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# Washington State Snowy Plover Population Monitoring, Research, and Management: 2009 Nesting Season Research Progress Report

By Scott F. Pearson, Cyndie Sundstrom, William Ritchie, and Kathryn Gunther



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Washington Department of Fish and Wildlife
Wildlife Science Division

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

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December 2009

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# OVERVIEW

During the 2009 Western Snowy Plover (*Charadrius alexandrinus nivosus*) nesting season, we monitored breeding phenology, nest success, fledging success and the number of nesting adult plovers in Washington. Field monitoring and research was conducted primarily by Kathryn Gunther, William Ritchie and Cyndie Sundstrom with assistance from Marie Fernandez, Max Zahn, Warren Michaelis, Scott Pearson, and Steve Spencer. Volunteers assisting with window, occupancy and adult surveys included: Ann Musché, Alan Richards, Tom Finn, Mike Elledge,Vicki Elledge, Russ Geh, Nathalie Hamel, Don McIvor, Randy Robinson, Mary Ann Spahr, Jan Strong, Susan Clark, and Darrel Hopkins**.** A summary of some of our 2009 activities and results:

Breeding Phenology

- Clutches were initiated between 10 April and 13 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 14 June and the last chick known to fledge, fledged around 1 September.

Breeding Range

- Conducted 38 surveys on 21 sites to either assess occupancy or to count the number of nesting adults
- Snowy Plovers nested on Leadbetter and Midway Beach. Plovers did not nest on recently occupied sites or surrounding areas (Graveyard Spit and Damon Point) and there was no evidence of plover presence on other areas surveyed.

Number of Breeding Adults

- The mean 2009 Washington breeding adult population was 35 (95% Confidence interval: 26-44). All of the breeding adults observed were found on Leadbetter Point and Midway/Grayland Beach. Staff and volunteer surveyors conducted surveys with volunteers contributing approximately 144 hours to survey efforts.
- The Washington population is declining by approximately 8 birds per year over the past four years ($p = 0.0005$), and has declined from four nesting sites to two.

Nest success

- Forty-one nests were discovered and monitored.
- The percent of nests that survived from egg laying through hatching during the 2009 nesting season was 30% which is about 5% lower than the previous two seasons.
- As in past years, the primary sources of nest failure were predation (primarily by crows and ravens), nests buried by drifting sand, and abandonment. At least one nest was destroyed by humans.

Fledging Success

- The average number of young fledged per adult male on two nesting sites in Washington was 0.71 (95% Confidence interval: 0.55-0.96). Population viability analyses indicate that at least one young must fledge per adult male on average to have a stable population. As in past years, our results indicate that the Washington population should be declining which is consistent with trends in adult population estimates (8% decline per year/4 years).

Management Actions

- *Education:* Washington Department of Fish and Wildlife presented a program on Snowy Plovers at the Seattle Aquarium in 2009 and presented other programs that discussed snowy plovers to several organizations. In addition, Refuge and WDFW biologists conduct opportunistic outreach with

visitors while working on the beaches. The Refuge also conducts outreach through their Friends group.

- *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*: 18 nests were exclosed on the Wildlife Refuge at Leadbetter, and no 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*: The U.S. Fish and Wildlife Service habitat restoration area at Leadbetter Point is 121 acres and oyster shell has been added to 54 of the 121. Restoration and maintenance activities conducted in 2009 included: 1) Maintaining the 121 acre restoration area mechanically and through the use of herbicide; 2) Cuts in the high foredune were widened to at least 24 feet, and alleyways were cleared to the bare sand beach. Cuts were disked and compacted in an attempt to better control non-native beachgrass; 3) In September 2009 an additional 63 acres were treated with an aerial herbicide application including the primary foredune and a portion of the outer beach west of the foredune; 4) oyster shell was added to 8.65 acres of the restoration area to provide camouflage for ground nesting birds and to reduce blowing sand. The Leadbetter habitat restoration area supports the only known population of pink sand verbena (*Abronia umbellata*) in Washington State; a plant species that was thought to be extirpated in the state until its rediscovery in 2006. Pink sand verbena seed was collected and broadcast in transects within the restoration area and on the outer beach. Pink sand verbena seeds will be collected and broadcast and/or propagated, and additional seed will be placed in long term seed storage at the Berry Botanical Garden for conservation. A collaborative partnership has begun with the Shoalwater Bay Tribe to propagate additional pink sand verbena plants.
- Five experimental plot openings approximately 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 in 2009) and initial treatments to control non-native beachgrasses were conducted by Washington Department of Fish and Wildlife. Pre-treatment vegetation data was collected in the summer of 2007, the first treatment occurred in October 2007 and the second treatment occurred in Sept.-October 2008. Expansion of plots to add approximately 2-3 additional acres, and a third herbicide treatment is planned for November 2009. Treatement 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 2009. One to three plover access cuts to the beach were bulldozed in each plot. Post treatment vegetation data was collected in August 2009, and data will be summarized during winter 2009-2010. No plover or lark use was found during four surveys in summer 2009.

Recommendations

- Summarize, write-up and publish population monitoring results from Oregon, Washington, and northern California.
- Estimate survival (chick and adult) using banded bird re-sights
- Continue to examine the effectiveness of habitat restoration areas
- Identify the conditions where plover populations are more likely to 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 engage volunteers in monitoring.

- Continue to link management activities with research and monitoring.
- Continue to evaluate the effectiveness and continued use of nest exclosures.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- Expand education and outreach activities by working with organizations that actively engage volunteers in beach monitoring like COASST.

# 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 nest 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, three nesting sites were occupied, Leadbetter Point, Midway Beach (Grayland vicinity), and Graveyard Spit. However, because of the very close proximity of Graveyard Spit to Midway/Grayland Beach, this could be considered one site. During the 2009 nesting season, only Leadbetter Point and Midway Beach (Grayland vicinity) were occupied.

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.

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 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 plover populations such as the use of wire nest exclosures 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 is coordinating its monitoring efforts with U.S. Fish and Wildlife Service, and Oregon Department of Fish and Wildlife. This coordinated effort was initiated in 2006.

The primary objectives of our monitoring for the 2009 nesting season were:

- Conduct the U.S. Fish and Wildlife Service facilitated winter window surveys.
- Conduct the U.S. Fish and Wildlife Service facilitated 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 adult breeding plover population size estimates for Washington.
- Attempt to increase nest success through habitat restoration efforts, the use of nest exclosures and by restricting human activities on 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, three sites were occupied by breeding plovers, Leadbetter Point, Graveyard Spit, and Midway Beach. During the 2009 nesting season plovers nested at two sites, Leadbetter Point 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 2009. 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. 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 salt marsh 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 2009 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 2009, the window survey occurred the week of 17 May. For this survey, 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. Although not considered part of the formal window survey, during this same week we also surveyed the stretch of beach from Ocean City (2nd Ave.) south to just north of the North Jetty (S of Taurus Blvd), in Ocean Shores

For the sites that were previously occupied by plovers but were thought to be unoccupied at the beginning of the 2009 field season (Damon Point, Connor Creek and Copalis Spit), an experienced biologist surveyed appropriate habitat on foot. We did not conduct a driving survey of the south Long Beach Peninsula during the breeding window week because of inappropriate weather conditions. This stretch was driven on two occasions later in the season.

More effort was devoted to surveying occupied sites than unoccupied sites because we were attempting to determine population size at occupied sties and site occupancy at unoccupied 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, one or two observers 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 the southern end 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 and 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. See Elliot-Smith and Haig (2006a) for details of the survey methods used.

**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 or 2 | 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 2009, the window survey occurred from 6-12 January when we surveyed Connor Creek, Copalis Spit, Damon Point, Midway/Grayland Beach, 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 and where we have failed 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 an 87% - 99% probability of correctly determining site occupancy. We conducted repeated visits to Damon Point to assess occupancy during the 2009 nesting season.

### *Occupancy surveys with only 1 or 2 visits*

We visited several sites that were previously occupied or with suitable nesting habitat between 15 April and 14 August to informally assess occupancy and look for banded plovers: South Benson Beach to North Benson Beach (n = 1), Moclips to Pacific Beach (n = 1), Pacific Beach to Copalis River (n = 1), Copalis Spit (n = 2 visits), Connor Creek (n = 2 visits), Ocean Shores North Jetty area (n = 2 visits), and Long Beach Peninsula south of Oysterville Road (n = 2 driving surveys). We also visited three islands in Willapa Bay during the first week of June (n = 1 visit each: Appendix I) to look for nesting plovers, and three islands in Grays Harbor during the first week of July (n = 1 visit each; Appendix I).

### *Estimating Number of Adult Plovers*

All occupied sites (Leadbetter Point, Midway Beach) and recently occupied sites (Damon Point and Graveyard Spit) were surveyed four to five times between 20 April and 1 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 2009 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 0.10 and the average proportion of missed birds per survey was 0.22. 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 (= 1.12) by the number of birds detected per survey.

We derived population estimates for the nesting sites based on counts conducted during four survey windows (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. In the Results, we present the mean of these four surveys and the 95% confidence intervals. 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 roughly rectangular in shape. Transects were established through the center of the long access of each restoration and control site. Each transect at each site was visited 6 times between 15 April and 11 September, 2009. 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 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.

## *Nest success*

Leadbetter Point and Midway Beach were visited several times a week to search for and monitor Snowy Plover nests from April 1 until August 18, 2009. Searching was conducted both during adult surveys and during frequent visits to the nesting sites. Nests were located in many 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 adults 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 place 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 capable of sustained flight until 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 both 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 and determining their fate. To help us identify and follow individual 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 known egg laying dates. Regardless of the method used to estimate hatch dates, we checked nests daily or every other day around predicted hatching dates. For unbanded chicks, we 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 13 out of 18 nests that hatched at least one egg, 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 date when a banded adult male accompanied chicks that allowed us to accurately assign the chicks to a specific nest. 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 Unit has approximately 1 m accuracy with post-processing and the Garmin has approximately 15 m accuracy. Nest site habitat data were also collected and will be analyzed in late 2010 or early 2011.

## Banding

To help us estimate fledging success in 2009 we banded 27 chicks from 13 nests. Chicks were banded on the nest or very near the nest and usually on their hatch date. 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 2009 breeding window survey, which was the same as 2008, lower than the 2006 and 2007 counts (Table 3), and higher than all other breeding window surveys since 1998. However, 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 four season's 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 2009.**

| Site | 2005 | 2006 | 2007 | 2008 | 2009 | 2009 Survey Dates | 2009 Adult Males | 2009 Adult Females | 2009 Adult Unknown |
|---|---|---|---|---|---|---|---|---|---|
| Copalis Spit | - | 0 | 0 | 0 | 0 | 21 May | 0 | 0 | 0 |
| Conner Creek | - | 0 | 0 | 0 | 0 | 21 May | 0 | 0 | 0 |
| Damon Point | 5 | 0 | 0 | 0 | 0 | 20 May | 0 | 0 | 0 |
| Graveyard | - | - | 0 | 1 | 0 | 22 May | 0 | 0 | 0 |
| Midway Beach | 23 | 25 | 22 | 12 | 16 | 19 May | 8 | 7 | 1 |
| Leadbetter Point | 9 | 42 | 28 | 29 | 26 | 18 May | 13 | 8 | 5 |
| South Long Beach | - | 0 | 0 | 0 | 0 | 18 May | 0 | 0 | 0 |
| Total | 37 | 67 | 50 | 42 | 42 | | 21 | 15 | 6 |

## *Winter Window Survey*

Nineteen adult plovers were detected on two sites during the January 2009 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 2009.**

| Site | 2006-2007 Total Count | 2007-2008 Total Count | 2008-2009 Total Count | 2008-2009 Survey Dates | 2008-2009 Adult Males | 2008-2009 Adult Females | 2008-2009 Adult Unknown |
|---|---|---|---|---|---|---|---|
| Copalis Spit | 0 | 0 | 0 | 12 Jan | 0 | 0 | 0 |
| Conner Creek | 0 | 0 | 0 | 12 Jan | 0 | 0 | 0 |
| Damon Point | 0 | 0 | 0 | 10 Jan | 0 | 0 | 0 |
| Graveyard | 0 | - | - | - | - | - | - |
| Midway Beach | 21 | 15 | 10 | 9 Jan | 4 | 3 | 3 |
| Leadbetter Point | 17 | 14 | 9 | 6 Jan | 5 | 1 | 3 |
| S. Long Beach | - | - | - | - | - | - | - |
| Total | 38 | 29 | 19 | | 9 | 4 | 6 |

## *Adult Surveys*

As indicated in Table 5 we conducted 44 surveys at 18 sites between 15 April and 11 September 2009.

**Table 5. Snowy Plover survey dates, number of surveys and surveyors and type of survey by site during the 2009 nesting season**

| Site | Type of Survey | # Surveys | # Surveyors | Walking or Driving | Survey Dates |
|---|---|---|---|---|---|
| Damon Point | Occupancy/Window | 5 | 1-2 | Foot | 4/22, 5/20, 6/04, 6/26, 7/01 |
| Midway | Breeding Adult/ Window | 5 | 3 | Foot | 4/20, 5/04, 5/19, 6/01, 6/15 |
| Graveyard | Breeding Adult/ Window | 6 | 2 | Foot | 4/24, 5/08, 5/22, 6/08, 6/26, 7/22 |
| Leadbetter | Breeding Adult/ Window | 4 | 6-7 | Foot | 4/21, 5/18, 6/02, 6/16 |
| Moclips to Pacific Beach | Opportunistic | 1 | 1 | Drive | 8/14 |
| Pacific Beach to Copalis River | Opportunistic | 1 | 1 | Drive | 8/14 |
| Connor Creek | Opportunistic/ Window | 2 | 1 | Foot, Drive | 5/21, 8/14 |
| Copalis | Window | 2 | 1 | Foot | 5/21, 8/14 |
| Ocean Shores/North Jetty | Opportunistic | 2 | 1 | Drive | 5/21, 8/14 |
| Misc. Long Beach | Opportunistic | 3 | 1 | Drive | 4/16, 6/26, 8/14 |
| Cranberry Bch Rd. to Ocean Park | Opportunistic | 1 | 1 | Drive | 7/6 |
| State restoration sites | Research | 6 | 1-3 | Foot | 4/15, 5/7, 5/27, 6/11, 7/7, 9/11 |
| Gunpowder Island Willapa Bay | Opportunistic | 1 | 3 | Foot | 6/4 |
| Snag Island, Willapa Bay | Opportunistic | 1 | 3 | Foot | 6/4 |
| Un-named island, Willapa Bay | Opportunistic | 1 | 3 | Foot | 6/4 |
| E. Sand Island, Grays Harbor | Opportunistic | 1 | 2 | Foot | 7/9 |
| W. Sand Island, Grays Harbor | Opportunistic | 1 | 2 | Foot | 7/9 |
| Whitcomb Flats, Grays Harbor | Opportunistic | 1 | 2 | Foot | 7/9 |

Our goal was to determine plover presence-absence at Damon Point and we surveyed this site 5 times this season. At 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), islands in Willapa Bay and Grays Harbor, Westhaven State Park and the Ocean Shores area, and surveys in the area of Moclips and Pacific Beach (Table 4; Appendix I).

### *Site occupancy*

Because Damon Point was very recently occupied by nesting birds, we conducted five surveys during the 2009 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, an 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 Long Beach (south of Oysterville Road), islands in Willapa Bay and Grays Harbor, Westhaven State Park and the Ocean Shores area, and surveys in the area of Moclips and Pacific Beach (Table 4; Appendix I).

## *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.

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 and May and continue to depart (or die) throughout the season. For males, the pattern is similar to that exhibited by females (Figure 1) except there are few departures until the end of the nesting season. 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 due to these population fluctuations. Although not captured in Figure 1, there is also an increase in the number of plovers associated with the addition of locally hatched chicks to our nesting sites starting primarily in late June. Juveniles from locations south of Washington don't arrive in August or later.

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 (average resights per day) between the sexes (Figure 2). This result and nearly identical result in 2006, 2007, and 2008 indicates that there is no need to adjust counts for differences in detectability between males and females.

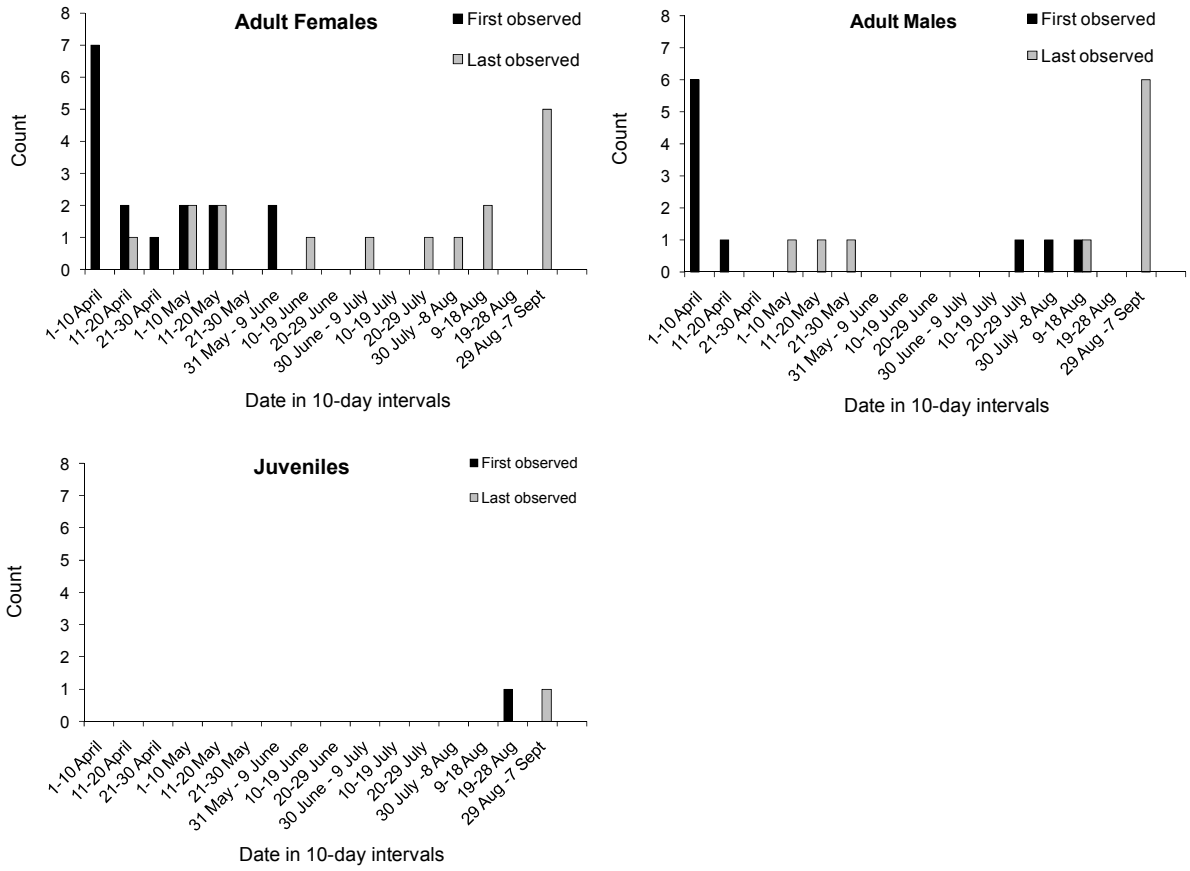


**Figure 1. Dates banded female, male, and juvenile Snowy Plovers were first and last detected on Midway Beach and Leadbetter Point combined in 2009. Juveniles only include birds banded outside of Washington and observed in Washington.**

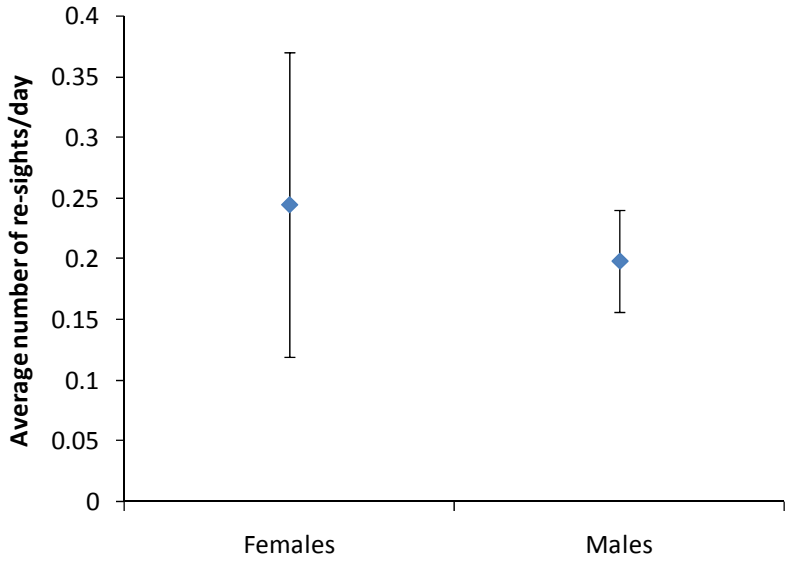


**Figure 2. Average number of re-sights per banded adult female (n = 16) and male (n = 9) Snowy Plovers per day (± SD) during the 2009 nesting season.**

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 conducted 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 4 surveys from pre-determined weeks between 20 April and 16 June to estimate the breeding adult population (Figure 3, Table 6). Adult population counts are declining for the 2006-2009 period (Table 6, Figure 3).

**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, 2008, and 2009.**

| | 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) |
| 2009 Adjusted Counts | 0 | 16 (14-19) | 0 | 19 (11-27) | 35 (26-44) |

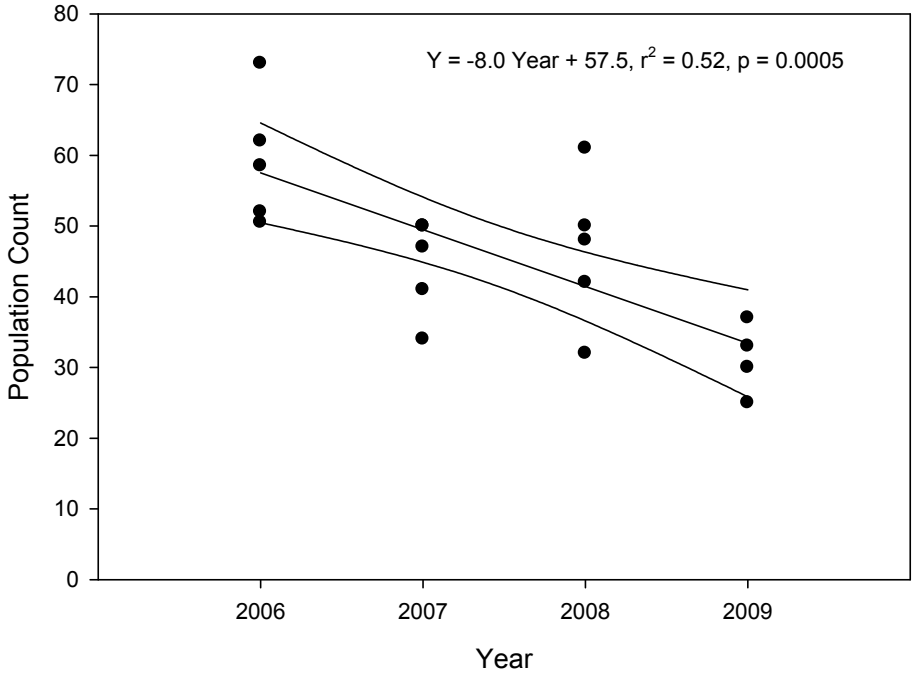


**Figure 3. Washington adult plover population trend (95% CI) from 2006 – 2009 using unadjusted counts. The trend is almost identical for adjusted counts (Y = -8.2 bird per year + 62.9, $r^2$ = 0.46, p = 0.001).**

### *State Park Habitat Restoration Area Surveys*

Six surveys of treatment and control plots were conducted in 2009 and no Snowy Plovers or Streaked Horned Larks were detected. Volunteers contributed approximately 144 hours to this survey effort and to measuring the vegetation response to treatments.

## *Clutch Initiation Dates and Breeding Phenology*

Clutches were initiated between 10 April and 13 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 14 June and the last chick known to fledge, fledged around 1 September (Figure 5B).

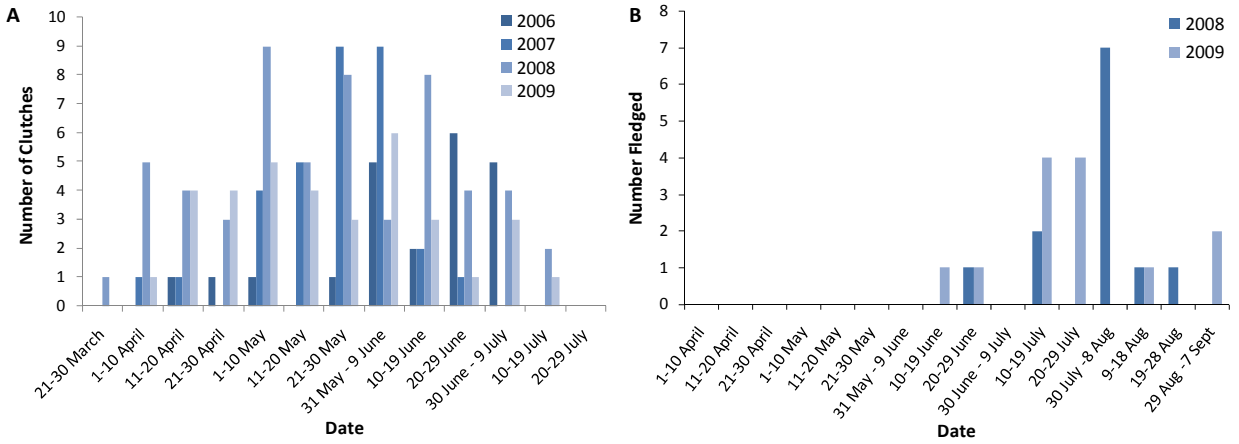


**Figure 4. Number of Snowy Plover clutches initiated in 2006, 2007, 2008, and 2009 (A) and number of chicks fledged (B) in 2008 and 2009 in 10-day intervals for all Washington nesting sites combined.**

Scrape building and territory defense occurs prior to egg laying consequently, the active nesting season occurred between mid-March and early September in 2009. In Figure 4, we present the number of clutches initiated and number of chicks fledged 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 and most chicks fledged in July and early August. Looking at all years combined, the nesting season starts in late March and continues through early September.

## *Nest success*

We located and monitored the outcome of 41 plover nests in 2009. We know that at least one nest went undiscovered because fledglings from an undiscovered nest were observed on the beach. Undiscovered nests are not included in nest success analyses because they bias estimates upward (there were likely undiscovered failed nests also). Of these 41 nests, 23 were located at Leadbetter and 18 at Midway Beach (Table 7). For a map of nest locations see Appendix I. Seventeen of these nests hatched. For nests that failed to hatch, predation was the primary source of nest failure (58%). Corvids were the only identified predator and both American Crows (*Corvus brachyrhynchos*)/Northwestern Crow (*Corvus Caurinus*); Table 8) and Common Ravens (*Corvus corax*) depredated nests. Again this year, drifting sand was a significant source of nest failure (25%; Table 8). Three nests were abandoned and one was crushed by humans.

**Table 7. Nest outcomes by Snowy Plover nesting locality in 2009. Outcomes include successful (hatched), failed or unknown outcome.**

| Site | | Outcome | | |
|---|---|---|---|---|
| | # Nests | Hatch | Fail | Unknown |
| Midway | 18 | 5 | 13 | 0 |
| Leadbetter | 23 | 12 | 11 | 0 |
| Exclosed[1] | 18 | 12 | 6 | 0 |
| Not exclosed | 23 | 5 | 18 | 0 |
| Totals | 41 | 17 | 24 | 0 |

[1]Exclosures were only used at Leadbetter

**Table 8. Sources of Snowy Plover nest failure in 2009. Sources of failure include predators (American/Northwest Crows, Common Ravens, unknown Corvid, or Unknown predator) eating eggs or other sources of failure including Human activities, drifting Sand covering the nest, Abandoned nests and Unknown sources of failure.**

| Site | Failures | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Predator | | | | | Other Sources | | | |
| | Crow | Raven | Corvid | Coyote | Unknown | Human | Sand | Abandon | Unknown |
| Midway | 2 | 2 | 2 | 0 | 2 | 1 | 4 | 0 | 0 |
| Leadbetter | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 3 | 0 |
| Exclosed | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 3 | 0 |
| Not exclosed | 2 | 2 | 2 | 0 | 6 | 1 | 5 | 0 | 0 |
| Totals | 2 | 2 | 3 | 0 | 7 | 1 | 6 | 3 | 0 |

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 2009 nesting season and compare to the previous nesting seasons. The probability of nest survivorship was 15% at Midway and Graveyard combined and 43% at Leadbetter. This difference in nest success is the result of exclosing most of the nests at Leadbetter and none of the nests at Midway. The probability of nest survivorship of unexclosed nests was only 9% (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 2009. Eighteen Leadbetter nests were exclosed and five were unexclosed.**

| Site | Daily Survival Probability | Nest Survival |
|---|---|---|
| Midway | 0.94 | 0.15 |
| Leadbetter | 0.97 | 0.43 |
| Midway exclosed | - | - |
| Midway unexclosed | 0.94 | 0.15 |
| Washington exclosed | 0.99 | 0.63 |
| Washington unexclosed | 0.93 | 0.09 |
| Washington Total (including exclosures) | 0.96 | 0.30 |

**Table 10. Mayfield estimates of nest survival by site from 2006 - 2009. Almost all nests (79-93%) were exclosed at Leadbetter in 2007- 2009, and 33%, 39% and 0% were exclosed Midway in 2007, 2008, and 2009 respectively.**

| Site | Nest Survival 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| Midway and Graveyard | 0.23 | 0.28 | 0.25 | 0.15 |
| Leadbetter | 0.26 | 0.51 | 0.54 | 0.43 |
| Washington Total (including exclosures) | 0.25 | 0.37 | 0.36 | 0.30 |

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, Pearson et al. 2009, see discussion below).

## *Evaluating Nest Exclosures*

Nest exlosures are wire cages placed around plover nests and are designed to exclude potential nest predators – particularly larger mammals and avian predators. We first evaluate Washington's exclosure data and make recommendations for future use. We then used the published literature and 1 unpublished report to evaluate the effectiveness of exclosures.

### *Washington Results*

Exclosed nests survive better than unexclosed nests as indicated by differences in average daily survival probability and nest survival (Table 11). These results are consistent with nearly all other studies of nest exclosures (see below). In contrast, the number chicks fledged per nest and the proportion of hatchlings that survive to fledging is higher from unexclosed nests (Table 11).

**Table 11. Average daily survival probability (DSP), average nest survival, average number of chicks fledged per nest and the proportion of hatchlings that fledge for exclosed and unexclosed nests from 2007-2009.**

| | Sample Size | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | Ave. DSP (SE) | Ave. Nest Survival (SE) | Ave. Number Fledged/nest that hatched (SE) | Proportion of hatchlings that fledge (SE) |
| Exclosed | 25 | 38 | 18 | 0.975 (0.007) | 0.563 (0.032) | 0.177 (0.118) | 0.213 (0.085) |
| Unexclosed | 18 | 15 | 23 | 0.930 (0.006) | 0.103 (0.021) | 0.340 (0.124) | 0.583 (0.083) |

However, the use of nest exclosures was implemented as a management action and not with the goal of researching the effectiveness of nest exclosures. Answering this research question requires both temporal and spatial controls. With this in mind, there is no evidence of temporal bias associated with the data collected – the distribution of nest initiation (clutch initiation) is nearly identical for exclosed and unexclosed nests. However, there is a significant source of spatial bias, which confounds the interpretation of these results. Nests were exclosed on both Leadbetter Point and Midway/Graveyard but a greater percent of the nests were exclosed on Leadbetter (78-93% per year) than on Midway/Grayland (0-39% per year). In addition, no unexclosed nests included in this analysis at Leadbetter hatched and 90% of the exclosed nests that hatched were located at Leadbetter. As a result, the difference in fledging success between unexclosed and exclosed nests is very likely a difference in chick survival between the two sites that has nothing to do with exclosures. Because of this small and unbalanced sample size by site, there is no way to address this

issue statistically. In the future, we strongly recommend using proper temporal and spatial controls, if evaluating the effectiveness of exclosures on fledging success is an important research question.

## *Literature Review*

To assess the effectiveness of nest exclosures, we reviewed 15 published manuscripts that evaluated the effects of nest exclosures on nest success and other response variables (see Literature Cited). In addition, we included one unpublished report (Lauten et al. 2003) and unpublished monitoring data from Washington (above). Eight different shorebird species were included in these studies but the majority of the studies were focused on the Piping Plover (*C. melodus*), Snowy Plover and Killdeer (*C. vociferous*).

- Nest survival of exclosed nests was significantly higher in 10 studies and there was no difference in 2 studies (See Appendix II)
- Exclosed nests appear to be only vulnerable to reptilian and small mammal predators while unexclosed nests are vulnerable to predators of all sizes (Mabee and Estelle 2000).
- No difference in fledging success between exclosed and unexclosed nests in 4 studies and higher fledging success for exclosed nests in 2 studies (See Appendix II). There was no difference in fledging success between exclosed and unexclosed nests for all studies involving snowy plovers (See Appendix II).
- Adult mortality associated with exclosures was reported in 6 of the 8 studies that included or mentioned this response variable (See Appendix II). Only 3 studies compared adult mortality between exclosed and unexclosed nests and 2 reported significant increases in adult mortality associated with exclosures and 1 reported no difference (See Appendix II).
- Adult mortality appears to be largely attributable to raptors and appears to be episodic (Murphy et al. 2003, Neuman et a. 2004, Hardy and Colwell 2008) and differs among habitats (Murphy et al. 2003).
- Larson et al. 2002 examined the effect of exclosures on population growth for piping plovers and found the effect to be positive.
- Abandonment was higher for exclosed nests in 2 studies where this was compared directly (Isaksson et al., 2007, Hardy and Colwell 2008).
- Abandonment was not associated with the construction process, size, shape, mesh size and fence height (Vaske et al. 1994). Covered exclosures are more likely to be abandoned than uncovered exclosures (Vaske et al. 1994).
- Exclosures increased incubation length by 1 day but did not influence chick condition (Isaksson et al. 2007).
- Egg hatchability was higher in 3 studies (Melvin et al. 1992, Isaksson et al. 2007, Pauliny et al. 2008) but no difference was observed in one study (Hardy and Colwell 2008).
- Breeding adults may receive false messages regarding site quality and encouragement to continue to breed in sink habitats (Hardy and Colwell 2008). This is an important research question that should be examined but no data support this contention.

Given these results and our observations in Washington, we recommend the following:

- Any use of exclosures should be accompanied by close monitoring to evaluate their effectiveness (Hardy and Colwell 2008) and to detect adult plover predators early (Pauliny et al. 2008).
- Because adult predation associated with exclosures is largely episodic we recommend early detection and once adult predation is observed, we recommend that managers discontinue their use for the season and remove existing exclosures.
- If raptors, especially falcons, are present early in the spring managers may want to delay the date of first exclosure use in the spring until raptor numbers are reduced to reduce predation rates (Lauten et al. 2003). This is the approach currently used in Oregon and Washington.

- If there is no overall increase in fledging rates (needed for a population response) associated with the use of exclosures, then managers may want to reconsider their strategy to improve nest and chick survival to include predator control and consider the value of continued nest exclosure use.
- Because researchers have reported no significant difference between type of exclosure and effectiveness in reducing nesting success (Lauten et al. 2003) or reducing abandonment rates (Vaske et al. 1994) we do not recommend the use of any specific type of exclosure.

## *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. 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.

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 14 chicks should have fledged from the nests that successfully hatched at both sites combined. Using direct observations of fledglings on the beach, we estimated that 12 or 13 chicks fledged in 2009. 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 0.71 (95% CI = 0.55-0.96). This estimate suggests that the plover population on these sites should be declining and is therefore not being maintained by local production (see Nur et al. 1999). This result is consistent with Washington's population trend.

**Table 12. Estimated number of males (rounded values) and observed numbers of fledglings by site in 2007-2009.**

| | 2007 Ave. number of males | 2007 Number of fledglings observed | 2008 Ave. number of males | 2008 Number of fledglings observed | 2009 Ave. number of males | 2009 Number of fledglings observed |
|---|---|---|---|---|---|---|
| Leadbetter | 14 | 9 | 19 | 6 | 9.5 | 4-5 |
| Midway & Graveyard | 11 | 13 | 9 | 6 or 7* | 8.5 | 8 |
| Washington total | 25 | 25 | 27 | 12 or 13 | 18 | 12 or 13 |

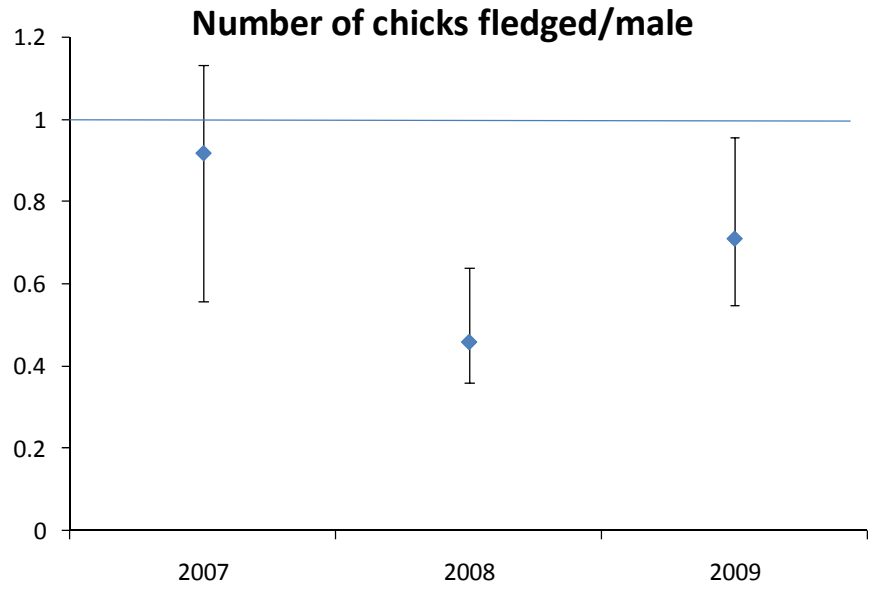


**Figure 5. Number of Snowy Plover chicks fledged per adult male from 2007-2009 for all Washington nesting sites combined. Population modeling indicates that one chick fledged per male is needed on average to maintain a stable population.**

The population decline in Washington would likely be greater without immigration. The number of banded adult birds detected on our adult population surveys at Leadbetter and Midway averaged 59% and 35% respectively in 2008 and 40% and 44% respectively in 2009 and very few of these banded birds were banded in Washington indicating that birds are moving into Washington. The immigration of Oregon birds into Washington is likely the result of Oregon's increasing plover population and high fledging success rate ( ≥ 1.0; Lauten et al. 2006, 2007, 2008, 2009). Indeed, most of the banded adults observed in Washington during the nesting season originated in Oregon.

## *Nest Locations*

2009 nest locations are presented by nesting site in Appendix I. At Midway Beach, birds nested in Grayland Beach State Park south to Washaway Beach. 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.

**Table 13. Number of nests discovered by location and year.**

| Location | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| USFWS Leadbetter Point –outer Beach | 13 | 3 | 8 | 3 |
| USFWS Leadbetter Point – Habitat Restoration Area | 16 | 17 | 20 | 20 |
| State Parks Leadbetter Point | 0 | 1 | 1 | 0 |
| Midway Beach | 29 | 22 | 25 | 18 |
| Shoalwater (Graveyard Spit) | 3 | 2 | 1 | 0 |
| Damon Point/Oyhut | 1 | 0 | 0 | 0 |
| Total | 62 | 45 | 56 | 41 |

## *Effectiveness of Habitat Restoration Areas*

There are two habitat restoration projects in Washington, both at Leadbetter Point. The US Fish and Wildlife Service initiated a restoration area in 2002 at Leadbetter by clearing one acre of non-native beachgrass (*Ammophila spp.*) using a bulldozer and followed this treatment with an herbicide application to surviving plants. Oyster shell has been added to portions of the restoration area to provide plover nests with cover and potentially protect nests from blowing sand (Brennan and Jaques 2002). The area was gradually increased in size over a 7-year period to its current 121 acres. Cuts were made in the foredune with a bulldozer to provide plovers walking access to the restoration area. Washington Departments of Fish and Wildlife and State Parks with funding from US Fish and Wildlife Service created 5 additional 1-acre openings on State Park land at Leadbetter Point. Again, these openings consist of areas scraped free of vegetation inside the foredune with access cuts to the beach that were created by bobcat, raking, and herbicide treatment.

**Table 14. 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 (See Brennan and Jaques 2002, Brennan 2003, and Brennan and Fernandez 2004 & 2006).**

| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| HRA Size | 1 | 8.7 | 16 | 40 | 63 | 84 | 121 | 121 |
| Acres covered in oyster shell | 4 small patches | 4 larger patches | 1 | 14 | 28 | 41.1 | 45 | 54 |
| Number of nests in the HRA | 1 | 2 | 3 | 22 | 16 | 17 | 20 | 20 |

Have the restoration areas been successful? The federal restoration area was successful in attracting nearly all of the Snowy Plover nesting activity at Leadbetter Point to the restoration area. Moreover, nearly all nests within the restoration area were found within areas where oyster shell was applied. This restoration area also successfully attracted nesting Streaked Horned Larks (State Endangered: approximately 8-10 territories in the HRA in 2009). In addition, two pink sand verbena plants (*Abronia umbellate*; State Endangered) were discovered in the restoration area in 2006, the first record of this species in over 50 years! Today, with active propagation by the Refuge, there are 1000s of pink sand verbena plants at Leadbetter. The state restorations have not yet attracted nesting plovers or larks.

Despite this success, the relationship between the size of the federal restoration area and the number of plover nests discovered within this area suggest that plovers are not habitat limited at Leadbetter Point (Figure 6). The number of nests within the restoration area initially increased as the size of the area increased but quickly reached a peak at around 20 nests despite the continued enlargement of the restoration area. This conclusion is further emphasized by the lack of use of the state habitat restoration areas by plovers in 2008 or 2009.

However, the Willapa National Wildlife Refuge is currently writing a Comprehensive Conservation Plan and Environmental Impact Statement for the Refuge lands. Two of the management alternatives proposed in this plan include some form of plover predator management. After implementing predator management in Oregon, the State's plover population has experienced an increasing population trend for the first time and unlike the years prior to predator management, fledging success has been above 1.0 chicks fledged per male for each year. If Willapa National Wildlife Refuge implements predator management at Leadbetter and the plover population increases, then the restored and apparently suitable habitat at Leadbetter will be needed by the growing population.

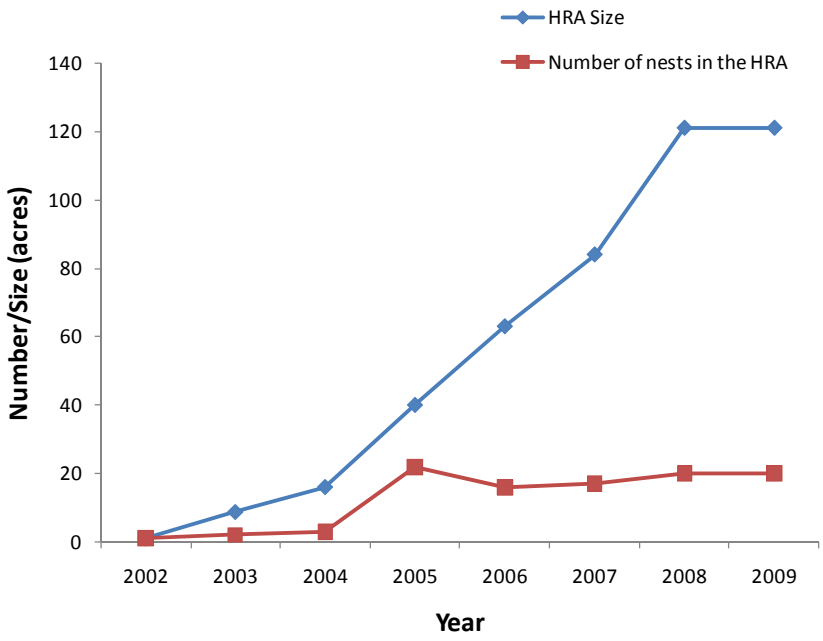


**Figure 6. Relationship between the Habitat Restoration Area at Leadbetter Point and the number of Snowy Plover nests discovered within the restoration area between 2002 and 2009.**

# PROGRESS ON RECOVERY OBJECTIVES

Federal Recovery Objectives:

*Objective 1: 250 breeding adults in Recovery Unit 1.*

The 2009 Washington nesting population was 35 (95% CI = 26-44) and the 2009 Oregon nesting population was 149-150 (Lauten et al. in prep.) for a total of 184.5 (range = 175-194) nesting adult plovers in Recovery Unit 1. In 2007 and 2008, the nesting adult population in Recovery Unit 1 was 210 and 183 respectively.

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

In 2009, the average number of young fledged per adult male in Washington was 0.71 (95% CI = 0.55-0.96). The number of young fledged per adult male in Oregon was 1.37 in 2009 (Lauten et al. in prep). We combined the Oregon and Washington estimates of the number of breeding adult males and the number of young fledged (n = 118-119) to derive a combined Unit 1 fledging success per male of 1.25 (95% CI = 1.18-1.32). The combined Unit 1 fledging success per male was 1.43 (95% CI = 1.37-1.50) in 2007 and 0.92 (95% CI = 0.85-1.01) in 2008. 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 35 (95% CI = 26-44) nesting adults in 2009 and approximately 50% of these birds are females and 50% are males. If all females are paired, these estimates indicate that there are approximately 17-18 pairs (95% CI = 13-22 pairs) in Washington in 2009. There were 27 pairs in 2008, 24 pairs in 2007 and 32 pairs in 2006. The average number of breeding pairs over these four years is approximately 25 pairs but note that the population is declining (see Figure 3 above).

*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 0.71 (95% CI = 0.55-0.96) in 2009, 0.46 (95% CI = 0.36-0.64) in 2008, and 0.91 (95% CI = 0.77 - 1.13) in 2007. The average fledging rate for these three years is 0.69. Currently plovers are nesting on two primary sites. One site is a National Wildlife Refuge while 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”.

# 2009 MANAGEMENT ACTIONS

A number of the management actions that occurred in 2009 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. There are two dog restriction signs at trail junctions and trailheads on Leadbetter Refuge lands and there is a "Share the Beach" sign posted 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. We recommend that symbolic fencing be added to trailhead #5 at Grayland Beach State Park and if nests are discovered adjacent to this trail, we recommending considering closing or re-routing this trail.
- 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 on this beach but was closed in 2009. As a result, there was much less disturbance to plovers in this area this season. Birds now nest on the old roadway and, as a result, opening this gate during the nesting season could result in the loss of plover nests.
- U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife biologists put nest exclosures around 18 nests on the Willapa National Wildlife Refuge. No nests were exclosed at Grayland Beach State Park in 2009 because they appeared to attract people to nests at this site and resulted in the apparent taking of plover eggs (both real and fake eggs) in 2008.
- 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.
- In 2009 there were 7 razor clam digs at Leadbetter (April 11,12,25,26,27 and May 9,10) and 8 at Midway/Grayland beach (April 10,11,12,25,26,27 and May 9,10) during the active nesting season. This was down from 10 and 15 respectively in 2008. 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.

## *Restoration*

- The U.S. Fish and Wildlife Service habitat restoration area at Leadbetter Point is 121 acres and oyster shell has been added to 54 of the 121. Restoration and maintenance activities conducted in 2009 included: 1) Maintaining the 121 acre restoration area mechanically and through the use of herbicide; 2) Cuts in the high foredune were widened to at least 24 feet, and alleyways were cleared to the bare sand beach. Cuts were disked and compacted in an attempt to better control non-native beachgrass; 3) In September 2009 an additional 63 acres were treated with an aerial herbicide application including the primary foredune and a portion of the outer beach west of the foredune; 4) oyster shell was added to 8.65 acres of the restoration area to provide camouflage for ground nesting birds and to reduce blowing sand. Treating and maintaining the restoration area is necessary to stop the advancement and narrowing of the outer beach by the colonization of non-native beachgrass. This activity will widen the bare sand potion of the outer beach, allowing additional habitat for nesting. The Leadbetter habitat restoration area supports the only known population of pink sand verbena (Abronia umbellata) in Washington State; a plant species that was thought to be extirpated in the state until its rediscovery in 2006. Pink sand verbena seed was collected and broadcast in transects within the restoration area and on the outer beach. Pink sand verbena seeds will be collected and broadcast and/or propagated, and additional seed will be placed in long term seed storage at the Berry Botanical Garden for conservation. A collaborative partnership has begun with the Shoalwater Bay Tribe to propagate additional pink sand verbena plants.

- Five experimental plot openings approximately 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 in 2009) and initial treatments to control non-native beachgrasses were conducted by Washington Department of Fish and Wildlife. Pre-treatment vegetation data was collected in the summer of 2007, the first treatment occurred in October 2007 and the second treatment occurred in Sept.-October 2008. Expansion of plots to add approximately 2-3 additional acres, and third herbicide treatment is planned for November 2009. Treatement 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 2009. One to three plover access cuts to the beach were bulldozed in each plot. Post treatment vegetation data was collected in August 2009, and data will be summarized during winter 2009-2010. No plover or lark use was found during four surveys in summer 2009.

## *Education*

- Washington Department of Fish and Wildlife presented a program on Snowy Plovers at the Seattle Aquarium in the 2009 and presented other programs that discussed snowy plovers to several organizations. In addition, Refuge and WDFW biologists conduct opportunistic outreach while working on the beaches and encountering visitors. The Refuge also conducts outreach through their Friends group.

# FUTURE RESEARCH & MONITORING CONSIDERATIONS

- Summarize, write-up and publish population monitoring results from Oregon, Washington, and northern California.
- Estimate survival (chick and adult) using banded bird re-sights
- Continue to examine the effectiveness of habitat restoration areas
- Identify the conditions where plover populations are more likely to 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 engage volunteers in monitoring.
- Continue to link management activities with research and monitoring.
- Continue to evaluate the effectiveness and continued use of nest exclosures.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- Initiate education and outreach activities.

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Max Zahn and Warren Michaelis from Washington Department of Fish and Wildlife, Marie Fernandez from U.S. Fish and Wildlife Service, Steve Spencer from the Shoalwater Tribe, and volunteers Vicki and Mike Elledge and Deborah Jaques conducted adult population surveys. State Park Ranger Darrel Hopkins assisted with Winter Window surveys. Volunteers assisting with window, occupancy and adult surveys included: Ann Musché, Alan Richards, Tom Finn, Mike Elledge, Vicki Elledge, Russ Geh, Nathalie Hamel, Don McIvor, Randy Robinson, Mary Ann Spahr, Jan Strong, Susan Clark, and Darrel Hopkins**.** State Parks managers Ed Girard, Evan Roberts, and Jim Schmidt assisted with logistics and land management issues including enforcement, signing and fencing. 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. Dave Lauten and Kathy Castelein provided invaluable advice on several aspects of this work. Much of this work was funded by a grant from U.S. Fish and Wildlife Service and by Washington Department of Fish and Wildlife and U.S. Fish and Wildlife Service operating funds. Thank you all!!!

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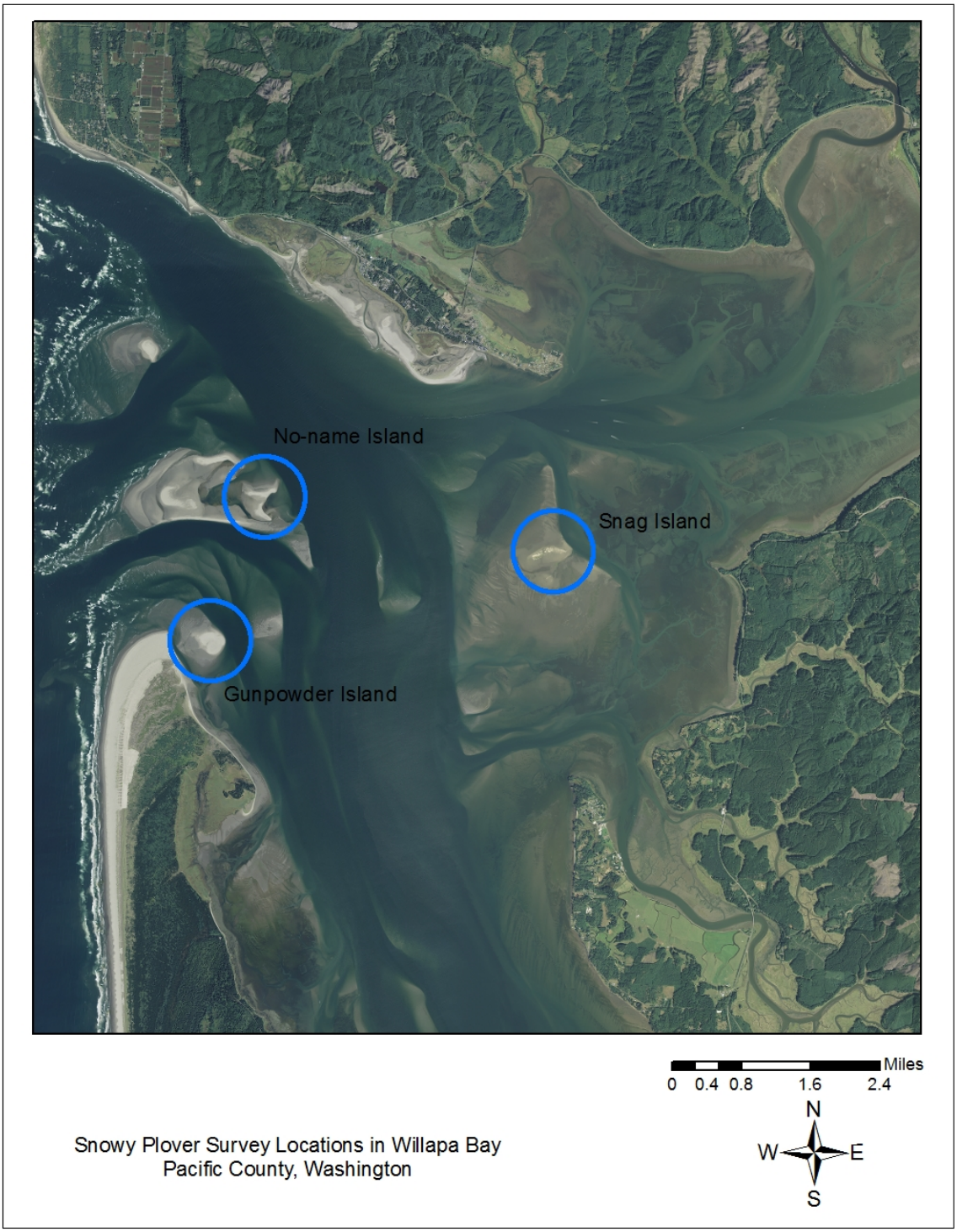
# APPENDIX I

Blue circles represent locations of Snowy Plover nests in 2009 at Leadbetter Point, U.S. Fish and Wildlife Service Refuge lands. All of the orthographic photos were taken in 2009.

Blue circles represent locations of Snowy Plover nests in 2009 at Midway Beach. All of the orthographic photos were taken in 2009.

Islands in Willapa Bay surveyed by U.S. Fish and Wildlife and Washington Department of Fish and Wildlife Biologists during the 2009 nesting season. No plovers were detected.



Islands in Grays Harbor surveyed by Washington Department of Fish and Wildlife Biologists during the 2009 nesting season. No plovers were detected.

# APPENDIX II. Evaluating effects of exclosures on nest survival, fledging success and/or adult predation.

| Study | Species | Exclosed nest survival[1] | Unexclosed nest survival[1] | Differences significant? | Fledging Success difference? | Adult predation? observed | Adult predation higher in exclosures? | Adult predator |
|---|---|---|---|---|---|---|---|---|
| Hardy and Colwell 2008 | Snowy Plover (*C. alexandrinus*) | 0.985 | 0.876 | Yes | No difference | Yes (1 observed, 7 others possible) | | Raptor |
| Lauten et al. 2004 | Snowy Plover (*C. alexandrinus*) | 67.10% | 11.40% | Yes | | Yes (n = 34) | | |
| Pearson et al. unpub. | Snowy Plover (*C. alexandrinus*) | 0.98 - 0.99 | 0.92-0.93 | Yes | | Yes (n = 2) | | Raptor (owl?) |
| Melvin et al. 1992 | Piping Plover (*C. melodus*) | 0.994 | 0.93 | Yes | Exclosure higher | No | | |
| Larson et al. 2002 | Piping Plover (*C. melodus*) | | | | Exclosures higher | | | |
| Murphy et al. 2003 | Piping Plover (C. melodus) | | | | | Yes (n = 73, 5% of nests) | Yes | Raptor |
| Mabee and Estelle 2000 | Piping Plover (C. melodus), Snowy Plover (C. alexandrinus), Killdeer (C. vociferus) | 0.96-0.88 | 0.98-0.99 | No | | | | |
| Rimmer and Deblinger 1990 | Piping Plover (C. melodus) | 92% | 25% | Yes | | | | |
| Johnson and Oring 2002 | Killdeer (C. vociferus) | 0.97 (+- 0.01 SE) | 0.92 (+- 0.01 SE) | Yes | | | | |
| Nol and Brooks 1982 | Killdeer (C. vociferus) | 0.96 | 0.95 | No | | | | |
| Pauliny et al. 2008 | Southern Dunlin (Calidris alpina schinzii) | 0.67 (95%CL = 0.28-0.60 | 0.41 (95%CL = 0.49-0.90) | Yes | No difference | Yes (3 by crows) | No, similar | crows |
| Isaksson et al. 2007 | Northern Lapwing (Vanellus vanellus), Redshank (Tringa totanus) | 0.989 & 0.997 | 0.966 & 0.964 | Yes | | Yes | Yes | |
| Niehaus et al. 2004 | Western Sandpiper (Calidris mauri) | 0.99 (+-0.01 95%CI) | 0.96 (+-0.01 95%CI) | Yes | | No | | Jaegers chasing adults |
| Estelle et al. 1996 | Pectoral Sandpiper (Calidris melanotos) | 0.982 (SE = 0.01) | 0.717 (SE = 0.039) | Yes | | | | |

[1]Reported as daily survival rate for all studies except Lauten et al. (2003) where percent of successful nests are presented.

# APPENDIX III

**Snowy Plover Chicks Banded in 2009 at Midway Beach and Leadbetter Point, Pacific County, WA.**

| Location | Left Band | Right Band | Fledge Date | May | June | July | August | Sept | Information/Comments |
|---|---|---|---|---|---|---|---|---|---|
| Midway | **RV** | **BR** | 9/2 | | | | 5, 11, 15, 24 | 21 | Nest 18. HY 2009 (8/05/09), Midway Beach, WA. Fledged. Parent: RV:YG ♀. |
| Midway | **RV** | **BW** | 7/16 | | 18, 19, 29 | | | | Nest 8. HY 2009 (6/18/09), Midway Beach, WA. Not known to have fledged. 3rd chick not banded (believed to have fledged). |
| Midway | **RV** | **GR** | 9/2 | | | | 5, 11, 15 | | Nest 18. HY 2009 (8/05/09), Midway Beach, WA. Not likely to have fledged. Parent: RV:YG ♀. |
| Midway | **RV** | **GW** | 7/16 | | 18 | 10, 15, 20, 22, 28, 29 | 4, 24, 29 | 21 | Nest 11. HY 2009 (6/18/09), Midway Beach, WA. Fledged. |
| Midway | **RV** | **OW** | 7/16 | | 18 | 10, 15, 28 | | | Nest 11. HY 2009 (6/18/09), Midway Beach, WA. Fledged. |
| Midway | **RV** | **RR** | 8/20 | | | 23 | 3, 8, 10, 11, 21, | 2, 21 | Nest 15. HY 2009 (7/23/09), Midway Beach, WA. Fledged. "Real parent": GLG:Y ♀; Surrogate parents: G:R ♀ , S:X ♂ . |
| Midway | **RV** | **RW** | 7/16 | | 18, 19 | 9, 10, 14, 15, 16, 21, 23, 28 | 7* | | Nest 8. HY 2009 (6/18/09), Midway Beach, WA. Fledged. 3rd chick not banded. *:Photos by Keith Brady of juvenile N of Copalis River |
| Midway | **RV** | **WW** | 7/16 | | 18 | | | | Nest 11. HY 2009 (6/18/09), Midway Beach, WA. Not known to have fledged. |
| Midway | **RV** | **YR** | 9/2 | | | | 5, 11, 15, 24 | 21 | Nest 18. HY 2009 (8/05/09), Midway Beach, WA. Fledged. Parent: RV:YG ♀. |
| Leadbetter | **VB** | **AB** | 8/6 | | | 9 | | | Nest 17. HY 2009 (7/09/09), Leadbetter, WA. Unknown if fledged. Parent: VW:GW ♀. |
| Leadbetter | **VB** | **AR** | 8/6 | | | 9 | | | Nest 17. HY 2009 (7/09/09), Leadbetter, WA. Unknown if fledged. Parent: VW:GW ♀. |
| Leadbetter | **VB** | **AW** | 8/6 | | | 9 | | | Nest 17. HY 2009 (7/09/09), Leadbetter, WA. Unknown if fledged. Parent: VW:GW ♀. |
| Leadbetter | **VB** | **AY** | 8/14 | | | 17, 27, 31 | | | Nest 20. HY 2009 (7/17/09), Leadbetter, WA. Unknown if fledged. Parents: VR:WB ♀, Y:WGW ♂. |
| Leadbetter | **VB** | **PR** | 8/6 | | | 9, 27, 31 | | | Nest 16. HY 2009 (7/09/09), Leadbetter, WA. Fledged? |
| Leadbetter | **VB** | **PW** | 8/14 | | | 17, 27, 31 | | | Nest 20. HY 2009 (7/17/09), Leadbetter, WA. Unknown if fledged. Parents: VR:WB ♀, Y:WGW ♂. |
| Leadbetter | **VB** | **PY** | 8/14 | | | 17 | | | Nest 20. HY 2009 (7/17/09), Leadbetter, WA. Not known to have fledged. Parents: VR:WB ♀, Y:WGW ♂. |
| Leadbetter | **VB** | **RY** | 7/23 | | 25 | 13, 20, 21, 31 | 13 | | Nest 14. HY 2009 (6/25/09), Leadbetter, WA. Fledged. Parents: W:Y ♀, YG:Y(S)(X) ♂. |
| Leadbetter | **VB** | **WY** | 7/23 | | 25 | 13 | | | Nest 14. HY 2009 (6/25/09), Leadbetter, WA. Not known to have fledged. Parents: W:Y ♀, YG:Y(S)(X) ♂. |
| Leadbetter | **VB** | **YY** | 7/23 | | 25 | | | | Nest 14. HY 2009 (6/25/09), Leadbetter, WA. Not known to have fledged. Parents: W:Y ♀, YG:Y(S)(X) ♂. |
| Leadbetter | **VR** | **AB** | 6/27 | 30 | 2, 3, 16, 20 | 6, 13 | 6, 11, 12, 13 | | Nest 9. HY 2009 (5/30/09), Leadbetter, WA. Fledged. 3rd chick not banded. |
| Leadbetter | **VR** | **AR** | 7/10 | | 12, 16 | | | | Nest 13. HY 2009 (6/12/09), Leadbetter, WA. Unknown if fledged. |
| Leadbetter | **VR** | **AW** | 6/27 | 30 | 2, 3, 16 | | | | Nest 9. HY 2009 (5/30/09), Leadbetter, WA. Unknown if fledged. 3rd chick not banded - unknown if fledged. |
| Leadbetter | **VR** | **AY** | 8/27 | | | 30, 31 | 4, 8, 13* | | Nest 23. HY 2009 (7/30/09), Leadbetter, WA. Unknown if fledged. *: 1 banded chick on 8/13 but unknown which one. |
| Leadbetter | **VR** | **BR** | 7/6 | | 8 | | | | Nest 11. HY 2009 (6/08/09), Leadbetter, WA. Not known to have fledged. 2nd & 3rd chick not banded - not known to have fledged. |
| Leadbetter | **VR** | **BY** | 8/27 | | | 30, 31 | 4, 8, 13* | | Nest 23. HY 2009 (7/30/09), Leadbetter, WA. Unknown if fledged. *: 1 banded chick on 8/13 but unknown which one. |
| Leadbetter | **VR** | **PR** | 6/14 | 17, 18, 27 | | | | | Nest 1. HY 2009 (5/17/09), Leadbetter, WA. Unknown if fledged. 3rd chick not banded. Parent: S:B ♀. |
| Leadbetter | **VR** | **RR** | 6/14 | 17, 18, 27 | | | | | Nest 1. HY 2009 (5/17/09), Leadbetter, WA. Unknown if fledged. 3rd chick not banded. Parent: S:B ♀. |