PROPOSED

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Piping Plover (*Charadrius melodus melodus*) in Canada

Piping Plover, *melodus* subspecies

2012

Canada

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For copies of the recovery strategy, or for additional information on species at risk, including COSEWIC Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

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PREFACE

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996) agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c.29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years.

The Minister of the Environment and the Minister responsible for the Parks Canada Agency are the competent ministers for the recovery of the Piping Plover, *melodus* subspecies and have prepared this strategy, as per section 37 of SARA. It has been prepared in cooperation with the Provinces of Newfoundland and Labrador, Nova Scotia, Prince Edward Island, New Brunswick, and Québec, also Aboriginal groups and the Eastern Canadian Piping Plover Recovery Team, as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment Canada and the Parks Canada Agency, or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of the Piping Plover, *melodus* subspecies and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment Canada and the Parks Canada Agency and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

ACKNOWLEDGMENTS

This strategy was developed by the Atlantic Species at Risk Recovery Unit of the Canadian Wildlife Service, Environment Canada, with support from the Canadian Wildlife Service's Quebec Region and much thoughtful input and advice from the Eastern Canadian Piping Plover Recovery Team.

EXECUTIVE SUMMARY

The Piping Plover (*Charadrius melodus melodus*) is listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act* and as Threatened in the United States under provisions of the United States *Endangered Species Act*. Within Canada, the *melodus* subspecies occurs in New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, and Québec. The latest North American population estimate for *C. m. melodus* obtained through the 2006 International Piping Plover Census consisted of 3323 adults, of which 460 (14%) were located in Canada (Goossen and Amirault-Langlais 2009). Despite major conservation efforts implemented across the subspecies' range, ongoing threats from habitat loss and degradation, predation, and human disturbance continue to create challenges in meeting population objectives. In many jurisdictions the Piping Plover (*melodus* subspecies) is now acknowledged as being management-dependent.

The recovery of the Piping Plover (*melodus* subspecies) is deemed feasible.

The short-term population objectives are to achieve and maintain a regional population of 255 pairs and an annual productivity of 1.65 chicks fledged per territorial pair. Long-term, the objectives are to increase the population to 310 pairs distributed across eastern Canada as follows: New Brunswick—105, Newfoundland and Labrador —30, Nova Scotia—60, Prince Edward Island—60, and Québec—55. In its Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan (U.S. Fish and Wildlife Service 1996), the U.S. Fish and Wildlife Service established a population objective of 800 adults (400 pairs) for the four Atlantic Provinces and Québec. Should the long-term population objective of this recovery strategy of 620 adults be met, the feasibility of meeting this larger population objective will be evaluated, in conjunction with an assessment of carrying capacity and habitat availability.

The following broad strategies are recommended to address threats to the Piping Plover (*melodus* subspecies): Ensure enough suitable habitat to meet population objectives, Reduce predation, Reduce human disturbance, Minimize impacts of adverse weather conditions, Minimize impacts of poorly understood mortality factors, Address key knowledge gaps to recovery, and Monitor the population.

Critical habitat is fully identified in this strategy. Any site with suitable habitat (defined in the key habitat attributes section) occupied by at least one nesting pair of Piping Plovers (*melodus* subspecies) in at least one year since 1991 (the year of first complete survey coverage) is critical habitat under the *Species at Risk Act*.

One action plan will be developed to address the requirements of the *Species at Risk Act* and will be completed within two years of the final version of this recovery strategy being posted on the Species at Risk Public Registry.

RECOVERY FEASIBILITY SUMMARY

The recovery of the Piping Plover (*melodus* subspecies) is deemed feasible, based on the four criteria outlined by the Government of Canada (2009). The following four questions were considered:

1. *Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.* Yes.

2. *Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.* Yes.

3. *The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.* Yes.

4. *Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.* Yes.

Eastern Canadian agencies use management approaches similar to those in other jurisdictions and these techniques have resulted in tremendous population increases elsewhere. During the period 1991-2006, the population on the U.S. Atlantic coast increased by 95% and the population of the *circumcinctus* subspecies in the Great Lakes increased by 175%. To achieve the recommended recovery objectives would require a 19% increase from 2008 population levels. The success of similar programs elsewhere suggests that such a population increase is feasible. Although conservation efforts elsewhere have achieved positive results, the Piping Plover (*melodus* subspecies) is now considered to be management-dependent on the Atlantic coast (U.S. Fish and Wildlife Service 1996).

Formal and informal partnerships with industry, scientists, municipal governments, federal/provincial governments, conservation organizations, property owners, and the public will help achieve the long-term conservation and recovery of the Piping Plover (*melodus* subpecies).

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1. COSEWIC SPECIES ASSESSMENT INFORMATION

Date of Assessment: May 2001

Common Name (population): Piping Plover *melodus* subspecies

Scientific Name: *Charadrius melodus melodus*

COSEWIC Status: Endangered

Reason for designation: The number of individuals of this subspecies breeding in Canada is small. The quality of nesting habitat is decreasing, and predation and other disturbances limit reproductive success. No significant increase in numbers of breeding pairs has resulted despite strong conservation initiatives.

Canadian Occurrence: Québec, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island

COSEWIC Status History: The species was considered a single unit and designated Threatened in April 1978. Status re-examined and designated Endangered in April 1985. In May 2001, the species was re-examined and split into two groups according to subspecies. The *melodus* subspecies was designated Endangered in May 2001.

2. SPECIES STATUS INFORMATION

The Piping Plover (*melodus* subspecies) is listed as Endangered in Canada under Schedule 1 of the *Species at Risk Act*. The subspecies also occurs along the Atlantic coast of the United States, where it is listed as Threatened under the United States' *Endangered Species Act*. The Piping Plover is listed as Endangered under provincial legislation in New Brunswick, Newfoundland and Labrador, and Nova Scotia, and is listed as Threatened under provincial legislation in Québec. Prince Edward Island is currently reviewing the status of the species.

Table 1. Conservation ranks for the Piping Plover (*melodus* subspecies)

	IUCN	**Global (G) Rank**	**National (N) Rank**	**Sub-national (S) Rank**	**COSEWIC Status**
Piping Plover (*Charadrius melodus melodus*)	Near Threatened	G3 (very rare and local throughout its range)	N3B (nationally rare breeder)	Breeding occurrences: Nova Scotia: S1B (especially vulnerable to extirpation) Insular Newfoundland: S1B Prince Edward Island: S1B New Brunswick: S2B (may be vulnerable to extirpation)	Endangered

Despite active conservation programs throughout eastern Canada, there was a decline in regional numbers during the four international census time period from 1991 to 2006 (−10%).

A banding research program was conducted in eastern Canada (New Brunswick, Nova Scotia, Newfoundland and Labrador, Prince Edward Island, and Québec) from 1998 to 2003 to obtain the information required to calculate demographic parameters for the regional population. Population modelling of this data indicated interesting trends and predictions (Calvert 2004). Although the Gulf of St. Lawrence subpopulation includes a larger total number of birds, the model suggested that this subpopulation is currently in decline (−3.5% per year). This subpopulation was predicted to decrease from its current level "to only about 100 adults within 40 years". Conversely, the southern Nova Scotia subpopulation was predicted to remain stable or to increase slowly (+0.5% per year). This subpopulation was therefore projected to increase slowly over time. However, caution should be used when interpreting these results. It was not possible to state with certainty whether either of the subpopulations was increasing, decreasing, or stable. The demographic parameters used in the development of the models were based on the results of the banding study, which was of relatively short duration and may have under-represented some parts of the range (particularly remote areas). Furthermore, population data show the Gulf of St. Lawrence subpopulation has increased while the southern Nova Scotia group has declined since the end of the banding study.

3. SPECIES INFORMATION

3.1 Species Description

The Piping Plover, *Charadrius melodus,* is a small, stocky shorebird that depends on its cryptic coloration (adults, chicks, and eggs) for defence from predators. The dorsal plumage is light grey to pale brown, resembling the colour of dry sand. The ventral plumage is white. The short bill is orange with a black tip. Adults weigh 43-63 g and have a total body length of 17-18 cm. Piping Plovers are capable of breeding at one year of age.

The Piping Plover nests only in North America. Two populations, each with subspecies status, exist within Canada: the eastern Canada population (*melodus* subspecies) and the Prairie and Great Lakes population (*circumcinctus* subspecies). This recovery strategy applies only to the *Charadrius melodus melodus* subspecies (Figure 1).

Piping Plovers (*melodus* subspecies) normally arrive on the nesting grounds from the end of March to early May. Young may hatch starting in late May or early June onwards, depending on when nesting was initiated. Nest initiation may occur any time after the birds arrive until mid-July. Nests are only occasionally initiated after this time. Migration back to the wintering grounds begins in early to mid-July. The bulk of the population has left Canada by early September.

Adults normally produce a clutch of four eggs; however, fewer eggs may be produced, often with re-nesting attempts. Five-egg clutches are occasionally produced. Young hatch after 26 to 28 days of incubation and are able to fly within 25 to 28 days of hatching. The chicks are precocial and usually leave the nest within hours of hatching. Young plovers forage independently shortly after leaving the nest. One brood is normally produced per year; however, re-nesting is possible if a clutch is lost. The normal lifespan of birds once they reach adulthood is 8-11 years (Haig 1992).

There appear to be two discrete subpopulations or groups of *C. m. melodus* - one located in southern Nova Scotia and another in the Gulf of St. Lawrence (Canadian Wildlife Service – Atlantic Region, unpublished data). There is an indication of limited genetic exchange between the U.S. Atlantic coast subpopulation and the Gulf of St. Lawrence group; however, at this time the southern Nova Scotia group appears to be isolated from both areas. Survival rates of adults were similar for the two subpopulations, at 72% for the Gulf of St. Lawrence and 73% for southern Nova Scotia (Calvert 2004). However, post-fledging survival rates of juvenile birds were lower for the Gulf of St. Lawrence (34%) than for southern Nova Scotia (53%). Although adult survival rates were similar to those calculated for the U.S. Atlantic coast population (75%), juvenile survival rates for the Gulf of St. Lawrence population were considerably lower than the 48% calculated for Massachusetts, which is the closest neighbouring population (U.S. Fish and Wildlife Service 1996).

3.2 Population and Distribution

The global breeding population of the Piping Plover (*C. melodus*) was estimated at 8092 during the 2006 International Piping Plover Census (Elliott-Smith et al. 2009). During the 2006 census, the Canadian population of *C. m. melodus* was estimated at 460 adults (Goossen and Amirault-Langlais 2009) or 21% of the total national nesting population of *C. m. melodus* and *C. m. circumcinctus* (2164) and 6% of the total North American population of *C. m. melodus* and *C. m. circumcinctus* (Elliott-Smith et al. 2009). Annual population counts are now conducted routinely in most areas of eastern Canada. In 2008, the adult population of the Piping Plover (*melodus* subspecies) was estimated at approximately 511 adults, including 250 breeding pairs (end of year count).

The Piping Plover (*melodus* subspecies) nests in coastal areas of Newfoundland (southwest coast), Québec (Magdalen Islands), Nova Scotia (southern Atlantic coast, a few beaches along the Northumberland Strait, and Cape Breton Island), Prince Edward Island (along the Gulf of St. Lawrence coast), and New Brunswick (the Gulf of St. Lawrence and Northumberland Strait coast). Figure 1 presents the sites identified as critical habitat for the Piping Plover (*melodus* subspecies), which correspond to the current known nesting distribution in eastern Canada.

The Piping Plover (*melodus* subspecies) winters along the southern Atlantic coast of the United States and in the Caribbean. Plovers banded in eastern Canada have been observed during the winter in North and South Carolina, Georgia, Florida, the Bahamas, and Cuba (Gratto-Trevor pers com and Amirault-Langlais, in prep.).

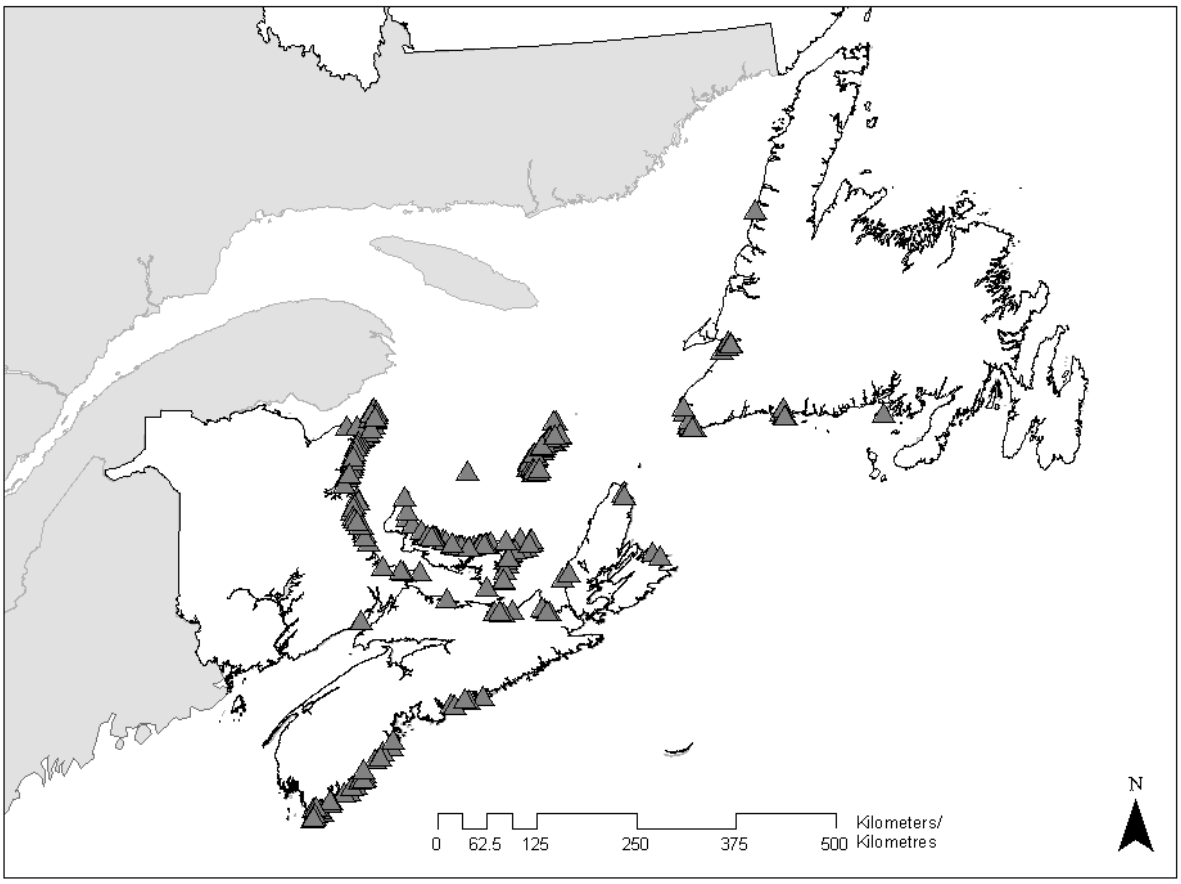

Figure 1. Sites in eastern Canada identified as critical habitat for the Piping Plover (*melodus* subspecies)

3.3 Needs of the Piping Plover (*melodus* subspecies)

The Piping Plover requires specific habitats to successfully achieve nesting, brood-rearing, feeding, and overwintering. Habitat requirements for staging and migration are not well understood, but there appears to be more flexibility in use of habitats during those times of the year.

General habitat description

The Piping Plover (*melodus* subspecies) nests on wide sand, gravel, or cobble beaches, barrier island sandspits, or peninsulas in marine coastal areas. Early successional habitat, most often free of dense vegetation, is preferred for nest sites. Feeding areas must be locally available so flightless chicks can gain access to them. A more complete description of habitat requirements can be found in the Piping Plover status report (Boyne 2001).

The location and specific characteristics of nesting beaches have been well documented in eastern Canada (Amirault et al. 1997; Waddell 2000; Boates et al. 1994). The specific characteristics of nesting beaches and their associated role in feeding, brood-rearing, and staging are discussed in detail below.

Ecological processes

The Piping Plover (*melodus* subspecies) depends on the maintenance of early successional habitat, characterized by open sand, pebble, or gravel areas interspersed with shells and with sparse or little vegetation for successful nesting. Natural ecological processes such as ice scour, storms, and extreme high tides promote the maintenance of habitat in early succession. The tips of sandspits or sites near channels are particularly vulnerable to the extreme natural events that keep areas free of vegetation and redistribute nesting substrate onto beach areas. These areas tend to be preferred nesting sites. The maintenance of natural ecological processes along coastal areas is essential to the protection of nesting areas.

Nesting habitat

Piping Plover nesting habitat refers to the habitat component where nest sites are located. The Piping Plover (*melodus* subspecies) generally selects the widest section of a beach for nesting. Plovers rarely nest in areas of pure sand, but instead select sandy areas with sparse vegetation or sufficient gravel, pebble, cobble, shell fragments, wrack (dry algae normally deposited by storms or by tidal or wave action above the mean high tide mark), or other debris to provide camouflage for incubating birds and to enable nests to be hidden from predators (Flemming et al. 1992). The level of human disturbance may influence the suitability of sites.

Sites overwashed by winter storms are often chosen for nesting because they are maintained in an early stage of beach succession. Typical nesting habitat is often located on mainland beaches or barrier islands, sandspits, and sand bar beaches or other areas exhibiting suitable habitat characteristics. These habitats are important since they allow adults and young access to feeding sites along lagoons or bays, where rich food resources are located.

Brood-rearing habitat

Piping Plover brood-rearing habitat refers to the habitat component where adult plovers normally lead young plovers after hatching. Brood-rearing habitat provides the necessary elements for feeding; refuge from high tides; locations where the birds can hide from human disturbance or predators; and shelter from harsh weather (wind, rain) (shelter supplements brooding by adults).

Brood-rearing habitat must be present within an appropriate distance of nesting sites since flightless young must be able to gain access to these areas. Broods are known to move a considerable distance from their nest location. Observations from various studies in the United States show that broods may move several hundred metres from the nest location (U.S. Fish and Wildlife Service 1996). Preliminary information suggests that this is also the case in eastern Canada (Amirault-Langlais and Shaffer, unpubl. data). The mean distance from nests for 25 broods was 165 m (minimum 0 m from the nest site; maximum 702.7 m). Younger broods can be expected to be located in closer proximity to the nest site than older juveniles, which are more mobile and may move up to several kilometres away from the nest site to gain access to prime

feeding areas. Feeding areas for young are also prime feeding areas used by adults (for more detail, see under Feeding habitat). Enhanced survival rates of young plovers have been found in areas with access to interior or bayside flats (Loegering and Fraser 1995). Access to these important feeding sites are created by wash-throughs that sometimes occur across barrier beaches during winter storms.

Other important components of brood-rearing habitat are pieces of driftwood, wrack, large rocks, and other objects which may provide shelter from the rain, wind, and blowing sand. These structures may also be used by adult plovers for the same purpose. Young plovers rely on brooding by adult birds for warmth during cold and shelter from heat; however, older juveniles that spend less time being brooded, may increasingly utilize these habitat components for shelter. Young plovers also rely on sparsely vegetated dunes as refuges during high tides or to escape from potential predators and human disturbance. Densely vegetated dunes are ineffective since young birds have limited mobility and cannot penetrate these areas.

Feeding habitat

Piping Plover feeding habitat refers to the habitat component used by adult and young for feeding purposes.

Foraging habitat for flightless young overlaps with brood-rearing and adult feeding areas. Feeding sites for young must be located within walking distance of the nest site because young are flightless until approximately 25 days of age. Juvenile Piping Plovers (*melodus* subspecies) feed in marine and bayside intertidal zones above the mean high water mark, open sand, mud flats, and algal flats. Ephemeral pools and areas of wrack are excellent feeding areas. Young birds may travel a considerable distance (in excess of several kilometres) to gain access to prime feeding areas. It is not uncommon for the brood to use many feeding sites within a nesting pair's territory, including the nesting, brood-rearing, and feeding habitats.

Adult Piping Plovers (*melodus* subspecies) forage in habitats similar to those used by flightless young. Adult birds are able to gain access to foraging sites beyond the immediate nesting or brood-rearing area and are often seen flying across channels or gullies to use nearby feeding sites. Areas used by feeding plovers are often used by large numbers of other species of shorebirds during migration, indicating an abundance of invertebrate prey.

Migration/staging habitat

Piping Plover migration/staging habitat refers to habitats which are used post-breeding in preparation for migration to wintering grounds.

Migration patterns of the Piping Plover (*melodus* subspecies) are not well known. Small groups of plovers often congregate at nesting and non-nesting beaches. This suggests that migration may occur in stages (Boyne 2001). Since there are few beaches which are used on a regular basis by large numbers of Piping Plovers (*melodus* subspecies) during migration, the characteristics and significance of beaches used are difficult to determine. The availability of habitats for use during migration does not appear to be limiting since use of any particular beach during migration is sporadic, suggesting that habitat requirements at this time may be less specific.

Wintering habitat

There are no occurrences of Piping Plovers wintering in Canada. Wintering habitats are thought to be significant since the bulk of the annual life cycle is spent on the wintering grounds, fidelity to wintering sites within and between years has been demonstrated, and these areas may be of key importance to increasing adult survival.

4. THREATS

4.1 Threat Assessment

Table 2. Threat Assessment Table

Threat	Level of Concern[1]	Extent	Occurrence	Frequency	Severity[2]	Causal Certainty[3]
Habitat Loss or Degradation						
Human disturbance	High	Widespread	Continuous	Continuous	High	High
Coastal development	High	Widespread	Continuous	Continuous	High	High
Natural processes	Medium	Widespread	Historic, Current, Anticipated	Continuous	Moderate	Medium
Oil or contaminant spills	Medium	Widespread	Anticipated	One-time	High (local) Low (range-wide)	High
Changes in Ecological Dynamics (Predation)						
Predation of adults, eggs, and young	High	Widespread	Historic, Current, Anticipated	Seasonal	High	High
Disturbance or Harm						
Recreational beach use	High	Widespread	Historic, Current, Anticipated	Seasonal	High	High
Vehicles	High	Widespread	Historic, Current, Anticipated	Seasonal	High	High
Climate and Natural Disasters						
Flooding and extreme weather events	Medium	Widespread	Historic, Current, Anticipated	Seasonal	Medium	High
Pollution and Natural Processes						
Oil spills	Medium	Widespread	Anticipated	One-time	High (local) Low (range-wide)	High
Environmental contaminants	Low	Unknown	Unknown	Unknown	Unknown	Low

[1] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table).*

[2] *Severity: reflects the population-level effect (High: very large population-level effect, Moderate, Low, Unknown).*

[3] *Causal certainty: reflects the degree of evidence that is known for the threat (High: available evidence strongly links the threat to stresses on population viability; Medium: there is a correlation between the threat and population viability e.g. expert opinion; Low: the threat is assumed or plausible).*

4.2 Description of Threats

Factors which directly threaten the survival of individuals include habitat loss and degradation; predation; human disturbance in nesting habitat; and adverse weather conditions during nesting, overwintering, and migration (hurricanes, storm surges, extreme high tides, storms, periods of severe cold weather and rain). The role of oil spills, toxic chemicals and injury at a population level are not clearly understood at this time. The threats assessment is based on the population's entire range. The threats may not be distributed equally across the range and the threat level may vary within jurisdictions.

Habitat loss or Degradation

The habitat of the Piping Plover (*melodus* subspecies) is threatened by:

- human disturbance (e.g. high levels of human activity and vehicle use)

Recreational activities (e.g. kite flying, fireworks) may not always physically destroy available habitat but the level of disturbance they cause may render sites unsuitable and impair habitat function.

- coastal development (e.g. residential or commercial developments, construction of wharves, jetties, and erosion control structures, beach cleaning)

These developments may physically destroy or alter the function of a site and render it unsuitable for nesting. Beach cleaning removes important components of plover habitat such as wrack and natural debris that provide feeding areas and shelter from inclement weather.

- natural processes (e.g. coastal erosion, sea-level rise, catastrophic weather events, vegetation encroachment)

Catastrophic weather events (hurricanes, flooding) may cause localized erosion and thereby loss of habitat and potentially direct loss of adults and chicks. Conversely, when unimpeded by coastal development or activities required for maintenance of infrastructures, severe weather events may create new habitat through accretion/deposition; severe weather may also maintain the early successional stage habitat required for successful nesting. It is unclear what impact climate change will have on the habitat of the Piping Plover (*melodus* subspecies).

- oil or contaminant spills

Oil spills not only have the potential to impact the birds and their habitat but also their invertebrate prey. The greatest impact may be experienced by flightless chicks which are unable to access alternative foraging grounds.

Changes in Ecological Dynamics (Predation)

Predation has been identified as one of the most important factors limiting populations across the North American breeding range (Goossen et al. 2002). Current predation rates appear to be higher than they were in the past. A study of 174 nests on Long Island between 1937 and 1958 reported 91% hatching success (Wilcox 1959). No predator control measures were taken during this study. Current estimates from eastern Canada suggest that hatching success is less than 55% (Amirault-Langlais, unpubl. data). There are many known or suspected predators of Piping Plover adults, chicks, and eggs, including American Crow (*Corvus brachyrhynchos*), Red Fox (*Vulpes vulpes*), Common Raven (*Corvus corax*), gulls (*Larus* spp.), Merlin (*Falco columbarius*), Raccoon (*Procyon lotor*), Coyote (*Canis latrans*), Striped Skunk (*Mephitis mephitis*), Short-tailed Weasel (*Mustela erminea*), American Mink (*Mustela vison*), domestic dogs, and feral cats. Human activities and land use practices have resulted in artificially high predator populations (Raithel 1984 *in* Melvin et al. 1991). These predators may hunt or opportunistically take adult Piping Plovers, chicks, or eggs. Increasing predation pressure can have a negative impact on populations of the Piping Plover (Burger 1987; U.S. Fish and Wildlife Service 1996).

Disturbance or Harm

Many human activities result in disturbance to Piping Plovers (*melodus* subspecies). Disturbance generally causes changes in normal nesting or feeding behaviour. Human-related disturbance factors include pedestrian traffic; unleashed pets; camping and campfires; sunbathing; collection of driftwood, shells or wrack; horseback riding; fishing; kite flying; kite buggying; fireworks; and motorized vehicle traffic (cars, trucks, and off-road and all-terrain vehicles).

The degree of severity, frequency of disturbance, and proximity to nest sites and feeding areas within any specific component of the habitat will dictate how plovers are affected. Severe disturbance (vehicular traffic on nesting beaches and brood-rearing and foraging habitat, unleashed pets, horseback riding, fireworks, camping and campfires, kite buggying) increases the likelihood of nesting failure, could potentially result in adult and young mortality, and may compromise nest site selection. Moderate and minor disturbance factors (walking, swimming, sunbathing, collecting driftwood or other natural beach components, fishing, flying kites) increase the likelihood of lower productivity due to increased energy expenditures to avoid the activity or a decrease in efficiency in conducting normal activities. Even though some activities such as walking on the beach may be considered low disturbance, nests are highly camouflaged and pedestrians may inadvertently trample them. There have also been several confirmed instances of children removing chicks from nesting beaches.

Operation of off-road, all-terrain, kite buggies, or other vehicles on beaches used by plovers may result in chick mortality, destruction of the eggs or nest, and, in some cases, nest abandonment (Ryan 1996; Flemming et al. 1988; Loegering and Fraser 1995; Melvin et al. 1994). Compaction of substrate caused by vehicle traffic may reduce invertebrate abundance and therefore local prey availability (Wolcott and Wolcott 1984).

Climate and Natural Disasters

Extreme high tides may flood nests above the mean high water mark. This can result in considerable nest loss if high tides coincide with the peak nesting season. Long periods of intense rain following hatching can decrease chick survival rates. Adverse weather conditions during overwintering and migration may also affect survival. Hurricanes, periods of cold weather, and storms could contribute to adult mortality.

Pollution and Natural Processes

Oil spills and oil discharge from bilge water pose a risk to foraging adults and chicks. Oil affects birds through physical contact, physiological changes, and acute toxic poisoning. Oiled birds may be affected by the disruption in the natural water-repellency of feathers, affecting their thermo-regulatory capacity (Leighton 1994), or there may be reduced hatching success if oil is transferred to the eggs during incubation (McGill and Richmond 1979; Lewis and Malecki 1984). Ingestion of toxic compounds while preening also commonly occurs. Ingested toxins can lead to severe internal damage and organ failure (Peakall et al. 1983). Three cases of oiled adult Piping Plovers (*melodus* subspecies) have been recorded in Canada (Amirault-Langlais et al. 2007). Several oil spills have affected Piping Plovers (*melodus* subspecies) in the United States. There is a similar risk along the coastline in Canada.

Limited information is available on the presence and impacts of toxins on the Piping Plover (*melodus* subspecies) in Canada. Analyses of unhatched eggs collected in two locations have indicated that only trace levels of toxic chemicals are present in eastern Canada (P. Laporte, unpubl. data; N. Burgess, pers. comm.). Although available information suggests that toxins do not currently pose a threat to Piping Plovers (*melodus* subspecies), monitoring should be periodically undertaken to identify potential problems.

Injuries to feet and legs are occasionally observed, presumably due to the fact that shorebirds tend to walk a large proportion of the time. Wing injuries are less frequently observed. Dogs are suspected to have been responsible for some cases of adult plovers with broken wings.

5. POPULATION AND DISTRIBUTION OBJECTIVES

Short-term population objective 1

Achieve and maintain a minimum of 255 pairs of Piping Plover (*melodus* subspecies). This reflects maintenance of the regional population at 1991 International Piping Plover Census levels.

Short-term population objective 2

Achieve and maintain an annual productivity of at least 1.65 chicks fledged per territorial pair. This is the minimum productivity rate that has been calculated to maintain the population at its current level (Calvert 2004).

Long-term population and distribution objectives

Increase the population to 310 pairs to be achieved and maintained in the long term (during three consecutive international censuses, which occur every five years). Population objectives for each province (identified in Table 3) are based on the maximum number of pairs documented on nesting beaches in recent years and closely approximate historical estimates (eg. Cairns and McLaren 1980).

In its Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan (U.S. Fish and Wildlife Service 1996), the U.S. Fish and Wildlife Service established a population objective of 800 adults (400 pairs) for the four Atlantic Provinces and Québec. Should the long-term population objective of this recovery strategy of 310 pairs be met, the feasibility of meeting this larger population objective will be evaluated, in conjunction with an assessment of carrying capacity and habitat availability.

Table 3. Population objectives (end of year count) within eastern Canadian jurisdictions.

Province	Population objective (pairs)	2008 population (pairs)	Required to meet population objective (pairs)
New Brunswick	105	86	+19
Newfoundland and Labrador	30	27	+3
Nova Scotia	60	44	+ 16
Prince Edward Island	60	49	+ 11
Québec	55	44	+11
Total	310	250	+ 60

Note: Jurisdictional objectives are subject to reinterpretation based on evaluation of carrying capacity. In order to ensure that population recovery is maintained, conservation measures must be sustained once the jurisdictional objectives have been achieved. Partitioning of populations objectives amongst provinces may be warranted based on factors such as response to recovery measures or regionally unique biological or genetic characteristics. Such refinements will be made where supported by population research, monitoring, and evaluation.

6. BROAD STRATEGIES AND GENERAL APPROACHES TO MEET OBJECTIVES

6.1 Actions Already Completed or Currently Underway

Recovery programs for the Piping Plover were initiated in 1985, with many conservation techniques having been developed and implemented since this time to address human-induced and natural threats. A National Recovery Plan for the Piping Plover (*Charadrius melodus*)

(Goossen et. al. 2002) outlining the approach recommended to recover the population was published in 2002. That recovery plan expired in 2004. Approaches to conservation that have been implemented to help achieve the recovery objectives include public education; "guardian" programs and volunteer and landowner involvement in protecting nesting plovers; protection of key nesting habitats through acquisition and minimizing human disturbance (symbolic fencing, signage, beach closures in three National Parks of Canada); reduction of predation (predator exclosures, beach clean-up programs, litter management, and localized predator management); increased enforcement of legislation prohibiting the use of vehicles in coastal areas; research on factors affecting the species and its habitat, including the wintering grounds; the discouragement of beach developments; and population monitoring.

Recent federal and provincial cooperation for endangered species conservation via legislation and other measures has enhanced efforts to protect the subspecies and its habitat. The *Species at Risk Act*, proclaimed in 2003, ensures the protection of individuals and the residence of the Piping Plover (*melodus* subspecies) throughout Canada and will enable the protection of its critical habitat on federal lands once it has been identified. All eastern Canadian provinces now also have legislation to identify and protect species at risk and their habitat. The Piping Plover is now designated as Endangered in New Brunswick, Newfoundland and Labrador, Nova Scotia, and Québec. The Province of Prince Edward Island is currently reviewing the status of species to establish its list of species at risk.

Substantive involvement on the part of many agencies occurs every year to protect the species. The Eastern Canadian Piping Plover Recovery Team and Working Group meet annually to discuss progress made during the previous year and to plan future efforts. The team includes representatives from the Canadian Wildlife Service (Atlantic and Québec regions) of Environment Canada, Parks Canada, the five provincial wildlife agencies, and non-governmental organizations. Several non-governmental organizations have had much success in protecting sensitive coastal features and the Piping Plover (*melodus* subspecies): Species at Risk – Nature NB (northeastern New Brunswick) and Irving Eco-Centre – La Dune de Bouctouche (southeastern New Brunswick); Codroy Valley Area Development Association (Newfoundland and Labrador); Bird Studies Canada, the Canadian Parks and Wilderness Society, Eskasoni Fish and Wildlife Commission Inc., Halifax Field Naturalists, and the Nova Scotia Bird Society (Nova Scotia); Island Nature Trust (Prince Edward Island); and Attention FragÎles of the Îles-de-la-Madeleine (Québec).

Environmental assessment reviews of projects that may pose a risk to the Piping Plover (*melodus* subspecies) are conducted frequently. Identification of measures to mitigate potential negative impacts of projects has been an important activity to ensure the maintenance of habitat. Measures are recommended that ensure the risk to nesting plovers is eliminated or reduced, while also addressing public safety issues.

6.2 Strategic Direction for Recovery

Table 4. Recovery Planning Table

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Habitat loss or degradation	High	Ensure enough suitable habitat to meet population objectives	• Address plovers in comprehensive coastal planning and management strategies
			• Protect habitat
			• Outreach and Stewardship
			• Consider plovers in environmental assessments
			• Enhance habitat
Changes in ecological dynamics or natural processes	High	Reduce predation	• Waste management • Appropriate use of exclosures and other recovery techniques • Predator management
Disturbance or harm	High	Reduce human disturbance	• Outreach and Stewardship
			• Compliance promotion
Natural disasters	Low	Minimize impacts of adverse weather	• Maintain habitat • Mitigate nest flooding
Pollution Natural processes Disturbance or harm	Medium/ Low	Minimize impacts of poorly understood mortality factors	• Oil spill contingency planning
			• Remain vigilant for population-level threats
			• Rehabilitate injured/ill plovers
Knowledge gaps	Medium/ High	Address key knowledge gaps to recovery	• Research • Form and maintain partnerships • Evaluate environmental assessments
Population size and distribution information gaps	High	Monitor the population	• Count adults
			• Measure productivity
			• Evaluate habitat

6.3 Narrative to Support the Recovery Planning Table

The following broad strategies and approaches are recommended to address the threats described in section 4.

Ensure enough suitable habitat to meet population objectives

Proper assessment and evaluation of projects undertaken in the coastal zone will ensure the continued availability of suitable coastal habitats required for nesting, successful brood-rearing, staging, migration, and overwintering. Inclusion of Piping Plover (*melodus* subspecies) habitat requirements in coastal zone planning processes could help ensure that natural habitats are safeguarded and the integrity of coastal processes is maintained over the long term. Within coastal zone planning, activities which are deemed to have an adverse impact on Piping Plover (*melodus* subspecies) habitat should be controlled to the extent possible. Environmental assessment project reviews should consider potential changes in habitat related to climate change so that Piping Plover habitat requirements are taken into account. Increased compliance promotion for laws, regulations, and policies to protect the coastal zone is required.

The review of project proposals through federal and provincial governments, local planning authorities, and appropriate provincial agencies charged with regulating and overseeing environmental assessments in coastal areas should always consider the potential for interactions with the Piping Plover (*melodus* subspecies) and its habitat. Attention should be given to any project or related activity which could result in 1) the loss or degradation of habitat, 2) the introduction and proliferation of predators 3) human disturbance, and 4) oil spills. Multiple projects and activities may have cumulative effects that are undetectable in the short term.

Through development and application of best practices and environmental assessment processes, project alternatives should be identified, potential impacts avoided or minimized, uncertainties investigated, impact predictions verified, and mitigation effectiveness tested; taking into account the goals, objectives, and conservation measures set out in the recovery strategy. Monitoring of effects and follow-up programs should be undertaken by personnel experienced with the Piping Plover (*melodus* subspecies), and should be sensitive enough to detect subtle cumulative effects.

Development of programs to engage landowners in planning and implementation of habitat protection measures will be a key element for ensuring effective long-term protection for coastal habitats. This will ensure the maintenance of natural habitat features to make species recovery possible.

Reduce predation

Predator management will include the use of short-term techniques and by development of long-term solutions to address the problem of elevated levels of predator populations. The usefulness of techniques such as electric fencing and predator aversion should be investigated as potential short-term solutions to localized predator problems. Maintaining dialogue with management agencies elsewhere may result in the identification of other potential control programs. Long-term solutions for managing predator populations, including identification of effective waste management practices, may be integrated into the development of coastal zone planning strategies. Attention to predators in environmental assessment reviews will help curb the proliferation of predators, most notably those related to agricultural projects, food and fish processing plants, and mink farms. These reviews will recommend measures that will result in less favourable conditions for predators.

Reduce human disturbance

Human disturbance will be reduced in critical habitat designated under the *Species at Risk Act* during the nesting and chick-rearing season. This will be achieved with stewardship and beach guardian programs and education and outreach programs and by implementing restrictions on certain types of beach activities for the period from the establishment of nesting territories until chicks have fledged. Other tools have been used successfully in other parts of the species' range to mitigate threats from human disturbance, predation and flooding (e.g. nest and chick translocation, sand bagging of nests, captive rearing of young from viable but abandoned nests). These techniques should be evaluated to determine if they may be used to enhance the potential for recovery of the species.

Increased compliance promotion for prohibitions against vehicular use of beaches will be necessary to achieve the desired objectives. Better coastal land use planning and practices will ensure that some areas are maintained with little human presence and therefore free from human disturbance. Environmental assessments could provide input on proposed activities and reduce potential negative impacts. Habitat securement should be pursued wherever feasible.

Minimize impacts of adverse weather conditions

Long-term coastal planning processes should result in the maintenance of habitat in sufficient quantity and of sufficient quality to provide shelter for the Piping Plover (*melodus* subspecies) during periods of adverse weather. Efforts should be undertaken to mitigate impacts of flooding on nests. Efforts to curb climate change should continue. Wherever possible, natural sea level rise should not be restricted by erosion control structures, in order to allow coastal wetlands to be re-established.

Minimize impacts of poorly understood mortality factors

Existing oil spill contingency plans should include measures for mitigating this threat to the Piping Plover. Oil spill prevention efforts should continue and be enhanced. Education and incentive programs aimed at encouraging ship and boat operators to dispose of oily bilge water at appropriate facilities should increase compliance. Increased enforcement of existing laws, including amendments to the *Migratory Birds Convention Act, 1994* and the *Canadian Environmental Protection Act, 1999* that came into force in 2005, will send a strong message that dumping oil at sea is a serious offence. These efforts should help prevent the oiling of marine birds.

Threats related to toxic chemicals should be monitored as appropriate. Flame retardants have already been banned in some parts of Europe. Similar measures should be pursued in Canada if negative impacts on the Piping Plover (*melodus* subspecies) or its habitats are suspected.

Address key knowledge gaps to recovery

In order to develop an effective and adaptive science-based recovery program, there is a need to conduct research both on nesting grounds and in wintering areas. The successful implementation of research projects to answer key questions will provide direction for recovery activities.

A collaborative approach to planning and implementing research is proposed. An impressive network of agencies and individuals is currently involved in recovery program implementation.

Engaging key partners to work collaboratively to initiate and complete priority research projects will ensure that relevant and pressing questions are addressed (see Appendix B). By forming partnerships with U.S. colleagues, questions relating to wintering issues can be identified and addressed. Key research questions may be addressed by forming partnerships with organizations, universities and other research-based groups. Environmental assessment review practitioners will be encouraged to evaluate the outcome of comments provided through their review process.

Monitor the population

Monitoring is required to determine whether conservation actions being delivered are achieving desired outcomes and are resulting in population recovery. In this way, the success of management techniques can be evaluated. Productivity must also be monitored periodically so it can be compared to the productivity target established in this strategy. Productivity rates are also necessary for projecting future population trends.

Population monitoring will be conducted at least every five years as part of the International Piping Plover Census; mini-censuses and annual censuses provide useful information and should be conducted whenever possible. Ideally, productivity, calculated as the number of chicks fledged per territorial pair, should be estimated on an annual basis.

7. CRITICAL HABITAT

7.1 Identification of the Species' Critical Habitat

Approach

Protection of habitat is an important consideration for the recovery of the Piping Plover (*melodus* subspecies). Although habitat does not appear to be a limiting factor in terms of quantity, the quality of existing habitat is negatively affected by anthropogenic factors and predation. Sufficient information is available on the subspecies' habitat requirements and distribution to identify critical habitat in this recovery strategy. An action plan will be developed to support the implementation of this strategy and will outline proposed measures to protect critical habitat.

Key habitat attributes

Piping Plovers (*melodus* subspecies) select the following sites: wide sand, gravel, or cobble beaches; barrier island sandspits; or peninsulas in marine coastal areas. Piping Plovers (*melodus* subspecies) nest in early successional habitat characterized by the lack of dense vegetation. Plover distribution frequently shifts in response to habitat changes. Beach width, substrate composition, access to local feeding areas, presence of wrack, vegetation cover, and degree of human disturbance are thought to influence selection of nesting sites. The interaction of these features may also influence site selection. Suitable habitat may be roughly approximated by the following key habitat attributes (Boyne and Amirault 1999):

Slope: gently sloping foredune
Beach width: wide stretches of beach that afford protection from flooding at normal high tide
Substrate: sand, gravel, or cobble, or some combination of these
Foredune vegetation density: sparsely vegetated or relatively free of vegetation

The area of beach considered suitable for nesting, feeding and/or cover includes the area of the coastal zone from the low water mark, the intertidal zone and up to the crest or peak of the vegetated dune (typically identified by the presence of marram/beach grass or other dune vegetation). This could include habitat managed for the benefit of the species. Although these are the most common habitat parameters, the subspecies will occasionally nest in non-traditional habitats such as dredge spoils or in gravel parking areas.

Habitat required for feeding and brood-rearing must be located in close proximity to nesting sites. Piping Plovers (*melodus* subspecies) may use the entire beach area from the intertidal zone to the toe of the foredune. Microhabitat features such as the presence of wrack, driftwood, and ephemeral pools enhance habitat quality by providing feeding opportunities and shelter. The entire beach area from the low water mark and the intertidal zone up to the line of vegetation (marram/beach grass or other vegetation) or up to the crest or peak of the vegetated dune is therefore an important component of critical habitat.

Criteria for identification of critical habitat

The population objectives have not been met; therefore, any site with suitable habitat (defined in the key habitat attributes section) occupied by at least one nesting pair of Piping Plovers (*melodus* subspecies) in at least one year since 1991 (the year of first complete survey coverage) is critical habitat under the *Species at Risk Act*. The complete list of sites in eastern Canada that currently meet these criteria, and are therefore critical habitat under the *Species at Risk Act,* is in Appendix C.

Additional sites

Piping Plovers (*melodus* subspecies) frequently occupy new sites in response to creation of habitat by winter storms, ice scour, tidal surges, and other natural or anthropogenic events. Appendix C will be updated if new sites are occupied by nesting pairs.

Furthermore, sites that do not meet the criteria for critical habitat but are suitable (defined in the key habitat attributes section) could be considered critical habitat in the future if carrying capacity determines that protection of additional habitat is necessary to meet population objectives.

Nests in non-critical habitat

Nests in non-traditional habitats, such as parking lots, dredge spoils, or sites with steep embankments, are sometimes used by nesting Piping Plovers (*melodus* subspecies). These sites may be less significant than typical habitat because some key feature of the habitat is often missing (e.g., access to feeding areas for chicks). In many cases, these sites will not be formally identified as critical habitat under the *Species at Risk Act*, although the general prohibitions under the *Species at Risk Act* protect the birds and their residences from destruction and harassment.

Boundaries of critical habitat

Identifying boundaries for critical habitat helps to focus conservation efforts and ensure effective enforcement. Coastal features are, however, constantly changing. The following is provided for further clarification and guidance for establishing the limits of critical habitat.

Barrier beaches/islands: The entire barrier beach or barrier beach island area (the intertidal zone from the low water mark, the sand flats, the upper beach, the dune, and associated habitats) associated with the sites presented in Appendix C is critical habitat.

Mainland beaches: The entire area of habitat suitable for nesting, feeding and cover, including the intertidal zone from the low water mark, the sand or mud flats, and upper beach that normally includes dune vegetation (marram/beach grass or other vegetation) up to the crest or peak of the vegetated dune (to facilitate recognition of the boundary line) associated with the sites presented in Appendix C is critical habitat. Breaches that cross from the ocean to bays, low back shores, landward extensions of washovers, washover fans, sand fans, runs from ponds, and pond outlets are considered extensions of the beach habitat and therefore are critical habitat. When a distinct dune crest does not exist (i.e., where a dune is not present), the landward boundary of critical habitat extends to the line of permanent non-beach vegetation (e.g. marsh or bog vegetation, shrubs, trees, farmland) or another permanent physical structure (e.g. road, bridge, culvert, river).

7.2 Schedule of Studies to Identify Critical Habitat

The information currently available is sufficient to fully identify critical habitat under the *Species at Risk Act*; therefore, a schedule of studies is not required.

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Any anthropogenic activity which alters or disturbs the key habitat attributes described in section 7.1 above is considered an activity likely to result in the destruction of critical habitat. Also, any activity that reduces access to habitat by plovers or reduces the functionality of habitat for plovers is considered a destruction of critical habitat. Examples of activities which are likely to result in the destruction of critical habitat include:

- off-road, all-terrain, or motorized vehicle use;
- coastal development occurring in plover habitat or in other habitats closely associated with plover habitat, including construction of cottages, homes, or tourist accommodations, boardwalks, and trails;
- beach nourishment;
- beach stabilization;
- sand mining and extraction;
- beach cleaning or raking activities that remove elements of natural habitat; and
- deliberate or accidental discharge of oil and toxic chemicals.

8. MEASURING PROGRESS

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

This recovery strategy and supporting action plan will be subject to an adaptive management approach, whereby new information will be integrated on an ongoing basis in order to take advantage of new tools, knowledge, challenges, and opportunities. A five-year evaluation of the recovery strategy will be based upon the performance measures listed below.

Annually, success of the recovery strategy implementation will be measured against the following performance indicators:

- The population is maintained at 255 pairs;
- Regional productivity target of 1.65 chicks fledged per territorial pair is achieved

Over three consecutive international censuses, which occur every five years, success of the recovery strategy implementation will be measured against the following performance indicators

- The population is increased to 310 pairs
- The population distribution is unchanged from the 1991 International Census

9. STATEMENT ON ACTION PLANS

One action plan will be developed to address the requirements of sections 47-50 of the *Species at Risk Act*. Specifically, the action plan will be developed in cooperation with the Parks Canada Agency, appropriate provincial ministers, aboriginal organizations, and any other person or organization that will be directly affected by the action plan, including landowners. The action plan will provide additional information on the protection of critical habitat, outline the measures that will be taken to implement the recovery strategy, and evaluate the socio-economic costs of the action plan and the benefits to be derived from its implementation. This action plan will be completed within two years of the final version of this recovery strategy being posted on the Species at Risk Public Registry.

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APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The implementation of this recovery strategy is not expected to result in a significant negative impact on other species that occupy Piping Plover (*melodus* subspecies) habitat. Past efforts have resulted in enhanced protection for sensitive coastal features. There may be benefits to Gulf of St. Lawrence Aster (*Symphyotrichum laurentianum*) (currently listed under Schedule 1 of the *Species at Risk Act* as Threatened) in locations where both the Piping Plover (*melodus* subspecies) and the plant are found. Sensitive coastal habitats will be conserved. Locally, there may be a reduction in populations of Herring Gulls (*Larus argentatus*), American Crow, and red fox, where enhanced coastal management practices which result in more effective litter management are implemented and predator populations may become better regulated.

APPENDIX B: KNOWLEDGE GAPS TO RECOVERY

The Piping Plover (*melodus* subspecies) is one of the best monitored birds in eastern Canada. In most years, the majority of sites used by plovers are now monitored, and productivity information is gathered for almost all accessible occupied sites. There have been many studies conducted on the subspecies, but some knowledge gaps still exist.

The Piping Plover (*melodus* subspecies) would benefit from research and other efforts in, but not limited to, the following areas:

- identification of non–breeding grounds (i.e. wintering, staging, and migration);
- identification of threats to plovers on non-breeding grounds;
- evaluate recovery management techniques (e.g. predator management, vegetation manipulation);
- identification of the predators of adults, eggs, and young and an assessment of their population-level impacts;
- the relative success of environmental assessment advice, of the accuracy of impact predictions for the purposes of environmental assessments, and of the effectiveness of recommended mitigation measures;
- stressors in the coastal zone that affect plover habitat, with the ultimate objective of developing and implementing effective coastal planning strategies that balance human activities with the habitat requirements of plovers and include long-term solutions to the problems posed by predation;
- analyses of population viability so the probability of population persistence can be calculated and the possible outcomes of different management scenarios can be explored;
- conservation genetics (to determine population links within eastern Canada and with populations outside the region);
- factors affecting reproductive success and survival;
- accuracy of fledgling rate estimates;
- movement of adult and young between areas;
- the carrying capacity of habitats in eastern Canada and whether there is a need to protect or manage currently unoccupied sites in order to meet population recovery objectives;
- compare characteristics of occupied habitat to apparently suitable but unoccupied habitat;
- the impact of sea level rise as a result of climate change on critical habitat designated under the *Species at Risk Act*;
- the influence of invertebrate population distribution and abundance on habitat selection by plovers;
- factors affecting invertebrate prey abundance and juvenile and adult survival availability (e.g vehicles);
- the response of plovers to disturbance, harassment, and habitat management.

APPENDIX C: SITES IN EASTERN CANADA IDENTIFIED AS CRITICAL HABITAT FOR THE PIPING PLOVER (*MELODUS* SUBSPECIES)

Prov	Beach	longitude (W)	latitude (N)	Land ownership
NB	Baie de Petit Pokemouche	-64.725	47.690	Federal, Private
NB	Bouctouche Bar	-64.652	46.507	Private
NB	Cap-Bateau	-64.531	47.822	Private
NB	Cape Jourimain NWA*	-63.832	46.161	Federal Protected
NB	Cedar Road South	-64.902	47.394	Private, Provincial
NB	Cedar Road Spit	-64.907	47.374	Private
NB	Chiasson Office	-64.639	47.729	Private
NB	Chockpish	-64.720	46.606	Private
NB	Côte-Sainte-Anne	-64.715	46.562	Private
NB	Dune de Maisonnette	-64.969	47.822	Municipal, Provincial
NB	Dune de Neguac	-65.001	47.247	Private, Provincial
NB	Dune de Tabusintac	-64.916	47.337	Private
NB	École la Vague	-64.698	47.705	Municipal, Private
NB	Escuminac	-64.820	47.019	Private, Provincial
NB	Grand Lac	-64.609	47.749	Provincial
NB	Grand Passage	-64.755	47.674	Federal, Private, Provincial
NB	Grande Plaine	-64.548	48.003	Private, Provincial
NB	Île Pokesudie	-64.796	47.819	Private
NB	Johnston Point	-64.094	46.172	Private
NB	Lac Frye	-64.519	48.021	Private
NB	Little Cape	-64.142	46.182	Private
NB	Marks Point South	-64.583	47.895	Federal, Private
NB	Middle Miscou	-64.472	47.967	Private, Provincial
NB	Miscou Beach	-64.481	47.992	Federal, Private, Provincial
NB	Neguac (Spit) North	-64.981	47.262	Provincial
NB	North Kouchibouguac Dune KNP▪	-64.912	46.864	Federal Protected
NB	Pigeon Hill Beach	-64.502	47.884	Private, Provincial
NB	Pigeon Hill Sandspit	-64.489	47.901	Provincial
NB	Plover Ground North	-64.791	47.644	Private
NB	Plover Ground South	-64.809	47.614	Private
NB	Pointe à Barreau	-64.888	47.432	Private
NB	Pointe à Bouleau	-64.872	47.496	Federal, Private, Provincial
NB	Pointe Sapin	-64.814	46.974	Private, Provincial
NB	Pointe Sapin Dune, KNP▪	-64.873	46.933	Federal Protected
NB	Pointe Verte	-64.837	47.586	Federal, Private
NB	Portage Island NWA*	-65.034	47.171	Federal Protected
NB	Portage River Dune, KNP▪	-64.898	46.898	Federal Protected
NB	Ruisseau Chenière	-64.557	47.965	Private, Provincial
NB	South Kouchibouguac Dune KNP▪	-64.893	46.808	Federal Protected
NB	South Richibucto	-64.746	46.700	Private

Prov	Beach	longitude (W)	latitude (N)	Land ownership
NB	South Richibucto (North Barrier Island)	-64.804	46.707	Federal, Private
NB	Sainte-Marie - Saint-Raphael	-64.564	47.783	Private, Provincial
NB	Swinging Point	-64.962	47.278	Provincial
NB	Tern Islands KNP▪	-64.874	46.778	Federal Protected
NB	Tracadie Dune	-64.866	47.529	Private
NB	Val Comeau	-64.872	47.467	Federal. Private, Provincial
NB	Waterside	-64.810	45.627	Private
NB	Wilson Point North	-64.467	47.944	Private, Provincial
NB	Wilson Point South	-64.490	47.920	Federal, Private, Provincial
NL	Big Barachois Beach	-59.240	47.606	Provincial
NL	Big Barasway (Burgeo)	-57.730	47.650	Provincial
NL	Big Barasway (Seal Cove)	-56.035	47.497	Private, Provincial
NL	Bottles Barachois (Rocky Barachois Beach)	-59.232	47.591	Private, Provincial
NL	Cape Ray Beach, J.T. Cheeseman Provincial Park	-59.283	47.622	Provincial
NL	Crow Head Beach	-57.682	47.627	Private, Provincial
NL	Flat Bay Peninsula	-58.587	48.420	Provincial
NL	Fourth Beach - Sandbanks Provincial Park	-57.661	47.698	Provincial
NL	Grand Codroy Provincial Park	-59.33	47.83	Provincial
NL	Little Codroy Beach (MacDougall's Beach)	-59.309	47.761	Provincial
NL	Osmond Beach	-59.255	47.618	Private, Provincial
NL	Sandy Point, Flat Island	-58.491	48.457	Provincial
NL	Seal Cove - Stephenville Crossing	-58.463	48.515	Private
NL	Second Beach - Sandbanks Provincial Park	-57.647	47.603	Provincial
NL	Second Beach (Grand Bay West)	-59.200	47.583	Provincial
NL	Shallow Bay Beach▪	- 57.755	49.948	Federal Protected
NL	Short Sand Beach	-59.252	47.671	Private, Provincial
NL	Stephenville Crossing	-58.430	48.500	Private, Provincial
NL	Stephenville Crossing – Main Gut south	-58.430	48.480	Unknown
NL	Third Beach - Sandbanks Provincial Park	-57.653	47.601	Provincial
NS	Beach Meadows	-64.638	44.057	Municipal
NS	Big Merigomish Island	-62.367	45.677	Private, Provincial
NS	Black Point	-65.050	43.701	Private
NS	Bowen Island	-62.548	45.656	Provincial
NS	Bulls Head	-65.570	43.465	Federal, Private
NS	Burks Point	-65.501	43.494	Private
NS	Cape Bay, Cape LaHave Island	-64.377	44.193	Municipal
NS	Captains Pond and Monks Head	-61.851	45.679	Private, Provincial
NS	Carters & Wobamkek	-64.817	43.907	Private
NS	Cherry Hill (Conrad)	-64.511	44.142	Provincial
NS	Clam Harbour	-62.895	44.726	Private, Provincial
NS	Clam Point	-65.570	43.500	Provincial
NS	Conrads (East and West)	-63.369	44.643	Private, Provincial
NS	Cranberry Pond	-64.808	43.899	Private
NS	Crescent	-65.120	43.695	Municipal, Private
NS	Crow Neck (Baccaro)	-65.465	43.477	Private, Provincial

Prov	Beach	longitude (W)	latitude (N)	Land ownership
NS	Daniels Head (Southside)	-65.595	43.434	Private, Provincial
NS	Dominion (Lingan)	-60.040	46.221	Provincial
NS	Dunns	-61.885	45.691	Private, Provincial
NS	Fox Bar	-65.330	43.609	Private
NS	Glace Bay Bar	-59.926	46.179	Federal
NS	Goose (Indian) Point	-65.515	43.498	Private
NS	Grahams Cove	-61.775	45.645	Private
NS	Hawk Point	-65.616	43.411	Provincial
NS	James	-62.554	45.659	Private
NS	Johnstons Pond	-64.948	43.778	Provincial
NS	Little Port Joli Bay, Keji NP Seaside[ϕ]	-64.810	43.861	Federal Protected
NS	Louis Head	-65.010	43.758	Private, Provincial
NS	Mahoneys	-61.895	45.698	Private, Provincial
NS	Martinique	-63.127	44.692	Provincial
NS	Melmerby	-62.506	45.659	Private, Provincial
NS	North Harbour	-60.459	46.921	Provincial
NS	Northeast Point	-65.608	43.514	Municipal, Private, Provincial
NS	Oak Island	-63.405	45.848	Private
NS	Pictou Bar Spit (Lighthouse)	-62.658	45.683	Federal, Provincial
NS	Pomquet	-61.809	45.648	Private, Provincial
NS	Port Joli (Goose Haven)	-64.870	43.863	Private
NS	Ragged Harbour	-64.559	44.087	Municipal, Private
NS	Rainbow Haven Park (Cole Harbour)	-63.415	44.649	Provincial
NS	Red Head	-65.345	43.571	Private
NS	Round Bay & Roseway	-65.350	43.601	Provincial
NS	Sand Hills Provincial Park (Sebim)	-65.561	43.534	Provincial
NS	Sandy Bay	-64.888	43.824	Private, Provincial
NS	Shipping Point	-61.535	46.015	Private, Provincial
NS	South Harbour	-60.433	46.882	Private
NS	South West Mabou	-61.426	46.059	Provincial
NS	St. Catherines River, KejiNP Seaside[ϕ]	-64.829	43.842	Federal Protected
NS	Stoney (Lawrencetown Head)	-63.357	44.644	Private, Provincial
NS	Stoney Island	-65.582	43.460	Private, Provincial
NS	Summerville	-64.819	43.950	Provincial
NS	The Cape	-65.627	43.399	Federal, Provincial
NS	The Hawk	-65.612	43.422	Provincial
PE	Adams Pond, Darnley	-63.605	46.554	Private
PE	Basin Head	-62.090	46.389	Private, Provincial
PE	Beach Point, Kings County	-62.478	46.022	Federal, Private, Provincial
PE	Black Pond[†]	-62.159	46.367	Private, Provincial
PE	Blooming Point, PEINP[℘]	-63.007	46.415	Federal Protected
PE	Boughton Island	-62.414	46.198	Private
PE	Campbells Pond, Park Corner	-63.546	46.539	Private
PE	Canavoy	-62.822	46.433	Private, Provincial
PE	Cascumpec Sand Hills	-64.024	46.776	Federal, Private
PE	Cavendish Sandspit, PEINP[℘]	-63.446	46.506	Federal Protected

Prov	Beach	longitude (W)	latitude (N)	Land ownership
PE	Clarkes Pond, PEINP℘	-63.40	46.50	Federal Protected
PE	Conway Sand Hills	-63.931	46.696	Provincial
PE	Cousins Pond, Cousins Shore	-63.557	46.541	Private
PE	Covehead, PEINP℘	-63.166	46.430	Federal Protected
PE	Darnley Point	-63.679	46.561	Private
PE	Deroche Pond	-62.934	46.425	Private, Provincial
PE	Diligent Pond	-61.989	46.442	Private
PE	East Lake	-62.010	46.463	Private, Provincial
PE	East Point	-61.984	46.458	Private, Provincial
PE	Eglington Cove	-62.350	46.320	Provincial
PE	Fortune	-62.344	46.335	Private
PE	Greenwich Central (includes PEINP℘)	-62.71	46.44	Federal, Private
PE	Greenwich Tip, PEINP℘	-62.726	46.445	Federal
PE	Hog Island	-63.790	46.617	Federal
PE	Howe Bay Sandspit	-62.376	46.296	Provincial
PE	Jacques Cartier Provincial Park East – Kildare Point Sandspit	-64.013	46.849	Federal, Private, Provincial
PE	Nail Pond	-64.052	47.004	Private, Provincial
PE	North Rustico Sandbar	-63.289	46.450	Provincial
PE	Old Ferry Spit, St. Georges	-62.421	46.253	Provincial
PE	Panmure Island	-62.467	46.132	Provincial
PE	Pigots Pond, Savage Harbour	-62.846	46.433	Private
PE	Poverty Beach	-62.484	46.038	Provincial
PE	Poverty Island	-62.484	46.030	Provincial
PE	Priest Pond	-62.178	46.482	Private
PE	Robinson's Island Sandspit, PEINP℘	-63.271	46.446	Federal Protected
PE	Ross Lane, PEINP℘	-63.127	46.427	Federal Protected
PE	Rustico Island Causeway, PEINP℘	-63.227	46.434	Federal Protected
PE	Savage Harbour (West)	-62.830	46.433	Federal, Provincial
PE	Schooner Pond, PEINP℘	-62.665	46.459	Federal
PE	Shaws Beach, PEINP℘	-63.192	46.430	Federal Protected
PE	Souris Causeway	-62.271	46.356	Municipal, Provincial
PE	South Lake	-62.031	46.418	Private, Provincial
PE	Spry Cove	-62.374	46.271	Provincial
PE	St Peters Harbour	-62.739	46.442	Federal, Private
PE	St Peters Lake Run	-62.775	46.439	Private
PE	Stanhope, PEINP℘	-63.096	46.420	Federal Protected
PE	Stanhope Cape, PEINP℘	-63.141	46.431	Federal Protected
PE	Tracadie Sandbar	-63.025	46.415	Private, Provincial
PE	Wood Islands	-62.761	45.954	Private
QC	Anse aux Baleiniers	-61.898	47.420	Private, Provincial
QC	Anthony's Nose	-61.474	47.783	Provincial
QC	Barge échouée	-61.787	47.471	Provincial
QC	Bassin aux Huîtres (east)	-61.507	47.554	Provincial
QC	Bassin aux Huîtres (west)	-61.532	47.543	Provincial
QC	Cap du Dauphin	-61.543	47.625	Provincial
QC	Cap Noddy île Brion	-61.511	47.780	Provincial

Prov	Beach	longitude (W)	latitude (N)	Land ownership
QC	Chemin Coulombe	-61.951	47.350	Provincial
QC	Chenal de la Grande-Entrée	-61.559	47.548	Provincial
QC	Digue à Fernand	-61.960	47.362	Private
QC	Dune de l'Ouest	-61.963	47.312	Provincial
QC	Dune du Bassin secteur 1	-61.914	47.223	Private, Provincial
QC	Dune du Bassin secteur 2	-61.883	47.222	Provincial
QC	Dune du Sud (début)	-61.694	47.507	Provincial
QC	Dune du Sud (milieu)	-61.661	47.534	Provincial
QC	Dune du Sud (pointe)	-61.594	47.558	Provincial
QC	Étang à Ben	-61.953	47.357	Private, Provincial
QC	Étang à Procul-Bourgeois	-61.895	47.352	Private
QC	Étang des Caps	-61.998	47.264	Private, Provincial
QC	Goulet du Havre-aux-Basques	-61.982	47.282	Provincial
QC	Grande Brèche-Dune du Nord	-61.630	47.576	Provincial
QC	Grande Échouerie	-61.411	47.614	Provincial
QC	L'Éolienne	-61.740	47.460	Provincial
QC	La Cormorandière	-61.715	47.483	Private, Provincial
QC	La Digue	-61.842	47.400	Private
QC	La Pointe	-61.835	47.402	Private
QC	Le Corfus	-61.957	47.330	Provincial
QC	Mine de sel	-61.570	47.612	Provincial
QC	Old-Harry	-61.468	47.585	Provincial
QC	Plage de Grosse-Île	-61.497	47.624	Provincial
QC	Plage de la Martinique	-61.931	47.294	Provincial
QC	Plage de l'Hôpital	-61.864	47.427	Provincial
QC	Plage du Havre Aubert	-61.909	47.261	Provincial
QC	Pointe de l'Est	-61.409	47.630	Private, Provincial
QC	Pointe-aux-Loups	-61.688	47.541	Provincial
QC	Pont du Détroit	-61.750	47.497	Provincial
QC	Portage-du-Cap	-61.884	47.243	Private, Provincial
QC	Sandy Hook (à la base)	-61.821	47.230	Provincial
QC	Sandy Hook (bout)	-61.790	47.262	Provincial
QC	Sandy Hook (milieu)	-61.800	47.252	Provincial
QC	Secteur avant mine de sel	-61.586	47.604	Provincial
QC	Secteur lac Goose	-61.603	47.593	Provincial
QC	Secteur-îlet- Pointe-aux-loups	-61.738	47.507	Provincial

† A portion of this site is located within Black Pond Migratory Bird Sanctuary.

*NWA – National Wildlife Area

▪ KNP – Kouchibouguac National Park of Canada

ϕ Keji NP Seaside – Kejimkujik National Park of Canada Seaside Adjunct

℘ PEINP – Prince Edward Island National Park of Canada

Note: the coordinates provided in this Appendix are intended to orient the reader to the general location of a given beach. They are not intended to mark the exact centre of the beaches, which are part of dynamic coastal systems and change from time to time. Critical habitat exists at these beaches where the criteria for identification of critical habitat (Section 7.1) have been met.

Sites occupied in at least one year since 1991 that no longer have suitable habitat (defined in the key habitat attributes section). These sites are not identified as critical habitat.

Prov	Beach	Lat	Long	Rationale*
NB	Crab Island	-64.953	47.290	1
NB	Petit Barachois	-64.439	46.236	2
NB	North Richibucto Dune, KNP▪	-64.832	46.743	2
NL	First Beach - Grand Bay West	-59.18	47.58	1
NL	Kelby Cove, Grand Bay West	-59.224	47.583	1
NL	Searston Beach	-59.335	47.832	1
NS	Conrods, Petpeswick Inlet	-63.180	44.705	1
NS	Oxners Beach	-64.340	44.278	2
NS	Roaring Bull Point	-62.573	45.681	2
PE	Brandor's Pond, Sea View	-63.584	46.548	1
PE	Cabot Provincial Park	-63.693	46.557	1
PE	Lower Darnley, Adams Cottages	-63.622	46.548	1
PE	Naufrage	-62.406	46.468	1
PE	North Rustico, PEINP℘	-63.293	46.459	1
QC	Port de Grosse-Île	-61.514	47.626	2

* 1 – habitat not suitable
2 – insufficient suitable habitat

▪KNP – Kouchibouguac National Park of Canada
℘ PEINP – Prince Edward Island National Park of Canada