Technical Memorandum
Take Estimate for the Western Snowy Plover Habitat Conservation Plan

Western Snowy Plover Habitat Conservation Plan ■ Fish and Wildlife Service and Oregon Parks and Recreation Department ■ July 2008

ICF Jones & Stokes
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Take Estimate for the Western Snowy Plover
Habitat Conservation Plan

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Executive Summary

Population data presented in this technical memorandum indicates the Pacific Coast population of western snowy plover (snowy plover) (*Charadrius alexandrinus nivosus*) is increasing. Some take of eggs, hatchlings, fledglings and adult equivalents from recreational activities on the Oregon Coast is ongoing as the population increases. The level of take is highest (absolute numbers and percentage) for the fledgling and hatchling stages. Natural resource management activities, including recreational use restrictions, habitat restoration, and predator control measures at snowy plover management areas (SPMA) and Recreation Management Areas (RMAs), appear to compensate for the estimated take through increased fecundity and hatchling to fledgling survival. Fledglings appear to be the most vulnerable as they rear and forage on the wrack line at the edge of the wet sand. The fledglings are not strong fliers and are likely to be negatively influenced by recreational activities compared to adults. Future take of hatchlings and fledglings could be reduced by natural resource management planning to reduce recreation conflicts with juveniles at occupied and unoccupied sites.

Table of Contents

Tables

Figures

Acronyms

ATV/OHV	all-terrain vehicle/off-highway vehicle
CZMA	Coastal Zone Management Act
Corps	U.S. Army Corps of Engineers
ESA	Endangered Species Act
FWS	Fish and Wildlife Service
HCP	habitat conservation plan
HRA	Habitat Restoration Area
IA	Implementing Agreement
ITP	Incidental Take Permit
OPRD	Oregon Parks and Recreation Department
ORNHIC	Oregon Natural Heritage Information Center

RMA	RMA
SNA	State Natural Area
SPMA	Snowy Plover Management Area
USFS	U.S. Forest Service

Chapter 1. Introduction

Non-federal landowners who wish to conduct activities that might incidentally harm (or take) wildlife listed as endangered or threatened under the federal Endangered Species Act (ESA) must first obtain an incidental take permit (ITP) from the Fish and Wildlife Service (FWS). Take is generally defined as the act of harming, harassing, and hunting, pursuing, or killing a protected species, or adversely affecting their habitat.

The Oregon Parks and Recreation Department (OPRD) has submitted an application to the FWS for an ITP in accordance with Section 10(a)(1)(B) of the ESA, as amended. The issuance of an ITP from the FWS would provide OPRD with the long-term regulatory assurance that implementation of their coastal management responsibilities would comply with the ESA, while providing protection to the snowy plover, a species listed as threatened under the ESA.

Permit issuance criteria prescribed in the Code of Federal Regulations (50CFR 17.22(b)(2), 50 CFR 17.32(b)(2)), and Section 10(a)(2)(B) of the ESA state:

- The taking must be incidental.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking.
- The applicant will ensure that adequate funding for the habitat conservation plan (HCP) and procedures to deal with unforeseen circumstances will be provided.
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild.
- Other measures may be required as necessary or appropriate for the purposes of the HCP.

An HCP that documents compliance with Section 10 of the ESA must be submitted by a project applicant for an ITP to be issued by FWS. OPRD has prepared the draft *Western Snowy Plover Habitat Conservation Plan* to meet those requirements (Oregon Parks and Recreation Department 2007). Among other things, OPRD's HCP must specify the impact that will likely result from the taking of covered species and the steps the applicant will take to monitor, minimize, and mitigate such activities.

The purpose of this technical memorandum is to estimate the level of take that may result from implementation of the addressed activities covered by the HCP (covered activities), over the term of the proposed 25-year ITP (2009 to 2034). This chapter summarizes the management area and activities covered in the HCP.

1.1. Area Covered

The geographic area covered under the HCP (the covered lands), includes the portions of the Ocean Shore along the Oregon Coast that extend between the mouth of the Columbia River South Jetty on the north and the California/Oregon border on the south (approximately 230 miles of beach). The Ocean Shore includes the area from extreme low tide to the actual or statutory vegetation line, whichever is most landward. The Ocean Shore does not include estuaries or river mouths, which are under the jurisdiction of the Oregon Department of State Lands.

Federal land ownership does occur within the Ocean Shore above the mean high tide line, but does not affect the definition of the boundary of the State's Ocean Shore. Covered lands for the HCP do not include the Federal lands within the Ocean Shore boundary because actions that may occur on Federal lands, regardless of who conducts the activity, would be the responsibility of the Federal landowner and would require separate consultation with FWS. If these Federal actions could result in effects on uses or natural resources within Oregon's coastal zone, the actions must be consistent with state enforceable policies, including OPRD's Ocean Shore authority as required by the Coastal Zone Management Act (CZMA). Special considerations related to implementing the HCP on Federal lands are discussed in Section 5.3, under the heading, "Public Use/Recreation" in the HCP and the Implementing Agreement (IA) as presented in Appendix H of the HCP.

In addition, specific portions of the following State Parks, State Natural Areas, and State Recreation Areas are included in the covered lands. The parenthetical reference after each listing reflects the name of the associated SPMA included in the HCP.

- Fort Stevens State Park (Columbia River South Jetty),
- Gearhart Ocean State Recreation Area (Necanicum Spit),
- Nehalem Bay State Park (Nehalem Spit),
- Cape Lookout State Park (Netarts Spit), and
- Bandon State Natural Area (Bandon).

1.2. Covered Activities

Activities covered in the HCP are described according to three categories:

- public use and recreation management,
- natural resources management, including snowy plover management and other habitat restoration activities, and
- beach management.

1.2.1. Public Use/Recreation Management

One of OPRD's responsibilities is to regulate activities on beaches and lands under its jurisdiction. Permissible recreational uses commonly observed on the covered lands include dog exercising, kite flying, non-motorized vehicle use, driving, and other dry sand activities such as camping, walking, jogging, and picnicking.

Under the proposed HCP, OPRD would manage the public's use of the covered lands to minimize potential effects on snowy plover. Recreational use restrictions currently in place, such as limitations on beach camping in State Parks, would remain in place in the future. Additional recreational use restrictions associated with management of SPMA and RMAs would also be implemented, as summarized under *Snowy Plover Management*. Special consideration for implementing recreational use restrictions at RMAs is discussed below. The following provides a description of permissible recreational uses on the covered lands, and the recreational use restrictions that would be implemented under the HCP.

Dog Exercising

Under existing conditions, dogs are required to be on leash within all Oregon State Parks, and on a leash, or under voice or signal command along the beaches in the communities of Seaside, Rockaway Beach, and Cannon Beach. This is both to protect the biological resources found along the beach, and to ensure the safety of beach visitors. Under the HCP, additional restrictions on dog exercising would be implemented at occupied and targeted SPMAs, as described under Section 1.2.2, Natural Resources Management - Snowy Plover Management below.

Kite Flying

Restrictions on kite flying would be implemented at occupied SMPAs and RMAs, as described under Section 1.2.2, Natural Resources Management - Snowy Plover Management below. Kite flying is currently not restricted.

Non-Motorized Vehicle Use

Non-motorized vehicle use, which typically occurs on the wet sand portions of the beach, includes bicycling, land sailing (riding a cart with a sail attached to it), kite-buggying (riding a sit-down buggy that is steered with the feet and powered by a kite), and kite-mountain boarding (riding an all-terrain skateboard which is powered by a kite). Under the HCP, non-motorized vehicle use would be prohibited at both occupied and targeted SPMAs, as described under Section 1.2.2, Natural Resources Management - Snowy Plover Management below.

Driving

Driving includes use of all-terrain vehicles/off-highway vehicles (ATV/OHV) and "street legal" motor vehicles, such as cars, trucks, and campers. The HCP does not propose to further limit ATV/OHV use, which would continue to be allowed at Sand Lake Recreation Area and Dunes National Recreation Area.

Under the HCP, use of street legal motor vehicles would be prohibited at occupied and targeted SPMAs and RMAs during the nesting season. Driving is already prohibited year round at several locations along the Oregon Coast, including Necanicum Spit, Nehalem Spit, Netarts Spit, Bayocean Spit, portions of the Bandon State Natural Area, New River, Sutton/Baker Beach, Siltcoos Spit, and Tenmile Estuary. Current restrictions are in place to protect the biological resources found along the beach, and also to ensure the safety of beach visitors.

Additional seasonal driving restrictions also would be implemented at South Sand Lake Spit and Coos Bay North Spit under the HCP if the sites became actively managed or occupied by nesting snowy plovers. Beaches closed to driving would be accessible only with a motor vehicle permit issued by OPRD, or in the event of an emergency. For more information about driving restrictions, see Section 1.2.2, Natural Resources Management - Snowy Plover Management below.

Other Dry Sand Activities

The public uses the dry sand portion of the Ocean Shore for a variety of recreational activities, including camping, walking, jogging, hiking, picnicking, horseback riding, beach fires, beachcombing, and driftwood collection and removal. The following restrictions would continue to be implemented under the HCP.

- **Camping**. Camping would continue to be allowed on the beach and dune areas next to beaches along the Oregon Coast, unless otherwise specified by a State rule that disallows that use (e.g., certain beaches in Tillamook County). Beach camping would continue to be prohibited on beaches adjacent to State Parks and within the city limits of Seaside, Cannon Beach, Manzanita, Rockaway Beach, Lincoln City, Newport, Bandon, and Gold Beach; North Manzanita city limits to the base of Neahkahnie Mountain; and from the Necanicum River to the Columbia River. The only places that camping would be allowed in State Parks would be in specifically designated campgrounds inland from the beach.
- **Horseback riding**. Horseback riding would continue to be allowed on all Oregon beaches, with the exception of those beaches located within the city limits of Rockaway, where equestrian use on the beach is prohibited by State rule. Horse concessions would continue to be allowed at Nehalem Bay State Park, and Baker/Sutton Beach.

- **Beach Fires**. Small recreational fires would continue to be allowed on the Ocean Shore, as long as they are located in open, dry, sandy areas, downwind of and below beachgrass and driftwood lines; and beyond 25-feet of a seawall constructed of wood or other combustible material. Under OPRD authority, fires could be restricted or prohibited during high fire hazard conditions.

Additional restrictions on the dry sand would be implemented at occupied and targeted SPMAs, as described under Snowy Plover Management below.

Recreation Management Areas

Within the Ocean Shore, there are several areas that are managed for snowy plover by other landowners. Although OPRD does not manage these lands, it is responsible for considering applications on lands within its jurisdiction from non-Federal landowners requesting that limits on recreational use be authorized when nesting populations of snowy plover are present. On Federal lands within the Ocean Shore, these restrictions would be implemented in cooperation with Federal landowners as described in the IA (Appendix H of the HCP).

Under the HCP, OPRD would potentially implement recreational use restrictions at up to 11 RMAs as the areas become occupied, or if unoccupied, are actively managed under a FWS-approved site-management plan. These 11 areas would include the five RMAs that currently support nesting populations of snowy plover (Sutton/Baker Beach; Siltcoos Estuary/Dunes Overlook/Tahkenitch Estuary; Tenmile Estuary; Coos Bay North Spit; and New River), and six RMAs that may be targeted by other landowners for management in the future (Bayocean Spit; South Sand Lake Spit; Tahkenitch South; Umpqua River North Jetty; Elk River; and Euchre Creek). For the purpose of this analysis sites were delineated based on their unique habitat characteristics, and the availability of habitat, snowy plover, and recreation data.

If an RMA becomes occupied, but a site management plan does not exist, OPRD will implement the recreational use restrictions described above on lands within its jurisdiction. As mentioned previously, at RMAs with Federal ownership, the recreational use restrictions would be implemented as indicated in the IA presented in Appendix H of the HCP. At non-Federal RMAs, OPRD will issue and continue to enforce recreational use restrictions within the full extent of the RMA until an agreement is reached between FWS and the landowner and/or a site management plans is developed and OPRD is notified of any changes that may modify recreational use restrictions to a more focused area.

In the event that a FWS-approved site management plan has been developed, OPRD will implement recreational use restrictions in cooperation with the landowner as directed by the site management plan. If an RMA is unoccupied, OPRD will only implement recreational use restrictions at the request of the landowner and after consultation with FWS and collaboration with ODFW.

OPRD would also seek to modify the State Rule to provide a mechanism for Federal RMA landowners noted above to implement and enforce seasonal recreational activities on an annual basis, if they meet the following terms and conditions. Petition to change the State Rule would occur after an ITP had been issued by the FWS, and would require that eligible landowners provide OPRD with documentation describing the following:

- management activities they would implement (e.g., installing fences and signs, enforcing access restrictions, and conducting public outreach and education);
- locations where those activities would take place; and
- documentation from FWS stating that the proposed management actions were reviewed and approved (e.g., an ESA Section 7 biological opinion or an approved ESA Section 10 HCP).

OPRD would also work with County and private landowners to provide supervision and enforcement at RMAs, and avenues for their enforcement authority.

1.2.2. Natural Resources Management

Snowy Plover Management

Management of Occupied Snowy Plover Management Areas

Under the HCP, up to five SPMAs (Bandon SPMA and the four currently unoccupied areas described below) would be managed as occupied over the term of the 25-year ITP. The habitat restoration area at the Bandon State Natural Area would be managed as the Bandon SPMA. Within 1 year of issuance of an ITP, a draft site management plan would be developed for FWS review. FWS approval would be obtained within 6 months of completing the draft plan. The site management plan would be implemented the following nesting season and would specify management prescriptions, including information on recreational use restrictions and enforcement, habitat maintenance, predator management, monitoring, and public outreach and education.

Recreational use restrictions at occupied SPMAs during the nesting season, including the Bandon SPMA, would include prohibitions on non-motorized vehicle use, kite flying, dogs, and use of the dry sand. Recreational use would be directed to the wet sand unless already prohibited by the HCP. Beach driving would be prohibited for areas where driving restrictions were not already officially in place.

Management of Targeted Snowy Plover Management Areas

Under the HCP, up to four currently unoccupied areas would be identified as SPMAs and targeted for possible restoration and management of nesting populations of

snowy plover over the term of the 25-year ITP. Three SPMAs would initially be managed by OPRD for nesting populations of snowy plover.

- Columbia River South Jetty;
- Necanicum Spit; and
- Nehalem Spit.

These three areas were identified by OPRD, the Oregon Department of Fish and Wildlife, and FWS as the areas under OPRD ownership with the greatest opportunities to implement snowy plover restoration and management activities. In addition, the resource agencies determined that these three areas could help support the viability of the Pacific Coast population by distributing the population along the Oregon Coast, while minimizing potential conflicts with continued recreational use in occupied areas.

Within 2 years of obtaining an ITP, OPRD would prepare site management plans for these three SPMAs. Similar to the site management plan for the Bandon SPMA, these plans would outline measures for attracting nesting populations of snowy plover, and would identify a series of management prescriptions, including seasonal recreational use restrictions (e.g. dogs on leash and driving prohibited), habitat restoration activities, predator management activities, monitoring, reporting, and enforcement activities, and public outreach and education activities. Active management would begin the nesting season after site plans have been approved by the FWS. FWS would be obtained within 6 months of the draft plan being completed.

One additional SPMA, Netarts Spit, could also be managed under the HCP if (1) Columbia River South Jetty, Necanicum Spit, or Nehalem Spit become occupied and (2) one of the following RMAs is not already under active FWS approved management for snowy plover.

- Bayocean Spit (owned/managed by the U.S. Army Corps of Engineers [Corps]);
- South Sand Lake Spit (under private ownership/management);
- Tahkenitch South (owned/managed by the U.S. Forest Service [USFS]);
- Umpqua River North Jetty (owned/managed by the USFS/Oregon Department of State Lands [DSL]);
- Elk River (under private ownership/management);
- Euchre Creek (under private ownership/management);

Under these circumstances, OPRD would commit to managing Netarts Spit for nesting snowy plover to ensure that a minimum of three unoccupied SPMAs would be actively managed at any given time over the term of the 25-year permit. In

addition, if Columbia River South Jetty, Necanicum Spit, or Nehalem Spit is not occupied within 5 years of active site management, and none of the other Recreation Management Areas identified above are being actively managed by other landowners, OPRD would prepare a site management plan for Netarts Spit.

Protections for Nests Outside of Targeted Areas

If a snowy plover should nest outside an occupied or unoccupied SPMA or RMA on the covered lands, OPRD will install fencing around the individual nest in coordination with the landowner, and will consider installing a nest exclosure after consultation with FWS. Specifically, OPRD will install a 50-meter-radius (164-foot) roped buffer around the nest that allows access along the wet sand, and will determine if use of an exclosure to protect the nest from predation is in the best interest of the nest. OPRD will also work with FWS and landowner to install signage, as appropriate, to indicate the presence of nesting snowy plovers. On Federal lands within the Ocean Shore, OPRD or the Federal landowner will implement measures as indicated in the IA presented in Appendix H of the HCP.

Predator Management

Under the HCP, OPRD would provide funding to manage snowy plover predators along the Oregon Coast. The level of funding would increase as additional SPMAs are targeted for management over the term of the 25-year permit.

Predator management funded by OPRD would be implemented by the U.S. Department of Agriculture (USDA) between February and August and would include both lethal and non-lethal methods. If for some reason the USDA discontinued predator management activities over the term of the ITP, OPRD would assume responsibility for implementing these activities at all actively managed SPMAs.

Snowy Plover Monitoring, Reporting, and Enforcement

Under the HCP, OPRD would provide funding to the Oregon Natural Heritage Information Center (ORNHIC) to monitor snowy plover numbers, evaluate habitat, and conduct compliance monitoring. OPRD would also continue to provide staff to conduct additional monitoring and surveying information as described in Section 5 of the HCP. The level of funding for these activities would increase as additional SPMAs are targeted for management over the term of the 25-year permit. OPRD would also compile information for submittal in an annual report to FWS as indicated in Section 5 of the HCP and use this information to evaluate the HCP effectiveness on an annual basis and with ODFW and FWS every five years.

In addition, OPRD would continue to fund three full time beach ranger positions to ensure compliance with beach restrictions. OPRD would also work with the Oregon State Police and/or local law enforcement offices to provide additional enforcement support, where necessary and possible.

Public Outreach and Education

Under the HCP, OPRD would continue to recruit and train volunteers to serve as docents for public outreach and education at the China Creek access to the Bandon SPMA. As new SPMAs became occupied, OPRD would recruit and train volunteers to serve as docents for public outreach and education as specified in that site's site management plan. OPRD would also provide signage to inform the public of the presence of nesting snowy plovers and the applicable recreational use restrictions at access points, nesting sites outside of SPMAs and RMAs, and at the boundaries of SPMAs.

Adaptive Management

As described in Chapter 5 of the HCP, six adaptive management actions have been incorporated into the HCP to allow monitoring data or other relevant scientific research to inform the conservation strategies describe above, and to allow OPRD and the FWS to minimize the uncertainty associated with gaps in scientific information or biological requirements. The circumstances where adaptive management will be implemented include situations where:

- biological monitoring reports indicate a decline in the snowy plover population along the Oregon coast;
- a snowy plover nest is found outside of an identified SPMA 3 years in a row;
- nest exclosures have been determined to be ineffective through monitoring efforts;
- nesting at currently unoccupied, actively managed SPMAs is unsuccessful;
- OPRD purchases a RMA that seems to provide better habitat potential than the proposed SPMAs; and
- the effects of the covered activities on wintering populations of snowy plovers are determined to rise to the level of take.

The specific measures that would be implemented in response to these conditions are discussed in Section 5.3.3, "Adaptive Management," of the HCP. Any adjustments in management practices will occur only with OPRD and FWS consensus unless otherwise noted under the adaptive management measures or changed circumstances discussed in Sections 5 and 7 of the HCP, respectively.

Other Habitat Restoration - Dune Management and Invasive Species Removal

Under the HCP, OPRD would manage dunes and remove targeted invasive species to provide habitat for native species, in addition to the habitat restoration activities targeted toward snowy plover (see Section 1.2.2, Natural Resources Management - Snowy Plover Management). These habitat restoration activities would be implemented on the portions of the covered lands owned or leased by OPRD over the term of the incidental take permit, and outside of the nesting season in areas occupied by snowy plover.

1.2.3. Beach Management

Under the HCP, OPRD personnel would respond to boat and marine mammal strandings; would implement public safety activities, and would participate in law enforcement activities in accordance with existing management practices and to minimize potential effects on snowy plover.

Response to Boat and Marine Mammal Strandings

OPRD personnel would respond to boat strandings and monitor salvage operations in accordance with existing management practices. Similarly, OPRD personnel would investigate, report, bury, or remove marine mammals from the Ocean Shore, as necessary. Depending on the remoteness of the beach and the time of year, some dead marine mammals would be left to decompose on the beach.

Responses to boat and/or mammal strandings may involve beach disturbance, driving and operating machinery, and increased pedestrian traffic. These activities would be conducted in a manner that minimizes potential effects on snowy plover, to the extent possible. In areas where nesting populations of snowy plover are known to be present, OPRD would work collaboratively with ODFW and FWS to ensure that encroachment into occupied SPMAs would be minimized.

Public Safety

Public safety activities involve maintaining emergency access points on lands owned by OPRD or leased by OPRD under agreement with the landowner; and, on all Oregon beaches, investigating reports of dangerous logs; where necessary removing those logs; monitoring, photographing, and documenting erosion and storm damage; investigating reports of hazardous materials on the beach; and implementing closures and coordinating the clean-up of spilled hazardous materials when necessary. OPRD would implement public safety activities in accordance with existing management practices and to minimize potential effects on snowy plover, to the extent possible.

Law Enforcement

Law enforcement activities include assisting law enforcement personnel with human injury/death investigations, as requested; monitoring and checking for valid recreational use permits; issuing citations; and patrolling beaches. Law enforcement activities would be completed by OPRD staff in accordance with existing management practices and to minimize potential effects on snowy plover, to the extent practical. Enforcement activities related to ensuring that recreational use restrictions associated with SPMAs are adhered to are described in Section 1.2.2, Natural Resources Management - Snowy Plover Management.

1.2.4. Changed Circumstances

Under the Federal ESA, changed circumstances are those changes during the course of an HCP that can reasonably be anticipated and planned for. OPRD and FWS have identified the following circumstance that could occur during the term of the ITP, and that could affect the ability of OPRD to properly implement the conservation strategies described in the HCP.

Listing of a New Species

If a currently unlisted species is federally listed as endangered or threatened pursuant to the ESA after the ITP has been issued, OPRD would request that FWS determine if there is potential for incidental take of that species to occur as a result of the covered activities in the HCP. If take is possible, OPRD would work with the FWS to either modify their management actions to avoid take of the species, or would request that the ITP coverage be extended to the newly listed species.

Global Climate Change and Rising Sea Levels

A growing body of research has documented changes in the biotic and abiotic environment that are a result of an increase in global temperature and the continued concentration of greenhouse gases in the Earth's atmosphere.

In coastal areas, one of the primary concerns associated with global climate change is the potential for sea levels to rise and for the frequency and intensity of coastal storm events to increase. In the event that rising sea levels result in a net loss of snowy plover nesting habitat over the term of the ITP, OPRD will discuss with the FWS appropriate implementation measures to address these changes. Future actions responding to this changed circumstance will be determined by consensus agreement between OPRD and the FWS, and will be based on the nature and extent of the effects associated with rising sea levels.

Chapter 2. Methods

2.1. Approach

This technical memorandum evaluates take based on trends in the number of snowy plover nests, eggs, chicks, and adults at the Bandon SPMA and at five other occupied RMAs on the Oregon Coast between 2000 and 2006. Conclusions about the take of individuals and habitat from covered activities were based on both quantitative analyses and qualitative estimates. Whenever possible, a quantitative approach was used. Specifically, existing data on the level and types of recreational use on Oregon beaches (Oregon Parks and Recreation Department 2005) were used to assess the potential effects of public recreational use on snowy plover. A qualitative approach was used for other covered activities (e.g., beach management) because data were not available on the frequency of those other activities.

Our take assessment for covered activities included the following steps:

1. Assess population performance at occupied sites during the past 7 years of monitoring data for nests, eggs, hatchlings, fledglings, and adults using life tables and population models.
2. Link recreation activities to population performance based on the correlation between life table information and OPRD estimates of the frequency of each activity.
3. Qualitatively assess which activities are resulting in take based on the strength and shape of the correlations developed in step #2.
4. Model "take" for all relevant activities by estimating the annual production of nests, eggs, hatchlings, fledglings and adult equivalents with and without each recreational activity.

2.2. Assessing Population Performance

The snowy plover uses the Ocean Shore for nesting, feeding, rearing of chicks, and roosting. This species' population has declined over the years primarily as a result of human interactions (e.g. development, introduction of predators, habitat modification through the introduction of European beachgrass [*Ammophila arenaria*], and recreational activities).

Nesting birds at coastal locations consist of both year-round residents and birds that migrate for the winter (Page et al. 1995). Snowy plovers begin arriving at their Oregon breeding sites in early March (Wilson 1980). Since some individuals nest at multiple locations during the same year, birds may continue to arrive through July. On the Oregon Coast nesting may begin as early as mid-March (Wilson-Jacobs and

Meslow 1984), with peak nest initiation occurring from mid-May to early July (Stern et al. 1990).

Egg-laying usually takes 4 to 5 days (Warriner et al. 1986). The usual clutch size is three eggs (with a range of two to six eggs) (Page et al. 1995). Single egg clutches are almost always abandoned (Warriner et al. 1986). Sustained incubation begins after the third egg is laid and lasts approximately 27 days (Warriner et al. 1986). Snowy plovers readily re-nest after loss of their eggs (Wilson 1980, Warriner et al. 1986). Up to five re-nesting attempts have been observed for a pair (Warriner et al. 1986). After hatching, females typically leave the male to rear the brood to fledging and attempt to re-nest with a different male. This allows the female to find a new mate and lay a second and occasionally third clutch of eggs (Page et al. 1995). Along the Oregon Coast, hatching occurs from mid-April through mid-August, and the young fledge approximately one month (mean = 31 days) after hatching (Warriner et al. 1986). Peak hatching occurs from June through July, and most fledging occurs from mid-July through August, though some individuals from late nests may not fledge until the third week in September.

The life-cycle of snowy plover operates on the daily and monthly timescales described above. In contrast, the data describing nest, egg, hatchling, fledgling, and adult abundance by site are based on annual counts. Individual bird, nest, and clutch performance estimates are not available. To address inconsistencies in the time scale of different life stages, an annualized stage-structured life-cycle was used to create life-tables and assess population performance (Figure 1).

Figure 1. Stage-Structured Life Cycle for Snowy Plover

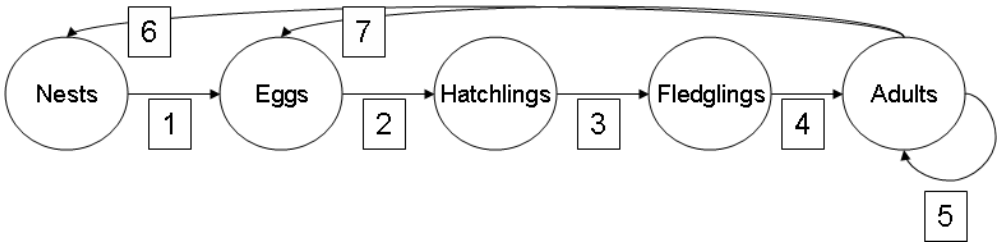


Figure 1 Notes: The numbered arrows represent survivals and fecundities; 1) eggs per nest, 2) egg to hatchling survival, 3) hatchling to fledgling survival, 4) fledgling to adult survival, 5) annual adult survival, 6) nest production, and 7) fecundity (eggs per adult).

Population performance was assessed by comparing the number of individuals in one life stage to the number of individuals in the next life stage (e.g. survival from egg to hatchling or hatchling to fledgling). Population data were organized by site, year, and life stage to produce life tables, which were used to describe population performance in terms of:

- Abundance: number of individual animals
- Fecundity: number of offspring produced per adult (as explained below)

- Survival: the annual rate of change in abundance one life stage to the next.

Abundance provides a useful measurement of population performance. A time series of nest attempts, egg, chick, hatchling, and adult abundance were developed for each site, and for all sites combined. Due to the high-mobility of snowy plover and the multiple life stages they pass through, however, abundance alone could not be used to assess population performance or take from covered activities. For example, a site might be attracting many adult birds year after year, but fail to produce many hatchlings or fledglings, resulting in a long-term population decline. As a result, fecundity and survival metrics were also used to evaluate population performance.

Fecundity can be expressed in a variety of ways. Often, it is expressed in terms of eggs per female, number of female young per female, or eggs per mating pair. However, due to the high-mobility of snowy plover, multiple nest attempts of both males and females, and the species' promiscuous behavior, it is not reasonable to directly assess the number of eggs or chicks that any particular female "produced." Instead, fecundity was estimated in terms of the number of eggs produced in one year divided by the maximum number of birds that were surveyed at a site during the same year.

Survival can be expressed in numerous ways as well. For organisms that have simple continuous reproduction and indeterminate growth (e.g., earthworms), survival is often expressed in terms of the survival from one week, month, or year to the next. The survival of snowy plover is more complex because a) the life-span of individual adults is not known, b) survival occurs across multiple discrete life stages (i.e., nests, eggs, hatchlings, fledglings, adults), c) the length of each life stage differs (i.e., adults live throughout a year, whereas other stages are shorter), d) multiple nesting attempts are made annually, and e) due to their migratory nature, snowy plover survival is affected both in and outside of the management areas.

In this memorandum, snowy plover survival has been expressed in terms of average survival from one life stage to the next for all juvenile life stages. In terms of adult survival, the modeling conventions used in the snowy plover viability analysis from the draft Recovery Plan (Fish and Wildlife Service 2001) were followed. It was assumed that annual adult survival was the same for all age classes and sites, and averaged 75%. Since the sex ratio of the juvenile life stages is unknown, a 1:1 ratio was assumed. Similarly, although emigration and immigration likely contribute to population performance at any given management site, these elements were not considered since they operate at scales that are larger than the covered areas and activities.

Life Tables and Lambda

Abundance, fecundity, and survival, collectively called "vital rates," are indicators of population performance. An additional useful indicator of population performance is

the rate of historical or future change expressed as the intrinsic capacity for change or "lambda." Lefkovitch (1965) described the process for calculating the intrinsic capacity (lambda) life tables for stage-structured populations, such as snowy plover. This process was used and average abundance, fecundity, and survival for each population and life stage between 2000 and 2006 were estimated. Ramas EcoLab version 2.0 was used to estimate lambda for each site and the collection of all sites (Caswell 2001). The matrix configuration used for these estimates is described below (Table 1).

Table 1. Stage-Based Matrix Model Structure and the Vital Rates for Snowy Plover Used In This Take Assessment

	Eggs	Hatchlings	Fledglings	Adults
Eggs	--	--	--	Fecundity (eggs per adult)
Hatchlings	Egg to hatchling survival			--
Fledglings	--	Hatchling to fledgling survival	--	--
Adults	--	--	Fledgling to adult survival	Annual adult survival (75%)

Notes:

Due to limitations in the data, this take assessment did not directly address the impacts of activities on adult recruitment or survival, except as they relate to the production of eggs, hatchlings, or fledglings. These variables were set to 100% for the take assessment modeling described below.

Lambda is a fairly intuitive measurement of population performance in its application. In theory, a lambda greater than 1 means that the population abundance will increase in the future. A lambda less than 1 suggests that population abundance will decrease in the future. However, since lambda is usually calculated using historical information, it is not always a good predictor of future performance. Rather, it is best to consider lambda in terms of a population's past performance, and its likely performance in the very near term: next year perhaps. An even more conservative use of lambda might be to consider it as an indicator of the population's preparedness for growth (i.e., is the population poised to increase or face additional decline). In combination with life-stage-specific estimates of abundance, fecundity, and survival through time, lambda is a useful indicator of population performance on the whole.

2.2.1. Linking Recreation Activities and Population Performance

A simple correlation analysis was used to assess whether covered activities might be related to population performance. The benefit of simple correlation analysis is that the analysis works well with relatively small sample sizes. The disadvantage of simple correlations is that the analysis is not sensitive to spurious relationships. For

example, if multiple factors are impacting population performance in different ways at all sites, it may not be immediately apparent in the results. Therefore, some interpretation and careful scrutiny is required. A more sophisticated approach would involve what is called "de-trending." De-trending analysis involves removing the effects of all variables on population performance, and then re-assembling the relationship between covered activities and population performance site-by-site, and activity-by-activity. A de-trending analysis was attempted with the snowy plover data set; however, the sample size (number of sites and years) was too small to produce valid models. This analysis might be more informative if conducted using a longer time series; however, this is not appropriate for the snowy plover dataset because the management regime has changed dramatically in recent history.

A simple Pearson's correlation coefficient analysis was used to assess the relationship between recreation activities and population performance. This analysis included a simple line-fitting exercise where the outcomes (abundance, fecundity, survival, or lambda) were graphed against the recreation activities by site. The results of the analysis include a simple line formula that describes the relationship between the activity (x) and the outcome or performance metric (y), using a line function where:

Equation 1: $y = mx + b$

The variables m (slope) and b (intercept) describe the line of fit between the level of recreation and the performance metric. The analysis also includes the Pearson's correlation coefficient; a statistic from 0 to 1 that describes the percent "*goodness of fit*" between the level of each activity and the outcome across all sites. In short, the correlation coefficient demonstrates how much of the variability in the outcome (population performance) can be explained by the impact of the activity (recreation or restoration). Variables that are positively related and have a strong correlation (i.e. more restoration results in more eggs over time) would have a positive slope and a large correlation coefficient. Variables that are not related to each other could have any slope, but would have a comparatively small correlation coefficient. For this analysis, variables (recreation activities) of interest include those that have a negative relationship and a strong correlation, suggesting decreased population performance associated with a specific covered activity. For some relationships, a non-linear version of Equation 1 known as the quadratic equation was used, but the formula still holds the form of slope (m), intercept (b), and the dependent and independent variables x and y.

A simple decision tree was used to determine which estimates of activities (recreation and restoration) most clearly explained activities that might be negatively impacting the performance of populations. First, correlations between all activities and all performance measurements were calculated. Next, these correlations were evaluated to determine if, a) the slope of the relationship was greater than or less then 1, and b)

the correlation coefficient was greater than 0.10 (e.g. does the presence of the activity explain at least 10% of the variability observed in the population performance). If the correlation coefficient was less than 0.10 the relationship between the activity and population performance was too weak to make judgments about how the activity could be impacting performance. Overall, this approach determined whether increased activity was resulting in decreased population performance for a given life stage.

2.2.2. Take Assessment Modeling

There is no "right" or "correct" model for estimating take. Qualitative, quantitative, and Bayesian approaches have all been used. Quantitative assessments can be more informative, but require more data and careful thought (Caswell 2000; Hitchcock 1996). In determining which model to use, it is important to design an approach that produces a reasonable and scientifically supported estimate of take, based on the data and information that is available. In addition, take assessment modeling should produce results in terms that are easily translated into management actions, and which can be readily explained to stakeholders. The most robust approach to assessing the impacts of anthropogenic activities is to construct a simulation that assesses population performance under different scenarios through long time periods (Caswell 1989). However, these more complex analyses are not appropriate for models constructed from data where the abundance or environmental conditions (such as the availability of habitat or predator management activities in this case) have changed dramatically during the period of record. In the instance of snowy plover, where both population performance and environmental conditions have changed recently, a more simplistic approach is recommended (Burnham 1998).

Caswell (2001) recommends assessing the relationship between environmental conditions (including recreation activities) and each vital rate independently. In the case of snowy plover there are multiple vital rates (four survival rates plus fecundity) and multiple activities (recreation and restoration). The activities occur at multiple sites. This variable set is too complex for a simple factorial or "experimental" design and requires a multiple regression analysis.

Standard least squares multivariate regression modeling was used to estimate take associated with each of the activities. For each vital rate (fecundity, survival, and lambda), a standard least squares regression was run for the activities that passed the screening exercise described above (i.e. $r^2>0.10$, and $p<0.20$). This threshold is considered to be biologically significant. The multivariate regression model produced a line function that described the relationship between the vital rate (y) and the combined influence of the recreation activities (x) in the form of:

Equation 2: $y = m_1X_1 + m_1X_1 + \ldots. m_xX_x + b$

As with the simple regression, the variables m_x (slope) and b (intercept) describe the line function for the relationship. This analysis also generated an R^2 (note: "r^2" was used for simple correlations and "R^2" for multivariate regressions) value that describes the "goodness of fit" between the multivariate model and the performance metric, and a "p" that describes the statistical significance of the multivariate model. An estimate of the vital rate that might result in the absence of the activity was then calculated for each site. This was accomplished by setting the variables "x" to zero, thus removing their influence on the estimate "y." This modeled estimate of "y" described what the population performance might be if the relevant activities were absent, but all other conditions remained the same. This evaluation was completed for each recreational activity and each vital rate. This information was organized into a new life table that described snowy plover survival and fecundity without the influence of each individual activity, as well as one table that described survival and fecundity in the absence of all recreation activities.

Finally, the changes in survival and fecundity associated with each activity were translated into estimates of abundance. An average life table was developed for all currently occupied SPMAs and RMAs. The modeled survival and fecundity estimates were inserted, and the resulting annual abundance was estimated. The difference between the current level and the modeled production of nests, eggs, hatchling, and chicks was equal to the modeled estimate of take associated with the recreation activities.

2.3. Uncertainty and Assumptions

The snowy plover population has been monitored consistently along the Oregon Coast since the early 1990's. Data has been collected on the number of breeding birds along with nest and fledgling success each year. Due to the level of information available on the species, it is possible to carry out a more rigorous assessment of how the covered activities will impact the population during the ITP term rather than using habitat loss as a surrogate for impact on species, as is done in most HCPs. As described above, in this analysis, take was calculated by looking for correlations between covered activities and population performance and then quantified by the number of nests, chicks, adults, and habitat that might be lost during the ITP term. Still, there is a level of uncertainty associated with any take estimate. That uncertainty and how it was dealt with in this analysis is discussed below.

Controlling for Habitat Quality

As discussed in Warriner et al. (1986), Lafferty (2001a), Ruhlen et al. (2003), and FWS (2001a, 2001b, and 2005), there is an inherent uncertainty associated with assessing take in terms of nests, chicks, and adults. On beaches that are used for recreation the difficulty is often how to assign impacts to natural versus human

causes. Further, directly associating take with particular discrete activities can be difficult. For example, studies assessing the impacts of recreation on snowy plovers during the breeding season (Warriner et al. 1986; Persons 1998; Applegate and Schultz 2000; Ruhlen et al. 2003), and during the winter (Lafferty 2001b), noted that most of the time, the causes of mortality (such as nest failure) are unknown. Although biologists have been able to determine natural causes of impact, such as abandonment (i.e., when no humans were near) or nests being covered by windblown sand (Lauten et al. 2006), mortality resulting directly from human activity (e.g., chick being eradicated from nest by dog) is not typically documented. Take in the form of harassment can and has been documented; however, determining when cumulative instances of harassment equate to the loss of an individual or a nest was not possible. Therefore, this estimate of take includes direct take (i.e., mortality) and harassment of any kind. The results do not distinguish between these two forms of take.

Site size and access to each management site will impact habitat quality. Larger sites can offer larger "buffer" zones surrounding recreational versus nesting areas. Access points can increase traffic and the probability of encountering juvenile life history phases. These elements were included in the take assessment to account for their impacts on population performance. Access information for the currently occupied management areas is presented in Table 2.

Table 2. Size of and Access to the Occupied Management Areas

Site	Total Size of Site (acres)	Number of Access Points Adjacent to the Management Area
Sutton	384	3
Siltcoos North and South	140	3
Dunes Overlook	44	1
Tahkenitch North	119	0
Tenmile	95	2
Coos Bay North Spit	221	2
Bandon	154	2
New River	256	0

Also, the snowy plover breeding habitat quality on the Oregon Coast has changed in the last two decades. Management activities since 1994 have included habitat restoration and maintenance, monitoring, and predator control measures. These resource management activities have generally contributed to the creation of more, higher quality habitat for breeding snowy plovers on the Oregon Coast, and the population has increased substantially since that time. Most habitat restoration took place between 1994 and 2000, and since then the number of acres of restored breeding habitat has remained relatively stable (Table 3). Although snowy plover

population data is available since 1992, the conclusions presented in this memorandum are based on an analysis of data collected on population performance between 2000 and 2006 following the restoration process. As a result pre-and post-restoration data are not mixed, and the data used for the take assessment represent the ongoing effects of resource management activities, including habitat restoration. The decision to use the post-restoration data set reduces variation in the environmental conditions, increases certainty in the vital rates, and increases certainty in the take assessment.

Table 3. Number of Acres Restored at SPMAs and RMAs along the Oregon Coast

	Year Restored	Number of Restored Acres
Sutton/Baker Beach	1996	20
Tahkenitch	1995	25
Dunes Overlook North	1998	20
Dunes Overlook South	1998	20
Tenmile South	1995	25
Coos Bay North Spit	1998	170
Bandon	1998	50
New River	1998	160

It is anticipated that populations of snowy plover on covered lands would either continue to reside primarily in areas where they have been documented in the recent past, or would use areas proposed for management in the future. These include areas owned or leased by OPRD under the HCP (i.e., SPMAs [up to five]) and areas managed by other landowners (i.e., RMAs [up to 11]). For this analysis, it was assumed that the potential for take of snowy plover would only occur in these areas, and the locations have been summarized in Chapter 1. This assessment does not incorporate individual bird movements or metapopulation dynamics. In other words, it was assumed that the adult birds that were observed on a site were part of the population of birds that were contributing to nest, egg, and chick production. While this is not completely "biologically accurate" it serves as an index of the number of adults present relative to the overall productivity of a site and allows for modeling of the population.

The conclusions drawn in this memorandum assumed that impacts to snowy plovers in the future would be similar to what has been observed in the recent past (2000-2006), and that management of SPMAs and RMAs would be similar to ongoing management (i.e., habitat restoration/maintenance, recreational use restrictions, predator control). Further, it was assumed that management at the unoccupied SPMAs would be similar to the management at Bandon SPMA. This assessment

should be reconsidered if management of any of these areas, including lands owned by other landowners (RMAs), would be significantly altered during the term of the 25-year ITP.

It should also be noted that the dynamics of the snowy plover population along the Oregon Coast would change over time. Although the assessment was based on population performance metrics between 2000 and 2006, these metrics would likely change over the 25-year permit term. As such, the assessment of take should also change to reflect the most current population performance. During the 25-year permit term, it is recommended that the thresholds for incidental take be reassessed every 5-years to reassess assumptions made in this assessment.

Uncertainty and Assumptions in Modeling

Most real-world ecological phenomena are multifaceted, interrelated, and difficult to explain. Ecologists and population biologists use models to support management and planning because ecological systems are so complex. Models are simply representations or simulations of the "real-world" and are neither correct nor incorrect. They are neither true, nor false, and should be judged in terms of their explanatory power and utility. Two types of modeling were used in this take assessment; life table modeling and regression analysis. A formal decision tree was used to design each of the models. Caswell (2001) outlines the process for selecting and designing life-table based models. Life tables are collections of historic observations from different life-stages, and vital rates describing movement from one stage to the next. Although there were no assumptions or uncertainties associated with the life-tables themselves, their quality was subject to uncertainty in the data that went into them. For this take assessment, it was assumed that the nest, egg, hatchling, fledgling, and maximum adult observations were representative of recent performance.

Lambda was calculated directly from life tables for each site and for all sites combined. The estimation of lambda is subject to uncertainties in life-table data, and to assumptions in the design of the matrix, as described above. For this take assessment adult mortality was not considered. In addition, "nest to egg survival" was not considered, based on the assumption that nests themselves do not limit production, but that adults do. Localized impacts of covered activities on vital rates were also used, rather than metapopulation dynamics (immigration and emigration). The re-sighting of color-banded snowy plovers has shown that the Oregon snowy plover population is immigrating and emigrating adults annually (Lauten et al. 2006). These dynamics could be addressed in the future using a metapopulation matrix model based on bird movement data, but it would have limited applicability because migration and over-wintering survival operate at scales that are larger than the covered areas and activities.

Numerous assumptions and uncertainties were also associated with the regression modeling. Regression models are based on the correlation between variables. A correlation exists between two variables when one of them is related to the other in some way. Correlations have a shape, slope, statistical power, and significance level. The shape of correlations were not considered in this analysis due to the small number of sites and vital rates available; concerns of non-linearity are best reserved for larger data sets where non-linear regressions can be carefully designed. Slope, statistical power (r value), and significance levels (p value) were considered to reduce uncertainty in the take assessment. The slope of each correlation was used to include or exclude specific relationships when analyzing take in association with a specific vital rate.

Some indicators (proxies) of recreation and restoration were statistically significant, and were used to estimate take. For this analysis it was assumed that the relationship was having an effect if the model had a negative slope, explained at least 10% of the variability in the vital rate, and was biologically significant ($p<0.20$). Several correlations that did not meet these parameters were excluded from the assessment. These exclusions may have increased uncertainty in the take assessment because activities that were excluded may be impacting a vital rate in some way that is not apparent in the data, or could result in take in the future.

Several specific activities appeared to be positively correlated with survival (Table 6), although the significance of these correlations was relatively low. It is possible that these recreational activities are cross-correlated with each other, that their impacts are confounding, or that the activities are correlated with some other variable unrelated to (but somehow correlated with) snowy plover performance. However, the true impacts of specific recreational activities on snowy plover performance remain somewhat uncertain.

Finally, correlation and regression models are used to associate one variable with one or more other variables. They do not determine cause-effect relationships. The data that directly describe take for snowy plover are rare or do not exist. For example, there has not been a robust study of the direct displacement of adults or fledglings by joggers. For this take assessment, it was assumed that the recreational activities that have been regularly observed and documented are the likely causes of take. Other indirect and undocumented causes are conceivable. These should be explored in the future if new information becomes available.

Chapter 3. Population Performance

The breeding snowy plover population has been increasing on the Oregon Coast since consistent monitoring started in 1992. The number of breeding snowy plovers and the productivity of nesting individuals at each occupied site have fluctuated between years, likely depending on management regime, restoration activities, habitat quality, food availability, and the presence of potential mates.

The snowy plover population along the Oregon Coast increased from 2000 – 2006 as did the number of nests, eggs, hatchlings and fledglings (Figure 2). Offspring appear to be increasing faster than adults, but overall, the increase in adults over time has a "good fit" for linear growth ($R^2 = 0.73$). These data are presented for all years in Table 4a and include data from Sutton Beach, Siltcoos Estuary RMA, Dunes Overlook RMA, Tahkenitch Estuary RMA, Tenmile Estuary RMA, Coos Bay North Spit RMA, Bandon State Recreation Area SPMA, and New River Estuary RMA.

The following individual analyses (presented in this chapter) and the coast-wide analysis (presented in Chapter 4) are based on the population information presented in Table 4a with some modifications. Necanicum Spit, Floras Lake, and Sutton Beach were excluded from the individual analyses because there were inadequate data for these sites due to the low number of observations collected over a limited number of years. In addition, proxy data for Sutton Beach were used in the coast-wide analysis (presented in Chapter 4) in order to be able to include information from this site. The number of nests and fledglings recorded at Sutton Beach were used to determine 1) the number of eggs that were likely present and 2) the number of young that hatched during each year based on similar relationships at other sites. Without these proxies the data from Sutton Beach would have been incomplete and unusable for model development. The modified data used in the coast-wide analysis is presented in Table 4b.

Figure 2. Changes in Snowy Plover Population along the Oregon Coast (2000 To 2006)

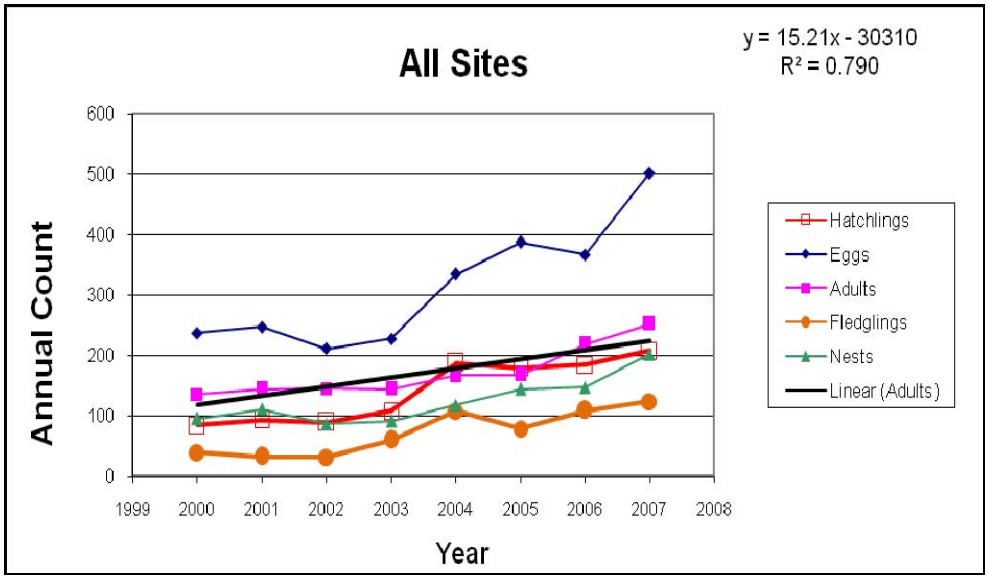


Table 4a. Life Table for All Snowy Plover Monitoring Sites within the Covered Lands

Year	Number of nests	Number of eggs laid[1]	Number of hatchlings[2]	Number of fledglings	Maximum number of adults observed
2000	100	237	84	43	136
2001	111	247	93	32	144
2002	89	211	89	31	145
2003	91	227	108	60	144
2004	117	334	187	108	166
2005	144	387	179	78	167
2006	147	367	184	110	219
2007	202	502	208	123	252
All years	799	2010	924	462	1121
Annual Average	114	287	132	66	160

[1] This column does not include number of eggs laid at Necanicum Spit, Sutton Beach, or Floras Lake.

[2] This column does not include number of hatchlings at Necanicum Spit, Sutton Beach, or Floras Lake.

Table 4b. Snowy Plover Metrics Used in Regression Models

Year	Number of nests[1]	Number of eggs laid[2]	Number of hatchlings[2]	Number of fledglings[1]	Maximum number of adults observed
2000	95	258	94	39	136
2001	111	292	114	32	144
2002	86	220	93	31	145
2003	91	230	109	60	144
2004	117	334	187	108	166
2005	144	387	179	78	167
2006	147	379	190	110	219
All years	791	2100	966	458	1121
Annual Average	113	300	138	65	160

[1] The numbers in this column do not include data from Necanicum Spit or Floras Lake. Those sites were not included in the analysis because they did not meet minimum data requirements.

[2] The numbers in this column to do not include data from Necanicum Spit or Floras Lake. The numbers do include a proxy data set created for Sutton Beach that was derived from the relationship of other variables. For example, the number of eggs laid at Sutton Beach was based on the number of nests recorded there and derived from the nest-to-egg ratio observed coast-wide.

With the exception of migration, the Oregon snowy plover population's life cycle is discretely contained within the stages listed in Table 4a, and depicted in the life-cycle diagram in Figure 1. The annual vital rates for all sites combined are presented in Table 5, and provide a picture of population performance within years, as well as summed across years. Lambda was positive during this period (lambda = 1.072), and each nest held an average of 2.65 eggs. The probability that an individual survived from egg to hatchling and hatchling to fledgling was 45% for both rates (Table 5). Nests-per-adult was less than one because the rate includes males, females, and non-reproductive adults. The intrinsic capacity for all sites peeked in 2004 due to high fecundity and strong egg and hatchling survival. It was lowest in 2001 due to low fecundity and low survival.

Table 5. Vital Rates for All Snowy Plover Monitoring Sites within the Covered Lands

Year	Fecundity	Nests per adult	Eggs per nest	Egg to hatchling survival	Hatchling to fledgling survival	Fledgling to adult survival	Lambda
2000	2.15	0.70	2.72	0.36	0.42	2.51	1.02
2001	1.53	0.77	2.63	0.39	0.28	3.69	0.98
2002	1.59	0.60	2.56	0.42	0.33	4.52	1.01

Year	Fecundity	Nests per adult	Eggs per nest	Egg to hatchling survival	Hatchling to fledgling survival	Fledgling to adult survival	Lambda
2003	2.33	0.63	2.53	0.48	0.55	4.63	1.12
2004	2.33	0.70	2.85	0.56	0.58	2.77	1.16
2005	2.27	0.86	2.69	0.46	0.44	1.55	1.07
2006	1.37	0.67	2.58	0.50	0.57	2.80	1.13
All years	1.94	0.70	2.65	0.45	0.45	3.21	1.072

Notes: Lambda is calculated using the matrix depicted in Table 1, and assumes birds that survive to adulthood survive throughout the time period (i.e. no post-fledgling mortality).

Following is a brief summary of population change and vital rates for each of the monitoring sites that were used in this take assessment. Some of the detailed data and vital rates were omitted for brevity. They are graphed in the sections below, and in the regression graphs in the following chapter.

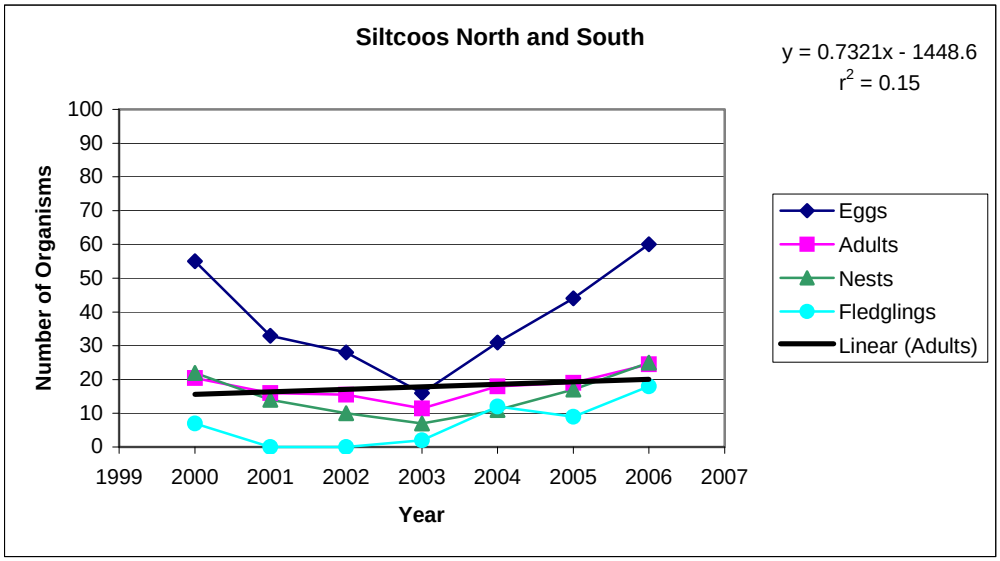
3.1. Siltcoos Estuary RMA

The Siltcoos Estuary RMA is owned and managed by the U.S. Forest Service (USFS). Snowy plovers have nested at this site since 1993. Predator management activities were started in 2004. Seasonal dry sand restrictions at this site have included restrictions on dog use during the snowy plover nesting season and year-round prohibitions on driving.

There were 12.63 people per mile reported along this section of beach during peak use with a dispersed distribution of visitors (Oregon Parks and Recreation Department 2005). The primary reasons that the public accesses the beach in this area is to walk/run (37%) or to relax (31%). None of the visitors surveyed reported bringing dogs to the beach and only 3% were flying kites. Kayakers and canoers at Siltcoos Estuary resulted in the most disturbances to snowy plovers, but these impacts were typically the result of the public accessing restricted areas (Oregon Parks and Recreation Department 2007).

The breeding population at the Siltcoos Estuary RMA increased (lambda = 1.01) between 2000 and 2006, with a down period in 2002 and 2003 (Figure 3). The number of eggs yielded by each nest at this site and the probability of survival from one life stage to the next is presented in Table 5.

Figure 3. Changes in Snowy Plover Population at Siltcoos Estuary RMA (2000 To 2006)



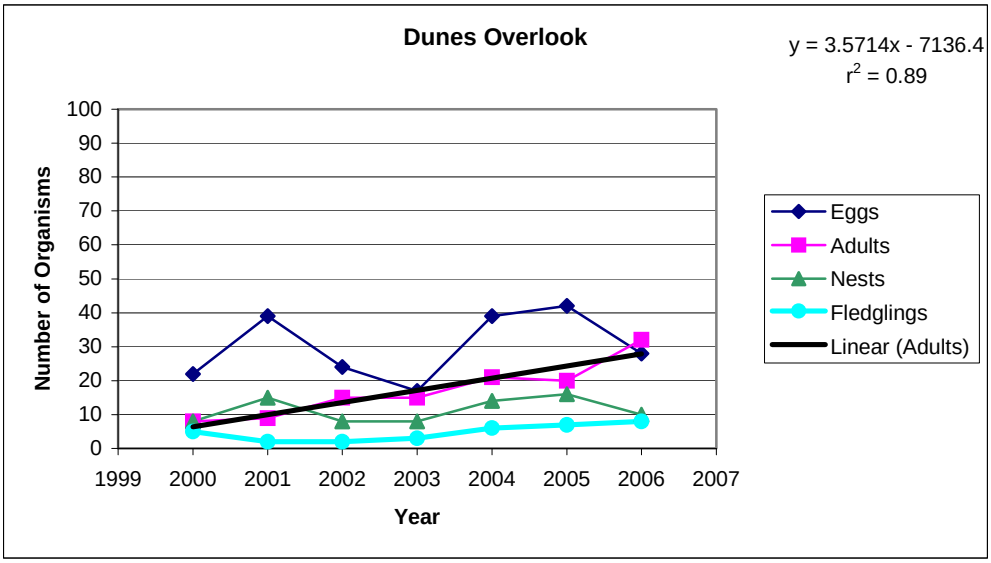
3.2. Dunes Overlook RMA

The Dunes Overlook RMA is owned and managed by the USFS. Snowy plovers have nested at this site since 1999. Predator management activities were started in 2004. Seasonal dry sand restrictions at this site have included restrictions on dog use during the snowy plover nesting season.

There were 4.91 people per mile reported along this section of beach during peak use with a dispersed distribution of visitors (Oregon Parks and Recreation Department 2005). The primary reasons that the public accesses the beach in this area is to walk/run (52%) or to relax (29%). Only 2% of those surveyed reported bringing dogs to the beach while 5% reported flying kites (Oregon Parks and Recreation Department 2005).

The breeding population at the Dunes Overlook RMA increased (lambda = 1.06) between 2000 and 2006 (Figure 4), with down periods in 2002 and 2003. The number of eggs yielded by each nest at this site and the survival from one life stage to the next is presented in Table 5.

Figure 4. Changes in Snowy Plover Population at Dunes Overlook RMA (2000 To 2006)



3.3. Tahkenitch Estuary RMA

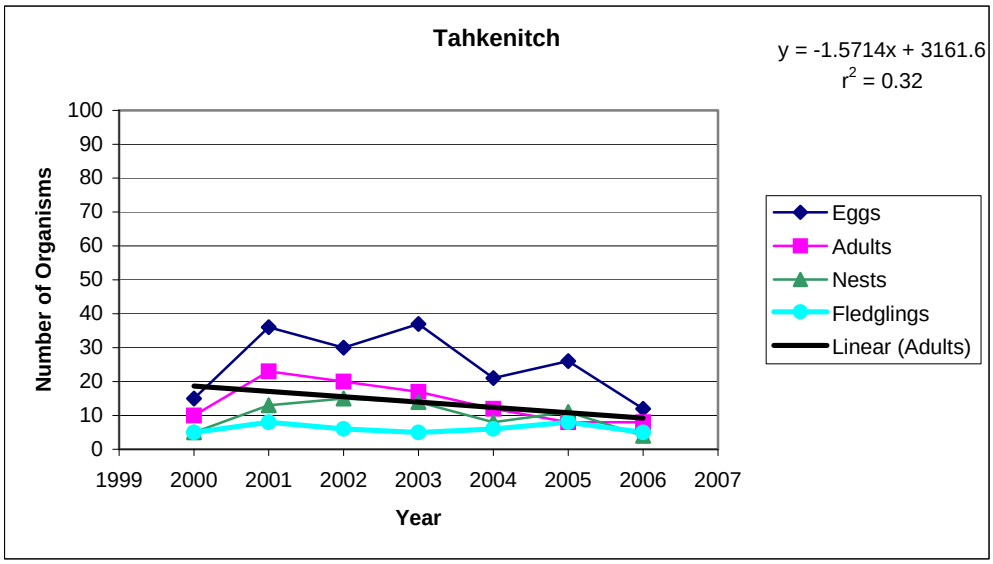
The Tahkenitch Estuary RMA is owned and managed by the USFS. Snowy plovers have nested at this site since 1994. Predator management activities were started in 2004. Seasonal dry sand restrictions at this site have included restrictions on dog use during the snowy plover nesting season.

In 2005, 6.55 people per mile were reported along this section of beach during peak use with a dispersed distribution of visitors (Oregon Parks and Recreation Department 2005). The primary reasons that the public accesses the beach in this area is to walk/run (39%) or to relax (24%). Only 3% of those surveyed reported bringing dogs to the beach while another 3% were flying kites (Oregon Parks and Recreation Department 2005).

The breeding population at the Tahkenitch Estuary RMA increased (lambda = 1.14) between 2000 and 2006 (Figure 5). Although the numbers of adults, nests, and fledglings have decreased at this site during the last 7 years, adults have continued to produce high numbers of eggs, which is likely keeping the population growth (lambda) positive even though the number of adults decreased. If the number of adults at Tahkenitch continues to decline, the number of eggs will eventually decline, lambda may eventually drop below 1.0, and the breeding population may eventually be lost.

The number of eggs per nest at this site and the survival from one life stage to the next is presented in Table 5.

Figure 5. Changes in Snowy Plover Population at Tahkenitch RMA (2000 To 2006)



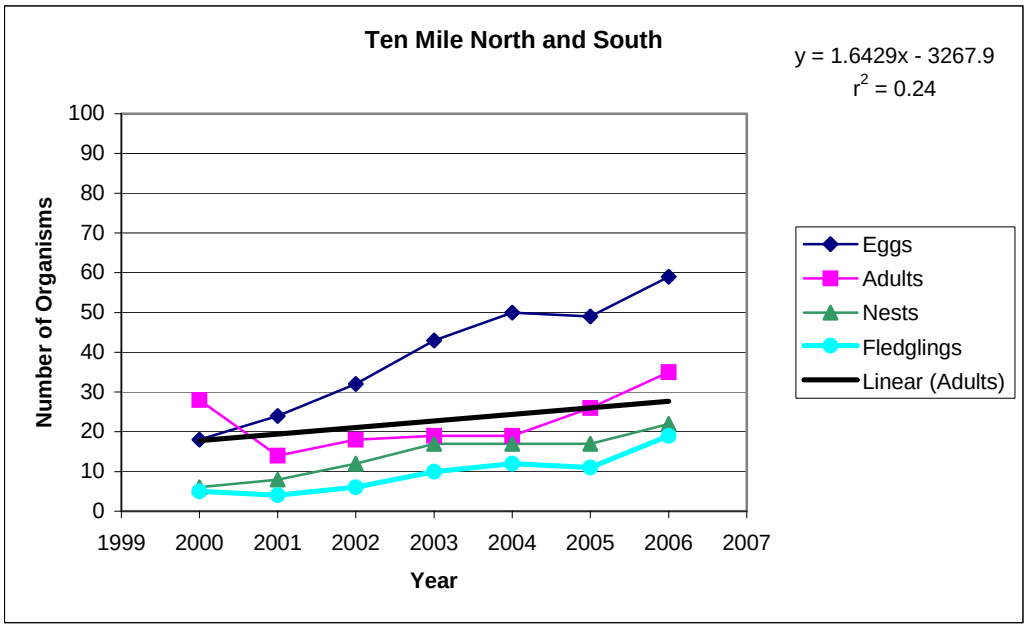
3.4. Tenmile Estuary RMA

The Tenmile Estuary RMA is owned and managed by the USFS. Snowy plovers have nested at Tenmile Estuary habitat restoration area (HRA) since 1992. Predator management activities were started in 2004. Seasonal dry sand restrictions at this site have included restrictions on dog use during the snowy plover nesting season and year-round prohibitions on driving.

Public use at this site is low but occasional violations of imposed driving restriction have been observed (Oregon Parks and Recreation Department 2007). It was reported that there were 5.54 people per mile reported along this section of beach during peak use with a dispersed distribution of visitors (Oregon Parks and Recreation Department 2005). The primary reasons that the public accesses the beach in this area are to walk/run (26%) or to relax (31%). Of those surveyed, 7% reported bringing dogs to the beach while only 1% reported flying kites (Oregon Parks and Recreation Department 2005).

The breeding population at the Tenmile Estuary RMA generally increased (lambda = 1.01) between 2000 and 2006 (Figure 6). The number of eggs yielded by each nest at this site and the survival from one life stage to the next is presented in Table 5.

Figure 6. Changes in Snowy Plover Population at Tenmile Estuary RMA (2000 To 2006)



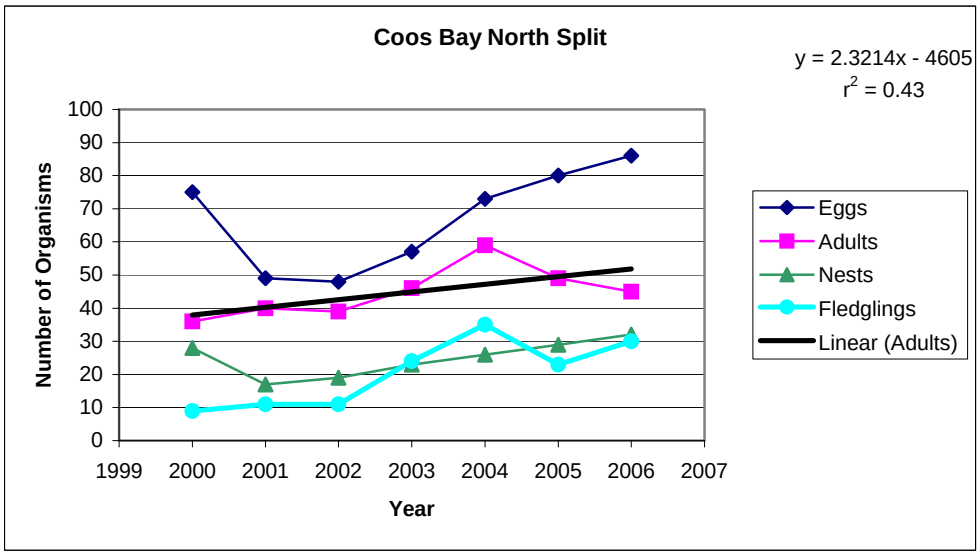
3.5. Coos Bay North Spit RMA

The Coos Bay North Spit RMA is owned by the Bureau of Land Management (BLM). Snowy plovers have nested at the Coos Bay North Spit RMA since 1990. Predator management activities were started in 2002. Seasonal dry sand restrictions at this site have included restrictions on dog use and driving during the nesting season, although some illegal ATV/OHV use has been observed (Oregon Parks and Recreation Department 2007).

It was reported by OPRD (2005) that here were 3.84 people per mile along this section of beach during peak use with a dispersed distribution of visitors. The primary reasons that the public accesses the beach in this area are to walk/run (16%) or to relax (21%). Of those surveyed 4% reported bringing dogs to the beach; nobody reported flying kites (Oregon Parks and Recreation Department 2005).

The breeding population at the Coos Bay North Spit RMA increased (lambda = 1.08) between 2000 and 2006 (Figure 7). The average number of eggs per nest at this site and the survival from one life stage to the next is presented in Table 5.

Figure 7. Changes in Snowy Plover Population at Coos Bay North Spit RMA (2000 To 2006)



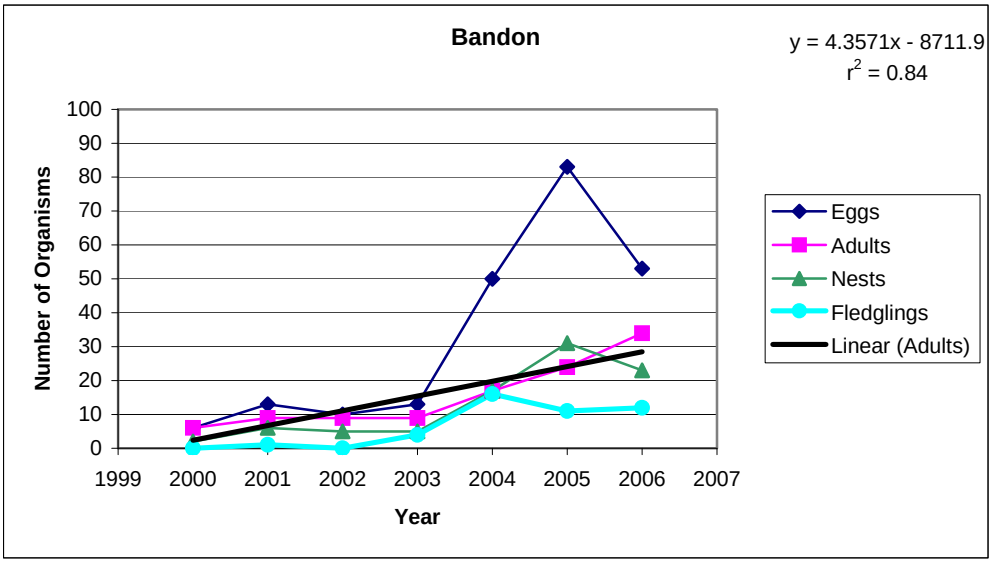
3.6. Bandon State Natural Area SPMA

The Bandon State Natural Area is owned and managed by OPRD. Snowy plovers have nested at the Bandon SNA since 1991. Predator management activities were started in 2002. Within the habitat restoration area, seasonal dry sand restrictions have included restrictions on off-leash dogs during the snowy plover breeding season and a year-round prohibition on driving.

In 2005, OPRD reported 13.22 people per mile along this section of beach during peak use, with a dispersed distribution of visitors. The primary reasons that the public accesses the beach in this area are to walk/run (47%) or to relax (27%). Of those surveyed 7% reported bringing dogs to the beach and 3% reported flying kites (Oregon Parks and Recreation Department 2005).

The breeding population at the Bandon SPMA increased (lambda = 1.02) between 2000 and 2006 (Figure 8). The average number of eggs per nest at this site and the survival from one life stage to the next is presented in Table 5.

Figure 8. Changes in Snowy Plover Population at Bandon SPMA (2000 to 2006)



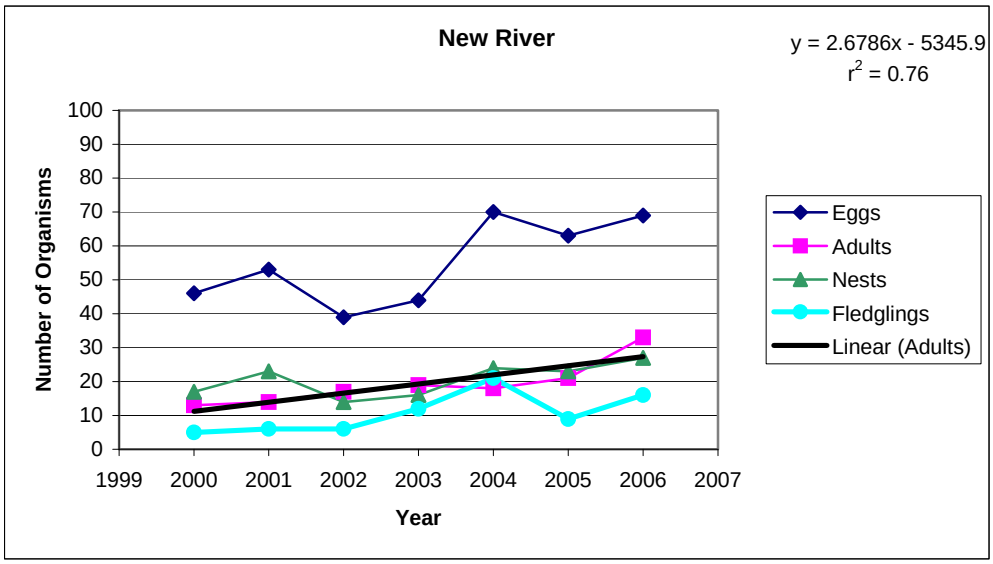
3.7. New River RMA

The New River RMA is owned and managed by the BLM and Coos County. Snowy plovers have nested at this site since 1990. Predator management activities were started in 2002. Seasonal dry sand restrictions at this site have included restrictions on dog use and driving during the nesting season.

In 2005, OPRD reported 3.45 people per mile along this section of beach during peak use, with a dispersed distribution of visitors. The primary reasons that the public accesses the beach in this area are to walk/run (71%) or to relax (12%). Of those surveyed 4% reported bringing dogs to the beach; nobody reported flying kites. An additional 9% reported accessing the site to surf (Oregon Parks and Recreation Department 2005).

In general, the breeding population at the New River RMA increased (lambda = 1.14) between 2000 and 2006 (Figure 9). The number of eggs per nest and the survival from one life stage to the next is presented in Table 5.

Figure 9. Changes in the Snowy Plover Population at New River RMA (2000 to 2006)



3.8. Columbia River South Jetty, Nehalem Spit and Netarts Spit SPMA

Under the HCP, OPRD would manage up to four currently unoccupied areas for nesting populations of snowy plover, including SPMAs at Columbia River South Jetty, Nehalem Spit, Netarts Spit, and Necanicum Spit (see Section 1.2.2 Natural Resources Management - *Management of Targeted Snowy Plover Management Areas* for a discussion of the circumstances under which these SPMAs would be actively managed). Necanicum Spit is discussed in Section 3.9.

Proposed management (i.e., habitat restoration) at the Columbia River South Jetty, Nehalem Spit, and Netarts Spit SPMAs would be similar under the HCP. The area restored at each site would be approximately 40-acres and the sites would be maintained for at least the duration of the ITP term. If it were implemented, restoration at Netarts Spit would likely be completed later in the term than the other two sites, and only if other targeted RMAs are not being actively managed by other landowners (Section 1.2.2 Natural Resources Management - *Management of Targeted Snowy Plover Management Areas*).

The number of people per mile along the stretches of beach that contain all three of these SPMAs is higher than the number of people per mile at all of the occupied areas discussed above. The number of people per mile on the beaches near Columbia River South Jetty, Nehalem Spit, and Netarts Spit are 17.28, 24.85, and 21.02 people per mile, respectively (Oregon Parks and Recreation Department 2005). While these

SPMAs may be located in isolated areas away from most beach activity, in general, the number of people on the beach near these SPMAs is higher.

The reasons that people access these beaches are the same as all of the occupied areas, i.e. relaxing, walking/running, and flying kites. It is not possible to anticipate how snowy plovers will respond to restoration and management at these SPMAs. However, based on the number of people on the beach and their types of activities, it is likely that the correlation between recreation activities and the different life stages of breeding snowy plovers would be similar to those observed at the occupied areas between 2000 and 2006, assuming that populations of breeding snowy plovers began using the SPMAs following restoration.

3.9. Necanicum Spit

In addition to SPMAs at Columbia River South Jetty, Nehalem Spit, and Netarts Spit, OPRD could also manage an SPMA at Necanicum Spit for nesting snowy plovers (see Section 1.2.2 Natural Resources Management - *Management of Targeted Snowy Plover Management Areas* for a discussion of the circumstances under which these SPMAs would be actively managed).

No seasonal dry sand restrictions are currently implemented at either of these sites. Proposed management of the Necanicum Spit is the same in the HCP (i.e., restoration is not proposed, but a change in management to favor snowy plovers is), so the potential for nesting or foraging snowy plovers to use these sites is considered to be similar. Necanicum Spit has not been regularly occupied by nesting or foraging snowy plovers (one nest was recorded at Necanicum Spit in 2002) since data collection started in 1992.

The number of people per mile on the beaches near Necanicum Spit is 17.28. Although the Necanicum Spit SPMA would be located away from most beach activity, the number of people on the beach near this SPMA is higher than what is currently experienced at other occupied nesting areas. The reasons that people access these beaches are the same as at the occupied SPMAs (Oregon Parks and Recreation Department 2005).

It is not possible to anticipate how snowy plovers would respond to changes in management at these SPMAs. However, based on the number of people on the beach and the types of activities that they are doing, it is likely that the correlation between recreation activities and the different life stages of breeding snowy plovers would be similar to those observed at occupied areas between 2000 and 2006, assuming that populations of snowy plovers begin using these sites following a change in management.

3.10. Breeding or Wintering Habitat outside of SPMAs and RMAs within the Covered Lands

The HCP covered lands include the sandy beaches of the Ocean Shore along the Oregon Coast between the mouth of the Columbia River South Jetty and the California/Oregon border (approximately 230 miles of beach). The Ocean Shore includes the area from extreme low tide to the actual or statutory vegetation line, whichever is most landward. Much of this area is outside of the specific SPMAs and RMAs described above. However, OPRD management activities that occur outside of those areas and along sandy beaches also have the potential to affect nesting populations of snowy plovers.

In particular, portions of the covered lands that were originally proposed for critical habitat designation in 2004 or that are designated as Recovery Beaches in the *Western Snowy Plover Recovery Plan* (Fish and Wildlife Service 2001), have some potential to support plovers year-round and could be affected by public use/recreation management. For reference, these sites include, but are not limited to, Bayocean Spit, South Sand Lake Spit, Tahkenitch South, Umpqua River North Jetty, Elk River, and Euchre Creek. Although none of these areas are occupied by snowy plovers currently (2006), some of them have supported the species on a limited basis in the past.

Chapter 4. Regression Analysis

The snowy plover HCP and this Take Assessment describe population change and vital rates at the various sites across time, and the relationship between those parameters and the covered activities. This will allow managers, planners, and biologists to focus efforts on the specific life-stages that are most vulnerable to take, and on the specific activities that impact these life-stages. As described in Chapter 3, the relationship between each vital rate and lambda using correlation analysis was first calculated. A formal perturbation analysis was not conducted due to limitations in the data set and the constraints these placed on the matrix models (Caswell 2001).

The activities that were impacting each vital rate were then identified using simple correlations between these variables, and screening for the models that had a positive slope, an $r^2>0.10$, and a significance level of $p<0.20$. Multivariate models between each vital rate and all of the activities that appeared to be impacting each rate were constructed. The regression analysis was completed by estimating a vital rate that was free from the impacts of the associated activities. These modeled vital rates were used to produce the take assessment in the following chapter.

This quantitative analysis was only completed for one set of covered activities, public use/recreation management, due to a lack of information on the frequency of occurrence for the other covered activities (i.e., natural resource management, beach management).

4.1. Relationship between Vital Rates and Intrinsic Capacity (lambda)

Two vital rates, survival and fecundity, were used to compute lambda. Survival was measured as egg to hatchling survival, the number of eggs per nest, and hatchling to fledgling survival. Changes in adult to adult and fledgling to adult survival were excluded from this analysis because these vital rates are not reflective of local conditions in the management area, and are impacted by environmental and anthropogenic conditions in the migratory and over-wintering areas. The relationships between each vital rate and lambda for each site were examined to understand which sites had high lambdas, and which vital rates were influencing the intrinsic capacity of these sites.

4.1.1. Survival

Egg to Hatchling Survival

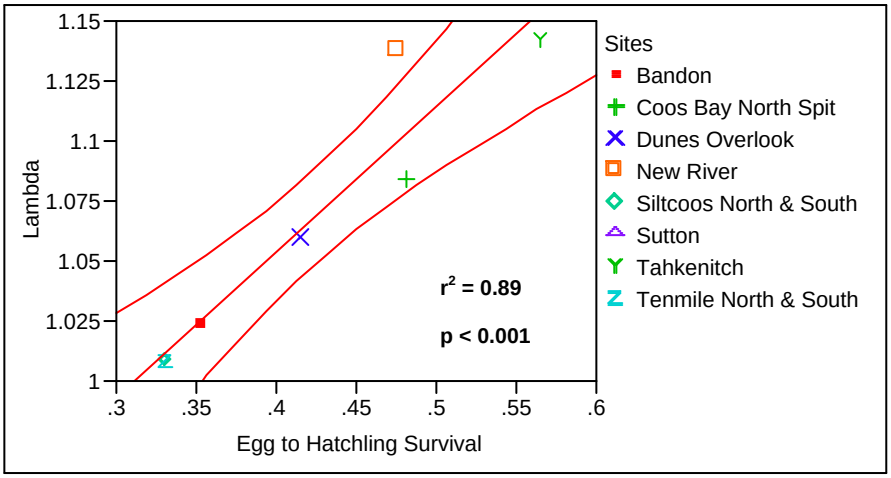
The vital rate that was the most strongly correlated with intrinsic capacity (lambda) from 2000 to 2006 was survival from egg to hatchling (Figure 10). The analysis indicated that approximately 89% of the variability seen in the population's intrinsic capacity from 2000-2006 (i.e., lambda) could be explained by changes in egg to hatchling survival based on the equation:

Lambda = -1.536466 + 0.994177 Nest to Egg Survival

As more eggs successfully hatched, the population increased; if this rate were to decrease, the growth of the population would slow.

Since egg to hatchling survival was closely tied to overall population change, egg to hatching survival was used to further examine correlations between recreation activities and population performance. That analysis is described below.

Figure 10. Relationship between Egg to Hatchling Survival and the Intrinsic Capacity (Lambda) from 2000 - 2006 along the Oregon Coast



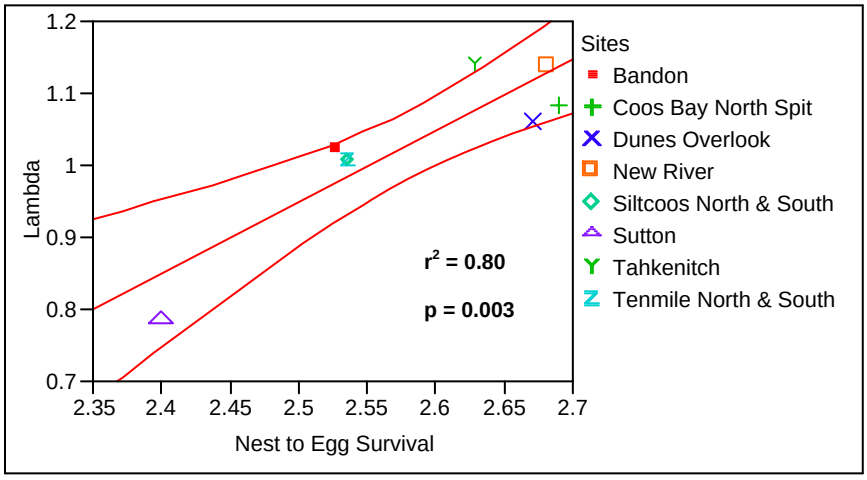
Eggs Per Nest

A second parameter that was correlated (R^2 = 0.80) with intrinsic capacity (i.e., lambda) from 2000 to 2006 was the number of eggs per nest (Figure 11*)* based on the equation:

Lambda = 0.8118152 + 0.605279 Egg to Hatchling Survival

Therefore, this vital rate was also examined to determine whether it was correlated with activities. The number of eggs per nest had a strong correlation with lambda, but it did not seem to be influenced by recreation on the beach. All of the recreation activities were examined individually and together and no revealing correlations were detected. Due to these weak correlations no further analysis was done on the number of eggs per nest in relation to covered activities, and no discussion is presented below. Instead egg and nest production was dealt with in terms of fecundity (Section 4.1.4).

Figure 11 . Relationship between Number of Eggs per Nest and Intrinsic Capacity (Lambda) from 2000 - 2006 along the Oregon Coast



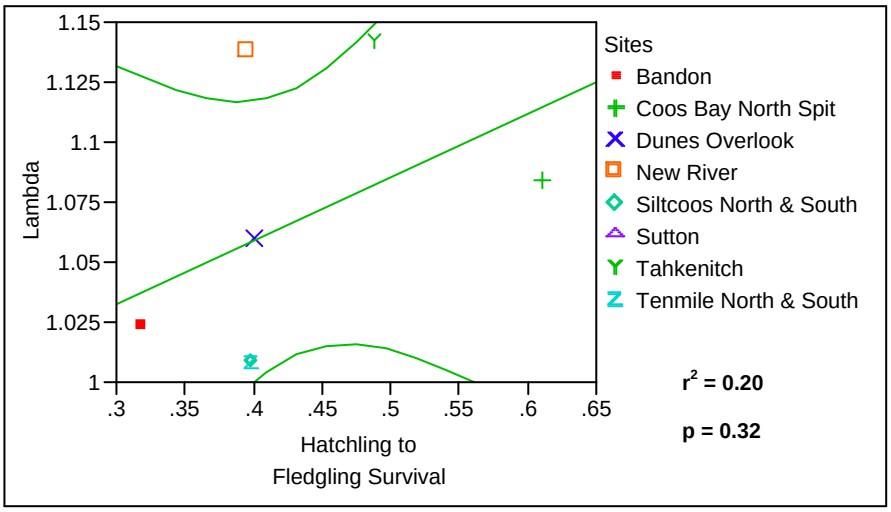
Hatchling to Fledgling Survival

A third life history parameter, hatchling to fledging survival, had a weak correlation ($R^2 = 0.18$) with intrinsic capacity (lambda) for the 7-year evaluation period (Figure 12) based on the equation:

Lambda = 0.9535969 + 0.2631331 Hatchling to Fledgling Survival

In other words, only 18% of the variability seen in lambda could be explained by changes in hatchling to fledgling survival. Since there was some correlation between hatchling to fledgling survival and intrinsic capacity, this vital rate was also examined to determine the correlation between the vital rate and recreational use. The results of that analysis are described below in Section 4.2.

Figure 12 Relationship between Hatchling to Fledgling Survival and the Intrinsic Capacity (Lambda) from 2000 - 2006 along the Oregon Coast



4.1.2. Fecundity

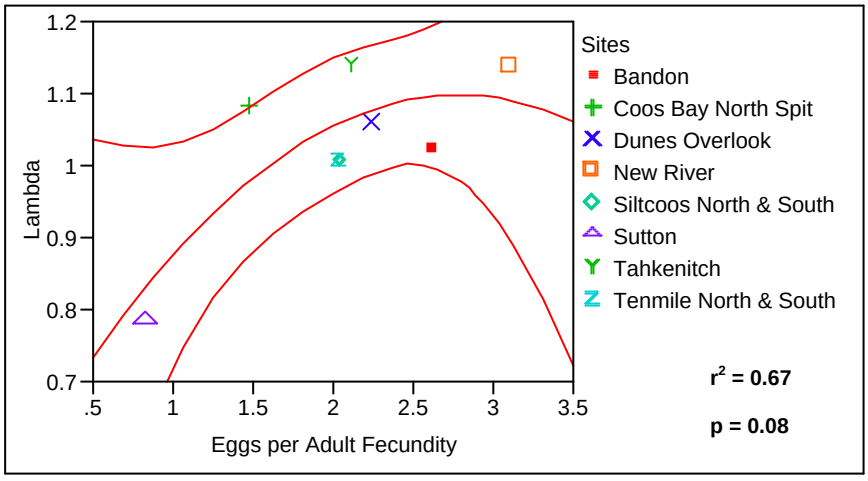
Fecundity was highly variable among sites and years. The relationship between fecundity and lambda appears to be non-linear. Fecundity at the poorest performing sites was quite low, whereas the relationship between fecundity and lambda "leveled off" across sites with higher overall lambdas.

Based on a polynomial correlation between fecundity and lambda, this vital rate was strongly correlated with intrinsic capacity as shown in Figure 13 (R^2=0.67) based on the polynomial equation:

Lambda = 0.8919843 + 0.0604255 Fledgling to Adult survival - 0.0384818 (Fledgling to Adult survival-2.97955)^2

It is difficult to imagine how covered activities might impact fecundity directly through female egg production. However, the data used in this take assessment relate to the number of eggs successfully placed in a nest by a given population of adult birds on a site per year. Covered activities could directly impact this vital rate at the courtship, copulating, or egg deposition phase, or in the lag between egg deposition and documentation by field staff. Since there was strong correlation between this vital rate and lambda, relationships between covered activities and fecundity were examined as described in the text below.

Figure 13. Relationship between Fecundity and Intrinsic Capacity (Lambda) from 2000-2006 Along the Oregon Coast



4.2. Relationship between Recreational Activities and Vital Rates

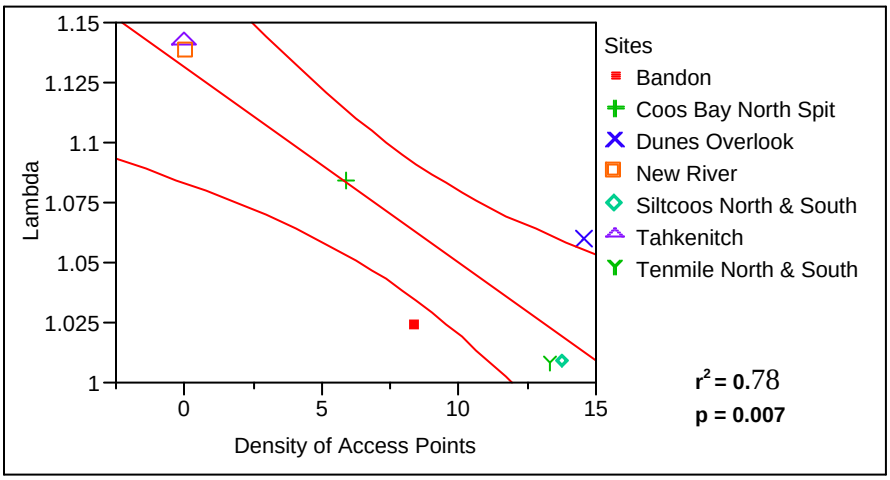
The proportion of recreationists participating in specific activities was previously estimated using field observations and mail-in surveys. In addition, the peak number of people per mile during the snowy plover breeding season was estimated by visual observations in a controlled survey (Shelby and Tokarczyk 2002).

In the field surveys, which were typically given during peak hours of visitor traffic, park visitors were asked to classify the primary reasons for their visits to the beach on that day. Mail-in surveys were given to numerous visitors who completed the forms

from home, and related their recreational activities to their average experiences instead of to a single visit. The mail-in surveys suggested that approximately one third (35%) of all visitors brought one to two dogs with them to the beach; whereas in the field surveys, less than 10% of visitors classified this as the primary purpose of their visit. The majority of respondents (61%) admitted they did not leash their dogs some of the time during their typical visits. The majority of this use occurred during the snowy plover breeding season.

The majority of visitors (93%) did not ride horses or drive on the beach. The majority of visitors (90%) were groups of family and friends. Most (76%) were unaware of restrictions associated with snowy plovers. The peak number of people per mile, number of access points, distance to the nearest access point, and the number of access points per mile of beach (access point density) are all indicators of the overall traffic a management area would receive. The recreational use mail-in surveys suggested that this increased traffic would express itself primarily in the form of groups of family and friends and their dogs. Out of the group of general indicators of recreational activity levels, the density of access points was the best predictor of lambda (r^2=0.78, p=0.007) as shown in Figure 14.

Figure 14. Relationship between the Density of Access Points (Points per Acre) and Lambda



Three vital rates, egg to hatchling survival, hatchling to fledgling survival, and fecundity were regressed against recreational activities to determine how the activities were influencing them. The field estimates of dog exercising, vehicle use, and horse traffic were excluded from the analysis because they differed drastically from the mail-in surveys. Instead, the density of access points and peak number of people per mile were used as general indicators of dog exercising, vehicle use, and horse traffic. A discussion of specific recreational activities follows below and the

reader is referred to the recreational use study for additional details on these activities.

The equivalent number of adults that might be lost from the population based on the number of eggs or fledglings taken through recreational activities was calculated as a measure of a third vital rate; abundance. The goal of this analysis was to estimate and help explain the overall impacts of recreation on population performance. Although these relationships do not "prove causation," they are highly suggestive of the types of activities that should be included in the take assessment, and which vital rates these activities are associated with.

4.2.1. Survival

Nest Production

Although nests are not a component of the snowy plover biological life-cycle, they are an essential component of the reproductive process. Nest productivity can be impacted pre- or post-construction, and would be extremely difficult to detect. It is unclear from the data whether nest productivity is actually a limiting stage, or whether nests are simply correlated with some other factor such as bird densities. None of the indicators of recreation were strongly related to nest productivity. Although direct nest loss may result from recreation such as dog-related impacts or vehicle traffic, these patterns are not evident at the site level.

Eggs per Nest

The number of eggs per nest is a biological variable related to the physiological fecundity (as opposed to the number of eggs per adult or apparent fecundity). Females lay one to three eggs per nest, and the reasons for this are not immediately clear in the literature or the data. None of the indicators of recreational activities were strongly related to the number of eggs per nest.

Egg to Hatchling Survival

The number of people per mile during peak visitation ranged from 3.45 at the New River RMA to 13.22 at the Bandon SPMA in 2003 (Oregon Parks and Recreation Department 2005). In general these numbers will increase during the term of the 25-year ITP due to human population increase. These numbers represent the number of people visiting an entire beach segment, as defined in the Ocean Shores Management Plan, and are likely an overestimate of recreational use on the portion of beach where snowy plover typically nest.

At all of the occupied snowy plover nesting areas (see Chapter 3), the distribution of people was described as dispersed, rather than clumped, and on a crowding scale of 1 to 5, all of the beach segments with snowy plover breeding sites were rated as 1 (not

crowded) by beach visitors (Oregon Parks and Recreation Department 2005). The number of people per mile was a poor predictor of egg to hatchling survival (r^2=0.38, p>0.19).

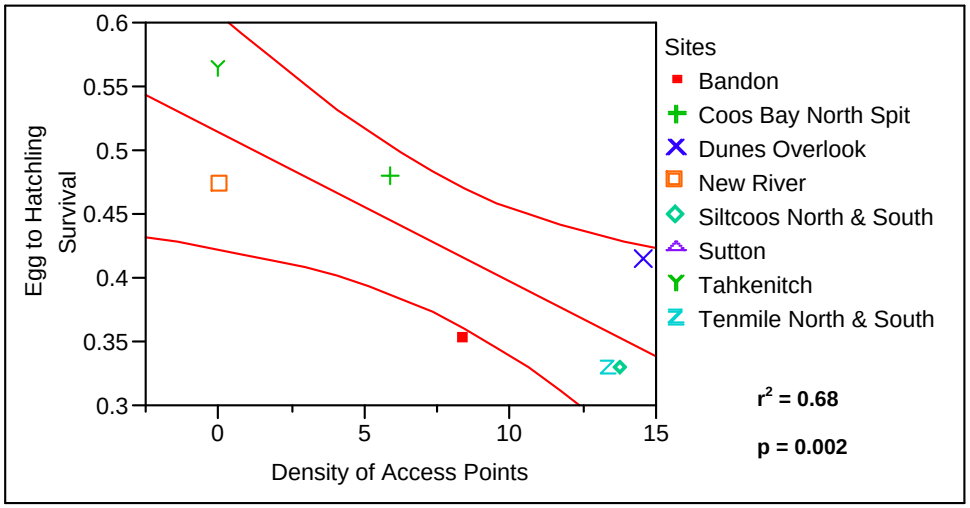
Site access was considered in terms of the number of access points per acre of total habitat in each management area; the "density of access points." Density of access points was the strongest indicator of a relationship between recreational activities and egg to hatchling survival as shown in Figure 15 (r^2=0.68, p=0.002) based on the formula:

Egg to Hatchling Survival = 0.5144741 - 0.0117903 Density of Access Points

The density of access points is an overall indicator of recreational activity. It is not possible to determine what specific activities are directly contributing to the overall impacts of recreation on survival. Dogs are likely a factor, as the 30% of the respondents from the survey of recreational activities included dogs in their beach visits. Other impacts, such as the attraction of predators from food and refuse, and harassment from recreational activities other than dogs, are likely at play. Some of these are analyzed in more detail below.

The line function relating the egg to hatchling survival rate to recreation as indicated by the density of access points provides a reference for estimating take associated with these covered activities. The intercept with the y axis (0.52) is the predicted survival that would occur if the density of access points were similarly low at all sites, and all other factors were equal. The actual coast-wide mean egg to hatchling survival was 0.42, suggesting that recreational activities depress this survival by 10%.

Figure 15. Relationship between Egg to Hatchling Survival and the Density of Access Points (2000-2006)



The decrease in hatching rate from 0.52 (the predicted mean) to 0.42 (the actual mean) has, in theory, impacted the number of hatchlings produced between 2000 and 2006. The coast-wide average number of eggs produced was 300 per year, which resulted in an average of approximately 136 hatchlings, or 0.45 hatchlings per egg. It can be inferred (with all other conditions remaining the same), that if recreational activities had not occurred near the occupied snowy plover management areas between 2000 and 2006 there would have been an additional 30 hatchlings annually because 10% of the ~300 eggs would have survived.

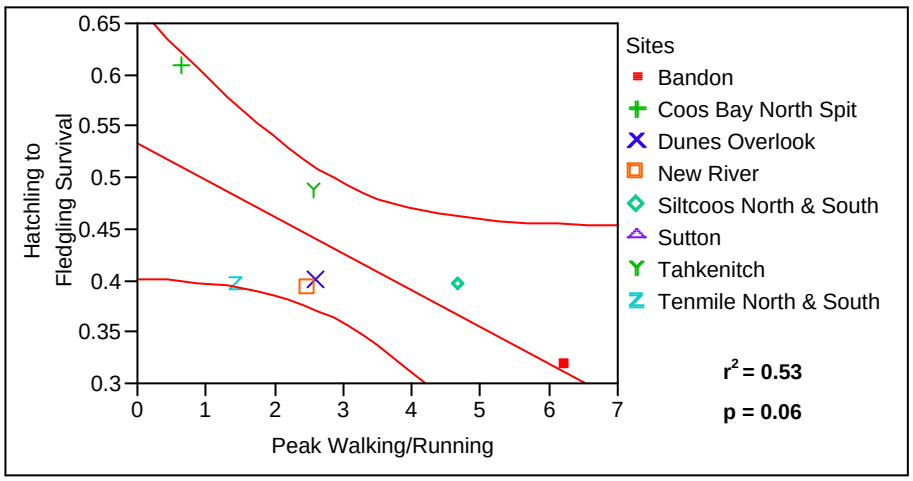
Hatchling to Fledgling Survival

Hatchling to fledgling survival was less strongly related to lambda then the egg to hatchling stage. This vital rate was not significantly related to the general indicators of recreation (peak number of people per mile and the density of access sites). The site-specific peak number of people per mile was multiplied by the proportion of various activities to determine if hatchling to fledgling survival were related to those activities (Figure 16). The peak number of people walking/running was predictive of hatchling to fledgling survival (r^2=0.53, p=0.06) based on the equation:

Hatchling to Fledgling Survival = 0.5334897 - 0.03575 Peak Walking/Running

This is somewhat intuitive, given that walking/running is the primary recreational activity across all sites. As discussed above, most of the walking/running visitors were groups of friends and families with dogs. Further correlations with recreation specific activities are presented in Table 6 below.

Figure 16. Relationship between Hatchling to Fledgling Survival and Peak Number of People Walking/Running along the Oregon Coast (2000-2006)



If the influence of people walking/running on the beach is removed, the model indicates that the survival from hatchling to fledgling stage would be 0.53. Given that the survival from eggs to hatchlings along the Oregon Coast between 2000 and 2006 was also 0.45, the model suggests that the difference in survival when there are no people walking/running on the beach (0.53) and the survival from hatchlings to fledglings with those activities (0.45) would be 0.08.

If that survival rate (0.08) is multiplied by the average number of hatchlings on the Oregon Coast during that 7-year period (138), the average number of hatchlings that would fledge each year would have increased by 11 fledglings per year if there were no people walking/running on the beach.

4.2.2. Fecundity

None of the general or activity-specific indicators of recreation were predictive of fecundity.

4.2.3. Abundance

The equivalent number of adults that might be lost from the population based on the number of eggs or fledglings taken through recreation activities was calculated. Between 2000 and 2006, there was an annual average of 0.5 adults per egg along the Oregon Coast, and 160 total adults in the population (Table 4a). Across all sites the Oregon snowy plover population increased by 13.8 birds per year from 2000 and 2006 by producing 138 hatchlings per year (Table 4a). Assuming that the local increase in population size was due to local production, and not immigration, each hatchling produced approximately 0.10 adult birds (13.8 birds per year/138 hatchlings per year = 0.10 adults). Based on this estimate the 30 hatchlings "taken" through recreational activities is the equivalent of approximately three adult birds per year (30 hatchlings per year x 0.10 adults per hatchling = 3 adult birds per year).

Similarly, during the 7-year time period there were 65 fledglings produced annually that resulted in the 13.8 annual increase in adults (Table 4a). Each fledgling produced approximately 0.21 adult birds (13.8 birds per year/65 fledglings per year = 0.21 adults) Based on this estimate, the loss of 11 fledglings per year to recreational activities is the equivalent of losing about 2.3 adults per year (11 fledglings per year x 0.21 adults per fledgling = 2.3 adults per year).

In total, it is estimated that between 2000 and 2006, recreational activities resulted in the loss of 30 hatchlings and 11 fledglings, which equated to the loss of up to 5 adult equivalents per year.

4.2.4. Impacts of Specific Recreation Activities

Beach visitors engage in specific activities, each of which have different mechanisms and pathways that may or may not affect snowy plover performance. The footprint of these activities differs at each site (Ecotrust 2003). Many recreational activities co-occur, making it difficult to understand their direct impacts on snowy plovers. There has been little study of the direct take through harassment or mortality associated with specific activities, further complicating the assessment of their impacts.

Nonetheless, there are some interesting relationships between recreational activities at specific sites, which may be useful in applying the results of this take assessment with professional judgment. The peak number of people per mile at each site was previously estimated based on field observations (Shelby and Tokarczyk 2002). In that same study, visitors were approached and asked to classify their primary reason for visiting the beach (it should be noted that the results of those surveys differed in many regards from those of a follow-up mail-in survey that was analyzed by the same group).

To estimate the peak number of people per mile engaged in a specific activity, the peak number of people per mile at each site was multiplied by the fraction of people primarily engaged in a specific activity. These estimates were regressed against the vital rates to estimate the impacts of specific recreation activities on snowy plover performance (Table 6). Many of the relationships were counter-intuitive, spurious, or insignificant, while some seem to show promise and could be the focus of future field study. The results are included to inform the reader in their application of the take assessment, but were not used in calculating take due to their limited explanatory power.

Table 6. Correlations between Specific Recreation Activities and Western Snowy Plover Vital Rates (r^2/p-value/slope of the fit line)

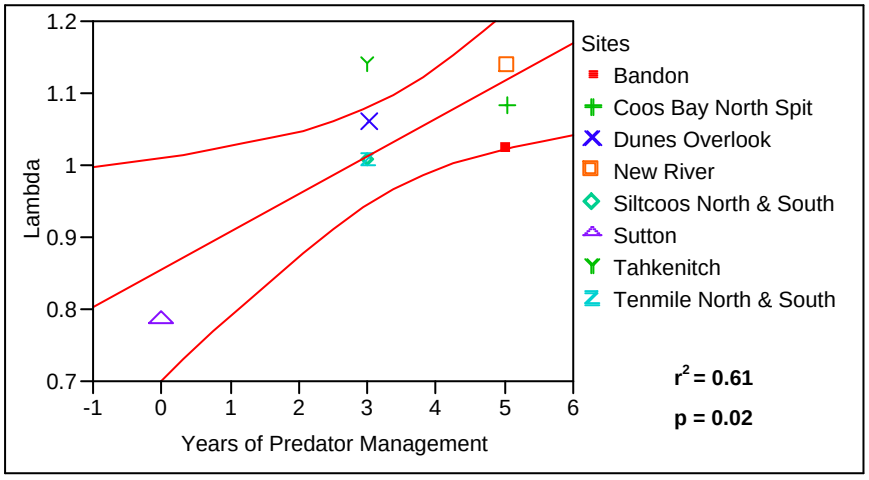
Indicator	Egg to Hatchling Survival	Hatchling to Fledgling Survival	Fecundity	Lambda
Peak number of people per mile	0.31/0.19/-0.01	0.29/0.21/-0.01	0.05/0.60/+0.04	0.01/0.86/-0.00
Peak walking/running activity	0.20/0.31/-0.02	0.53/0.06/-0.04	0.40/0.09/+0.21	0.08/0.50/+0.02
Peak dog related activity	0.11/0.48/-0.09	0.23/0.28/-0.14	0.17/0.31/+0.93	0.02/0.76/+0.05
Peak relaxing activity	0.43/0.11/-0.04	0.28/0.23/-0.04	0.02/0.75/+0.07	0.02/0.73/-0.01
Peak surf sports activity	0.04/0.67/+0.17	0.04/0.68/-0.17	0.50/0.05/+4.65	0.25/0.21/+0.54
Peak kite flying activity	0.19/0.33/-0.23	0.32/0.19/-0.31	0.12/0.41/+1.38	0.01/0.78/+0.08

Indicator	Egg to Hatchling Survival	Hatchling to Fledgling Survival	Fecundity	Lambda
Peak camping activity	0.21/0.30/+0.29	0.03/0.69/+0.12	0.00/0.91/+0.24	0.14/0.36/+0.31
Peak vehicles activity	0.01/0.88/+0.01	0.61/0.07/+0.08	0.10/0.45/-0.26	0.03/0.69/+0.02

4.3. Correlation with Restoration Activities

In addition to the impacts of recreation activities, the correlation between restoration and management at the currently occupied snowy plover nesting areas and various vital rates were modeled for the period 2000 and 2006. The same model screening criteria was used for restoration activities as was used for recreation activities (i.e. R^2>0.10 and p<0.20). Only models that suggested a positive relationship between restoration and each vital rate were included. The benefits of the years of restoration, the acres of restored habitat available, and the number of years of predator management at each site were all considered in this assessment. Restoration appears to be generating benefits that are detectible at the site-level, and coast wide. The years of predator management was highly correlated with lambda as shown in Figure 17 (r^2=0.61, p=0.02). The impacts on specific vital rates are discussed below.

Figure 17. Relationship between Years of Predator Management and Lambda

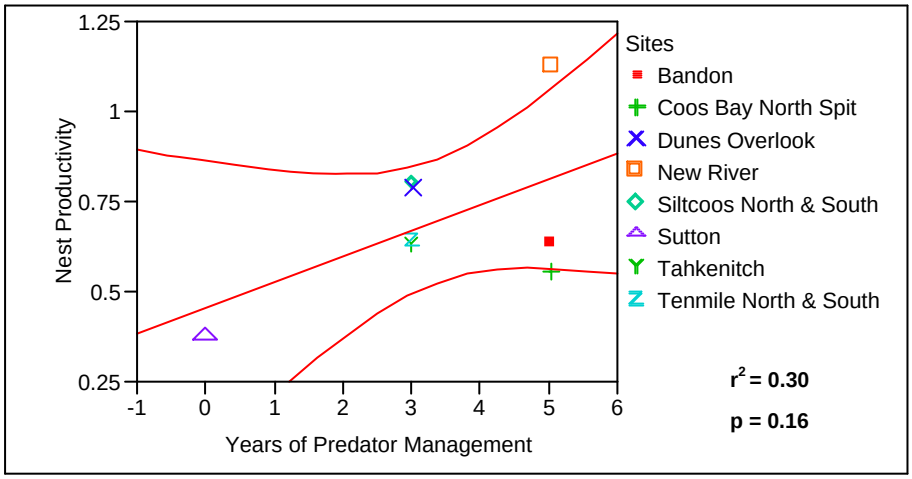


4.3.1. Survival

Nest Production

The number of nests produced per adult was correlated with the years of predator management (r^2=0.30, p=0.16) (Figure 18). It is possible that predators destroy nests before they are detected by surveyors, or that predator densities somehow disrupt the nest-construction process. It is also possible that nests are abandoned following egg predation, and are therefore not detected by surveyors. For the purpose of the take assessment, it was assumed the benefits associated with nest production are best expressed in terms of the fecundity estimate due to the strong relationships discussed below.

Figure 18. Relationship between the Years of Predator Management and Nest Productivity



Eggs Per Nest

To be consistent with the matrix models and regression analysis described above, the impacts of restoration activities on the number of eggs per nest were assessed in terms of fecundity instead of the number of eggs per nest (Section 4.3.4).

Egg to Hatchling Survival

To estimate the effect that restoration activities had on egg to hatchling survival between 2000 and 2006, a least squares multivariate regression model was used. For each activity, the regression model examined how the level of activity influenced the survival of snowy plover from the egg to hatchling life stage. None of the restoration activities appeared to have a positive and significant impact on egg to hatchling survival, therefore these models were not considered further in this analysis.

Hatchling to Fledgling Survival

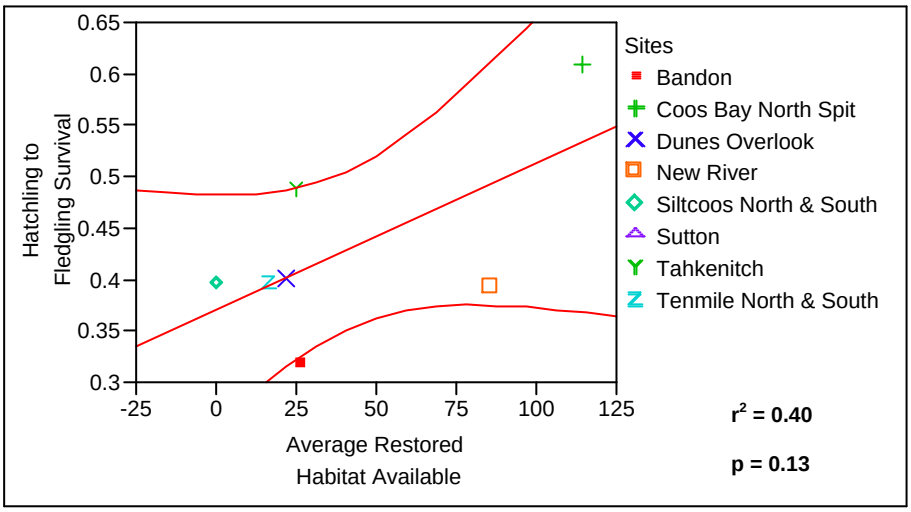
Increases in the acres of restored habitat available was correlated with increased hatchling to fledgling survival (R^2=0.40, p=0.13; Figure 17). The simple regression model that explained this relationship was:

Hatchling to Fledgling Survival = 0.3700527 + 0.0014326 Average Restored Habitat Available

The difference between hatchling to fledgling survival on the Oregon Coast with and without restoration activities was calculated using the above regression model. The average number of hatchlings produced between 2000 and 2006 was 138 per year, and the survival from hatchlings to fledglings was 0.45. If the effects of the restoration activities described above are removed (i.e. if the values in the regression equation are 'zeroed'), the model indicates that the survival of hatchlings to fledgling would be approximately 0.37. Given that the survival from hatchlings to fledglings along the Oregon Coast between 2000 and 2006 was 0.45, the model suggests that the difference between the survival from eggs to hatchlings with the considered restoration activities (0.45) and the survival from eggs to hatchlings without those activities (0.37) would be 0.08.

The average increase in fledglings per year resulting from habitat restoration can be inferred by multiplying the modeled change in survival from restoration (0.08) times the average number of fledglings produced annually (138) (Figure 19). If restoration activities had not occurred near occupied snowy plover nesting areas between 2000 and 2006, and all other conditions remained the same, there would have been 11 fewer fledglings each year (0.08 * 138 = 11). There are uncertainties in this analysis because the correlation coefficients are relatively low, and several models were excluded due to their low explanatory power. The conclusions presented here and below should be viewed as estimates with some level of uncertainty, and should be tempered with best professional judgment.

Figure 19. Relationship between Hatchling to Fledgling Survival and the Acres of Restored Habitat Available at Sites along the Oregon Coast (2000-2006)

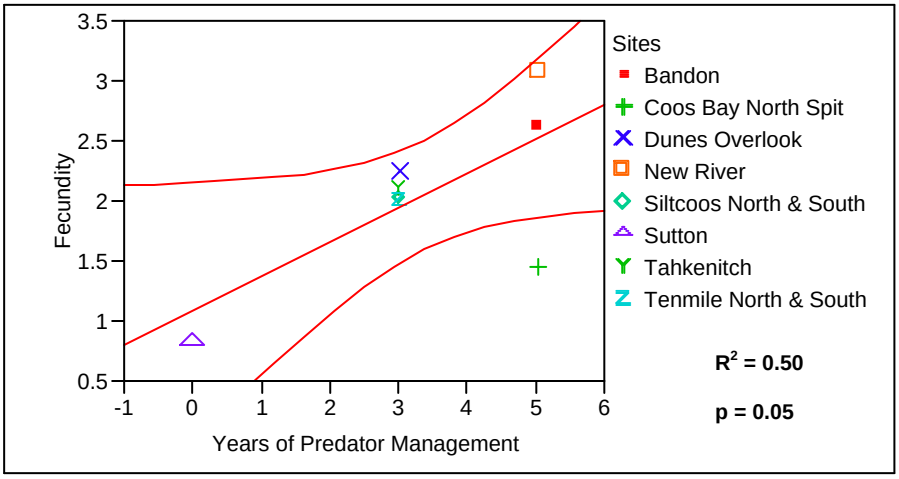


4.3.2. Fecundity

Increases in the years of predator management were correlated with increased fecundity (R^2=0.50, p=0.05; Figure 20). The simple regression model that explained this relationship was:

Adult Fecundity = 1.08 + 0.29 Years of Predator Management

Figure 20. Relationship between Fecundity and the Years of Predator Management at Sites along the Oregon Coast (2000-2006)



The difference between fecundity on the Oregon Coast with and without restoration activities was calculated using the above regression model. The average number of eggs produced between 2000 and 2006 was 300 per year, and the number of eggs

produced per adult was 1.94 (Table 4a). If the restoration activities described above are removed (i.e. if the values in the regression equation are 'zeroed'), the model indicates that the fecundity would be approximately 1.08. Given that the fecundity from hatchlings to fledglings along the Oregon Coast between 2000 and 2006 was actually 1.94, the model suggests that the difference between the fecundity with the considered restoration activities (1.94) and the fecundity without those activities (1.08) would be 0.86 eggs per adult.

The average number of adults in the population between 2000 and 2006 was 160 (Table 4a). As such, it could be inferred that, if restoration activities had not occurred near occupied snowy plover nesting areas between 2000 and 2006, and all other conditions remained the same, there would have been 138 fewer eggs each year (160 adults x 0.86 eggs per adult = 138 eggs per year). There are uncertainties in this analysis because the correlation coefficients are relatively low, and several models were excluded due to their low explanatory power. The conclusions presented here and below should be viewed as estimates with high levels of uncertainty, and should be tempered with best professional judgment.

4.3.3. Abundance

The equivalent number of adults that might be added to the population based on the number of eggs or fledglings gained through restoration efforts was calculated. Between 2000 and 2006, there was an annual average of 0.5 adults per egg along the Oregon Coast, and 160 total adults in the population (Table 4a). Across all sites, the snowy plover population increased by 13.8 birds per year from 2000 to 2006 by laying approximately 300 eggs per year (Table 4a). Assuming that the local increase in population size was due to local production, and not immigration, each egg laid produced approximately 0.05 birds (13.8 birds per year/300 eggs per year = 0.05 birds). Based on this estimate, the 138 egg per year improvement related to restoration activities produced an equivalent of 7 adults per year (138 eggs x 0.05 adults/egg = 7 adults).

Similarly, during the 7-year time period there were 13.8 adult birds produced from the 138 birds fledged annually. Assuming that the local increase in population size was due to local production, and not immigration, each hatchling produced approximately 0.10 adult birds (13.8 birds per year/138 hatchlings per year = 0.10 adults). By gaining 9 fledglings per year due to restoration efforts, it is estimated that the population gained about 1 adult/year (9 fledglings x 0.10 adults/fledgling = 1 adult).

In summary, it is estimated that restoration efforts along the Oregon Coast between 2000 and 2006 resulted in an increase of 138 eggs and 9 fledglings, which equated to an increase of 8 adult equivalents per year.

Chapter 5. Take Assessment

The following provides an assessment of the potential for the covered activities to result in take of snowy plovers. The take assessment is based on population performance data at occupied snowy plover nesting areas between 2000 and 2006, and the correlations between population performance data and recreational activities.

The take assessment was calculated by determining how likely it was that recreation activities would lower survival from one life stage to the next at the currently occupied SPMA and other RMAs. That information was then used to arrive at a quantitative estimate for the amount of take that may occur over the 25-year ITP term at currently occupied snowy plover nesting areas.

A qualitative estimate of take is provided for currently unoccupied SPMAs, based on assumptions about proposed management prescriptions and timelines for habitat restoration. In addition, a qualitative estimate is made for take as the result of natural resource management and beach management. The beneficial effects that proposed restoration at SPMAs may have on the breeding population are also considered.

5.1. Public Use / Recreation Management

5.1.1. Eggs and Nests

As described in Chapter 4, between 2000 and 2006, there was a very low correlation between the number of eggs laid per adult and recreation activities. There was no evidence that recreation activities would directly result in take in terms of the number of nests produced. Due to this weak relationship, no further analysis was completed to quantify the potential effects of recreation on these life stages. As such, there is no data to indicate that public use/recreation management would have a negative relationship with the number of eggs laid at any of the occupied or targeted SPMAs or RMAs during the term of the 25-year ITP.

There was a positive relationship between fecundity (i.e. number of eggs laid per adult) and restoration activities; especially the number of acres of restored habitat available at each site. As a result of restoration activities, snowy plover management, and predator management, it is estimated that 138 eggs were hatched each year between 2000 and 2006 (Table 7). Understanding that the average number of eggs laid each year between 2000 and 2006 was 300 (Table 4b), this represents a 46% increase in the total number of eggs hatched per year (138 eggs / 300 eggs hatched = 46% increase). A similar pattern would likely be observed at the new SPMAs that are restored or managed in the future. This analysis points to the importance of

restoring habitat and management activity at the currently unoccupied sites as soon as snowy plover sightings are made.

Table 7. Estimated Change in the Number of Eggs, Nests, Fledglings, and Adults per Year as a Result of Habitat Restoration, Predator Management, and Recreational Use

	Six Year Average[1]	Habitat Restoration / Predator Management Benefits [2]	Recreation Activity Impacts[3]	Annual Net Gain/Loss	25-year Total for Occupied Sites
Number of Eggs (% of 6-year average)	300	+ 138 (+46%)	--	+ 138 (+46%)	+ 3,450
Number of Hatchlings (% of 6- year average)	136	--	– 30 (22 %)	– 30 (22 %)	- 750
Number of Fledglings (% of 6-year average)	62	+ 9 (+14%)	- 11 (-17%)	- 2 (-3%)	- 50
Number of Adult Equivalents (% of 6-year average)	13.8	+ 8 (+58%)	- 5 (-36%)	+ 3 (+22%)	+ 75

1 Represents the number of eggs, hatchlings, fledglings, and adult equivalents produced each year on the covered lands (including SPMAs and RMAs) between 2000 and 2006.

2 Represents the number of eggs, fledglings and adult equivalents estimated to be present on the covered lands each year as a direct result of ongoing restoration activities, snowy plover management, and predator management at sites currently occupied by snowy plover. These figures are based on benefits realized between 2000 and 2006 on lands owned both by OPRD and other landowners, and are not specific to restoration, predator management efforts, or snowy plover management efforts at Bandon SPMA, the only currently occupied SPMA owned by OPRD. As such, these estimates may overstate the net benefit to plover as a result of OPRD actions. Of note, the figures in the table do not capture the restoration benefit that would be realized at currently unoccupied SPMAs in the future, should nesting populations of plover utilize those areas. It is anticipated that restoration of up to a total of 120 acres at the Columbia River South Jetty SPMA, the Necanicum SPMA, and the Nehalem SPMA, and future predator management activities, would result in additional habitat restoration benefits not captured in this table.

3Figures represent the number of hatchlings, fledglings, and adult equivalents lost each year as a result of recreational use on the covered lands. Associated percentage represents the percentage of the 6-year average.

5.1.2. Hatchlings

There was a correlation between recreation activities and survival from egg to hatchling stage at occupied snowy plover nesting areas between 2000 and 2006. Taken together, it was estimated that these activities resulted in 30 fewer eggs hatching each year. Understanding that the average number of hatchlings that fledged each year on the Oregon Coast between 2000 and 2006 was 138 (Table 4b), this represents a 22% reduction in the total number of eggs hatched during that period (30 eggs / 138 hatchlings = 22% reduction).

This rate of loss (30 eggs per year) is expected to continue during the term of the 25-year ITP at areas currently occupied by nesting plover, although the actual loss should be viewed as a percent reduction (about 22%) of eggs per year. This is due to the fact that take would likely increase as the snowy plover population grows, the human population increases, and new SPMAs are restored and occupied (Table 7). In addition, given the assumptions and application of the model (i.e., relationships were modeled using the peak number of people engaged in that activity on a given beach segment), this potential for annual take should be viewed as a maximum number.

Similar effects on hatchlings are expected at unoccupied SPMAs once they become occupied and the number of individuals increases to levels similar to the occupied sites. If the abundance and fraction of hatchlings lost at the currently unoccupied sites are similar to that of the currently occupied sites, it is possible that the sub-populations at the currently unoccupied sites will never increase to sustainable levels. It is also possible that the number of hatchlings lost at the currently unoccupied sites may be greater because levels of recreation are higher at all of the proposed SPMAs.

5.1.3. Fledglings

Relaxing and kite flying during peak recreation periods seemed to impact hatchling to fledgling survival. When these activities were lumped together they explained the loss of 11 fledglings per year between 2000 and 2006 (Table 7). Understanding that the average number of fledglings on the Oregon Coast during that period was 65 (Table 4b), this represents a 17% reduction in the total number of fledglings (11 fledglings/65 fledgling = 17% reduction).

This rate of loss (11 fledglings per year) is expected to continue during the term of the 25-year ITP at areas currently occupied by nesting plover, although the actual loss should be viewed as a percent reduction (17%) of fledglings per year due to the fact that take would likely increase as the snowy plover population grows, the human population increases, and new SPMAs are restored and occupied (Table 7). In addition, given the assumptions and application of the model (i.e., relationships were modeled using the peak number of people engaged in that activity on a given beach segment), this potential for annual take should be viewed as a maximum number.

Similar effects on fledglings are expected at unoccupied SPMAs once they become occupied, although the number of fledglings lost may be greater because levels of recreation are higher at all of the proposed SPMAs. Similar to the occupied areas, the number of fledglings lost should be considered relative to the number of hatchlings in a given SPMA.

Restoration activities, snowy plover management, and predator management could result in an estimated additional 9 fledglings each year. This would represent a 14% increase in hatchling to fledgling survival (9 fledglings/65 fledglings = 14%

reduction). While there will be an estimated "net loss" of 5 fledglings each year due to recreational activities, this would likely be offset through gains in fecundity from restoration activities (Table 7). A similar pattern would likely be observed in the future at unoccupied SPMAs once they were restored and managed. More hatchlings would fledge as the result of restoration activities, but recreation activities would still result in the take of some number of fledglings each year. The balance between these gains and losses at the currently unoccupied sites would depend upon the intensity of restoration versus recreational activities.

5.1.4. Adult Equivalents

Under the HCP, the rate of loss of adult equivalents would be based on the number of eggs or fledglings taken through recreation activities. In total, it is estimated that recreational activities resulted in the annual loss of 30 hatchlings and 11 fledglings between 2000 and 2006, which equated to the loss of 5 adult equivalents per year. Understanding that between 2000 and 2006, on average, the adult population increased by 13.8 adults across all occupied sites, this would represent a 36% decrease in the adult equivalent population (5 adults/13.8 adults = 36%).

Similar to other life stages, it is anticipated that restoration activities will have a beneficial effect on adult production. As a result of restoration activities, snowy plover management, and predator management, it is estimated that an additional 8 adults would be produced each year. This would represent a 58% increase in the adult equivalent population per year (8 adults / 13.8 adults = 58%). Overall, there would be an estimated "net gain" of 3 adults each year at occupied snowy plover nesting areas (Table 7). A similar pattern would likely be observed at the new SPMAs that are restored or managed in the future.

The number of adult equivalents lost each year would likely increase as the snowy plover population increases, but the percentage of loss would remain similar (about 5%). This loss would be minimized by restoration activities, which would likely result in a net gain in the number of adults despite the losses due to recreation activities. Recreation management that would occur on both occupied and actively managed snowy plover nesting areas would further reduce the overall loss of adults.

5.1.5. Wintering Snowy Plover Populations

During the winter, resident snowy plovers congregate into foraging groups in several sites along the Oregon Coast. In the recent past these sites have included Baker Beach, North and South Siltcoos Spit, Tenmile Spit, Coos Bay North Spit (South Beach), Bandon State Natural Area, and New River. Bayocean Spit has been used as a snowy plover wintering site in recent history. However, few plovers have been observed at the site since 2000 (unpublished data, Fish and Wildlife Service 2008

Recreation activities on the beaches along the Oregon Coast are lower during the winter months than they are during the spring and summer (snowy plover breeding season). In addition, the normal behavior of wintering plover is to flock, presumably to avoid disturbance. It is generally thought that the security of a large group enables an individual to relax its personal predator awareness and feed more deliberately and efficiently. Joining a flock therefore, theoretically decreases the cost that an individual endures to avoid predators and increase the benefit per individual in the group, thus placing evolutionary pressure on flock formation (Gill 1995). It is anticipated that the effects on wintering populations would be within the normal range of disturbance. Given these factors, disturbance is likely to be minimal and is not anticipated to rise to the level of take.

An analysis to determine the relationships between wintering birds and recreation activities was not completed because recreation data were not available solely for winter months. It is presumed that the activities covered under the HCP will not result in a loss of winter habitat for snowy plovers or a change in the winter population distribution during the ITP term.

5.1.6. Habitat

General habitat features would not be changed as a result of public use of the beach. In addition, recreational use restrictions will be implemented at these sites in the future, and loss of snowy plover habitat is not expected.

5.2. Natural Resources Management

5.2.1. Snowy Plover Management

As described in Chapter 1, snowy plover management activities include recreational use restrictions at occupied and targeted SPMAs (see discussion of public use/recreational use above for take associated with recreational use); habitat maintenance/restoration; predator management; snowy plover monitoring; and public outreach and education. The net benefits of habitat restoration at occupied snowy plover nesting areas is described in Section 5.1, Public Use/Recreation Management, and summarized in Table 7.

Habitat maintenance and restoration activities (e.g., plowing to remove European beach grass) to create or enhance habitat for snowy plover on the Ocean Shore would not result in take of snowy plovers during the breeding season because restoration activities would not be carried out in occupied breeding areas during the breeding season. Further, restoration activities are not proposed for any known snowy plover wintering sites. Overall these activities would result in a net gain of suitable breeding habitat for snowy plovers and no loss of individuals.

Other habitat maintenance activities, such as installation of fencing, nest monitoring, and predator management would occur during the breeding season. These activities bring biologists in close contact with nesting birds and could result in take in the form of harassment of nesting snowy plovers. Although it is acknowledged that these activities largely increase the productivity of the breeding population at occupied SPMAs and RMAs, they have the potential to flush adults from nests and force both adults and young into less suitable habitats temporarily. As such, it is likely that monitoring and predator management activities may affect snowy plover, although it is not possible to determine if these effects would rise to the level of take. However, the effects of these activities would be reduced as the monitoring staff builds experience.

5.2.2. Other Habitat Restoration (Dune Management and Invasive Species Removal)

As described in Chapter 1, OPRD is also responsible for managing dunes and removing targeted invasive species on covered lands to provide habitat for native species. These activities would be conducted outside of the nesting season in areas occupied by snowy plovers to avoid take. As a result, habitat restoration activities on the covered lands are not expected to affect nesting snowy plovers during the 25-year ITP. Restoration activities could affect wintering snowy plover; however, it is likely that the effects would not rise to the level of take, given that snowy plovers spend most of the winter foraging on the wet sand and that restoration activities would be confined to the dunes. In addition, surveys for shorebirds would be conducted before restoration activities would be implemented. As a result, it is unlikely that habitat restoration activities would result in take of snowy plover over the term of the ITP.

5.3. Beach Management

The Chapter 1 discussion covered OPRD's responsibility for managing beaches within the covered lands, including coordinating efforts to resolve marine mammal strandings; ensuring beaches are safe for public use; assisting law enforcement personnel with pending investigations; and assisting with boat strandings and other salvage operations.

This management activity would be implemented by OPRD to minimize potential effects to snowy plover. In areas where nesting populations of snowy plovers are present, OPRD would work collaboratively with ODFW and the FWS to ensure that encroachment into occupied SPMAs during the nesting season would be minimized.

Based on the above, it is possible that activities associated with public safety (i.e., removal of dangerous logs or investigation of storm erosion), law enforcement actions (i.e., injury/death investigations), or security issues (i.e., parties or bonfires)

may result in take of snowy plover nests, fledglings, or adults. The activities are not predictable and the effects are not quantifiable, but the amount of take would likely be small and infrequent.

5.4. Changed Circumstances

As described in Section 1, the HCP includes provisions for dealing with changed circumstances that may occur during the term of the ITP that could affect the ability of OPRD to properly implement the conservation strategies described in the HCP. These include provisions for addressing the possible listing of a new species and global climate change. Of those circumstances, global climate change has the potential to result in take of snowy plover. The other circumstance would only be implemented, in coordination with FWS, if it would result in a net benefit to snowy plover and are not discussed further.

5.4.1. Global Climate Change

In coastal areas, one of the primary concerns associated with global climate change is the potential for sea levels to rise and for the frequency and intensity of coastal storm events to increase. Climate change simulations completed by the California Climate Change Center (2006) project a substantial rate of global sea level rise over the next century due to thermal expansion as the oceans warms, and as runoff from melting land based snow and ice accelerates. Under a mean sea level rise scenario, the sea level could rise 2 to 4 inches along the west coast of North America by 2032 (California Climate Change Center 2006), which could result in a loss of beach habitat available for nesting shorebirds, including snowy plover.

Although the potential effects of increasing sea levels on snowy plovers are not certain, OPRD and FWS have included provisions for dealing with rising sea levels in the covered lands. Specifically, in the event that rising sea levels result in a net loss of snowy plover nesting habitat over the term of the ITP, OPRD would discuss with the FWS appropriate implementation measures to address these changes. Future actions responding to this “changed circumstance” would be determined by consensus agreement between OPRD and the FWS, and would be based on the nature and extent of the effects associated with rising sea levels.

Chapter 6. Conclusion

Activities covered under this HCP have the potential to result in take of snowy plovers during the 25-year ITP term. Take would occur as a result of recreational activities harassing adults foraging or tending nests, and young foraging on the dry and wet sand. It is not likely that natural resources management and beach management would result in the loss of nests, chicks, adults, or habitat during the ITP term.

While the covered activities may result in some harassment of adults or fledglings, and the loss of eggs and nests, when considered in the context of proposed management and restoration activities, there would be an increase in the number of eggs. In spite of the conservation measures, there would be some losses of hatchlings and fledglings, but overall, there would be in an increase in the number of adult birds on the Oregon Coast (Table 7).

It should also be noted that the dynamics of the snowy plover population along the Oregon Coast will likely change over time and that they are part of a larger coastal population that includes California and Washington. Although the assessment is based on population performance metrics between 2000 and 2006, these metrics will change over the 25-year permit term. As such, the assessment of take should also change to reflect the most current population performance. During the 25-year permit term, it is recommended that the thresholds for incidental take be reassessed every 5-years to ensure that tolerable levels remain biologically relevant, especially in areas where there is currently no data available (i.e., currently unoccupied, targeted SPMAs under OPRD ownership).

There is uncertainty in this assessment and its conclusions. Due to the limited nature of the data set, a very liberal standard was used for accepting model results ($r^2>0.10$, and $p<0.20$). Despite this liberal standard numerous models were excluded due to their low explanatory powers. Due to these limitations, the take assessment and its conclusions should be applied carefully (using best professional judgment), but should serve as a useful starting point for estimating the impacts of restoration and recreation activities on snowy plover performance in Oregon.

6.1. Eggs and Nests

There was a very low correlation between the number of eggs laid per adult and recreation activities, and no evidence that recreation activities would directly result in take in terms of the number of nests produced assuming the current level of recreation management continues. Loss of eggs and nests due to recreational use would likely continue under the proposed HCP over the 25-year term of the ITP. It is

likely that some of this loss would be avoided through site management planning and as a result of increased recreational use restrictions at both occupied snowy plover nesting areas and targeted SPMAs under the HCP.

Potential loss of eggs or nests as a result of beach management or other natural resources management could not be determined. There was a positive relationship between fecundity (i.e. number of eggs laid per adult) and restoration activities; specifically the number of acres of restored habitat available at each site. It is estimated that restoration activities, snowy plover management, and predator management would result in additional eggs each year over the term of the permit. Restoration seemed to be responsible for an additional 46% of the eggs observed on the Oregon Coast from 2000 to 2006 (about 138 eggs). A similar pattern would likely be observed at the SPMAs that are restored or managed in the future.

6.2. Hatchlings

Based on population data at occupied snowy plover nesting areas between 2000 and 2006, regression modeling indicated that recreation activities resulted in a reduced probability that eggs survive to hatchlings. That reduced egg to hatchling survival was estimated to result in a 22% decrease (30 fewer hatchlings) in the number of hatchlings produced per year, based on the average number of hatchlings produced per year on the Oregon Coast during that time period. Given that recreation use was expressed as the peak frequency, the actual annual loss of hatchlings could be lower than this estimate.

Loss of hatchlings due to recreational use would continue under the proposed HCP over the 25-year term of the ITP. It is possible that some of this loss would be avoided due to site management planning and as a result of increased recreational use restrictions at both occupied snowy plover nesting areas and targeted SPMAs under the HCP. Potential loss of hatchlings as a result of beach management or other natural resource management activities could not be determined.

6.3. Fledglings

Regression modeling indicated that recreation activities resulted in a reduced hatchling to fledgling survival. That reduced rate was estimated to result in a 17% decrease (11 fewer fledglings) in the number of fledglings produced each year, based on the annual average number of fledglings produced on the Oregon Coast. Given that recreation use was expressed as the peak frequency, the actual loss might be lower than estimated.

Loss of fledglings due to recreational use would continue under the proposed HCP over the 25-year term of the ITP. It is possible that some of this loss would be

avoided due to site management planning and as a result of increased recreational use restrictions at both occupied snowy plover nesting areas and targeted SPMAs under the HCP. It is also possible, however, that the actual number of hatchlings that fail to fledge as the result of recreation on the beach would increase as the snowy plover population increases due to the percent lost from a larger population at the occupied sites and up to five new SPMAs. Potential loss of fledglings as a result of beach management or other natural resource management activities could not be determined.

Between 2000 and 2006, restoration, snowy plover management, and predator control activities increased hatchling to fledgling survival. It is likely that this increase was related to predator management that was occurring on each site. Restoration activities, snowy plover management, and predator management resulted in an estimated 14% increase (9 additional fledglings) each year between 2000 to 2006 on the Oregon Coast. While there was an estimated "net loss" of 2 fledglings each year (3%), restoration and management seemed to lessen that effect through gains in fecundity (Table 7). Similar results are expected at new SPMAs in the future. Losses may be offset by restoration and management, but there would still be a net loss of fledglings due to recreation on the beach.

6.4. Adults

The number of adults potentially lost due to recreation activities was calculated by extrapolating egg, hatchling, and fledgling survival to adults, and by using the correlations between recreation activities and effects to eggs and fledgling life stages, as discussed above. Between 2000 and 2006, it was estimated that 36% (5 adults) of the average number of adults observed at occupied snowy plover nesting areas were lost each year as a result of recreational activities. Given that recreation use was expressed as the peak frequency, the actual loss might be lower than estimated.

Loss of adults due to recreational use would likely continue under the proposed HCP over the 25-year term of the ITP. It is possible that some of this loss would be avoided due to site management planning and as a result of increased recreational use restrictions at both occupied snowy plover nesting areas and targeted SPMAs under the HCP. It is also possible, however, that the actual number of adults effected by recreational use would increase as the snowy plover population increases due to the percent loss from a larger population at occupied sites and up to five new SPMAs. Potential loss of adults as a result of beach management or other natural resources management could not be determined.

From 2000 to 2006, restoration, snowy plover management, and predator control activities seemed to be responsible for an overall increase in the number of adults on the Oregon Coast. This increase was likely related to the number of acres that had been restored and the types of management that was occurring on each site. It is

estimated that restoration activities, snowy plover management, and predator management resulted in a 58% increase (8 adult equivalents) in the number of adult adults on the Oregon Coast, and a "net increase" of 3 adults per year when considered in combination with the effects of recreational activities (Table 7). Similar results are expected at new SPMAs in the future, meaning that restoration and management may offset losses of adults attributed to recreation activities.

Habitat

Activities covered under the HCP would not take (remove or alter) any suitable snowy plover habitat on the covered lands. In fact, as a result of the HCP, restoration and management activities would result in a net increase in suitable breeding habitat for this species on lands under OPRD jurisdiction. This measurable increase would be realized at the Columbia River South Jetty SPMA, Nehalem SPMA, and Netarts Spit SPMA as proposed in the HCP. Restoration at these areas could increase nesting habitat by as much as 120 acres, depending upon the prescriptions in the site management plans.

As noted above, habitat restoration efforts have benefited snowy plover populations along the Oregon Coast in the past, so it is reasonable to assume that restoration attempts at other SPMAs would be benefit the species in the future. Additional acreage outside of the restored area at these SPMAs would also be managed for snowy plovers (e.g. exclusion fencing, predator control, etc.), and similar management activities at Necanicum Spit SPMA would be implemented.

Chapter 7. References

Applegate, T.E. and S.J. Schultz. 2000. Western snowy plover monitoring on Vandenberg Air Force Base – 1999 Final Report. BioResources. Pp. 23.

Bennet, K.A. and E.F. Zuelke. 1999. The effects of recreation on birds: A literature review. Delaware Natural Heritage program, Division of Fish & Wildlife, Department of Natural Resources and Environmental Control. Pp. 17.

Burnham, K. P., and D. R. Anderson 1998. Model selection and inference: a practical information-theoretic approach. Springer-Verlag, New York, New York.

Caswell, H. 1989. Analysis of life table response experiments. I. Decomposition of effects on population growth rate. Ecological Modeling 46:221-237.

———. 2000. Prospective and retrospective perturbation analysis and their use in conservation biology. Ecology 81:617-627.

———. 2001. Matrix Population Models. Sinauer Associates, Inc., Sunderland, Massachusetts.

Ecotrust. 2003. Data Maps that support the Ocean Shore Management Plan/Habitat Conservation Plan. Available at: http://www.oregon.gov/OPRD/PLANS/osmp_map.shtml. Accessed on September 30, 2006.

Fish and Wildlife Service. 2001a. Western Snowy Plover (*Charadrius alexandrius nivosus*) Pacific Coast Population – Draft Recovery Plan. Region 1. May 2001.

———. 2001b. Biological Opinion for Beach Management and The Western Snowy Plover on Vandenberg Air Force Base for the 2002 Breeding Season (1-8-02-F-7). December 20, 2001.

———. 2005. Biological Opinion for the Management of the Western Snowy Plover on Federal Lands within the New River Area of Critical Environmental Concern during 2003 to 2010 and Wintering Season, Coos and Curry Counties, Oregon (1-7-05-F-0324).

Gill, F.B. 1995. Ornithology, Second edition. New York. pp. 340-341.

Haig, S. M., and E. Elliott-Smith. 2004. Piping Plover. *The Birds of North America Online*. (A. Poole, Ed.) Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Piping_Plover/.

Hitchcock, C. L., and C. Gatto-Trevor. 1996. Diagnosing a shorebird local population decline with a stage-structured population model. Ecology 78:522-534.

Lafferty, K.D. 2001a. Birds at a southern California beach: seasonality, habitat use and disturbance by human activity. *Biodiversity and Conservation* 10:1949-1962.

———. 2001b. Disturbance to wintering western snowy plovers. *Biological Conservation*. 101: 315-325.

Lauten, D.J., K.A. Castelein, S. Weston, K. Eucken, and E.P. Gaines. 2006. The Distribution and Reproductive Success of the Western Snowy Plover Along the Oregon Coast – 20065. Unpublished report by the Oregon Natural Heritage Information Center to the Coos Bay Bureau of Land Management, Oregon Dunes National Recreation Area, U.S. Fish and Wildlife Service, Oregon Department of Fish and Game, and the Oregon Department of Parks and Recreation. Pp. 82.

Lefkovitch, L. P. 1965. The study of population growth in organisms grouped by stages. Biometrics 21:1-18.

Oregon Natural Heritage Information Center and Oregon Parks and Recreation Department 2004. Habitat Conservation Plan for the Western Snowy Plover. Oregon Parks and Recreation Department – 2004. Prepared by the Oregon Natural Heritage Information Center and the Oregon Parks and Recreation Department. Pp. 160.

Page, G.W., J.S. Warriner, J.C. Warriner, and P.W.C. Paton. 1995. Snowy Plover (*Charadrius alexandrinus*). In The Birds of North America, No. 154 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA and The American Ornithologists' Union, Washington, D.C. 24 pp. Persons, P.E. 1998. Differences in reproductive success of the snowy plover between recreation beaches and closed beaches at Vandenberg Air Force Base, California. Prepared for 30CES/CEVPN Environmental Flight, Vandenberg Air Force Base under contract to Point Reyes Bird Observatory. Pp. 8.

Ruhlen, T.D., S. Abbott, L.E. Stenzel, and G.W. Page. 2003. Evidence that human disturbance reduces Snowy Plover chick survival. *Journal of Field Ornithology*. 74(3):300-304.

Shelby, B. and Tokarczyk, J. 2002. Oregon Shore Recreational Use Study. Prepared for the Oregon Department of Parks and Recreation, 130 pages.

Stern, M.A., J.S. McIver, and G.A. Rosenberg. 1990. Investigations of the western snowy plover at the Coos Bay North Spit and adjacent sites in Coos and

Curry Counties, Oregon, 1990. Unpublished report by the Oregon Natural Heritage Information Center and The Nature Conservancy to Oregon Department of Fish and Wildlife. 34 pp.

Warriner J.S., J.C. Warriner, G.W. Page, and L.E. Stenzel. 1986. Mating System and Reproductive Success of a Small population of Polygamous Snowy Plovers. *Wilson Bulletin*. 98(1) pp 15-37.

Wilson, R.A. 1980. Snowy plover nesting ecology on the Oregon Coast. Masters Thesis, Oregon State University, Corvallis. 41 pp.

Wilson-Jacobs, R. and E.C. Meslow. 1984. Distribution, abundance, and nesting characteristics of snowy plovers on the Oregon Coast. Northwest Science. Vol. 58, no. 1, pp. 40-48.

Personal Communications

Schutt, Kate. Planning Manager. Oregon Parks and Recreation Department. Email correspondence with Troy Rahmig (Jones and Stokes) regarding restoration acreage at OPRD sites along the Oregon Coast. September 18, 2006.

Strong, Cheryl. Waterbird Program Manager. San Francisco Bay Bird Observatory. Email correspondence with Troy Rahmig (Jones and Stokes) regarding the 2006 western snowy plover “Window Survey” data.