

Snowy Plover Population Monitoring, Research, and Management Actions: 2008 Nesting Season Research Progress Report

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Willapa National Wildlife Refuge**

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TABLE OF CONTENTS

OVERVIEW	1
INTRODUCTION.....	4
METHODS	6
<i>Study Areas</i>	<i>6</i>
<i>Breeding Window Surveys</i>	<i>6</i>
<i>Winter Window Surveys</i>	<i>7</i>
<i>Adult Surveys.....</i>	<i>7</i>
<i>Clutch Initiation Dates.....</i>	<i>9</i>
<i>Nesting Success</i>	<i>9</i>
<i>Fledging Success.....</i>	<i>9</i>
<i>Nest Locations.....</i>	<i>10</i>
<i>Banding</i>	<i>10</i>
<i>Reading Color Bands.....</i>	<i>11</i>
RESULTS & DISCUSSION.....	12
<i>Breeding Window Survey.....</i>	<i>12</i>
<i>Winter Window Survey.....</i>	<i>12</i>
<i>Adult Surveys.....</i>	<i>13</i>
<i>Clutch Initiation Dates and Breeding Phenology</i>	<i>17</i>
<i>Nesting Success</i>	<i>17</i>
<i>Fledging Success.....</i>	<i>19</i>
<i>Nest Locations.....</i>	<i>20</i>
PROGRESS ON RECOVERY OBJECTIVES.....	21
2008 MANAGEMENT ACTIONS	22
FUTURE RESEARCH & MONITORING CONSIDERATIONS.....	24
ACKNOWLEDGMENTS	25
LITERATURE CITED.....	26
APPENDIX I	28

LIST OF TABLES

Table 1. Approximate locations and land ownership for the 2008 Snowy Plover nesting localities in Washington.....	6
Table 2. Starting and ending locations, survey types and number of surveyors for each survey site in Washington.....	7
Table 3. Breeding Window survey counts by site, sex, and age and counts of nests and broods in 2008.....	12
Table 4. Winter Window survey counts by site and sex in 2008.....	12
Table 5. Snowy Plover survey dates, number of surveys and surveyors and type of survey by site during the 2008 nesting season	13
Table 6. Adjusted counts (95% CI) of the breeding adults at four nesting sites in Washington and the total population estimate for the State in 2007 and 2008.....	16
Table 7. Nest outcomes by Snowy Plover nesting locality in 2008.....	18
Table 8. Sources of Snowy Plover nest failure in 2008.....	18
Table 9. Mayfield estimates of Snowy Plover nest survival and of daily nest survival probability by site and by exclosed and unexclosed nests in 2008.....	19
Table 10. Mayfield estimates of nest survival by site from 2006 - 2008.....	19
Table 11. Estimated number of males and observed numbers of fledglings by site in 2007 & 2008.....	20
Table 12. Number of nests discovered by location and year.	20
Table 13. Change in the size of the U.S. Fish and Wildlife Service Habitat Restoration Area (HRA) over time.	23

LIST OF FIGURES

Figure 1. Dates banded female, male, and juvenile Snowy Plovers were first and last detected on Midway Beach and Leadbetter Point combined in 2008.	14
Figure 2. Average number of re-sights per banded adult female (n = 20) and male (n = 18) Snowy Plovers per day during the 2008 nesting season.	15
Figure 3. Total counts of adult Snowy Plovers at Midway Beach, Graveyard Spit and Leadbetter Point combined for each of five survey periods.....	16
Figure 4. Washington adult plover estimates (95% CI) from 2006 – 2008.	16
Figure 5. Number of Snowy Plover clutches initiated in 2006, 2007, and 2008 and number of chicks fledged in 2007 and 2008.....	17

OVERVIEW

During the 2008 Western Snowy Plover (*Charadrius alexandrinus nivosus*) nesting season, we monitored breeding phenology, nesting success, fledging success and the number of nesting adult plovers in Washington. Field monitoring and research was conducted primarily by Cyndie Sundstrom, Kathryn Gunther, Deborah Jaques, and Kirsten Brennan, with assistance from biologists Joe Buchanan, Marie Fernandez, Mark Hopey, Martha Jensen, Warren Michaelis, Scott Pearson, Bill Ritchie, Steve Spencer, and Max Zahn. State Park Rangers Ron Jamieson, Brad Staab, and Stephen Woods assisted with Window surveys. Volunteers assisting with window, occupancy and adult surveys included: Ann Musché, Alan Richards, Margaret Green, John Green, Susan Clark, Tom Finn, Nathalie Hamel, Carolyn Norred, Laura Payne, and Craig Zora. A summary of some of our 2008 activities and results:

Breeding Phenology

- Clutches were initiated between 24 March and 15 July. However, very early nests could have gone undetected because intensive surveys did not start until after April 1.
- The first chick to fledge, fledged around 8 June and the last chick known to fledge, fledged around 3 September.

Breeding Range

- Conducted 39 surveys on 12 sites to either assess occupancy or to count the number of nesting adults
- Snowy Plovers nested on Leadbetter, Midway Beach, and Graveyard Spit. Plovers did not nest on Damon Point or surrounding areas and there was no evidence of plover presence on other areas surveyed.
- To determine site occupancy, we continue to recommend conducting three surveys of a potential nesting site by experienced observers between early to mid-May and the end of the first week of July – the period of greatest plover nesting activity – to have a very high probability of determining site occupancy.

Number of Breeding Adults

- The mean 2008 Washington breeding adult population was 55 (95% Confidence interval: 42-68). Nearly all of the breeding adults were found on Leadbetter Point and Midway/Grayland Beach. Staff and volunteer surveyors conducted surveys with volunteers contributing approximately 306 hours.
- Errors associated with double counting and detectability were addressed.

Nesting Success

- Fifty-six nests were discovered and monitored.
- The percent of nests that survived from egg laying through hatching during the 2008 nesting season was 36% which was almost identical to the 2007 nesting season.
- As in past years, the primary sources of nest failure were predation (primarily by crows and ravens but also coyotes) and nests buried by drifting sand. A number of nests were abandoned and two nests were destroyed by humans.

Fledging Success

- The average number of young fledged per adult male on three nesting sites in Washington was 0.46 (95% Confidence interval: 0.36-0.64). Population viability analyses indicate that at least one young must fledge per adult male to have a stable population. Our results indicate that the Washington population should be rapidly declining and is therefore not being maintained by local production.

Management Actions

- *Education:* State Park rangers contacted hundreds of visitors and their enforcement and patrol activities emphasized education and not citation. Washington Department of Fish and Wildlife presented one program on Snowy Plovers to approximately 10 Audubon volunteers in the spring of 2008.
- *Enforcement:* State Parks Beach Rangers patrolled nesting habitat in the Grayland Beach State Park vicinity (Midway/Grayland Beach) and Cape Disappointment State Park (Leadbetter Point). Seven State Park Rangers contacted approximately 33 people on foot, 8 people in vehicles and 3 people on horses within the closed nesting area at Grayland Beach State Park. Contacts emphasized education and no citations were issued. In 2008 there were 10 razor clam digs at Leadbetter and 15 at Midway/Grayland beach and the digs occurred on beaches where Snowy Plovers were actively nesting. State Parks Rangers spent approximately 20 hours during clam tides at Leadbetter point to protect plovers when they made approximately 100 educational contacts. US Fish and Wildlife Service had one or 2 officers work most clam digs for approximately 100 officer hours worked and focused their efforts on keeping people out of the restricted nesting habitat. To accomplish this, they contacted and educated approximately 45 people, they issued warnings to another 49 people, and they issued violation notices (citations) to 19 people. Another 9 people were observed within the closed nesting area, but were gone before officers could get to them. Wildlife Biologist Cyndie Sundstrom worked three clam tides in April and four in May to discourage entry into restricted areas. Technician John Deibert worked with Cyndie during the May 24th clam tide. A Federal agent also followed-up on the apparent removal of eggs from a Snowy Plover nest by people but no arrests or citations occurred because of lack of evidence and authority.
- *Restrictions:* Beaches were closed to fireworks at locations where State Parks and U.S. Fish and Wildlife Service are the upland land owners.
- *Nest exclosures:* 28 nests were exclosed on the Wildlife Refuge at Leadbetter, and 9 nests were exclosed on State Park land at Midway Beach.
- *Signing:* Approximately 7.5 miles of beach was signed at Leadbetter and approximately 1 mile of Midway Beach was signed to restrict human access to the dry portion of the beach and protect nests. Access restrictions did not occur on private land.
- *Restoration:* U.S. Fish and Wildlife Service cleared approximately 37 acres at Leadbetter dominated by non-native beachgrasses, bringing the total acres treated at this restoration site to 121. Two hundred and sixty-nine cubic yards of oyster shell were added to 3.9 acres. Additional treatments included mechanical clearing of beach grass in January, February and early March, and the herbicide, Imazapyr (brand name: Polaris AQ), was applied by hand (backpack spray) to beachgrass in September to the portion of the HRA containing pink sand verbena plants. Beachgrass near individual pink sand verbena plants was pulled in order to avoid accidentally spraying the verbena plants. A tractor-mounted spray boom was used in October to apply chemical to the remainder of the previously cleared area. Herbicide was also applied from a helicopter to a 40 acre area of dense beachgrass on the foredune and outer beach in September.
- In 2007, Washington Department of Fish and Wildlife and State Parks established five treatment plots on Leadbetter State Park (approximately 1 acre each) and five control plots to evaluate the effectiveness of restoration activities for both native plants, Snowy Plovers and Streaked Horned Larks. Pre-treatment bird and plant monitoring was conducted by Washington Department of Fish and Wildlife under the supervision of Dave Hays with the assistance of Audubon volunteers and initial treatments to control non-native beachgrasses were conducted by Washington Department of Fish and Wildlife. Pre-treatment vegetation data were collected in summer 2007 followed by an initial treatment in October 2007 and a second treatment in Sept - Oct 2008. Treatment plots were sprayed with a combination of Polaris AQ (4 pints/acre) and Aquaneat (4.5

pints/acre) each year. The surfactant used was crop oil applied at 1% solution. Each year native plants were covered to prevent direct herbicide application. To remove thatch and to create an open habitat, dead grass was raked in February/March 2008. Another raking is planned for February 2009. Post-treatment vegetation data will be collected in the summer 2009 and an additional treatment is planned for the fall of 2009. The first year of post-treatment bird monitoring occurred in the spring/summer of 2008 with the help of Willapa Hills and Grays Harbor Audubon volunteers and volunteers from the Shoalwater Bird Club who contributed approximately 280 hours to both bird and vegetation monitoring.

Recommendations

- Continue testing methods for estimating adult population size.
- Continue to engage volunteers in monitoring.
- Conduct research to identify the conditions where plover populations can be self sustaining.
- Conduct research to identify habitat features important to successful plover nesting.
- Initiate a study to examine the effectiveness of predator control.
- Continue to link management activities with research and monitoring.
- Evaluate effectiveness and continued use of nest exclosures.
- Evaluate effectiveness and need for habitat restoration areas.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- Evaluate effectiveness of enforcement activities on reducing human impacts to plovers.
- Initiate education and outreach activities.

INTRODUCTION

The Pacific coastal population of the Western Snowy Plover (*Charadrius alexandrinus 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 addition, it also nests on sandy river bars, salt pans at lagoons and estuaries, salt pond levees, dry salt ponds, and on dredge spoils (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 plover eggs, weather, shoreline modification, dune stabilization, and recreational activities have been attributed to reduced nesting success and have been cited as the causes of local population declines (Washington Department of Fish and Wildlife 1995).

Historically, five areas supported nesting 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, only three nesting sites were occupied, Leadbetter Point, Midway Beach (Grayland vicinity), and Graveyard Spit. Because of the very close proximity of Graveyard Spit to Midway/Grayland Beach, this could be considered one site.

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 male (U.S. Fish and Wildlife Service 2007). The last recovery criterion is 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 does not address progress on this last criterion.

According to the Washington State Recovery Plan for the Snowy Plover (1995), the plover will be considered for down listing to Threatened when the state supports a 4-year average of at least 25 breeding pairs and 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 of these plans require effective monitoring of breeding adults and monitoring of fledging success to assess progress toward these recovery goals. Effective monitoring is also necessary to evaluate the effectiveness of conservation actions such as the use of wire nest enclosures used to exclude potential predators 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 started coordinating its monitoring efforts with U.S. Fish and Wildlife Service, Washington

State Parks, and Oregon Department of Fish and Wildlife during the 2006 nesting season and continued this coordinated effort since.

The primary objectives of our monitoring for the 2008 nesting season were:

- Conduct U.S. Fish and Wildlife Service winter window surveys.
- Conduct U.S. Fish and Wildlife Service breeding window surveys.
- Conduct unoccupied breeding site surveys at Copalis Beach, Connor Creek, and Damon Point.
- Estimate hatching success rates and sources of nest mortality during the egg laying/incubation stage for all nest locations.
- Provide fledging success and breeding adult plover population size estimates for Washington.
- Attempt to increase nesting success through habitat restoration efforts, the use of nest enclosures and by restricting human activities in nesting sites and evaluate the effectiveness of these activities.
- Provide information to land management agencies during the field season to help them protect nesting plovers from potential threats.
- Produce a joint report with U.S. Fish and Wildlife Service Willapa National Wildlife Refuge 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 the entire 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, only three sites were occupied, 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 2008. Leadbetter Point and Midway Beach are dune backed beaches and have an unusually wide area that is unvegetated or sparsely vegetated and is located between the mean high tide and the foredune. 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 and 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 dune backed beach, sparsely vegetated foredunes, sand spits, swales and unvegetated deflation plains adjacent to saltmarsh communities. For definitions of terms used to describe coastal sand dune morphology in this section, we recommend referring to Wiedemann (1984).

Table 1. Approximate locations and land ownership for the 2008 Snowy Plover nesting localities in Washington.

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

Breeding Window Surveys

The breeding window survey occurs annually in late May and early June along the entire U.S. Pacific coastline where Snowy Plovers nest. The specific dates for a particular year are selected by the U.S. Fish and Wildlife Service and all participants follow the methods of Elliot-Smith and Haig (2006a). In 2008, the window survey occurred the week of 19 May. We surveyed Connor Creek, Copalis Spit, Damon Point, Midway/Grayland Beach, Graveyard Spit, Leadbetter Point (north of Oysterville Road) and we drove the Long Beach Peninsula south of Oysterville Road.

For the sites that were previously occupied by plovers but were thought to be unoccupied at the beginning of the 2008 field season (Connor Creek and Copalis Spit), an experienced biologist surveyed appropriate habitat on foot. The south Long Beach Peninsula survey was a driving survey with two experienced surveyors looking for plovers on either side of a vehicle moving at approximately 15 mph or slower.

More effort was devoted to surveying occupied sites than unoccupied sites because we were attempting to determine site occupancy at unoccupied sites and conduct complete plover counts at occupied sites. Also, because occupied sites are generally wider with uneven surfaces and more vegetated hummocks than other localities, more observers were required to adequately cover the site. For the Leadbetter survey, a single observer walked the southern section (the narrow beach section) north of the Oysterville Road to the Refuge (just south of the habitat restoration area). Three observers walked the wider section of beach from just south of the habitat restoration area to the north and around the tip of the Peninsula to the

second cove south on the eastern side. Two biologists most familiar with the habitat at the USFWS Leadbetter restoration area walked a serpentine route through the area. The three observers surveying the northern beach section walked approximately 50-75 m apart but parallel to each other. All plovers observed were communicated to other observers by 2-way radio to a single data recorder (usually the middle observer) to avoid double counting. All birds were allowed to pass between observers and every effort was made to avoid flushing plovers, which could result in double counting or unnecessary disturbance. All observers started at approximately the same time and they walked from south to north. The Midway Beach survey consisted of three observers walking parallel and approximately 50-100 m apart and again, they communicated by 2-way radios and allowed birds to pass between observers.

Table 2. Starting and ending locations, survey types and number of surveyors for each survey site in Washington. The Leadbetter counts in the figures and tables that follow include birds detected in the Habitat Restoration Area (HRA), the northern Refuge beach section (from the refuge land just south of the habitat restoration area to the tip of the Peninsula and around) and southern beach section (between Oysterville Road and just south of the habitat restoration area on the Refuge).

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	Foot
Damon Point	46° 56' 05", 124° 09' 18"	46° 56' 11", 124° 06' 18"	1	Foot
Midway Beach	46° 47' 38", 124° 05' 55"	46° 44' 07", 124° 05' 29"	3	Foot
Graveyard Spit	46° 43' 33", 124° 03' 07"	46° 42' 25", 124° 00' 36"	1 or 2	
Leadbetter - North	46° 37' 40.7", 124° 04' 17.4"	46° 38' 50.5", 124° 03' 13.6"	3	Foot
Leadbetter HRA	46° 37' 40.9", 124° 04' 07.8"	46° 38' 30.4", 124° 04' 07.2"	2	Foot
Leadbetter - South	46° 32' 54.0", 124° 03' 40.8"	46° 37' 40.7", 124° 04' 17.4"	1 or 2	Foot
Long Beach (south of Oysterville Rd.)	46° 32' 54.0", 124° 03' 40.8"	46° 22' 03.8", 124° 03' 24.4"	2	Vehicle

Winter Window Surveys

The winter window survey occurs annually in January along the entire U.S. Pacific coastline where Snowy Plovers nest. All sites are surveyed during a specific week and the U.S. Fish and Wildlife Service select the dates for any given year. All participants follow the methods of Elliot-Smith and Haig (2006b). In 2008, the window survey occurred the week of January 6th and we surveyed Connor Creek, Copalis Spit, Damon Point, Midway/Grayland Beach, Graveyard Spit, Leadbetter Point (north of Oysterville Road) but did not drive the Long Beach Peninsula south of Oysterville Road.

Adult Surveys

Site occupancy

Our goal was to determine presence/absence at the sites most likely to become reoccupied or at sites that are currently occupied but where we may be failing to detect plovers. 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 a 87% - 99% probability of correctly determining site occupancy. We conducted repeated visits to Damon Point to assess occupancy during the 2008 nesting season.

Opportunistic surveys

We visited several sites that were previously occupied or with suitable nesting habitat between 15 April and 20 June to informally assess occupancy: Connor Creek (n = 2 visits), Copalis Spit (n = 1 visit), Ocean Shores North Jetty area (n = 1 visit), and Long Beach Peninsula south of Oysterville Road (n = 5 driving surveys). We also visited three islands in Willapa Bay (n = 1 visit each) to look for nesting plovers in May of 2008.

Estimating Number of Adult Plovers

All three occupied sites (Leadbetter Point, Midway Beach, and Graveyard Spit) were surveyed five times between 14 April and 3 July using the methods described in Elliot-Smith and Haig (2006a). One of these surveys was also the Breeding Window Survey and we used the number of surveyors and methods described under the Breeding Window Survey above. We surveyed the entire nesting area with enough surveyors to consider these complete counts.

Even though these are complete counts, there are likely errors of both omission (birds missed that should have been counted) and commission (double counted birds). As a result, we corrected our counts for both errors of omission and commission. To estimate the number of double counts during each Midway Beach and Leadbetter survey, we determined how many times a color marked bird was double counted during a given survey. To estimate the number of birds not detected that should have been detected (omissions), we used our re-sight data of banded birds to determine the number of banded birds that were not observed during the survey but that were observed both during the two week period before the survey and the two and a half week period after the survey at that site. We used a two and a half week period post surveys because, in one instance, the closest survey in time was two and a half weeks after the survey of interest. These are the birds associated with the site that should have been detected during our survey but were not. To develop a correction factor, we used surveys where > 25% of the birds were banded in 2008 because we wanted a reasonable sample size of banded birds upon which to base our correction factor. The average proportion of double counts per survey (n = 8 surveys) was 0.15 and the average proportion of missed birds per survey was 0.30. We then used these two proportions to develop a single correction factor for any survey by subtracting the proportion of double counts from the proportion of omissions and multiplying this resulting value by 1 (= 1.15) by the number of birds detected per survey.

When deriving these population estimates, we only used counts between 14 April and 3 July. These counts occurred when there was the least amount of immigration and emigration into and out of Washington and before post-nesting dispersal. For all sites (Midway Beach, Graveyard Spit and Leadbetter Point) we used the 5 surveys and survey periods that were assigned before the nesting season for our estimates. We took the adjusted count of adult birds from these surveys and we present the mean of these five surveys and the 95% confidence interval surrounding this estimate of the mean. We rounded all estimates to the nearest whole bird.

State Park Habitat Restoration Area Surveys

Five approximately 1 acre restoration sites and five control sites were established in 2007 that were approximately rectangular in shape (see Appendix I). Transects were established through the center of the long access of each restoration site. Each transect at each site was visited 8 times between 8 April and 15 August, 2008. During the surveys, an observer walked the transect very slowly and recorded all birds detected inside and outside the site. The approximate width of this transect was 30 meters but ranged from 26 to 42 meters.

Clutch Initiation Dates

Unless observed directly, we calculated clutch initiation date by backdating from hatching dates. Backdating using hatch dates requires information on the time intervals associated with the egg laying and incubation stages. Because our sample size of nests under observation prior to egg laying was too small to compute these time intervals directly, 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.

Nesting Success

Nesting sites were visited several times a week to search for and monitor Snowy Plover nests from April 8 until August 18, 2008. Searching was conducted both during adult surveys and during frequent visits to the nesting sites. Nests were located in most cases by following plover tracks to nests. Nests were also located by observing scrape building by males, locating adults incubating eggs, or by flushing incubating adults. Date and status (presence of parents and eggs) of each nest was recorded approximately every 3-5 days. Nest success was calculated using the Mayfield method (Mayfield 1961, 1975). Nest outcome was reported 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 sources of failure.

Nest Exclosures

We used the mini-exclosure design provided by plover biologists Dave Lauten and Kathy Castelein of Oregon (Lauten et al. 2003). The mini-exclosure was constructed of 2x4 inch mesh wire fencing with four sides, 4 feet long and wide and 2 feet 8 inches high. The sides were fastened together to form a square. A 'bubble' top of wire fencing was fastened to the top of the square, making the exclosure approximately 3 feet high. Under the wire bubble top we secured a taut layer of 3/4 inch polypropylene black mesh netting. This soft layer was used to keep a startled plover from flying up and hitting the wire bubble top of the exclosure, if a raptor should land above them. A door was cut in one side of the exclosure so that eggs could be accessed if necessary; doors were fastened closed with pliable, heavy gauge wire. The completed exclosure was centered over the nest creating an imprint in the sand and removed. Following the exclosure imprint, a trench, 8 inches deep, was dug and the mini-exclosure was placed in the trench. Fifteen inch stakes were placed on each corner of the exclosure to help hold it in place prior to filling in the trench. The 2 x 4 inch mesh allows adult plovers free access to the nest from all sides but excludes American Crows, Common Ravens and larger mammals.

Fledging Success

Snowy Plover chicks are precocial, leaving the nest within hours after hatching to search for food. They are not able to fly for approximately 4 weeks after hatching. Adult plovers do not feed their chicks after hatching, but lead them to suitable feeding areas. Adults warn of approaching predators 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 three 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.

Determining the number of young fledged requires following broods from hatch date to 28 days post hatching. To accomplish this, we needed to be able to assign a hatch date to each brood and to develop methods for tracking specific broods. We attempted to band as many chicks as possible on hatch date. Hatch date was estimated by floating eggs following Hays and LeRoy (1971) or by counting forward from egg laying. For nests where we missed hatching, we were able to estimate hatch dates because we checked nests every 1-3 days around hatching and could therefore estimate hatch date to within 3 days. We were often able to use chick plumage and size for chicks observed within a couple of days of hatching to narrow down the assignment of hatch date to plus or minus one day. We used several methods independently and, when possible, in concert to track chick survival for the 28 days post hatching. For 16 nests out of 26 nests that hatched, we banded one or more chicks. Chicks from banded broods were then followed for at least 28 days post hatching. For some nests without banded young, we were able to track 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 dates when a banded adult male accompanied chicks. Fortunately, all chicks could be assigned to specific nests/hatch dates using bands, chick age (size and plumage) and location along the beach and/or by using the color band combination of an accompanying adult male.

Nest Locations

Each nest was photographed and its location was recorded using a hand held GPS unit. On Leadbetter Point, the U.S. Fish and Wildlife Service used both a Trimble and Garmin GPS unit. Washington Department of Fish and Wildlife used Garmin GPS unit. The Trimble Units has approximately 1 m accuracy with post-processing and the Gramin has approximately 15 m accuracy.

Banding

The 2007 nesting season was the first season that Washington has banded Western Snowy Plovers for the purpose of estimating fledging success. In 2007 and 2008, only chicks were banded and all chicks were banded on the nest or very near the nest on their hatch date and usually within 3 hours of hatching. Hatch date was determined from laying dates when known, by floating eggs, observing adult behavior, and by examining eggs for signs of hatching or sounds from chicks inside the egg. Each chick was fitted with three XCL Darvic or celluloid color bands and 1-1P U.S. Fish and Wildlife Service band. On the left leg, we placed red above violet bands for Midway Beach birds and violet above either red or dark blue for Leadbetter Beach birds. Two plastic bands were placed on the left leg and a plastic band was placed above the U.S. Fish and Wildlife Service band on the right leg. Darvic bands were sealed shut with a soldering iron and celluloid bands were sealed with acetone. Color auto pin striping tape was placed on top of the U.S. Fish and Wildlife Service band and sealed to transform this metal band into a color band.

Reading Color Bands

A number of Washington's breeding birds were banded in Oregon or California 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 Reyes Bird Observatory 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 a 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. Exact color combinations for a banded bird were only assigned when the birds were observed with spotting scopes and where the color combination could confidentially be determined. 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

Forty-two adult plovers were detected in Washington during the 2008 breeding window survey, which was lower than the 2006 and 2007 count (Table 3) but higher than all other breeding window surveys since 1998. 2006 was the first year that we followed the methods of Elliot-Smith and Haig (2006a), and consequently, more effort was devoted to locating birds than in previous years. As a result, the past three seasons' results are not necessarily comparable with those from previous seasons.

Table 3. Breeding Window survey counts by site, sex, and age and counts of nests and broods in 2008.

Site	2005	2006	2007	2008	2008	2008					
						Survey Dates	Adult Males	Adult Females	Unknown n	Juvenile s	Brood s
Copalis Spit	-	0	0	0	20 May	0	0	0	0	0	0
Conner Creek	-	0	0	0	20 May	0	0	0	0	0	0
Damon Point	5	0	0	0	30 May	0	0	0	0	0	0
Graveyard	-	-	0	1	22 May	1	0	0	0	0	0
Midway Beach	23	25	22	12	28 May	6	6	0	0	0	2
Leadbetter Point	9	42	28	29	19 May	10	12	7	0	0	1
South Long Beach	-	0	0	0	19 May	0	0	0	0	0	0
Total	37	67	50	42		17	18	7	0	0	3

Winter Window Survey

29 Adult plovers were detected on two sites during the January 2008 Winter Window Survey (Table 4). This was a very low count compared to previous counts.

Table 4. Winter Window survey counts by site and sex in 2008.

Site	2006		2007-2008		2007-2008		2007-2008	
	2007	2008	Survey Dates	Adult Males	Adult Females	Unknown n	Adult Unknown n	Adult Unknown n
Copalis Spit	0	0	6 Jan	0	0	0	0	0
Conner Creek	0	0	6 Jan	0	0	0	0	0
Damon Point	0	0	9 Jan	0	0	0	0	0
Graveyard	0	-	-	-	-	-	-	-
Midway Beach	21	15	8 Jan	0	0	15	0	15
Leadbetter Point	17	14	9 Jan	5	1	8	0	8
South Long Beach	-	-	-	-	-	-	-	-
Total	38	29		5	1	23	0	23

Adult Surveys

As indicated in Table 5 we conducted 39 surveys at 12 sites between 16 April and 20 July 2008.

Table 5. Snowy Plover survey dates, number of surveys and surveyors and type of survey by site during the 2008 nesting season

Site	Type of Survey	Number of Surveys	Number of Surveyors	Walking or Driving	Survey Dates
Damon Point	Occupancy/Window	5	1-2	Walking	4/16,4/29,5/30,6/17,7/01
Midway	Breeding Adult/ Window	5	2-3	Walking	4/16,5/01,5/28,6/17,6/27
Graveyard	Breeding Adult/ Window	5	1-2	Walking	4/21,5/09,5/22,6/19,7/03
Leadbetter	Breeding Adult/ Window	5	5-7	Walking	4/17,4/30,5/19,6/12,7/02
Connor Creek	Opportunistic/ Window	2	1-2	Driving	5/14,5/20
Copalis	Window	1	2	Walking	5/20
Ocean Shores/North Jetty	Opportunistic	1	1	Driving	5/14
Misc. Long Beach	Opportunistic	6	1	Driving	4/15,5/8,5/19,5/20,6/11,6/20
State restoration sites	Research	6	1-5	Walking	4/18,5/8,5/20,6/15,7/7,7/20
Gunpowder Island, Willapa Bay	Opportunistic	1	3	Walking	5/29
Snag Island, Willapa Bay	Opportunistic	1	3	Walking	5/29
Un-named island, Willapa Bay	Opportunistic	1	3	Walking	5/29

Our goal was to determine plover presence-absence at Copalis and Connor Creek and we surveyed each of these sites at least 4 times throughout the season using volunteers. At Damon Point, Midway Beach, Graveyard Spit, and Leadbetter our goal was to estimate the number of breeding adults and we surveyed each site at least 4 times during the nesting season. We also conducted opportunistic surveys at Long Beach (south of Oysterville Road), Westhaven and the Ocean Shores area. On May 29, Kirsten Brennan, Cyndie Sundstrom and Kathie Gunther surveyed three islands with potential habitat for nesting plovers and no plovers were observed (Table 4; Appendix I).

Site occupancy

Because Damon Point was very recently occupied by nesting birds, we conducted five surveys during the 2008 nesting season and found the site to be unoccupied. According to Pearson et al. (2006), there is a 67% probability of correctly determining site occupancy with one visit, a 89% probability with two visits, a 96% probability with three visits, and a 99% probability with four visits. Because sites are colonized and go extinct within a season as demonstrated by Damon Point in the past, it is important to spread out visits between early to mid-May and the end of the first week of July – the period of greatest nesting activity.

Opportunistic Surveys

No plovers were observed during opportunistic surveys conducted on the stretch of beach between Ocean City and Ocean shores north jetty, at Connor Creek, or on the Long Beach Peninsula south of Oysterville Road.

Estimating Number of Adult Plovers

Estimating the number of breeding adults requires an understanding of movement patterns among sites within Washington and patterns of immigration and emigration between Washington and localities to the south. In addition, sex specific estimates require an understanding of differences in detectability between males and females. Sex specific estimates are needed to calculate fledging success.

We examined patterns of immigration and emigration using dates when banded birds were either first detected on a nesting site or last detected (Figure 1). We started searching nesting areas for plovers and nests at the beginning of April when most of the breeding birds were already on the nesting sites. As a result, there is an apparent peak in the number of banded birds first observed at this time – these birds may have been present all winter or may have recently arrived. We ended our nest, chick and adult monitoring at the end of August. Again, there is an apparent peak in the number of final observations for the season on the final survey dates – many of the birds last observed during the final surveys of the season likely stayed at these sites for at least a few more weeks and subsequent visits and observations of these birds indicates that some stay on the nesting sites throughout the winter.

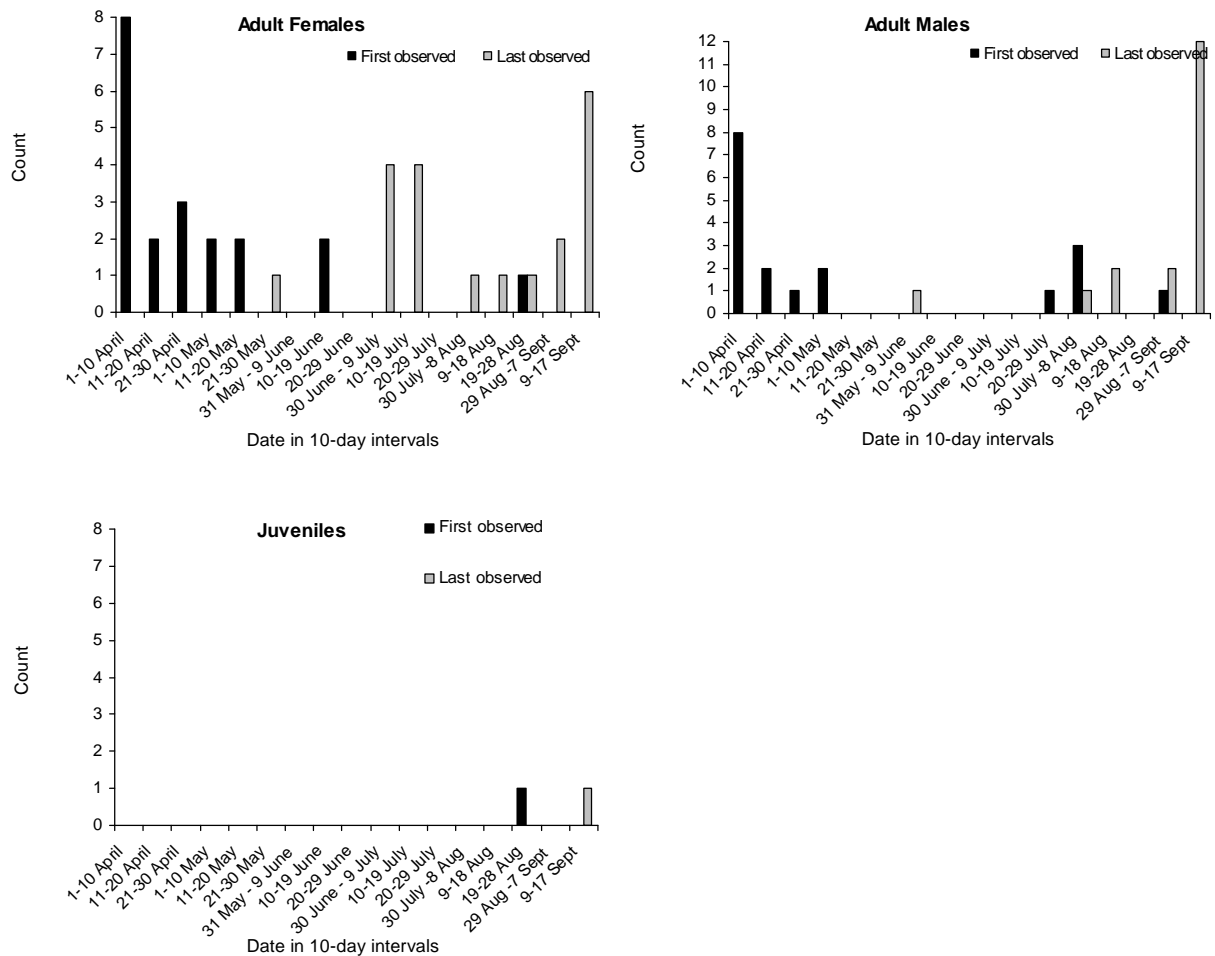


Figure 1. Dates banded female, male, and juvenile Snowy Plovers were first and last detected on Midway Beach and Leadbetter Point combined in 2008. Juveniles only include birds banded outside of Washington and observed in Washington.

Patterns of arrival and departure (and/or mortality) after our early monitoring (1-10 April) and before the end of our monitoring (9 - 17 Sept.) suggest that most banded female plovers are either already present on these sites or are arriving in April with fewer females arriving in May and June. There is increased movement away from Washington in late July and August after completing nesting (Figure 1). For males, the pattern is similar to that exhibited by females (Figure 1).

Banded juvenile plovers start arriving on Washington nesting sites from their Oregon and California hatch sites in August (Figure 1). Because plovers are moving in and out of the state during the nesting season, actual counts will differ among surveys. Although not captured in Figure 1, there is also an increase in plovers associated with locally hatched birds starting primarily in late June.

We also examined the number of times each banded male and female was observed in a given season to determine if there are differences in detectability between the sexes and we found no differences even when accounting for potential differences in the amount of time each bird was found on our sites (Figure 2). This result and nearly identical result in 2006 and 2007 indicates that there is no need to adjust counts to account for differences in detectability between males and females.

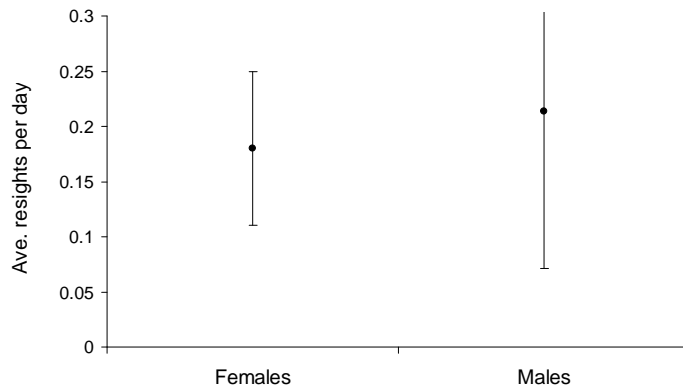


Figure 2. Average number of re-sights per banded adult female (n = 20) and male (n = 18) Snowy Plovers per day during the 2008 nesting season.

The sex specific resighting information and the information on immigration and emigration indicates that 1) populations are not closed and likely vary slightly week to week; 2) that populations are less dynamic between late April and the first week of July and are likely composed primarily of local breeders during this period; 3) and there are no sex biases in our counts associated with differences in detectability between males and females. We conducted repeated counts of adult birds during the 2006 season for a longer window of time and our results also indicated that adult numbers declined after the first week in July suggesting that some birds are dispersing from these sites after either failing to breed or females dispersing after leaving their mate with the final clutch or brood of the season and that counts increase through early April suggesting that birds are still arriving on the nesting grounds (Pearson et al. 2007).

This pattern suggests that surveys of breeding adult birds should be completed between late April and before the second week in July when populations are more stable and largely composed of local breeders. Repeated counts help us understand the variability associated with estimates. As a result, we used 5 surveys from pre-determined weeks between 19 April and 10 July to estimate the breeding adult population (Figure 1, Table 5). In Figure 3, we provide both the uncorrected and corrected counts for each survey period and in Table 6 we present breeding adult population estimates by nesting site and for the entire State.

Adult population counts have changed little between 2006 and 2008 (Table 6, Figure 4).

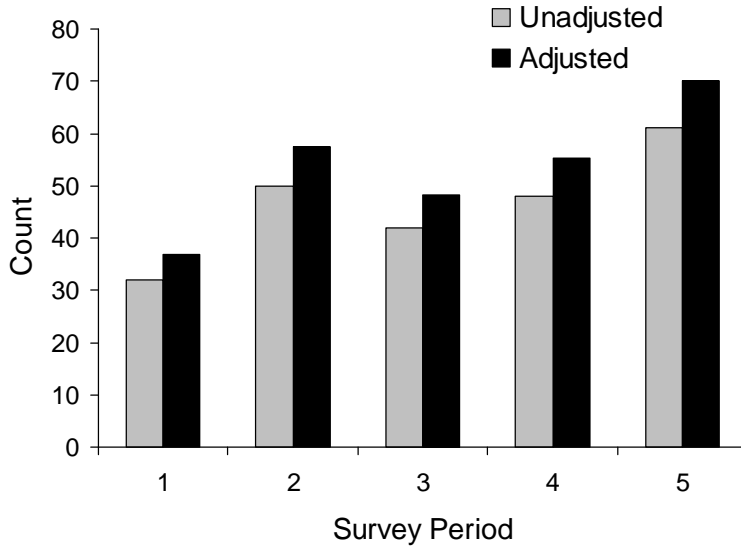


Figure 3. Total counts of adult Snowy Plovers at Midway Beach, Graveyard Spit and Leadbetter Point combined for each of five survey periods. Adult surveys were conducted once at each site during the following survey periods: Period 1 = 19 April – 26 April; Period 2 = 10 May – 17 May; Period 3 = 21 May – 25 May, Period 4 = 11 June – 22 June; Period 5 = 25 June – 2 July. Unadjusted counts are the number of birds actually detected and Adjusted counts account for both double counts and birds missed that should have been counted (see Estimating Numbers of Breeding Adults in the Methods above).

Table 6. Adjusted counts (95% CI) of the breeding adults at four nesting sites in Washington and the total population estimate for the State in 2007 and 2008.

	Damon	Midway	Graveyard	Leadbetter	Total
2006 Adjusted Counts	1 (-1-3)	23 (15-30)	2(-1-6)	39 (28-49)	65 (53-77)
2007 Adjusted Counts	0	19 (16-23)	2(-1-5)	27 (22-33)	48 (39-58)
2008 Adjusted Counts	0	16 (11-22)	1 (0-2)	36 (26-47)	54 (38-69)

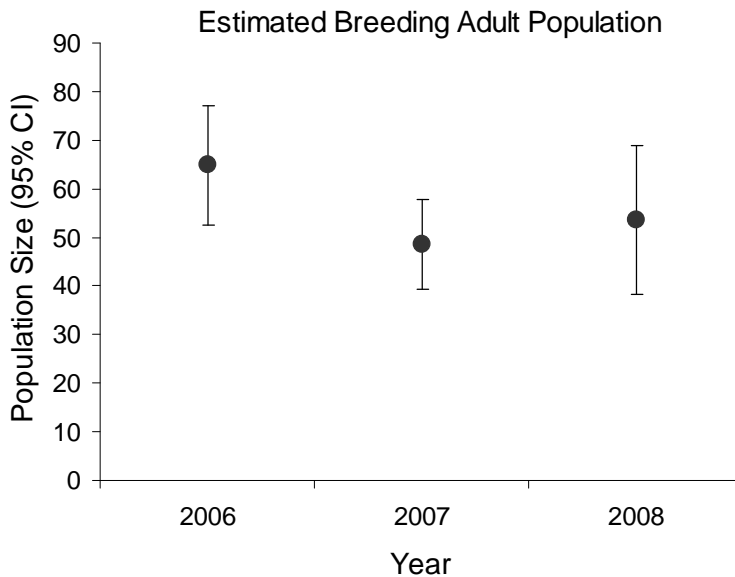


Figure 4. Washington adult plover estimates (95% CI) from 2006 – 2008.

State Park Habitat Restoration Area Surveys

Six surveys of treatment and control plots were conducted in 2007 and no Snowy Plovers or Streaked Horned Larks were detected. Eight surveys of treatment and control plots were conducted by volunteers and wildlife biologist Kathy Gunther in 2008 and no Snowy Plovers were detected. One streaked horned Lark was detected in a control plot on 9 July. A second detection of a lark occurred in a treatment plot on 9 July but not during the official survey. Volunteers contributed approximately 280 hours to this survey effort and to measuring the vegetation response to treatments. In the summer of 2009 we will measure the post-treatment vegetation response and report the results in next year's report.

Clutch Initiation Dates and Breeding Phenology

For clutches where we observed clutch initiation or could calculate clutch initiation using back-dating, we found that clutches were initiated between 24 March and 15 July (Figure 5A). However, very early nests could have gone undetected because intensive surveys did not start until after April 1. The first chick to fledge, fledged around 8 June and the last chick known to fledge, fledged around 3 September (Figure 5B).

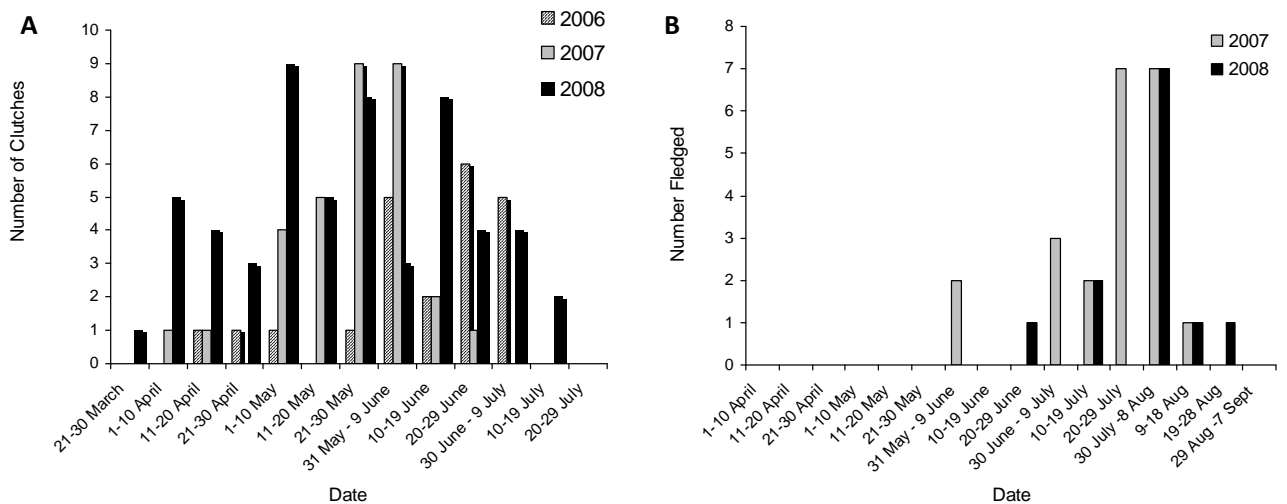


Figure 5. Number of Snowy Plover clutches initiated in 2006, 2007, and 2008 (A) and number of chicks fledged (B) in 2007 and 2008. Counts are presented in 10-day intervals for all Washington nesting sites combined.

Scrape building and territory defense occurs prior to egg laying consequently, the active nesting season occurred between mid-March and early September in 2008. In Figure 5, we present the number of clutches initiated in ten-day intervals at all sites combined. The vast majority of the nests are initiated between the first week of May and the last week of June.

Nesting Success

We located and monitored the outcome of 56 plover nests in 2008. Of these 56 nests, 29 were located at Leadbetter, 26 at Midway Beach, and 1 at Graveyard Spit (Table 7). For a map of nest locations see Appendix I. Twenty-five of these nests hatched. For nests that failed to hatch, predation was the primary source of nest failure, with most nests depredated by Corvids. Both American Crows (*Corvus brachyrhynchos*; Table 8) and Common Ravens (*Corvus corax*) depredated nests. Coyotes (*Canis*

latrans) depredated three nests at Midway Beach. Again this year, drifting sand was a significant source of nest failure especially at the outer beach of Leadbetter (Table 8). Six nests were abandoned. Of the abandoned nests, we suspect that Plover mates were depredated from two of the exclosed and abandoned nests because a decapitated male was found near one exclosure and feathers were found near the other. One abandoned nest was a one-egg nest suggesting that the clutch was never completed. One abandoned nest was incubated for 87 days before she “abandoned” the eggs suggesting that the eggs were addled or infertile. Both of these eggs were far below the minimum measurements of ‘normal’ snowy eggs.

Table 7. Nest outcomes by Snowy Plover nesting locality in 2008. Outcomes include successful (hatched), failed or unknown outcome.

Site	# Nests	Outcome		
		Hatch	Fail	Unknown
Graveyard	1	1	0	0
Midway	26	4	22	0
Leadbetter	29	20	9	0
Exclosed ¹	37	23	15	0
Not exclosed	18	2	16	0
Totals	56	25	31	0

¹28 nests at Leadbetter Point and 9 at Grayland Beach (Midway)

The other two abandoned nests were abandoned for unknown reasons. The final source of nest failure was nest destruction caused by human actions. In one case, the exclosure door was opened (only humans can untwist the wires holding the door shut), the eggs were missing, human foot prints led up to and away from the nests, and a hand print was visible in the sand inside the exclosure. This incident was reported to both federal and state enforcement agents because of potential “Take” under the Endangered Species Act. In the other case, tracks in the sand indicated that horses crushed the eggs (Table 8). We assume that the horses were ridden and steered by people because we have never seen horses on the beach without humans on their back. In another incident, we observed horse tracks approaching and leaving from an exclosed nest, the exclosure had been pulled partially out of the ground but the eggs were still intact – the three eggs in this nest successfully hatched. Finally, a decoy nest exclosure with fake eggs placed inside was also pulled out of the sand by people and the fake eggs were stolen.

Table 8. Sources of Snowy Plover nest failure in 2008. Sources of failure include predators (American Crows, Common Ravens, unknown Corvid, or Unknown predator) eating eggs or other sources of failure including Human activities (stealing eggs from nest and horseback riding), drifting Sand covering the nest, Abandoned nests and Unknown sources of failure.

Site	Failures								
	Crow	Raven	Predator			Human	Other Sources		
Corvid			Coyote	Unknown	Sand		Abandon	Unknown	
Graveyard	0	0	0	0	0	0	0	0	0
Midway	4	3	1	3	0	2	2	6	1
Leadbetter	0	0	0	0	0	0	8	0	1
Exclosed	0	0	0	0	0	1	10	4	1
Not exclosed	4	3	1	3	0	1	0	2	1
Totals	4	3	1	3	0	2	10	6	2

We used the Mayfield method to estimate nest survival probability. The Mayfield method accounts for potential biases associated with the date of nest discovery and the resulting number of days that a nest is exposed to predators by calculating a probability of survival associated with the number of exposure days (number of days observed). In Tables 9 and 10, we report Mayfield nest success estimates for the 2008

nesting season and compare to the previous two nesting seasons. The probability of nest survivorship was 25% at Midway and Graveyard combined and 54% at Leadbetter. This difference in nest success is the result of exclosing all but one of the nests at Leadbetter but only about a third of the nests at Midway. The probability of nest survivorship of unexclosed nests was only 6% (Table 9).

Table 9. Mayfield estimates of Snowy Plover nest survival and of daily nest survival probability by site and by exclosed and unexclosed nests in 2008. All but one Leadbetter nest were exclosed.

Site	Daily Survival Probability	Nest Survival
Midway and Graveyard	0.96	0.25
Leadbetter	0.98	0.54
Midway exclosed	0.98	0.50
Midway unexclosed	0.92	0.07
Washington exclosed	0.95	0.54
Washington unexclosed	0.92	0.06
Washington Total (including exclosures)	0.97	0.36

Table 10. Mayfield estimates of nest survival by site from 2006 - 2008. Almost all nests were exclosed at Leadbetter in 2007 and 2008 and one third of the Midway nests were exclosed in 2008.

Site	Nest Survival		
	2006	2007	2008
Midway and Graveyard	0.23	0.28	0.25
Leadbetter	0.26	0.51	0.54
Washington Total (including exclosures)	0.25	0.37	0.36

The differences in hatching success between exclosed and unexclosed nests observed here is consistent with other research. Lauten et al. (2004) compared the percent of nests that failed from exclosed (n = 692) and unexclosed (n = 271) nests and found that 67% of the exclosed nests successfully hatched and only 11% of the unexclosed nests successfully hatched. There is some evidence that exclosures may increase adult predation as we observed in 2008 (Lauten et al. 2004).

Fledging Success

The U.S. Fish and Wildlife Service uses the number of young fledged per adult male to determine whether or not the population is growing, stable or decreasing. The recovery objective is at least one young fledged per adult male and is based on the population viability analysis by Nur et al. (1999). Population modeling by Nur et al. (1999) indicate that productivity of at least 1.0 chicks 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.

Deriving this metric for Washington requires an estimate of both the number of breeding adult males and the number of chicks fledged. When using just the proportion of the banded chicks that fledged, we estimated that 8.4 chicks should have fledged from the nests that successfully hatched at all three sites combined. We estimated that 12 or 13 chicks fledged using direct observations of both banded and unbanded chicks. Because we know at least 12 or 13 chicks fledged, we used 12.5 to estimate fledging success. We used the proportion of males from our breeding adult surveys to determine the number breeding males in Washington. Because there was no difference in the sightability of males and females (Figure 3), this result should be unbiased. Using our estimate of breeding males and number of young actually thought to have fledged (Table 11), we estimate that the number of young fledged per adult male was 0.46 (95% CI = 0.36-0.64). This estimate suggests that the plover population on these sites should be declining rapidly and is therefore not being maintained by local production (see Nur et al. 1999).

Table 11. Estimated number of males and observed numbers of fledglings by site in 2007 & 2008.

Location	2007		2008	
	Ave. estimated number of males	Number of fledglings observed	Ave. estimated number of males	Number of fledglings observed
Leadbetter	14	9	19	6
Midway & Graveyard	11	13	9	6 or 7 ²
Washington total	25	25	27	12 or 13

*Three chicks fledged from two Graveyard Spit nests in 2007 and 2 or 3 chicks fledged from a single nest in 2008

Why then is the population in Washington apparently stable over time? We believe that the Washington population is being maintained primarily by immigration of Oregon plovers and secondarily by California plovers. This hypothesis is supported by several lines of evidence: 1) Washington appears to have a declining population growth rate based on fledging success data; 2) Oregon has an increasing plover population (Lauten et al. 2006, 2007, 2008); 3) the number of banded adult birds detected on our adult population surveys at Leadbetter and Midway averaged 59% and 35% respectively and almost none of these banded birds was banded in Washington indicating that birds are moving into Washington; and, for example, 4) of the color banded birds observed at these sites in 2006 where we could determine the location where they were originally banded, approximately 81% were originally banded in Oregon and approximately 19% were originally banded in California indicating that birds are moving into Washington from Oregon and California.

Nest Locations

2008 nest locations are presented by nesting site in Appendix I. At Midway Beach, birds nested in Grayland Beach State Park south to Washaway Beach. At Graveyard Spit, birds nested on the Shoalwater Indian Reservation. On Leadbetter Point plovers nested on the tip of the Peninsula on the outer beach and in the habitat restoration area on the Willapa National Wildlife Refuge. One nest was located south of the Refuge on State Park land on Leadbetter.

Table 12. Number of nests discovered by location and year.

Location	2006	2007	2008
USFWS Leadbetter Point – outer Beach	13	3	8
USFWS Leadbetter Point – Habitat Restoration Area	16	17	20
State Parks Leadbetter Point	0	1	1
Midway Beach	29	22	25
Shoalwater (Graveyard Spit)	3	2	1
Damon Point/Oyhut	1	0	0
Total	62	45	56

PROGRESS ON RECOVERY OBJECTIVES

Federal Recovery Objectives:

Objective 1: 250 breeding adults in Recovery Unit 1.

The 2008 Washington nesting population is 54 (95% CI = 38-69) and the 2008 nesting population in Oregon was 129 plovers (Lauten et al. 2008) for a total of 183 (range = 167-198) nesting adult plovers in Recovery Unit 1. In 2007, the nesting population in Recovery Unit 1 was estimated at 210 adult nesting plovers.

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

In 2008, the average number of young fledged per adult male in Washington was 0.46 (95% CI = 0.36-0.64). The number of young fledged per adult male in Oregon was 1.13 in 2008 (Lauten et al. 2008). We combined the Oregon and Washington estimates of the number of breeding adult males and the number of young fledged (n = 83-84) to derive a combined Unit 1 fledging success per male of 0.92 (95% CI = 0.85-1.01). The combined Unit 1 fledging success per male in 2007 was 1.43 (95% CI = 1.37-1.50). Combined Oregon and Washington fledging success data are not available for years prior to 2007 because it was not monitored in Washington.

Washington State Recovery Objectives:

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

We estimate that there were 54 (95% CI = 38-69) nesting adults in 2008 and approximately 49% of these birds are females and 51% are males. If all females are paired, these estimates indicate that there are approximately 27 pairs (95% CI = 19-35 pairs) in Washington in 2008. There were 24 pairs in 2007 and 32 pairs in 2006.

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 was 0.46 (95% CI = 0.36-0.64) in 2008 and 0.91 (95% CI = 0.77 - 1.13) in 2007. Currently plovers are nesting on two primary sites. One site is a National Wildlife Refuge the other site consists of private and Washington State Park lands.

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”.

2008 MANAGEMENT ACTIONS

A number of the management actions that occurred in 2008 involved restricting some human activities on active Snowy Plover nesting sites during the nesting season. Human related disturbance has been restricted because it has been shown to negatively affect hatching success of Snowy Plovers (Warriner et al. 1986, Schulz and Stock 1991) and Snowy Plover chick survival by as much as 72% (Ruhlen et. al. 2003). Disturbances to wintering Snowy Plovers is 16 times higher at a public beach than at a protected beach and 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 has also been shown to negatively affect hatching rates and chick survival for various plover species (Flemming et al. 1988, Buick and Paton 1989, Dowling and Weston 1999).

Management

- The nesting areas above the wet sand were closed to all human activities on Grayland Beach State Park at Midway/Grayland Beach and on National Wildlife Refuge and State Park lands on Leadbetter Point. Private lands at Midway/Grayland Beach were not closed to human activities. Approximately 7.5 miles of beach nesting habitat was closed at Leadbetter by State Parks and U.S. Fish and Wildlife Service and slightly under a mile of beach was closed to foot traffic at Midway/Grayland Beach by State Parks and Washington Department of Fish and Wildlife. The lower beach, adjacent to the ocean, remained open to the public. In addition, two dog restriction signs were added to trail junctions and trailheads on Refuge lands at Leadbetter and a “Share the Beach” sign was installed at Grayland Beach State Park.
- Symbolic fencing was put along beach access trails at Leadbetter by U.S. Fish and Wildlife Service staff to direct people toward the wet sand and away from plover nesting habitat. Symbolic fencing was not used on State Park land at Grayland Beach State Park.
- On the Long Beach Peninsula, the beach is closed to vehicle traffic north of Oysterville Road to the southern Leadbetter State Park boundary from April 15 to the day after Labor Day. Willapa National Wildlife Refuge is closed to vehicle traffic year round. However, driving is allowed in these areas during razor clam harvest openings. All of the Midway/Grayland beach area is open to vehicle traffic and there are vehicle access points at Cranberry Beach Road, Midway Beach Road and Warrenton-Cannery Road. The Midway Beach Road access cuts through the center of the highest use area for plover nesting.
- U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife biologists put nest exclosures around 28 nests on the Willapa National Wildlife Refuge, and 9 nests on Grayland Beach State Park.
- The discharge of fireworks is not allowed on Damon Point, Grayland Beach State Park, State Park lands on the Long Beach Peninsula or on Willapa National Wildlife Refuge lands at Leadbetter Point. Rangers actively patrolled the beach at Grayland Beach State Park between June 28th and July 5th. Park Rangers contacted visitors discharging fireworks.

Enforcement

- State Parks Beach Rangers patrolled nesting habitat in the Grayland Beach State Park vicinity (Midway/Grayland Beach) and Cape Disappointment State Park (Leadbetter Point). Seven State Park Rangers contacted approximately 33 people on foot, 8 people in vehicles and 3 people on horses within the closed nesting area at Grayland Beach State Park. Contacts emphasized education and no citations were issued.
- In 2008 there were 10 razor clam digs at Leadbetter (April 6,7,8,19,20 and May 3,4,5,6,7) and 15 at Midway/Grayland beach (April 6,7,8,9,19,20,21,22,23 and May 3,4,5,6,7,24). These digs

occurred on beaches where Snowy Plovers were actively nesting and resulted in numerous incursions into nesting habitat that was clearly marked by signs restricting such access. State Parks Rangers spent approximately 20 hours during clam tides at Leadbetter Point to protect plovers when they made approximately 100 educational contacts. U.S. Fish and Wildlife Service had one or 2 officers work most digs for approximately 100 officer hours worked. These officers were only focusing their efforts on keeping people out of the restricted nesting habitat. To accomplish this, they contacted and educated approximately 45 people, they issued warnings to another 49 people, and they issued violation notices (citations) to 19 people. Another 9 people were observed within the closed nesting area, but were gone before officers could get to them. Wildlife Biologist Cyndie Sundstrom worked 7 clam tides in April and May to discourage entry into restricted areas.

- A Federal agent followed-up on the apparent removal of eggs from a Snowy Plover nest but there were no arrests or citations because of lack of evidence and authority.

Restoration

- U.S. Fish and Wildlife Service increased the size of the habitat restoration area at Leadbetter from 84 acres in 2007 to 121 acres in 2008. The amount of area within the restoration area covered with oyster shell was also increased by 3.9 acres to a total of 45 acres. A total of 269 cubic yards of oyster shell was added. The herbicide Imazapyr (6 pints/acre with Hasten as the surfactant) was applied by tractor-mounted spay boom to *Ammophila* that had resprouted in the restoration area. In areas with pink sand verbena plants, herbicide was applied with backpack units and beachgrass was pulled by hand around individual plants. A helicopter sprayed approximately 40 acres of the foredune between the restoration area and the outer beach where dense areas of beachgrass were present.

Table 13. Change in the size of the U.S. Fish and Wildlife Service Habitat Restoration Area (HRA) over time. Areas are in acres and represent the total number of acres in each category not the number of new acres.

	2002	2003	2004	2005	2006	2007	2008
HRA Size	1	8.7	16	40	63	84	121
Acres covered in oystershell	4 small patches	4 larger patches	1	14	28	41.1	45
Number of nests in the HRA	1	2	3	22	16	17	20

- Under the direction of Dave Hays with Washington Department of Fish and Wildlife, five experimental openings about 1 acre each were created on Leadbetter State Park to examine both plover and streaked horned lark response to treatments. Pre-treatment bird and plant monitoring was conducted by Washington Department of Fish and Wildlife with the assistance of Willapa Hills and Grays Harbor Audubon volunteers and volunteers from Shoalwater Bird Club (approximately 279 volunteer hours to date) and initial treatments to control non-native beachgrasses were conducted by Washington Department of Fish and Wildlife. Pre-treatment data was collected in the summer of 2007, the first treatment occurred in October 2007 and the second treatment occurred in September - October 2008. Treatment areas were sprayed with a combination of Polaris AQ (4 pints/acre) and Aquaneat (4.5 pints/acre). Surfactant was crop oil applied at 1% solution. Native plants were covered to prevent herbicide application. Dead beachgrass was raked from the plots in February/March 2008 and will occur again in February

2009. Additional treatment planned in fall 2009. Plots were surveyed for both Western Snowy Plovers and Streaked Horned Larks (see above).

Education

- Enforcement and patrol activities by State Park Beach Rangers emphasized education and not citation.
- Washington Department of Fish and Wildlife presented one program on Snowy Plovers to approximately 10 Audubon volunteers in the spring of 2008.

FUTURE RESEARCH & MONITORING CONSIDERATIONS

- Continue testing methods for estimating adult population size.
- Continue to engage volunteers in monitoring.
- Conduct research to identify the conditions where plover populations can be self-sustaining.
- Conduct research to identify habitat features important to successful plover nesting.
- Initiate a study to examine the effectiveness of predator control.
- Continue to link management activities with research and monitoring.
- Evaluate effectiveness and continued use of nest exclosures.
- Evaluate effectiveness and need for habitat restoration areas.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- Evaluate effectiveness of enforcement activities on reducing human impacts to plovers.
- Initiate education and outreach activities.

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LITERATURE CITED

- Buick, A.M., and D.C. Paton. 1989. Impact of off-road vehicles on the nesting success of Hooded Plovers *Charadrius rubricollis* in the Coorong region of South Australia. *Emu* 89: 159-172.
- Dowling, B. and M.A. Weston. 1999. Managing a breeding population of the Hooded Plover *Thinornis rubricollis* in a high-use recreational environment. *Bird Conservation International* 9: 253-270.
- Elliot-Smith, E., and S.M. Haig. 2006a. Western Snowy Plover breeding window survey protocol – final draft.
- Elliot-Smith, E., and S.M. Haig. 2006b. Western Snowy Plover winter window survey protocol – final draft.
- Elliot-Smith, E., and S.M. Haig. 2006c. Draft protocol for surveying Snowy Plovers at unoccupied breeding sites on the Oregon coast.
- Flemming, S.P., R.D. Chiasson, P.C. Smith, P.J. Austin-Smith, and R.P. Bancroft. 1988. Piping Plover status in Nova Scotia related to its reproductive and behavioral response to human disturbance. *Journal of Field Ornithology* 59:321-330.
- Hays, H., and M. LeCroy. 1971. Field criteria for determining incubation stage in eggs of the common tern. *Wilson Bulletin* 83:425-429.
- Lafferty, K.D. 2001. Disturbance to wintering western snowy plovers. *Biological Conservation* 101:315-325.
- Lauten, D.J., K.A. Castelein, B. Smithers., K.C. Jander, E. Elliot-Smith, E.P. Gaines. 2003. The Distribution and Reproductive Success of the Western Snowy Plover Along the Oregon Coast – 2003. Unpublished report to Coos Bay Bureau of Land Management, Oregon Dunes National Recreation Area, U.S. Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and Oregon Parks and Recreation Department.
- Lauten, D.J., K.A. Castelein, E.P. Gaines, and M.A. Stern. 2004. The efficacy of nest exclosures for the Western Snowy Plovers (*Charadrius alexandrinus nivosus*) on the Oregon Coast, 1990-2003. Unpublished report for U.S. Fish and Wildlife Service, Newport, OR.
- Lauten, D.J., Kathleen A. Castelein, Susan Weston, Krista Eucken, and Eleanor P. Gaines. 2006. The Distribution and Reproductive Success of the Western Snowy Plover Along the Oregon Coast – 2006. Oregon Natural Heritage Information Center, Portland, Oregon.
- Lauten, D.J., Kathleen A. Castelein, Susan Weston, Krista Eucken, and Eleanor P. Gaines. 2007. The Distribution and Reproductive Success of the Western Snowy Plover Along the Oregon Coast – 2007. Oregon Natural Heritage Information Center, Portland, Oregon.
- Lauten, D.J., Kathleen A. Castelein, David C. Bailey, Travis Lewis, and Eleanor P. Gaines. 2008. The Distribution and Reproductive Success of the Western Snowy Plover Along the Oregon Coast – 2008. Oregon Natural Heritage Information Center, Portland, Oregon.
- Mayfield, H. 1961. Nesting success calculated from exposure. *Wilson Bulletin* 73:255-261.
- Mayfield, H. 1975. Suggestions for calculating nest success. *Wilson Bulletin* 87:456-466.
- Nur, N., G.W. Page, and L.E. Stenzel. 1999. Population viability analysis for Pacific Coast Snowy Plovers. Point Reyes Bird Observatory, Stinson Beach, California.
- Page, G.W., J.S. Warriner, J.C. Warriner, and P.W.C. Paton. 1995. Snowy Plover (*Charadrius alexandrinus*). In *The Birds of North America*, No. 154 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.
- Pearson, S.F., C. Sundstrom, K. Brennan, and M. Fernandez. 2007. Snowy Plover Distribution, Abundance and Reproductive Success: 2006 Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia.

- Pearson, S.F., K. Brennan, C. Sundstrom, and K. Gunther. 2008. Snowy Plover Population Monitoring, Research, and Management Actions: 2007 Nesting Season Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia.
- Ruhlen, T.D., A. Abbot, L.E. Stenzel, and G.W. Page. 2003. Evidence that human disturbance reduces Snowy Plover chick survival. *Journal of Field Ornithology* 74:300-304.
- Schultz, R. and M. Stock. 1993. Kentish plovers and tourists: competitors on sandy coasts? *Wader Study Group Bulletin* 68:83-91.
- U.S. Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*). Sacramento, California. xiv + 751 pages.
- Warriner, J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating system and reproductive success of a small population of polygamous Snowy Plovers. *Wilson Bulletin* 98:15-37.
- Washington Department of Fish and Wildlife. 1995. Washington State recovery plan for the Snowy Plover. Olympia, Washington. 87pp.
- Wiedemann, A. M. 1984. The ecology of Pacific Northwest coastal sand dunes: A community profile. U.S. Fish and Wildlife Service. FWS-OBS-84-04. 130 pp.

APPENDIX I

Leadbetter Point, U.S. Fish and Wildlife Service Refuge lands



Note: The U.S. Fish and Wildlife Service habitat restoration area (HRA) at Leadbetter Point is the area in purple, yellow and pink along the beach edge (Purple = areas where oystershell was added, Yellow = HRA size in 2007, Pink = addition to HRA in 2008). Although not pictured, oystershell was also applied to the area of the HRA where the northern cluster of HRA nests occurred – all nests occurred in areas with oystershell. Black circles represent locations of Snowy Plover nests in 2008. All of the orthographic photos were taken in 2006.

Leadbetter Point, State Park lands south of the U.S. Fish and Wildlife Service Refuge



The Washington Department of Fish and Wildlife and Washington State Parks Habitat Restoration Areas on Leadbetter State Park are the four small areas in coral. The black circle represent the location of a Snowy Plover nest on State Park lands in 2008.

Midway Beach and Graveyard Spit (Shoalwater Indian Reservation)



Black circles represent locations of Snowy Plover nests in 2008.

Islands in Willapa Bay surveyed by U.S. Fish and Wildlife and Washington Department of Fish and Wildlife Biologists during the 2008 nesting season. No plovers were observed.

