The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2014

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North Bend, Oregon 97459

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Corvallis OR, 97333

U.S. Fish and Wildlife Service
2127 SE OSU Drive
Newport, Oregon 97365
Recovery Permit TE-839094-5

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Abstract

We monitored the distribution, abundance and productivity of the federally threatened Western Snowy Plover (*Charadrius nivosus nivosus*) along the Oregon coast from 1 April – 15 September 2014. From north to south, we surveyed and monitored plover activity at Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit, Bandon Snowy Plover Management Area, New River HRA and adjacent lands, and Floras Lake. Our objectives in 2014 were to: 1) estimate the size of the adult Snowy Plover population along the Oregon coast, 2) locate plover nests, 3) determine nest success, 4) use mini-exclosures (MEs) to protect nests from predators as needed, 5) determine fledging success, 6) monitor brood movements, and 7) collect general observational data about predators.

We observed an estimated 338 adult Snowy Plovers; a minimum of 280 individuals were known to have nested. The adult plover population was the highest estimate recorded since monitoring began in 1990. We monitored 346 nests in 2014. Overall apparent nest success was 60%. Nest failures were attributed to unknown depredation, unknown cause, mammalian depredation, abandonment, wind/weather, one-egg nests, avian depredation, overwashed, infertility, and corvid depredation. We monitored 221 broods, including 12 from unknown nests, and documented a minimum of 272 fledglings. Overall brood success was 77%, fledging success was 48%, and 1.68 fledglings per male were produced.

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Introduction

The Western Snowy Plover (*Charadrius nivosus nivosus*) breeds along the coast of the Pacific Ocean in California, Oregon, and Washington and at alkaline lakes in the interior of the western United States (Page *et al.* 1991). Loss of habitat, predation pressures, and disturbance have caused the decline of the coastal population of Snowy Plovers and led to the listing of the Pacific Coast Population of Western Snowy Plovers as threatened on March 5, 1993 (U.S. Fish and Wildlife Service 1993). Oregon Department of Fish and Wildlife lists the Western Snowy Plover as threatened throughout the state (ODFW 2009).

Oregon Biodiversity Information Center (ORBIC, formerly Oregon Natural Heritage Information Center) completed our 25th year of monitoring the distribution, abundance, and productivity of Snowy Plovers along the Oregon coast during the breeding season. In cooperation with Federal and state agencies, plover management has focused on habitat restoration and maintenance at breeding sites, non-lethal and lethal predator management, and management of human related disturbances to nesting plovers. The goal of management is improved annual productivity leading to increases in Oregon's breeding population, sustainable productivity, and stable populations at recovery levels. Previous work and results have been summarized in annual reports (Stern *et al.* 1990 and 1991, Craig *et al.* 1992, Casler *et al.* 1993, Hallett *et al.* 1994, 1995, Estelle *et al.* 1997, Castelein *et al.* 1997, 1998, 2000a, 2000b, 2001, and 2002, and Lauten *et al.* 2003, 2005, 2006, 2006b, 2007, 2008, 2009, 2010, 2011, 2012, and 2013). Our objectives for the Oregon coastal population in 2014 were to: 1) estimate the size of the adult Snowy Plover population, 2) locate plover nests, 3) determine nest success, 4) use mini-exclosures (MEs) to protect nests from predators as needed, 5) determine fledging success, 6) monitor brood movements, and 7) collect general observational data about predators.

Study Area

We surveyed Snowy Plover breeding habitat along the Oregon coast, including ocean beaches, sandy spits, ocean-overwashed areas within sand dunes dominated by European beachgrass (*Ammophila arenaria*), open estuarine areas with sand flats, a dredge spoil site, and several habitat restoration/management sites. From north to south, we surveyed and monitored plover activity at Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit (CBNS), Bandon Snowy Plover Management Area (SPMA), New River (extending from private land south of Bandon SPMA to the south end of the New River Area of Critical Environmental Concern (ACEC) habitat restoration area), and Floras Lake (Figure 1). A description of each site occurs in Appendix A. For the purposes of this report and for consistency with previous years' data, we define Bandon Beach as the area from China Creek to the mouth of New River, and Bandon SPMA as all the state land from the north end of the China Creek parking lot south to the south boundary of the State Natural Area south of the mouth of New River.

Methods

Window Surveys

Annual breeding season window surveys were coordinated by US Fish and Wildlife Service in late May. Breeding season window surveys were conducted at both currently active and historic nesting areas (Elliott-Smith and Haig 2007). Historic nesting areas surveyed during the breeding window survey include: Clatsop Spit, Necanicum Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sand Lake South Spit, Nestucca Spit, South Beach (Newport), Muriel O. Ponsler Wayside to Heceta Head, Whiskey Run to Coquille River, Blacklock Point to Sixes River, Sixes River South Spit, Elk River, Euchre Creek, Otter Point to Rogue River, and Myers Creek to Pistol River.

Monitoring

Breeding season fieldwork was conducted from 1 April to 15 September 2014. Survey techniques, data collection methodology, and information regarding locating and documenting nests can be found in Castelein *et al.* 2000a, 2000b, 2001, 2002, and Lauten *et al.* 2003 and are in Appendix B. No modifications to survey techniques were implemented in 2014.

We report three separate measures of adult population size: minimum number of birds present, birds documented breeding, and resident plovers. The minimum number of Snowy Plovers present includes all adult birds observed along the Oregon coast during the field season (1 April through 15 September), and includes birds migrating through the area during that time. Most adults are banded and thus uniquely identifiable, but unbanded birds are difficult to accurately count because they move within and between sites. To avoid over counting unbanded birds, we recorded the number of unbanded plovers observed at each site within 10-day intervals during the peak nesting season (May, June and the first week of July). We selected this period because it encompasses the period of maximum nesting effort and minimum movement between sites. For each 10-day interval we subtracted the number of adults that were subsequently banded during the breeding season and selected the 10-day interval with the highest remaining count. Based on nesting records and daily observation data, this method underestimates the actual number of unbanded plovers present, but it provides a minimum number of unbanded plovers present (Castelein *et al.* 2001). This number was added to our count of banded adults present, resulting in the minimum number of adults present. We also report the total number of plovers positively identified breeding. Because some nests are undetected or fail before adults can be identified, we are unable to identify 100% of plovers that attempt breeding. Resident plovers are defined here as any adult plover detected during the nesting period (between 15 April and 15 July). Not all plovers recorded during the summer are Oregon breeding plovers; some plovers are only recorded early or late in the breeding season, suggesting that they are either migrant or wintering birds. These plovers are not included in the tally of resident plovers.

We determined the number of individual banded female and male plovers and the number of individual unbanded female and male plovers that were recorded at each nesting area along the Oregon coast from the beginning to the end of the 2014 breeding season. Data from nesting sites with a north and south component (Siltcoos, Overlook, Tahkenitch, and Tenmile) were combined because individual plovers use both sides of these estuaries. Data from CBNS nesting sites were aggregated for the same reason. We separated data from Bandon SPMA, New River HRA, and Floras Lake because of different management at these sites, despite plovers frequently moving between these areas. The total number of individual plovers recorded at each site indicates the overall use of the site, particularly where plovers congregate during post breeding and wintering. We also determined the number of individual breeding female and male plovers for each site. The number of individual breeding adults indicates the relative level of nesting activity for each site.

We calculated overall apparent nest success, which is the number of successful nests divided by the total number of nests observed, for all nests and for each individual site. The cause of nest failure was recorded when identifiable.

Male Snowy Plovers typically rear their broods until fledging. In order to track the broods, we banded most nesting adult males, females that tended to broods, and most hatch-year birds with both a USFWS aluminum band and a combination of colored plastic bands. Trapping techniques are described in Lauten *et al.* 2005 and 2006 (Appendix B). We monitored broods and recorded brood activity or adults exhibiting broody behavior at each site (Page *et al.* 2009). Chicks were considered fledged when they were observed at least 28 days after hatching. We calculated brood success, the number of broods that successfully fledged at least one chick; fledging success, the number of chicks that fledged divided by the number of eggs that hatched; and fledglings per known breeding male for each site.

We compare plover productivity before and after implementation of lethal predator management activities by site and coast-wide. We evaluate changes in hatch rate, fledging rate, productivity index, and fledglings per male from years prior to lethal predator management compared to years with lethal predator management. The productivity index is a measure of overall effort based on how many eggs the plovers laid divided by the number of fledglings produced. If plovers produced many fledglings compared to eggs laid, then their productivity and the resulting index was high for the amount of effort (eggs laid). If plovers produced low numbers of fledglings relative to high numbers of eggs laid, then their productivity and the resulting index was low. Data for brood success, fledging success, and fledglings per male were all normally distributed. We used t-test to compare the mean brood success, the mean fledging rate and the mean number of fledglings per male prior to predator management (1992-2004, depending on site) to post-predator management (2002-2013, depending on site). When comparing pre- and post-predator management productivity coast-wide, we did not include the years 2002 and 2003 in the analysis because three sites (CBNS, Bandon Beach, and New River) had predator management in those years but all other sites did not. We did not include Sutton and Floras Lake in our comparisons of productivity by site because occupancy at these sites has been low and sporadic, making such comparisons misleading.

We report brood movements based on the nest site (for example, broods that originated from a nest at Overlook, but moved to Tahkenitch, are reported as Overlook broods). We record banded adults and chicks that return to Oregon from previous seasons and calculate overwinter return rates for each group. Point Blue Conservation Science coordinates observations of banded birds throughout the range, and regularly reports observations of birds banded in Oregon that are sighted elsewhere. Overwinter return rates are the number of banded plovers (adults or first year birds) that return to Oregon, divided by the number of banded adults or chicks observed the previous year.

Predator Management

Protective nest exclosures continue to be an important management tool, particularly at sites with high levels of corvid predation, but their use has declined in recent years because of concerns about adult mortality in and around exclosed nests (Lauten *et al.* 2010, 2011, 2012, and 2013, Appendix C). As in past years, exclosures were not used until after May 15, to avoid predation of adult plovers incubating inside exclosures by migrating raptors (Castelein *et al.* 2001, 2002, Lauten *et al.* 2003). In 2014, exclosures were deployed at three sites: Sutton Beach, New River HRA, and Floras Lake; all were mini-exclosures (MEs, Lauten *et al.* 2003).

Lethal predator management was conducted at all active nesting areas by USDA Wildlife Services (Burrell 2014). ORBIC monitors reported causes of nest failure and daily predator observations to Wildlife Services staff.

Results and Discussion

Window Surveys and Monitoring

During the May breeding window surveys, 228 plovers were observed, and none were detected outside of the current known nesting areas (USFWS 2014). The annual breeding window survey count and minimum number of plovers present is in Table 1.

Of the minimum number of plovers present during the 2014 breeding season, 305 (90%) were banded. The number of unbanded plovers estimated by the 10-day interval method was 33; however we know that the number of unbanded birds was actually higher because we counted 44 individual unbanded birds nesting at different nests. During the breeding season we observed 177 banded males, 128 banded females, 11 unbanded males, and 22 unbanded females.

Of the total estimated population, 280 plovers (83%) were documented nesting, near the mean percentage for 1993-2013 (78%). A minimum of 143 banded males and 93 banded females nested, and approximately 20 unbanded males and 24 unbanded females nested. There were a total of 172 banded resident males and 122 banded resident females present during the 2014 breeding season (15 April – 15 July). Using the minimum number of unbanded individuals estimated by the 10-day interval method, the minimum estimated Oregon resident plover population was 327.

By all measures, the Oregon coastal population was the largest recorded since monitoring began in 1990 (Table 1). In 2014, the Oregon coastal plover population was above the recovery goal set for the state (U.S. Fish and Wildlife Service 2007).

Overwinter Return Rate

Adult overwinter survival is known to be an important parameter of population growth (Sandercock 2003, USFWS 2007, Dinsmore *et al.* 2010, Lauten *et al.* 2010, 2011, 2012, and 2013). A large part of overwinter survival is reflected in adults returning to breed the following year. Of the 281 banded adult plovers recorded in 2013, 224 were recorded in 2014 along the Oregon coast. The overwinter return rate based on returning banded adult plovers was 80%, well above the 1994-2014 mean of 66%, considerably higher than 2013 (65%; Lauten *et al.* 2013), and the highest recorded adult return rate for Oregon. The high adult overwinter survival was responsible for the increase in the Oregon plover population size in 2014.

In 2013, we reported 103 chicks fledged (Lauten *et al.* 2013). Of these, we observed 54 in Oregon in 2014. We also recorded one banded hatch year bird in 2014 that had not been documented fledged in 2013, raising the total number of chicks known to have fledged in 2013 to 104 (Table 2). The return rate was near the 1992-2014 average (Table 2). Of the returning HY13 birds, 26 (48%) were males and 28 (52%) were females. Thirty-two of the HY13 returning plovers were confirmed breeding (59%).

During the 2014 season, we captured and rebanded 20 adult plovers with brood band combinations that needed to be updated to unique adult combinations. Thirteen were males and seven were females. We banded eight unbanded adult male plovers, three unbanded adult female plovers and 490 chicks.

Distribution

To show relative plover activity at sites, we recorded banded and unbanded adults and the number that nested at each site on the Oregon coast (Table 3). Nesting areas with low activity are at the northern and southern

extreme of the current Oregon plover nesting range (i.e., Sutton Beach and Floras Lake). The distribution of plovers is similar to previous years (Lauten *et al.* 2013), with nesting activity concentrated between Overlook and Bandon SPMA. Sites with low numbers of nesting adults relative to the number present reflect high plover use in the non-nesting season (i.e., Siltcoos). In 2014 there was an increase in the number of adults confirmed nesting over 2013, in part because of an increased population (Table 1), and in part due to higher nest success, giving us more opportunity to positively identify adults associated with nests.

Plovers continue to occupy available habitat adjacent to the traditional nesting areas (Lauten *et al.* 2010, 2011, 2012, and 2013). Nesting or brood rearing activities occurred between South Siltcoos and North Overlook (Figure 4), South Overlook and North Tahkenitch (Figure 5), along the beach at South Tahkenitch (Figure 5), and along the beach north of North Tenmile spit (Figure 6). Plovers did not nest north of the FAA towers at CBNS, or north of China Creek at Bandon SPMA. Plovers often move to alternate nesting sites after nest failure; high nest success in 2014 likely contributed to the lack of nests in these areas. High nest failure (as in 2013, see Lauten *et al.* 2013) often leads adult plovers to search for new or unused areas to attempt to renest. We expect the plovers to continue to utilize sections of beach adjacent and between the main nesting sites, due to an increasing population and occasional years with poor nesting success.

Nest Activity

Table 4 shows the number of nests and broods we located during the 2014 nesting season (Figures 2-11). Although fewer nests were found in 2014 compared to 2013, this should not be interpreted as reduced productivity. Nest success was high in 2014 (Table 5), thus there were fewer nest attempts. There was nesting activity at Sutton and South Tahkenitch for the second consecutive year, and Floras Lake had two nest attempts after having no nest attempts in 2013.

The first nests were initiated about 19 March (Figure 12), the earliest initiation date since monitoring began in 1990. Nest initiation increased through mid-May and remained high through the end of June. Peak nest activity (n = 107) occurred during the 31 May – 9 June time interval. The last nest initiation occurred on 30 July.

Predator Management

In 2013, Northern Harriers were positively identified depredating plover nests at both CBNS and in the Siltcoos to Tahkenitch area. Two harriers were removed from CBNS in 2013 (Burrell 2013). In 2014 at least one harrier was noted at CBNS, but no harrier depredations were identified, and there was little observation data to suggest harriers were a problem at CBNS. Wildlife Services did not target harriers at CBNS in 2014. No harriers were removed from the Siltcoos to Tahkenitch area in 2013, but after documenting several early season nest depredations by harriers in this area, one harrier was trapped and removed near the nest site in 2014 (Burrell 2014). After the harriers were removed, corvid management continued, and there were no nest depredations due to corvids. Predator management continues to be successful in reducing corvid numbers at all sites, removing non-native red fox from the Bandon SPMA and New River area, and targeting specific new or unique threats to plovers. See Burrell (2014) for a complete discussion of the predator management program.

Exclosures were used on three nests in 2014 (1%, Figure 13). One nest at Sutton Beach was exclosed for 18 days and one nest at Floras Lake was exclosed for eight days. Both these nests were successful (Table 5). A third exclosure was erected at New River HRA, however three days later we removed the exclosure due to Great Horned Owl tracks within 30m of the exclosed nest. This nest subsequently hatched unexclosed. Table 5 shows the annual apparent nest success rates for 2014. Nest success was the highest since 1994 and well above the mean (Table 6).

Since 2006 (Figure 13) the number of exclosures used to protect plover nests from predators has declined for three reasons. First, we are concerned about documented mortality of adults associated with exclosures

(Neuman *et al.* 2004, Hardy and Colwell 2008, Lauten *et al.* 2010, 2011, 2012, and 2013). Second, as the population has increased, field staff have less time to provide the additional monitoring exclosures require (Appendix C). Finally, lethal predator management has simultaneously improved success of unexclosed nests (Table 6) and reduced observed corvid activity (Burrell 2014). Despite this, exclosures remain an important tool, particularly in areas of high corvid activity.

Cameras have helped document causes of nest failure and to positively identify individual raptors that are preying on plovers so land management agencies can effectively manage specific threats. Due to advances in camera technology, cameras are more cryptic, easier to install, and need less frequent checks and maintenance. We intend to continue to use cameras where they are feasible, as time is available, and where better documentation of nest failure is needed.

Nest Failure

In 2014, most nests failures were attributed to unknown depredation and unknown cause (Table 7, 53% of the total failures). Nest depredations were classified as unknown because they had clearly been depredated, but the predator could not be identified. Of the 37 nest failures to unknown depredation, 23 (62%) occurred between Siltcoos and Tahkenitch. It is likely that many of the unknown depredations from South Siltcoos to North Tahkenitch were due to Northern Harrier, as most of these failures occurred early in the season when harriers were known to be depredating nests in this area. After Wildlife Services removed one harrier from the area, no additional harrier depredations were recorded, although monitors noted continued harrier activity, particularly later in the season, and some broods may have been lost to harriers.

Fox and harrier were the main cause of nest failure that could be attributed to a particular predator (Table 7). In previous years corvids have been the main cause of nest failure (Castelein *et al.* 1997, 1998, 2000a, 2000b, 2001, and 2002, and Lauten *et al.* 2003, 2005, 2006, 2006b, 2007, 2008, 2009, 2010, 2011, 2012, and 2013). In 2014, corvids were present on all nesting areas, but due to effective management by Wildlife Services, very few nests were attributed to corvid depredation.

A large portion of nest failures were due to unknown causes; a portion of these may have been depredated, but there was no evidence at the nest site to allow us to identify the cause of failure. Half of these nests occurred at Bandon SPMA (Table 7). Fox depredation and wind/weather were the main identifiable causes of nest failure at Bandon SPMA. While it is possible that some of the unknown failures were actually due to fox or wind/weather, soft sand and windy conditions prevented monitors from determining the cause of failure. ORBIC and Wildlife Services corvid observations indicated low corvid activity, and there was no evidence that corvids were responsible for many of these unknown nest failures. Wildlife Services continues to focus on fox removal at Bandon SPMA and New River as their presence is persistent even after annual removal of fox.

Productivity

In general, productivity was excellent in 2014. We monitored 120 more broods in 2014 (Table 8) compared to 2013 (n = 101) and confirmed a record high number of fledglings (Table 9). Of the 221 broods we monitored, 13 were from undiscovered nests. The overall fledging success (Table 8) was slightly higher than the post-predator management average (Table 10). The overall brood success rate (Table 8) was above the 1991 – 2014 average (67% +/- 10). The overall number of fledglings per male (Table 8) was higher than the 2004 – 2014 average (Table 10) and the highest since 2004.

Sutton

Of the two nests at Sutton Beach in 2014, one hatched; the first nest to hatch at this site since 2003 (Table 5). Due to brood activity, there was plover use at Sutton throughout the breeding season. One fledgling was confirmed from Sutton Beach, the first fledgling from Sutton since 2000 (Table 9). The productivity index at Sutton was 25%. The number of fledglings per male was the lowest of all sites (Table 8), however only two males attempted to nest at Sutton Beach in 2014 (Figure 2).

Siltcoos

North Siltcoos had low nest success in 2014; one nest hatched (Table 5). Nest success at South Siltcoos was much higher and near the average (Figure 3). Overall, nest success for Siltcoos was much higher in 2014 compared to 2013 (19%). The main causes of nest failure at Siltcoos were unknown and avian depredations (Table 7). Four depredations at South Siltcoos were attributed to Northern Harrier, and harriers were suspected in additional depredations. Due to raptor activity at this site, exclosures were not used at Siltcoos.

There were 19 fewer nest attempts at Siltcoos in 2014 compared to 2013 (Table 4), and therefore the number of eggs laid was considerably fewer than in 2013 (Table 11). However the same number of eggs hatched in 2014 compared to 2013 and therefore the hatch rate was considerably higher and equal to the post-predator management average (Table 11). There was one fewer brood at Siltcoos in 2014 (Table 8) compared to 2013 (Lauten *et al.* 2013). Twice as many chicks fledged, and brood and fledging success were much higher in 2014 compared to 2013. However, despite this improved productivity, fledging success, number of fledglings per male, and the productivity index were all below the post-predator management average (Table 11).

Overlook

Nest success at Overlook in 2014 (Table 5) was much higher than in 2013 (5%) and higher than the average (Figure 4). The main cause of nest failure was unknown depredation (Table 7), however most of these depredations occurred early in the season, when harriers were frequently observed in the area. Because depredations were occurring before 15 May, and harriers were being observed in the area, nests were not exclosed at Overlook. After one harrier was removed from the Siltcoos-Tahkenitch area (Burrell 2014), nest failures decreased substantially, and exclosures were not needed.

The number of nests at Overlook in 2014 was similar to 2013 (Table 4), and therefore the number of eggs laid was also similar between 2014 and 2013 (Table 12). However, 80 more eggs hatched in 2014 compared to 2013 and therefore the hatch rate was much higher and above the post-predator management average (Table 12). In 2013 there were only three broods at Overlook; in 2014 there were 34 broods (Table 8) and overall brood success was 74%. Brood and fledging success, and number of chicks fledged per male were all much higher at Overlook in 2014 compared to 2013. Fledging success and number of chicks fledged per male were close to the post-predator management average (Table 12). The productivity index was above the post-predator management average (Table 12), indicating high fledgling production for the number of eggs laid.

Tahkenitch

Nest success at North Tahkenitch in 2014 (Table 5) was much higher than in 2013 (12%) and higher than average (Figure 5). The number of nests at North Tahkenitch was much lower than in 2013 (Table 4); improved nest success led to fewer nest attempts. The primary causes of nest failure were unknown depredation and unknown cause; most of these failures were clustered early in the season before Wildlife Services removed a harrier from the vicinity. In April Northern Harriers were documented depredating at least two plover nests (Table 7), and several other nests failed to unknown depredations that were likely harrier depredations based on the circumstances and timing of the failures. Because of harrier activity in the area and timing (these nests were lost before May 15), exclosures were not used. After early season failures, plovers dispersed and some moved to South Tahkenitch. There were four nest attempts at South Tahkenitch at this time, but all four attempts failed. Once Wildlife Services removed one harrier, harrier activity ceased, all new nest attempts occurred at North Tahkenitch, nest success improved, and exclosures were not needed.

Due to fewer nest attempts, there was a decline in the number of eggs laid but the hatch rate was considerably higher in 2014 and above the post-predator management average (Table 13). Fledging success in 2014 was similar to 2013, and above the post-predator management average, but 16 more fledglings were produced in 2014 (Table 13). Because more fledglings were produced from fewer eggs, the productivity index was much higher than in 2013 and above the post-predator management average (Table 13). The number of fledglings per male was much higher than the post-predator management average (Table 13).

Tenmile

Since 2009, Tenmile has had relatively poor nest success (Lauten *et al.* 2009, 2010, 2011, 2012, and 2013), but in 2014 nest success was over double the rate in 2013 (42%), and much higher than the average (Table 5, Figure 6). In 2014, Tenmile was one of the few sites that had more nests in 2014 compared to 2013 (Table 4). The number of plovers detected was similar to 2013 (n=72, Table 3), but in 2013 nests often failed soon after egg laying, and monitors likely missed nests because they failed faster than they could be found. In 2014, high nest success led to improved nest detection (nests are more likely to be detected the longer they persist), and therefore an increase in the number of nests recorded.

Because more nests were discovered, there was an increase in the number of eggs laid at Tenmile in 2014 compared to 2013 (Table 14). Sixty-four more eggs hatched in 2014 compared to 2013, and the hatch rate increased substantially and was nearly double the post-predator management average (Table 14). There were 27 more broods in 2014 compared to 2013, and overall brood success was 85% (Table 8). Fledging success in 2014 was similar to 2013 and above the post-predator management average, but there were 37 more fledglings produced compared to 2013 (Table 14). The productivity index was double the post-predator management average, and the number of fledglings per male was well above the post-predator management average (Table 14).

Of the 47 nests at Tenmile, two failed on the north side and four failed on the south side. Of the six failed nests, only two were recorded as depredations (Table 7). Exclosures were not needed because very few nests failed to predation.

Coos Bay North Spit

Nest success at CBNS in 2014 (Table 5) was much higher than in 2013 (27% overall) and much higher than average for this site (Figure 7). No nest failures were recorded as depredations (Table 7). Poor nest success in 2013 was attributed to Northern Harrier depredations (Lauten *et al.* 2013). Harriers did not cause any depredations in 2014, and while we recorded at least one harrier hunting on CBNS, this harrier was not documented targeting plover nests.

There were 30 fewer nests found at CBNS in 2014 compared to 2013 (Table 4) and 46 fewer eggs laid (Table 15). However, 94 more eggs hatched in 2014 compared to 2013, the hatch rate was three times higher than in 2013, and was well above the post-predator management average (Table 15). The total number of nests at CBNS was much less than 2013 (Table 4) because high nest success led to fewer renest attempts. There were 41 more broods in 2014 compared to 2013 (n = 29) and the overall brood success rate was 79%, much higher than in 2013 (52%). Fledging success and the number of chicks fledged per male were also much higher in 2014 compared to 2013 and near the post-predator management average (Table 15). An additional 59 fledglings were produced compared to 2013. Due to the high fledging rate, the productivity index was much higher than the previous year and higher than the post-predator management average (Table 15). No plover nest activity was found north of the FAA towers.

Bandon SPMA

In 2014, Bandon SPMA had more nests (Table 4), and much higher nest success (Table 5) than in 2013 (33%), near the average (Figures 8 and 9). Fifteen more nests hatched in 2014 compared to 2013, and the number of failed nests was similar to 2013 (n = 42). The increase in the number of nests at Bandon SPMA was not due to high nest failure, but to an increase in the number of plovers using Bandon SPMA, particularly south of New River (Table 3, Lauten *et al.* 2013). The Bandon Beach section of the SPMA had fewer nests in 2014 (Figure 8) than in

2013 (44, Lauten *et al.* 2013). However, the New River side of the SPMA had more than twice the number of nests in 2014 (Table 5, Figure 9) compared to 2013 (n = 20, Lauten *et al.* 2013). Due to the increase in number of successful nests, more eggs were laid, more chicks hatched, and the hatch rate was higher in 2014 compared to 2013. The hatch rate was higher than the post-predator management average (Table 16).

There were 15 more broods at the SPMA in 2014 (Table 8) compared to 2013 (n = 22), and the brood success rate was similar between the years (71% in 2013). Fourteen more chicks fledged, and the fledging success rate was similar to 2013 and the post-predator management average (Table 16). The productivity index was higher than in 2013 and slightly higher than the post-predator management average (Table 16). For only the third time in 10 years, the number of fledglings per male was higher than 1.00, and was above the post-predator management average (Table 16).

The main cause of nest failure at the Bandon SPMA was unknown cause (Table 7); the main cause of depredation was unknown depredation followed by fox depredation. Corvids were known to have depredated just one nest. There was some crow activity in the China Creek area, but ORBIC monitors and the Wildlife Services agent noted the general lack of corvids using the SPMA in 2014, particularly on the New River side. Fox however were a fairly persistent predator in 2014, despite sustained removal efforts (see Burrell 2014 for details). We noted Great Horned Owl tracks, Peregrine Falcons and Northern Harriers throughout the breeding season on the Bandon SPMA. Due to the low corvid activity, the relatively high nest success, and raptor activity along the SPMA, exclosures were not used for the first time since 1990.

On the Bandon Beach side, no nests were found north of China Creek in 2014, unlike the previous two years (Lauten *et al.* 2012 and 2013). There were two nests west of the China Creek parking lot (Figure 8), and three other nests in the China Creek overwash area, the area with the highest recreational activity.

New River

Nest success at New River HRA was much lower in 2014 (Table 5) compared to 2013 (78%). There was a slight increase in the number of nests on the HRA (n = 9 in 2013) likely due to higher nest failure. While there was an increase in plover use at New River in 2014 (Table 3), there was a decline in the number of plovers that actually nested (n = 22 in 2013). Despite fewer nesting plovers, seven more nests were found in 2014 compared to 2013 (Table 4). In 2014 more eggs were laid, but fewer hatched compared to 2013, resulting in a hatch rate well below the post-predator management average for this area (Table 17).

Brood success was high (Table 8), as it was in 2013 (Lauten *et al.* 2013), and while there were fewer fledglings produced, fledging success was higher than in 2013 and higher than the post-predator management average (Table 17). Due to the relatively high number of eggs laid compared to fledglings produced, the productivity index was much lower than in 2013 and lower than the post-predator management average (Table 17). The number of fledglings per male was equal to the post-predator management average (Table 17).

The main cause of nest failure on the HRA was fox and unknown depredation (Table 7). There were no known corvid depredations, and ORBIC and Wildlife Services corvid observations were very low for the HRA (Burrell 2014). Similar to Bandon SPMA, fox activity was erratic throughout the season. We also noted Great Horned Owl activity on the beach and HRA area. Due to the low corvid activity, and concerns about fox and Great Horned Owls, we were cautious about erecting exclosures. However, on 6 July we noted raven tracks near an active nest on the north end of the HRA, We exclosed this nest, but three days later we found fresh Great Horned Owl tracks 30 m from the exclosed nest. We removed the exclosure from the nest at that time to avoid losing incubating adults. The nest subsequently hatched. We did not include this nest in nest success calculations because it does not fit into either category (exclosed or unexclosed), but its exclusion did not alter results. Overall nest success for the New River HRA (with or without the exclosed nest) was 26%.

Four nests were found on private lands at New River in 2014 compared to three in 2013, and nest success was similar each year (Table 5, 67% in 2013). Overall nest success for the New River area (37%) was below average (Figure 10).

Floras Lake

There were two nests at Floras Lake in 2014 (Figure 11), compared to none in 2013 (Table 4). Both nests were found on 30 April; one failed on 7 May to skunk depredation (Table 7). Raven activity near Floras Lake was persistent, so on 17 May we exclosed the remaining nest and it successfully hatched (hatch rate 50%). The productivity index for Floras Lake was 33% in 2014.

Productivity Before and After Lethal Predator Management

Post-predator management hatch rates declined for Overlook, Tenmile, CBNS, Bandon SPMA, and New River while remaining stable at Siltcoos and Tahkenitch (Table 18). However, the overall post-predator management nest success rate (44%) is not significantly different from the overall pre-predator management nest success rate (51%; t = 1.28, df = 22, $P = 0.10$). We attribute the decline in nest success and hatch rates to the decreased use of exclosures (Figure 13); unexclosed nests have a lower nest success rate than exclosed nests (Table 6).

Despite the lower nest success and hatch rates, productivity as measured by fledging success, brood success, number of fledglings per male, and the overall number of fledglings produced has increased. The data from Floras Lake and Sutton Beach are very sparse and not normally distributed. Thus we did not include them in our productivity analyses. Using the data from the productivity tables (Tables 11-17), the overall mean post-predator management fledging success rate (0.46) was significantly higher than the mean pre-predator management fledging success rate (0.39, t = 1.68, df = 19, $P = 0.05$). The post-predator management fledging success rate has improved for Siltcoos, Overlook, Bandon SPMA, and New River and has remained relatively stable at Tahkenitch and CBNS (Table 18). The post-predator management mean brood success rate (2004-2014) was significantly higher than the pre-predator management brood success rate (1991-2001; t = 2.76, df = 21, $P = 0.006$). The fledging success rate at Tenmile has declined, but the decline is not significant (t = 0.77, df = 21, $P = 0.22$). The overall mean number of fledglings per male post-predator management (2004-2014; $x = 1.30$) was higher than the pre-predator management mean number of fledglings per male (1992-2001; $x = 1.11$, t = 1.47, df = 19, $P = 0.08$). The mean number of fledglings per male has significantly improved at Siltcoos, Overlook, Bandon SPMA and New River, and has remained stable or increased at Tahkenitch, Tenmile, and CBNS (Table 18). For the period of 2004-2014 (n = 1286), plovers produced 935 more fledglings than from 1992-2001 (n = 351). We conclude that in the post-predator management time period plover productivity has improved.

Brood Movements

Sutton, Siltcoos, Overlook, and Tahkenitch

The brood at Sutton remained in the vicinity of the HRA and adjacent beach until fledging. There was only one brood at North Siltcoos in 2014 (Table 8) and that brood was never recorded after the hatch date, suggesting it failed soon after hatching. Six of seven broods were successful at South Siltcoos (Table 8). Three of the broods remained on the spit and HRA area, and one other brood spent most of its time on the spit but moved south to the Waxmyrtle trail area before moving back north onto the spit. Two of the broods moved south along the beach to the Carter Lake area and fledged along the beach.

Eleven of 17 broods were successful from North Overlook (Table 8). Two of the successful broods hatched on the beach north of North Overlook and remained on the beach until fledged. The other nine successful broods hatched on the HRA and all but one brood remained on the HRA. One brood moved to South Overlook where it fledged. Fourteen of 17 broods were successful at South Overlook (Table 8). Nine of the fourteen successful broods moved south of the HRA onto the beach including two broods that moved south to North Tahkenitch. Five broods remained on the HRA or the adjacent beach area.

Fourteen of 17 broods from North Tahkenitch were successful (Table 8). Of the fourteen successful broods, only one brood moved north along the beach where it fledged. The remaining broods all stayed on the spit and HRA area of North Tahkenitch. There were no broods at South Tahkenitch in 2014.

Tenmile

Twenty of 26 broods were successful at North Tenmile in 2014 (Table 8). Of the 26 broods, only one brood, from an undiscovered nest, originated along the beach north of the HRA. This brood was found south of the John Dellenbach trail. This brood remained in that area until fledged. All the remaining broods originated on the spit and HRA, and all brood activity was on the spit, the east side estuary, and the beach north of the HRA. One brood swam across the river to the south spit, and then all three chicks were noted at fledging age swimming back across the river to the north side. Only one brood failed at South Tenmile in 2014 (Table 8). Of the 19 successful broods, two originated on the beach south of the HRA; both these broods remained along the beach until fledged. All the other broods originated on the HRA and spit area and remained on the HRA and the spit.

Coos Bay North Spit

In fall of 2013, vegetation was removed from gaps in the berms along the foredune road and the foredune to create corridors for plover broods to move west to access the beach. Dense vegetation along the berms and foredune had prevented broods from freely moving to the beach where food resources are more abundant. On the 95HRA in 2014, 13 of the 17 broods moved to the beach. On the 98EHRA, eight of the 15 broods moved to the beach, and of the seven that were not noted on the beach, five of those failed. On the 94HRA only one of eight broods moved to the beach; of the seven other broods, five remained on the HRA and fledged. On South Spoil, seven of the 12 broods moved to the beach and three of the remaining eight stayed on the nesting area and fledged. On South Beach, no broods moved north towards the FAA towers in 2014. Most brood activity was from north of the Olson wreck to the jetty area. Broods were noted using the jetty area south of the I-beam sign on a regular basis, and we noted broody males and brood tracks on the foredune road and recreation area adjacent to the base of the jetty.

Bandon SPMA

At Bandon Beach, eight broods originated from nests on the beach or in cutouts, and four broods originated from nests on the HRA. All four broods from the HRA were successful. Three of the broods remained on or adjacent to the HRA for the brood period. One brood moved north of the HRA, then disappeared before suddenly reappearing near cutout 2 (Figure 8) just after the fledge date in early July. Of the broods that originated on the beach, two broods hatched in early May, one from the second cutout and one brood from the fourth cutout. The brood from the second cutout failed within 10 days of hatching. The brood from the fourth cutout spent most of the brood period between cutout 2 and cutout 4 before fledging. Another brood from a nest west of the China Creek parking lot spent the brood period in and around the China Creek overwash area until it fledged. A fourth brood that originated on the beach between cutout 3 and 4 spent the brood period in this same area until it fledged. Four other broods hatched on 28 June, 29 June, 14 July, and 16 July. The two broods that hatched at the end of June were active along the beach between cutout 2 and 4 through 15 July. By 20 July all four of these broods suddenly disappeared, and none were ever confirmed fledged. Two of the adult males associated with these broods were recorded after this date, one in Humboldt Co and one at the New River portion of the SPMA. The weather during the time period was typical summer weather (sunny, sometimes windy and/or foggy). We do not know the cause of the sudden disappearance of all four broods, which were all along the same section of beach, but we have rarely documented all broods at one location failing at the same time during peak summer conditions. There was no brood activity on the China Creek spit or north of China Creek, nor did any broods cross New River in either direction.

Eighteen of 25 broods (72%) that originated on the south side of New River at Bandon SPMA in 2014 were successful. Four of the eighteen broods moved south onto private land, and one of these broods moved as far south as the north end of the New River HRA. Three of these four broods originated near the south boundary of the SPMA. The remaining fourteen broods all stayed within the boundaries of the SPMA.

New River

Three broods originated on private land in 2014 and all were successful. Two broods originated on Michael Keizer's property just south of the Bandon SPMA and stayed in this vicinity for the brood period. A third brood originated from a nest along the beach about half the distance between Keiser's property and the north end of the HRA. This brood remained along private property until it fledged.

Three of four broods that originated from the New River HRA in 2014 were successful (Table 8). The southernmost brood originated from the Croft Lake breach. Four days after this brood hatched we found it active on the south end of the Bandon SPMA. The brood remained on the SPMA until it fledged. A second brood hatched on the north end of the HRA and spent the brood period between Croft Lake breach and the north end of the HRA. The third brood hatched at the north boundary of the HRA and moved north onto private land where it spent the brood period.

Floras Lake

One brood hatched from Floras Lake in 2014 (Table 8). Four days after hatching we found the brood approximately 4 miles north, near the Croft Lake breach on the New River HRA. The brood stayed on the New River HRA in the area of New Lake and Croft Lake breach for the brood period until two fledglings were confirmed.

Immigrant Plovers

Sixteen adult plovers banded in California and two adult plovers banded in Washington were observed in Oregon in 2014. Seven were females and 11 were males, including one female and one male from Washington. Four females were confirmed nesting and the other three were present during the breeding season, although two were only seen briefly in late June and early July and may not have attempted to nest. Nine males were confirmed nesting and one other was present during the breeding season and may have attempted to nest but was not confirmed. One other male was only seen briefly in early April.

Of the 16 plovers banded in California, three females and four males originally hatched in Oregon and were subsequently rebanded at coastal nest sites in California. The other nine plovers, three females and six males, were originally banded in California, including one male that was raised at Monterey Aquarium in 2012. Both adults from Washington were banded as hatch year birds at Midway Beach in 2013.

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Table 1. Minimum window survey counts and the minimum number of Snowy Plover present on the Oregon Coast, 2004-2014.

YEAR	WINDOW SURVEY	# SNPL PRESENT
2004	82	136
2005	100	153
2006	91	177
2007	125	181
2008	98	188
2009	136	199
2010	158	232
2011	168	247
2012	206	293
2013	215	304
2014	228	338

Table 2. Number of Snowy Plover fledglings, number of previous year fledglings returning, return rate, number nesting, and percent nesting in first year of return along the Oregon coast, 1992 - 2014.

Year	# of fledglings from previous year	# of HY birds from previous year sighted on OR coast	Return Rate (#HY/#Fled)
2014	104[a]	54	52%
2013	180	91	51%
2012	172	92	51%
2011	84	53	63%
2010	107	54	50%
2009	73	35	48%
2008	124	52	42%
2007	110	32	29%
2006	78	29	37%
2005	108	43	40%
2004	60	26	43%
2003	31	14	45%
2002	32	18	56%
2001	43	23	53%
2000	53	31	58%
1999	32	18	56%
1998	41	14	34%
1997	47	30	64%
1996	57	18	32%
1995	56	37	66%
1994	36	16	44%
1993	33	10	30%
1992	16	6*	38%

* - minimum number sighted

Average return rate = 47%

SD = 11.0%

[a] – adjusted from 103 to 104 based on hatch year returns

Table 3. Plover activity based on the number of adult plovers at each nesting area on the Oregon Coast, 2014. Plovers move between nesting areas throughout the summer, therefore this is not a tally of the total number of plovers present.

	Females				Males					
	Banded		Unbanded		Banded		Unbanded		Total	
Site	**# banded**	**# nested**	**# unbanded**	**# nested**	**# banded**	**# nested**	**# unbanded**	**# nested**	**# plovers**	**# nested**
Sutton	2	1	1	1	4	2	1	0	8	4
Siltcoos	27	8	4	1	37	5	2	2	70	16
Overlook	29	14	7	7	43	31	9	9	89	61
Tahkenitch	29	15	2	1	33	14	3	2	67	32
Tenmile	36	15	5	3	36	32	4	4	81	54
CBNS	36	25	6	5	49	44	9	3	100	77
Bandon SPMA	38	24	6	6	41	29	3	0	88	59
New River HRA	13	8	3	0	21	9	2	0	37	17
Floras Lake	2	2	0	0	2	2	0	0	4	4

Table 4. Number of nests by site on the Oregon Coast 2004 – 2014. Cells tally nests only and not broods from undiscovered nests. The number of broods from undiscovered nests is totaled for each year only.

Site Name	04	05	06	07	08	09	10	11	12	13	14
SU	0	0	4	3	0	0	1	0	0	1	2
SI:											
North	7	8	12	15	30	14	17	13	10	13	6
South	4	9	13	13	6	9	24	21	22	30	18
OV:											
North	11	11	9	13	14	9	21	29	28	33	35
South	3	5	1	3	1	5	16	28	31	28	23
TA											
North	8	11	4	10	5	6	7	23	36	52	32
South	0	0	0	0	0					6	4
TM:											
North	9	6	10	20	12	13	13	15	17	19	26
South	8	11	12	21	16	41	30	35	29	17	21
CBNS:											
SB	2	4	0	8	5	19	17	16	7	36	20
SS	8	9	14	12	18	16	14	15	15	12	13
HRAs	16	16	18	19	26	30	33	26	39	58	43
BSPMA											
BB	17	31	23	30	28	31	26	28	48	44	28
NR spit	7	11	9	16	6	10	12	9	12	20	54
NR HRA	6	1	7	14	27	27	27	29	17	9	15
NR other	11	11	11	5	2	3	3	2	1	3	4
FL	0	0	0	0	0	3	0	0	2	0	2
Tot nst	**117**	**144**	**147**	**202**	**196**	**236**	**261**	**289**	**314**	**381**	**346**
Tot brd[a]	**2**	**3**	**15**	**4**	**3**	**8**	**2**	**4**	**11**	**8**	**12**

[a] – broods from undiscovered nests only; these broods are not tallied in the total number of nests

SU – Sutton, SI – Siltcoos, OV – Overlook, TA – Tahkenitch, TM – Tenmile, CBNS – Coos Bay North Spit (SB - South Beach, SS – South Spoil, BSPMA – Bandon Snowy Plover Management Area (BB - Bandon Beach, NR spit - New River spit), NR HRA – New River HRA, NR other - private and other owned lands, FL – Floras Lake

Table 5. Apparent nest success of Snowy Plovers on the Oregon Coast, 2014.

		Nests Exclosed			Nests Not Exclosed			Exclosed Nests	Nests Not Exclosed	
Site	**Total #**	**Hatch**	**Fail**	**Unknown**	**Hatch**	**Fail**	**Unknown**	**App Nest Success**	**App Nest Success**	**Overall Nest Success**
Sutton	2	1	0		0	1		100%	0%	50%
Siltcoos										
North	6	-	-		1	5		-	17%	17%
South	18	-	-		7	11		-	39%	39%
Combined	24				8	16			33%	33%
Overlook										
North	35	-	-		18	17		-	51%	51%
South	23	-	-		17	6		-	74%	74%
Combined	58				35	23			60%	60%
Tahkenitch										
North	32	-	-		16	16		-	50%	50%
South	4	-	-		0	4		-	0%	0%
Combined	36				16	20			44%	44%
Tenmile										
North	26	-	-		24	2		-	92%	92%
South	21	-	-		17	4		-	81%	81%
Combined	47				41	6			87%	87%
CBNS										
South Beach	20	-	-		14	6			70%	70%
South Spoil	13	-	-		12	1			92%	92%
HRAs	43	-	-		38	4	1		88%	88%
Combined	76				64	11	1		84%	84%
Bandon SPMA	82	-	-		36	41	5	-	44%	44%
New River										
HRA	15 [a]	-	-		3	10	1	-	21%	21%
Other Lands	4	-	-		3	1		-	75%	75%
Floras Lake	2	1	0		0	1		100%	0%	50%
Totals	346	2	0		206	130	7	100%	60%	60%

a – one nest had an exclosure for three days, then exclosure was removed. Nest hatched successfully without exclosure; nest not included in calculations due to variable treatment.

Table 6. Apparent nest success of exclosed and unexclosed Snowy Plover nests on the Oregon coast, 1990 - 2014.

Year	All nests (%)	Exclosed (%)	Not Exclosed (%)
1990	31	*	28
1991	33	75	9
1992	67	85	11
1993	68	83	27
1994	75	80	71
1995	50	65	5
1996	56	71	10
1997	48	58	14
1998	56	72	8
1999	56	64	0
2000	38	48	0
2001	35	68	0
2002	44	66	6
2003	51	77	9
2004	62	85	8
2005	48	72	14
2006	47	66	32
2007	42	71	35
2008	34	49	30
2009	33	76	25
2010	35	72	23
2011	50	71	48
2012	45	86	42
2013	24	83	21
2014	60	100	60
Average =	47.52	72.63	21.44
STDEV =	12.98	11.74	18.75

* Multiple experimental designs used, data not included

Table 7. Causes of Snowy Plover nest failure at survey sites along the Oregon coast, 2014.

Site Name	Tot Nsts	# Fail	Depredations				Other					
			Corvid	Unk	Avian	Mammal	Wind-Weather	Over wash	Abandon	One Egg Nest	Infer	Unk cause
Sutton	2	1		1								
Siltcoos:												
North	6	5	1	1					2			1
South	18	11		6	4					1		
Overlook												
North	35	17		6		3 [a]	3		2	1		2
South	23	6		3	1						1	1
Tahkenitch												
North	32	16		5	2			1	1	1		6
South	4	4		2						1		1
Tenmile:												
North	26	2		1								1
South	21	4		1					2		1	
Coos Bay North Spit:												
South Beach	20	6							3	1		2
South Spoil	13	1									1	
HRAs	43	4								2		2
Bandon SPMA	82	41	1	7		6 [b]	7	2		2		16
New River												
HRA	15	10		3		4[c]		1	1		1	
Other lands	4	1		1								
Floras Lake	2	1				1 [d]						
TOTALS	**346**	**130**	2	37	7[e]	14	10	4	11	9	4	32

[a] – 3 coyote depredation
[b] – 5 fox depredation, 1 raccoon depredation
[c] – 3 fox depredation, 1 skunk depredation
[d] – 1 skunk depredation
[e] – all harrier depredation

Table 8. Fledging success, brood success, and number of fledglings per male for Snowy Plovers on the Oregon Coast, 2014.

Site Name	Total # Broods*	% Brood Success*	Total # Eggs Hatched	Min. # Fledged		% Fledging Success**	# of Breeding Males[a]	# of Fledglings/ Male*	# of Fledglings/Male – Combined[c]
				From Known Nests	From Undiscovered Nests				
Sutton Beach	1	100%	2	1	-	50%	2	0.50	0.50 (2)
Siltcoos:									
North Siltcoos	1	0%	3	0	-	0%	1	0.00	1.14 (7)
South Siltcoos	7	86%	19	8	-	42%	6	1.33	
Overlook									
North Overlook	17	65%	41	17	-	41%	15	1.13	1.35 (31)
South Overlook	17	82%	48	25	-	52%	17	1.47	
Tahkenitch									
North Tahkenitch	17	76%	46	24	0	52%	14	1.71	1.71 (14)
South Tahkenitch	0	-	-	-	-	-	-	-	
Tenmile:									
North Tenmile	26	77%	59	33	2	56%	18	1.94	1.94 (32)
South Tenmile	20	95%	42	23	4	55%	14	1.93	
Coos Bay N. Spit									
South Spoil	12	75%	31	13	-	42%	11	1.18	2.05 (44)
South Beach	18	94%	38	23	5	61%	18	1.56	
HRA	40	73%	95	46	3	48%	31	1.58	
Bandon SPMA	37	68%	94	33	1	35%	29	1.17	1.17 (29)
New River									
HRA	4	75%	7	3	-	43%	7	0.43	1.00 (9)
Other lands	3	100%	8	6	-	75%	3	2.00	
Floras Lake	1	100%	3	2	-	67%	2	1.00	1.00 (2)
TOTALS	**221**	**77%**	**536**	**257**	**15**	**48%**	**162**[b]	**1.68**	
TOTAL FLEDGED				**272**					

% Brood success = # broods with at least 1 chick fledged / total # of broods

% Fledging Success = # of young fledged / # of eggs hatched

* Includes broods from undiscovered nests:

** Does not include fledglings from undiscovered nests because we do not know how many eggs hatched from those nests.

[a] – number of males confirmed nesting at each site; some males were confirmed nesting at multiple sites.

[b] – number of confirmed breeding males in entire population; this is not a tally of confirmed males from each site as some males may have nested at more than one location

[c] – number of fledglings for both sites combined and number of known individual breeding males for both sites combined. Sample size of males in parenthesis.

Table 9. Total number of young fledged from select sites on the Oregon Coast 2000-2014, includes fledglings from broods from undiscovered nests.

Site Name	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
SU	3	0	0	0	0	0	0	0	0						1
SI:															
North	0	0	0	0	7	2	11	7	5	8	4	4	1	2	0
South	7	0	0	2	5	7	7	4	3	11	4	8	16	4	8
OV:															
North	5	1	2	3	3	5	8	12	3	7	12	27	22	3	17
South	0	1	0	0	3	2	0	1	0	2	7	23	27	0	25
TA:															
North	2	4	1	3	6	8	5	2	0	1	3	20	26	9	24
South	3	4	5	2	0	0	0	0	0					3	0
TM:															
North	0	0	3	1	3	6	12	13	3	2	3	1	5	15	35
South	5	4	3	9	9	5	7	14	6	19	13	5	5	8	27
CBNS:															
SS	3	4	2	7	13	9	11	7	17	4	2	6	10	2	13
SB	0	1	1	3	0	8	1	10	7	17	13	22	16	18	28
HRAs	6	6	8	14	22	6	19	9	16	10	5	28	34	3	49
BSPMA															
BB	0	1	0	4	16	11	12	13	2	6	6	16	11	8	12
NR spit	0	0	0	1	10	0	3	12	2	1	0	5	1	14	22
NR HRA	1	3	3	7	5	1	7	16	7	17	12	7	4	12	3
NR other	4	3	3	4	6	8	7	4	2	2	0	0	0	3	6
FL	3	0	0	0	0	0	0	0	0	0	0	0	2		2
Total	**43**	**32**	**31**	**60**	**108**	**78**	**110**	**124**	**73**	**107**	**84**	**172**	**180**	**104[a]**	**272**

[a] – adjusted from based on hatch year returns

SU – Sutton, SI – Siltcoos, OV – Overlook, TA – Tahkenitch, TM – Tenmile, CBNS – Coos Bay North Spit (SB - South Beach, SS – South Spoil, BSPMA – Bandon Snowy Plover Management Area (BB - Bandon Beach, NR spit - New River spit), NR HRA – New River HRA, NR other - private and other owned lands, FL – Floras Lake

Table 10. Fledging success and mean number of fledglings/male on the Oregon Coast, 2004 – 2014.

Year	% Fledging Success	Mean # Fled/Male
2004	55	1.73
2005	41	1.28
2006	48	1.56
2007	54	1.60
2008	47	1.13
2009	50	1.33
2010	35	0.97
2011	47	1.61
2012	44	1.41
2013	39	1.04
2014	48	1.68
’03-’14 mean	46.2 $\pm$ 6.1	1.39 $\pm$ 0.27

Table 11. Productivity of Snowy Plovers at Siltcoos, Lane Co., Oregon coast, 1993-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledging success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Siltcoos	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/ male
	2014	57	22	39%	8	36%	14%	7	7	1.00
	2013	102	22	22%	4	18%	4%	4	10	0.40
	2012	92	38	41%	15	39%	16%	15	13	1.15
	2011	87	36	41%	11	31%	13%	11	13	0.85
	2010	105	30	29%	8	27%	8%	8	10	0.80
	2009	54	28	52%	17	61%	31%	17	11	1.55
	2008	68	22	32%	8	36%	12%	8	9	0.88
	2007	67	24	36%	11	46%	16%	11	10	1.10
	2006	60	22	37%	13	60%	22%	11	5	2.20
	2005	44	17	39%	9	53%	20%	9	7	1.29
	2004	31	18	58%	12	67%	39%	12	5	2.40
	2003	16	5	31%	2	40%	13%	2	4	0.50
	2002	28	8	29%	0	0%	0%	0	2	0.00
	2001	33	1	3%	0	0%	0%	0	3	0.00
	2000	55	19	35%	7	37%	13%	7	8	0.88
	1999	59	21	36%	6	29%	10%	6	8	0.75
	1998	10	10	100%	6	60%	60%	6	3	2.00
	1997	8	4	50%	0	0%	0%	0	2	0.00
	1996	7	3	43%	0	0%	0%	0	1	0.00
	1995	12	6	50%	2	33%	17%	2	3	0.67
	1994	9	4	44%	1	25%	11%	1	3	0.33
	1993	1	0	0%	0	0%	0%	0	0	0.00
Pre-pred mang (1993-2003)	**total**	238	81		24			24	37	
	AVE			38%		20%	11%			0.47
	STDEV			26%		21%	17%			0.61
Post-pred mang (2004-2014)	**total**	767	279		116			115	100	
	AVE			39%		44%	18%			1.24
	STDEV			10%		16%	10%			0.60

[a] - productivity index = number of fledglings/number of eggs laid

Table 12. Productivity of Snowy Plovers at Overlook, Douglas Co., Oregon coast, 1999-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledging success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Overlook	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/male
	2014	161	89	55%	42	47%	26%	39	31	1.26
	2013	152	9	6%	3	33%	2%	3	6	0.50
	2012	158	73	46%	40	55%	25%	40	25	1.60
	2011	152	80	53%	48	60%	32%	41	22	1.86
	2010	92	39	42%	15	38%	16%	15	15	1.00
	2009	31	14	45%	9	64%	29%	9	5	1.80
	2008	34	5	18%	2	40%	6%	2	3	0.67
	2007	46	19	41%	11	58%	24%	11	9	1.22
	2006	28	18	64%	8	44%	29%	8	4	2.00
	2005	42	16	38%	7	44%	17%	7	5	1.40
	2004	39	14	36%	6	43%	15%	6	6	1.00
	2003	17	9	53%	3	33%	18%	3	4	0.75
	2002	24	13	54%	2	15%	8%	2	4	0.50
	2001	39	10	26%	2	20%	5%	2	4	0.50
	2000	22	8	36%	5	63%	23%	5	7	0.71
	1999	6	6	100%	3	50%	50%	3	2	1.50
Pre-pred mang (1999-2003)	**total**	108	46		15			15	21	
	AVE			54%		36%	21%			0.79
	STDEV			28%		20%	18%			0.41
Post-pred mang (2004-2014)	**total**	935	298		191			181	131	
	AVE			40%		48%	20%			1.30
	STDEV			16%		10%	10%			0.49

[a] - productivity index = number of fledglings/number of eggs laid

Table 13. Productivity of Snowy Plovers at Tahkenitch, Douglas Co., Oregon coast, 1993-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledging success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Tahkenitch	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/male
	2014	93	46	49%	24	52%	26%	24	13	1.85
	2013	141	14	10%	8	57%	6%	8	5	1.60
	2012	104	56	54%	26	46%	25%	26	19	1.37
	2011	59	37	63%	19	51%	32%	18	9	2.00
	2010	14	7	50%	3	43%	21%	2	3	1.00
	2009	13	6	46%	1	17%	8%	1	2	0.50
	2008	14	0	0%	0	0%	0%	0	1	0.00
	2007	23	6	26%	2	33%	9%	2	4	0.50
	2006	12	9	75%	4	44%	33%	4	3	1.33
	2005	26	14	54%	8	57%	31%	8	4	2.00
	2004	21	14	67%	6	43%	29%	6	5	1.20
	2003	37	17	46%	3	18%	8%	3	10	0.30
	2002	30	16	53%	6	38%	20%	6	5	1.20
	2001	36	22	61%	8	36%	22%	8	8	1.00
	2000	15	6	40%	5	83%	33%	5	2	2.50
	1999	9	1	11%	1	100%	11%	1	2	0.50
	1998	18	11	61%	1	9%	6%	1	4	0.25
	1997	41	10	24%	6	60%	15%	6	7	0.86
	1996	51	21	41%	8	38%	16%	8	9	0.89
	1995	21	16	76%	12	75%	57%	12	7	1.71
	1994	9	8	89%	1	13%	11%	1	3	0.33
	1993	0	0	0%	0	0%	0%	0	0	0.00
Pre-pred mang (1993-2003)	**total**	267	128		51			51	57	
	AVE			46%		43%	18%			0.87
	STDEV			27%		33%	16%			0.73
Post-pred mang (2004-2014)	**total**	479	209		99			98	66	
	AVE			45%		40%	20%			1.21
	STDEV			24%		18%	12%			0.66

[a] - productivity index = number of fledglings/number of eggs laid

Table 14. Productivity of Snowy Plovers at Tenmile, Coos Co., Oregon coast, 1992-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledging success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Tenmile	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/ male
	2014	136	101	74%	56	55%	41%	56	32	1.75
	2013	95	37	39%	19	51%	20%	19	14	1.36
	2012	104	18	17%	9	50%	7%	9	6	1.50
	2011	117	18	15%	4	22%	3%	4	10	0.40
	2010	113	51	45%	16	31%	14%	16	18	0.89
	2009	117	27	23%	16	59%	14%	16	9	1.78
	2008	77	21	27%	8	38%	10%	8	8	1.00
	2007	89	43	48%	27	63%	30%	27	19	1.42
	2006	59	28	47%	16	57%	27%	16	10	1.60
	2005	49	21	43%	8	38%	16%	8	8	1.00
	2004	50	29	58%	12	41%	24%	12	9	1.33
	2003	43	20	47%	10	50%	23%	10	8	1.25
	2002	32	14	44%	3	21%	9%	3	8	0.38
	2001	24	10	42%	4	40%	17%	4	4	1.00
	2000	18	14	78%	5	36%	28%	5	4	1.25
	1999	13	8	62%	7	88%	54%	7	3	2.33
	1998	20	8	40%	3	38%	15%	3	4	0.75
	1997	6	6	100%	4	67%	67%	4	2	2.00
	1996	11	6	55%	4	67%	36%	4	4	1.00
	1995	13	11	85%	2	18%	15%	2	4	0.50
	1994	18	3	17%	3	100%	17%	3	2	1.50
	1993	24	15	63%	5	33%	21%	5	5	1.00
	1992	27	19	70%	14	74%	52%	14	7	2.00
Pre-pred mang (1992-2003)	**total**	249	134		64			64	55	
	AVE			59%		53%	30%			1.25
	STDEV			23%		26%	19%			0.61
Post-pred mang (2004-2014)	**total**	1006	394		191			191	144	
	AVE			40%		46%	19%			1.28
	STDEV			18%		13%	11%			0.42

[a] - productivity index = number of fledglings/number of eggs laid

Table 15. Productivity of Snowy Plovers at Coos Bay North Spit, Coos Co., Oregon coast, 1992-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledging success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	CBNS	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/male
	2014	220	164	75%	82	50%	37%	77	41	1.87
	2013	266	70	26%	23	33%	9%	23	24	0.96
	2012	175	135	77%	50	37%	29%	50	44	1.14
	2011	156	109	70%	52	48%	33%	52	31	1.69
	2010	160	40	25%	20	50%	13%	20	17	1.18
	2009	171	58	34%	28	48%	16%	28	22	1.27
	2008	125	63	50%	40	63%	32%	38	19	2.00
	2007	108	45	42%	26	58%	24%	26	12	2.17
	2006	86	54	63%	22	41%	26%	22	14	1.57
	2005	80	38	48%	23	61%	29%	21	12	1.75
	2004	73	42	58%	31	74%	42%	31	15	2.06
	2003	57	29	51%	21	72%	37%	20	9	2.22
	2002	48	21	44%	11	52%	23%	11	10	2.22
	2001	49	21	43%	11	52%	22%	11	8	1.38
	2000	75	23	31%	9	39%	12%	9	6	1.50
	1999	38	35	92%	26	74%	68%	26	10	2.60
	1998	49	18	37%	9	50%	18%	9	8	1.13
	1997	64	32	50%	12	38%	19%	12	11	1.09
	1996	77	48	62%	20	42%	26%	17	14	1.21
	1995	53	35	66%	20	57%	38%	19	11	1.72
	1994	50	44	88%	29	66%	58%	28	12	2.33
	1993	26	18	69%	9	50%	35%	9	7	1.29
	1992	32	21	66%	9	43%	28%	9	7	1.29
Pre-pred mang (1992-2001)	**total**	513	295		154			149	94	
	AVE			60%		51%	32%			1.55
	STDEV			20%		12%	18%			0.52
Post-pred mang (2002-2014)	**total**	1725	838		429			419	274	
	AVE			51%		53%	27%			1.70
	STDEV			17%		12%	10%			0.44

[a] - productivity index = number of fledglings/number of eggs laid

Table 16. Productivity of Snowy Plovers at Bandon Snowy Plover Management Area, Coos Co., Oregon coast, 1995-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledgling success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Bandon SPMA	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/ male
	2014	210	94	45%	33	35%	16%	33	28	1.18
	2013	185	51	28%	19	37%	10%	19	23	0.83
	2012	160	30	19%	12	40%	8%	12	14	0.86
	2011	92	43	47%	21	49%	23%	21	15	1.40
	2010	87	36	41%	6	17%	7%	6	12	0.50
	2009	95	20	21%	7	35%	7%	7	12	0.58
	2008	85	8	9%	3	38%	4%	3	15	0.20
	2007	114	40	35%	24	60%	21%	23	16	1.44
	2006	75	29	39%	11	38%	15%	7	8	0.88
	2005	111	45	41%	11	24%	10%	11	17	0.65
	2004	71	48	68%	26	54%	37%	25	15	1.67
	2003	33	14	42%	3	21%	9%	3	7	0.43
	2002	16	4	25%	0	0%	0%	0	4	0.00
	2001	16	8	50%	1	13%	6%	1	3	0.33
	2000	9	0	0%	0	0%	0%	0	2	0.00
	1999	26	16	62%	3	19%	12%	3	9	0.33
	1998	6	3	50%	0	0%	0%	0	2	0.00
	1997	34	9	26%	0	0%	0%	0	6	0.00
	1996	12	8	67%	1	13%	8%	1	3	0.33
	1995	37	11	30%	6	55%	16%	6	6	1.00
Pre-pred mang (1995-2001)	**total**	140	55		11			11	31	
	AVE			41%		14%	6%			0.28
	STDEV			23%		20%	6%			0.36
Post-pred mang (2002-2014)	**total**	1334	439		176			170	186	
	AVE			35%		34%	13%			0.82
	STDEV			15%		16%	10%			0.50

[a] - productivity index = number of fledglings/number of eggs laid

Table 17. Productivity of Snowy Plovers at New River (HRA and private lands), Coos Co., Oregon coast, 1999-2014.

Number of eggs laid, number hatched, hatch rate, # fledged, fledgling success rate, and productivity index based on all known nests. Number of fledglings per male based on nests with known adult males only, therefore number of fledglings may vary from total number of fledglings.

	Year	total # eggs laid	total # hatched	hatch rate	total # fledged	fledging success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings/ male
	2014	52	15	29%	9	60%	17%	9	9	1.00
	2013	35	23	68%	12	52%	34%	12	11	1.09
	2012	46	13	28%	2	15%	4%	2	6	0.33
	2011	59	26	44%	7	27%	12%	7	10	0.70
	2010	71	24	34%	12	50%	17%	12	15	0.80
	2009	76	38	50%	16	42%	21%	16	13	1.23
	2008	54	28	52%	7	25%	13%	7	12	0.58
	2007	38	24	63%	14	58%	37%	14	8	1.75
	2006	18	14	78%	6	43%	33%	6	6	1.00
	2005	3	2	67%	1	50%	33%	1	1	1.00
	2004	18	11	61%	5	45%	28%	5	4	1.25
	2003	14	10	71%	7	70%	50%	7	5	1.40
	2002	18	8	44%	3	38%	17%	3	4	0.75
	2001	21	11	52%	3	27%	14%	3	5	0.60
	2000	11	10	91%	1	10%	9%	1	4	0.25
	1999	9	6	67%	2	33%	22%	2	3	0.67
Pre-pred mang (1999-2001)	**total**	41	27		6			6	12	
	AVE			70%		23%	15%			0.51
	STDEV			20%		12%	7%			0.23
Post-pred mang (2002-2014)	**total**	502	236		101			101	104	
	AVE			53%		44%	24%			0.99
	STDEV			17%		15%	13%			0.37

[a] - productivity index = number of fledglings/number of eggs laid

Table 18. Average Snowy Plover productivity on the Oregon coast pre- and post-predator management, 1992-2014.

	Siltcoos		Overlook		Tahkenitch		Tenmile		CBNS		Bandon SPMA		New River HRA	
	Pre-pred mang (1993-2003)	Post-pred mang (2004-2013)	Pre-pred mang (1999-2003)	Post-pred mang (2004-2013)	Pre-pred mang (1993-2003)	Post-pred mang (2004-2013)	Pre-pred mang (1992-2003)	Post-pred mang (2004-2013)	Pre-pred mang (1992-2001)	Post-pred mang (2002-2013)	Pre-pred mang (1995-2001)	Post-pred mang (2002-2013)	Pre-pred mang (1999-2001)	Post-pred mang (2002-2013)
ave hatch rate	38%+/-26%	39%+/-10%	54%+/-28%	40%+/-16%	46%+/-27%	45%+/-24%	59%+/-23%	40%+/-18%	60%+/-20%	51%+/-17%	41%+/-23%	34%+/-15%	70%+/-20%	53%+/-17%
ave fledging success rate	20%+/-21%	44%+/-16%	36%+/-20%	48%+/-10%	43%+/-33%	40%+/-18%	53%+/-26%	46%+/-13%	51%+/-12%	53%+/-12%	14%+/-20%	36%+/-17%	23%+/-12%	44%+/-15%
ave productivity index	11%+/-17%	18%+/-10%	20%+/-10%	20%+/-10%	18%+/-16%	20%+/-12%	30%+/-19%	19%+/-11%	32%+/-18%	27%+/-10%	6%+/-6%	13%+/-10%	15%+/-7%	24%+/-13%
ave # of fledglings/male	0.47+/-0.61	1.24+/-0.60	0.79+/-0.41	1.30+/-0.49	0.87+/-0.73	1.21+/-0.66	1.25+/-0.61	1.28+/-0.42	1.55+/-0.52	1.70+/-0.44	0.28+/-0.36	0.82+/-0.50	0.51+/-0.23	0.99+/-0.37

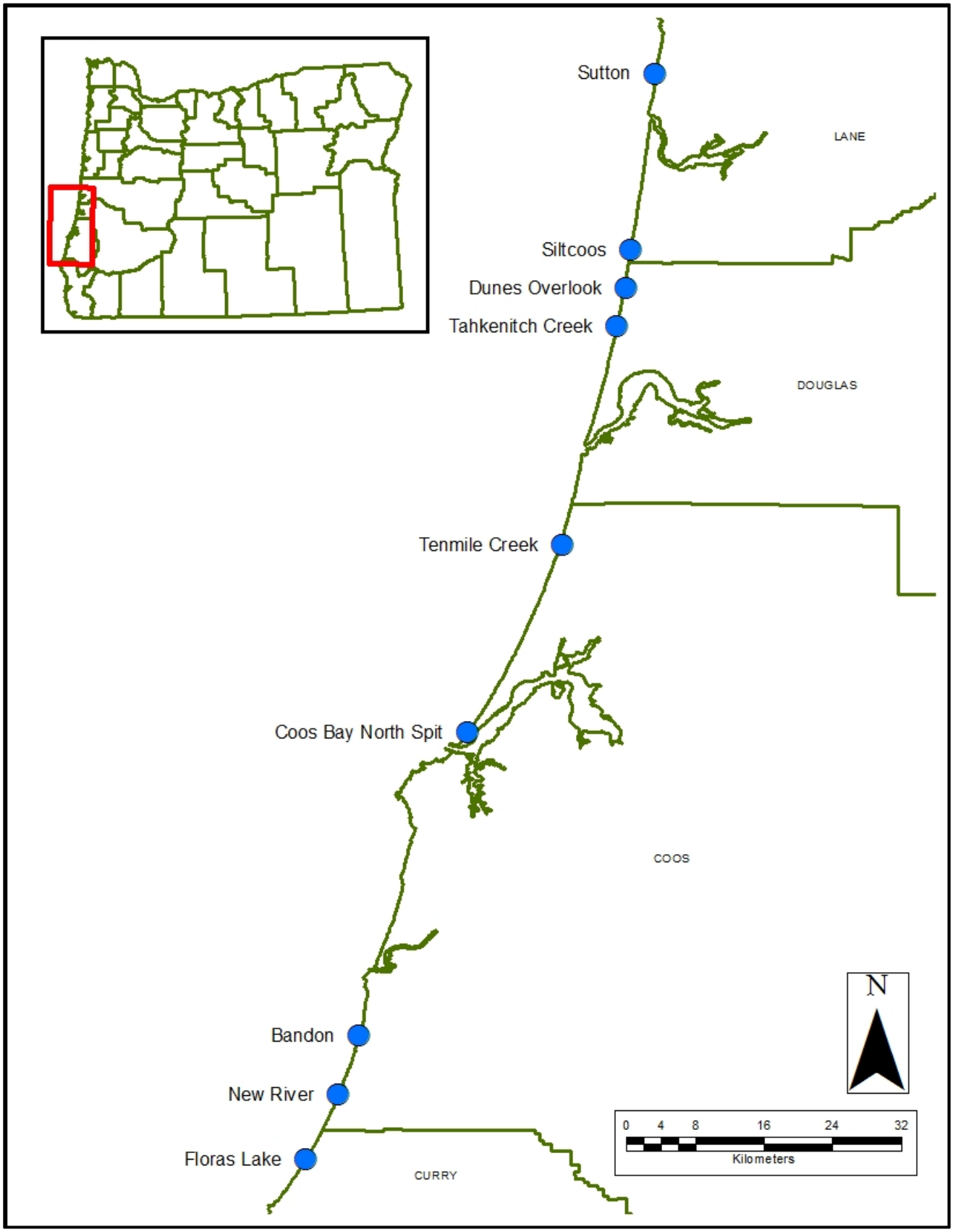


Figure 1. Snowy Plover monitoring locations along the Oregon coast, 2014.

Figure 2. Snowy Plover nest locations at Sutton Beach, Oregon, 2014

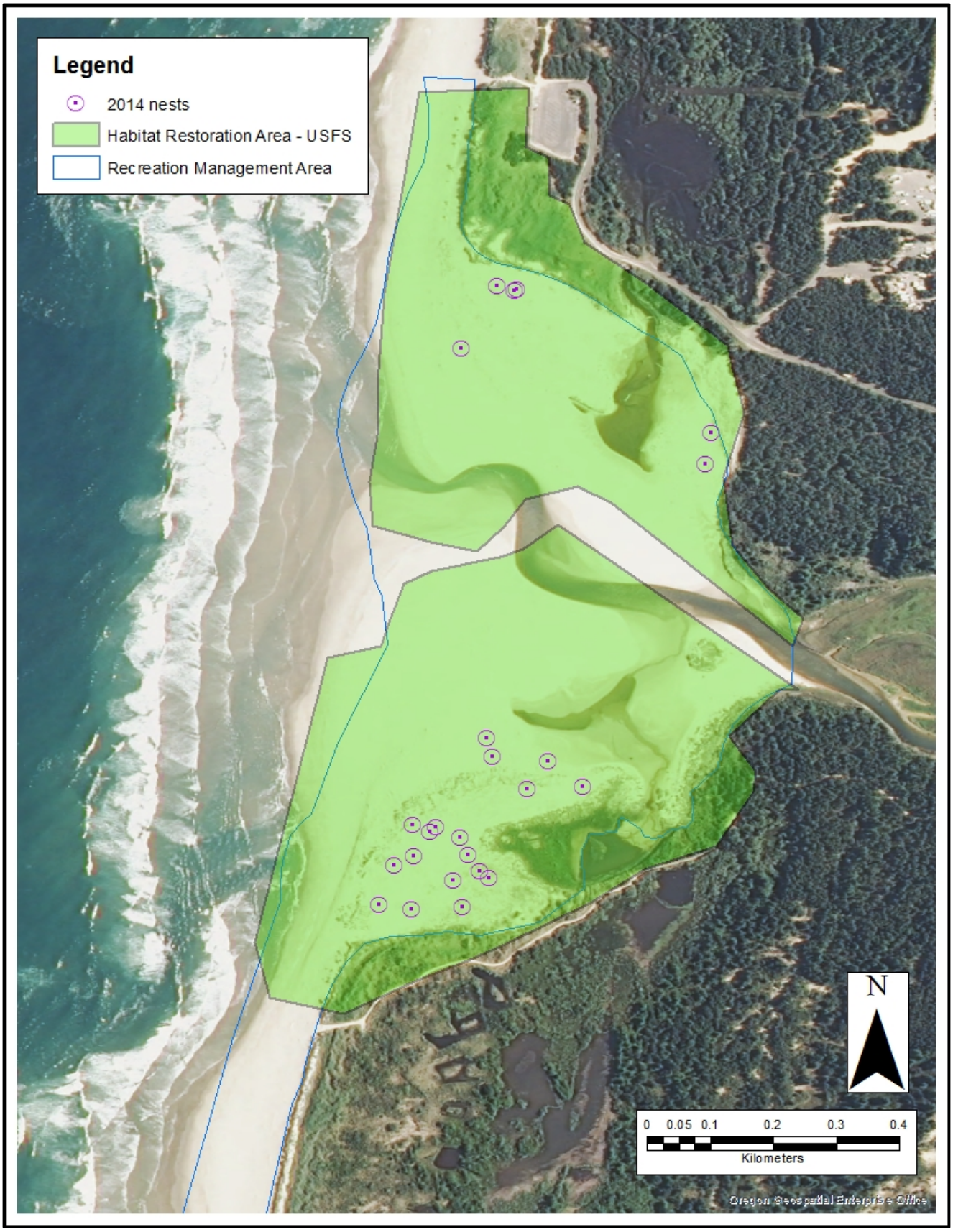


Figure 3. Snowy Plover nest locations at Siltcoos Estuary, Oregon, 2014

Figure 4. Snowy Plover nest locations at Dunes Overlook, Oregon, 2014

Figure 5. Snowy Plover nest locations at Tahkenitch Creek, Oregon, 2014

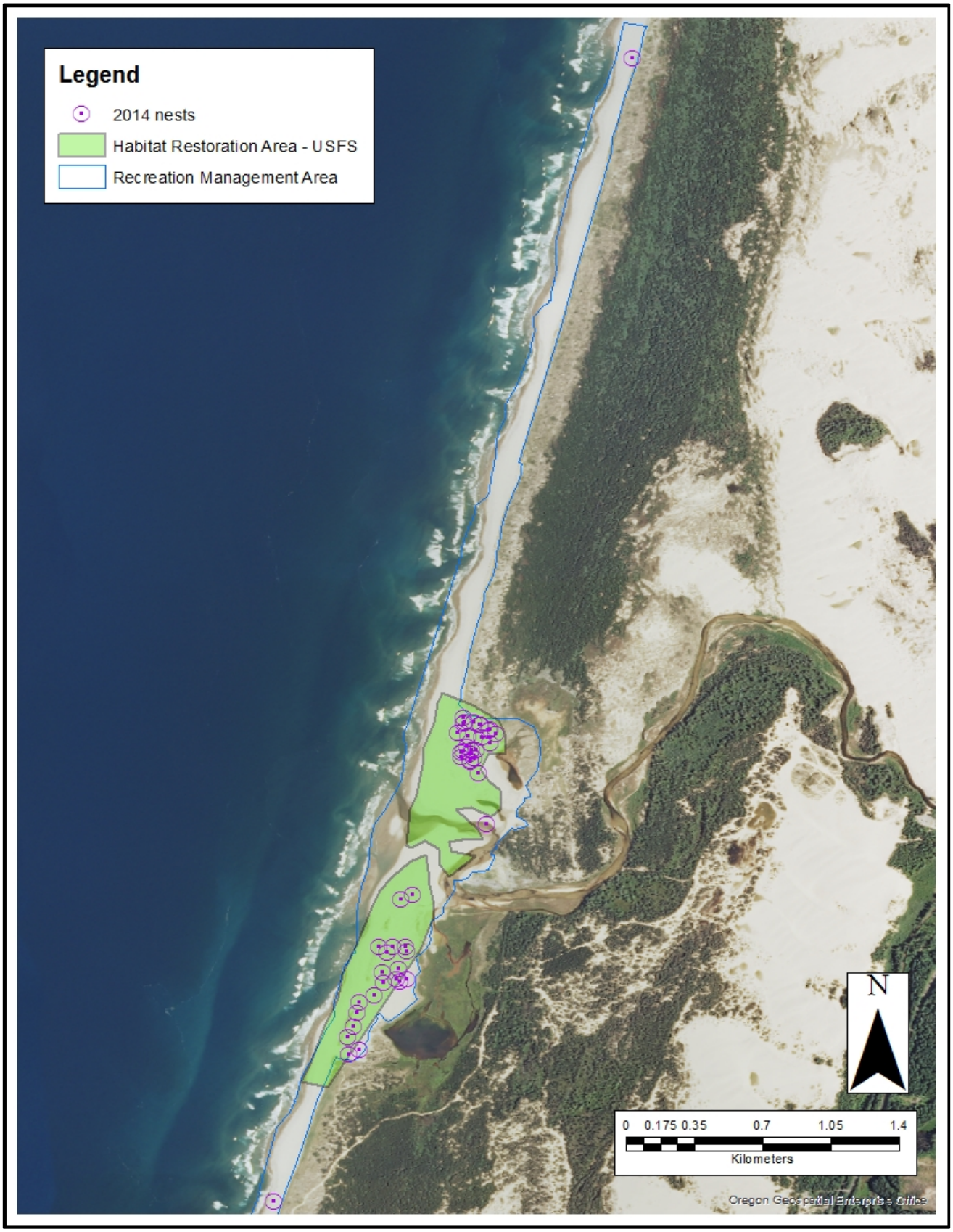


Figure 6. Snowy Plover nest locations at Tenmile Creek, Oregon, 2014

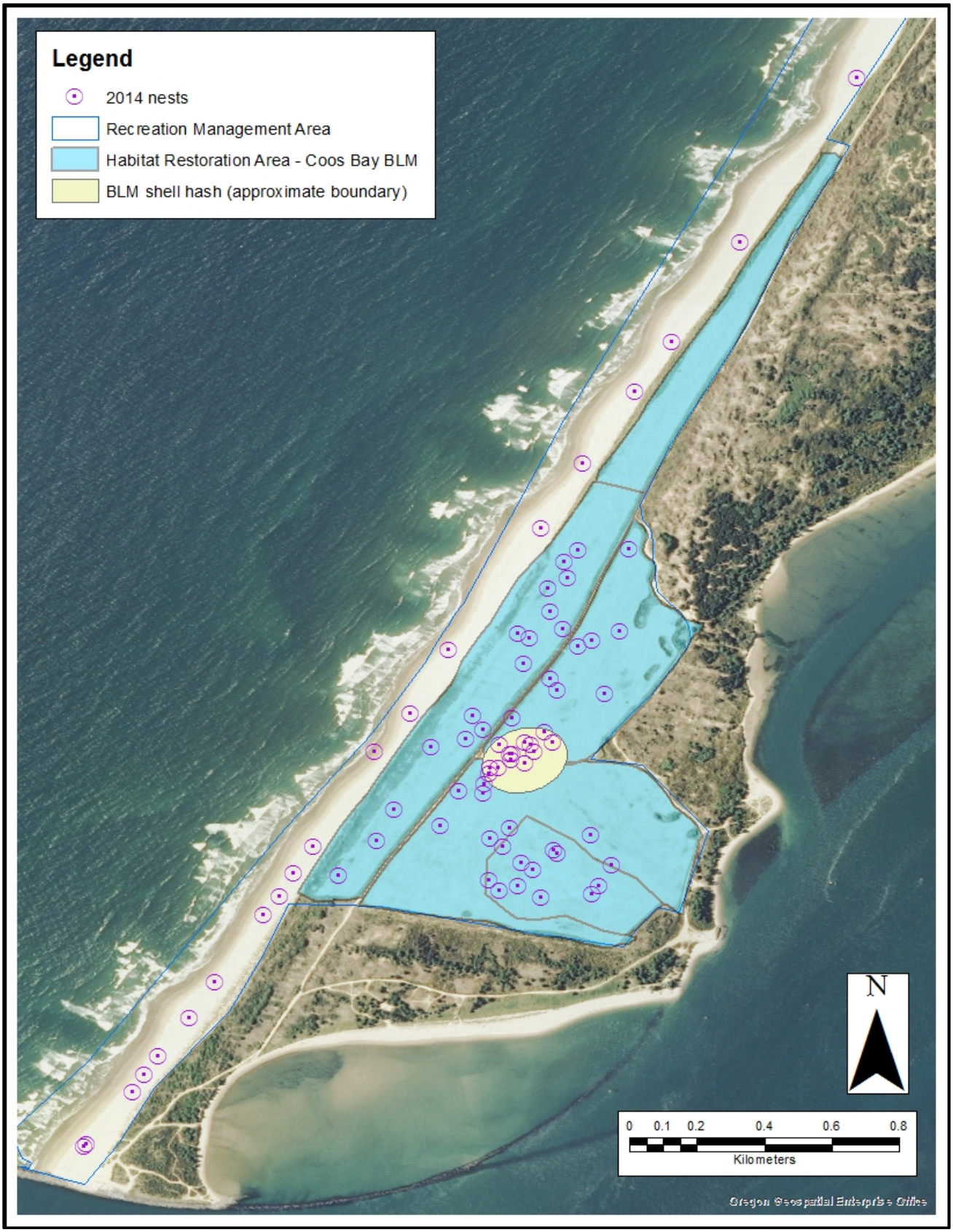


Figure 7. Snowy Plover nest locations at Coos Bay North Spit, Oregon, 2014

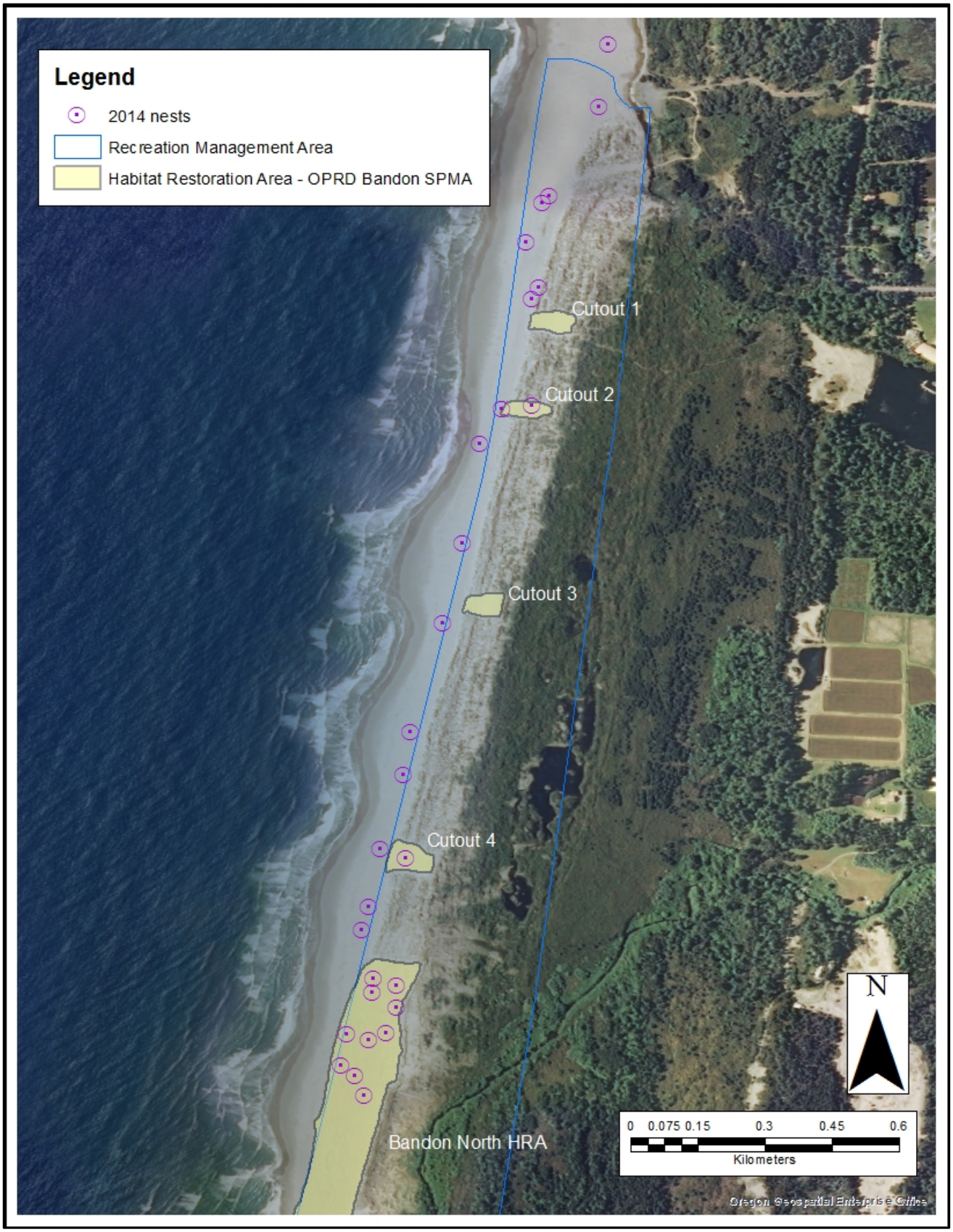


Figure 8. Snowy Plover nest locations at Bandon SPMA north of New River mouth, Oregon, 2014

Figure 9. Snowy Plover nest locations at Bandon SPMA south of New River mouth, Oregon, 2014 Because of river movement, the mouth of New River is not shown correctly on the base map (photo). Correct location is as marked.

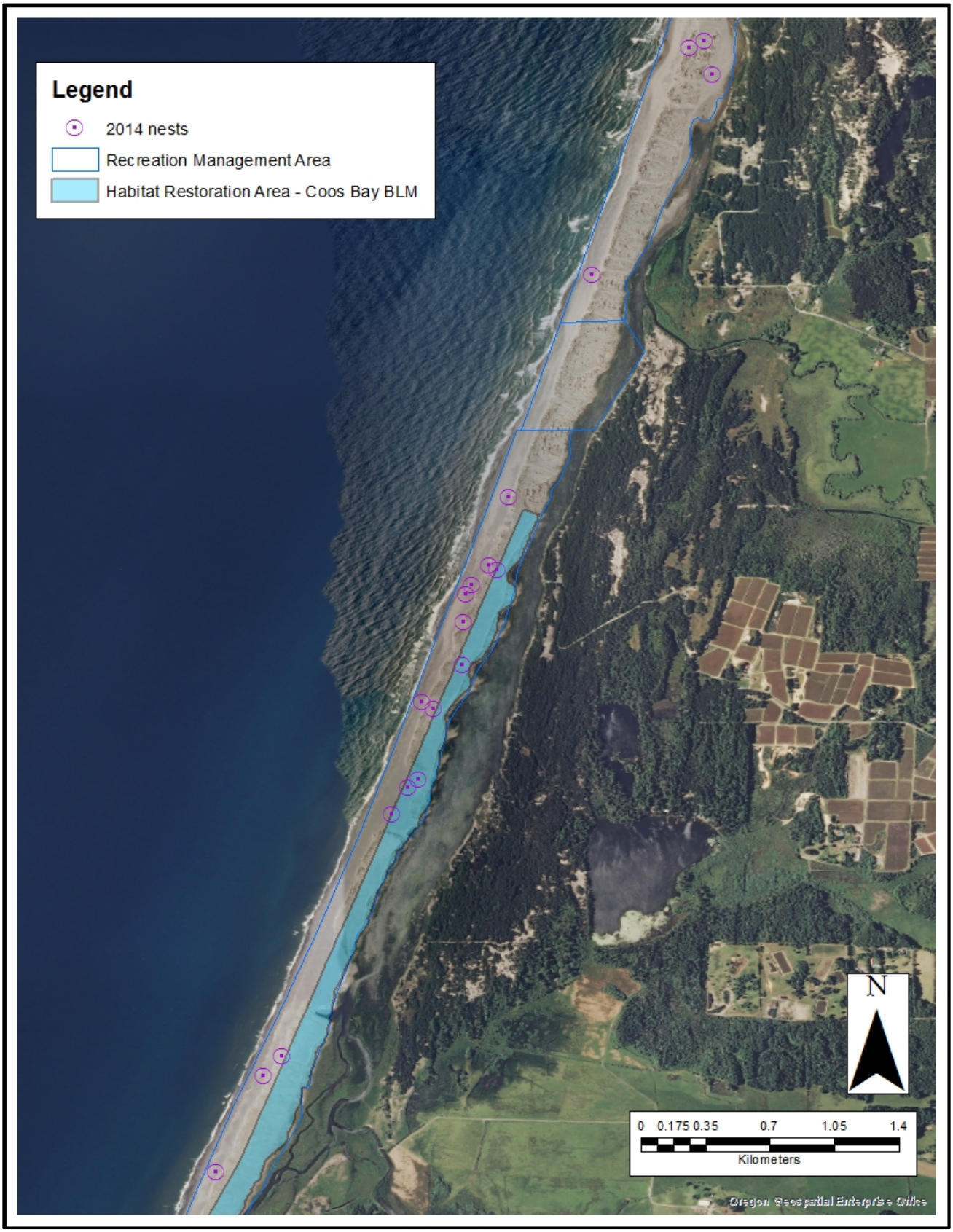


Figure 10. Snowy Plover nest locations at New River HRA, Oregon, 2014

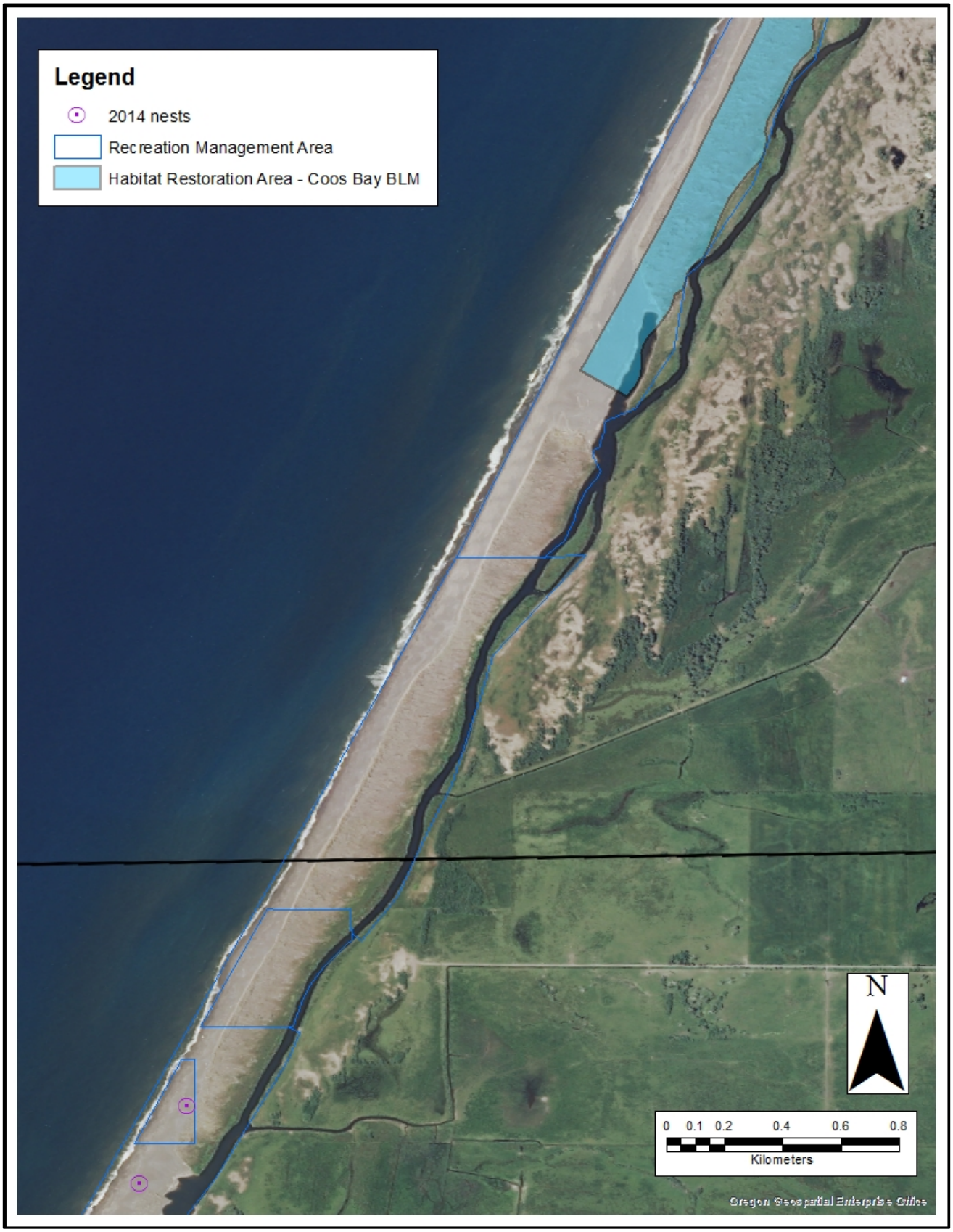


Figure 11. Snowy Plover nest locations at Floras Lake, Oregon, 2014

Figure 12. Number of active Snowy Plover nests within 10-day intervals on the Oregon coast, 2014. Dashed lines represent +/- 2 standard deviations.

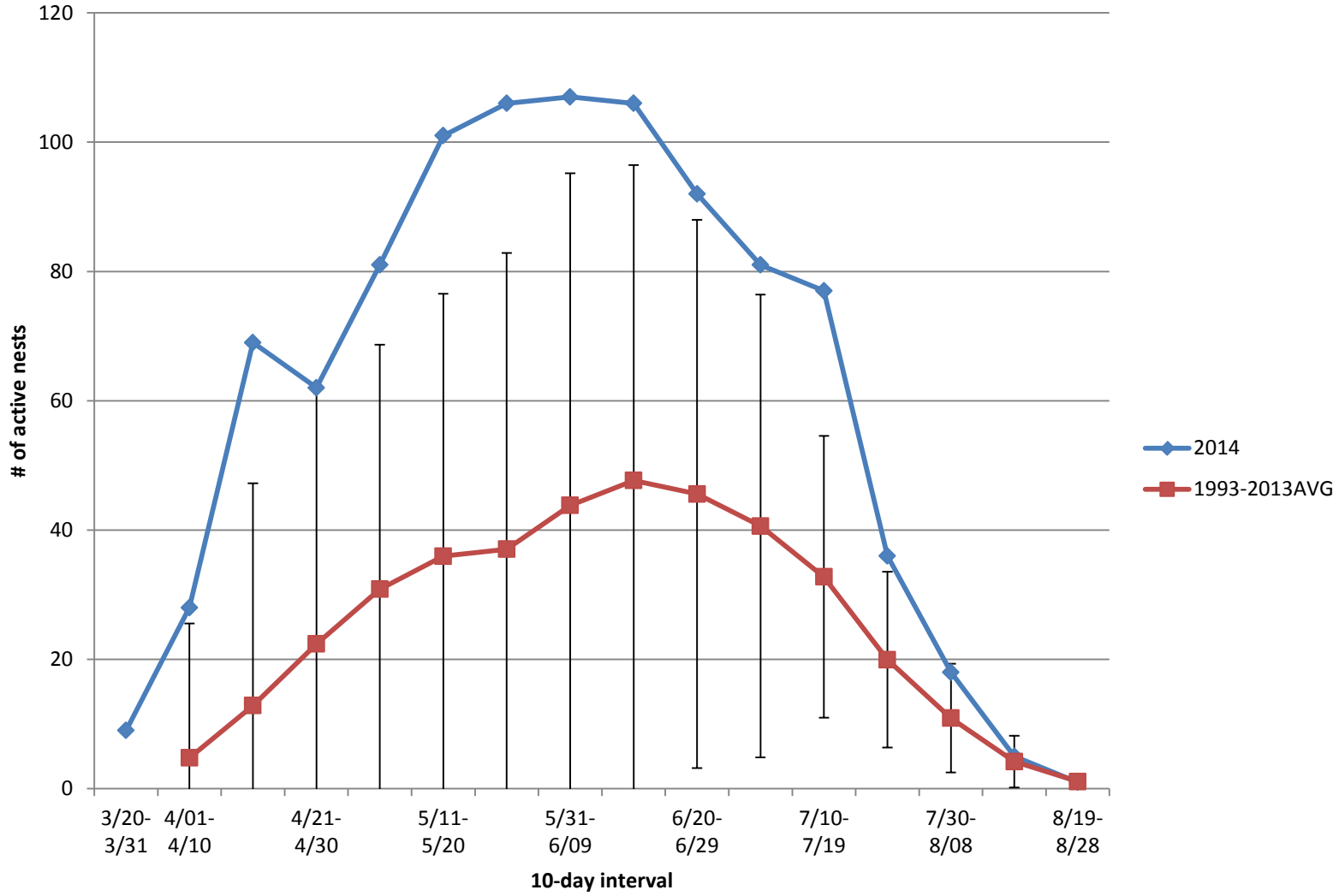
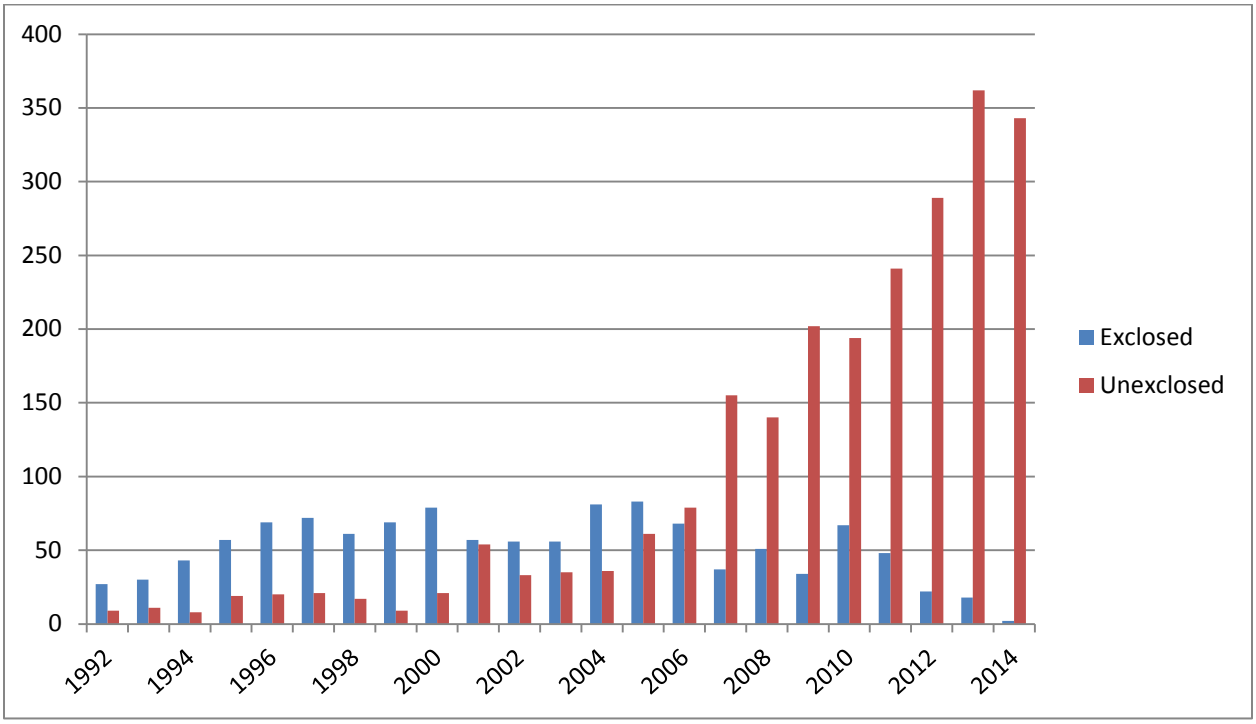


Figure 13. The number of exclosed and unexclosed Snowy Plover nests on the Oregon coast, 1992-2014.



APPENDIX A.

Study Area

The study area encompassed known nesting areas along the Oregon coast including all sites between Berry Creek, Lane Co., and Floras Lake, Curry Co. (Fig. 1). Survey effort was concentrated at the following sites, listed from north to south:

Sutton Beach, Lane Co. - the beach north of Berry Creek south to the mouth of Sutton Creek.

Siltcoos: North Siltcoos, Lane Co. (Figure 2). - the north spit, beach, and open sand areas between Siltcoos River mouth and the parking lot entrance at the end of the paved road on the north side of the Siltcoos River; and South Siltcoos, Lane Co. - the south spit, beach, and open sand areas between Siltcoos River mouth and south to Carter Lake trail beach entrance.

Dunes Overlook Clearing, Douglas Co. (Figure 3). – the area directly west of the Oregon Dunes Overlook off of Hwy 101 including the beach from Carter Lake trail to the north clearing, and south to the Overlook trail south of the south clearing.

Tahkenitch Creek, Douglas Co. (Figure 4) - Tahkenitch North Spit - the spit and beach on the north side of Tahkenitch Creek including the beach north to Overlook trail; and South Tahkenitch – from the south side of Tahkenitch Creek to south of Threemile Creek north of the north Umpqua River jetty.

Tenmile: North Tenmile, Coos and Douglas Cos. (Figure 5) - the spit and ocean beach north of Tenmile Creek, north to the Umpqua River jetty; and South Tenmile, Coos Co. - the south spit, beach, and estuary areas within the Tenmile Estuary vehicle closure, and continuing south of the closure for approximately 1/2 mile.

Coos Bay North Spit (CBNS), Coos Co. (Figure 6): South Beach - the beach between the north jetty and the F.A.A. towers; and South Spoil/HRAs - the south dredge spoil and adjacent habitat restoration areas (94HRA, 95HRA, 98HRA);

Bandon Snowy Plover Management Area, Coos Co. (Figure 7): This site includes the Bandon SPMA and all nesting areas from north of China Creek to the south end of state land south of the mouth of New River.

New River, Coos Co. (Figure 8) - the privately owned beach and sand spit south of Bandon Snowy Plover Management Area south to BLM lands, and the BLM Storm Ranch Area of Critical Environmental Concern habitat restoration area (HRA).

Floras Lake, Curry Co. (Figure 9) – the beach and overwash areas west of the confluence of Floras Creek and the beginning of New River, north to Hansen Breach.

The following additional areas were either surveyed in early spring or the breeding window survey: Clatsop Spit, Necanicum Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sand Lake South Spit, Nestucca Spit, Whiskey Run to Coquille River, Sixes River South Spit, Elk River, Euchre Creek, and Pistol River.

APPENDIX B

Snowy Plover Monitoring Methods

Nest Surveys

Monitoring began the first week in April and continued until all broods fledged, typically by mid-September. We used two teams of two biologists; one team covering Tenmile and sites north, and the other covering Coos Bay North Spit and sites south (Fig. 1). In some years this division has been modified to accommodate staff needs. All data collected in the field was recorded in field notebooks and later transferred onto computer. Surveys were completed on foot and from an all-terrain vehicle (ATV). Data recorded on nest surveys included:

- site name
- weather conditions
- start time and stop time
- direction of survey
- number of plover seen, broken down by age and sex
- band combinations observed
- potential predators or tracks observed
- violations/human disturbance observed

Weekly surveys were attempted, but were not always possible due to increasing workload associated with an increased plover population. Additional visits were made to check nests, band chicks, or monitor broods.

Population Estimation

We estimated the number of Snowy Plovers on the Oregon Coast by determining the number of individually color banded adult Snowy Plovers recorded during the breeding season, and then adding an estimated number of unbanded Snowy Plovers. We determined the number of unbanded Snowy Plovers observed within ten-day intervals during the breeding season, selected the highest count of unbanded birds and then subtracted the number of adults that were banded subsequently. We also determined the number of plovers known to have nested at the study sites, including marked birds and a conservative minimum estimate of the number of unbanded plovers.

Nest Monitoring

We located nests using methods described by Page *et al.* (1985) and Stern *et al.* (1990). We found nests by scoping for incubating plovers, and by watching for female plovers that appeared to have been flushed off a nest. We also used tracks to identify potential nesting areas. We defined a nest as a nest bowl or scrape with eggs or tangible evidence of eggs in the bowl, i.e. egg shells. We predicted hatching dates by floating eggs (Westerskov 1950) and used a schedule, developed by G. Page based on a 29-day incubation period (Gary Page, pers comm). We attempted to monitor nests once a week at minimum. We checked nests more frequently as the expected date of hatching approached. We defined a successful nest as one that hatched at least one egg. A failed nest was one where we found buried or abandoned eggs, infertile eggs, depredated eggs, signs of depredation (e.g. mammalian or avian tracks or eggshell remains not typical of hatched eggs or nest cup disturbance) or eggs disappeared prior to the expected hatch date and were presumed to have been predated. In some instances we found nests with only one egg; often there was no indication of incubation or nest defense, and it was uncertain to what extent the nest was abandoned, or simply a “dropped” egg. Because it was difficult to make this determination, we considered all one egg clutches as nest attempts, and classified them as abandoned when there was no indication of incubation or nest defense. Data recorded at nest checks included:

- nest number
- number of eggs in nest
- adult behavior
- description of area immediately around nest

- whether or not the nest is exclosed
- GPS location

Brood Monitoring

We monitored broods during surveys and other field work, and recorded brood activity or males exhibiting brood defense behavior at each site. "Broody" males will feign injury, run away quickly or erratically, fly around and/or vocalize in order to distract a potential threat to his chicks. Information recorded when broods were detected included:

- Number of adults and chicks
- Band combinations of adults/chicks seen
- Sex of adults
- Behavior of adults
- Brood location

Banding

Adults were normally trapped for banding on the nest, during incubation, using a lilly pad trap and noose carpets. Lilly pad traps are small circular traps made of hardware cloth with a blueberry net top. The traps have a small door that the plover will enter. Noose carpets are 4" x 30" lengths of hardware cloth covered with small fishing line nooses. Plovers walk over the carpets and the nooses snag their legs. We limited attempts to capture adults to 20 minutes per trapping attempt. Chicks were captured for banding by hand, usually in the nest bowl. Banding was completed in teams of two to minimize time at the nest and disturbance to the plovers.

APPENDIX C.

Recovery Unit 1 (Oregon & Washington)

Exclosure Use Guidelines Developed by Oregon Biodiversity Information Center for the Western Snowy Plover Working Team

2/27/2012

Nest exclosures are mesh fences that surround a Western Snowy Plover (*Charadrius nivosus nivosus*) nest and act to keep out predators. Nest exclosures have been used in Oregon since 1991 to protect plover nests from depredation by mammalian and avian predators. Prior to implementation of comprehensive predator management, plovers suffered high rates of nest depredation. Exclosures have been successful at increasing nest success rates (Table 6) (Stern *et al.* 1990, 1991, Craig *et al.* 1992, Casler *et al.* 1993, Hallett *et al.* 1994, 1995, Estelle *et al.* 1997, Castelein *et al.* 1997, 1998, 2000a, 2000b, 2001, 2002, Lauten *et al.* 2003, 2005, 2006, 2006b, 2007, 2008, 2009, 2010, 2011). Predators that prey on snowy plover eggs include mammalian predators such as skunk (*Mephitis sp*.), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), mice (*Peromyscus* sp.), and weasel (*Mustela sp*.); and avian predators, mostly American crows (*Corvus brachyrhynchos*) and common ravens (*Corvus corax*).

Since 1990, we have found 2650 snowy plover nests along the Oregon coast, of which 1057 (40%) have been exclosed. Over the years we have had to adapt exclosure techniques in response to predator behavior around exclosures (see Castelein *et al.* 2000a, 2000b, 2001, Lauten *et al.* 2003).

In 1995 we began seeing evidence of adult snowy plover depredations in or immediately outside exclosures. From 1995 to 2011 we documented a minimum of 48 adult losses associated with exclosure use. These losses include 21 cases where blood, feathers, or plover body parts were found in or adjacent to exclosures and 27 cases where incubating adults disappeared from an established, exclosed nest. Forty-eight adult losses associated with 1057 exclosed nests indicate that exclosures subject adult plovers to additional predation risk (approximately 4%). Similar threats associated with exclosures have been reported in other plover populations (Murphy *et al.* 2003, Hardy and Colwell 2008, Pearson *et al.* 2009). We do not have information on how many adults may be lost at nests not associated with exclosures.

Predator exclosures increase snowy plover hatching success and the number of chicks hatched per male, but not fledging success or the number of chicks fledged per male (Neuman *et al.* 2004, Dinsmore *et al.*, 2014). In Oregon, they pose an additional risk to incubating adults and may negatively impact adult survival. As in Washington, exclosure use in Oregon has been a management technique, not part of a study of their effectiveness in increasing the overall plover population. Data from Oregon indicates that exclosure use has a strong positive impact on nest success (Dinsmore *et al.* 2014). Further analysis is underway to determine potential impacts of exclosure use on adult success and fledging success *et al.* (see Pearson *et al.* 2009, Neuman *et al.* 2004).

Scott Pearson *et al.* (2009) conducted a search of existing literature on the effects of nest exclosures on nest success for plovers and other ground nesting species (primarily shorebirds). Their findings are summarized below:

- Nest survival of exclosed nests was significantly higher in ten studies (Rimmer and Deblinger 1990, Melvin *et al.* 1992, Estelle *et al.* 1996, Johnson and Oring 2002, Lauten *et al.* 2004, Niehaus *et al.* 2004, Isaksson *et al.* 2007, Hardy and Colwell 2008, Pauliny *et al.* 2008, Pearson *et al.* unpublished), and there was no difference in two studies (Nol and Brooks 1982, Mabee and Estelle 2000).
- Exclosed nests appear to be only vulnerable to reptilian and small mammal predators while unexclosed nests are vulnerable to predators of all sizes (Mabee and Estelle 2000).

- No difference in fledging success between exclosed and unexclosed nests in four studies (Hardy and Colwell 2008, Pauliny *et al.* 2008, Lauten *et al.* 2004, Pearson *et al.* unpublished data) and higher fledging success for exclosed nests in two studies (Larson *et al.* 2002, Melvin *et al.* 1992). There was no difference in fledging success between exclosed and unexclosed nests for all studies involving snowy plovers.
- Adult mortality associated with exclosures was reported in six of the eight studies that included or mentioned this response variable (Murphy *et al.* 2003, Lauten *et al.* 2004, Isaksson *et al.* 2007, Hardy and Colwell 2008, Pauliny *et al.* 2008, Pearson *et al.* unpublished). Only three studies compared adult mortality between exclosed and unexclosed nests and two reported significant increases in adult mortality associated with exclosures (Murphy *et al.* 2003 and Isacsson 2007) and one reported no difference (Pauliny *et al.* 2008).
- Adult mortality appears to be largely attributable to raptors and appears to be episodic (Murphy *et al.* 2003, Neuman *et al*. 2004, Hardy and Colwell 2008) and differs among habitats (Murphy *et al.* 2003).
- Larson *et al.* 2002 examined the effect of exclosures on population growth for piping plovers and found the effect to be positive.
- Abandonment was higher for exclosed nests in two studies where this was compared directly (Isaksson *et al.* 2007, Hardy and Colwell 2008).
- Abandonment was not associated with the construction process, size, shape, mesh size and fence height (Vaske *et al.* 1994). Covered exclosures are more likely to be abandoned than uncovered exclosures (Vaske *et al.* 1994).
- Exclosures increased incubation length by one day but did not influence chick condition (Isaksson *et al.* 2007).
- Egg hatchability was higher in three studies (Melvin *et al.* 1992, Isaksson *et al.* 2007, Pauliny *et al.* 2008) but no difference was observed in one study (Hardy and Colwell 2008).
- Breeding adults may receive false messages regarding site quality and encouragement to continue to breed in sink habitats (Hardy and Colwell 2008). This is an important research question that should be examined but no data support this contention.

Our data and that of others (Murphy *et al.* 2003, Hardy and Colwell 2008, Pearson *et al.* 2009) indicate that adult plovers are at increased risk of predation while in exclosures. In the absence of research to quantify that risk, and based on the above information, we developed the following guidelines for exclosure use in Oregon:

- Since raptors appear to be the primary threat to adult plovers in exclosures, delay use of exclosures until peak raptor migration has passed. Currently, we have identified May 15 as a suitable cutoff, but this date could be altered as needed.
- Delaying exclosure use until May 15 allows field personnel time to assess causes of early nest failures, although weather conditions can make accurate assessment difficult. During this time, and contingent on funding, we recommend an owl survey be run at each site.
- If nests are being lost primarily to mice, exclosures will not help the problem, and may pose additional risk if the mice are being preyed upon by raptors. In this case exclosure use is not appropriate.
- If corvids and/or large mammals are identified as the main predator at a site, removal of the predators should be the primary goal with exclosures used as a supplemental measure to help protect nests.
- Any use of exclosures should be accompanied by close monitoring to evaluate their effectiveness (Hardy and Colwell 2008) and to detect predators of adult plovers early (Pauliny *et al.* 2008). Weather permitting, exclosed nests should be checked at least twice per week. If conditions do not allow checks twice a week, exclosure use should be seriously reconsidered.
- Adult predation associated with exclosures is often episodic (Castelein *et al.* 2000b, Lauten *et al.* 2006). Once adult predation is suspected, all exclosures should be removed from the site and their use discontinued for the season.
- To minimize the risk of episodic predation on adult plovers, additional caution should be used when placing exclosures within sight of each other (this puts multiple adults at risk).

- Exclosures should not be placed along the foredune.
- Exclosures should not be placed in a windy location that might result in nest drifting. Since the ME's are 4 feet per side, the nest is only about 2 feet from each sidewall. If the nest begins to drift, it could come close to a sidewall, and a predator such as a raccoon could reach in and grab the eggs. If an exclosed nest is in a potentially windy location, it must be monitored frequently to ensure the safety of the nest and adults (especially on windy days).