

Washington State Snowy Plover Population Monitoring, Research, and Management: 2016 Nesting Season Research Progress Report

Scott F. Pearson, Cyndie Sundstrom, William Ritchie, Katelyn
Raby, & Anthony Novack



Washington Department of
Fish and Wildlife



U.S. Fish and Wildlife Service
Willapa National Wildlife Refuge

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Scott F. Pearson¹, Cyndie Sundstrom¹, William Ritchie², Katelyn Raby¹, & Anthony Novack¹

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¹Washington Department of Fish and Wildlife
Wildlife Program

1111 Washington St. SE
Olympia, WA 98501
scott.pearson@dfw.wa.gov

²U.S. Fish and Wildlife Service
Willapa National Wildlife Refuge
3888 SR 101
Ilwaco, WA 98624

TABLE OF CONTENTS

OVERVIEW	1
INTRODUCTION.....	3
METHODS	5
<i>Study Areas</i>	<i>5</i>
<i>Site Occupancy.....</i>	<i>5</i>
<i>Adult Population Surveys.....</i>	<i>6</i>
<i>Nest phenology and success.....</i>	<i>7</i>
<i>Fledging Success.....</i>	<i>7</i>
<i>Nest Locations.....</i>	<i>8</i>
<i>Reading Color Bands.....</i>	<i>8</i>
RESULTS & DISCUSSION	8
<i>Breeding Window Survey.....</i>	<i>8</i>
<i>Winter Window Survey.....</i>	<i>9</i>
<i>Adult Surveys</i>	<i>9</i>
<i>Clutch Initiation Dates and Breeding Phenology.....</i>	<i>11</i>
<i>Nest success</i>	<i>11</i>
<i>Fledging Success.....</i>	<i>13</i>
<i>Nest Locations.....</i>	<i>14</i>
<i>Predator Management</i>	<i>14</i>
PROGRESS ON RECOVERY OBJECTIVES.....	15
2016 MANAGEMENT ACTIONS	16
ACKNOWLEDGMENTS	18
LITERATURE CITED & REFERENCES	19
APPENDIX I	22

LIST OF TABLES

Table 1. Approximate locations and land ownership/management of the 2016 snowy plover nesting localities in Washington.....	5
Table 2. Starting and ending locations by survey type.	6
Table 3. Breeding Window survey counts.	8
Table 4. Winter Window survey counts.	9
Table 5. Snowy plover survey dates, number of surveys and surveyors and type of survey by site during the 2016 nesting season.	9
Table 6. Mean counts (range) of the breeding adults at four nesting sites in Washington.....	10
Table 7. Nest outcomes by snowy plover nesting locality in 2016.	12
Table 8. Sources of snowy plover nest failure in 2016.....	12
Table 9. Mayfield estimates of nest survival by site from 2008 – 2016.....	12
Table 10. Number of American crows and common ravens dispersed or killed by year.	15
Table 11. Estimated number of breeding adult snowy plovers in Recovery Unit 1 by year.	15
Table 12. Estimated number of chicks fledged per breeding adult male in Recovery Unit 1 by year.	15
Table 13. Estimated number of breeding pairs in Washington (2011-2016).....	16
Table 14. Estimated number of chicks fledged per adult male in Washington (2011-2016).	16

LIST OF FIGURES

Figure 1. Breeding adult snowy plover population trend	10
Figure 2. Proportion of 2016 Snowy Plover clutches initiated in ten-day intervals compared to the mean initiated (\pm SD) between 2006-2015 and proportion of 2016 chicks fledged compared to the mean (\pm SD) between 2008-2015.	11
Figure 3. Nests success of unexclosed nests by year	13
Figure 4. Number of snowy plover chicks fledged per adult male 2007-2016 for all Washington nesting sites combined.	14

OVERVIEW

During the 2016 western snowy plover (*Charadrius nivosus nivosus*) nesting season, we monitored breeding phenology, nest success, fledging success and number of nesting adult snowy plovers in Washington. Field monitoring and research was conducted by Cyndie Sundstrom, William Ritchie, Katelyn Raby, Larissa Ritzman, with assistance from Warren Michaelis and Anthony Novack. Management activities included restricting human access to nesting sites, predator management, and restoring nesting habitat. A summary of some of our 2016 activities and results:

Breeding Phenology

- Clutches were initiated between 2 April and 11 July (Figure 2). However, very early nests could have gone undetected because intensive surveys did not start until early April.
- The first chick known to have fledged, fledged around 5 June and the last chick known to fledge, fledged around 11 Sept.
- There was an early and a mid-season peak in both clutch initiation and fledging.

Breeding Range

- We conducted 17 surveys at 12 sites between 16 May and 13 July 2016 to either assess site occupancy status or to count the number of adults.
- Snowy plovers were only found nesting on Leadbetter Point, Midway Beach, and Graveyard Spit.
- Plovers were detected and nesting was confirmed on one island in Willapa Bay and a lone banded female was detected at Copalis Spit who returned to Graveyard Spit to nest.

Number of Breeding Adults

- The mean 2016 Washington breeding adult population was 93 (Range: 85-100). Breeding adults were observed on Leadbetter Point, Midway Beach, Graveyard Spit, Copalis Spit and on an island in Willapa Bay off Leadbetter Point.
- From 2006-2009 the Washington snowy plover population declined annually and precipitously. From 2009-2012, the adult breeding population was fairly stable, around 31-36 birds. Since 2013, the population has been growing at a high rate.

Nest success

- One hundred and fourteen nests were discovered and monitored at Midway Beach/Graveyard Spit, Leadbetter Point, and an island off the tip of Leadbetter Point. Based on chicks observed on the beach, we know there were at least 5 additional nests that we did not locate. Not all nests were observed regularly and are therefore not included in the numbers below when assessing outcome.
- The percent of nests that survived from egg laying through hatching during the 2016 nesting season was approximately 66% (apparent nesting success). When accounting for exposure, nest success was almost identical = 67% (Mayfield Method). Wire cages were not placed around nests to exclude predators (exclosures) in 2014-2016. This is an extremely high nest success rate for unexclosed nests and is likely attributable to USDA Wildlife Service's ongoing predator management on Leadbetter Point and Midway Beach.
- For the fourth consecutive year, nest predation was not the primary source of nest failure. Corvids and a coyote were the only confirmed nest predators identified from tracks left at the nest. This season, wind-blown sand and human activities were the primary non-predator sources of nest failure.

Fledging Success

- The average number of young fledged per adult male on the three Washington nesting sites was 0.96 (0.74-1.21). Population viability analyses indicate that, on average, at least one young must fledge per adult male to have a stable population (Nur et al. 1999). The fledging rate for the past four years has been approximately 1.0 or greater which suggests a stable to growing population.

Management Actions

- *Nest exclosures*: No nests were exclosed in 2016.
- *Signing*: In an effort to protect nests from human activities, approximately 8.0 miles of beach at Leadbetter Point and approximately 1.3 miles of beach at Midway Beach were signed to restrict human access on the dry portions of the beach. Access restrictions on private land only occurred where permitted by the land owner. New signs were purchased and now all signs have a similar appearance and message regardless of land ownership.
- *Clam tides*: Washington Department of Fish and Wildlife coordinated law enforcement activities especially during clam tides. All clamming was prohibited at Midway due to high levels of the toxin domoic acid. A total of 94 days were open to recreational razor clamming at Long Beach in 2016 (7 January – 8 May). Thirty-nine of those days were during the plover breeding season (an increase of 62% over 2015). Portable toilets were again placed on the beach at Leadbetter to minimize intrusions into the closed nesting habitat.
- *Nest Predation*: Predator management was conducted by wildlife specialists with USDA APHIS Wildlife Services on both Leadbetter Point and Midway/Grayland Beach in 2016. Management consisted of dispersing or targeted lethal removal of known nest predators (corvids) in or adjacent to the plover nesting areas. Results suggest that this activity is successful in increasing nest hatching rates and fledging rates.
- *Restoration*: The Willapa NWR habitat restoration area (HRA) at Leadbetter Point now totals more than 400 acres and the restoration area on Washington State Parks land at Leadbetter Point was expanded to 15 acres. These areas have been mostly cleared of non-native beachgrass using mechanical and chemical methods.

INTRODUCTION

The Pacific coastal population of the western snowy plover (*Charadrius nivosus nivosus*) is listed as Threatened under the Endangered Species Act, and is listed as Endangered by Washington State. The current Pacific coast breeding population extends from Midway Beach, Washington, to Bahia Magdalena, Baja California, Mexico. The snowy plover winters in coastal areas from southern Washington to Central America. This coastal population nests above the high tide line on a variety of beach and dune types including coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes, beaches at creek and river mouths, and bluff-backed beaches (U.S. Fish and Wildlife Service 2007). In winter, snowy plovers are found on many of the beaches used for nesting as well as on beaches where they do not nest (U.S. Fish and Wildlife Service 2007).

According to the U.S. Fish and Wildlife Service (2007), “Habitat degradation caused by human disturbance, urban development, introduced beachgrass (*Ammophila* spp.), and expanding predator populations have resulted in a decline in active nesting areas and in the size of the breeding and wintering populations”. In Washington, predators eating snowy plover eggs, adverse weather, shoreline modification, dune stabilization, and recreational activities have been attributed to reduced nest success and have been cited as the causes of local population declines (Washington Department of Fish and Wildlife 1995).

Historically, five known areas supported nesting snowy plovers in Washington (Washington Department of Fish and Wildlife 1995). During the 2006 nesting season, there were four nesting locations: Leadbetter Point, Midway Beach (Grayland vicinity), Graveyard Spit, and Damon Point. During the 2007 and 2008 nesting season, three nesting sites were occupied, Leadbetter Point, Midway Beach, and Graveyard Spit. However, because of the very close proximity of Graveyard Spit to Midway Beach, this could be considered one site for analyses. During the 2009-2016 nesting seasons, Leadbetter Point and Midway Beach were occupied and Graveyard Spit was occupied in 2012-2016, but not in 2009-2011. This is the first year that we have confirmed nesting on an island in Willapa Bay since the 1990s.

According to the federal Recovery Plan for the western snowy plover, Washington and Oregon compose Recovery Unit 1 (U.S. Fish and Wildlife Service 2007). The primary recovery criterion for this unit are maintaining 250 breeding adults for 10 years and a 5-year average productivity of at least 1.0 fledged chick per adult male (U.S. Fish and Wildlife Service 2007). The recovery plan calls for the development and implementation of mechanisms to assure long-term protection and management of breeding, wintering, and migration areas in Recovery Unit 1 (U.S. Fish and Wildlife Service 2007). This report describes progress on all of these criteria except the final one.

According to the Washington State Recovery Plan for the snowy plover (1995), the snowy plover will be considered for down listing to Threatened when the state supports a 4-year average of at least 25 breeding pairs that fledge at least one young per pair per year at two or more nesting areas with “secure” habitat. Delisting will be considered when the “average” population reaches 40 breeding pairs at three or more secure nesting areas.

Both the federal and state recovery plans require monitoring of breeding adults and monitoring of fledging success to assess progress toward these recovery goals. Monitoring is also necessary to evaluate the impact of conservation actions on snowy plover populations such as predator management and the effectiveness of habitat restoration efforts. To provide the information needed to assess recovery progress and to assess the effectiveness of conservation actions, Washington Department of Fish and Wildlife (WDFW) is coordinating its monitoring efforts with U.S. Fish and Wildlife Service (USFWS), and Oregon Department of Fish and Wildlife. This coordinated effort was initiated in 2006 although state-specific monitoring was initiated years before.

The primary objectives of our monitoring for the 2016 nesting season were:

- Conduct winter window surveys in conjunction with a range-wide survey effort.
- Conduct breeding window surveys in conjunction with a range-wide survey effort.
- Conduct unoccupied breeding site surveys at Copalis Spit, Connor Creek, and Damon Point.
- Estimate hatching success rates and sources of nest mortality during the egg laying/incubation stage for all nest locations.
- Estimate fledging success and adult breeding snowy plover population size for Washington.
- Attempt to increase nest success through habitat restoration efforts, restricting human activities on nesting sites, predator management, and evaluate the effectiveness of these activities.
- Provide information to land management agencies during the field season to help them protect nesting snowy plovers from potential threats.
- Fund USDA APHIS Wildlife Services to conduct predator management activities.
- Produce a joint report with USFWS Willapa National Wildlife Refuge (Willapa NWR) that summarizes methods used, numbers of breeding adults, and hatching success (this report).
- Coordinate monitoring efforts with Oregon Department of Fish and Wildlife to produce consistent monitoring metrics for Recovery Unit 1 (Oregon and Washington). However, specific methods may differ between states.

This report summarizes the progress on all of these objectives.

METHODS

Study Areas

During the 2007 and 2008 nesting seasons, three sites were occupied by breeding snowy plovers, Leadbetter Point, Graveyard Spit, and Midway Beach (Table 1). During the 2009-2011 nesting seasons, snowy plovers nested at two sites, Leadbetter Point and Midway Beach. During the 2012-2016 field seasons, snowy plovers nested at Leadbetter Point, Graveyard Spit, Midway Beach, and a small island off Leadbetter Point. The orthographic photos of the nest sites in Appendix I provide a pictorial overview of the primary areas used for nesting in the spring/summer of 2016. Leadbetter Point and Midway Beach are dune backed beaches and have an exceptionally wide area that is unvegetated or sparsely vegetated and is located between the mean high tide and the foredune. Snowy plovers also use the sparsely vegetated foredunes and areas behind the foredune. The snowy plover habitat at Midway Beach consists of swales, sparsely vegetated foredunes, and a large deflation plain with ephemeral dune ponds. Leadbetter Point is part of a very long sand spit or peninsula. The habitat at Leadbetter Point consists of unvegetated beach above the summer high tide line, sparsely vegetated foredunes, blowouts, and human modified habitat of sand and oyster shell landward of the foredune (habitat restoration area). Graveyard Spit is located on the north shore of Willapa Bay. The nesting habitat at this site consists of a sparsely vegetated low lying sand spit, with hummocks and swales, and unvegetated deflation plains adjacent to salt marsh communities. In both 2012 and 2013 sand was deposited to construct a shoreline protection berm on Graveyard by contractors working for the U.S. Army Corps of Engineers. For definitions of terms used to describe coastal sand dune morphology in this section, see Wiedemann (1984).

Table 1. Approximate locations and land ownership/management of the 2016 snowy plover nesting localities in Washington.

Site	Approximate Location	Ownership/Management
Midway Beach	46° 45' 32"N, 124° 05' 46"W	South Beach State Park, Private
Leadbetter Point	46° 36' 24"N, 124° 03' 25"W	Leadbetter State Park, Willapa National Wildlife Refuge
Graveyard Spit	46° 42' 57"N, 124° 01' 25"W	Shoalwater Bay Indian Reservation

Site Occupancy

Our goal was to determine snowy plover abundance and trend at sites that are currently occupied. For sites where we have failed to detect snowy plovers in the recent past, but are most likely to become re-occupied due to suitable habitat and relatively close proximity to occupied sites, we conducted surveys to assess site occupancy status. Wildlife species are rarely detected with perfect accuracy and non-detection does not necessarily mean that a species was absent from a site unless the probability of detecting the species (detectability) was 100%. This leads to a fundamental problem -- the measure of occupancy is confounded with the detectability of the species. Specifically, an observed "absence" occurs if either the species was present at the site but not detected, or the species was truly absent. In Pearson et al. (2008), we recommended three to four visits to a site to determine if it is being used as a nesting site and that those visits occur between early to mid-May and the end of the first week of July. Following this recommendation, there is an 87% - 99% probability of correctly determining site occupancy.

Adult Population Surveys

Breeding window survey

The breeding window survey occurs annually in late May along the entire U.S. Pacific coastline where snowy plovers are known to nest. The specific dates for a particular year are selected by the USFWS and all participants follow the methods of Elliot-Smith and Haig (2006a). In 2016, the window survey occurred between the 17th and 20th of May. We surveyed Connor Creek, Copalis Spit, Damon Point/Oyhut Spit, Midway Beach, Graveyard Spit, Leadbetter Point, Long Beach, Willapa Bay Islands, and Benson Beach. Our primary intent during breeding window surveys was to count the adult population at occupied sites (Midway Beach, Leadbetter Point, Graveyard Spit) and sites that were historically occupied (Connor Creek, Copalis Spit, Damon Point/Oyhut Spit).

Estimating breeding adult population size

In addition to the breeding window survey, we conducted two additional surveys at all occupied sites (Leadbetter Point, Midway Beach, and Graveyard Spit). We completed all surveys between 17 May and 22 June following the breeding window methods (USFWS 2007 Appendix J-1). We conducted these surveys at a time of year when there was the least amount of immigration and emigration into and out of the Washington breeding sites. We used these three surveys to derive estimates of breeding adult abundance. In the Results, we present the average of these two surveys and the range. We rounded all estimates to the nearest whole bird.

Table 2. Starting and ending locations, survey types and number of surveyors for each survey site in Washington. The Leadbetter Point counts in the figures and tables that follow include birds detected in the Habitat Restoration Area (HRA), the Willapa NWR beach section (from the Willapa NWR land south of the HRA to the tip of the Peninsula and around), and the beach section of Leadbetter Point State Park (between Oysterville Road and the Willapa NWR boundary).

Site	Starting Point	Ending Point	Number of Surveyors	Survey Type
Copalis Spit	47°07' 16.5", 124° 10' 59.9"	47° 08' 15.6", 124° 10' 58.4"	1	Foot
Connor Creek	47° 04' 14", 124° 10' 24"	47° 07' 16.5", 124° 10' 59.9"	1	Vehicle/ Foot
Ocean City	47° 04' 14.2", 124° 10' 37.8"	46° 57' 12.7", 124° 10' 31.8"	1	Vehicle/ Foot
Damon Point	46° 56' 05", 124° 09' 18"	46° 56' 11", 124° 06' 18"	1 or 2	Foot
Midway Beach	46° 47' 38", 124° 05' 55"	46° 44' 07", 124° 05' 29"	4 or 5	Foot
Graveyard Spit	46° 43' 33", 124° 03' 07"	46° 42' 25", 124° 00' 36"	4	Foot
Willapa Bay Islands	Various	Various	2-3	Foot
Leadbetter Point North	46° 37' 40.7", 124° 04' 17.4"	46° 38' 50.5", 124° 03' 13.6"	3	Foot
Leadbetter Point HRA	46° 37' 40.9", 124° 04' 07.8"	46° 38' 30.4", 124° 04' 07.2"	2	Foot
Leadbetter Point South	46° 32' 54.0", 124° 03' 40.8"	46° 37' 40.7", 124° 04' 17.4"	1 or 2	Vehicle
Long Beach ¹ (S. of Oysterville Rd.	46° 32' 54.0", 124° 03' 40.8"	46° 22' 03.8", 124° 03' 24.4"	1	Vehicle

¹ This area includes surveys from Oysterville Road to North Head and from North Head to the Columbia River North Jetty. It includes Long Beach and Benson Beach.

Winter window survey

The winter window survey occurs annually in January along the entire U.S. Pacific coastline where snowy plovers nest or historically nested. All sites are surveyed during a specific week and the USFWS selects the dates for any given year. All participants follow the methods of Elliot-Smith and Haig (2006b). In 2016, the

window survey occurred from 18-25 January and we surveyed Connor Creek, Copalis Spit, Damon Point, Midway Beach, Graveyard Spit, Leadbetter Point, and Benson Beach.

Nest phenology and success

We visited Leadbetter Point, Midway Beach and Graveyard Spit approximately two to several times a week from early April until mid-September to search for and monitor snowy plover nests. In many cases, we located nests by following snowy plover tracks to nests. We also located nests by observing scrape building by males, by locating adults incubating eggs, or by flushing incubating adults. We recorded date and status (presence of adults and eggs) of each nest approximately every 3-5 days.

Unless observed directly, we calculated clutch initiation date by backdating from known laying or hatching dates. Backdating using hatch dates requires information on the time intervals associated with the egg laying and incubation stages. We used the following time intervals from California and reported in Page et al. (1995) to calculate clutch initiation dates: egg laying = 2.5 days between laying egg 1 and 2 and 2.3 days between laying eggs 2 and 3, incubation = 27 days or 32 days from the first egg laid until hatching. We calculated nest success using the Mayfield method (Mayfield 1961, 1975). We reported nest outcome as the number of successful nests, nests that failed, nests lost to predation, nests abandoned, nests covered by drifting sand, nests lost to human activities (vehicles, walking, horseback riding, etc.) or unknown causes of failure.

Nest Enclosures

With active predator control occurring on both Leadbetter Point and Midway Beach, it was not necessary to use nest enclosures in 2016.

Fledging Success

Snowy Plover chicks are precocial, leaving the nest within hours after hatching to search for food. They are not capable of sustained flight until approximately 4 weeks after hatching. Adult snowy plovers do not feed their chicks after hatching, but lead them to suitable feeding areas. They also “brood” their young for several days after hatching. Adults warn of approaching predators or other perceived threats and use distraction displays to lure predators and people away from chicks. Chicks fledge (i.e., are capable of sustained flight) at 28 to 33 days (mean equals 31 days) post hatching (Warriner et al. 1986). The Recovery Plan considers chicks fledged at 28 days post hatching (U.S. Fish and Wildlife Service 2007). According to the Recovery Plan, the productivity information most useful for determining recovery is the annual number of young fledged per adult male. Because males are responsible for post-hatching parental care (Warriner et al. 1986) and because male population trends and survivorship can be estimated with greater certainty than for females, they are used in determining this metric of reproductive success (U.S. Fish and Wildlife Service 2007). We estimated the number of young fledged per adult male for all active nesting sites combined by using the estimates of the number of breeding adult males from the adult surveys described above and by estimating the number of young fledged.

The USFWS uses the number of young fledged per adult male to determine whether or not the population is growing, stable, or decreasing (λ). This threshold of 1.0 is based on the population viability analysis conducted by Nur et al. (1999). Their population modeling indicates that productivity of at least 1.0 chick fledged per breeding male per year should result in a stable population and productivity of 1.2 or more chicks fledged per breeding male should increase population size at a moderate pace.

Determining the number of young fledged requires following broods from hatch date to 28 days post hatching and determining their fate. To help us identify and follow individual broods, we attempted to identify hatch dates for successful nests and then follow broods post hatching. We estimated hatch date by

floating eggs following Hays and LeRoy (1971) or by counting forward from known egg laying dates. Regardless of the method used to estimate hatch dates, we checked nests daily or every other day around predicted hatching dates. For unbanded chicks, we used chick plumage and the size of chicks observed within a couple of days of hatching to narrow down the assignment of hatch date to plus or minus one day. For some nests, we determined the outcome of the brood because no other chicks were of similar age along a particular stretch of beach. In other cases, we were able to assign broods to a specific nest and hatch date because a banded adult male accompanied the chicks, which allowed us to accurately assign the chicks to a specific nest.

Nest Locations

We photographed each nest and recorded its location using a hand held GPS unit or Trimble. We used both a Trimble and Garmin GPS unit to document nest locations at Leadbetter Point and only a Garmin GPS unit at Midway Beach and Graveyard Spit. The Trimble Unit has approximately 1 m accuracy with post-processing and the Garmin is accurate to within 10 m.

Reading Color Bands

A number of Washington's breeding snowy plovers were banded in Oregon or California as adults and young of the year or were banded as young of the year in Washington. Most birds have two color bands on each lower leg and each color combination should be unique. Gary Page with Point Blue Conservation Science currently coordinates color banding for the Pacific coast and assigns unique color combinations to each state. Color bands are read top down from the belly to the foot of the bird. Colors on the birds' left leg are read first, and then the colors on the right leg are read. For example, if a bird has red band on top of an aqua band on the left leg and a white band over a red band on the right, its combination would be red, aqua: white, red or RA:WR. We assigned exact color combinations for a banded bird only when the birds were observed with spotting scopes and when we could confidently determine the color combination. To help us determine if a color combination was confidently assigned, we assigned a confidence score (0-100% confident) to each color combination recorded.

RESULTS & DISCUSSION

Breeding Window Survey

We detected 101* adult snowy plovers in Washington during the 2016 breeding window survey (Table 3). This is a record number of birds detected and the first time a bird had been detected on Copalis Spit during a survey for a very long time.

Table 3. Breeding Window survey counts by site, sex, and age and counts of nests and broods between 2011 and 2016. Note that the Leadbetter count includes 3 birds observed on the island just to the north of the Point.

Site	2011	2012	2013	2014	2015	2015	2016 Survey Dates	Adult Males	2016 Adult Females	Adult Unknown
Copalis Spit	0	0	0	0	0	1	20 May	0	1*	0
Conner Creek	0	0	0	0	0	0	19 May	0	0	0
Damon Point	0	0	0	0	0	0	20 May	0	0	0
Graveyard	0	0	1	6	3	18	18 May	9	9	0
Midway Beach	22	11	24	9	20	39	16 May	23	11	3
Leadbetter Pt.	12	15	20	28	41	45	17 May	22	21	2
S. Long Beach	0	0	-	0	0	0	20 May	0	0	0

Total	34	26	45	43	64	103	54	44	5
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*female observed at Copalis Spit was later determined to be a double-count from the Graveyard Spit survey (based on band combo and info from Oregon banding records) thus, in true actuality only 100 unique individuals were observed although 101 was the official number of record reported to USFWS

Winter Window Survey

We detected 69 adult snowy plovers on three sites during the January 2016 Winter Window Survey (Table 4).

Table 4. Winter Window survey counts by site, sex, and year.

Site	2012	2013	2014	2015	2016	Survey Dates	Adult Males	Adult Females	Adult Unk.
Copalis Spit	0	0	0	0	0	27 January	0	0	0
Conner Creek	0	0	0	0	0	27 January	0	0	0
Damon Point	0	0	0	0	0	NA	0	0	0
Oyhut Spit	0	0	0	0	0	2 February	0	0	0
Graveyard	-	0	0	0	0	25 January	0	0	0
Midway Beach	22	24	22	22	31	20 January	4	3	24
Leadbetter Pt.	12	6	45	0	28	20 January	7	1	20
S. Long Beach	0	-	0	-	10	19 January	0	1	9
Benson Beach	-	-	0	0	0	18 January	0	0	0
Total	34	28	71	22	69		11	5	53

Adult Surveys

As indicated in Table 5, we conducted 17 surveys at 10 “sites” between 17 May and 22 June 2016. Note that the Willapa Bay survey included all exposed sand islands.

Site occupancy

We conducted occupancy surveys at seven sites to assess snowy plover presence/absence on suitable and/or historically occupied sites (Table 5).

Table 5. Snowy plover survey dates, number of surveys and surveyors and type of survey by site during the 2016 nesting season.

Site	Type of Survey	# Surveys	# Surveyors	Walking or Driving	Survey Dates
Midway	Breeding Adult/Window	3	4-5	foot	5/16, 6/01, 6/21
Leadbetter Pt.	Breeding Adult/Window	3	5-6	foot & drive	5/17, 5/21, 6/22
Graveyard	Breeding Adult/Window	3	2-3	foot	5/18, 6/02, 6/16
Damon Pt.	Occupancy/Window	3	1-2	foot	5/20
Connor Creek	Occupancy/Window	2	1	drive	5/19
Copalis Spit	Occupancy/Window	2	1	foot	5/20
Long Beach (Oysterville to N. Head)	Occupancy/Window	2	1	drive	5/19
Ocean Shores (N. Jetty - Ocean City)	Occupancy	1	1	drive	5/19
Willapa Bay islands	Occupancy	2	2-3	foot	5/18
Benson Beach	Occupancy	1	1	foot	5/19

Estimating Number of Adult Snowy Plovers

We used the annual mean from the three surveys to estimate trends in the breeding adult population (Figure 1, Table 6). Adult population counts were declining precipitously through 2012 but with a higher average counts in 2013-2016, the population appears to be increasing (Table 6, Figure 1).

Table 6. Mean counts (range) of the breeding adults at four nesting sites in Washington and the total population estimate for the State, 2006-2016.

Year	Damon	Midway	Graveyard	Leadbetter	Total
2006	1 (0-2)	21 (14-28)	2 (0-5)	35 (26-45)	59 (48-70)
2007	0	18 (14-21)	2 (0-4)	25 (20-30)	44 (36-53)
2008	0	14 (10-19)	1 (0-2)	32 (23-40)	47 (33-60)
2009	0	15 (13-17)	0	17 (10-24)	31 (23-39)
2010	0	14 (11-18)	0	21 (17-26)	36 (33-38)
2011	0	19 (8-30)	0	12 (6-19)	31 (15-47)
2012	0	14 (5-23)	2 (0-3)	18 (6-29)	33 (15-52)
2013	0	20 (16-24)	4 (1-6)	20 (19-20)	43 (41-45)
2014	0	11 (9-13)	7 (6-8)	24 (21-28)	41 (40-43)
2015	0	24 (19-33)	8 (3-11)	43 (34-54)	77 (65-98)
2016	0	37 (33-40)	21 (18-25)	33 (25-32)	93 (85-103)

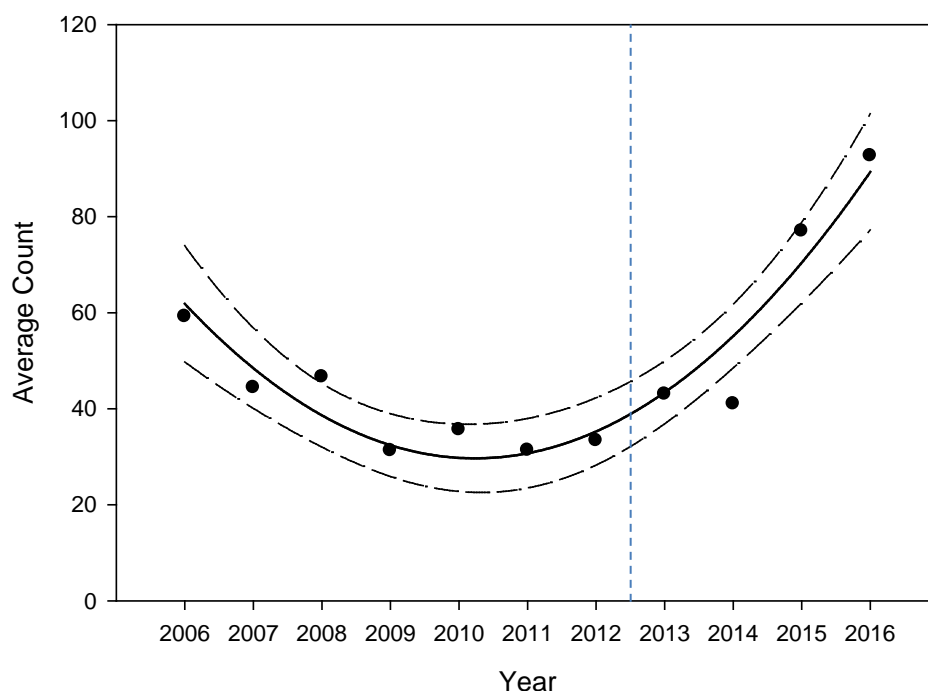


Figure 1. Breeding adult snowy plover population trend of average yearly counts for all Washington sites (2006 – 2016). Blue line indicates when predator management was initiated.

Clutch Initiation Dates and Breeding Phenology

The nesting season occurred between early-April and mid-September in 2016. Clutches were initiated between 2 April and 11 July (Figure 2A). However, very early nests could have gone undetected because we did not initiate intensive surveys until early April. The first chick fledged around 5 June and the last chick fledged around 11 September (Figure 2B). Overall, there was a bimodal distribution to clutch initiation with many nests initiated in early-April and again in late-May to early-June which resulted in a bimodal fledging distribution. The bimodal distribution of clutch initiations was the result of a catastrophic loss of nests during the first week in May at all three nesting locations. Drier than normal weather conditions (lack of dew, mist, rain, fog) combined with high wind events (>20 mph) for extended periods of time caused many nests to be abandoned and buried by windblown sand. A high number of nest initiations in April followed by a high number of nest losses in the first week of May and again during the latter part of May corresponds with the two separate fledging peaks. Many of the bird pairs who lost their nests during this time frame did not initiate renesting for several weeks after the event which corresponds to both the increase in clutches discovered in late-May/early June and chicks fledged in late-July/early August.

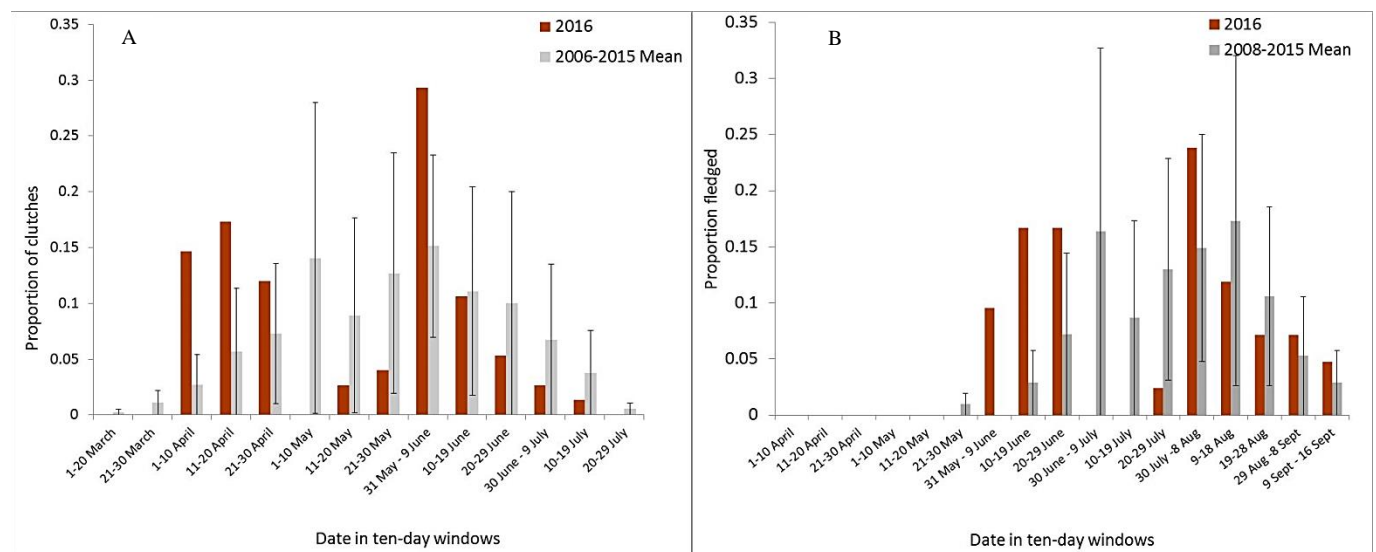


Figure 2. Proportion of 2016 Snowy Plover clutches initiated in ten-day intervals compared to the mean initiated (±SD) between 2006-2015 (A) and proportion of 2016 chicks fledged compared to the mean (±SD) between 2008-2015 (B). Results are presented for all Washington nesting sites combined. Note the bimodal pattern of clutch initiations and fledglings with unusually early clutch initiation and fledging dates.

Nest success

We located 114 nests and we know at least another 4 nests went undiscovered based on the number of broods on the beach. Of the 114 nests, we monitored 77. Of these 77 nests, 26 were found at Midway Beach, 22 at Graveyard Spit, and 29 at Leadbetter Point (Table 7). For a map of nest locations see Appendix I. Fifty-one (66%) of the 77 nests that we monitored hatched. For the fourth consecutive year, predation was not the primary source of nest failure (Table 8). At the eight depredated nests, we observed only tracks of corvids and a coyote (Table 8).

In Table 9, we report Mayfield nest success estimates for the 2016 nesting season and compare these results to the previous nesting seasons. The probability of nest survivorship was 61% at Midway/Graveyard and 77% at Leadbetter Point. Exclosures were not placed around any nests to exclude predators in 2014-2016.

For unexclosed nests at Leadbetter Point, nest success is usually about 20% when nest success is optimal (late in the nesting season) and below 20% during the rest of the season. Nest success since initiating predator management by USDA AHIS Wildlife Service has been very high (Figure 3).

Table 7. Nest outcomes by snowy plover nesting locality in 2016. Outcomes include successful (hatched), failed, or unknown outcome. Nests without exposure days (found after success or failure) were excluded from all tables below. No nests were exclosed in 2016.

Site	# Nests	Outcome		
		Hatch	Fail	Unknown
Midway	26	14	10	2
Graveyard	22	15	6	1
Leadbetter	29	22	6	1
Totals	77	51	22	4

Table 8. Sources of snowy plover nest failure in 2016 for nests that failed to hatch. Sources of failure include predators (common raven, unknown corvid, or unknown predator) eating eggs, or other sources of failure including Human activities, drifting Sand covering the nest, Abandoned nests and Unknown sources of failure.

Site	Failures								
	Predator					Other Sources			
	Crow	Raven	Corvid	Coyote	Unknown	Human	Sand	Abandon	Unknown
Midway	0	2	1	1	1	0	5	0	0
Graveyard	0	0	0	0	1	4	0	0	1
Leadbetter	0	1	0	0	1	0	3	0	1
Totals	0	3	1	1	3	4	8	0	2

Table 9. Mayfield estimates of nest survival by site from 2008 – 2016. We also include the percent of nests exclosed by site and year because of the large influence of exclosures on nest success.

Site	2008	2009	2010	2011	2012	2013	2014	2015	2016
Midway and Graveyard	0.25	0.15	0.20	0.26	0.26	0.35	0.52	0.38	0.61
% Exclosed	0.00	0.06	0.16	0.29	0.15	0.10	0.00	0.00	0.00
Leadbetter	0.54	0.44	0.83	0.33	0.17	0.79	0.64	0.46	0.76
% Exclosed	0.97	0.78	0.88	0.00	0.40	0.00	0.00	0.00	0.00
Washington Total (including exclosures)	0.36	0.30	0.46	0.28	0.21	0.45	0.59	0.41	0.67

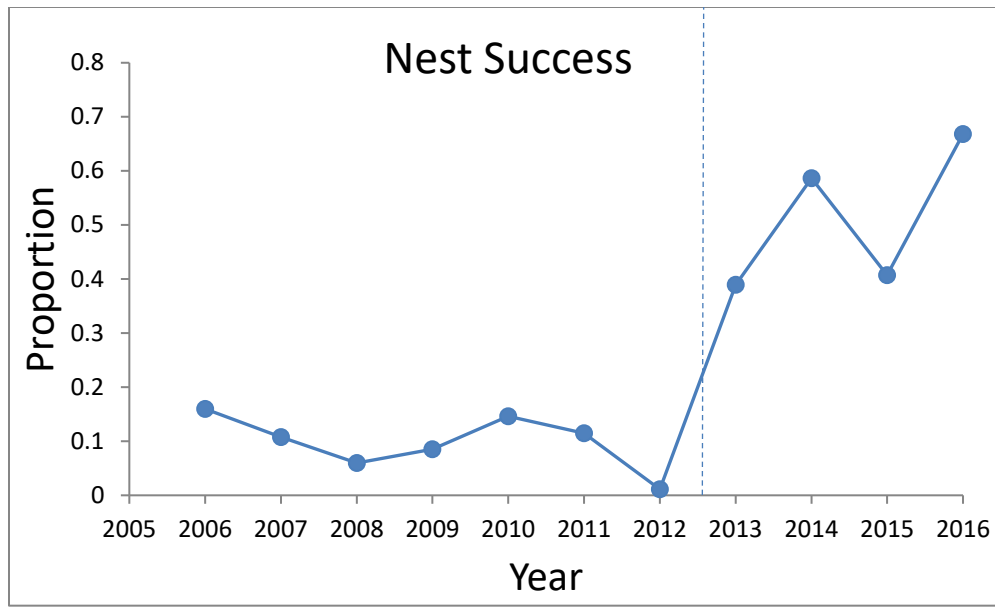


Figure 3. Nest success of unexclosed nests by year. Note that nest success increased dramatically after predator management was initiated in 2013.

Fledging Success

Again, fledging success is defined as the number of chicks fledged per adult male. Using direct observations of fledglings on the beach, we estimated between 42 and 52 chicks fledged in 2016. During our repeated counts to occupied sites, we counted 43-57 males during the three adult surveys. Using the mean of these two estimates and the extremes of each (e.g., high male count and low fledge estimate), we estimated that 0.96 (0.74-1.21) chicks fledged/male.

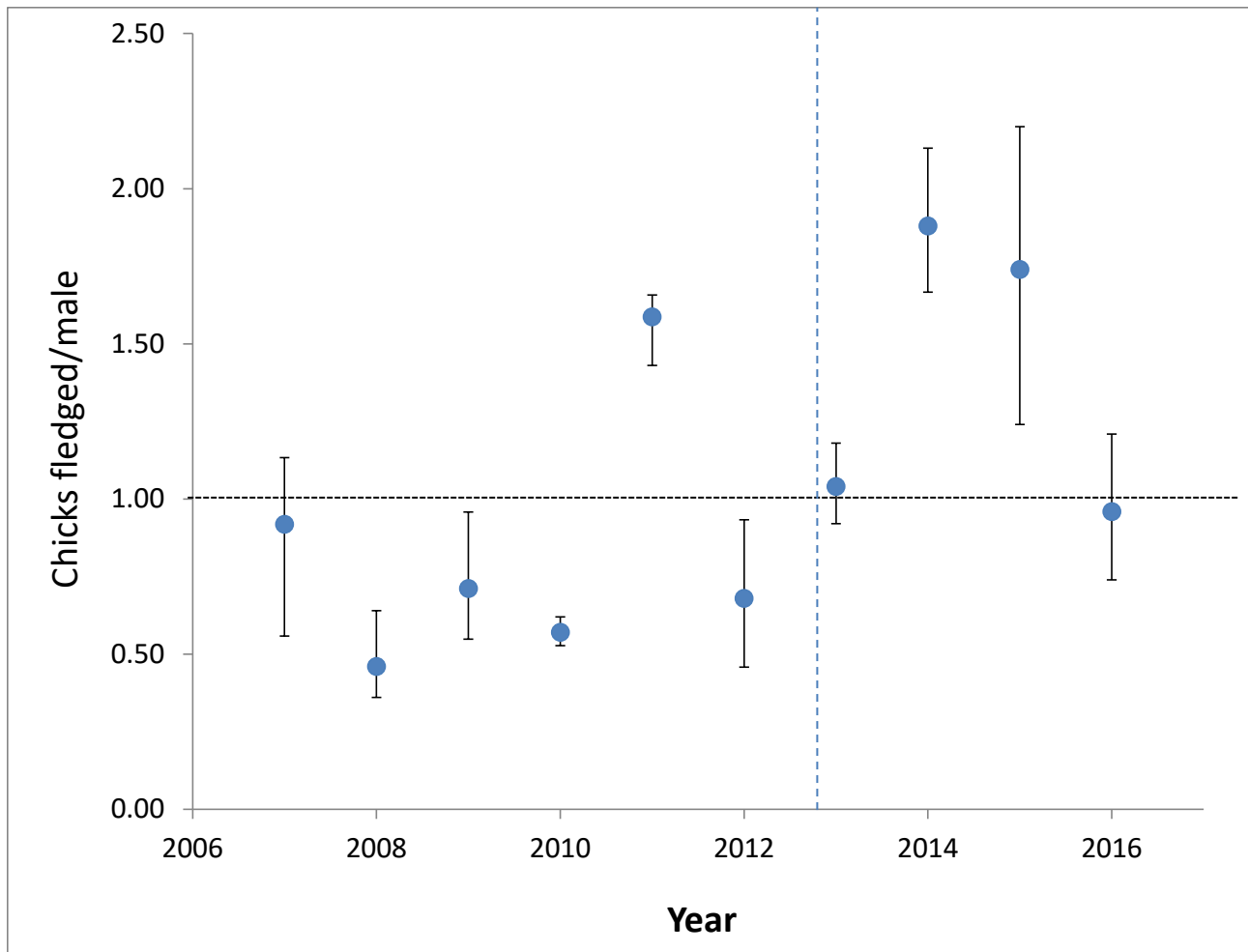


Figure 4. Number of snowy plover chicks fledged per adult male 2007-2016 for all Washington nesting sites combined. Population modeling indicates that one chick fledged per adult male is needed on average to maintain a stable population (black line). Fledging success was clearly above 1.0 in three years, 2011, 2014, and 2015 and approximately 1.0 in 2013 and 2016. Note that predator management was initiated in 2013 (blue dashed line).

Nest Locations

2016 nest locations are presented by nesting site in Appendix I. At Midway Beach, snowy plovers nested in Grayland Beach State Park and on the beach immediately south of Grayland Beach State Park to Warrenton-Cannery Road. At Graveyard Spit, six nests were located on the landward side of the dune barrier (berm) while the others were either on top of the berm or on the outer beach. At Leadbetter Point, snowy plovers nested on the tip of the Peninsula, Refuge Island, and State Parks Seashore Conservation Area (SCA) on the outer beach and in the Willapa NWR and Washington State Parks habitat restoration areas.

Predator Management

Predator management occurred on both Midway/Grayland Beach and Leadbetter Point in 2016. Predator management and monitoring of predator activities were conducted by one Wildlife specialist with USDA APHIS Wildlife Services who worked primarily during the active (April-July) plover nesting season. APHIS activities were focused on removing the predator species (crows and ravens) primarily responsible for most of the nest predation events observed over the past 10 years. Communication between plover biologists and wildlife specialists helped focus activities on locations and individual predators that were apparently causing

the most plover depredations. Management activities included observing predator activities in plover nesting sites and then conducting targeted dispersal or lethal removal as appropriate. No negative impacts to plovers were reported from APHIS's activities.

Ultimately, we plan on evaluating the success of the predator management program by comparing nest and fledging success and post-hatching survival rates before and after predator removal activities. This type of comparison takes several years of data before and after management activities were conducted. Preliminary plover nest success and fledging success results (above) are very promising.

Table 10. Number of American crows and common ravens dispersed or killed by year (2013-2016). Note that most of the predator management activities focused on dispersing corvids.

	Leadbetter Point				Midway			
	American Crow		Common Raven		American Crow		Common Raven	
Sum of #	Dispersed	Killed	Dispersed	Killed	Dispersed	Killed	Dispersed	Killed
2013	60	32	13	18				
2014	63	30	16	11	248	25	11	13
2015	33	11	15	8	16	2	2	8
2016	35	9	11	4	33	2	8	4

PROGRESS ON RECOVERY OBJECTIVES

Federal Recovery Objectives:

Objective 1: 250 breeding adults in Recovery Unit 1.

The 2016 Washington nesting population was 93 (range = 85-100) and the 2016 Oregon nesting population was 529 (Lauten et al. 2016) for a total of 622 (range = 614-632) nesting adult snowy plovers in Recovery Unit 1.

Table 11. Estimated number of breeding adult snowy plovers in Recovery Unit 1 by year.

2012	2013	2014	2015	2016
268 (246-290)	234 (231-236)	379 (378-381)	526 (514-547)	622 (614-632)

Objective 2: A 5-year average productivity of at least 1.0 fledged chick per adult male

We combined the Oregon and Washington estimates of the number of breeding adult males and the number of young fledged to derive the fledgling rate per adult male for Recovery Unit 1. The number of chicks fledged per adult male in Recovery Unit 1 was 0.66 (0.63-0.68) in 2016. The average number of young fledged per adult male for the past five years was 1.22.

Table 12. Estimated number of chicks fledged per breeding adult male in Recovery Unit 1 by year.

	2012	2013	2014	2015	2016
Chicks fledged/male	1.12 (1.08-1.16)	1.04 (1.02-1.07)	1.71 (1.68-1.74)	1.55 (1.49-1.57)	0.66 (0.63-0.68)

Washington State Recovery Objectives:

Downlisting objective 1: A 4-year average of at least 25 breeding pairs

We estimated there were 93 (range = 85-100) adult nesting snowy plovers in Washington during the 2016 nesting season and approximately 43-57 of these birds were males. Assuming all of these males paired, we estimate there were 43-57 breeding pairs in Washington. The 4-year average number of breeding pairs in Washington is approximately 36.

Table 13. Estimated number of breeding pairs in Washington (2011-2016).

	2012	2013	2014	2015	2016
Breeding Pairs	19	22-24	23-27	35-55	43-57

Downlisting objective 2: Fledge at least one young per pair per year, at two or more nesting areas with secure habitat.

The average number of young fledged per adult male in Washington in 2016 was 0.96 (0.74-1.21). The number of chicks fledged per male was approximately 1.0 or above for four of the last five years. Currently, snowy plovers are nesting at Leadbetter Point (primarily on the Refuge), a Refuge island in Willapa Bay, Graveyard Spit, and Midway Beach. The first two sites are part of the Willapa National Wildlife Refuge and the other two are on private, tribal and Washington State Park lands.

Table 14. Estimated number of chicks fledged per adult male in Washington (2011-2016).

	2012	2013	2014	2015	2016
Fledge rate	0.68 (0.46-0.94)	1.04 (0.92-1.18)	1.88 (1.67-2.13)	1.74 (1.24-2.2)	0.96 (0.74-1.21)

Delisting objective 1: The average population reaches 40 breeding pairs at three or more secure nesting areas.

See Downlisting Objective 1. Recommend defining the term “secure” and determining the number of sites considered “secure”.

2016 MANAGEMENT ACTIONS

A number of the management actions that occurred in 2016 involved minimizing some human activities near active snowy plover nesting sites during the nesting season. Human related disturbance negatively affects hatching success of snowy plovers (Warriner et al. 1986, Schulz and Stock 1993) and snowy plover chick survival by as much as 72% (Ruhlen et. al. 2003). Disturbances to wintering snowy plovers are 16 times higher at a public beach than at a protected beach. Humans, dogs, American crows and other birds are the main sources of disturbance (Lafferty 2001). In addition, snowy plover feeding rates declined in response to disturbance (Lafferty 2001). Human disturbance negatively affects hatching rates and chick survival for various plover species (Flemming et al. 1988, Buick and Paton 1989, Dowling and Weston 1999).

Management

- *Nest site protection* - Approximately 8.0 miles of public beach at Leadbetter Point, 1.3 miles of beach at Midway Beach, and 0.75 miles or 60 acres at Graveyard Spit were demarcated with signs and PVC posts to restrict human access onto the dry portions of the beach and protect nesting

birds. Access restrictions on private land occurred at one parcel on Midway Beach where permitted by the land owner.

- The Midway Beach Road access cuts through the center of the highest snowy plover use area at this site, but has been closed to vehicle use since 2009. In 2013, a foot trail access was established on the Midway Beach Road right-of-way using symbolic fencing (i.e. ropes) but was removed at the end of the 2015 season due to a lack of maintenance and repeated emergency closures throughout the season due to plover nests either in the middle of the foot trail or within 50 feet on either side of it. No established foot trail existed in 2016 but human encroachment continued into the posted area, mostly during the latter part of the season when the wetland pond waters had receded. Symbolic fencing was also added to a private property access south of Midway Beach to prevent trespass by horseback riders.
 - Symbolic fencing, totaling over 1,500 feet in length, was placed along three trails that access the beach on the Long Beach Peninsula (1 private access, 1 State Park access, 1 National Wildlife Refuge access).
- *Clam Tides* –Razor clam digs only occurred at Long Beach
 - A total of 94 days were open to recreational razor clamming at Long Beach in 2016 (7 January – 8 May). Thirty-nine of those days were during the plover breeding season (an increase of 62% over 2015)
 - Twin Harbors all Razor clam digs were cancelled because of high domoic acid levels.
 - Portable toilets were again placed on the beach at Leadbetter Point during nine weekend clamming days to minimize human traffic into the closed nesting habitat
- *Enforcement*: Washington Department of Fish and Wildlife coordinated law enforcement activities especially during clam tides.
 - Additional enforcement effort was directed to the nesting beach during high traffic events such as the 4th of July holiday
 - Approximately 150 contacts and 27 verbal warnings were issued by WDFW enforcement as part of their emphasis on plover protection at Long Beach and Midway Beaches
 - The Refuge had three law enforcement officer visits during the nesting season.
- *Outreach*: WDFW Shellfish program continues to conduct outreach via their news releases relating to clam digging dates through distribution of a brochure entitled “Razor Clamming and Nesting Birds” which is distributed to recreational diggers.
 - Damon Point – Washington State Department of Natural Resources has installed “No Dog” signs on their property
- *Predator Management*: Between March and August, predator management was conducted by wildlife specialists with USDA APHIS Wildlife Services on public land at Leadbetter Point and both public and private lands at Midway/Grayland Beach in 2016. They visited Leadbetter Point and Midway/Grayland beach to disperse or lethally remove nest predators (crows and ravens) in or adjacent to the plover nesting areas.
- *Vehicle Restrictions*:
 - Coastal beaches at Willapa NWR and Leadbetter Point State Park are closed to vehicle traffic year round. However, driving is allowed on the wet sand portions of the beach in these areas during razor clam harvest openings.
 - All of the Midway Beach area is open to vehicle traffic and there are vehicle access points at Cranberry Beach Road and Warrenton-Cannery Road.
 - Overnight camping and fires are prohibited on the Refuge at Leadbetter Point. Campfires on State Park managed beaches are not permitted in driftwood or within 100 feet of the dunes.
- *Nest exclosures*: No nests exclosures were installed during 2016 and have not been used since 2013.

Restoration

- Pre-breeding:
 - The 10 acre habitat restoration area at the north end of the State Park was increased by approximately 5 acres by bulldozing and disking to remove non-native beach grasses.
 - About 10 acres of new habitat on the Willapa Wildlife Refuge was cleared with a bulldozer and disk.
 - Maintenance activities were conducted by disking invasive plants on 50 acres of Refuge lands.
- Post-breeding:
 - Volunteers assisted with habitat maintenance by hand pulling beachgrass from 1.3 acre of the restoration area.
- The US Fish and Wildlife habitat restoration area at Leadbetter Point is now around 400 acres in size.

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APPENDIX I

Blue circles represent locations of snowy plover nests at Leadbetter Point, Willapa National Wildlife Refuge and Leadbetter Point State Park in 2016. Orthographic imagery is from 2015.



Blue circles represent locations of snowy plover nests at Midway Beach and Graveyard Spit in 2016. Orthographic imagery is from 2015.

