State of Washington **April 2016**

Washington State Snowy Plover Population Monitoring, Research, and Management: 2015 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

Cover Photos: snowy plover and eggs by Jennifer Hahn, Midway Beach view by Scott Pearson

Recommended Citation:

Pearson, S.F., C. Sundstrom, W. Ritchie, K. Raby, and Anthony Novak. 2016. Washington State Snowy Plover Population Monitoring, Research, and Management: 2015 Nesting Season Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia.

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April 2016

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

OVERVIEW

During the 2015 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 2015 activities and results:

Breeding Phenology

- Clutches were initiated between 7 March and 30 June (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 30 May and the last chick known to fledge, fledged around 26 August.
- Both clutch initiation and fledging dates were unusually early this year.

Breeding Range

- We conducted 22 surveys at 10 sites between 18 May and 7 July 2015 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 on the sandy islands of Willapa Bay but we found no evidence of local breeding.

Number of Breeding Adults

- The mean 2015 Washington breeding adult population was 77 (Range: 65-98). All of the breeding adults observed were found on Leadbetter Point, Midway Beach, and Graveyard Spit.
- 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, it appears that the population is now growing.

Nest success

- Sixty nests were discovered and monitored at Midway Beach/Graveyard Spit and Leadbetter Point. Based on chicks observed on the beach, we know there were at least 16 additional nests that we did not locate.
- The percent of nests that survived from egg laying through hatching during the 2015 nesting season was approximately 70% (apparent nesting success). However, when accounting for exposure, nest success was 41% (Mayfield Method). Wire cages were not placed around nests to exclude predators (exclosures) in 2014 or 2015. 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 the initiation of predator management at Midway Beach.
- For the third consecutive year, nest predation was not the primary source of nest failure. Corvids were the only confirmed nest predators and were identified based on tracks left at the nest. This season, human caused nest failure and nest abandonment were the primary causes of nest failure.

Fledging Success

- The average number of young fledged per adult male on the three Washington nesting sites was 1.74 (possible range = 1.24-2.2). 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). This fledging rate is the highest that we have ever observed and may again be attributed to predator management.

Management Actions

- *Restrictions*: Fireworks were prohibited on beaches where State Parks and U.S. Fish and Wildlife Service (USFWS) are the upland land owners.
- *Nest exclosures*: No nests were exclosed in 2015.
- *Signing*: In an effort to protect nests, 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 when 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 and US Fish and Wildlife coordinated law enforcement activities especially during clam tides. A federal fish and wildlife officer helped keep people out of closure areas at Leadbetter Point during clam harvest openings. 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 2015. Management consisted of dispersing or targeted lethal removal of known nest predators (corvids) in or adjacent to the plover nesting areas. Early results suggest that this activity was 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 mainly in coastal areas from southern Washington to Central America. This coastal population nests primarily 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 2009-2015 nesting seasons, Leadbetter Point and Midway Beach were occupied and Graveyard Spit was occupied in 2012-2015, but not in 2009-2011.

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 2015 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 2012-2015 field seasons, snowy plovers nested at Leadbetter Point, Graveyard Spit, and Midway Beach. 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 2015. 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. Sand was deposited to construct a shoreline protection berm on Graveyard in both 2012 and 2013 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 2015 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. We conducted repeated visits to Damon Point, Connor Creek, and Copalis Spit to assess occupancy during the 2015 nesting season because these sites were historically occupied.

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 2015, the window survey occurred the week of 18 May. We surveyed Connor Creek, Copalis Spit, Damon Point, Midway Beach, Graveyard Spit, Leadbetter Point, Long Beach, 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).

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 18 May and 30 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
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 2015, the window survey occurred from 21-26 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 Exclosures

With active predator control occurring on both Leadbetter Point and Midway Beach it was not necessary to use nest exclosures in 2015.

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 (lambda). 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. We banded some chicks on the hatch date and followed them until fledging or until we were no longer able to locate them. 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. The Trimble Unit has approximately 1 m accuracy with post-processing and the Garmin has approximately 15 m accuracy.

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 64 adult snowy plovers in Washington during the 2015 breeding window survey (Table 3).

Table 3. Breeding Window survey counts by site, sex, and age and counts of nests and broods between 2010 and 2015.

Site	2010	2011	2012	2013	2014	2015	2015 Survey Dates	2015 Adult Males	2015 Adult Females	2015 Adult Unknown
Copalis Spit	0	0	0	0	0	0	21 May	0	0	0
Conner Creek	0	0	0	0	0	0	21 May	0	0	0
Damon Point	0	0	0	0	0	0	21 May	0	0	0
Graveyard	0	0	0	1	6	3	20 May	0	3	0
Midway Beach	18	22	11	24	9	20	18 May	12	8	0
Leadbetter Pt.	20	12	15	20	28	41	19 May	24	16	1
S. Long Beach	0	0	0	-	0	0	20 May	0	0	0
Total	38	34	26	45	43	64		36	27	1

Winter Window Survey

We detected 71 adult snowy plovers on two sites during the January 2015 Winter Window Survey (Table 4).

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

	2011	2012	2013	2014	2015	2015			
Site						Survey Dates	Adult Males	Adult Females	Adult Unk.
Copalis Spit	0	0	0	0	0	21 January	0	0	0
Conner Creek	0	0	0	0	0	21 January	0	0	0
Damon Point	0	0	0	0	0	21 January	0	0	0
Graveyard	-	-	0	0	0	21 January	0	0	0
Midway Beach	13	22	24	22	22	26 January	3	4	15
Leadbetter Pt.	9	12	6	45	0	30 January	0	0	0
S. Long Beach	0	0	-	0					
Benson Beach	-	-	-	0	0	31 January	0	0	0
Total	22	34	28	71	22		3	4	15

Adult Surveys

As indicated in Table 5, we conducted 22 surveys at 10 "sites" between 18 May and 30 June 2015. 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). We detected snowy plovers on the May Willapa islands survey only but there was no sign of nesting.

Table 5. Snowy plover survey dates, number of surveys and surveyors and type of survey by site during the 2015 nesting season.

Site	Type of Survey	# Surveys	# Surveyors	Walking or Driving	Survey Dates
Midway	Breeding Adult/Window	3	4-5	foot	5/18, 6/01, 6/23
Leadbetter Pt.	Breeding Adult/Window	3	5-6	foot & drive	5/19, 6/18, 6/30
Graveyard	Breeding Adult/Window	3	2-3	foot	5/20, 6/03, 6/17
Damon Pt.	Occupancy/Window	3	1-2	foot	5/21, 6/24, 7/07
Connor Creek	Occupancy/Window	2	1	drive	5/21, 6/24
Copalis Spit	Occupancy/Window	2	1	foot	5/21, 6/24
Long Beach (Oysterville to N. Head)	Occupancy/Window	2	1	drive	5/20, 6/17
Ocean Shores (N. Jetty - Ocean City)	Occupancy	1	1	drive	5/21
Willapa Bay islands	Occupancy	2	2-3	foot	5/12, 6/16
Benson Beach	Occupancy	1	1	foot	5/18

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 2013-2015, 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, 2006-2015.

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)

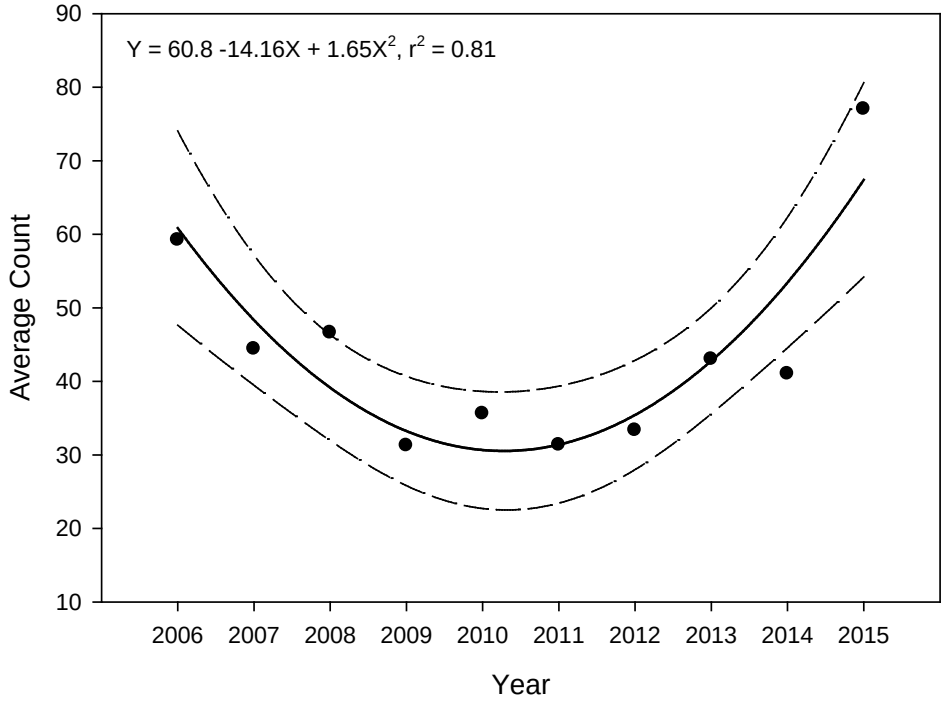

Figure 1. Breeding adult snowy plover population trend of average yearly counts for all Washington sites (2006 – 2015).

Clutch Initiation Dates and Breeding Phenology

The nesting season occurred between early-March and mid-September in 2015. Clutches were initiated between 7 March and 30 June (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 30 May and the last chick fledged around 26 August (Figure 2B). Overall, this was an early year for both fledging and clutch initiation dates.

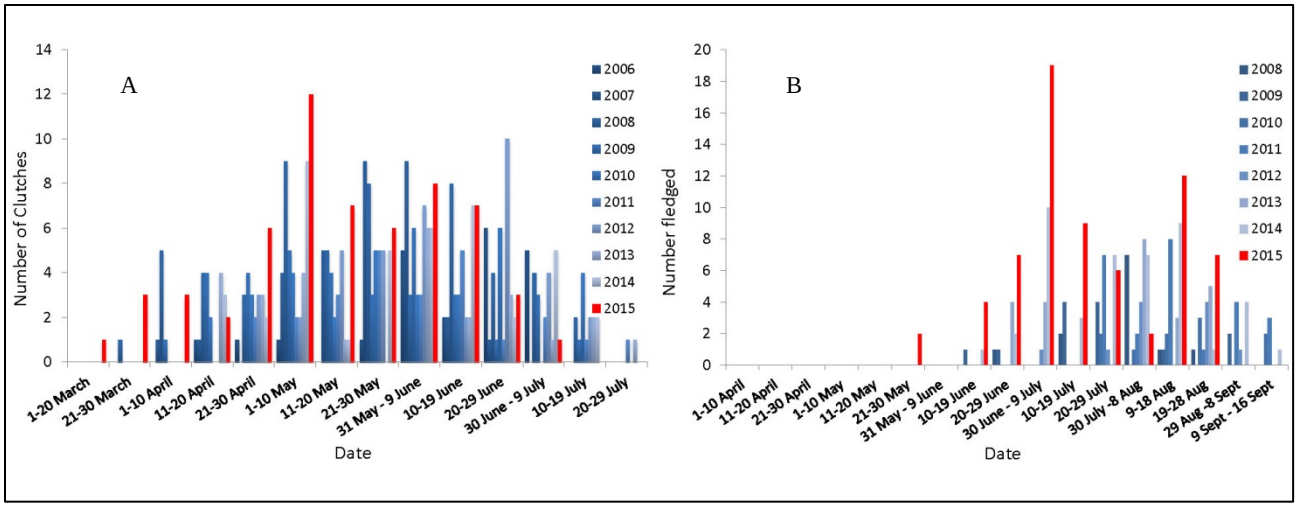

Figure 2. Number of Snowy Plover clutches initiated by date, 2006-2015 (A) and number of chicks fledged by date, 2008-2015 (B). Results are presented in 10-day intervals for all Washington nesting sites combined. Note the early clutch initiations and fledging dates compared to previous years.

Nest success

We located and monitored the outcome of 60 snowy plover nests in 2015. Of these 60 nests, 23 were found at Midway Beach, 14 at Graveyard Spit, and 35 at Leadbetter Point (Table 7). For a map of nest locations see Appendix I. Forty-two (70%) of the 60 nests that we monitored hatched. For the third year, predation was not the primary source of nest failure (Table 8). At the eight depredated nests, we observed only tracks of corvids (Table 8).

In Table 9, we report Mayfield nest success estimates for the 2015 nesting season and compare these results to the previous nesting seasons. The probability of nest survivorship was 38% at Midway/Graveyard and 46% at Leadbetter Point. Exclosures were not placed around any nests to exclude predators in 2014 or 2015.

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. The results from Leadbetter Point in 2013 and from both sites in 2014 and 2015, were truly remarkable (Figure 3) and are likely attributable to the active predator management by USDA AHIS Wildlife Services at Leadbetter Point in 2013-2015 and at Midway Beach 2014-2015.

Table 7. Nest outcomes by snowy plover nesting locality in 2015. 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 2015.

Site		Outcome		
	# Nests	Hatch	Fail	Unknown
Midway	23	14	9	0
Graveyard	12	9	3	0
Leadbetter	25	19	6	0
Totals	60	42	18	0

Table 8. Sources of snowy plover nest failure in 2015 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.

	Failures								
	Predator					Other Sources			
Site	Crow	Raven	Corvid	Coyote	Unknown	Human	Sand	Abandon	Unknown
Midway	0	1	3	0	0	2	0	3	0
Graveyard	0	0	0	0	1	1	0	1	0
Leadbetter	0	0	4	0	0	0	0	2	0
Totals	0	1	7	0	1	3	0	6	0

Table 9. Mayfield estimates of nest survival by site from 2007 – 2015. We also include the percent of nests exclosed by site and year because of the large influence of exclosures on nest success.

Site	2007	2008	2009	2010	2011	2012	2013	2014	2015
Midway and Graveyard	0.28	0.25	0.15	0.20	0.26	0.26	0.35	0.52	0.38
% Exclosed	0.39	0	0.06	0.16	0.29	0.15	0.10	0	0
Leadbetter	0.51	0.54	0.43	0.83	0.33	0.17	0.79	0.64	0.46
% Exclosed	0.86	0.97	0.78	0.88	0	0.40	0	0	0
Washington Total (including exclosures)	0.37	0.36	0.30	0.46	0.28	0.21	0.45	0.59	0.41

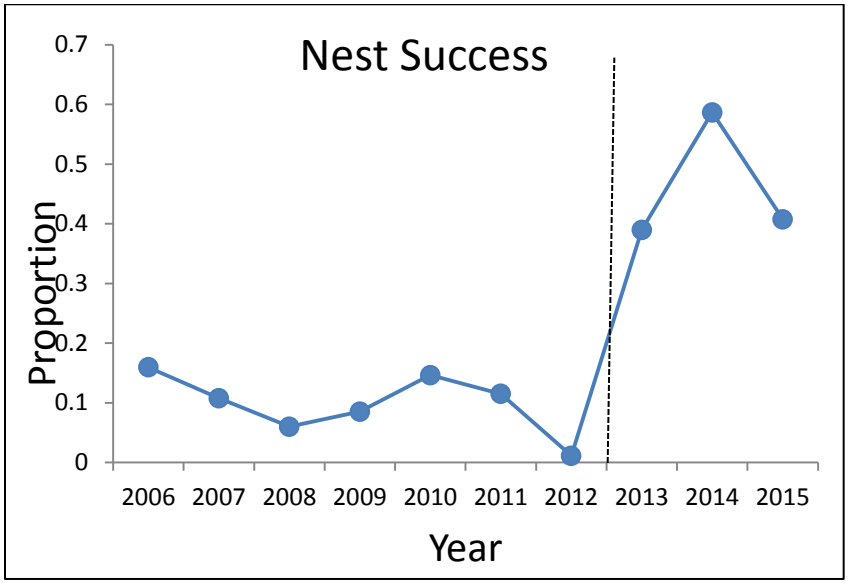

Figure 3. Nests success of unexclosed nests by year. Note that nest success increased dramatically after predator management was initiated in 2013.

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 68 and 77 chicks fledged in 2015. During our repeated counts to occupied sites, we counted 35-55 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 1.74 (Range = 1.24-2.2) chicks fledged/male.

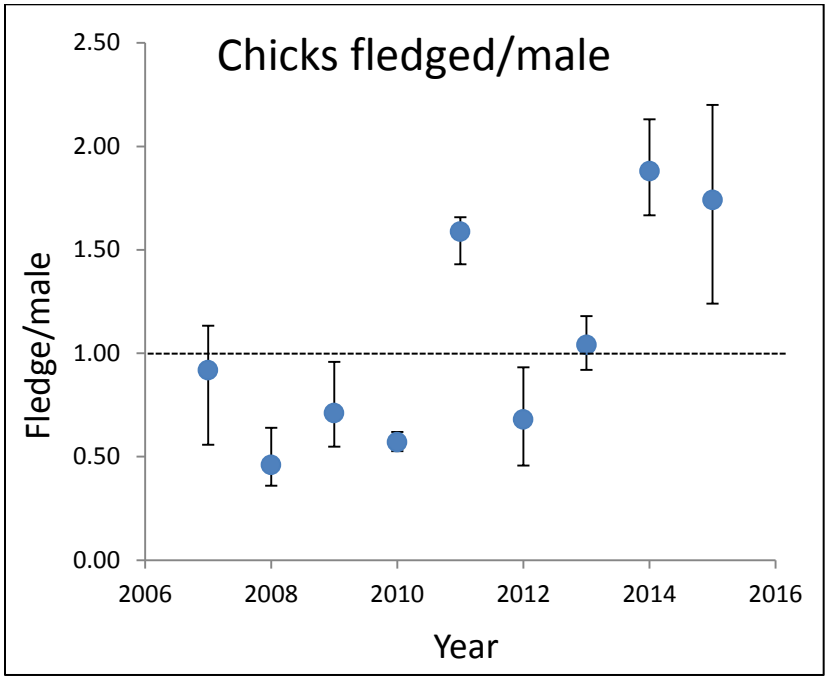

Figure 4. Number of snowy plover chicks fledged per adult male 2007-2015 for all Washington nesting sites combined. Population modeling indicates that one chick fledged per adult male is needed on average to maintain a stable population. Fledging success was clearly above 1.0 in three years, 2011, 2014,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

Nest Locations

2015 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. At Graveyard Spit, one nest was located on the landward side of the dune barrier (berm) while the others were on the outer beach. At Leadbetter Point, snowy plovers nested on the tip of the Peninsula on the outer beach and in the Willapa NWR habitat restoration area. One nest was located on the outer beach in the State Park Seashore Conservation Area.

Predator Management

Predator management occurred on both Midway/Grayland Beach and Leadbetter Point in 2015. Predator management and monitoring of predator activities were conducted by two Wildlife specialists with USDA APHIS Wildlife Services who worked 2-4 days per site per month during the active (primarily April-July) plover nesting season (Table 11). Activities were focused on the predator species responsible for most of the nest predation events observed over the past 10 years – corvids (crows and ravens). 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.

Here we provide a brief summary of corvid predator management activities by site and month (Figure 4). A male peregrine falcon was observed at Midway Beach targeting snowy plovers and was captured, banded and released. It appears this bird moved away from the site after being captured. 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 11. Number of predator control days by site and month. Predator control was conducted by USDA APHIS Wildlife Specialists.

Site	April	May	June	July	August	Total
Leadbetter	3	4	3	2	0	12
Midway	2	4	0	1	2	9
Total	5	8	3	3	2	21

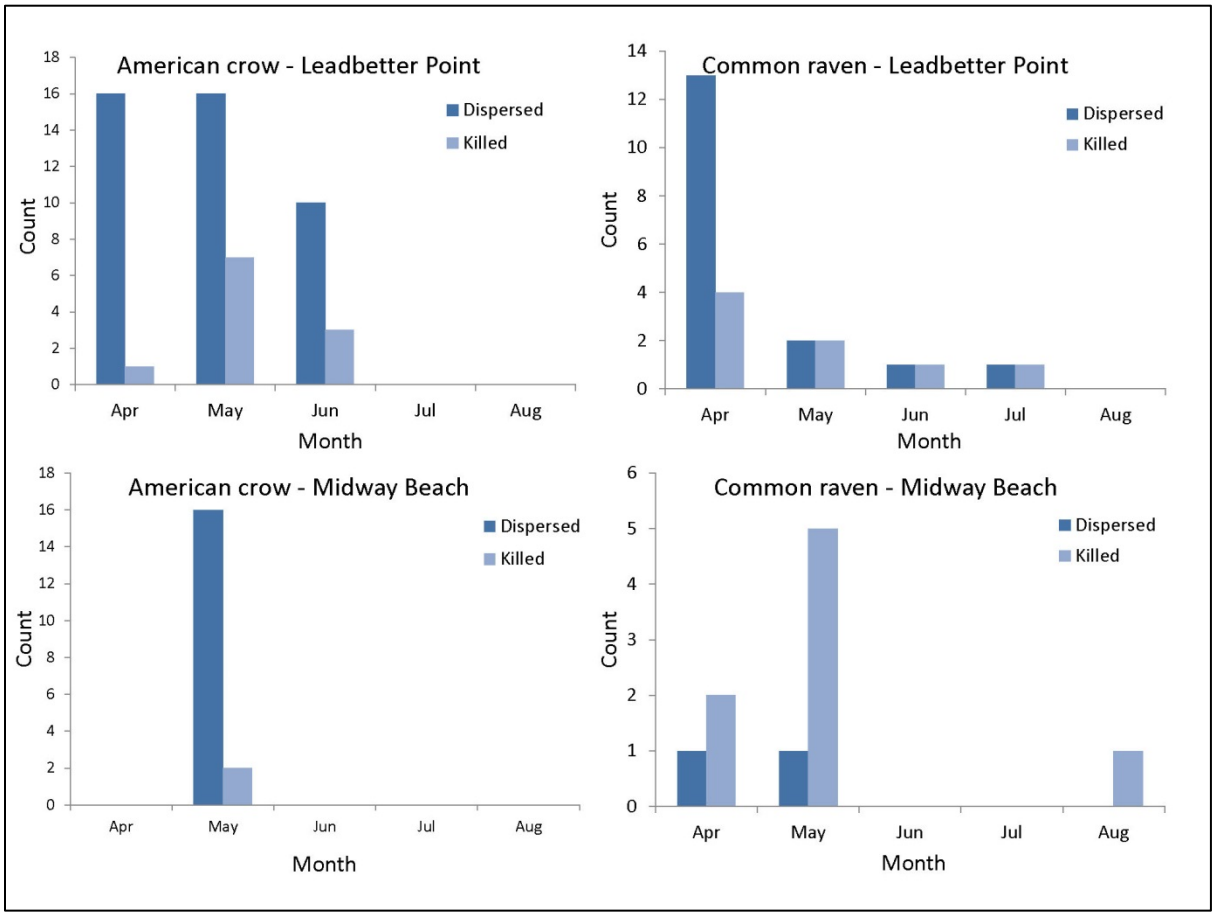

Figure 5. Number of American crows and common ravens observed, dispersed or killed by month and site in 2015. Note that most of the predator management activities focused on dispersing corvids. "Observed" corvids were simply observed and no predator management activity occurred. For example, people on the beach have precluded their ability to disperse or kill a crow or raven.

PROGRESS ON RECOVERY OBJECTIVES

Federal Recovery Objectives:

Objective 1: 250 breeding adults in Recovery Unit 1.
The 2015 Washington nesting population was 77 (range = 65-98) and the 2015 Oregon nesting population was 449 (Lauten et al. 2015) for a total of 526 (range = 514-547) nesting adult snowy plovers in Recovery Unit 1.

Table 12. Estimated number of breeding adult snowy plovers in Recovery Unit 1 by year.

2011	2012	2013	2014	2015
208 (188-228)	268 (246-290)	234 (231-236)	379 (378-381)	526 (514-547)

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 1.55 (1.49-1.57) in 2015. The average number of young fledged per adult male for the past five years was 1.40.

Table 13. Estimated number of chicks fledged per breeding adult male in Recovery Unit 1 by year.

	2011	2012	2013	2014	2015
Chicks fledged/male	1.59 (1.43-1.66)	1.12 (1.08-1.16)	1.04 (1.02-1.07)	1.71 (1.68-1.74)	1.55 (1.49-1.57)

Washington State Recovery Objectives:

Downlisting objective 1: A 4-year average of at least 25 breeding pairs
We estimated there were 77 (range = 65-88) adult nesting snowy plovers in Washington during the 2015 nesting season, and approximately 35-55 of these birds were males. Assuming all of these males paired, we estimate there were 35-55 breeding pairs in Washington. The 4-year average number of breeding pairs in Washington is approximately 27.

Table 14. Estimated number of breeding pairs in Washington (2011-2015).

	2011	2012	2013	2014	2015
Breeding Pairs	22	19	22-24	23-27	35-55

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 2015 was1.74 (1.24-2.2). The number of checks fledged per male was above 1.0 for all but one of the last five years. Currently, snowy plovers are nesting on two primary sites – one on a National Wildlife Refuge and the other on private, tribal and Washington State Park lands.

Table 15. Estimated number of chicks fledged per adult male in Washington (2011-2015).

	2011	2012	2013	2014	2015
Fledge rate	1.59 (1.43-1.66)	0.68 (0.46-0.94)	1.04 (0.92-1.18)	1.88 (1.67-2.13)	1.74 (1.24-2.2)

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".

2015 MANAGEMENT ACTIONS

A number of the management actions that occurred in 2015 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 and 1.3 miles of beach at Midway Beach 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. Since 2013, a foot trail access was established on the Midway Beach Road right-of-way using symbolic fencing (i.e. ropes). Symbolic fencing consisted of rope strung between stakes. 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* – During April/May, Razor clam digs occurred at both beaches April 4-10, 17th-24th, and May 2nd and all Razor clam digs after were cancelled because of high domoic acid levels.
    - Portable toilets were again placed on the beach at Leadbetter Point during the weekend clam digging to minimize human traffic into the closed nesting habitat
- *Enforcement*: Washington Department of Fish and Wildlife and US Fish and Wildlife coordinated law enforcement activities especially during clam tides. A federal fish and wildlife officer helped keep people out of closure areas at Leadbetter Point during clam harvest openings.
    - Additional enforcement effort was directed to the nesting beach during high traffic events on the 4th of July, and during a Jet ski competition August 7-9th
- *Outreach*: WDFW Shellfish program developed an outreach brochure entitled "Razor Clamming and Nesting Birds" which is distributed to recreational diggers and during public events.

    - A volunteer handed out brochures and walked the outer edge of the closure area with a flashing strobe light to discourage human traffic in the closed nesting area during the weekend dig of May 2nd-3rd.
- *Predator Management:* From April 1st through August 31st, 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 2015. They conducted fifteen visits to Leadbetter Point and 20 visits to Midway/Grayland beach to disperse or lethally remove of known nest predators (crows and ravens) in or adjacent to the plover nesting areas. Potential predator food sources, such as a dead elk, were removed from nesting areas or surrounding lands.
- *Vehicle and Fire Restrictions*: Fireworks were prohibited on beaches where State Parks and U.S. Fish and Wildlife Service (USFWS) are the upland land owners.
    - Campfires were banned at both locations from June 22/23rd through the end of September due to area wide drought.
    - 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.
- *Nest exclosures*: No nests exclosures were installed during 2015.

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 ½ acre of the restoration area.
- The US Fish and Wildlife habitat restoration area at Leadbetter Point is now around 400 acres in size.

ACKNOWLEDGMENTS

Plover monitoring was conducted by Katelyn Raby, Cyndie Sundstrom, and William Ritchie. In addition, Warren Michaelis (WDFW) and Larissa Ritzman (Shoalwater Bay Tribe) helped conduct adult population surveys and nest monitoring. State Parks managers Eric Plunkett, and Evan Roberts assisted with logistics and land management issues including enforcement, signing and fencing. Russ Lewis cleaned trash from nesting beaches, provided plover sightings, and assisted with signing and fencing at Leadbetter Point. Lisa Lantz has been extremely helpful in our successful efforts to coordinate management, enforcement and restoration efforts with State Parks. Martha Jensen has also been extremely helpful with advice, funding assistance, logistics, and helping us comply with Endangered Species Act requirements. James Lev, Ryan Kuhnau, and Laurence Schafer with Wildlife Services (USDA APHIS) provided effective and professional predator management support. Much of this work was funded by a USFWS Section 6 Grant, Recovery Program funding (15-01310), and by WDFW and Willapa National Wildlife Refuge operating funds. Thank you all!

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APPENDIX I

Blue circles represent locations of snowy plover nests at Leadbetter Point, Willapa NWR in 2015. Orthographic imagery is from 2015.

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