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Washington State Snowy Plover Population Monitoring, Research, and Management: 2010 Nesting Season Research Progress Report

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OVERVIEW

During the 2010 Western Snowy Plover (*Charadrius alexandrinus nivosus*) nesting season, we monitored breeding phenology, nest success, fledging success and number of nesting adult plovers in Washington. Field monitoring and research was conducted by Kathryn Gunther, Cyndie Sundstrom, William Ritchie, and Kerry Hosken with assistance from Marie Fernandez, Max Zahn, Warren Michaelis, Scott Harris, and Scott Pearson. Volunteers assisting with window, occupancy and adult surveys included: Ann Musché, Tom Finn, Carolyn Norred, Mary Ann Spahr, Bea and Jim Harrison, Normandie Hand, Tom Karczewski, Lori Summers, Kirsten Brennan, and Mark Hopey. A summary of some of our 2010 activities and results:

Breeding Phenology

- Clutches were initiated between 14 April and 18 July. However, very early nests could have gone undetected because intensive surveys did not start until after April 1.
- The first chick fledged around 22 July and the last chick known to fledge, fledged around 16 September.

Breeding Range

- Conducted 49 surveys on 14 sites to either assess occupancy or to count the number of nesting adults
- Snowy Plovers were only found nesting on Leadbetter Point and Midway Beach.

Number of Breeding Adults

- The mean 2010 Washington breeding adult population was 43 (95% Confidence interval: 39-46). 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 >120 hours to survey efforts.
- The Washington population is declining by approximately 6 birds per year over the past five years ($p < 0.001$), and has declined from four nesting sites to two.

Nest success

- Thirty three nests were discovered and monitored.
- The percent of nests that survived from egg laying through hatching during the 2010 nesting season was 46% (including exclosed and non-exclosed nests).
- As in past years, the primary sources of nest failure were predation (primarily by crows and ravens), abandonment, and nests buried by drifting sand. We suspect that one nest was destroyed by humans based on human tracks and crushed eggs.

Fledging Success

- The average number of young fledged per adult male on the two nesting sites in Washington was 0.57 (95% Confidence interval: 0.53-0.62). 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.

Management Actions

- *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*: Fourteen nests were exclosed on the Wildlife Refuge at Leadbetter, and one nest was 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.
- *Nest Predation:* Willapa National Wildlife Refuge began conducting preliminary surveys to collect data on nest predators occurring in and adjacent to the plover and lark nesting areas at Leadbetter Point. Logistics of implementing a proposed predator management strategy were investigated.
- *Restoration*: The U.S. Fish and Wildlife Service habitat restoration area (HRA) at Leadbetter Point is 121 acres, of which oyster shell has been added to approximately 62 of the 121 acres. Restoration and maintenance activities conducted in 2010 included: 1) Maintaining the 121 acre restoration area mechanically and through the use of herbicide; 2) The surface of the foredune and area between the foredune and the HRA that was treated with herbicide in 2009 was scraped using bulldozers to remove dead beachgrass. This has resulted in almost 3-miles of continuous, unvegetated access between the HRA and the outer beach, eliminating the need for alleyways cut through the dune to provide plovers with access between the beach and the restoration area. ; 3) In September 2010 an additional 67 acres in a mile long stretch of beach south of the existing HRA was 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 approximately 8 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. Seed dispersal and plantings have resulted in plants now occurring in all but the extreme northern portion of the HRA. In November 2009 pink sandverbena seed was collected in a collaborative partnership with the Shoalwater Bay Tribe. A tribal greenhouse facility was established and 20 plants were propagated and out-planted on tribal lands.
- 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 Audubon, Grays Harbor Audubon, and Shoalwater Bird Club volunteers (approximately 98 volunteer hours in 2010) and initial treatments to control non-native beach grasses 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 occurred in November 2009. 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. No plover or lark use was found during four surveys in summer 2009 or five surveys in 2010.

Recommendations

- Summarize, write-up and publish population monitoring results from Oregon, Washington, and northern California.
- 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 on an annual basis.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- 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, adverse weather, shoreline modification, dune stabilization, and recreational activities have been attributed to reduced nest success and have been cited as the causes of local population declines (Washington Department of Fish and Wildlife 1995).

Historically, five 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 and 2010 nesting seasons, 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 although state-specific monitoring was initiated years before.

The primary objectives of our monitoring for the 2010 nesting season were:

- Conduct winter window surveys.
- Conduct 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 and 2010 nesting seasons 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 2010. 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. 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 2010 Snowy Plover nesting localities in Washington.

Site	Approximate Location	Ownership/Management
Midway Beach	46° 45’ 32”, 124° 05’ 46”	South Beach State Park, Private
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 2010, the window survey occurred the week of 24 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.

For the sites that were previously occupied by plovers but were thought to be unoccupied at the beginning of the 2010 field season (Damon Point, Connor Creek and Copalis Spit), an experienced biologist surveyed appropriate habitat on foot. We also conducted a driving survey of the Long Beach Peninsula south of Oysterville road for the breeding window survey.

Surveys attempted to determine population size at occupied sites and site occupancy at unoccupied sites, however, more effort was devoted to surveying 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, 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 beach sign number one 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 Refuge boundary).

Site	Starting Point	Ending Point	Number of Surveyors	Survey Type
Copalis Spit	47°07'16.5", 124° 10' 59.9"	47° 08' 15.6", 124° 10' 58.4"	1	Vehicle/ Foot
Connor Creek	47° 04' 14", 124° 10' 24"	47° 07' 16.5", 124° 10' 59.9"	1	Vehicle/ Foot
Damon Point	46° 56' 05", 124° 09' 18"	46° 56' 11", 124° 06' 18"	1 or 2	Foot
Midway Beach	46° 47' 38", 124° 05' 55"	46° 44' 07", 124° 05' 29"	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 (S. of Oysterville Rd.	46° 32' 54.0", 124° 03' 40.8	46° 22' 03.8", 124° 03' 24.4"	1	Vehicle

Winter Window Surveys

The winter window survey occurs annually in January along the entire U.S. Pacific coastline where Snowy Plovers nest or historically nested. All sites are surveyed during a specific week and the 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 2010, the window survey occurred from 20-26 January when we surveyed Connor Creek, Copalis Spit, Damon Point, Midway/Grayland Beach, and 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 sites that are currently occupied and at the sites most likely to become reoccupied 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 2010 nesting season because it was recently occupied.

Occupancy surveys with only 1 or 2 visits

We visited several sites that were previously occupied or with suitable nesting habitat between 10 April and 3 August to informally assess occupancy and look for banded plovers (see Table 5). We also visited three islands in Willapa Bay on 17 June (n = 1 visit each: Appendix I) to look for nesting plovers.

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 29 April and 7 July using the methods described in Elliot-Smith and Haig (2006a). One of these surveys was also the Breeding Window Survey. 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 in 2010 where > 25% of the birds were banded 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 = 10 surveys) was 0.04 and the average proportion of missed birds per survey was 0.23. 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 (= 1.198) 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 29 April and 7 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 5 times between 25 April and 03 August, 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 late March until mid-September. 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. Exclosures are not used in the early nesting season to reduce the risk of adult predation from migrating raptors.

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 9 nests out of 19 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.

Banding

To help us estimate fledging success in 2010 we banded 17 chicks from 9 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 blue over violet 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

Thirty-eight adult plovers were detected in Washington during the 2010 breeding window survey, which was the lowest in the past five years (Table 3).

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

Site	2006	2007	2008	2009	2010	2010 Survey Dates	2010 Adult Males	2010 Adult Females	2010 Adult Unknown
Copalis Spit	0	0	0	0	0	26 May	0	0	0
Conner Creek	0	0	0	0	0	26 May	0	0	0
Damon Point	0	0	0	0	0	27 May	0	0	0
Graveyard	-	0	1	0	0	27 May	0	0	0
Midway Beach	25	22	12	16	18	25 May	6	11	1
Leadbetter Pt.	42	28	29	26	20	24 May	10	8	2
S. Long Beach	0	0	0	0	0	24 May	0	0	0
Total	67	50	42	42	38		16	19	3

Winter Window Survey

Thirty-five adult plovers were detected on two sites during the January 2010 Winter Window Survey (Table 4).

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

Site	2006-2007	2007-2008	2008-2009	2009-2010	2009-2010 Survey Dates	2009-2010 Adult Males	2009-2010 Adult Females	2009-2010 Adult Unkn
Copalis Spit	0	0	0	0	26 January	0	0	0
Conner Creek	0	0	0	0	26 January	0	0	0
Damon Point	0	0	0	0	21 January	0	0	0
Graveyard	0	-	-	0	-	0	0	0
Midway Beach	21	15	10	12	22 January	2	3	7
Leadbetter Pt.	17	14	9	23	21 January	5	15	3
S. Long Beach	-	-	-	-	-	-	-	-
Total	38	29	19	35		7	18	10

Adult Surveys

As indicated in Table 5 we conducted 49 surveys at 14 sites between 10 April and 3 August 2010. Note that the surveys starting at Oysterville Approach to Ocean Park Approach to Cape Disappointment to Bolstad Approach are surveys of different portions of the same area on the Long Beach Peninsula.

Table 5. Snowy Plover survey dates, number of surveys and surveyors and type of survey by site during the 2010 nesting season

Site	Type of Survey	# Surveys	# Surveyors	Walking or Driving	Survey Dates
Midway	Breeding Adult/Window	5	3-4	Foot	5/12, 5/25, 6/08, 6/22, 7/07
Graveyard	Occupancy/Window	5	1	Foot	4/29, 5/14, 5/27, 6/08, 6/30
Damon Pt	Occupancy/Window	4	1-2	Foot	5/05, 5/13, 5/27, 6/23
Connor Creek	Occupancy/Window	3	1	Foot/Drive[1]	5/14, 5/26, 6/09
Copalis Creek	Occupancy/Window	3	1	Foot/Drive[2]	5/14, 5/26, 6/09
Leadbetter	Breeding Adult/Window	5	5-8	Foot/Drive[3]	5/11, 5/24, 6/07, 6/21, 7/06
Pacific Beach to Copalis River	Opportunistic	3	1	Drive	5/14, 5/26, 6/09
Ocean Shores/N. Jetty	Opportunistic	2	1	Drive	5/26, 6/09
Moclips to Pacific Beach	Opportunistic	1	1	Drive	6/9
Oysterville Approach to Ocean Park Approach	Opportunistic	4	1	Drive	4/01, 5/24, 6/23, 7/20
Benson Beach South to Benson Beach North	Opportunistic	1	1	Drive	4/10
Seaview to Bolstad Approach	Opportunistic	1	1	Drive	4/26
Cranberry Road Approach to Cape Disappointment	Opportunistic	1	1	Drive	5/2
Cranberry Road Approach to Klipsan Approach	Opportunistic	1	1	Drive	5/3
Ocean Park Approach to Cape Disappointment	Opportunistic	1	1	Drive	5/20
Ocean Park Approach to Cranberry Road Approach	Opportunistic	1	1	Drive	6/18
Bolstad Approach to Cranberry Road Approach	Opportunistic	1	1	Drive	7/26
Cape Disappointment to Bolstad Approach	Opportunistic	1	1	Drive	8/10
Leadbetter State Park Restoration Area	Research	5	1-4	Foot	4/25, 5/23, 6/10, 7/02, 8/03
Gunpowder Shoal, Willapa Bay	Opportunistic	1	3	Foot	6/17
Snag Island, Willapa Bay	Opportunistic	1	3	Foot	6/17
Unnamed Island, Willapa Bay	Opportunistic	1	3	Foot	6/17

[1]Half area surveyed by foot and half area driving
[2]Two surveys by foot and 1 driving
[3] Drove portions of 3 surveys. When driving, drove from Oysterville Rd north to Post 1

Our goal was to determine plover presence-absence at Damon Point, Connor and Copalis Creeks and Graveyard Spit and we surveyed these sites at least three times this season. At Midway Beach and Leadbetter our goal was to estimate the number of breeding adults and we surveyed each site five times during the nesting season. We also conducted opportunistic surveys at Long Beach (south of Oysterville Road), islands in Willapa Bay, the Ocean Shores area, and surveys in the area of Moclips and Pacific Beach (Table 5; Appendix I).

Site occupancy

Because Damon Point, Graveyard Spit, and Copalis and Connor Creeks were historically occupied by nesting birds, we conducted at least three surveys of each site during the 2010 nesting season and found all of these sites 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, Ocean Shores area, and surveys in the area of Moclips and Pacific Beach (Table 5; 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 beginning of September. 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 with some late season arrivals. For males, there appeared to be little movement this year but females continued to move in and out of our nesting sites throughout the nesting season (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 included 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 in late May. Juveniles from locations south of Washington don't arrive until August or later (see Pearson et al. 2009a and 2009b).

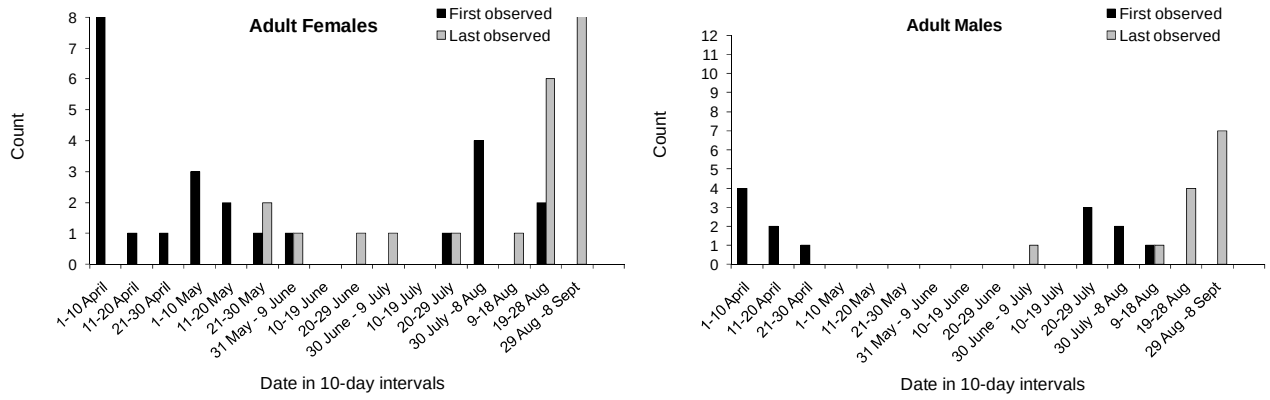

Figure 1. Dates banded female and male Snowy Plovers were first and last detected on Midway Beach and Leadbetter Point combined in 2010.

We also examined the average resights of banded male and female plovers per day during the 2010 nesting season to determine if there are differences in detectability (average resights per day) between the sexes (Figure 2). This result and nearly identical results in 2006 – 2009 indicates that there is no need to adjust counts for differences in detectability between males and females.

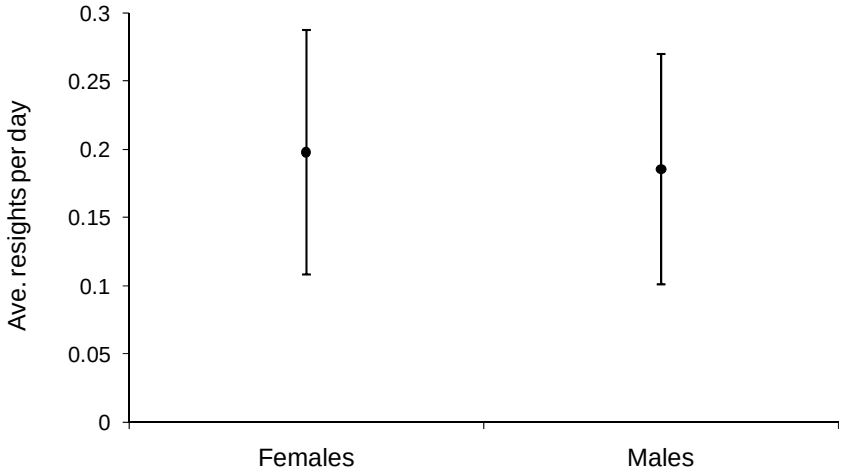

Figure 2. Average number of re-sights per banded adult female (n = 30) and male (n = 17) Snowy Plovers per day (± SD) during the 2010 nesting season.

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 also 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.

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 2006-2010.

	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)
2010 Adjusted Counts	0	17 (13-21)	0	25 (20-31)	43 (39-46)

Repeated counts help us understand the variability associated with estimates. We used 4-5 surveys from pre-determined weeks (mid to late-April – 7 July) to estimate the breeding adult population (Figure 3, Table 6). Adult population counts are declining for the 2006-2010 period (Table 6, Figure 3) but the rate of decline (slope) is less steep than that projected in 2009 (Pearson et al. 2009b).

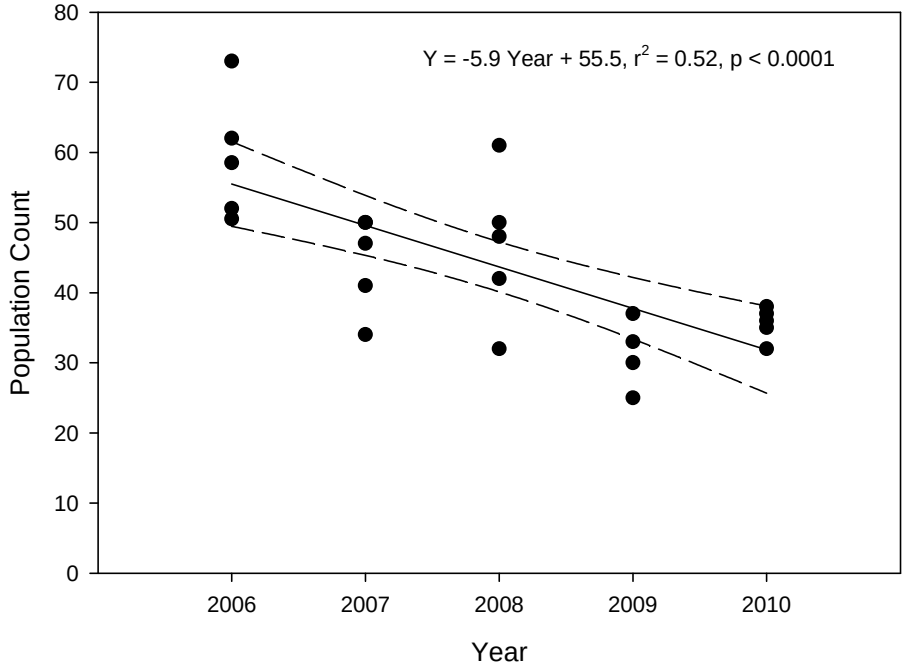

Figure 3. Washington adult plover population trend (95% CI) from 2006 – 2010 using unadjusted counts. The trend is almost identical for adjusted counts (Y = -5.6 birds per year + 60.5, r^2 = 0.42, p < 0.001).

State Park Habitat Restoration Area Surveys

Five surveys of treatment and control plots were conducted in 2010 and no Snowy Plovers or Streaked Horned Larks were detected. Volunteers contributed approximately 98 hours to this survey effort.

Clutch Initiation Dates and Breeding Phenology

Clutches were initiated between 14 April and 18 July (Figure 4). However, very early nests could have gone undetected because intensive surveys did not start until late March. The first chick known to fledged around 22 July and the last chick known to fledge, fledged around 16 September (Figure 5B).

Scrape building and territory defense occurs prior to egg laying, consequently the active nesting season occurred between late-March and mid-September in 2010. In Figure 4, we present the number of clutches initiated and number of chicks fledged in ten-day intervals at all sites combined. Clutch initiation was fairly evenly spread out between mid-April and mid-July. Overall, both nest initiation and fledging occurred much later this past nesting season than recent years. Looking at all years combined, the nesting season starts in late March and continues through mid-September.

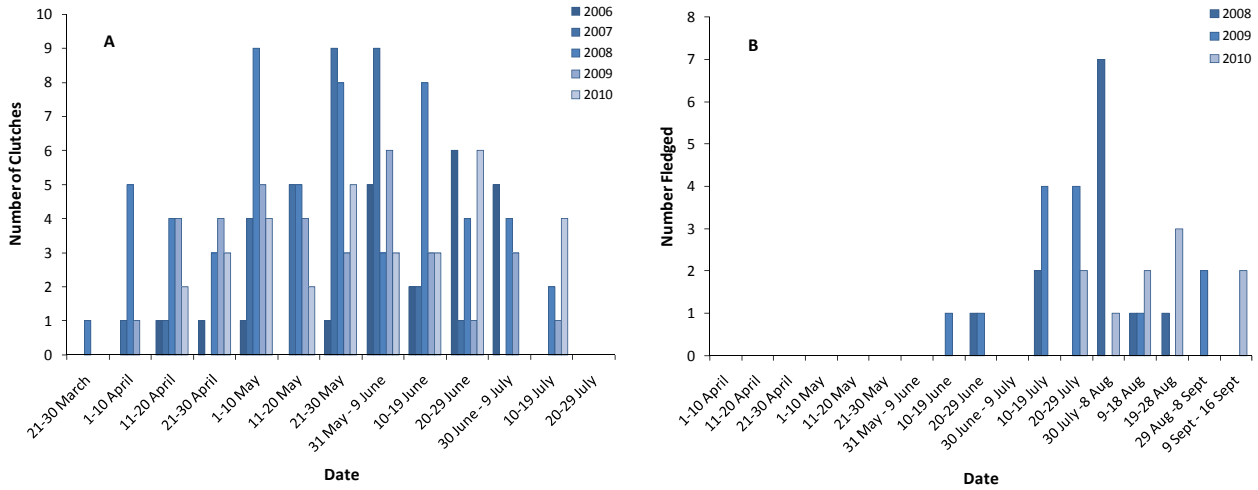

Figure 4. Number of Snowy Plover clutches initiated in 2006-2010 (A) and number of chicks fledged in 2008-2010 (B). Results are presented in 10-day intervals for all Washington nesting sites combined.

Nest success

We located and monitored the outcome of 33 plover nests in 2010. We know that there were at least two additional nests that we did not discover at Leadbetter because scrapes and egg fragments were discovered after they were apparently depredated. Undiscovered nests are not included in nest success analyses because of potential bias associated with including them. Of these 33 nests, 16 were located at Leadbetter and 17 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 Crows (*Corvus Caurinus*); and Common Ravens (*Corvus corax*) depredated nests (Table 8). 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	17	5	12	0
Leadbetter	16	14	2	0
Exclosed[1]	15	14	1	0
Not exclosed	18	5	13	0
Totals	33	19	14	0

[1]One exclosure was used at Midway the remaining exlosures were used at Leadbetter

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 2010 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 only one of the nests at Midway. The probability of nest survivorship of unexclosed nests was only 9% (Table 9).

Table 8. Sources of Snowy Plover nest failure in 2010. 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	1	1	3	0	1	1	1	4	0
Leadbetter	0	0	2	0	0	0	0	0	0
Exclosed	0	0	0	0	0	0	0	1	0
Not exclosed	0	1	3	0	4	1	1	3	0
Totals	1	1	5	0	1	1	1	4	0

Table 9. Mayfield estimates of Snowy Plover nest survival and of daily nest survival probability by site and by exclosed and unexclosed nests in 2010.

Site	Daily Survival Probability	Nest Survival
Midway	0.950	0.196
Midway exclosed	0.947	0.177
Midway unexclosed	0.951	0.198
Leadbetter	0.994	0.831
Washington exclosed	0.997	0.915
Washington unexclosed	0.943	0.154
Washington total (including exclosures)	0.976	0.462

Table 10. Mayfield estimates of nest survival by site from 2006 - 2010. Most nests (79-93%) were exclosed at Leadbetter in 2007- 2010, and 33%, 39%, 0%, and 6% were exclosed Midway in 2007, 2008, 2009, and 2010 respectively.

	Nest Survival				
Site	2006	2007	2008	2009	2010
Midway and Graveyard	0.23	0.28	0.25	0.15	0.20
Leadbetter	0.26	0.51	0.54	0.43	0.83
Washington Total (including exclosures)	0.25	0.37	0.36	0.30	0.46

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. 2009a and b).

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 11-12 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 10 chicks fledged in 2010. Because we know at least 10 chicks fledged, we used this value to estimate fledging success. We used the proportion of males from our breeding adult surveys (using known sex birds) 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 in 2010 was 0.57 (95% CI = 0.53-0.62). This estimate indicates 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 declining population trend.

Table 11. Estimated average number of males (rounded values) and observed numbers of fledglings by site in 2007-2010.

	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	2010 Ave. number of males	2010 Number of fledglings observed
Leadbetter	14	9	19	6	9.5	4-5	10	5
Midway & Graveyard	11	13	9	6 or 7*	8.5	8	7	5
Washington total	25	25	27	12 or 13	18	12 or 13	17	10

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, 40% and 44% respectively in 2009, and 61% and 60% respectively in 2010. Many of these banded birds were banded in Oregon and California 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.

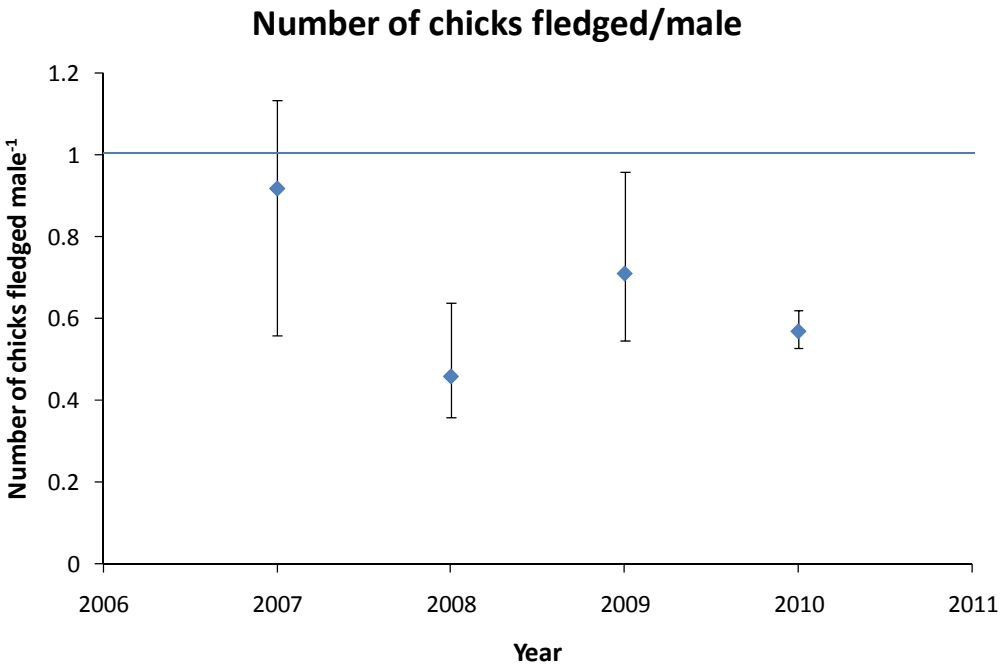

Figure 5. Number of Snowy Plover chicks fledged per adult male from 2007-2010 for all Washington nesting sites combined. Population modeling indicates that one chick fledged per male is needed on average to maintain a stable population.

Nest Locations

2010 nest locations are presented by nesting site in Appendix I. At Midway Beach, birds nested in Grayland Beach State Park and the beach immediately to the south. 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. Nesting now appears to be confined to the HRA and Midway beach while in previous years nests were found on additional sites. Also, the number of nests discovered over time has decreased (a 47% decline since 2006) despite increased effort looking for nests.

Table 12. Number of nests discovered by location and year. Note that the amount of effort looking for nests has increased slightly over time.

Location	2006	2007	2008	2009	2010
USFWS Leadbetter Point – outer Beach	13	3	8	3	0
USFWS Leadbetter Point – Habitat Restoration Area	16	17	20	20	16
State Parks Leadbetter Point	0	1	1	0	0
Midway Beach	29	22	25	18	17
Shoalwater (Graveyard Spit)	3	2	1	0	0
Damon Point/Oyhut	1	0	0	0	0
Total	62	45	56	41	33

PROGRESS ON RECOVERY OBJECTIVES

Federal Recovery Objectives:

Objective 1: 250 breeding adults in Recovery Unit 1.

The 2010 Washington nesting population was 43 (95% CI = 39-46) and the 2010 Oregon nesting population was 174 (Lauten et al. 2010) for a total of 217 (range = 213-220) nesting adult plovers in Recovery Unit 1.

Table 13. Estimated number of breeding adults in Recovery Unit 1 by year.

2007	2008	2009	2010
210 (201-220)	183 (167-198)	184.5 (175-194)	217 (213-220)

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

The number of chicks fledged per male in Unit 1 was 0.85 – 0.87 in 2010. We combined the Oregon and Washington estimates of the number of breeding adult males (n = 103-106) and the number of young fledged (n = 90) to derive this combined Unit 1 fledging success per male. The number of young fledged per male in Oregon was 0.92 in 2010 (Lauten et al. 2010).

Table 14. Estimated number of chicks fledged per breeding adult male in Recovery Unit 1 by year.

	2007	2008	2009	2010
Chicks/adult male	1.43 (1.37-1.50)	0.92 (0.85-1.01)	1.25 (1.18-1.32)	0.85-0.87

Washington State Recovery Objectives:

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

The mean 2010 Washington breeding adult population was 43 (95% Confidence interval: 39-46) and approximately 50% of these birds are females and 50% are males. If all females are paired, these estimates indicate that there are approximately 21-22 pairs (95% CI = 20-23 pairs) in Washington in 2010. We estimate that there were 17-18 pairs in 2009, 27 pairs in 2008, 24 pairs in 2007 and 32 pairs in 2006. The average number of breeding pairs over these five years is approximately 24.4 pairs.

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 0.57 (95% CI: 0.53-0.62) in 2010, 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 the past four years is 0.66. Currently plovers are nesting on two primary sites – one on a National Wildlife Refuge and the other on 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”.

2010 MANAGEMENT ACTIONS

A number of the management actions that occurred in 2010 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 where plovers were actively nesting on Grayland and South Beach State Parks 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 and on the Refuge trails at Leadbetter Point.
- Symbolic fencing was put at Long 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 recommend managers 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. Coastal beaches at Willapa National Wildlife Refuge and Leadbetter State Park are closed to vehicle traffic year round. However, driving is allowed on the wet sand portions of the beach in these areas during razor clam harvest openings. All of the Midway/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 and 2010. As a result, there was much less disturbance to plovers in this area again 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 14 nests on the Willapa National Wildlife Refuge. One nest was exclosed at Grayland Beach State Park.
- In 2010 there were 12 razor clam dig days at Leadbetter and Midway/Grayland beach during the active nesting season. This season WDFW, State Parks, and U.S. Fish and Wildlife Service coordinated enforcement activities during clam tides which reduced the amount of associated human activity in active nesting areas.

Restoration

- The U.S. Fish and Wildlife Service habitat restoration area (HRA) at Leadbetter Point is 121 acres, of which oyster shell has been added to approximately 62 of the 121 acres. Restoration and

maintenance activities conducted in 2010 included: 1) Maintaining the 121 acre restoration area mechanically and through the use of herbicide; 2) The surface of the foredune and area between the foredune and the HRA that was treated with herbicide in 2009 was scraped using bulldozers to remove dead beachgrass. This has resulted in almost 3-miles of continuous, unvegetated access between the HRA and the outer beach, eliminating the need for alleyways cut through the dune to provide plovers with access between the beach and the restoration area. ; 3) In September 2010 an additional 67 acres in a mile long stretch of beach south of the existing HRA was 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 approximately 8 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. Seed dispersal and plantings have resulted in plants now occurring in all but the extreme northern portion of the HRA. In November 2009 pink sandverbena seed was collected in a collaborative partnership with the Shoalwater Bay Tribe. A tribal greenhouse facility was established and 20 plants were propagated and out-planted on tribal lands.

- 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 98 hours in 2010) and initial treatments to control non-native beach grasses 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 occured in November 2009. 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 2009. One to three plover access cuts to the beach were bulldozed in each plot. Post treatment vegetation data was collected in August 2009. No plover or lark use was detected during four surveys in summer 2009 and five in 2010.

FUTURE RESEARCH & MONITORING CONSIDERATIONS

- Summarize, write-up and publish population monitoring results from Oregon, Washington, and northern California.
- 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 on an annual basis.
- Evaluate impact and timing of clam digging on plover nesting, foraging and fledging.
- Initiate education and outreach activities.

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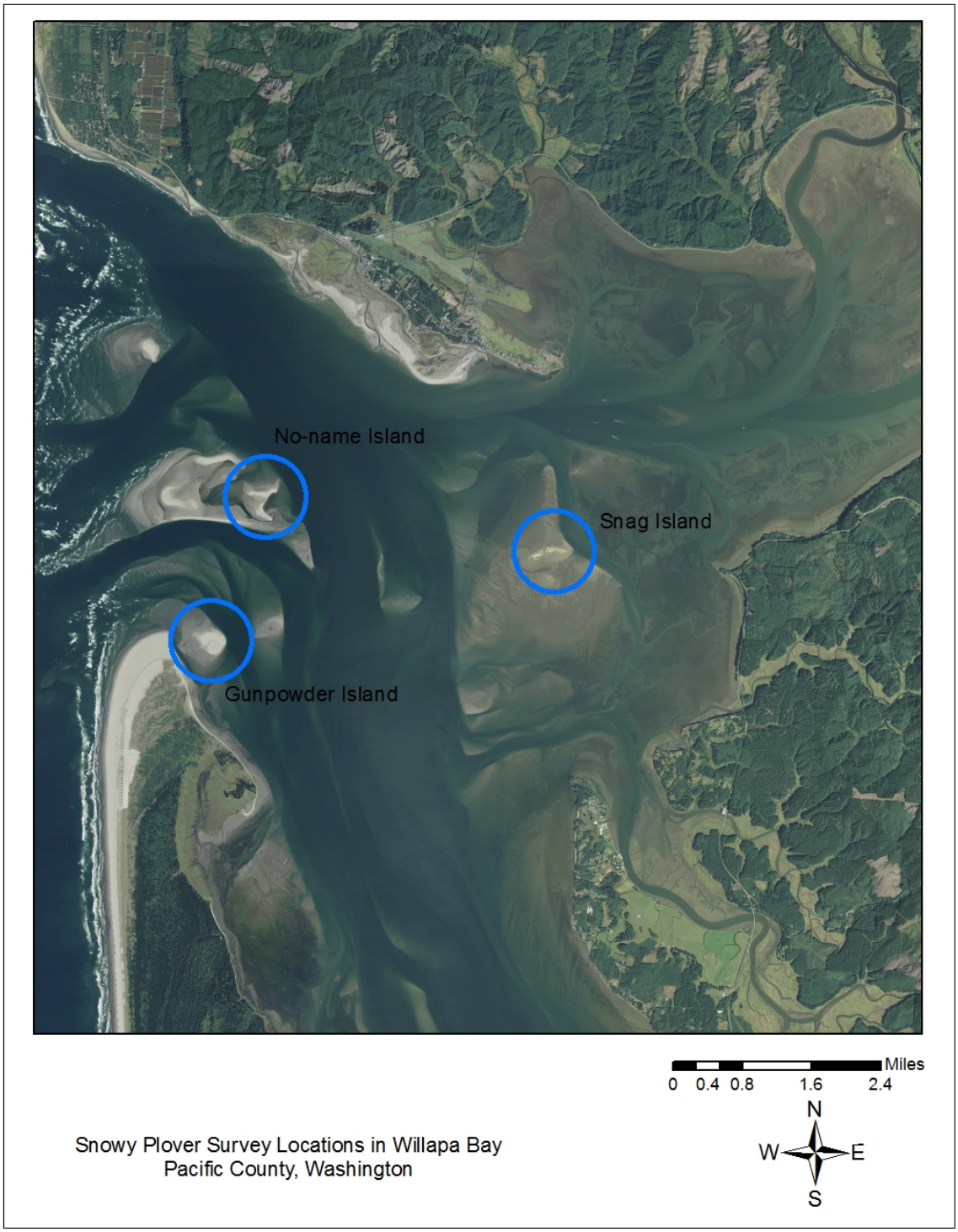
APPENDIX I

Blue circles represent locations of Snowy Plover nests in 2010 at Leadbetter Point, U.S. Fish and Wildlife Service Refuge lands. Locations for two nests were not recorded. All of the orthographic photos are from 2009.

2010 Snowy Plover Nest Locations
Leadbetter Point, Pacific County, Washington

Blue circles represent locations of Snowy Plover nests in 2010 at Midway Beach. All of the orthographic photos are from 2009.

Islands in Willapa Bay surveyed by U.S. Fish and Wildlife and Washington Department of Fish and Wildlife Biologists during the 2010 nesting season. No plovers were detected.