Saskatchewan
Prairie Conservation Action Plan

Guide to Managing for Optimal Habitat Attributes:

Piping Plover
Charadrius melodus circumcinctus

May 30, 2017

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TABLE OF CONTENTS

ABOUT THIS GUIDE

A New Approach To Managing For Species At Risk

The intent of this guide is to determine local and landscape-scale habitat features that are optimal for species at risk at different life stages, as well as important non-habitat related beneficial management practices. As habitat for species at risk declines and threats to populations increase in jurisdictions outside Canada, it becomes critical to provide optimal conditions on what remains if we are to conserve or recover a species.

This First Approximation of the guide for Piping Plovers should be considered a living or dynamic document that will continually evolve. As our knowledge of prairie species at risk improves with research and monitoring, this guide will need to be periodically revisited and updated.

Who Should Use This Guide?

Most grassland species at risk in Saskatchewan exist on working agricultural lands that most often support grazing livestock and sometimes support annual or perennial crops. This guide provides habitat targets and non-habitat related beneficial management practices (BMPs) for land managers who may have the opportunity to aid in the conservation of species at risk on the land under their control. Additionally, the habitat targets and BMPs may be used by conservation organizations in designing results-based agreements with land managers.

The Environmental Benefit Index (EBI) is designed to be used by any stakeholder to prioritize sites and/or projects for conservation and recovery programs, or by land managers to evaluate the value of their property for a particular species.

How To Use This Guide

This guide is presented in two parts. The first part summarizes the important spatial and temporal needs of the species and presents habitat targets and non-habitat related BMPs. Habitat targets are presented at two major spatial scales. Landscape-scale habitat targets are those attributes that an individual opts for when choosing a breeding location or home range. These targets are often land cover or topography-related, but may also include such factors as whether or not there are other individuals of the same species already in the area. Site-scale targets are those attributes that the individual prefers at a certain time (e.g., breeding, brood rearing, hunting or foraging) or in a certain portion of their home range. Site habitat targets are most commonly physical vegetation and/or soil parameters, but may also include such attributes as configuration of vegetation communities or land cover, burrow densities, presence/absence of human infrastructure, etc. The rationale for each

target or BMP is also provided so land managers can readily understand the relationship between the target and use of habitat by the species.

Guides have been prepared for individual species. Habitat targets for individual species give the land manager the choice of species they wish to benefit. Managing for a single species may result in habitat that is undesirable for another species. Conflicts between species are addressed in the EBI.

The second part of the guide presents an index that places values on the habitat targets and BMPs in combination with other considerations. An Environmental Benefit Index is a compound index that considers multiple environmental factors when determining an ecosystem outcome. EBIs can be used to evaluate and prioritize opportunities for conservation programs. An EBI is of considerable importance in determining priority sites to invest in, particularly when funds are limited.

EBIs were identified as a method to target programming and prioritize participation in the design of the Prairie Beef & Biodiversity program (Commission for Environmental Cooperation, 2013). An EBI was subsequently developed for the Greater Sage-Grouse (Ranchers Stewardship Alliance Inc., 2014).

The overall goal of the EBIs for species at risk habitat is to ensure maximum environmental value for an investment in results-based conservation programming. The EBI has several potential uses including:

- To geographically target the most important locations,
- To evaluate and rank candidate properties or projects for their environmental benefit,
- To rank the environmental benefit of candidate properties or projects by cost (or bid), and
- To evaluate projects over time to determine if environmental values are being improved or maintained, or to evaluate the efficiency of the investment over time.

Piping Plover Identification

Piping Plover

Features & Identifying Characteristics

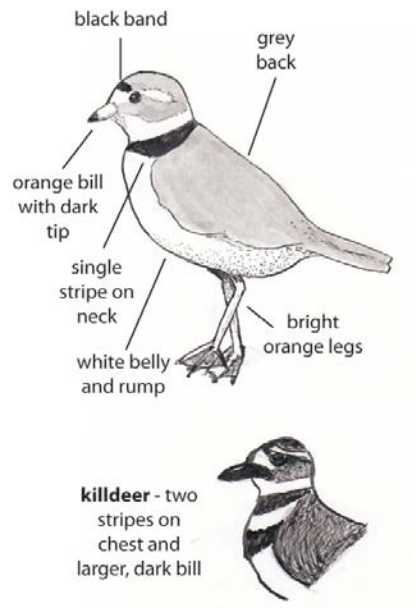
Size – Length: 7.25", Wingspan: 19" Weight**:** 1.9 oz. (55g)

In breeding season, adults pale brown above, under parts white. Single black breast band (black collar) and black band across forehead; stubby orange bill with black tip; partially black tail, white rump; bright orange legs.

Feed on insects and small aquatic animals.

Song - clear whistled peeps that end with a bell-like *peep-lo*.

Similar species - killdeer, which is larger, has two stripes on its neck and a larger, dark bill. Generally killdeers are more brown, compared to grey Piping Plovers



Source: H. Peat Hamm, 2016.

Where Do Piping Plovers Live?

In Canada the prairie subspecies of the Piping Plover (*Charadrius melodus circumcinctus*) breeds in central Alberta, southern Saskatchewan, southern Manitoba and the Lake of the Woods region of western Ontario. The number of Piping Plovers has been decreasing everywhere; however, the most dramatic declines have occurred in Ontario. Successful recovery activities have stimulated some recovery of the Great Lakes population.

Piping Plovers overwinter in the United States and Mexico on the coast of the Gulf of Mexico (Gulf Coast). They spend up to 70% of the year on wintering sites.

Piping Plovers on the Northern Great Plains use shorelines around small saline/alkaline lakes, large reservoir beaches, river islands and adjacent sand pits, beaches on large lakes, and in some rare cases industrial pond shorelines. They arrive on breeding grounds from mid-April through mid-May.

Piping Plovers have strong 'site fidelity' - a strong pull to return to the same breeding location every year. Piping Plovers will vary their use of particular lakes from year to year if the conditions are found unsuitable due to annual variation. Figure 1 shows key habitat and occurrences of Piping Plovers in southern Saskatchewan.

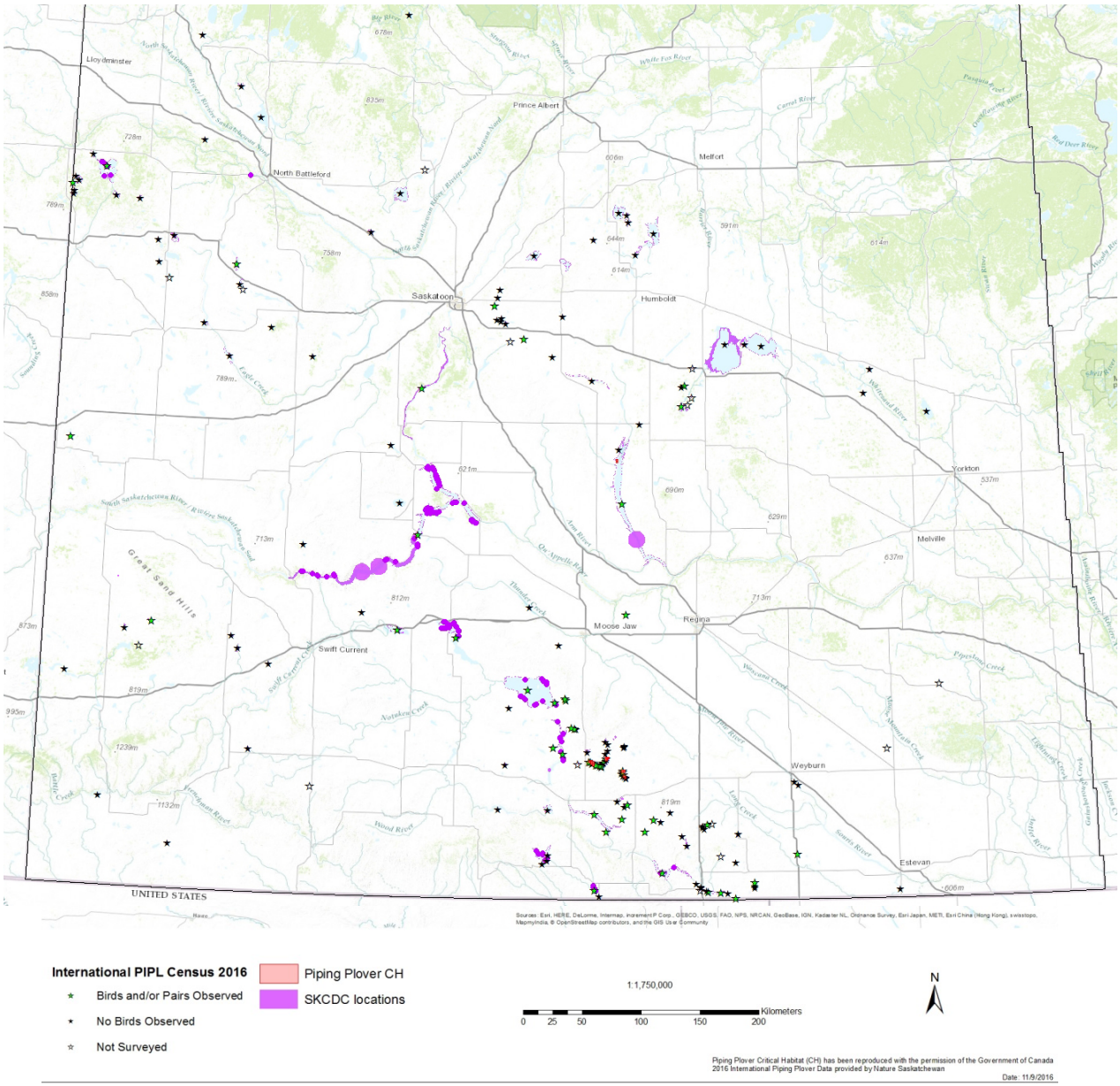


Figure 1. Results from the International Piping Plover census for 2016 (Smith 2016) showing key habitat and Saskatchewan Conservation Data Centre occurrences for Piping Plover in Southern Saskatchewan.

Piping Plovers nest just above the normal high-water mark on relatively flat, exposed, sparsely vegetated, wide beaches of gravel, sand, or pebbles. Periodic habitat disturbance such as grazing or flooding is needed to minimize vegetation encroachment. Figure 2 illustrates some of the main habitat preferences and avoidances for Piping Plovers.

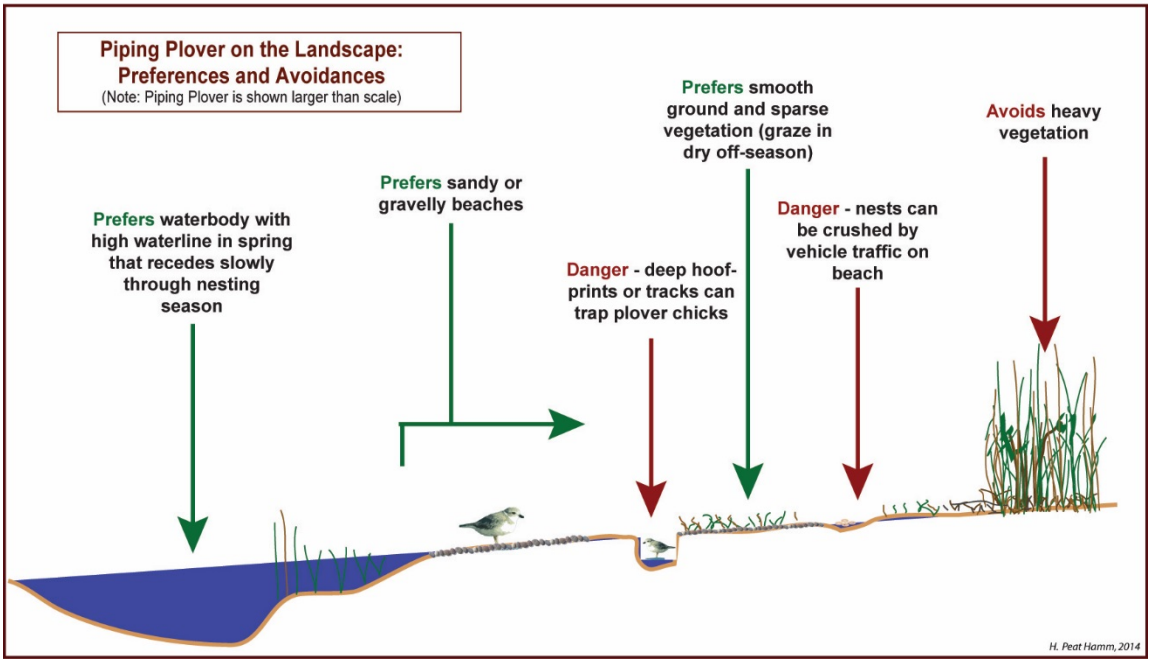


Figure 2. Habitat preferences and avoidances of Piping Plovers (Michalsky and Peat Hamm, 2009. Updated in 2014 by H. Peat Hamm.)

Brood-rearing habitat overlaps with nesting and feeding habitats. They forage mainly on aquatic, benthic and terrestrial invertebrates and other small animals near the shoreline or sometimes by the nest. Adult Piping Plovers and flightless juveniles feed at seeps, ephemeral river pools or the river edge, and along lakeshores or wetlands within the nesting territory. Adults that do not tend the nest and juveniles capable of flight will feed beyond the immediate nesting or broodrearing area. Birds feed primarily within 5 m of the water's edge (Environment Canada, 2006).

Nests are initiated in early to mid May. Males build the nest, which consist of a shallow scrape on the beach, sometimes lined with pebbles, shells and sticks as camouflage. Clutches are normally 4 eggs. Both parents are involved in incubating the eggs and taking care of the nestlings. Re-nesting will occur if the eggs are destroyed or a brood is lost early enough in the season. If the first nest fails, re-nesting usually occurs in mid-June to mid-July. Nestlings are precocious, leaving the nest within hours of hatching and soon finding their own food. Long periods of inclement weather or storms can result in loss of chicks on a large scale.

The Federal Piping Plover Recovery Team has adopted 1.25 chicks/pair/year as being necessary to maintain stable Piping Plover populations on the prairies (Environment Canada, 2006). Roche *et al*., (2012) found that Piping Plovers will disperse farther if reproductive success in the area they last nested in was low (*i.e.,* they go further away from sites where they and others in the area have been unsuccessful in raising chicks).

Piping Plovers forage using the run-and-peck method to capture prey on or <1cm beneath the beach surface. During the summer Piping Plovers forage on the open beach, rarely foraging in the water or in upland vegetation. Foraging occurs on the same beach as nesting, although sometimes habitat characteristics (*e.g.*, vegetation on beach) force adults to nest further from the shore than optimal. These pairs must then bring their chicks to the beach to forage, which is an energetic cost.

Threats To Piping Plovers In Canada

The primary limiting factor thought to influence the Piping Plover population is low reproductive success. Survival rates for young Piping Plovers are substantially lower than for adults (Cohen and Gratto-Trevor, 2011). They spend their breeding, nesting and brood-rearing stages on wide, exposed beaches. Factors thought to affect reproductive success are weather, fluctuating water levels, and egg and chick predation. Disturbance and damage to the habitat by humans and domestic animals may also be factors on some beaches.

Water levels that do not imitate the natural water regime can flood nests or render habitat unusable. All-terrain vehicles, predators, people and livestock can cause changes in habitat, destroy eggs, or kill young Piping Plovers. The 2011 International Piping Plover census collected disturbance data related to habitat over all breeding sites. In Saskatchewan, the results showed reported disturbance types in order of occurrence (most to least common): vehicle ruts, cattle trampling, housing development, invasive species, industry, and dredged material. There was also an 'other' category, which listed comments suggesting impacts from human recreation, dogs, ATVs, garbage, encroaching vegetation, erosion, etc., made worse in some cases by flood conditions.

PREDATION

Predation is a major concern for nestlings, particularly before they are able to fly. Studies have demonstrated that reproductive success on saline/alkaline prairie lakes can be improved from 0.89 fledglings per breeding pair to 1.28-1.78 with implementation of predator exclusion. A mean reproductive success rate of 1.24 fledglings per breeding pair has been calculated to be the minimum necessary to maintain a stable population.

VEGETATION ENCROACHMENT

Piping Plovers select nesting sites with high visibility in all directions. Vegetation encroachment and invasive plant species can detract from the attractiveness of gravel shoreline/beach habitat. Additionally, tree growth at the edge of the habitat may enable avian predators to use the area and thus have a negative impact on the Piping Plover population.

SILTATION AND PESTICIDES

Siltation from surrounding uplands onto gravelly beaches may also affect the quality of Piping Plover habitat. The direct effect of silt and smaller sediments on the surface texture of the beach may make habitat less desirable to Piping Plovers.

Invertebrate abundance on the beach may be affected by runoff from the use of pesticides in the surrounding upland areas.

OFF-ROAD VEHICLE USE

Vehicle activity on nesting beach habitat can crush nests and nestlings, unsettle Piping Plovers from their nests resulting in broken-wing behaviour (which is energetically costly and leaves the nest undefended), and generally cause Piping Plovers to spend their foraging time being vigilant rather than actively finding prey. Off-road vehicle use can also result in deep tracks that may entrap nestlings.

DOMESTIC LIVESTOCK GRAZING

Domestic livestock can be helpful in terms of removal of vegetation, prevention of overgrowth, reduction of undesirable plant species invasion and prevention of woody vegetation encroachment on beaches. Domestic livestock may be detrimental in terms of direct disturbance of nesting birds, crushing of nests (although the evidence of this is lean), and creation of deep hoof prints that may entrap nestlings.

WATER LEVEL MANAGEMENT

Fluctuating water levels can have a potentially devastating impact on Piping Plovers. Ideal Piping Plover habitat has a wide gravel beach with a water level that slowly recedes over the course of the breeding season (or at least does not rise). The recession of the water line continually creates new, moist habitat for the invertebrate insect prey of Piping Plovers. Rising water levels can flood nests (rendering eggs unviable) and force Piping Plovers up the beach into sub-optimal habitat.

Life Stage	Critical dates for Saskatchewan
Breeding	early May
Nesting	May through the end of July
Brood-rearing	until late August

Landscape Scale Features Important To Piping Plovers

On the prairies, nesting and brood rearing occurs on gravel shores of shallow, saline/alkaline lakes and wetlands, and on the sandy shores of larger prairie lakes. Piping Plovers do not seem to be limited by the availability of habitat. However, the maintenance of habitat in a suitable condition to attract and support Piping Plovers is critical to the species' recovery.

Preferred habitat features at the landscape scale are:

- Gravel substrate. Sand may be used but is not optimal and silt is avoided. Studies have shown that Piping Plovers may choose an unprotected beach (fine particles washed away, more gravel exposed) over a protected beach (sheltered from heavy wind and waves) despite it being clearly more treacherous for nestlings in terms of wind forces and wave action. If texture is equal in both types of areas, Piping Plovers will choose protected areas.
- Relatively low or slowly rising incline behind the beach. A study of shoreline in North Dakota found that Piping Plovers were nearly absent from shoreline where there was >25 m increase in elevation within 250 m of the shoreline (Anteau *et al.,* 2014).
- Shoreline configuration:
    a) Width of beach - the wider (from shoreline to vegetation) the beach, the better for Piping Plovers. Wide beaches, depending on slope, may enable nesting Piping Plovers to react to the threat of inundation from rising water by moving their nest further away from the waterline. Such repositioning of nests has been recorded in North Dakota (Wiltermuth *et al.,* 2009).

b) Shoreline length – an appropriate shoreline (characteristics noted above) extending for a minimum of 400 m (0.4 km) is preferred (Environment Canada, 2006).

- Tall structures such as trees, cliffs or buildings are avoided when they are close to the beach. Tall structures are ideally set back more than 200m from the beach.

Site Characteristics Of Piping Plover Habitat

Nesting habitats are ideally above the high waterline. The preferred nesting habitat is low elevation but farther from shore than brood-rearing habitats. Nests too close to the waterline may have higher failure rates due to inundation.

Even if nesting habitat is sufficient, foraging habitat may limit brood success. Adults tend to forage within 5 m of the water's edge, whereas chicks tend to feed on firmer ground farther from the water's edge. Preferred habitat features at the site scale are:

- Treeless and post-less. Avian predators may hunt chicks from shoreline trees, bushes and posts. A shoreline free of trees and posts is likely to result in lower predation and thereby higher productivity. Some Piping Plovers have been found nesting among cottonwood saplings where there was no ground canopy; however, these were mostly unsuccessful nesting attempts. Fencing intended to keep livestock away from beach habitat should be situated well into the vegetation/upland or have metal cones on posts to discourage perching of predators.
- Few on-beach competitors. Many of the beaches desirable to Piping Plovers are also desirable to gulls and crows, which will predate Piping Plover chicks (crows more so than gulls).
- Gravel is important for nest habitat and silt is avoided. Sometimes a multi-coloured gravel substrate is selected over more protected shoreline with less desirable substrate for nesting. Even a very small patch of gravel can suffice for a nesting habitat. For foraging/brood-rearing, shorelines protected from wave action are chosen. Evidence suggests protected shorelines have better chick survival rates than unprotected shorelines. Broods used habitat with less vegetation than average on a given site.
- Vegetative cover <15% is preferred on nesting habitat (Wiltermuth *et al*., 2009; Anteau *et al*., 2012). Grazing by domestic livestock outside of the breeding season can enhance Piping Plover habitat by reducing vegetation encroachment (but see smooth beach point below).
- No invasive plants that would inundate the habitat during the season (*e.g.*, sweet clover).
- Less than 30% obstruction of bare substrate is preferred (Wiltermuth *et al*., 2009).
- Brood rearing habitat with low beach slope and sparse vegetation. Piping Plovers prefer low-slope (<10%) over mid-slope (10-20%) or high slope (20%) and prefer less vegetation (<30% vegetated), avoiding vegetated beaches (>50% vegetated) (Wiltermuth *et al*., 2009; Anteau *et al*, 2012). If a nest is on less than optimal habitat,

young chicks will have to move a greater distance (towards the shoreline for brood rearing) and such movements can result in decreased chick growth.

- Consistent or slowly declining water level.
- A smooth beach. Pugging and tracks from animals or vehicles can leave dangerous ruts which impede movement of chicks. Often this damage will be naturally repaired through rain and snow melt over the course of a year, but in some cases may take longer if damage is severe.
- High quality water. Pollutants, either directly input to the water or from runoff from surrounding uplands, may have an impact on benthic invertebrates that are the prey of Piping Plovers.

Optimal habitat targets are listed in Table 1. Many of these habitat targets may be created through management of disturbance (i.e., grazing, prescribed fire or water level manipulation) on the land.

Table 1. Optimal habitat targets for Piping Plovers.

HABITAT	TEMPORAL SCALE	HABITAT TARGET
Nesting Habitat	Early May – mid July	<15% vegetation cover within 200 m of nest
		<30% obstruction of bare substrate
		Riparian Health Assessment (SK PCAP, 2008) vegetation cover question score = 0
		No invasive plant species present
		Riparian Health Assessment invasive plant species question score = 3 (maximum points)
		Riparian Health Assessment undesirable herbaceous plants question score = 3 (maximum points)
		Riparian Health Assessment woody vegetation canopy cover question score = 0
		<10% slope of beach or shoreline
		Gravel multicoloured
		Gravel size ~ 25 mm and smooth
Brood Rearing Habitat	Mid July – late August	<50% vegetation cover over entire beach or basin
		Riparian Health Assessment vegetation cover question score = 0

HABITAT	TEMPORAL SCALE	HABITAT TARGET
		No invasive plant species present
		Riparian Health Assessment invasive plant species question score = 3 (maximum points)
		Riparian Health Assessment undesirable herbaceous plants question score = 3 (maximum points)
		Riparian Health Assessment woody vegetation canopy cover question score = 0
		Smooth surface of beach (no rocks, pugging, vehicle tracks etc.)
		Riparian Health Assessment physical alteration of beach question score = 12 (maximum points)
		< 10% slope of beach
Upland Habitat	Growing season	Free of avian stick nests
		Healthy vegetation buffer between beach and cropland or cattle winter feeding area

OTHER OPTIMAL MANAGEMENT PRACTICES FOR PIPING PLOVERS

There are numerous management issues unrelated to the characteristic of the landscape or site that should be taken into consideration when managing to optimize habitat for Piping Plovers. These management considerations are:

- Refrain from allowing uncontrolled access of domestic pets to the beaches. They may disturb birds and prey on eggs or nestlings.
- Minimize access by livestock and humans as well as other persistent disturbances that can lead to nest abandonment. When undisturbed, Piping Plovers will spend 90% of their foraging time actively searching and feeding, but when disturbed, they spend more of their foraging time on vigilance.
- Avoid upward water level fluctuations during the breeding season (May 1 – August 15) in water bodies where the water levels are artificially controlled.
- In controlled waterbodies, draw down water as slowly as possible in spring and during summer to ensure prey availability. Recommended drawdown rates are 2 to 3 cm per week (Michalsky and Peat Hamm, 2009).
- Exclusion fencing, which excludes predators from accessing the beach, in combination with nest cages, has been shown to be a feasible and effective management tool. Nest cages alone are not as effective because chicks can emerge from the exclosure and are then at risk of being preyed upon.
- Remove debris/trash piles and abandoned buildings that provide habitat for predators of Piping Plovers.

ENVIRONMENTAL BENEFIT INDEX (EBI) FOR PIPING PLOVER HABITAT

Criteria And Scoring

The EBI was developed by compiling comprehensive categories of criteria based on available knowledge, such as Piping Plover population and habitat research, as well as species recovery strategy documents.

The EBI begins with two screening criteria. These criteria are either met, in which case the user continues to the next criterion, or not met, in which case the property or potential project is eliminated from further consideration. The remaining criteria are grouped into either landscape-level criteria (criteria 3 and 4), or site-level criteria (criteria 5 and 6).

A scoring system was devised for the EBI. Each criterion is weighted out of 200, 100, 50, or 30 based on relative importance to the species.

The total scores are calculated based on the following formula:

EBI= (1)(2)(3+4+*(*5.1+5.2+5.3+5.4*)*+6)

The EBI result may then be divided by the costs of the proposed project or the bid for the project to determine cost effectiveness. The cost to achieve the habitat requirements could include added management, added infrastructure or inputs or lost opportunities.

The range of possible scores for candidates that pass the screening criteria is quite wide. The lowest possible total score is 120 and the highest possible score is 680. When evaluating candidate properties for a project or program, it may be possible to divide the scores into more general High, Moderate and Low priorities. There are many uses for a general ranking. For example, a more general ranking could be used to determine the total cost of implementing results-based programming on all High priority sites.

SCREENING CRITERIA

1. The area of consideration supports a current or recent presence of Piping Plovers, because they return to sites that supported Piping Plovers in near history (previous years).
   Yes=1, No=0.

2. The area of consideration is free of water control structures or impediments that result in water levels being managed to regularly <u>increase</u> at any time between May 01 and August 31. In the absence of major flood events, natural systems would normally result in a slow, steady drawdown in water levels during that period.
   Yes=1, No=0.

3. Beach or shoreline configuration within the area of consideration: Piping Plovers select for a variety of shoreline attributes that provide some level of protection from predators. The width of the beach at nest initiation, the length of the shoreline and the distance from high water mark to tall structures such as trees or cliffs are all attributes that are used in selecting areas to nest and raise young. **(Max 200 points)**

Beach or Shoreline Configuration

200	Width of beach > 20 m; shoreline length > 1 km; distance from shoreline to tall structures such as trees or cliffs > 200 m.
100	Width of beach 15 -20 m; shoreline length 0.5 - 1 km; distance from shoreline to tall structures such as trees or cliffs 100 - 200 m.
50	Width of beach 10 -15 m; shoreline length 0.4 – 0.5 km; distance from shoreline to tall structures such as trees or cliffs 50 - 100 m.

4. Substrate of beach within the area of consideration: Piping Plovers select for specific substrate on the beaches or shores where they choose to nest. The ideal substrate is cobbly or gravelly. Saline/Alkaline or sandy substrates are also sometimes used but are considered suboptimal. **(Max 100 points)**

Substrate

100	Cobbly or gravelly substrate composes the majority of the shoreline or beach.
75	Cobbly or gravelly substrate occurs in patches along the shoreline or beach.
50	Saline/alkaline or sandy substrate composes the majority of shoreline or beach.

5. Criteria 5.1, 5.2, 5.3 and 5.4 all relate to habitat quality of a site for Piping Plovers. Habitat quality for Piping Plovers incorporates both substrate attributes and vegetation attributes which differ between nesting habitat, brood-rearing habitat and adjacent upland habitat. Although the spatial scale of nesting and brood-rearing habitat is similar, the habitat requirements differ on a temporal scale. Upland habitat is not used by Piping Plovers but it is tied to sediment and nutrient loading and pesticide accumulation which in turn influences the invertebrate population upon which Piping Plovers prey.

    1. Habitat quality – substrate and slope: Gravel size and colour are an important part of habitat quality for Piping Plovers. Optimal gravel size is ~ 25 mm and smooth, not sharp. Gravel colour should be a variety of colours. These attributes are best for disguising the presence of a nest and eggs. Some slope of beach is desirable, and < 10% slope is optimal. **(Max points 100)**

Habitat Quality - Substrate and Slope

100	Gravel size ~ 25mm and smooth; gravel variable in colour; slope 3 – 10%; no rocks
50	Gravel size <25 mm and smooth; gravel not variable in colour; slope <10%; no rocks
25	Any of the following: Gravel size >25 mm or sharp; slope > 10%; rocks present

    2. Habitat quality – nesting habitat: Line of sight is of critical importance for nesting habitat for both hunting and predator evasion. Therefore, vegetation must be short and sparse and bare ground substantial. (Max points = 100)

Habitat Quality – Nesting Habitat

100	< 15% vegetation cover within 200 m of nest; invasive plants absent; < 30% obstruction of bare substrate; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 3; Riparian Health Assessment undesirable herbaceous plants question score = 3; Riparian Health Assessment woody vegetation canopy cover question score = 0.
50	< 15% vegetation cover within 100 m of nest; invasive plants < 1% cover; < 30% obstruction of bare substrate; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 2; Riparian Health Assessment undesirable herbaceous plants question score = 3; Riparian Health Assessment woody vegetation canopy cover question score = 0.

Habitat Quality – Nesting Habitat

25	<15% vegetation cover within 50 m of nest; invasive plants 1 - 5% cover; <30% obstruction of bare substrate; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 2; Riparian Health Assessment undesirable herbaceous plants question score = 2; Riparian Health Assessment woody vegetation canopy cover question score = 0.

3. Habitat quality – brood rearing habitat: The beach surface must be smooth and free from pugging and vehicle tracks or anything which impedes the movement of chicks once they leave the nest. Vegetation cover over the entire beach or basin should ideally be <50% so chicks are able to hunt but also have some shelter.

Habitat Quality – Brood Rearing Habitat

100	< 50% vegetation cover over entire beach or basin; invasive plants absent; smooth ground surface of beach or shoreline; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 3; Riparian Health Assessment undesirable herbaceous plants question score = 3; Riparian Health Assessment woody vegetation canopy cover question score = 0; Riparian Health Assessment physical alteration of shore question score = 12.
50	< 50% vegetation cover over entire beach or basin; invasive plants < 1% cover; some pugging or rutting of ground surface; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 2; Riparian Health Assessment undesirable herbaceous plants question score = 3; Riparian Health Assessment woody vegetation canopy cover question score = 0; Riparian Health Assessment physical alteration of shore question score = 8.
25	<50% vegetation cover over at least 80% of beach or shoreline; invasive plants 1 - 5% cover; some pugging or rutting of ground surface; Riparian Health Assessment vegetation cover question score = 0; Riparian Health Assessment invasive plant species question score = 2; Riparian Health Assessment undesirable herbaceous plants question score = 2; Riparian Health Assessment woody vegetation canopy cover question score = 0; Riparian Health Assessment physical alteration of shore question score = 8.
0	Any of the following: >50% cover over half or more of the beach or shoreline; invasive plant cover >5%; pugging or rutting of ground surface >15% of beach or shoreline; Riparian Health Assessment vegetation cover question score >0; Riparian Health Assessment invasive plant species question score < 2; Riparian Health Assessment undesirable herbaceous plants question score < 2; Riparian Health Assessment woody vegetation canopy cover question score > 0; Riparian Health Assessment physical alteration of shore question score < 8.

4. Habitat quality – upland habitat: Upland habitat should be managed to reduce the presence of predators and to minimize the runoff of sediment, nutrients and pesticides into the basin affecting a) the water quality and its ability to produce invertebrates; b) substrate on the beach and its ability to provide camouflage for Piping Plovers nests; and/or c) the impediment to hunting and predator avoidance associated with increased vegetation cover. A healthy vegetation buffer should exist between the beach and any type of cropland, winter feeding area, or activity that might runoff into the basin impacting Piping Plovers habitat quality. **(Max points = 50)**

Habitat Quality – Upland Habitat

50	Upland consists of Healthy native grassland; no trees to support avian nests
25	Upland consists of cropland or winter feeding area but a Healthy vegetation buffer is maintained between the upland and the beach or shoreline; no trees to support avian nests
0	Upland consists of cropland or winter feeding area with no vegetation buffer between the upland and the beach or shoreline; and /or upland supports trees with avian nests

6. Interaction with other species at risk (SAR): Other SAR may exist in the area. The presence of optimal Piping Plover habitat may have a positive, negative or neutral effect on the other SAR found in the area of consideration. (Max points 30)

Interaction with other Species at Risk

30	Piping Plover habitat contributes positively to other area SAR.
0	Piping Plover habitat has no impact on other area SAR.
-30	Piping Plover habitat has a negative impact on other area SAR

$$\mathbf{EBI= (1)(2)(3+4+(5.1+5.2+5.3+5.4)+6)}$$

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