these tools has primarily been funded by the USFWS under the auspices of its authorities under the ESA. Furthermore, their implementation currently depends, in large measure, on the section 7 and section 9 protections of the ESA. Likewise, tools and strategies for communication with stakeholders (USFWS 2017) support, but are not a substitute for implementation of activities to reduce disturbance by humans and pets.

***Current adequacy of other existing regulatory mechanisms and their potential role in piping plover conservation***

The 11 State wildlife agencies play key roles in current conservation efforts, and they would be logically appropriate entities to lead piping plover conservation in the absence of the ESA. The exact nature of those roles, however, would reflect each state's regulatory authorities and ability to assume primary responsibility for specific protections from the primary threats. Consideration must also be given to how current challenges associated with reliability of funding for annual labor-intensive management activities (see Factor E) would be affected by absence of ESA protections. The sufficiency of each state's statutes and agency resources to conserve piping plovers in their Atlantic Coast breeding range in the absence of ESA listing is currently undetermined.

In 2016 Massachusetts Division of Fisheries and Wildlife (MDFW) received an incidental take permit for implementation of a 26-year HCP that promotes piping plover recovery while allowing some management flexibility (Massachusetts Division of Fisheries & Wildlife and ICF International 2016). Although it contains no explicit provisions for management of piping plovers after delisting, the Massachusetts HCP provides one potential model for transition to post-ESA conservation of Atlantic Coast piping plovers. The Massachusetts HCP, however, is tailored to the priorities of local land managers and MDFW's legal authorities. Furthermore, the Massachusetts HCP does not address Federal activities, including activities of the USACE or protection of plovers on lands managed by the NPS and the NWRS, as these agencies achieve ESA compliance through the section 7 process.

Potential agreements and other mechanisms for post-ESA protections for piping plovers are not limited to the state wildlife agencies. Federal lands, especially those managed by the NWRS and seven units of the NPS, are subject to other conservation authorities including the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd) and the National Park Service Organic Act (16 U.S.C. 1). Whether and to what extent these agencies would commit to conservation of piping plovers in the absence of the ESA has yet to be ascertained. The USACE's paramount role in conducting and authorizing widespread modifications to the Atlantic Coast piping plover's tidal inlet and sandy beach habitats makes identification of changes in that agency's post-ESA consideration of piping plovers and their habitat a key (but as yet unknown) determinant of how the species would be affected by removal of ESA protections. The implications for the effects of actions by other Federal agencies (e.g., BOEM, USCG, NASA) that currently consult under section 7 are also unknown.

Several tools that focus on a broad suite of shorebird species (e.g., guidance and best practices for predation management to benefit temperate breeding shorebirds (Hunt et al. 2018b) and guidance and best practices for evaluating and managing disturbances to migrating shorebirds (Mengak et al. 2019)) have been developed to meet needs identified by the Atlantic Flyway Shorebird Initiative (AFSI 2015). These new resources have potential to make important contributions to piping plover conservation, but their application is still in early stages and the extent to which implementation for piping plovers will rely on ESA authorities is not yet known.

In the past, enforcement of the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-712) has sometimes played a limited role in protection of piping plovers. However, the 2017 legal reinterpretation constrains the MBTA prohibitions to directed (intentional) killing and wounding (Office of the Solicitor, U.S. Department of Interior 2017), thus making that statute inapplicable to protection of piping plovers from almost all current and foreseeable threats.

The Canadian Species at Risk Act (SARA), enacted in 2002, provides many protections for the *melodus* subspecies of piping plovers (listed as endangered) in Canada that parallel those that the ESA currently confers to the species in the United States. In the absence of ESA protections, SARA would continue to provide protection for piping plovers when breeding in eastern Canada, but would not provide protection to these birds or habitat that they use for feeding and roosting in their migration and wintering range outside of Canada.

The ESA currently plays a critical role in progress toward piping plover recovery in their Atlantic Coast breeding range. Because the major threats are being managed, not eliminated, absence of ESA protections would create a large gap in mechanisms to address continuing threats from habitat loss and degradation, disturbance by humans and pets, predation, and accelerating sea level rise. Management of these threats is necessary for piping plovers to reach and sustain abundance and distribution of breeding pairs that will ensure representation, redundancy, and resiliency of Atlantic Coast piping plovers. 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.

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

***Unmanned aerial systems (drones)***

Unmanned aerial systems (UAS) are the only new category of potential threats to piping plovers in their Atlantic Coast breeding range that has been identified since the 2009 5-year review. Unmanned aerial systems have a variety of commercial, recreational, and other uses, as well as potential utility for wildlife research and monitoring. Anecdotal observations document disturbance to piping plovers caused by UAS (e.g., A. Protus, USFWS, pers. comm. 2019), but plover responses may vary depending on the size and type of UAS, its operation (e.g., altitude, speed, flight angle), and stage in the birds' annual cycle (Vas et al. 2015). Available information indicates that threats from UAS are currently low, but more information is needed to determine the likelihood that they will increase in the future.

***Disturbance by humans and dogs***

The 2009 5-year review stated that disturbance by humans and dogs is a continuing widespread and severe threat to Atlantic Coast piping plovers, requiring annual implementation of labor-intensive management during the entire breeding season. New information, summarized below, provides additional insight into the mechanisms by which disturbance affects piping plover breeding success. Furthermore, these studies indicate that implementation of management recommendations in the *Guidelines for Managing Recreation* (USFWS 1994, 2015) is sometimes insufficient and may require clarification.

DeRose-Wilson et al. (2018) document significantly lower rates of survival to fledging for piping plover chicks hatched in areas with high recreational use compared with chicks hatched in areas with low recreational use. Chicks hatched in high use areas fledged at a later age, and chicks exposed to all levels of disturbance had lower daily survival rates on weekends (when recreational activity was high) than on weekdays. On weekends, chicks spent less time in habitats with higher prey abundance, less time foraging, and made fewer foraging attempts per minute than they did on weekdays. Thus, current management in some locations with medium and high human use may not assure sufficient foraging opportunities for plover chicks[9].

Maslo et al. (2018) demonstrate the importance of managing human disturbance to prevent degradation of habitat suitability for piping plovers and least terns in New Jersey. Absent the current conservation network, less than 3 percent of nesting habitat would remain suitable for breeding piping plovers in New Jersey. Furthermore, management agreements tied to fixed portions of the shoreline prevented adequate protection of habitats created or improved by Hurricane Sandy that could have more than doubled the current suitable habitat (Maslo et al. 2019). .As noted under Factor A, habitat modification may limit piping plover nests and brood-rearing to sections of the beach where they are most likely to conflict with human recreation. Gieder et al. (2014, Figure 2) and USFWS (2014, Figure 11) illustrate shifts in distribution of piping plover nests towards the ocean shoreline as revegetation followed dune construction. Following overwash that scoured vegetation during Hurricane Sandy, Abouelezz (2013) observed a shift in piping plover nesting locations away from the Breezy Point shoreline at the Jamaica Bay Unit of the Gateway National Recreation area; mean distance of piping plover nests from the mean high tide line increased from 33.4 m in 2012 to 83.9 m in 2013.

[9] USFWS Guidelines (1994) state: Data from various sites distributed across the plover's Atlantic Coast range indicates that buffers larger than 50 m may be needed in some locations (Table 3 in USFWS 1996). This may include situations where plovers are especially intolerant of human presence, or where a 50 meter-radius area provides insufficient escape cover or alternative foraging opportunities for plover chicks.

Identification of threats to 15 focal shorebirds species from human disturbance (AFSI 2015) indicates that the current emphasis on reducing disturbance to piping plover breeding activity should be expanded to consider effects on their post-breeding and migration activities in the breeding range. Data collected at 41 sites from Nova Scotia to Florida found that five focal species (including piping plovers) were less abundant for each increase of approximately 10 people observed within 200 m (Hunt et al. 2019). Piping plovers, as well as the other four focal shorebird species, were less abundant when dogs were present relative to when dogs were absent within 200 m, and consistent patterns across the five species suggested individuals were more alert, relative to resting, when dogs were present (Hunt et al. 2019). Implications of impaired habitat availability for post-breeding plovers include findings that habitat prospecting by fledglings on the Missouri River may affect their selection of nesting sites in subsequent years (Davis et al. 2017). Guidance and best practices to evaluate and manage disturbance to shorebirds during southward migration on coastal lands (Mengak et al. 2019) became available in early 2019, and efforts to evaluate their efficacy have been initiated.

In 2017, the USFWS and a team of collaborators released a *Strategic Communications Plan for Reducing Human Disturbance to Atlantic Coast Piping Plovers* that provides messages and tools to increase public understanding of protection efforts (USFWS 2017). These tools play an important role in effective management to reduce human disturbance, but the primary actions for reducing threats to breeding piping plovers (e.g., symbolic fencing of nesting habitat, restrictions on vehicular traffic when flightless chicks are present) implemented by Federal and nonfederal landowners remain grounded in compliance with the take prohibitions in section 9 of the ESA and regulations extending those protections to threatened species. Implementation of supporting authorities (e.g., National Park Service Organic Act) and state statutes for the protection of threatened and endangered species are highly reliant on USFWS guidelines to avoid take under section 9. As discussed under Factor D, it may be possible to identify or develop alternative mechanisms to assure sufficient protection of piping plovers from disturbance and pets. However, how these mechanisms would function in the absence of the ESA and what protections they would provide have not yet been determined.

***Beach-raking***

There is no new information about the continuing direct and indirect threats posed by beach-raking machines that is specific to Atlantic Coast piping plovers. However, a Pacific Coast study documented significant lower species richness, abundance, and biomass of intertidal macroinvertebrates at urban beaches with intensive management regimes that included grooming, compared with nearby beaches that were not subject to mechanized maintenance (Schooler et al. 2019). Several settlement agreements between beach-owners and Federal and state governments have addressed the operation of beach-rakes when breeding piping plovers are present at Atlantic Coast sites (e.g., Borough of Sea Girt et al. 2010).

### *Oil spills*

No oil spills have occurred in the piping plover's Atlantic Coast breeding range since the 2009 5-year review, but restoration efforts for losses that occurred during the Bouchard No. 120 spill that occurred in Massachusetts and Rhode Island in 2003 were completed in 2019 (USFWS et al. 2012; M. Sperduto, USFWS, pers. comm. 2019).

Notwithstanding absence of recent spill events in the breeding range, six oil spills that affected Atlantic Coast piping plovers between 1989 and 2003 (Mierzykowski 2009) provide evidence of a continuing moderate threat to breeding Atlantic Coast piping plovers (USFWS 2009). 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*

Information about contaminants in Atlantic Coast piping plover egg samples (summarized by Mierzykowski 2009), has been supplemented by analyses of 11 eggs collected in 2009 in Delaware and two 4-egg clutches collected in 2011, one at Monomoy National Wildlife Refuge, Massachusetts and the other at Rachel Carson National Wildlife Refuge, Maine. Elevated concentrations of organochlorine compounds, including polychlorinated biphenyls (PCBs), dichloro diphenyl dichloroethylene (DDE), and polybrominated diphenyl ether (PBDE) were not detected in the Delaware samples (Mierzykowski 2010). Mercury and selenium levels in the Delaware samples were well below a suggested adverse effect threshold. Concentrations of strontium in Delaware piping plover eggs (28.4 ppm, dry weight) appeared elevated compared to studies of other mid-Atlantic coast bird species and to an effect level in black-crowned night heron embryos (11.3 ppm, dry weight). If an ecotoxicological threshold for strontium has been established, strontium concentrations in Delaware piping plover eggs may warrant additional study (Mierzykowski 2010). The 2011 Maine sample evidenced higher levels of PCB, DDE, PBDE, and perfluorooctanesulfonate (PFOS) than the 2011 sample from Massachusetts, but higher levels of mercury and lead were detected in the Massachusetts sample. However, contaminant concentrations in samples from both locations were generally unremarkable and not highly elevated (Mierzykowski 2010, 2012).

Environmental contaminants have not been identified as a factor affecting piping plover survival or reproduction in their Atlantic coast breeding range. 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*

Since the 2009 5-year review, the USFWS has concurred with a determination by the USACE that six wind turbines 2.8 miles off the coast of New Jersey with provisions for shut-downs during low visibility conditions during March 15-June 15 and August 1-October 31 are not likely to adversely affect piping plovers (J. E. Davis, USFWS, in litt. 2012). However, construction of this project has not yet been initiated. The USFWS also concurred with a determination that a five-turbine wind energy project, now operating approximately 3 miles southeast of Block Island, Rhode Island, was not likely to adversely affect piping plovers (T. Chapman, USFWS, in litt. 2013). In 2018, Cape Wind Associates relinquished its BOEM lease that had authorized construction of 130 wind turbine generators approximately 5 miles off the coast of Cape Cod, Massachusetts (BOEM 2018). Informal consultation with the BOEM regarding the 800 megawatt Vineyard Wind project (80 to 100 turbines) proposed for construction south of Martha's Vineyard, Massachusetts has been ongoing since 2017.

The primary potential threat to piping plovers posed by wind turbine generators is that of collisions. Results of Loring et al. (2019a) and Stantial and Cohen (2015, 2018a), summarized in section AC 2.5.2.1 (above) provide an improved basis for collision risk assessments. However, differences between migratory routes and departure timing of plovers breeding in Massachusetts versus Rhode Island, model uncertainty for estimates of flight altitude, and limitations on detections of birds flying offshore at lower altitudes from land-based receivers (Loring et al. 2019a, 2019b) are examples of considerations that may limit scope of inference. Other important remaining gaps in knowledge include effects of weather on flight altitude, avoidance rates under varying weather and light conditions, and northward migration routes and timing. Additional factors that will determine the magnitude of threats from wind turbines include the number of turbines that are constructed in areas used by piping plovers and provisions for monitoring post-construction effects and (if warranted) modifying their operations.

The magnitude of future threats to Atlantic Coast piping plovers from wind turbine generators, identified in the 2009 5-year review, continues to be uncertain. However, it may be at least a moderate threat, depending on numbers and locations of future turbine construction. Although the BOEM has cited other legal authorities for its funding of studies to determine exposure of piping plovers to offshore wind turbines (P. Loring, pers. comm. 2018), ESA recovery funds have enabled other studies (e.g., Stantial and Cohen 2015, 2018a) of flight behaviors that affect collision risk. Furthermore, informal and formal ESA section 7 consultations have provided measures to reduce and monitor impacts. Alternative mechanisms for consideration of collision risk, including in the offshore environments that are outside of state jurisdiction, have not yet been identified.

***Climate change***

The 2009 5-year review highlighted significant threats to Atlantic Coast piping plovers from two climate change-related threats, accelerating sea level rise and increased coastal storm activity. Since then, a 2014 assessment of climate change vulnerabilities of North American shorebirds predicted increased extinction risk for coastal piping plovers due to major (more than 50 percent) habitat loss of specialized breeding, migration, and wintering habitat as a result of accelerating sea level rise (Galbraith et al. 2014).

Recent information affirms observed and projected accelerating rate of global sea level rise. Global mean sea level has risen by about 7–8 inches since 1900, with about 3 inches occurring since 1993 (Sweet et al. 2017). Furthermore, relative sea level rise in this century in the breeding range of Atlantic Coast piping plovers is projected to be greater than the global average (Sweet et al. 2017).

Effects of accelerating sea level rise on future availability of Atlantic Coast piping plover breeding habitats will largely depend on the response of barrier islands and barrier beaches. With accelerating sea level rise, barrier islands that have historically retreated landward may simply retreat faster; under more drastic sea level rise projections, they may also become reduced in size (FitzGerald et al. 2008, Gutierrez et al. 2009). The dynamic nature of beach response to sea level rise will be heavily influenced by a variety of site specific factors (e.g. sediment supply, level of development, current elevation) (FitzGerald et al. 2008, Lentz et al. 2016), wherein worst case or even most likely relative sea level rise projections (Sweet et al. 2017) have the potential to outpace the rate at which barrier and mainland beaches are able to migrate laterally to maintain width and elevation (FitzGerald et al. 2008; Gutierrez et al. 2009).

Notwithstanding other uncertainties associated with barrier island and barrier beach response to accelerating sea level rise (FitzGerald et al. 2008), limiting overwash (i.e., on the developed portions of barrier beaches) can restrict an important sediment source, resulting in island narrowing and making the bayside more prone to erosion (Riggs and Ames 2003, FitzGerald et al. 2008). Similarly, coastal armoring (e.g., bulkheads, revetments) impedes natural erosion of bluffs and cliffs that contributes sediment to the littoral system (Fitzgerald et al. 2008). Thus, current and future efforts to preserve opportunities for near-term formation of overwash habitats and to maintain sediment supplies via ESA section 7 consultations can contribute to potential for barrier islands and their piping plover habitats to adapt to accelerating sea level rise.

Seavey et al. (2011) found that if development limits beach migration, sea level rise is likely to reduce piping plover breeding habitat. However, if habitat is able to migrate upslope and inland, breeding areas could increase with sea level rise (Seavey et al. 2011). Likewise, Sims et al. (2013) projected persistence and growth of Rhode Island piping plover habitats that are unconstrained by development and able to migrate landward. On the other hand, future loss of barrier island integrity in response to sea level rise may limit the extent of habitat (Gutierrez et al. 2009). Interdisciplinary modeling that is currently in progress will link predictions of sea level rise and beach geomorphology (Gutierrez et al. 2015), with piping plover habitat models (Gieder et al. 2014, Zeigler et al. 2017, 2019) to assess the distribution of Atlantic Coast piping plover breeding habitat under various rates of sea level rise and coastal engineering scenarios. Since most coastal engineering projects are subject to ESA section 7 consultations, the ESA provides a mechanism for addressing their effects on long-term habitat formation processes.

Even without changes in storm frequency and intensity, sea level rise alone will increase coastal flooding during storm surges (Sweet et al. 2017). Coastal flooding during breeding season storms may affect piping plover breeding success by making nest flooding or chick mortality due to harsh weather more likely, factors that could be exacerbated if coastal storm activity also increases. Although there is still considerable uncertainty, some projections anticipate that the strongest hurricanes along the Atlantic Coast will become both more frequent and more intense in the coming decades (Horton and Liu 2014; Kossin et al. 2017).

Other than those discussed above, we have no new information about other potential climate change related effects on piping plover plovers. However, they remain a continuing concern (USFWS 2009). Indirect effects of sea level rise on barrier island groundwater systems (Masterson et al. 2013), for example, could affect the amount, distribution, and character of important moist sediment plover foraging substrates or the composition of barrier island vegetation.

Accelerating sea level rise is a well-established factor that will continue to affect piping plovers in their Atlantic Coast breeding range. Increased habitat loss is anticipated on the 45 percent of sandy ocean beaches that are already developed (see Factor A) and hence unlikely to be able to respond dynamically. However, the extent and type of ongoing and near-term coastal modification activities are likely to strongly influence the mid- and long-term effects of sea level rise on the as-yet undeveloped habitat. The long-term effects of many coastal modifications on the quantity and quality of piping plover habitat can be addressed through section 7 consultations. Absent ESA protections, we are not aware of other existing regulatory mechanisms that provide opportunities to address this major long-term threat to the quality and quantity of piping plover habitat.

***Reliability of effort and expenditures for conservation measures***

There is no new information that changes the 2009 5-year review's assessment of the Atlantic Coast piping plover's reliance on continuing active management. Atlantic Coast piping plovers are the beneficiaries of the labor-intensive efforts of an extensive network of Federal, state, local government and private partners. Some funding is provided through ESA section 6 grants to the state wildlife agencies or by federal agencies under the authority of ESA section 7. Other funding is allocated by landowners seeking to closely monitor and intensively manage piping plovers to minimize constraints on beach recreation while avoiding violations of ESA section 9 (Hecht and Melvin 2009b). A number of nongovernmental organizations invoke the ESA status of the piping plover when they conduct fund-raising to defray the cost of piping plover management activities. Maintaining funding to manage beach recreation and predation threats to piping plovers remains a continuing challenge that would likely be exacerbated in the absence of ESA listing.

Provisions for increased flexibility in piping plover protections in areas where recovery unit targets have been attained can reduce conflicts with public use, but they may require even more intensive management and monitoring. The 2016 statewide *Massachusetts Habitat Conservation Plan for Piping Plover*, for example, requires implementation of measures to avoid, minimize, and mitigate take under each covered activity, as well as costs for program administration and for monitoring and adaptive management (Massachusetts Division of Fisheries & Wildlife and ICF International 2016). Statutory requirements for the issuance of HCPs require funding assurances, but how funding of protections would be assured in the absence of ESA listing is currently uncertain.

### 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) almost 34 years of ESA recovery planning and implementation for the Atlantic Coast population have been conducted consistent with the premise of demographic independence from other piping plovers (see section 2.1 in the 2009 Piping Plover 5-Year 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 and analyses 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 1,879 pairs in 2018, 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 and USFWS (2019), however, the security of the Atlantic Coast piping plover is fundamentally dependent on even distribution of population growth to maintain a sparsely-distributed species with strict biological requirements in the face of environmental variation, buffer it against catastrophes, and conserve adaptive capacity. The New England recovery unit has exceeded its subpopulation target for many more than the requisite 5 years, but the numbers of breeding pairs in the other three recovery unit populations remain below targets established in recovery criterion 1 and have declined since the 2009 5-year review.

Thirty years of population growth, albeit unsteady in large sections of the range, evidences the general efficacy of the ongoing Atlantic Coast piping plover recovery program. However, all of the major threats (habitat loss and degradation, predation, human disturbance) identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive. Development and artificial shoreline stabilization pose continuing widespread threats to the low, sparsely vegetated beaches juxtaposed with abundant moist foraging substrates used by breeding Atlantic Coast piping plovers. Severe threats from human disturbance and predation remain ubiquitous along the Atlantic Coast. Annual implementation of labor-intensive management to minimize the effects of these continuing threats, as specified in recovery plan tasks, is highly dependent on the legal requirements and recognition conferred by ESA listing.

Two threats that were identified in the 2009 5-year review, climate change (especially sea level rise) and wind turbines, are likely to affect Atlantic Coast piping plovers throughout their annual cycle. Some aspects of climate change remain uncertain, but ongoing acceleration of sea level rise is well documented. Further increases in sea level rise rates are foreseeable with a high degree of certainty, and effects of sea level rise on Atlantic Coast piping plovers and their habitat will be partially determined by coastal management activities. Although threats from wind turbine generators are foreseeable, their magnitude remains poorly understood. Information that has become available since 2014 will help assess effects of future proposed projects, but some key risk factors (e.g., avoidance rates) and the number and locations of future proposed turbines remain largely unknown.

New information demonstrates the important effect of wintering site conditions on annual survival rates of piping plovers, a factor to which piping plover populations are highly sensitive. Therefore, assuring the persistence of the Atlantic Coast piping plover also requires maintenance and protection of habitat in their migration and wintering range. 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.

New monitoring, decision support, and communications tools have improved and streamlined Atlantic Coast piping plover protection efforts, but their implementation is largely reliant on the authorities of the ESA. Absent ESA protections, there are currently no clear mechanisms in place to prevent reversal of gains in abundance and productivity, much less to fully attain recovery criteria. Considerable additional effort 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 attain and sustain population targets and productivity in all recovery units in the absence of ESA protections. Furthermore, few alternative mechanisms have been established to maintain wintering and migration habitat in the absence of ESA protection, as specified in recovery criterion 5.

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 34 years of intensive recovery efforts have reduced its near-term extinction risk by increasing the population and managing the continuing threats. However, the Atlantic Coast piping plover remains vulnerable to low numbers in three of its four recovery units. Furthermore, the factors that led to the piping plover's 1986 listing remain operative across its Atlantic breeding range (including in New

England), and many of these threats have increased. Interruption of labor-intensive efforts to manage these threats would quickly lead to steep population declines. The status of the Atlantic Coast piping plover remains consistent with the ESA definition of a threatened species.

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### *Correspondence and Electronic Communications*


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# 3.0 RESULTS

## 3.1 Recommended Classification

We recommend retaining the Atlantic Coast and Northern Great Plains populations of the piping plover as threatened throughout their ranges. We also recommend revising the current listing of the Great Lakes population to endangered throughout its current breeding, migration, and wintering range. We believe this continues to reflect the species' status across its entire range.

***Rationale***

At a current population of 71 breeding pairs, the Great Lakes piping plover has attained approximately 50% 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 mechanisms are needed to maintain the annual management activities aimed at maintaining habitat, and reducing threats from human disturbance and predation.

The Northern Great Plains piping plover estimated population size has increased, but it remains below the recovery goals set out in the 1988 recovery plan. In 2016, the Service published draft criteria in the "Draft Revised Recovery Plan for the Northern Great Plains Piping Plover (*Charadrius melodus*)". The Service is currently in the process of revising the recovery plan and the associated recovery criteria. Several of 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), continue to threaten piping plovers on the Northern Great Plains.

The Atlantic Coast piping plover is not currently in danger of extinction throughout all or a significant portion of its range because 34 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 three of its four recovery units. Furthermore, the factors that led to the piping plover's 1986 listing remain operative across its Atlantic breeding range (including in New England), and many of these threats have increased. Interruption of 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 (1) additional population growth is achieved outside New England and (2) mechanisms are established to assure conservation of habitat and continuation of the intensive annual management activities to reduce human disturbance and predation in the absence of ESA protections.

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. Recent research continues to demonstrate the importance of migration and wintering range habitat conditions on the adult survival rates of all three breeding populations, particularly the Great Lakes population due to its low numbers. Immediate efforts are needed to reduce threats from increasing human disturbance throughout the species' coastal migration and wintering range.

## 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. Any interruption of these efforts, however, 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 the 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 wintering habitat as well as the impacts of human disturbance 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 Listing and Reclassification of Priority Number

The listing should be revised to recognize the subspecies *Charadrius melodus melodus and Charadrius melodus circumcinctus*, and, within *C. m. circumcinctus* recognize two DPSs (as outlined in 2009 five-year review). This is consistent with ESA's requirement that vertebrate population listings are based on a population that "interbreeds when mature". As previously indicated, piping plover throughout their range exhibit ecological separation during breeding that has resulted in multiple, distinct interbreeding population segments. Banding studies and genetic analyses provide evidence of this ecological separation. The listing should be corrected to show that the endangered status of the Great Lakes population extends outside of the Great Lakes watershed, including both its migration and winter range. Although all three piping plover breeding populations are inherently indistinguishable within their coastal migration and wintering ranges, individuals from the Great Lakes population retain their endangered status outside of their breeding grounds. In addition, a long term banding effort in the Great Lakes makes a current majority of the individuals in the population identifiable. Band resightings within the coastal migration and wintering range have vastly increased over the years, which has contributed to a better understanding of the distribution of Great Lakes birds in their nonbreeding range (Gratto-Trevor et al. 2012). Priority for formal recognition and reclassification of three entities (as described in 48 FR 43098) and reclassification of the Great Lakes population as endangered throughout its entire range is 6 on a scale of 1 to 6, indicating that the proposed changes would have low management impact and that the action is not petitioned. The formal recognition of the these population segments and the correction to show the Great Lakes population as endangered throughout its entire range would have minimal regulatory impact, since section 7 of the ESA already considers the breeding population when evaluating the effects of proposed actions. Further, the Atlantic Coast and Northern Great Plains populations would remain classified as threatened.

# 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Recommendations for future recovery actions are organized by the geographic regions as described 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 Great Lakes and Northern Great Plains recovery plan, and the 1996 revised Atlantic Coast recovery plan. Recommended conservation actions in the 2012 Comprehensive Conservation Strategy for the Piping Plover in its Coastal Migration and Wintering Range in the Continental United States (CCS) synthesize tasks for protection of nonbreeding piping plovers in the approved recovery plans.

## 4.1 Recommendations for Wintering and Migration Range

Recovery Recommendations for the Wintering and Migration Range are described in detail in the 2012 CCS. In addition to the recommendations outlined in the CCS, the most urgent needs are listed below.

1. Secure reliable funding to determine the effect of human and pet disturbance on survival and fitness of piping plovers during the nonbreeding portion of their annual cycle (GL task 4.1, AC task 3.14, NGP task 3.221, CCS tasks 8.1 and 8.6).

2. Conduct piping plover surveys and resight bands to assess regional abundance and distribution at key sites and promptly report sightings to the banding projects (GL task 2.12, 2.13, 4.1, AC task 2.11, NGP tasks 1.2, 1.3, CCS tasks 3.1, 3.4).

3. Develop, in coordination with site managers and/or during section 7 consultations, stewardship and management plans for critical habitat units or other sites that support or could support nonbreeding piping plovers. Management may include, as appropriate, leash laws and/or dog free zones, off-road vehicle management, and bird only areas in key habitats, particularly high tide roosts. Stewardship and management plans should incorporate, as appropriate, recommendations from *Guidance and Best Practices for Evaluating and Managing Human Disturbances to Migrating Shorebirds on Coastal Lands in the Northeastern United States* (Mengak et al. 2019)(GL tasks 2.14, 2.22; AC tasks 2.13, 2.2; NGP tasks 4.42, 4.43, CCS tasks 2.1, 2.2, 2.4, 3.2, 7.4).

4. Implement the *Atlantic Coast Piping Plover Strategic Communications Plan: Reducing Human Disturbance* (USFWS 2017) to more effectively increase public awareness and foster

behavioral changes necessary to minimize disturbance to nonbreeding piping plovers (GL task 5.2, AC task 2.24, NGP task 5.2, CCS task 2.3).

5. Update CCS Appendix 1b (Habitat Modifications to Tidal Inlets) and 1c (Status of Sandy Oceanfront Beach Habitat) for the coastal migration and wintering range (GL task 2.16, AC task 2.1, NGP task 1.13, CCS tasks 3.5, 9.2).

6. Develop strategies to reduce threats from accelerating sea-level rise. Identify sites most likely to maintain (or increase) characteristics of suitable piping plover wintering and/or migration habitat (CCS task 7.5).

## 4.2 Recommendations for Great Lakes Population Breeding Range

1. Identify and secure additional sources of reliable funding for recovery partners to ensure 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. Expand partnership efforts to increase participation of non-governmental organizations, state agencies and volunteers as in recovery plan task 6.0

3. Monitor the population for disease outbreaks, particularly focused on the threat of Type E botulism. Continue to improve response activities when an outbreak occurs.

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).

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. 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, or increases associated with climate change. Identify sites most likely to maintain or increase areas of suitable piping plover habitat under different climate change scenarios.

9. Undertake studies addressing merlin and other predator foraging ecology and the relationships between merlins and piping plover breeding areas in the Great Lakes.

10. Continue to pursue opportunities for habitat restoration, particularly at previously occupied breeding locations. Habitat creation projects, similar to the Cat Island effort near Green Bay Wisconsin, should also be considered depending on location and the level of commitment for future management.

11. Conduct studies using geolocators, nanotags or similar technology to learn more about wintering locations and migratory pathways of Great Lakes piping plovers.

## 4.3 Recommendations for Northern Great Plains Population Breeding Range

1. Design and implement over-arching monitoring framework to track breeding habitat and population performance over time.

2. Create partnerships with conservation organizations and the public where the primary goal is to work together to ameliorate the threat of habitat loss.

## 4.4 Recommendations for Atlantic Coast Population Breeding Range

1. Increase efforts to restore and maintain natural coastal habitat formation processes, including overwash and dynamic inlets (recovery task 1.2). This action is critical to near-term availability of sufficient habitat to attain targets for breeding abundance and productivity. It is also key to preserving adaptive capacity of beach habitats in response to current and accelerating rates of sea-level rise.

2. Incorporate protocols for rapid assessment of storm-induced habitat changes into procedures for protecting habitat from degradation during post-storm management of beach habitat and beach recreation. Newly formed habitats should be protected from degradation by activities that directly or indirectly alter topography or accelerate succession of vegetation (recovery tasks 1.22 and 1.23). New and improved habitats should also be appropriately managed to prevent human disturbance that disrupts territory establishment and courtship and causes nest loss and chick mortality (recovery task 1.3).

3. 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 potential changes in coastal management that may decrease adverse effects of sea-level rise on coastal piping plover habitats and locations where they might be

implemented.

4. Incorporate new information about effects of disturbance on survival of piping plover chicks into specific beach management practices that will avoid incidental take (recovery task 1.3).

5. Continue and accelerate development and implementation of monitoring and decision support tools to improve and streamline piping plover conservation, including effective and efficient predator management and implementation of activities to prevent disturbance and indirect mortality of piping plovers due to beach recreation and other activities (recovery task 1.1, 1.3, and 1.4).

6. Assess the ability and willingness of state wildlife agencies to assume primary responsibility for protection and management of piping plovers and their habitat sufficient to maintain population targets and productivity. Develop long-term agreements for implementing specific protections that are independent of ESA sections 6 and 9 (recovery task 1.6).

7. Engage Federal agencies, including the NPS, the USACE, the FEMA, the BOEM, and others to ascertain their authorities (independent of ESA section 7) to incorporate conservation of Atlantic Coast piping plovers into activities that they implement, authorize, or fund. Develop long-term commitments for implementing specific protections that are consistent with each agency's other (non-ESA) regulatory authorities, funding, and personnel resources (recovery task 1.6).

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

9. Ascertain whether and to what extent landowners and other partners would be willing to conduct predator management activities if piping plovers are no longer classified as a threatened species under the ESA. Assess effects of foreseeable changes in predator management activities on piping plover abundance and productivity (recovery task 1.6).

10. Implement and refine communications tools and activities to increase public understanding of threats to breeding Atlantic Coast piping plovers and the recovery activities required to address them (recovery task 4).

11. Conduct full life-cycle demographic modeling to elucidate effects of variation in productivity, annual survival rates, dispersal rates, and carrying capacity of habitat on population viability within individual recovery (representative) units and the Atlantic Coast population as a whole. This information may be used (as warranted) to revise recovery criterion 3 to provide recovery unit-specific productivity targets sufficient to secure

populations (recovery task 3.5) and facilitate more effective conservation efforts.

12. Increase efforts to understand disturbance and other threats to post-breeding and migrating piping plovers within the Atlantic Coast breeding range, and implement activities to ameliorate them.

13. Continue studies to understand potential effects of wind turbine generators that may be located or proposed for construction within and between nesting and foraging habitats and along migration routes. Continuing information needs include (but are not limited to) weather factors affecting migration altitude, northward migration routes, and avoidance rates under varying light and weather conditions.

14. Support effective integrated predator management (recovery plan task 1.4) through studies of ecology and foraging behavior of key predators and effects of predation management on predator communities.

**U.S. FISH AND WILDLIFE SERVICE**
**5-YEAR REVIEW of Piping Plover**

**Current Classification**: Threatened/Endangered

**Recommendation resulting from the 5-Year Review:**

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_**X**_ No change needed

(Although no change in listing status is recommended, a revision to the listing language is suggested for the Great Lakes population, so as to extend its endangered status throughout its range).

**APPROVAL**:

**Lead Field Office Supervisor, Fish and Wildlife Service**

Approve SCOTT HICKS Digitally signed by SCOTT HICKS Date: 2020.03.26 13:39:09 -04'00' ____________________ Date _________