The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2006

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Abstract

From 2 April – 14 September 2006, we monitored the distribution, abundance and productivity of the federally Threatened Western Snowy Plover (*Charadrius alexandrinus nivosus*) along the Oregon coast. From north to south, we surveyed and monitored plover activity at Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit, Bandon Beach, and New River. Our objectives for the Oregon coastal population in 2006 were to: 1) estimate the size of the adult Snowy Plover population, 2) locate plover nests, 3) continue use of mini-exclosures (MEs) to protect nests from predators and evaluate whether exclosure use can be reduced, 4) determine nest success, 5) determine fledgling success, 6) monitor brood movements, 7) collect general observational data about predators, and 8) evaluate the success of predator management.

We observed an estimated 177-179 adult Snowy Plovers; a minimum of 135 individuals was known to have nested. The adult plover population was the highest estimate recorded since monitoring began in 1990, and we found the highest number of nests since monitoring began in 1990 (n = 147). Overall Mayfield nest success was 38%. Exclosed nests (n=68) had a 60% success rate, and unexclosed nests (n=79) had a 40% success rate. Nest failures were attributed to unknown depredation (18%), unknown cause (18%), one egg nests (16%), wind/weather (13%), abandonment (13%), corvid depredation (10%), adult plover depredation (6%), infertility (4%), and red fox (*Vulpes vulpes*) depredation (1%). We monitored 84 broods, including 15 from unknown nests, and documented a minimum of 109 fledglings, the highest number of fledglings since monitoring began in 1990. One other chick was raised in captivity at Newport Aquarium and released. Overall brood success was 76%, and fledgling success was 48%.

Continued predator management, habitat improvement and maintenance, and management of recreational activities at all sites are recommended to achieve recovery goals.

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Introduction

The Western Snowy Plover (*Charadrius alexandrinus 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 (Federal Register 1993).

We have completed our 17th year of monitoring the distribution, abundance, and productivity of Snowy Plovers found 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, predator management through both lethal and non-lethal predator control methods, and management of human related disturbances to nesting plovers. The goal of management is increased annual productivity that will lead to increases in the overall breeding population in Oregon and eventually lead to 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). Our objectives for the Oregon coastal population in 2006 were to: 1) estimate the size of the adult Snowy Plover population, 2) locate plover nests, 3) continue use of mini-exclosures (MEs) to protect nests from predators and evaluate whether exclosure use can be reduced, 4) determine nest success, 5) determine fledgling success, 6) monitor brood movements, 7) collect general observational data about predators, and 8) evaluate the success of predator management. The results of these efforts are presented in this report.

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 Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit (CBNS), Bandon Beach, and New River (south from Bandon Beach to the south end of the habitat restoration area) (Fig. 1). Due to field staff limitations and general lack of plover use, North Siuslaw and Floras Lake were not surveyed. A description of each site occurs in Appendix A.

Methods

In early April 2006, pre-breeding season surveys of historical nesting areas were completed and in late May 2006 breeding season window surveys were completed. State and federal agency personnel and volunteers surveyed sites between the Columbia River

south to Pistol River, Curry Co. The surveys were implemented to locate any prospecting plovers at locations not known as currently active nesting sites. The following additional areas were either surveyed in early spring or during the breeding window survey: Fort Stevens, Necanicum Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sand Lake Spit, Nestucca River Spit, Whiskey Run to the Coquille River, Elk River, Euchre Creek, and Pistol River.

Breeding season fieldwork was completed from 2 April to 14 September 2006. 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. No modifications to survey techniques were implemented in 2006.

All exclosed nests in 2006 were exclosed with mini-exclosures (MEs). Lauten *et al.* 2003 describes the materials, design, and erection procedures of MEs. Predator management occurred at all active nesting areas; corvids were targeted at all nesting sites and some mammal trapping, specifically targeting red fox (*Vulpes vulpes*), skunks (*Mephitis sp*.), and coyote (*Canis latrans*), occurred at certain specific sites. For information regarding the predator management program, see Little 2005b. We continued to delay the placement of exclosures around nests until early to mid-May, when peak raptor migration is believed to have passed (Castelein *et al.* 2001, 2002, Lauten *et al.* 2003). We also attempted to leave nests unexclosed when predation pressure was determined to be relatively low.

Male Snowy Plovers typically rear their broods until fledging. In order to track the broods we banded most nesting adult males, sometimes the female, and most hatch-year birds with both a USFWS aluminum band and a combination of colored plastic bands. Due to some quality problems with newly issued bands, some broods were not banded while we resolved the issues. Trapping techniques are described in Lauten *et al.* 2005 and 2006. We monitored broods and recorded brood activity or adults exhibiting broody behavior at each site. In previous years, chicks were considered fledged when they were observed 28 days after hatching. In 2006, we generally followed the same criteria, however in a few cases when we noted unbanded chicks from a brood at age 27 days, we considered these chicks fledged to help us determine the number of unbanded fledglings.

We estimated the number of Snowy Plovers on the Oregon coast during the summer of 2006 by determining the number of uniquely color-banded adult Snowy Plovers observed during the breeding season, and added our estimate of the number of unbanded Snowy Plovers that were also present. We determined the number of unbanded plovers by using the daily observation evaluation method described in Castelein *et al.* 2001, 2002 and Lauten *et al.* 2003. We estimated the breeding population by tallying the number of known breeding plovers. Not all plovers recorded during the summer are Oregon breeding plovers; some plovers are recorded early or late in the breeding season indicating that they are either migrant or wintering birds. Plovers that were present throughout or during the breeding season but were not confirmed breeders were considered Oregon resident plovers. We estimated an overall Oregon resident plover

population by adding the known breeders with the number of plovers present during the breeding season but not confirmed nesting.

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 of the 2006 breeding season until the end of the 2006 breeding season. Data from nesting sites with a north and south component (Siltcoos, Overlook, and Tenmile) were pooled because individual plovers use both sides of these estuaries. Data from Coos Bay North Spit nesting sites were all pooled for the same reason. We also pooled the data from Bandon Beach and New River because despite the relatively long distance from the north to the south end (6-8 miles), the plovers that use these nesting sites interchange and move freely between the areas. A tally from each site would suggest more plovers are using the area than each site actually supports. 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 level of nesting activity for each site.

We calculated nest success using apparent nest success and the Mayfield method of nest success (Mayfield 1961, Mayfield 1975). We calculated overall apparent nest success, which is the number of successful nests divided by the total number of nests, for all nests and for each individual site, and overall Mayfield nest success for all nests. We also calculated an adjusted Mayfield nest success for both exclosed and unexclosed nests. The adjusted nest success calculations for exclosed nests eliminated infertile nests because they did not fail due to an extrinsic cause (i.e., depredation or an environmental factor) and adults incubated the eggs longer than the typical incubation period, which would bias the Mayfield calculations. One egg nests and nests found that had already failed were eliminated from unexclosed nest success calculations. For the Mayfield calculations, these failed nests have a survival rate of zero because the nests have no known active dates, and therefore the calculation is divided by zero unexclosed days. Adding nests with no survival rates would bias the calculations to lower estimates of survival. We compared nest success of mini-exclosures and unexclosed nests by Chi-square analysis.

We calculated brood success, the number of broods that successfully fledged at least one chick; fledgling success, the number of chicks that fledged divided by the number of eggs that hatched; and fledglings per male for each site.

We completed a review of plover productivity after five years of predator management activities. Methods and results are documented in Appendix C.

We evaluated the activity patterns of plovers on four habitat restoration/management areas (HRAs): Overlook, the HRAs at CBNS, Bandon Beach HRA, and the New River HRA. We defined four main usage types: roosting, foraging, nesting, and brooding. Our intent was to show in a simple manner the response of

plovers to restored habitats, and therefore, the potential benefits to plovers afforded by habitat management projects.

Results

Abundance

Pre-breeding April surveys and the late May window survey at sites between the Columbia River and Pistol River, Curry Co. did not detect any plovers or plover activity outside of known nesting areas.

During the 2006 breeding season, we observed an estimated 177-179 adult Snowy Plovers at breeding sites along the Oregon coast (Table 1). Of 177-179 plovers, 153 were banded. Using the daily observation evaluation method of estimating unbanded plovers, a minimum of 24 unbanded plovers and a maximum of 26 unbanded plovers was present during the breeding season. For the breeding season, we observed 79 banded females, 74 banded males, 16-18 unbanded females, and 9 unbanded males.

Of the total estimated population, 135 plovers (76%) were known to have nested (Table 1), approximately equal to the mean percentage for 1993-2005 (79%). A minimum of 52 banded females and 14 unbanded females nested and 61 banded males and eight unbanded males nested. An additional 16 banded females, two to four unbanded females, seven banded males, and one unbanded male were present during the breeding season but were not confirmed nesting. The overall estimated Oregon resident plover population was 161-163.

In 2005 the estimated adult plover population was 153-158, of which 141 were banded. Of these 141 banded adult plovers, 41 (29%) were not recorded in 2006 and therefore are presumed not to have survived winter 2005-2006. The estimated overwinter survival rate based on returning banded adult plovers was 71%.

During the 2006 season, we captured and rebanded 17 banded adult plovers - eight were males and nine were female; we banded seven unbanded adult plovers - six were males and one was a female; and we banded 135 chicks during the 2006 season.

2005 Hatch-Year Returns

Due to analysis of hatch year returns, we adjusted the 2005 fledgling total to 78. Twenty-nine of the 78 hatch-year 2005 plovers returned to Oregon in 2006. The return rate was 37%, below the average return rate of 46% (Table 2). Of the returning 2005 hatch-year birds, 17 (59%) were females and 12 (41%) were males. Twenty-two of the hatch year 2005 returning plovers attempted to nest (76%), and they accounted for 21% of the banded adults.

Distribution

Table 3 shows the number of individual banded and unbanded adult plovers and the number of breeding adult plovers recorded at each main nesting area along the Oregon coast in 2006. At Sutton Beach, where approximately 20 plovers winter (ORNHIC unpublished data), we recorded a maximum of seven adult plovers, four of which were known to have nested. At Siltcoos, where the largest coastal Oregon wintering flock occurs, 49 individual adult plovers were recorded, and 16 adult plovers were known to have nested. At Overlook, which generally does not have any wintering plovers, 32 individual plovers were recorded during the breeding season and eight plovers were confirmed breeders. At Tahkenitch, which also does not usually have wintering plovers, eight individual adult plovers were recorded and six nested. At Tenmile, which does support wintering plovers (typically 15-30), 34-35 individual adult plovers were recorded and 23 were confirmed breeders. At CBNS, which typically only has 4-10 wintering plovers but supports one of the largest breeding populations, 45 individual adult plovers were recorded and 33 of these nested. At Bandon Beach/New River, where a large flock of plovers winters (up to 40), 66-67 individual plovers were recorded and 47 of these were confirmed breeders.

Nest Activity

We located 147 nests during the 2006-nesting season (Table 4), the highest number of nests found since monitoring began in 1990. In addition we recorded the highest number of broods from nests that we did not locate prior to hatching for any given year (n=15).

Sutton Beach had four nests in 2006 (Figure 2), the first nests since 2003. All four nests were located south of Holman Vista behind the ropes along the foredune but north of the Holman Vista HRA.

At North Siltcoos (Figure 3), 12 nests were found, the highest number of nests for any year at this site. Nests generally were within the roped area, although the ropes needed to be moved south when nests were found outside the protected area. At South Siltcoos, 13 nests were found. Many of the nests were on the open spit area and along the foredune, partly due to the dune nesting area being small and fairly heavily vegetated. Two broods from undiscovered nests were found at South Siltcoos. One brood was located near the Wax Myrtle Trailhead and the nest was believed to have been south of the trailhead along the foredune. The second brood was found in the vicinity of the Carter Lake Trailhead south of South Siltcoos; it is believed that this nest may have been located along the foredune in this general area. Overall there was an increase in the number of nests at Siltcoos compared to past years (Table 4).

At North Overlook nine nests were found in 2006 and one nest was found at South Overlook, although that latter nest was only a one egg nest that was never completed. All nests on the north side were within the roped nesting area (Figure 4). There were six fewer nests at Overlook in 2006 compared to 2005.

Despite excellent available habitat at North Tahkenitch, there were only four nests located in 2006 and one brood from an undiscovered nest (Figure 5). There was no available habitat on the south side again in 2006. The large roped nesting area at North Tahkenitch was not overly vegetated, yet plover use and nesting attempts were minimal. Ropes also had to be moved south to accommodate at least one nest that was on the open spit. The number of nests in 2006 was considerably lower than the previous four to five years (Table 4).

At North Tenmile, 10 nests were found in 2006, the highest number of nests ever found on the north side. The north spit was quite extensive, and all nests were within the roped area except one nest that was found east of the roped area (Figure 6). Ropes were erected around this nest. One brood from an undiscovered nest was also recorded. At South Tenmile, 12 nests were located and there was one brood from an undiscovered nest. All nests were within the roped area, although one nest was along the very east edge of the HRA under the ropes. Twenty-two total nests at Tenmile in 2006 is the highest number of nests since monitoring began in 1990.

At CBNS (Figure 7), 32 nests were found in 2006, the highest number of nests since monitoring began in 1990 and the highest number of nests for any site in any year. There were also six broods from undiscovered nests. The minimum total of 38 nests is the highest total number of nests recorded for any site on the Oregon coast for any year. There were no known nests on South Beach, however one brood from an undiscovered nest was found on South Beach and likely originated there. The 95HRA had six nests; one nest was west of the 94HRA, and the other five were all north of the 94HRA in the area that was much improved. The 98EHRA had two nests, both within the shell hash area. The 94HRA had 10 nests and South Spoil had 14 nests. Five broods from undiscovered nests were found on the HRAs and South Spoil. It was impossible to know the nest location of these broods, so we lumped these broods into the HRA category (Table 4). However it was likely that at least one and maybe more of the broods originated on the spoil and the others were from the HRAs.

At Bandon Beach (Figure 8), 23 nests were found in 2006, the second highest total since monitoring began in 1990, but down from 31 in 2005. Habitat restoration in winter 2006 improved the middle of the HRA, but the north and south end were not treated and therefore had large amounts of grass, which reduced some of the available nesting area. Plovers began nesting from China Creek overwash and along the entire foredune and on the HRA in the early spring. Plovers continued to nest around China Creek overwash all summer, with a total of four nests in and around the overwash. Plovers nested along the foredune from just south of the Christian Camp Trail to north of the HRA. Two nests were found on the HRA north of the treated area early in the spring, but use in this area was low after the grass grew thicker. Plovers used the treated area throughout the summer, which had a minimal amount of beachgrass growing during the breeding season. Several nests were located south of the treated area, particularly in one area that had thinner amounts of grass and more woody debris. The south end of the HRA was not extensively used

At New River (Figures 9 and 10), 27 nests were found in 2006, slightly higher than 2005. In 2006 we found seven nests on the HRA and two other broods from undiscovered nests were found on the HRA. In the beginning of the season we did not note much plover use of the area south of the Croft Lake breach, but as the season progressed plover use increased. By the end of the season we noted plovers using the HRA and beach from the north to the south end, and we noted plovers as far south as the Clay Island breach. We found nests from just west of the Storm Ranch boat launch, on the Croft Lake and New Lake breach areas, and south of the New Lake breach including one nest at the very south end of the HRA. North of Storm Ranch, two nests were found on the open beach adjacent to private land. Nine nests were found on Coos County land; four nests were found along the river on the east side of the dunes, and five other nests were found southwest of the Lower Fourmile access area. Nine other nests were found on the open spit, all on state owned land. These nests were spread out from just north of the Lower Fourmile access area north to just south of the mouth of the river. Bandon Beach State Natural Area from China Creek to the south boundary north of Coos County land had a total of 32 nests in 2006. Plover use was consistent all summer on state and Coos County land.

The latter part of the winter 2005-2006 and the early part of spring 2006 was wet and cool. Despite the weather, nest initiation by plovers in the 2006-nesting season was above average in the beginning of April and remained above average until mid July. (Figure 11). The first nest was initiated 8 April compared to 20 March in 2005. The higher than average number of active nests is a result of increasing plover populations. The maximum number of active nests during 10-day intervals was 59 during 10 – 19 June time period. This is the highest number of active nests recorded during any time interval since monitoring began in 1990. The last nest initiation occurred on 18 July.

Nest Success

The overall Mayfield nest success in 2006 was 38%, slightly lower than the mean (Table 5). Adjusted Mayfield nest success for all exclosed nests in 2006 was 60%, below the mean and less than the previous five years. For the first time since exclosure use began in 1991, the number of days nests were exclosed was nearly equal to the number of days nests were not exclosed (1149 exclosed days, 1110 unexclosed days). This is a reflection of both fewer days that nests were exclosed and improved survival of unexclosed nests. The adjusted Mayfield nest success rate for unexclosed nests in 2006 was 40%, which was double the mean. Only two other years have Mayfield nest success rates equal or greater than in 2006: in 1999 when the unexclosed Mayfield nest success was 40% based on 93 days unexclosed and 1994 when the unexclosed Mayfield nest success was 68% based on 143 days unexclosed. In all other years unexclosed Mayfield nest success was 27% or lower. This is the fourth year in a row that unexclosed Mayfield nest success rates were at or above the overall mean. Nest success of unexclosed nests was still significantly lower than nest success of exclosed nests ($\chi^2 = 8.013$, df = 1, $P < 0.01$).

In 2006, the overall annual apparent nest success rate was 47%, equal to the rate in 2005 and slightly lower than the 17-year mean of 50% (Table 6 and Figure 12). Apparent nest success for exclosed nests in 2006 was 66%, lower than 2005 (72%) and 2004 (85%). Apparent nest success for unexclosed nests in 2006 was 32%, double the rate in 2005 (14%) and triple the rate in 2004 (9%). At CBNS there were 27 unexclosed nests and only five exclosed nests, and unexclosed nests hatched at a slightly higher rate than the exclosed nests (63% compared to 60%). The high success rate of unexclosed nests at CBNS largely contributed to the improved overall unexclosed nest success rate. Unexclosed nest success rate improved at several sites: at Siltcoos 20% of the unexclosed nests hatched, at North Overlook 50% of the unexclosed nests hatched, at South Tenmile 25% of the unexclosed nests hatched, and 23% of the unexclosed nests at New River hatched. While these rates are improvements over previous years when rates tended to be 10% or less (see 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), some of the sample sizes tend to be small (Table 6) and these sites require higher unexclosed nest success rates to meet recovery goals. Overall nest success was nearly average for most sites in 2006 (compare Table 6 to Figure 12). Notable exceptions include fairly poor nest success at South Siltcoos (23% in 2006 compared to 36% average), above average nest success at North Overlook (67% in 2006 compared to 42% average) and North Tahkenitch (75% in 2006 compared to 51% average), and a lower than average rate at South Tenmile (42% in 2006 compared to 56% average).

Nest Exclosures

Of the 147 nests in the 2006 breeding season, 68 were exclosed with mini-exclosures (46%). We continued the policy of delaying erection of nest exclosures until approximately mid-May (Lauten *et al.* 2004). At that time we began erecting exclosures at all sites regardless of predation pressure. However, we modified our approach as the season progressed due to some problems encountered at certain sites and around certain exclosed nests.

At Sutton, the first two nests were not exclosed and failed relatively quickly. The other two nests were exclosed, and both failed due to wind blown sand. At North Siltcoos, one early season nest that went 18 days unexclosed was exclosed on 5 May. On 11 May we found evidence that coyotes had been within one meter of the exclosure, and the eggs, chicks, and adults were missing. A sea lion carcass near the exclosure had been attracting coyotes and Turkey Vultures (*Cathartes aura*) to the area. We could not determine whether the nest hatched or not, but evidence suggested that the coyotes may have depredated newly hatched chicks near the exclosure. The female was subsequently found alive, the male was never identified, and the chicks were never found. We continued to exclose nests at North Siltcoos until the end of June when we found a newly hatched nest had one chick dead just outside the exclosure with a bloody scratch mark on its back, and a second alive, wet chick nearby. Neither adult of the nest was tending to the live chick, nor was any adult acting broody around the exclosure. There was some evidence of coyote tracks nearby, but it was not clear whether the coyotes were responsible for dead chick or missing adults (we found no evidence of dead adult

plovers). The adults were not known at the time, so we were not certain whether they had been depredated or had abandoned the chicks. The one alive chick was taken to Newport Aquarium where it was raised and eventually was released at North Siltcoos. After this incident we did not exclose any new nests found at Siltcoos (one on the north side, one on the south side); both nests hatched without exclosures. At South Siltcoos we did not have any evidence that any exclosed nests failed due to predators, however one long time Siltcoos resident and very successful male disappeared around 6 June and may have been the male to an exclosed nest that subsequently failed to unknown cause.

At North Overlook nine of 11 nests were exclosed. One experienced and long time breeding female resident of Overlook who was incubating an exclosed nest disappeared on 22 June just prior to the expected hatch date. We did not find any direct evidence that she was depredated in or around the exclosure, however we believe she was depredated. The nest failed. We did not exclose the last nest we found at North Overlook because of concerns about depredations of adults, and this nest successfully hatched.

At North Tahkenitch we did not experience any problems with the four exclosed nests. On 12 August we found a newly hatched brood from an undiscovered nest at the very south end of the spit. At North Tenmile we also did not experience any problems around any exclosures despite the heavy use of the area by coyotes. We did at the end of the season leave one nest unexclosed, partly due to the reduced level of corvid activity on the site at that time of the year, partly due to the predation problems we were having at several other sites, and partly due to the need to test whether nests can survive to hatching with no exclosure (evidence from multiple sites was suggesting that nests could survive to hatching without exclosure use). This last nest was infertile, and was incubated for 43 days. Despite coyotes passing this nest within several meters on multiple occasions, the nest survived well past the normal 28 day incubation period.

At South Tenmile, we exclosed seven of 13 nests. One nest found in mid-May and exclosed was abandoned by early June. The female was unbanded and the male was unknown. The female suddenly stopped incubating after two weeks. Because she was unbanded we cannot be certain she disappeared, but we suspect that she may have been depredated because there was little reason for her to abandon a nest that was two weeks into incubation. In late June we found a nest that was in the process of hatching. Since we had already approached the nest and we were prepared to exclose it, we erected the exclosure and returned in the morning to band the chicks. This nest went through the incubation period without any exclosure. We also had found one brood from an undiscovered nest on the south side, and one brood on the north side, further indicating that some nests were reaching hatch date without any exclosures. Predation pressure from corvids at the end of June was determined to be low, so the last nest we found at South Tenmile was left unexclosed and the nest hatched successfully.

At CBNS, we began to erect exclosures in mid-May, erecting a total of five exclosures. Of these five exclosures, two successfully hatched. A third nest hatched, but two chicks were dead inside the exclosure and a third was near dead and clearly had not

been incubated all night. No adults were tending to the nest, and we had not previously identified the adults. We suspect that one or both of the adults may have been depredated, although we could not find any evidence in or around the exclosure (at least one known breeding male at CBNS disappeared after 16 May and is believed to have been depredated). Two other exclosed nests on the 95HRA mysteriously failed at the end of May. The eggs from both nests were gone, with no evidence of whether they hatched (both were not scheduled to be hatching) nor any evidence of what may have depredated the eggs (recent rain and wind had obliterated all evidence). At the time, predation pressure at CBNS was low and other nests that were not exclosed were hatching. We were also not experiencing any problems around unexclosed nests, so we ceased exclosing nests and continued to monitor the predation pressure. For the remainder of the season no nests were exclosed, egg losses to depredation were minimal, and unexclosed nests hatched at an excellent rate. We also found a total of six broods from undiscovered nests at CBNS, one on the beach and five on the HRA/Spoil, further indicating that unexclosed nests were having a high success rate.

At Bandon Beach in 2006 we experienced the most problems with exclosure use. Of the 23 nests found at Bandon Beach, we exclosed nine. In the beginning of the season before 15 May, we found a number of nests along the foredune as well as around China Creek and on the HRA. Most of these unexclosed nests failed due to depredation events. We began exclosing nests in mid-May. During 10-17 June, eight resident and established breeding plovers disappeared, four nests were abandoned due to the disappearance of the associated adult plovers, and one nest hatched but the chicks were either depredated or died due to the absence of the adults. Four of these nests were along the foredune, and one nest was at the south end of the HRA. We believe the adult plovers were all depredated, possibly at night and possibly by an owl. We could not find any evidence of mammal tracks or activity around the exclosed nests, nor did we find any feathers or body parts from the missing adults. After mid-June, we did not exclose any more nests at Bandon Beach. One nest near China Creek that was unexclosed failed, but two other nests that were unexclosed successfully hatched. We found two broods from undiscovered nests in mid-July, further indicating that unexclosed nests were successful. Because at least eight breeding adults disappeared in mid-June, the number of new nests (and associated plover activity) after these nests failed declined, thus the overall number of nests, and therefore chicks and fledglings, was reduced at Bandon Beach due to the depredation of established breeding adults.

At New River, 14 of 27 nests were exclosed: four of nine nests on state land, six of nine nests on county, and four of seven nests on the BLM HRA. One nest on state land was abandoned for unknown reason in late May. The female was known and was last noted on 25 May; it is not clear if she migrated from the area or was depredated (she was not an established resident breeder). No other exclosed nests failed due to depredations nor were any others mysteriously abandoned. Towards the latter part of the season we cautiously continued to use exclosures, opting to erect them in areas where we felt predation pressure from corvids warranted (particularly on the HRA). In other cases we opted to leave nests unexclosed because of location, low predation pressure, or the circumstances of the individual nest. In particular, two nests at the end of the season

were left unexclosed on state land near the mouth of Twomile Creek/New River because of their remote location, the low corvid use in the area, and concerns of adult depredations at nearby Bandon Beach. Both of these nests successfully hatched. Another nest at the very south end of the HRA was found one day before hatching, so we elected not to exclose the nest for one day and the nest successfully hatched. Other nests on the HRA were exclosed partly due to the presence of some corvids using the area. In one case corvids walked around the exclosure multiple times and likely perched on the top of the exclosure. This nest was located at the north end of the Croft Lake breach. We also found two broods from undiscovered nests that both hatched on the HRA, indicating that despite some corvid activity nests without exclosures were difficult to locate and able to hatch without exclosures.

Adult Mortalities

Twenty-six banded adults disappeared during the 2006 season, 14 females and 12 males. One female was seen only three times in April and may have migrated. Five birds, four males and one female, were last seen in July and may have migrated. Two other females (one HY05 and one unknown age but not a resident Oregon plover) disappeared in May and could have migrated. Two other females, one banded as an adult in 2005 in Oregon and one HY05, disappeared in June and could have migrated. The remaining 16 plovers, eight males and eight females, were all breeding resident Oregon plovers, and all are believed to have been depredated during the breeding season. Eight of these plovers disappeared during 10-17 June at Bandon Beach as documented above. One male disappeared in May and one female disappeared in June from CBNS. One male and one female from Tenmile disappeared in May. Two females disappeared from Overlook in late June; one was associated with an exclosed nest. Two males disappeared from Siltcoos in early June. Based on our experience, breeding resident plovers that disappear during the nesting season have not migrated, nor has there been any pattern of records at other locations (i.e., Washington or Humboldt County, CA), and they do not reappear in the following year, thus we conclude that these birds were depredated.

Nest Failure

Exclosed nests in 2006 had an overall failure rate of 34% (23 of 68), higher than the previous three years (27% in 2005, 15% in 2004, and 23% in 2003). Unexclosed nests had an overall failure rate of 68%, considerably less than 2005 (84%) and much less than the average since 2000 (94%). Overall nest failures were attributed to unknown depredation (18%), unknown cause (18%), one egg nests (16%), wind/weather (13%), abandonment (13%), corvid depredation (10%), adult plover depredation (6%), infertility (4%), and red fox depredation (1%, Table 7). Seven exclosed nests failed due to depredation, two to unknown predator and five due to adult plover depredation (Table 8). The main causes of nest failure of exclosed nests were abandonment (n=6, 26%) and wind/weather (n=6, 26%) followed by adult plover depredation (n=5, 22%). The main causes of failure for unexclosed nests were unknown depredation (n=12, 22%), unknown cause (n=12, 22%) and one egg nests (n=12, 22%), followed by corvid depredation (n=8, 15%). It is likely that corvids were responsible for many of the unknown depredations

and some of the unknown causes (some of the unknown causes were likely due to wind/weather). Therefore corvids continue to be the likely source of the majority of nest failures of unexclosed nests.

There was a fairly high number of one egg nests in 2006 (n=12). These nests are not exclosed and therefore exclosure use and management activities are not the likely cause for these nest attempts being abandoned. In 2006, 10 nests were abandoned, half the number of nests abandoned in 2005. Of the 10 abandoned nests, six were exclosed and four were unexclosed.

Fledgling Success

We monitored 84 broods in 2006 including 15 broods from undiscovered nests. This is the highest number of broods monitored in any year and the highest number of broods from undiscovered nest for any year. A total of 109 fledglings were confirmed, plus one chick was raised in captivity and released. This is the highest number of fledglings since monitoring began in 1990 (Table 9). Overall fledgling success was 48%, higher than the average (39%, Table 10). The overall number of fledglings per brood was 1.30 (109/84) compared to 1.07 in 2005 and 1.46 in 2004, and the overall number of fledglings per male was 1.56 (109/70, Table 11) compared to 1.28 in 2005 and 1.73 in 2004.

The overall brood success rate was 76% (Table 11) compared to 69% in 2005 and 88% in 2004. At Siltcoos, nine of 10 broods were successful (90%) including two broods from undiscovered nests. At Overlook, 67% (four of six) of the broods were successful. There were only four broods at Tahkenitch, three of which were successful (75%). Overall brood success at Tenmile (n=13) and CBNS (n=26) was 77%. At Bandon Beach, overall brood success was 89% (n=9), and at New River, overall brood success was 67% (n=15).

The lowest fledgling success rate for individual sites was at CBNS, where the HRAs had a fledgling success rate of 37%, the only site lower than 40% (Table 11). Overall at CBNS, fledgling success was 41%, the lowest rate of any nesting area. At South Siltcoos the fledgling success rate was 40%, but combined with North Siltcoos the overall fledgling success rate was 60%. Bandon Beach had a fledgling success rate of 42%, and North Overlook and North Tahkenitch had a 44% fledgling success rate. At New River, the HRAs had a fledgling success rate of 43% while the other lands had a 50% fledgling success rate. Overall at New River fledgling success was 47%. Overall at Tenmile fledgling success was 57%; the north side had a 63% fledgling success rate and the south side had a 50% fledgling success rate.

All sites except CBNS had fledgling success rates near average or higher than average for that site (compare Table 11 to Figure 13). At CBNS, the South Spoil and the HRAs have average fledgling success rates over 50%; neither site was over 50% in 2006. Sites that were much better than average were North Siltcoos, North Tenmile, Bandon

Beach and New River. North Overlook, North Tahkenitch, and South Tenmile had near average fledgling success rates in 2006.

The overall fledglings per male based on broods with known males at Siltcoos was 1.77 (Table 11). There were two broods raised by females at South Siltcoos and the males were never determined; if we assume two individual males were associated with these broods, then the overall fledglings per male rate was 1.64. The overall fledglings per male at Siltcoos was 1.29 in 2005, 2.40 in 2004 and 0.50 in 2003. North Siltcoos had the lowest fledglings per male of all sites in 2005 (0.66); in 2006 North Siltcoos had the highest fledglings per male for all sites (2.75). South Siltcoos had 1.67 fledglings per male in 2006; if we include the two broods raised by females then fledglings per male at South Siltcoos was 1.40. In 2005, South Siltcoos had 1.75 fledglings per male. At Overlook in 2006 there were no broods from the south side. The overall fledglings per male at North Overlook in 2006 was 2.00 compared to 1.40 in 2005, 1.00 in 2004 and 0.75 in 2003. Tahkenitch had 1.67 fledglings per male in 2006 compared to 2.00 in 2005, 1.20 in 2004 and 0.45 in 2003. At Tenmile, overall fledglings per male was 1.58 in 2006 compared to 1.22 in 2005, 1.33 in 2004, and 1.25 in 2003. North Tenmile had 1.71 fledglings per male, the second consecutive year over 1.00 (1.50 in 2005). South Tenmile improved to 1.40 in 2006 from 1.00 in 2005, but was not as high as 2004 (1.80) or 2003 (2.25). CBNS has consistently been very productive but fledglings per male was lower than the past three years: 1.55 in 2006, 1.77 in 2005, 2.16 in 2004, and 2.40 in 2003. At Bandon Beach, fledglings per male in 2006 improved to 1.50 compared to 0.92 in 2005 and was only the second year higher than 1.00 (1.50 in 2004). At New River overall fledglings per male was 1.31, an improvement over 2005 (0.90) but lower than 2004 (1.75). The BLM HRA had 1.00 fledglings per male for the second year in a row, and all other lands improved from 0.80 in 2004 to 1.43 in 2005.

Siltcoos had a total of 18 fledglings in 2006, twice as many as in 2005 and the highest number of fledglings ever produced at this site (Table 9). The north side produced 11 fledglings, nearly doubling the total number of fledglings for all years at this site. North Overlook produced eight fledglings in 2006, the highest number of fledglings ever for this site and the highest number of fledglings for both sites combined in any given year. North Tahkenitch had the fewest nests and broods of all sites (n=4), but still produced five fledglings. At Tenmile, the overall number of fledglings in 2006 was 19, the highest ever produced for this site. This is the fourth year in a row that Tenmile produced at least 10 fledglings (only one previous year (1992) had more than 10 fledglings). The north side had 12 fledglings, doubling the previous high in 2005 and nearly doubling the total number of fledglings ever produced on this side of the estuary. The south side had seven fledglings, a slight increase from 2005 (n=5). CBNS produced 30 fledglings in 2006, the second highest total for any given year (the highest was in 2004 (35) and 30 were also produced in 1994). Twelve fledglings produced at Bandon Beach in 2006 was the third year in a row of over 10 fledglings produced; previous to 2004 the average number of fledglings at Bandon Beach was 1.4 and the high was five in 1994. New River produced 17 fledglings, the second highest number of fledglings ever produced at this site. The BLM HRA had seven fledglings, equal to 2003 for the highest

number of fledglings for this area for any year. Coos County lands produced seven fledglings and state land produced three fledglings.

Brood Movements

Broods movements tend to be unpredictable and variable, and while we may determine a brood is still active by the behavior of the male, the actual location of the brood and the habitat they are using is much more difficult to determine, especially without a focused effort on this aspect of plover ecology.

While roped nesting areas act as a safe refuge from recreational activity on the beach, plovers do not stay within the confines of the nesting area. For instance, at North Siltcoos, we noted two active broods on the open spit near the mouth of the river while a large group of boaters were disembarking on the spit and other recreationists were walking along the wrackline. Both broods successfully fledged. One of these broods crossed the river and finished the brood rearing process on the south side; we noted the fledglings with the adult male just south of the Waxmyrtle Trailhead. We did not note any brood activity north along the foredune north of the roped nesting area at North Siltcoos. At South Siltcoos, the two broods from undiscovered nests actually were reared south of the Waxmyrtle Trailhead. One brood was found in the area of the Waxmyrtle Trailhead and stayed in this area for the brood rearing process. The other brood was discovered around the trailhead to Carter Lake and stayed in this area for the brood rearing process. One brood from North Overlook moved north along the foredune and was found active on the open spit of South Siltcoos, demonstrating the unpredictability of brood movements and the ability of young broods to move far distances. Other broods from North Overlook generally stayed around the nesting area, but broods do venture onto the beach to forage in the wrackline and near the water. Habitat at North Tahkenitch was extensive, but broods were still noted using the open spit south of the ropes near the mouth of the creek. The one brood from an undiscovered nest was noted mostly using the open spit area near the creek and along the west bank of the creek; however when it was confirmed fledged it was found just north of the nesting area along the foredune.

At North Tenmile, where the spit was very extensive in 2006, brood activity was also very extensive. Broods were noted using the entire roped spit, but much of the activity was concentrated at the north end of the roped spit, especially along the edge of the grassy dunes. Broods also used the wide lagoon area on the east side of the ropes, the edge habitat along the far east side near the vegetation line, and the sedge dominated area at the north end of the lagoon area. We also found much brood activity north along the foredune; broods went as far north as approximately a half-mile north of the nesting area. At South Tenmile, broods moved throughout the nesting area, with a concentration of brood activity towards the south end. Broods also moved south along the beach and were noted along the foredune just north of the motor vehicle closure sign at the south end of the beach. There was no evidence that any broods crossed the creek.

At CBNS, one brood from an undiscovered nest was found near fledging age on the beach and almost certainly came from a nest on the beach. No other broods hatched

on the beach, however a number of broods from the HRAs or the spoil moved to the beach during the brood rearing process. These broods were noted as far south as the area near the jetty south of the roped area, and north adjacent to the north end of the 95HRA and the 98WHRA. No broods were noted as far north as the FAA towers. Brood activity on the HRAs and spoil were more expansive than in previous years due to the improved habitat and the removal of berms that impeded plover movement. Broods from the 95HRA were noted as far north as the north end of the 98EHRA (or the northern gate on the foredune road). Broods from the 94HRA moved from the 94HRA to the 98EHRA and the 95HRA. Several broods were noted repeatedly using the area where berms were removed between the 94HRA and the 98EHRA. Broods also used areas along the north, east, and south end of the South Spoil more than they have in the past years due to the removal of large grassy dunes. The removal of these dunes exposed more shell hash that the plovers used for both nesting and brood rearing. By the end of the season, all broods had moved west and were either on the beach or on the south section of the 95HRA near the foredune.

The entire beach from China Creek to the south end of the HRA at Bandon Beach was used for brood activity. The brood from an early nest in China Creek overwash spent most of the brood rearing period in and around the China Creek overwash. Another brood from this area moved as far south as the motor vehicle closure sign adjacent to the HRA. Broods that hatched along the foredune south of China Creek tended to stay along the foredune, moving north and south during the brood rearing period. Broods that hatched on the HRA tended to spend most of their time on or adjacent to the HRA. No broods crossed the river to the New River spit side. At New River, most broods that hatched on the open spit tended to stay on the extensive open spit. Broods from the county land moved around on the county land but also moved north onto state owned land. There was also brood movement south along the foredune and use of the overwashes on private land. One of these broods continued to move south and was found near fledgling just north of the BLM HRA. This brood continued to move south after fledgling, with fledglings noted adjacent to the south end of the HRA and one fledgling as far south as the Clay Island breach. Broods from the BLM HRA tended to stay on the HRA and the adjacent beach. The broods from nests on the north end moved slightly south and tended to remain between the north end and the Croft Lake breach. The broods that hatched near the south end of the HRA also tended to stay in that area, only moving north as far as the New Lake breach.

Activity Patterns on HRAs

Table 12 shows the activity patterns of plovers on four habitat restoration areas: Overlook, the HRAs at CBNS, Bandon Beach HRA, and the New River HRA. We were unable to confirm all types of activity on each site for each year, therefore a missing activity does not necessarily indicate that that behavior is not occurring, rather we have not confidently identified that behavior for that given site and year.

Sightings of Snowy Plovers Banded Elsewhere

Twenty plovers banded in California were observed in Oregon in 2006. Twelve were females and eight were males. Eleven of the plovers, six females and five males, attempted to nest in Oregon. Five females and one male originally hatched in Oregon and were subsequently rebanded at coastal nest sites in California; two of the females and one male were confirmed nesting in Oregon (a third female likely nested but was not confirmed).

Six of the females were originally banded in Humboldt Co., CA, and one female was originally banded at Salinas SP, Monterey Co., CA in 2005. Two females, both originally from Oregon and rebanded in Humboldt Co., were present from July to the end of the season and did not attempt to nest. One female originally banded in Humboldt Co. was noted only early in the season and is a known wintering bird. Two hatch year banded females from Humboldt Co. were noted only early in the season; one attempted to nest in Oregon before disappearing. Four males were originally banded in Humboldt Co.; three nested in Oregon and one is a known wintering bird and was only noted early in the season. Two other males were originally banded at Pajaro Dunes, Santa Cruz Co., one in 2004 and one in 2005; one nested in Oregon and one moved north to Washington. One other male was a HY04 plover from Salinas SP, Monterey Co., CA and he nested at New River for the second year in a row.

Discussion

The 2006 nesting season had the highest population estimate since monitoring began in 1990, as well as the highest number of known breeding adults (Table 1). In addition, approximately 161-163 adult plovers were present during the breeding season and were considered resident Oregon plovers. These indices indicate the population of adult plovers is within 37 to 65 of the draft recovery goals for the Oregon coast (recovery goals for Oregon are 200 breeding adults; U.S. Fish and Wildlife Service 2001). Overwinter survival of adult plovers was approximately 71%, an improvement over the previous winter when overwinter survival was estimated to be 62% (Lauten et al. 2006). The hatch year return rate in 2006 was 37% (n=29), the lowest return rate since 1998 and nearly 10 percentage points lower than the average (Table 2). The number of returning hatch year plovers did not replace the number of lost adult plovers, indicating that the increase in population size continues to be influenced by immigration of plovers into the area from other breeding locations. Colwell *et al.* (2005 and 2006) indicates that the population in Humboldt Co., CA is partially maintained by immigration of plovers into the local breeding population. During winter 2006 and early spring 2006, Oregon had very wet and cold weather, however it is difficult to determine the effect on plover survival as adults appeared to have survived much better than in 2004-2005 (Lauten et al. 2006), but hatch year plovers did not survive as well as previous years (Table 2).

Winter distribution along the Oregon coast is well documented (ORNHIC unpublished data). During the winter of 2005-2006, the wintering flock at Siltcoos (ca.

50) was the one of the largest flocks of plovers noted since monitoring began in 1990, and was one of the largest flocks since pre-1980. Tenmile (ca. 27) and Bandon Beach/New River (ca. 40) also had fairly sizable flocks of wintering plovers. As the breeding season approaches, plovers begin to migrate to the breeding sites (Table 3). Despite Sutton having upwards of 20 wintering plovers, overall use there in summer has been very low in recent years (Table 4). In 2006, the first nests since 2003 were found, but plover use at the site was limited to about 4-7 plovers and after June plover activity was nonexistent. Siltcoos, Tenmile, and Bandon Beach/New River, all sites with large wintering flocks, tended to have a large number of individual plovers that use those sites throughout the year. Siltcoos however does not support such a high number of nesting plovers, possibly partly due to limited habitat, and this is indicated by the much lower number of nesting plovers than total number of plovers recorded at the site. At Overlook, there were a fairly high number of plovers recorded at the site, but again a much smaller percentage of plovers breed there. The high number of plovers using this area is partly due to the wintering Siltcoos plovers found using Overlook early or late in the season as an alternative roosting area. The number of plovers using North Tahkenitch in 2006 was very small. The reasons for this are unclear as the habitat was extensive and appeared to be in very good condition. The number of plovers using Tenmile is increasing and may be partly due to the increase in available habitat at North Tenmile. The percentage of nesting plovers at CBNS is relatively high compared to the overall number of plovers recorded there because of the relatively large breeding population but a small wintering population. The overall number of plovers using Bandon Beach/New River is the highest of all sites, and most of these plovers remain in the area to nest. This area has the largest number of breeding plovers on the Oregon coast.

As the plover population increases (Table 1), predictably the number of nests increases (Table 4) and the distribution of nests is expanding (see Maps). Nests were found at Sutton for the first time in three years, and nests were found as far south as the south end of the BLM Storm Ranch HRA. At Siltcoos and Tenmile, the north spits, formerly infrequently used, have had increased nesting activity since 2003 (Table 4). While better and larger habitat has contributed to the increased use, the south spits continue to be regularly used. At CBNS winter restoration work on the HRAs and South Spoil improved habitat by removing large berms and barriers between the 98EHRA and the 94HRA, and removing large grass-covered dunes around South Spoil. The 95HRA north of the area due west of the 94HRA was also improved with grass growth reduced and improved debris and nesting substrate. Due to the improvements plovers moved more freely around the nesting area and utilized larger portions of the nesting area, and nests were more distributed and in areas previously not used or heavily used. Some of the nests on the 94HRA and South Spoil were in areas that had been improved by removal of grass, particularly towards the boundary lines of the defined areas. These boundary lines were effectively removed by the improved conditions, and remain in concept only to help us define the areas. While plover use was widespread at New River, we did not detect much plover use on the Storm Ranch HRA until nests failed further north at Bandon Beach and on the New River spit. The Storm Ranch HRA has been significantly improved by both mechanical treatment and breaching of the foredune for winter water drainage. The breached areas, located in different locations each year,

reduced the foredune height and eliminate European beachgrass by removing the root structure. The breach areas are flat and due to the snaking of the outlet from currents are several hundred meters in length. With the repeated mechanical work and breaching the overall habitat on the HRA is excellent and provides extensive quality habitat for plovers to move around and successfully nest.

Three sites had decreases in nesting activity (Table 4). The lower number of nest attempts at Bandon Beach in 2006 compared to 2005 may partly be a reflection of established breeding adults being depredated during the nesting season, and some other plovers moved south to the Storm Ranch HRA. Despite North Tahkenitch having extensive habitat, plover use at the site was somewhat minimal, although successful. South Overlook had very little plover activity all summer, but also had somewhat limited habitat.

Nest success (both Mayfield and apparent) for exclosed nests was lower in 2006 than in 2005, but was still at very successful rates (Table 5 and 6). Nest success of unexclosed nests continues to improve (Table 5 and 6), and the large number of unexclosed days further indicates that predator management efforts are having a positive effect on reducing predation pressure on nests. Corvids continue to be the main cause of depredated unexclosed nests (Table 8). While exclosures do reduce the rate of corvid depredation of nests, we continue to experience adult mortalities associated with exclosed nests. Corvid predator management is critical to the success of plover nests and chicks, as well as reducing exclosure use and associated adult mortalities. Corvid management should continue to be constantly implemented, but the ability to respond quickly to the increased corvid activity is also essential. Techniques to manage corvids and other predators must be diverse as not all individual predators respond the same way to each technique.

While we believe that MEs are an important and useful management tool to increase hatching rates, we recommend that efforts be made to continue to reduce exclosure use. We continue to experience adult mortalities and in some cases chick mortalities around exclosure nests. It is not always clear that exclosures are directly linked to the mortalities, however exclosures likely increase the risk of adult mortalities by inhibiting movement of plovers when predators are approaching and exclosures reveal the location of what should be a cryptic nest. Some predators may associate exclosures with a food source and therefore target exclosures. Adult plovers that are depredated are a greater loss to the population than depredated nests, because depredated adults are removed from the population while adults that have nests depredated can still attempt to renest. The increased number of unexclosed days and the higher hatch rates of unexclosed nests suggest that predator management activities are reducing predation pressure on nests. We recommend that exclosure use not be pre-determined nor automatic in the future. We recommend close cooperation between Wildlife Services and ORNHIC staff to determine the levels of predation at each individual site on a constant basis. Exclosure use should be determined dependent on how intense the predation pressure is in combination with the density of plover nests and the location of plover nests. We believe an adaptive approach to exclosure use in combination with continued

intensive predator management can continue to reduce the number of exclosed days, increase the success of unexclosed nests to a rate that is consistent with recovery goals and an increasing population, and reduce adult mortalities associated with exclosed nests. Furthermore it is important to permit nests to remain unexclosed to further evaluate the success of the predator management program and to help determine what predator management activities are successful. We believe that a sustainable population of plovers will need management, but ideally would have a reduced level of predator protection of each individual nest. We believe a plover population near recovery numbers with adequate predator management in combination with habitat management and recreational management can have natural hatch rates and be sustainable.

Plover reproductive parameters in 2006 were excellent (Table 10), further indicating that predator management combined with habitat improvements and recreational management are having a positive effect. Almost all sites have significantly improved production, which is tending to increase with each year that predators are managed. However, Wildlife Services continues to remove about the same number of predators each year (see Appendix C, Little and Williams 2004, Little 2005, 2006). This indicates that new individuals are filling in where predators are being removed, most likely over the fall and winter when there are no predator management activities. Therefore it is important that the predator management program be supported at current or higher levels to continue to have a reduced predator population around the plover nesting areas. The continued rate of removal of predators from the nesting area also indicates that predator management activities are likely only have a very local effect and not greatly impacting the surrounding predator population levels.

We recommend that nesting areas continue to be maintained, improved, and expanded to provide the increasing plover population with adequate and high quality nesting habitat. With increasing populations, plovers will continue to expand their habitat use and having adequate available habitat will help prevent plovers from nesting in areas that may increase the chances of conflict with the recreating public. Also, larger areas of suitable habitat allow nests to be more spatially distributed, which can help hide the nests from potential predators. It is also important to have managed habitat so that if plovers fail in one area they can move to another area and attempt to renest. This occurred at Bandon Beach/New River in 2006 when some plovers that failed at Bandon Beach moved south to the Storm Ranch HRA at New River and successfully nested. In addition, plovers will likely return to these areas where they have successfully nested.

We recommend all sites use ropes and signs along nesting beaches and habitat restoration areas. Ropes and signs should be installed as early in the season as practical so that the closed sections of beach are adequately protected throughout the season and the public understands which sections of beach are closed and the message is consistent throughout the nesting season and from year to year. Installing ropes and signs at the beginning of the season also reduces the need to respond to individual nests that are within closed beach sections but not roped and signed. This reduces the disturbance to those nests and plovers when ropes and signs have to be installed after a nest is found.

Most of the public generally respects the roped and signed nesting areas. However we do continue to have some recreational problems and therefore it is important that agencies continue to be vigilant in monitoring recreational activities at all sites. In 2006 we noted several serious violations mostly at sites where there is recreating public near nesting plovers. In particular exclosures were vandalized at North Siltcoos and Bandon Beach, however we did not document any direct take from these instances. We also continue to have some problems with camping along Bandon Beach and New River. Off leash and out of control dogs continue to be a problem at some nesting sites. We believe the presence of seasonal employees and volunteers at nesting beaches as well as law enforcement presence has some of the most positive effect on both reducing violations and educating the public. However, we also recommend that maintenance of habitat management areas, especially ones away from parking lots and access points, is important to try to reduce the number of plovers that are near areas of high recreational use.

Habitat Restoration and Development Projects

The USFS continued habitat restoration projects at Sutton Beach in the winter of 2005-06. The 12 acres north of Berry Creek were not maintained in 2005-06 but will be cleared during winter 2006-07. South of Holman Vista 13.5 acres of habitat were maintained by bulldozers in 2005-06 and will be again treated in 2006-07. Spreading woody debris or shell hash on the areas may attract plovers as well as improve nesting potential.

There was no maintenance completed in winter 2005-06 at Siltcoos. During winter 2006-07, USFS plans to maintain 10 acres on the south spit.

At the Overlook in winter 2005-06, about three acres of habitat was cleared on the south side; no other work was completed. In winter 2006-07 USFS plans to maintain the entire north clearing and may have additional time to work on the south clearing.

At Tenmile, maintenance clearing of 15 acres on the south side was completed in the winter of 2005-06. This same area and possible a few additional acres will be maintained during winter 2006-07. Maintenance and improvement of the north spit should be considered for the future.

At CBNS in winter 2005-06, BLM significantly improved the habitat restoration areas. Vegetation was removed from the entire acreage (170 acres) using a tractor with attached implements, and additional work was done using an excavator and bulldozer. Use of the excavator and bulldozer enabled the removal of particularly well-established beachgrass from the South Spoil and the recontouring of the dune area within the South Spoil. In addition, long buried shell spoils were uncovered and redistributed on the surface of the South Spoil area, and a berm and old sand trail that bisected the 1994 and 1998 east HRAs was removed and the two areas graded together. In October of 2006, 360 cubic yards of oystershell was spread on the 1998 east HRA to supplement the 300 cubic yards that was applied in 2005.

At Bandon Beach, the HRA north of Twomile Creek/New River estuary was partially maintained in the winter of 2005-06. Approximately 20 acres of the middle section was extensively bulldozed and the height of the area was reduced to facilitate overwashing. The north and south end did not get treated due to limitations of time. The total area remains about 50 acres. The areas not treated last winter will be treated in winter 2006-07, and the bulldozed area will be again scraped for the upcoming breeding season.

At New River, BLM has created and maintained 120 acres of habitat restoration. In winter 2005-06, non-breach areas were treated with bulldozers. Breach areas and some overwash areas were not treated because of natural maintenance and the desire to protect native vegetation. A buffer area along the east edge of the HRA was maintained and improved to help reduce sand movement into the river. There are no plans for habitat work in winter 2006-07 due to a variety of reasons including the already very good quality of much of the habitat, lack of funding, and the need to complete a new environmental assessment before more restoration and maintenance can continue in the future.

Recommendations

Signing of Restricted Areas

Signing and roping for the 2007-nesting season should again be implemented to inform the public of plover nesting habitat and direct the public away from the nesting areas. High tides early in the season often make posting areas a challenge, but it is important to have signs in place beginning on 15 March. Maintenance of signs is important to keep violations to a minimum. To maximize the effectiveness of signs and ropes each site should continue to be evaluated and ways to improve the signing and ropes should be considered.

General Recommendations

Below are general recommendations. We also provide additional site-specific comments and management recommendations in Appendix B.

- Maintain, enhance and in some cases expand habitat restoration areas.
- Reduce use of mini-exclosures in conjunction with predator management to reduce the risks to adult plovers, decrease the time monitors spend around individual nests, and decrease disturbance to plovers. Determine exclosure use dependent on predation pressure, density of plover nests, and nest locations. Continue to move toward elimination of exclosures at all sites.
- Increase and/or maintain predator management at all sites and explore ways of better understanding the activity patterns and population levels of predators, particularly corvids.

- Continue to coordinate with federal agency employees regarding time frames of any habitat management work to be completed to minimize disturbance to nesting activity and broods.
- Coordinate agency activities in restricted/closed areas with plover biologists to minimize disturbance to nesting and brood rearing.
- Continue and explore ideas to document and monitor human disturbance by various recreational users in plover nesting areas.
- Continue to expand and refine volunteer efforts to monitor recreational use.
- Design educational programs to inform and educate the local communities and annual visitors about plover issues.
- Design informative/interactive presentations for schools for children.
- Continue intensive breeding season monitoring until plover numbers have reached the goals to be established in the USFWS Recovery Plan for Snowy Plovers, then monitor plover populations and productivity to ensure recovery goals are maintained.

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Table 1. Population estimates of the Western Snowy Plover on the Oregon Coast, 1990-2006 . For Window Survey, first number is counted plovers minus duplicate band combos and unidentified plovers, number in parenthesis is total head count without considering duplicate combos or unknown plovers.

YEAR	WINDOW SURVEY	# SNPL BREEDING	# SNPL PRESENT
1990	59	-	-
1991	35	-	-
1992	28	-	-
1993	45	55-61	72
1994	51	67	83
1995	64 (67)	94	120
1996	85	110-113	134-137
1997	73 (77)	106-110	141
1998	57 (59)	75	97
1999	49 (51)	77	95-96
2000	NC	89	109[a]
2001	71 (85)	79-80	111-113[b]
2002	71 (76)	80	99-102[c]
2003	63	93	102-107[d]
2004	82 (83)	120	136-142[e]
2005	100	104	153-158[f]
2006	91	135	177-179[g]

[a] - includes 13-15 adult plovers that were depredated during the breeding season

[b] - includes at least two adult male plovers that were depredated and 1M and 1F thought to have been depredated during the breeding season

[c] - includes at minimum of 6 adult plovers that were depredated and another 4 that possibly were depredated during the breeding season

[d] - includes 2 adult female plovers that were probably depredated during the breeding season

[e] - includes 2-3 males and 1-2 females believed to have depredated during the breeding season

[f] - includes 1 female and 6 males that may have been depredated during the breeding season

[g]- includes a minimum of 16 resident breeding plovers that probably were depredated during the breeding season

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, 1990 - 2006.

Year	# of Fledglings	# of HY birds from previous year sighted on OR coast	Return Rate (#HY/#Fled)	# that nested on OR coast	% nested on OR coast
2006	109	29	37%	23	79%
2005	78	43	40%	33	77%
2004	108	26	43%	21	81%
2003	60	14	45%	14	100%
2002	31	18	56%	15	83%
2001	32	23	53%	14	61%
2000	43	31	58%	25	81%
1999	53	18	56%	12	67%
1998	32	14	34%	11	79%
1997	41	30	64%	18	60%
1996	47	18	32%	10	55%
1995	57	37	66%	13	35%
1994	56	16	44%	8	50%
1993	36	10	30%	6	60%
1992	33	6*	38%	2	33%
1991	16	No chicks banded in 1990			
1990	3	x	x		

* - minimum number sighted

Average return rate = 46.4%
SD = 11.7%
Average percent of returning HY birds that nest in first season = 65.9%
SD = 19.0%

Table 3. Number of Adult Snowy Plovers at each nesting area on the Oregon Coast, 2006. First number is number of adults recorded at each site, and the second number is the number of breeding adults recorded at each site.

	Sutton	Siltcoos Total	Overlook Total	N Tahkenitch	Tenmile Total	CBNS	New River/Bandon Total
# of banded females/# nested	4/2	30/7	20/4	4/2	18/10	22/10	34/21
# of unbanded females/# nested	1/1	2/1	1/1	1/1	2-3/2	3/3	6-7/5
# of banded males/# nested	2/1	16/8	10/2	3/3	12/9	18/18	25/20
# of unbanded males/# nested	0	1/0	1/1	0	2/2	2/2	1/1
Total	7/4	49/16	32/8	8/6	34-35/23	45/33	66-67/47

Table 4. Total number of nests for all sites on the Oregon Coast 1990 – 2006; cells tally nests only and not broods from undiscovered nests. The number of broods from undiscovered nests is totaled for each year and site only.

Site Name	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	Total # nests	Total # broods [a]
Necanicum													1	0	0	0	0	1	1
Sutton Beach				2	1	2	6	14	8	3	7	15	3	1	0	0	4	66	1
North Siuslaw													1	0	0	0	0	1	0
Siltcoos:																			
North Spit				0	2	4	2	0	1	4	8	0	0	0	7	8	12	48	0
South Spit				1	2	2	1	3	3	17	14	14	10	7	4	9	13	100	2
Overlook																			
North										2	8	12	5	7	11	11	9	65	1
South										0	0	3	3	1	3	5	1	16	0
Tahkenitch:																			
North Spit				0	0	0	0	0	0	0	4	7	8	13	8	11	4	55	1
South Spit				0	3	9	18	14	6	3	1	6	7	1	0	0	0	68	2
Threemile Creek/ Umpqua River				0	0	0	1	0	0	0	0	0	0	0	0	0		1	0
Tenmile:																			
North Spit					2	2	1	0	0	0	1	2	3	5	9	6	10	41	3
South Spit	2	0	9	8	5	4	3	2	11	5	5	6	9	12	8	11	12	112	4
CBNS:																			
South Beach	0	4	6	3	4	3	3	6	6	0	1	1	2	3	2	4	0	48	10
South Spoil	20	9	4	6	9	12	22	14	5	2	5	3	2	9	8	9	14	153	13
North Spoil	5	1	1	0	0	0												7	0
HRAs					4	3	2	3	7	12	22	13	15	11	16	16	18	142	17
Anad. Spoil	0																	0	1
Menasha, N.Bend	1	0																1	0
Bandon	0	14	8	10	5	9	3	4	1	2	2	6	5	5	17	31	23	145	5
New River	6	6	2	0	6	20	18	25	26	28	17	23	14	16	24	23	27	281	8
Floras Lake/ New River Overwash	2	2	6	11	8	6	9	8	4	0	5	0	1	0	0	0	0	62	3
Total nests	**36**	**36**	**36**	**41**	**51**	**76**	**89**	**93**	**78**	**78**	**100**	**111**	**89**	**91**	**117**	**144**	**147**	**1413**	
Total broods [a]	**2**	**1**	**5**	**7**	**4**	**6**	**11**	**5**	**3**	**1**	**2**	**0**	**1**	**4**	**2**	**3**	**15**		**72**

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

Table 5. Nest Success (Mayfield Method) of Snowy Plovers on the Oregon coast, 1990-2006.

	% Nest Success				
Year	Overall[1]	Exclosed[2]	Unexclosed[2]	(N)[1]	(N)[2]
1990	13	-[3]	13	(36)	(29)
1991	20	77	5	(36)	(33)
1992	55	79	9	(36)	(34)
1993	56	77	16	(41)	(39)
1994	72	75	68	(51)	(47)
1995	41	62	7	(76)	(70)
1996	47	66	7	(89)	(87)
1997	40	52	26	(93)	(87)
1998	52	70	15	(78)	(70)
1999	54	62	40	(78)	(72)
2000	31	46	2	(100)	(91)
2001	26	67	4	(111)	(101)
2002	38	67	13	(89)	(76)
2003	43	79	23	(91)	(79)
2004	56	86	20	(117)	(109)
2005	45	70	27	(144)	(128)
2006	38	60	40	(147)	(126)
mean	42.8 ± 14.7	68.4 ± 10.5	19.7 ± 17.0	(1413)	(1278)

[1]Overall includes exclosed nests, unexclosed nests, infertile nests, and nests with one egg that were subsequently abandoned.

[2]Does not include infertile nests, nests with one egg that were subsequently abandoned, or nest found failed because the outcome of these nests was not affected by the presence or absence of an exclosure.

[3]Exclosed nests not included as multiple experimental designs were employed.

Table 6. Apparent nest success of Snowy Plovers on the Oregon Coast, 2006.

		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	4	0	2		0	2		0%	0%	0%
Siltcoos										
North	12	5	0	1	1	5		83%	20%	50%
South	13	2	5		1	5		29%	20%	23%
Combined	25	7	5	1	2	10		58%	20%	36%
Overlook										
North	9	5	2		1	1		71%	50%	67%
South	1	0	0		0	1			0%	0%
Combined	10	5	2		1	2		71%	33%	60%
N Tahkenitch	4	3	1					75%		75%
Tenmile										
North	10	6	0		0	4		100%	0%	60%
South	12	4	3		1	4		57%	25%	42%
Combined	22	10	3		1	8		77%	11%	50%
CBNS										
South Beach	0									
South Spoil	14	1	0		8	5		100%	62%	64%
HRAs	18	2	2		9	5		50%	64%	61%
Combined	32	3	2		17	10		60%	63%	63%
Bandon	23	5	4		2	12		56%	17%	30%
New River										
HRA	7	4	0		1	2		100%	33%	71%
Other Lands	20	6	4		2	8		60%	20%	40%
Combined	27	10	4		3	10		71%	23%	48%
Totals	147	44	23	1	25	54		66%	32%	47%

Table 7. Causes of Snowy Plover nest failure at survey sites along the Oregon coast, 2006.

Site Name	Total Nests	# Fail	Depredations				Other				
			Egg Depredations			Adult Depredated	Wind/ Weather	Abandon	One Egg Nests	Infertile	Unk cause
			Corvid	Unknown	Red Fox						
Sutton	4	4					3				1
Siltcoos:											
North	12	5	1						3		1
South	13	10	2				3	1	1		3
Overlook											
North	9	3		1		1		1			
South	1	1							1		
N Tahkenitch	4	1					1				
Tenmile:											
North	10	4							2	1	1
South	12	7		4				2			1
Coos Bay North Spit:											
South Beach	0	0									
South Spoil	14	5		2					1		2
HRAs	18	7		2			2	2			1
Bandon	23	16	4	4	1	4			1		2
New River	27	14	1	1			1	4	3	2	2
TOTALS	**147**	**77**	8	14	1	5	10	10	12	3	14

Table 8. Cause of failure for Snowy Plover nests protected by predator exclosures and nests unprotected by predator exclosures along the Oregon coast, 2006.

Cause of Failure		Exclosed	Unexclosed	Totals
Egg Depredation	**Corvid**		8	8
	Unknown	2	12	14
	Red Fox		1	1
	Adult Depredated	5		5
Other	**Wind/Weather**	6	4	10
	Infertile	2	1	3
	One Egg Nests		12	12
	Abandoned	6	4	10
	Unknown Cause	2	12	14
Totals		23	54	77

Table 9. Total number of young fledged for all sites on the Oregon Coast 1990-2006 includes fledglings from broods from undiscovered nests.

Site Name	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	Total
Necanicum											1	0	0	0	0	0	0	1
Sutton							0	1	1	0	3	0	0	0	0	0	0	5
N Siuslaw													0	0	0	0	0	0
Siltcoos:																		
North					0		0	0	2	4	0	0	0	0	7	2	11[c]	26
South					1	2	0	0	4	2	7	0	0	2	5	7	7	37
Overlook																		
North										3	5	1	2	3	3	5	8	30
South										0	0	1	0	0	3	2	0	6
Tahkenitch																		
North					0	0	0	0	0	0	2	4	1	3	6	8	5	29
South					1	12	8	7	1	1	3	4	5	2	0	0	0	44
Tenmile:																		
North					0	1	0	0	0	0	0	0	3	1	3	6	12	26
South			14	7	3	3	4	4	3	7	5	4	3	9	9	5	7	87
CBNS:																		
S Spoil	3	2	4	13	17	17	22	8	6	5	3	4	2	7	13	9	11	146
S Beach		11	9	2	6	2	2	7	2	0	0	1	1	3	0	8	1	55
HRAs					7	2	1	1	1	23	6	6	8	14	22	6	18	115
Bandon		1	1	3	5	0	1	0	1	1	0	1	0	4	16	11	12	57
New River			3	0	7	12	8	9	11	8	5	6	6	12	21	9	17	134
Floras Lake/ New River Overwash	0	2	2	11	9	6	1	3	0	0	3	0	0	0	0	0	0	37
Total	**3**	**16**	**33**	**36**	**56**	**57**	**47**	**40**	**32**	**54**	**43**	**32**	**31**	**60**	**108[a]**	**78[b]**	**109 [c]**	**835**

[a] –total modified based on siting of an additional banded HY04 plover in 2005.

[b] – total modified based on sitings of 2 fledglings from B1190 in Jan 2006; thought only one fledged **[b]**

[c]- not included in this total is one fledgling raised in captivity at Newport Aquarium and successfully released; total fledglings = 110

Table 10. Overall Mayfield nest success, fledgling success and total number of fledglings on the Oregon Coast, 1990 – 2006.

Year	% Nest Success[a]	% Fledgling Success[b]	# Fledglings[c]
1990	13	11	3
1991	20	45	16
1992	55	41	33
1993	56	42	36
1994	72	50	56
1995	41	50	57
1996	47	32	47
1997	40	30	40
1998	52	26	32
1999	54	43	54
2000	31	41	43
2001	26	34	32
2002	38	29	31
2003	43	47	60
2004	56	55	108
2005	45	41	78
2006	38	48	109
	Mean = 42.8 $\pm$ 14.7	Overall = 39	Total = 835

a – Overall Mayfield Success from Table 5

b – does not include fledglings from broods from undiscovered nests

c – total number of fledglings including from broods from undiscovered nests

Table 11. Fledgling success, brood success, and number of fledglings per male for Snowy Plovers on the Oregon Coast, 2006.

Site Name	Total # Broods*	% Brood Success*	Total # Eggs Hatched	Min. # Fledged		% Fledgling Success**	# of Breeding Males[a]	# of Fledglings/ Male	# of Fledglings/Male – Combined[c]
				From Known Nests	From Undiscovered Nests				
Sutton	0	0	0	0	0	0	1	0.00	
Siltcoos:									
North Siltcoos	5[d]	100	15	11	0	73	4	2.75	1.77 [e]
South Siltcoos	5	80	5	2	5	40	3	1.67 [e]	
Overlook									
North Overlook	6	67	18	8	0	44	4	2.00	2.00
South Overlook	0	0	0	0	0	0	0	0	
North Tahkenitch	4	75	9	4	1	44	3	1.67	
Tenmile:									
North Spit	7	86	16	10	2	63	7	1.71	1.58
South Spit	6	67	12	6	1	50	5	1.40	
Coos Bay N. Spit									
South Spoil	9	89	24	11	0	46	8	1.38	1.55
South Beach	1	100	0	0	1	0	1	1.00	
HRA	16[f]	69	30	11	7	37	13	1.38	
Bandon	9	89	19	8	4	42	8	1.50	
New River									
HRA	7	71	14	6	1	43	7	1.00	1.31
Other lands	8	63	20	10	0	50	7	1.43	
TOTALS**	**84**	**76**	**182**	**87**	**22**	**48**	**70**	**1.56**	
TOTAL FLEDGED				**109**					

% 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 known individual breeding males for each site

[b] – number of known breeding males in entire population; this is not a tally of known 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

[d] – one nest that hatched not included in this total because chick taken into captivity to Newport Aquarium, raised and released, see text

[e]– does not include two fledglings from two separate broods that were raised by females, males were unknown; if two additional males are assumed for these nests, then fledglings/male = 1.40 and for both sites combined 1.64

[f]– includes 5 broods from undiscovered nests – not clear where the location of these nests were, most likely on HRAs, some possibly on Spoil

Table 12. Activity patterns of Snowy Plovers on Habitat Restoration Areas along the Oregon Coast, 1994-2006. Note that absence of an activity type indicates we have not documented whether the activity is occurring. The Dunes Overlook and the New River HRA were first created in the winter of 1998-99. The 94HRA, 95HRA, 98HRA, and 98EHRA are all located at Coos Bay North Spit, and each was initially created in the winter of the respective year. The Bandon Beach State Park HRA was created in fall 2001 and significantly improved in fall 2002 and 2003. All areas have been maintain through 2006.

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Dunes Overlook						F?,N,B	F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N.B
94HRA	F,N,B	F,B	F,N,B	F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B
95HRA		R,F,N,B	F,B	N,B	F,N,B	F,B	F,N,B	F?,N,B	R,F?,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B
98HRA							N	F?,N,B	R?,F?,N	NA	NA	R	F,B
98EHRA								R?,F?,N,B	R?,F?,N,B	F,B	F,B	R,F,N,B	R,F,N,B
Bandon Beach									NA	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B
New River						N	F,N,B	F,N,B	F,N,B	R,F,N,B	R,F,N,B	R,F,N,B	R,F,N,B

Type of activity: **R** = roosting, **F** = foraging, **N** = nesting, **B** = brooding, **?** = uncertain, no direct evidence, but activity possibly occurring, **NA** = no activity.

Table 13. Summary of effort of predator management activities at Snowy Plover nesting sites along the Oregon coast, 2002-2006.

Year	Start date	End date	Total staff hours	Number of DRC-1339 eggs used	Total number of cage trap nights/days	Total number of padded jaw leghold trap nights/days	Total number of neck snare trap nights/days	Total raptor trap nights/days
2002	11-Mar	2-Aug	744	0	122	1362	99	54
2003	3-Feb	29-Aug	1126	NR	210	1675	340	0
2004	20-Jan	20-Aug	877	1498	175	1447	330	0
2005	22-Feb	2-Sep	1851	855	27	2048	405	0
2006	21-Feb	18-Aug	1640.5	1087	126	2933	203	0
Total			6238.5	3440	660	9465	1377	54
Mean			1247.6	1146.7	133.5	1893	275.4	
SD			480.58	325.63	79.68	639.15	122.79	

Table 14. Number of individual predators removed by Wildlife Services from Snowy Plover nesting sites along the Oregon coast, 2002-2006

	Red Fox	Gray Fox	Dog	Coyote	Raccoon	Opossum	Striped Skunk	River Otter[a]	Mink	Feral Cat	Bobcat	Common Raven	American Crow
2002	6	2	0	0	12	1	5	1	0	1	0	12	14
2003	12	2	0	0	8	1	6	0	0	1	0	150	38
2004	27	3	1	0	19	17	10	0	1	4	1	150	101
2005	15	0	0	0	0	3	3	0	0	2	0	88	131
2006	17	0	0	4	0	0	8	0	0	1	0	145	89
Total	77	7	1	4	39	22	32	1	1	9	1	545	373
Mean	15.4	1.4	0.2	0.8	7.8	4.4	6.4	0.2	0.2	1.8	0.2	109	74.6
Median	15	2	0	0	8	1	6	0	0	1	0	145	89
SD	7.701	1.342	0.447	1.789	8.136	7.127	2.702	0.447	0.447	1.304	0.447	60.225	47.690

a - the otther was translocated

Table 15. Number of corvids removed by DRC-1339 and other methods from Snowy Plover nesting areas along the Oregon coast, 2002-2006.

	Amercan Crow			Common Raven		
Year	Number removed by DRC-1339	Number removed by other methods	Total crows removed	Number removed by DRC-1339	Number removed by other methods	Total ravens removed
2002	0*	14	14	0*	12	12
2003	25	13	38	142	8	150
2004	82	19	101	139	11	150
2005	77	54	131	78	10	88
2006	30	59	89	124	21	145
Total	214	159	373	483	62	545
Mean	53.5	31.8	74.6	120.75	12.4	109
SD	30.16	22.73	47.69	29.57	5.03	60.22

* - DRC-1339 not used in 2002, therefore not included in mean calculation

Table 16. Productivity of Snowy Plovers at Siltcoos, Lane Co., Oregon coast, 1993-2006.

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.

Siltcoos	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
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
total before predator management (1993-2003)	238	81	34%	24	30%	10%	24	37	0.65
total after predator management (2004-2006)	135	57	42%	34	60%	25%	34	17	2.00

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

Table 17. Productivity of Snowy Plovers at Overlook, Douglas Co., Oregon coast, 1999-2006

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.

Overlook	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
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	6	35%	3	50%	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
total before predator management (1999-2003)	108	43	40%	15	35%	14%	15	21	0.71
total after predator management (2004-2006)	109	48	44%	20	42%	18%	20	15	1.33

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

Table 18. Productivity of Snowy Plovers at Tahkenitch, Douglas Co., Oregon coast, 1993-2006.

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.

Tahkenitch	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
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
total before predator management (1993-2003)	267	128	48%	51	40%	19%	51	57	0.89
total after predator management (2004-2006)	59	37	63%	18	47%	31%	18	12	1.50

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

Table 19. Productivity of Snowy Plovers at Tenmile, Coos Co., Oregon coast, 1992-2006.

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.

Tenmile	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
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
total before predator management (1992-2003)	249	134	54%	64	48%	26%	64	55	1.16
total after predator management (2004-2006)	158	78	49%	36	46%	23%	36	27	1.33

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

Table 20. Productivity of Snowy Plovers at Coos Bay North Spit, Coos Co., Oregon coast, 1992-2006.

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.

CBNS	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
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
total before predator management (1992-2001)	513	295	58%	154	52%	30%	149	94	1.58
total after predator management (2002-2006)	344	184	53%	108	59%	31%	105	60	1.75

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

Table 21. Productivity of Snowy Plovers at Bandon Beach, Coos Co., Oregon coast, 1992-2006.

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 Beach	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
2006	53	19	36%	8	42%	15%	7	6	1.16
2005	83	37	46%	11	30%	13%	11	12	0.92
2004	50	33	66%	15	45%	30%	14	10	1.40
2003	13	6	46%	2	33%	15%	2	4	0.50
2002	10	0	0%	0	0%	0%	0	2	0.00
2001	13	7	54%	1	14%	8%	1	3	0.33
2000	6	0	0%	0	0%	0%	0	2	0.00
1999	4	3	75%	1	33%	25%	1	2	0.50
1998	3	0	0%	0	0%	0%	0	1	0.00
1997	12	0	0%	0	0%	0%	0	2	0.00
1996	9	6	67%	1	17%	11%	1	2	0.50
1995	22	4	18%	0	0%	0%	0	3	0.00
1994	15	15	100%	5	33%	33%	5	4	1.25
1993	21	10	48%	3	30%	14%	3	5	0.60
1992	23	7	30%	1	14%	4%	1	4	0.25
total before predator management (1992-2001)	128	52	41%	12	23%	9%	12	28	0.43
total after predator management (2002-2006)	209	95	45%	36	38%	17%	34	34	1.00

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

Table 22. Productivity of Snowy Plovers at New River, Coos Co., Oregon coast, 1992-2006.

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.

New River	total # eggs laid	total # hatched	hatch rate	total # fledged	fledgling success rate	productivity index[a]	# fledged from known males	# of known breeding males	# of fledglings /male
2006	69	34	49%	16	47%	23%	16	12	1.33
2005	63	36	57%	9	26%	14%	9	10	0.90
2004	70	37	53%	21	57%	30%	21	12	1.75
2003	44	25	57%	12	48%	27%	12	10	1.20
2002	39	17	44%	6	35%	15%	6	9	0.67
2001	53	22	42%	6	27%	11%	6	8	0.75
2000	46	14	30%	5	36%	11%	5	8	0.63
1999	74	42	57%	8	19%	11%	8	14	0.57
1998	73	60	82%	11	18%	15%	11	16	0.69
1997	65	41	63%	8	20%	12%	8	12	0.67
1996	54	41	76%	7	17%	13%	7	12	0.58
1995	48	12	25%	8	67%	17%	8	8	1.00
1994	18	14	78%	6	43%	33%	5	5	1.00
1993	0	0	0%	0	0%	0%	0	0	0.00
1992	6	6	100%	1	17%	17%	1	2	0.50
total before predator management (1992-2001)	437	252	58%	60	24%	14%	59	85	0.69
total after predator management (2002-2006)	285	149	52%	64	43%	22%	64	53	1.21

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

Table 23. Least square mean hatch rates, fledgling success rates, productivity indexes, and fledglings per male for Snowy Plover for before predator management and after predator management, Oregon coast, 1992-2006.

	lsmean hatch rate	±95%CI	lsmean fledgling success rate	±95%CI	lsmean productivity index	±95%CI	lsmean fledglings/ male	±95%CI
Pre-predator management	0.5173	0.0593	0.3660	0.0498	0.2000	0.0360	0.8732	0.1327
Post-predator management	0.4984	0.0925	0.4708	0.0778	0.2406	0.0561	1.4430	0.2071

Table 24. Least square mean hatch rate, fledgling success rate, productivity index, and fledglings per male for Snowy Plovers on the Oregon coast, 1992-2006.

Site	lsmean hatch rate	±95%CI	lsmean fledgling success rate	±95%CI	lsmean productivity index	±95%CI	lsmean fledglings/ male	±95%CI
Siltcoos	0.4338	0.1532	0.4120	0.1289	0.1970	0.0930	1.2514	0.3431
Overlook	0.4810	0.1700	0.4163	0.1430	0.2056	0.1032	1.1297	0.3807
Tahkenitch	0.5776	0.1532	0.4750	0.1289	0.2545	0.0930	1.2882	0.3431
Tenmile	0.5395	0.1503	0.4900	0.1264	0.2591	0.0912	1.2760	0.3365
CBNS	0.5660	0.1275	0.5555	0.1073	0.3190	0.0774	1.6336	0.2855
Bandon Beach	0.3900	0.1275	0.2205	0.1073	0.1205	0.0798	0.5908	0.2855
New River	0.5672	0.1298	0.3596	0.1092	0.1867	0.0788	0.9370	0.2907

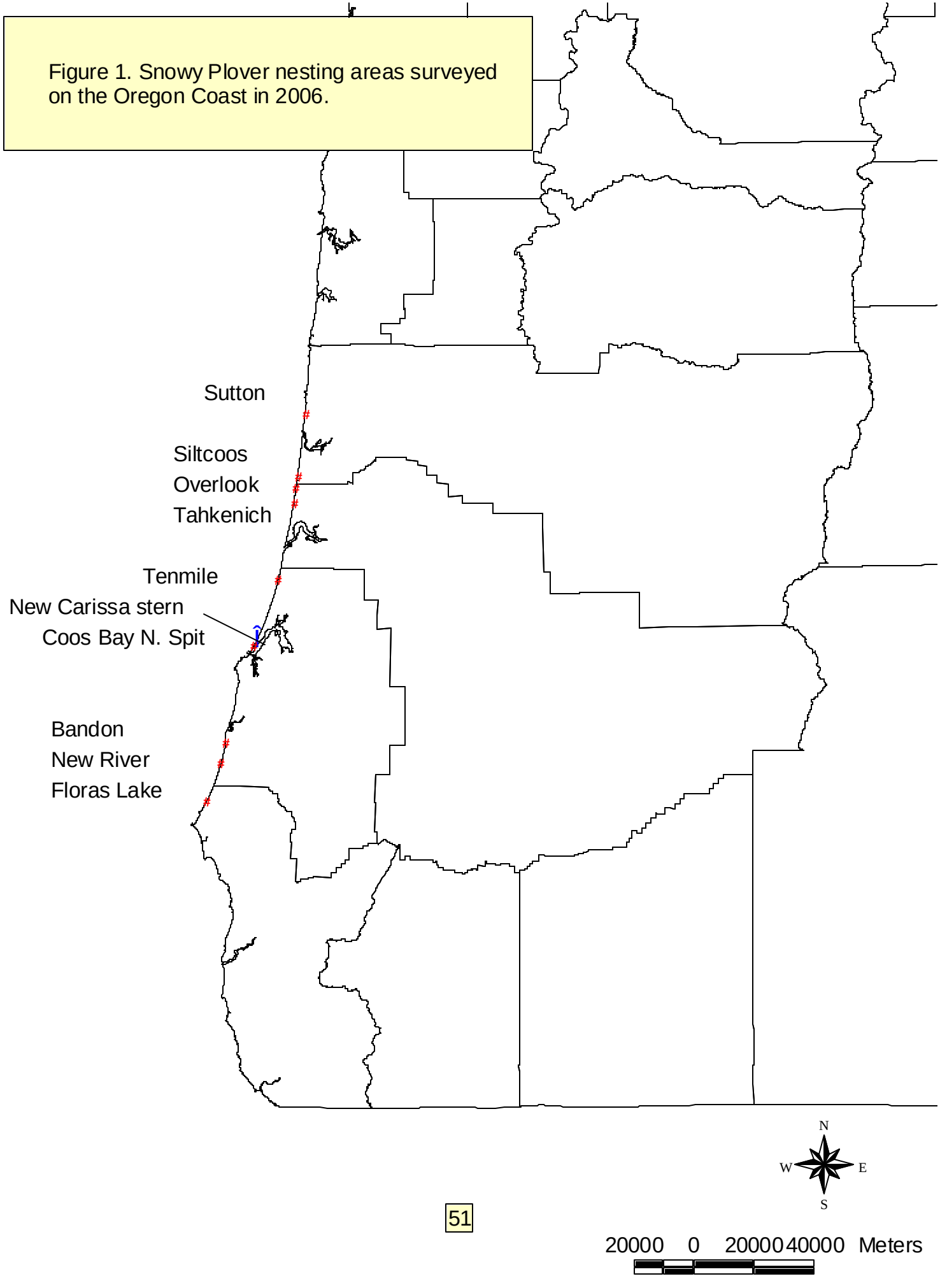


Figure 1. Snowy Plover nesting areas surveyed on the Oregon Coast in 2006.
Sutton
Siltcoos
Overlook
Tahkenich
Tenmile
New Carissa stern
Coos Bay N. Spit
Bandon
New River
Floras Lake
N
W
E
S
20000 0 20000 40000 Meters

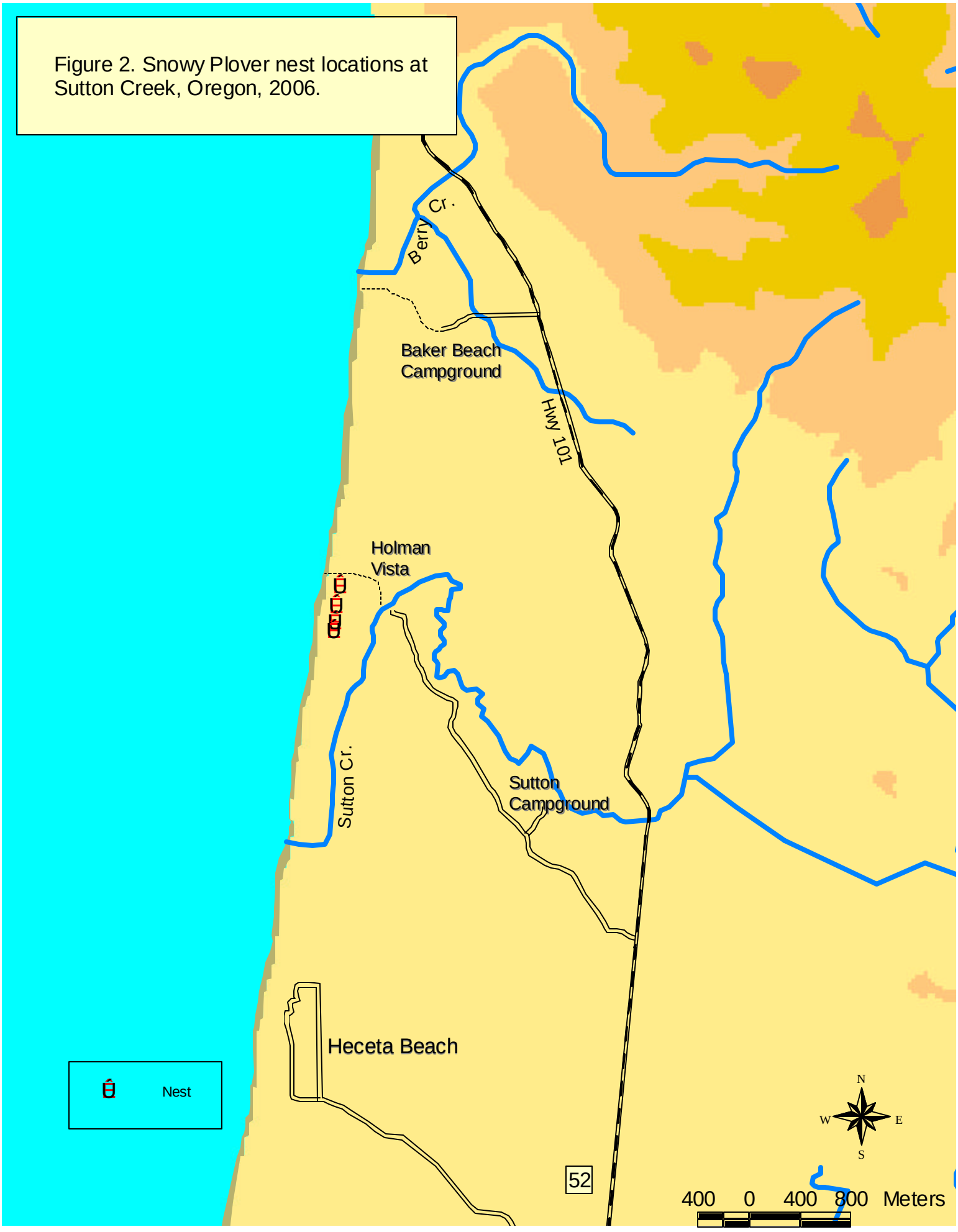


Figure 2. Snowy Plover nest locations at Sutton Creek, Oregon, 2006.
Berry Cr.
Baker Beach Campground
Hwy 101
Holman Vista
Sutton Cr.
Sutton Campground
Heceta Beach
Nest
52
N
W
E
S
400 0 400 800 Meters

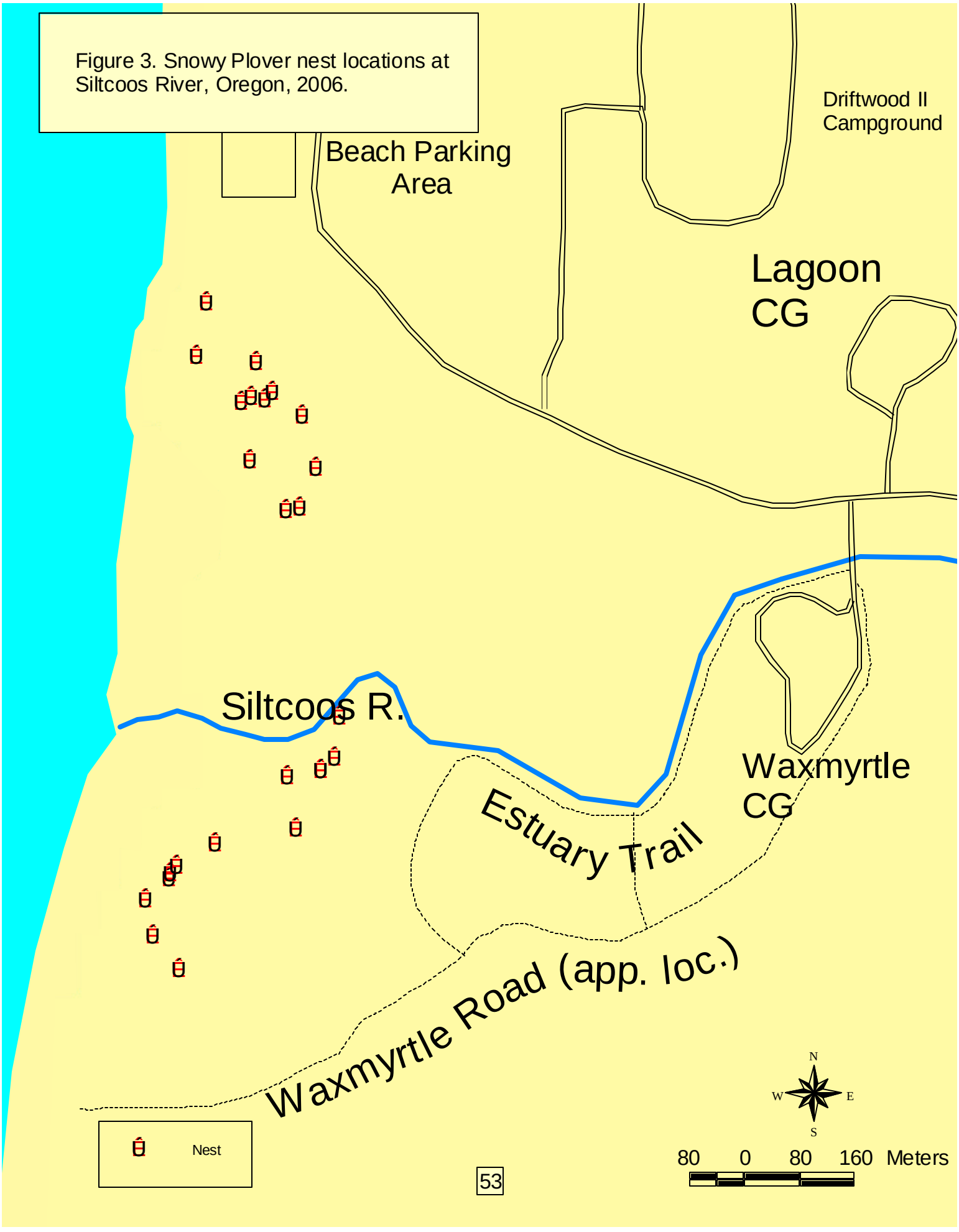


Figure 3. Snowy Plover nest locations at Siltcoos River, Oregon, 2006.
Beach Parking Area
Driftwood II Campground
Lagoon CG
Siltcoos R.
Waxmyrtle CG
Estuary Trail
Waxmyrtle Road (app. loc.)
N
W
E
S
80 0 80 160 Meters
Nest

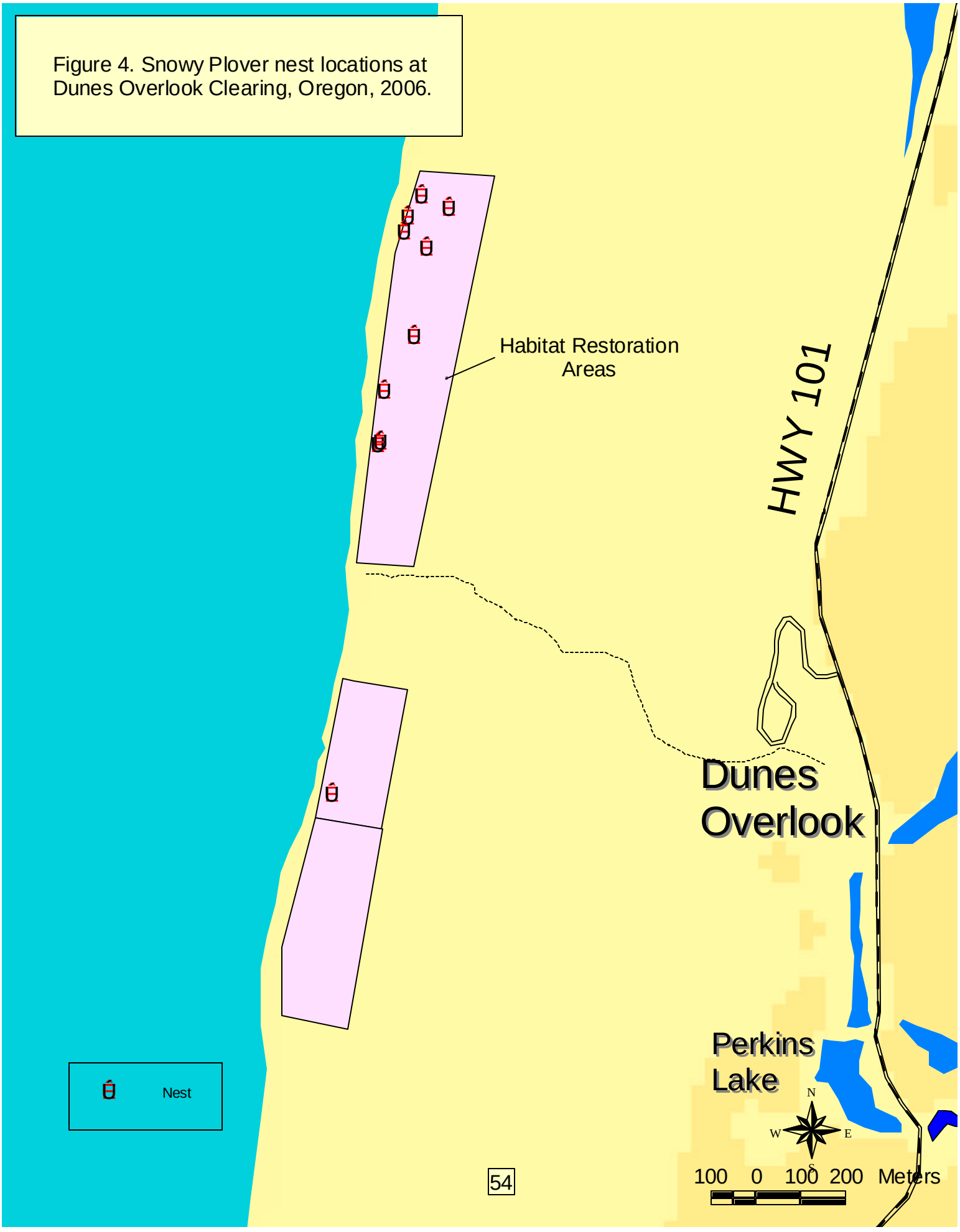


Figure 4. Snowy Plover nest locations at Dunes Overlook Clearing, Oregon, 2006.
Habitat Restoration Areas
HWY 101
Dunes Overlook
Perkins Lake
Nest
N
W
E
S
100 0 100 200 Meters

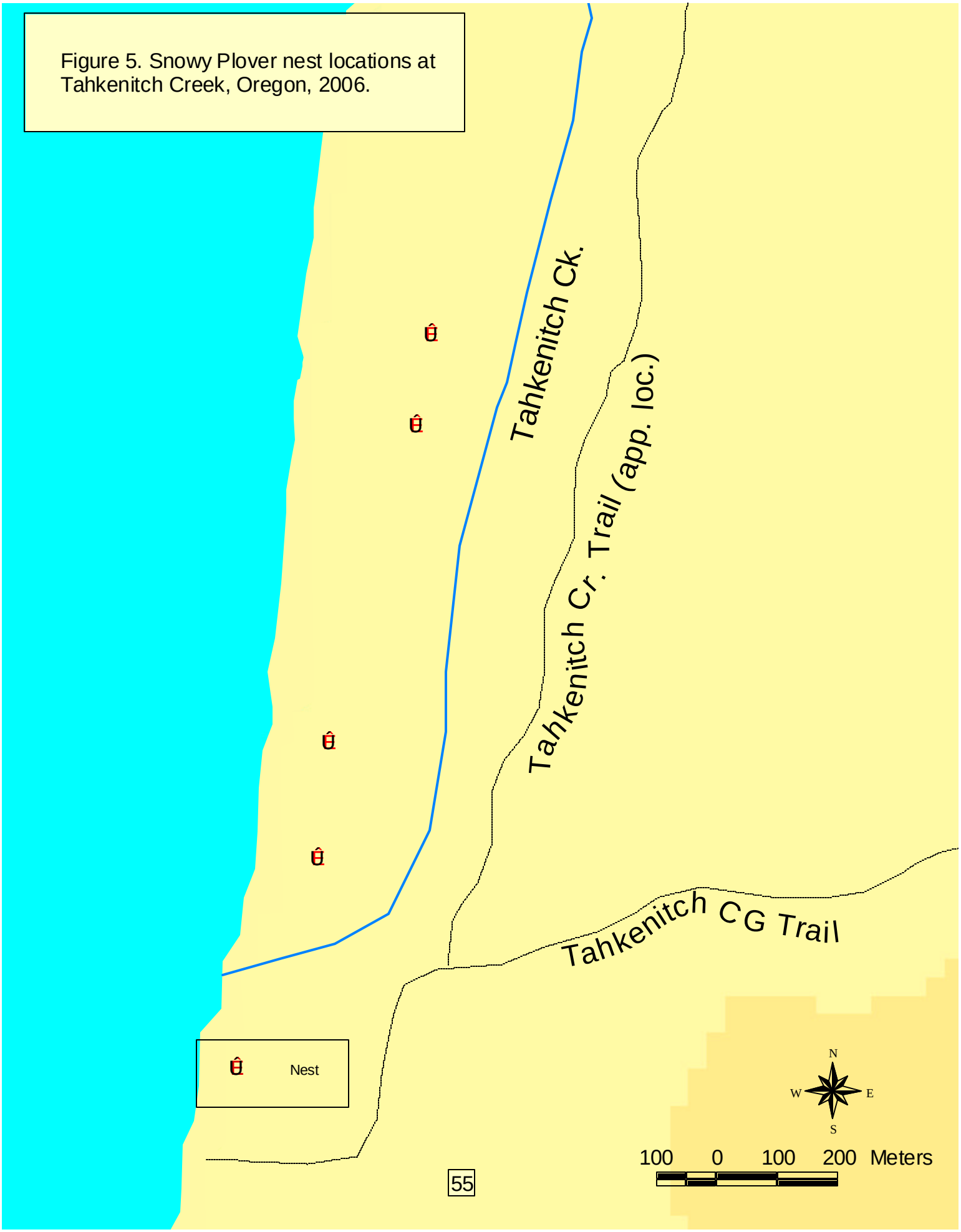


Figure 5. Snowy Plover nest locations at Tahkenitch Creek, Oregon, 2006.
Tahkenitch Ck.
Tahkenitch Cr. Trail (app. loc.)
Tahkenitch CG Trail
Nest
N
W
E
S
100 0 100 200 Meters

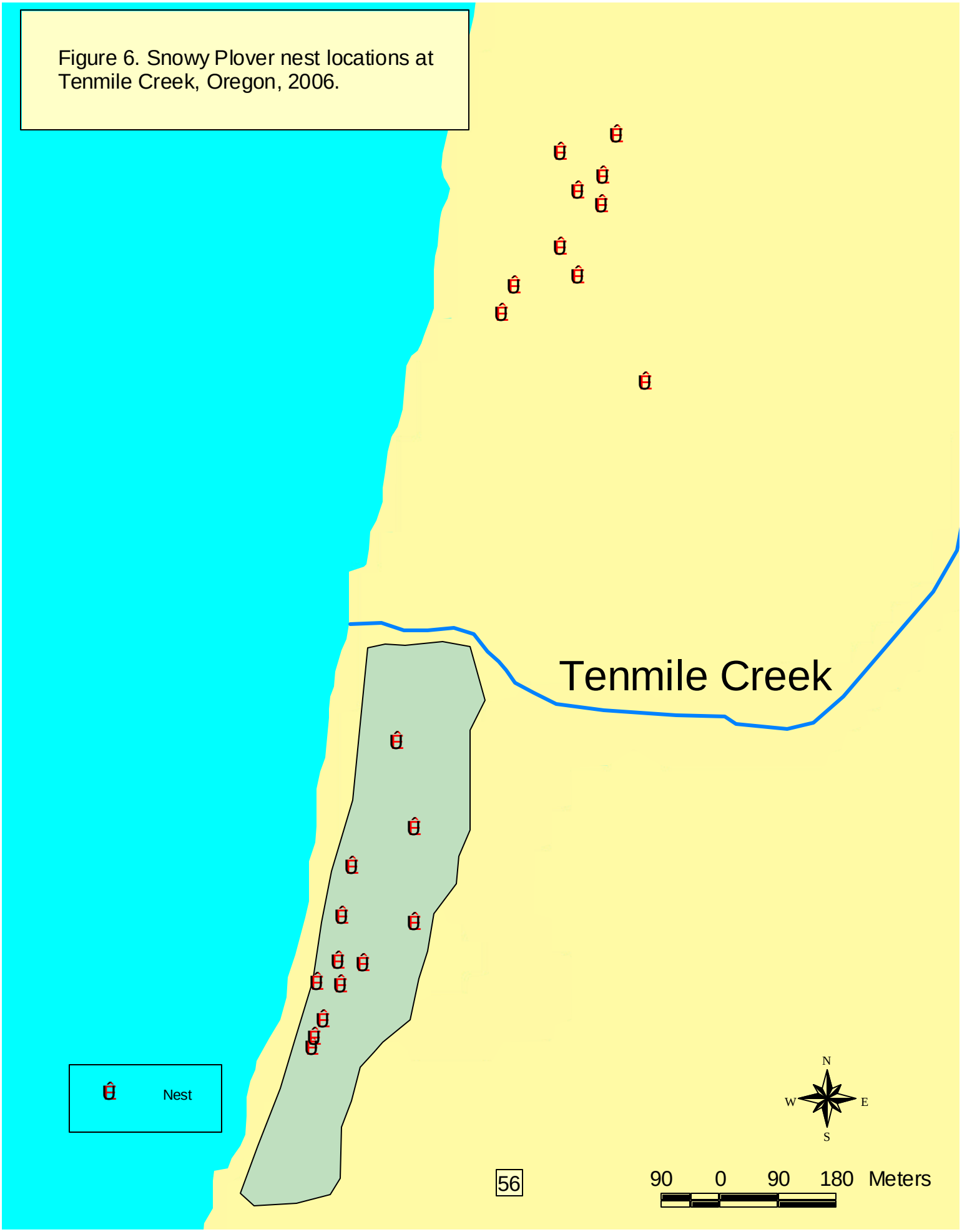


Figure 6. Snowy Plover nest locations at Tenmile Creek, Oregon, 2006.
Tenmile Creek
Nest
N
W
E
S
90 0 90 180 Meters
56

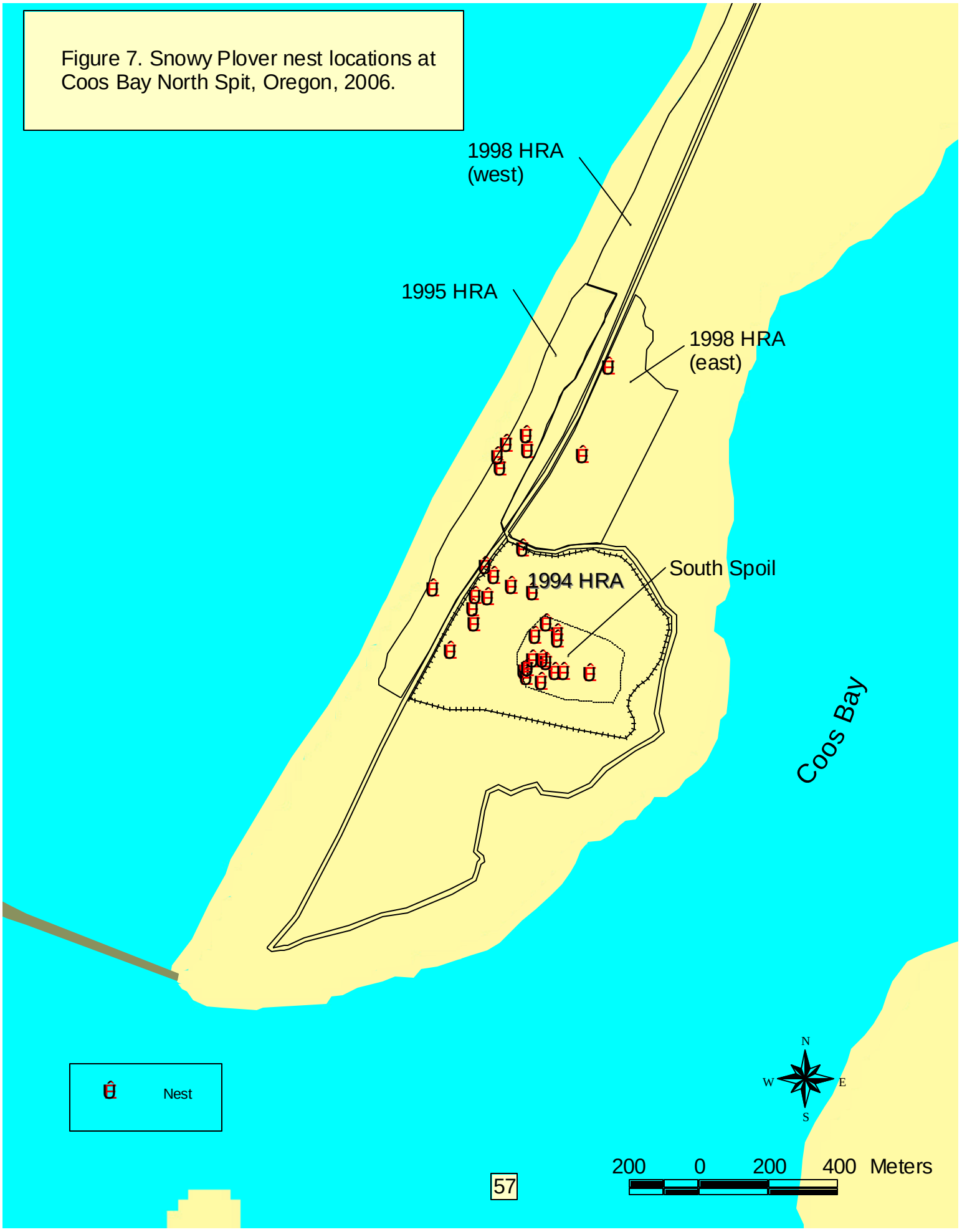


Figure 7. Snowy Plover nest locations at Coos Bay North Spit, Oregon, 2006.
1998 HRA (west)
1995 HRA
1998 HRA (east)
South Spoil
1994 HRA
Coos Bay
Nest
N
W
E
S
200 0 200 400 Meters

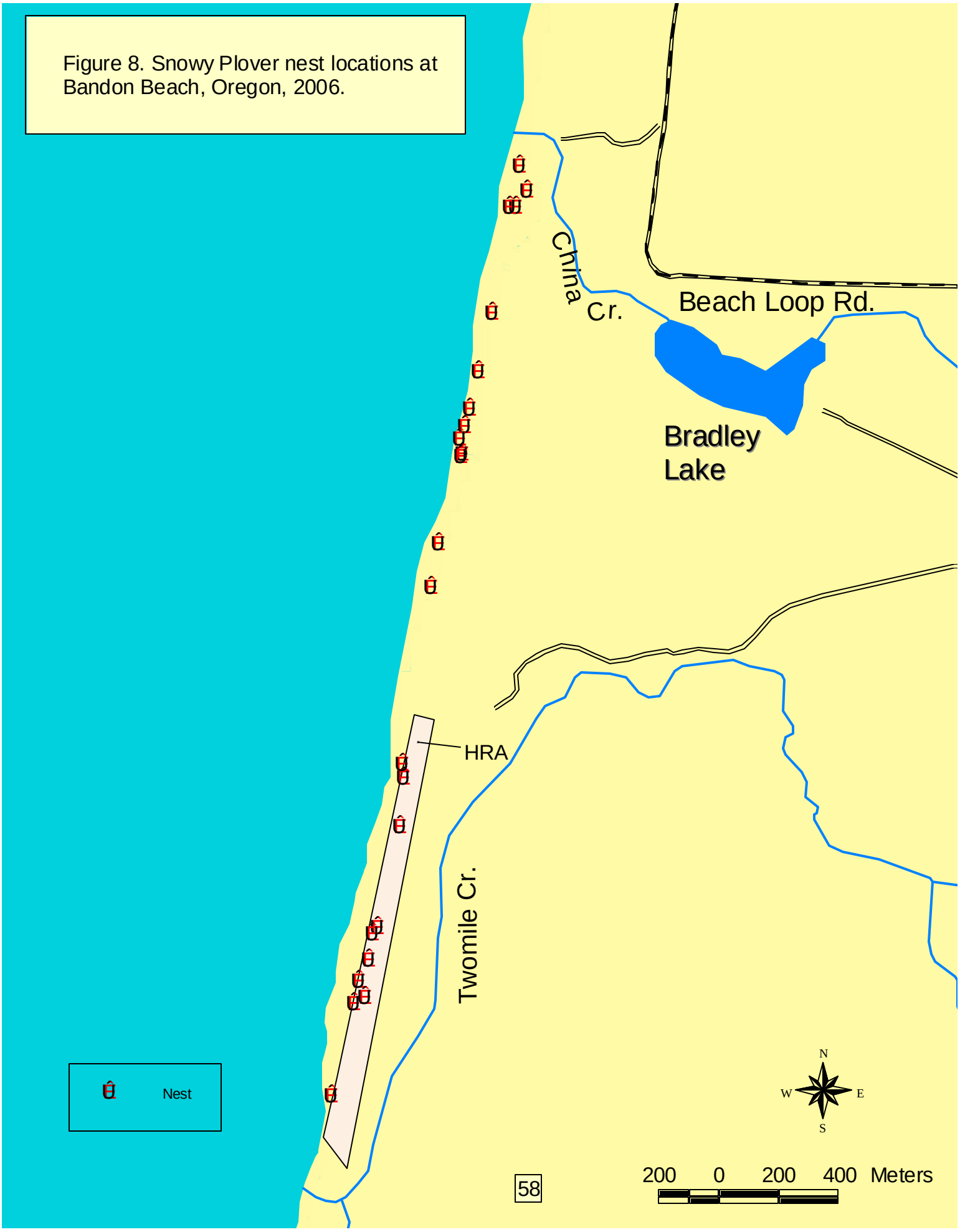


Figure 8. Snowy Plover nest locations at Bandon Beach, Oregon, 2006.
China Cr.
Beach Loop Rd.
Bradley Lake
HRA
Twomile Cr.
Nest
N
W
E
S
200 0 200 400 Meters
58

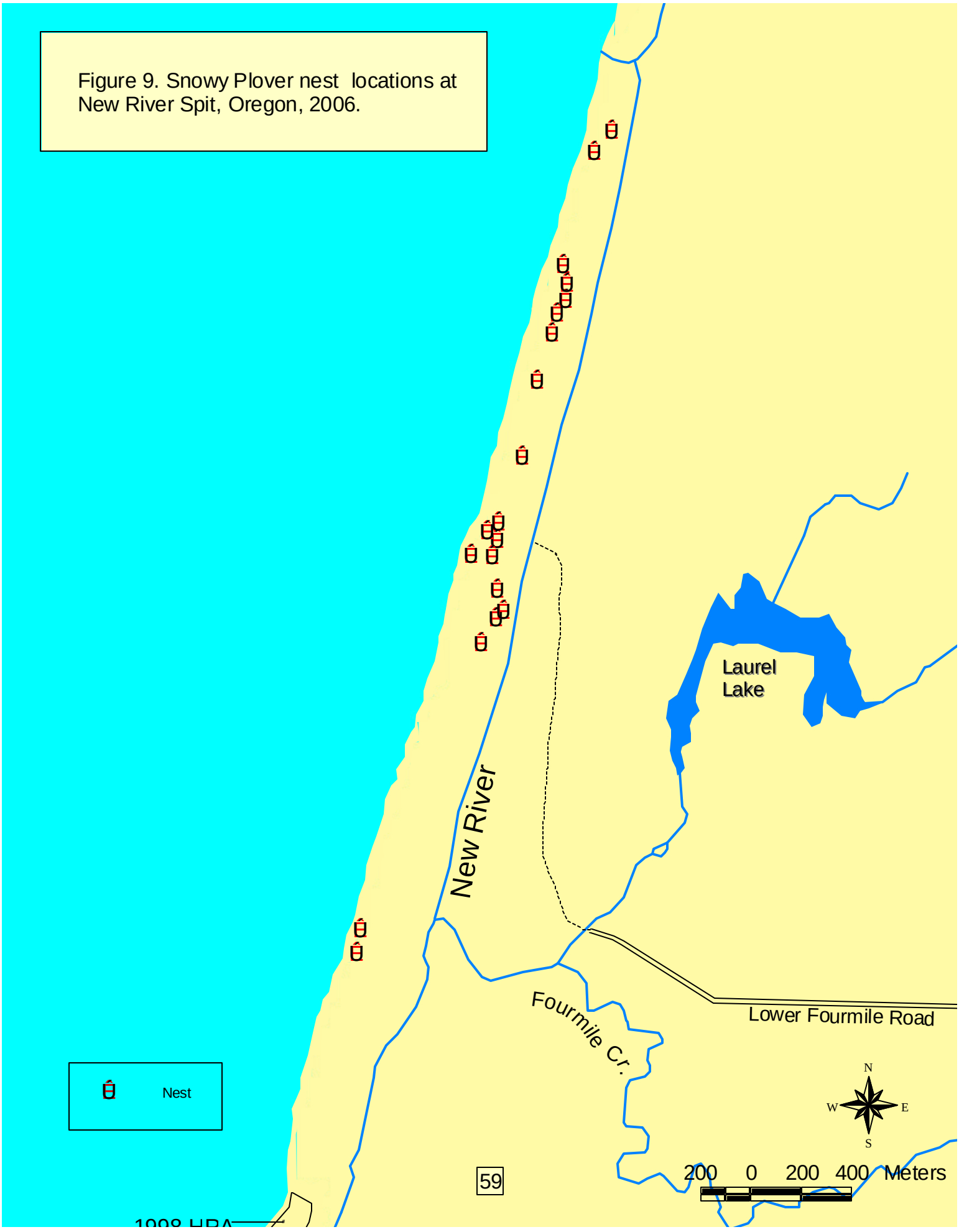


Figure 9. Snowy Plover nest locations at New River Spit, Oregon, 2006.
Laurel Lake
New River
Fourmile Cr.
Lower Fourmile Road
Nest
N
W
E
S
200 0 200 400 Meters
59
1998 HPA

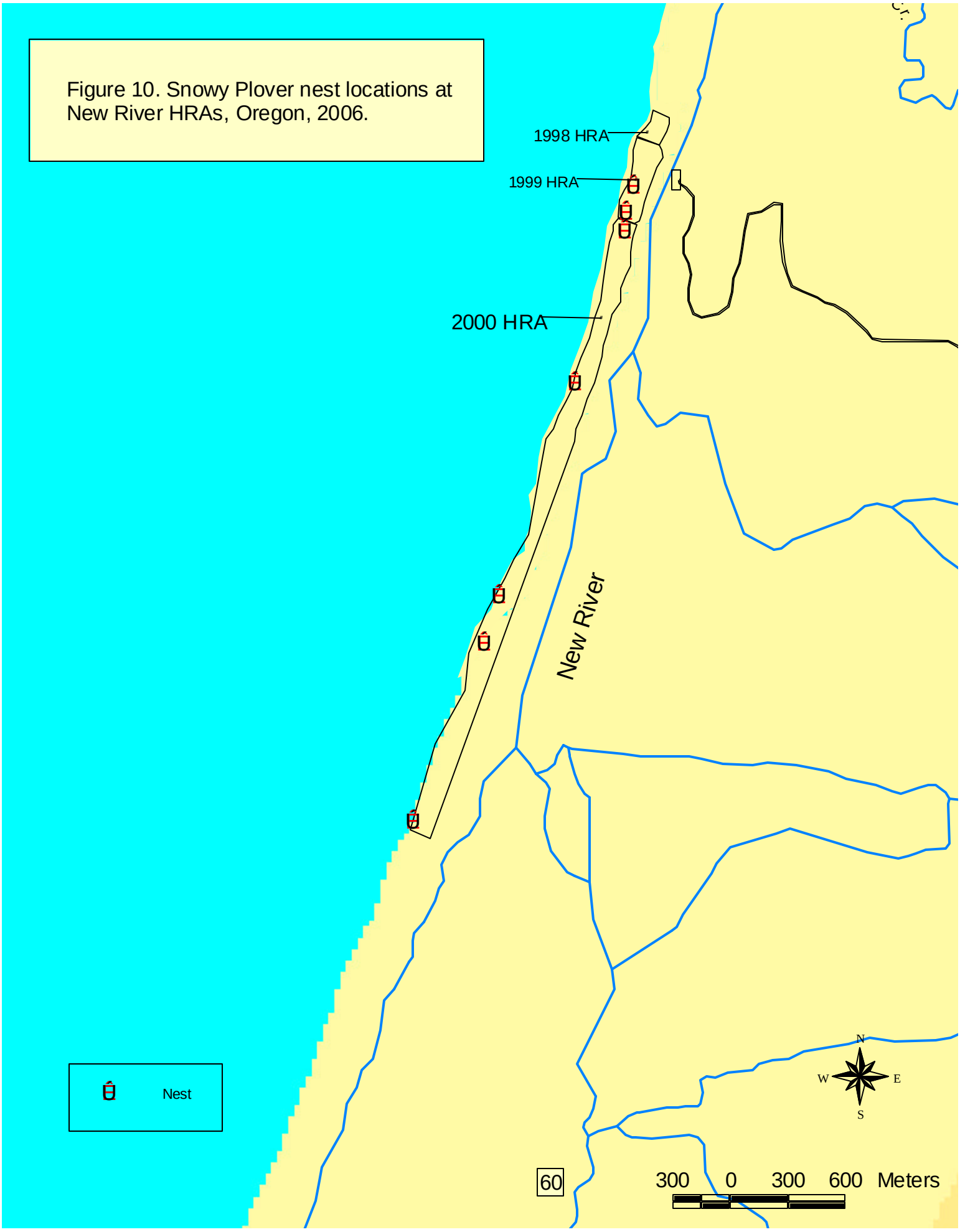


Figure 10. Snowy Plover nest locations at New River HRAs, Oregon, 2006.
1998 HRA
1999 HRA
2000 HRA
New River
Nest
N
W
E
S
60
300 0 300 600 Meters

Figure 11. Number of active Snowy Plover nests within 10-day intervals on the Oregon coast, 2006. Dashed lines represent +/- 2 standard deviations.

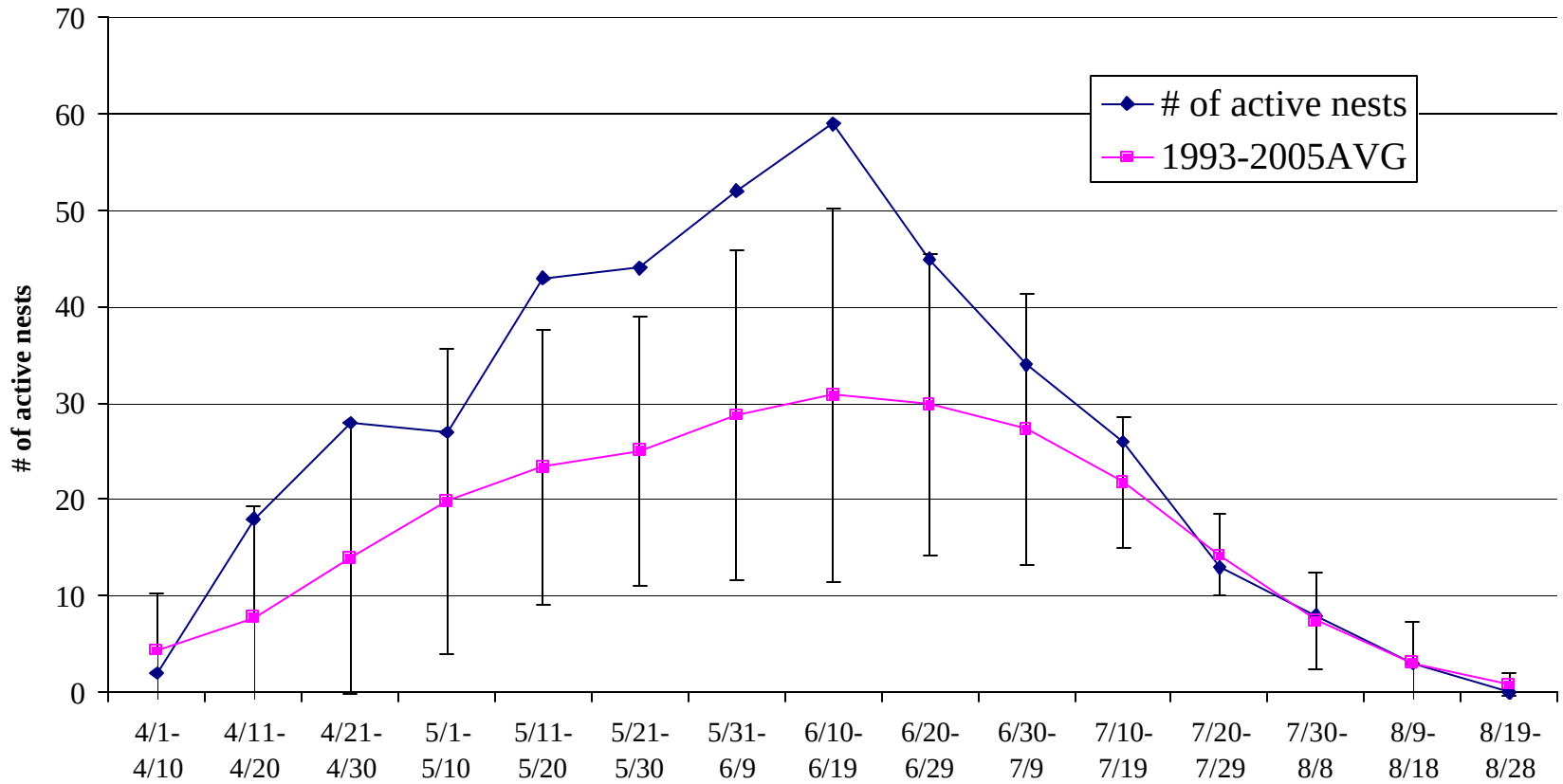


Figure 12. Total percent nest success for Snowy Plovers along the Oregon coast, 1990-2006. Above each bar is the total number of nests that hatched over the total number of nests.

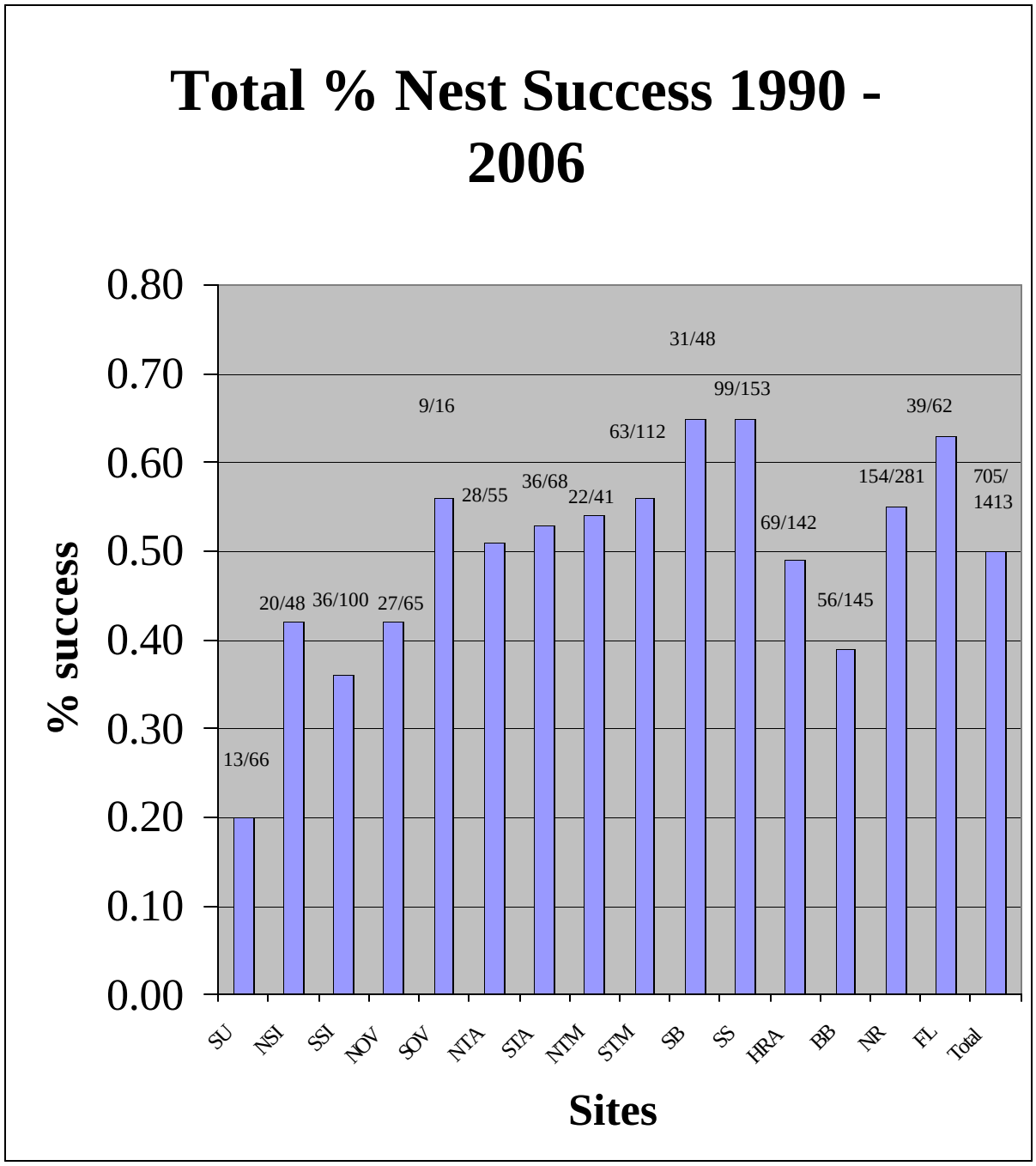


Figure 13. Percent fledgling success of Snowy Plovers at each nesting site along the Oregon coast, 1990-2006. Above each bar is the number of fledglings over the number of hatched eggs.

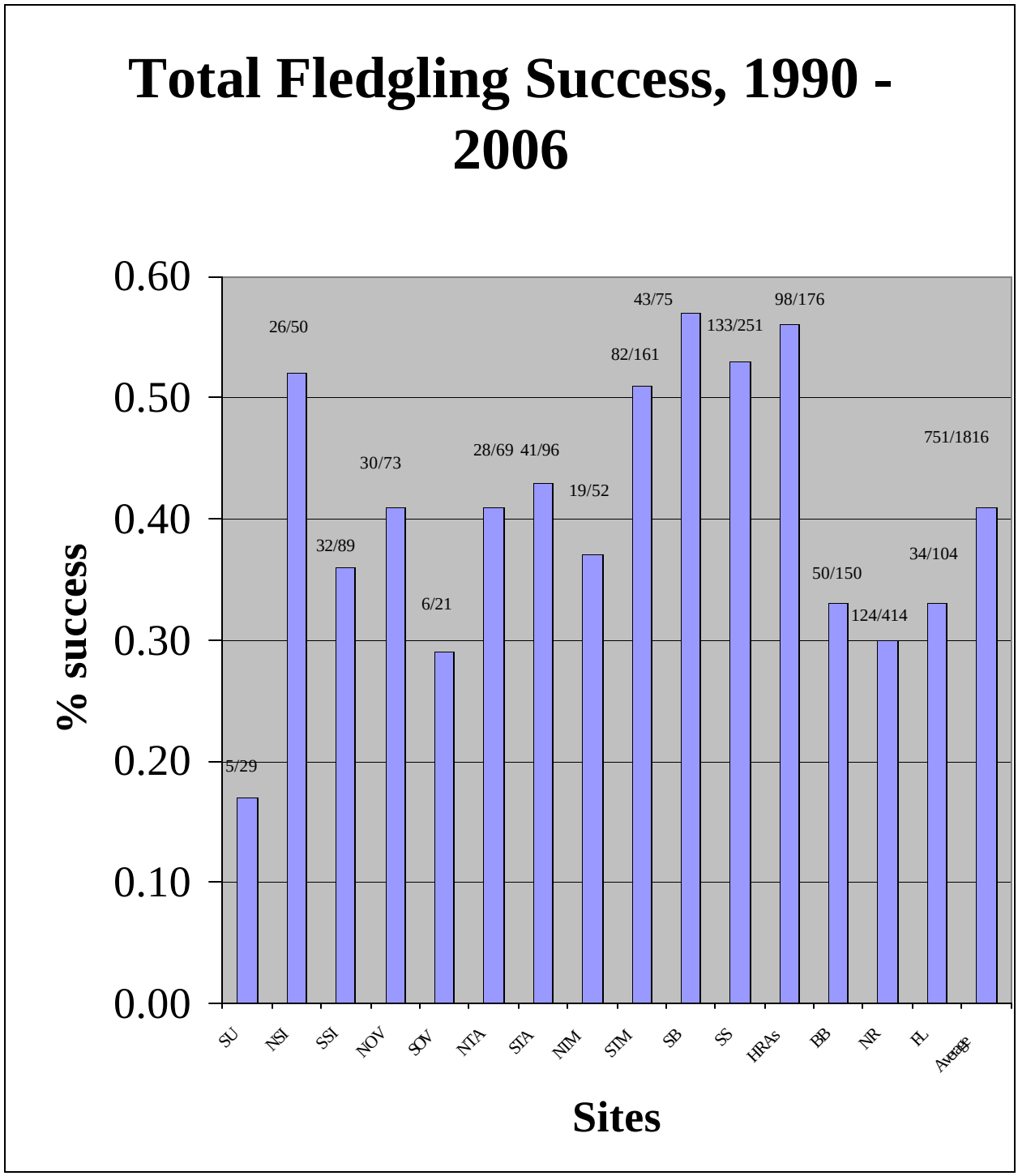


Figure 14. Apparent nest success of exclosed and unexclosed Snowy Plover nests along the Oregon coast, 1990-2006.

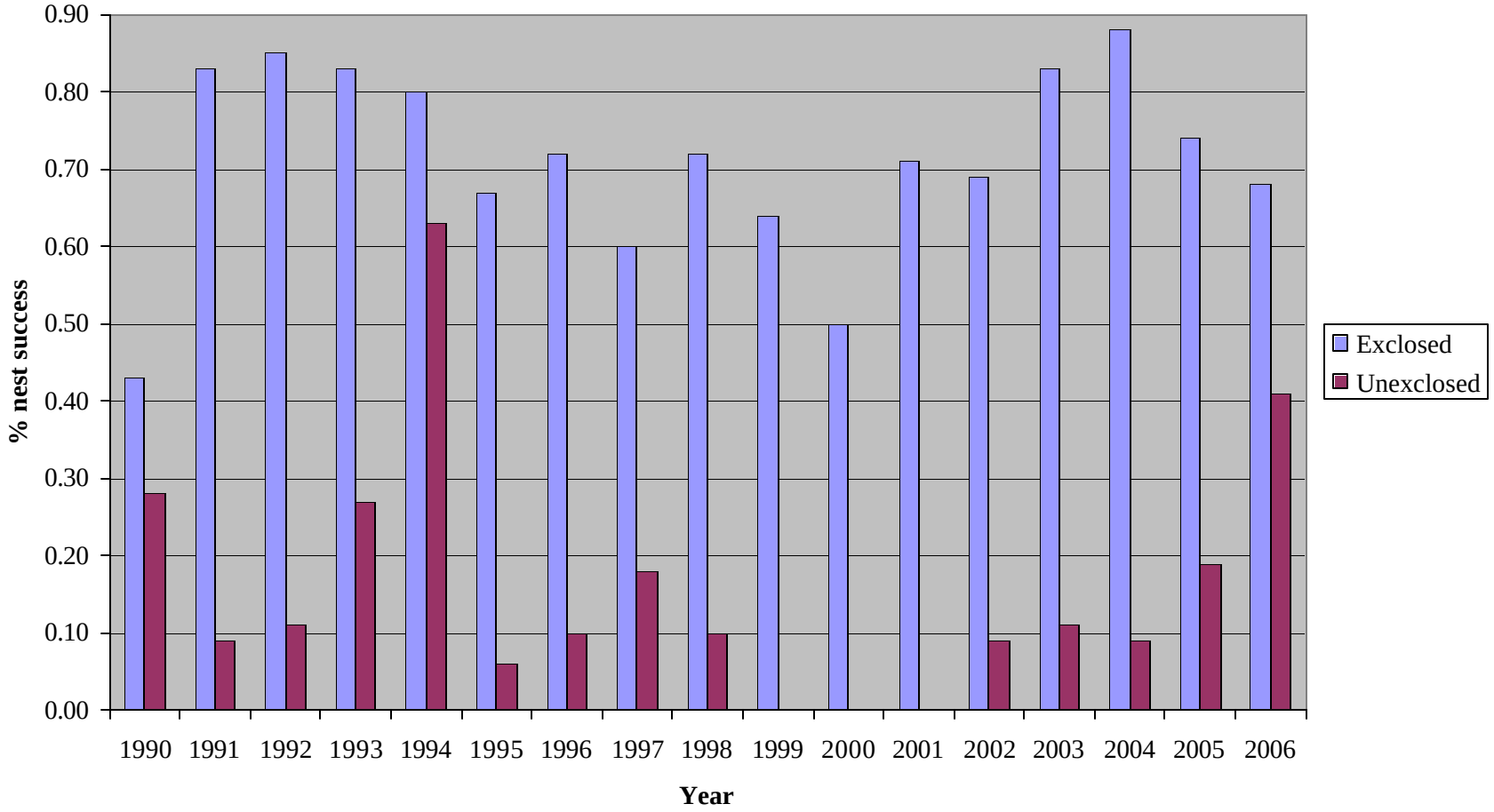


Figure 15. Fledgling success of Snowy Plovers along the Oregon coast, 1990-2001.

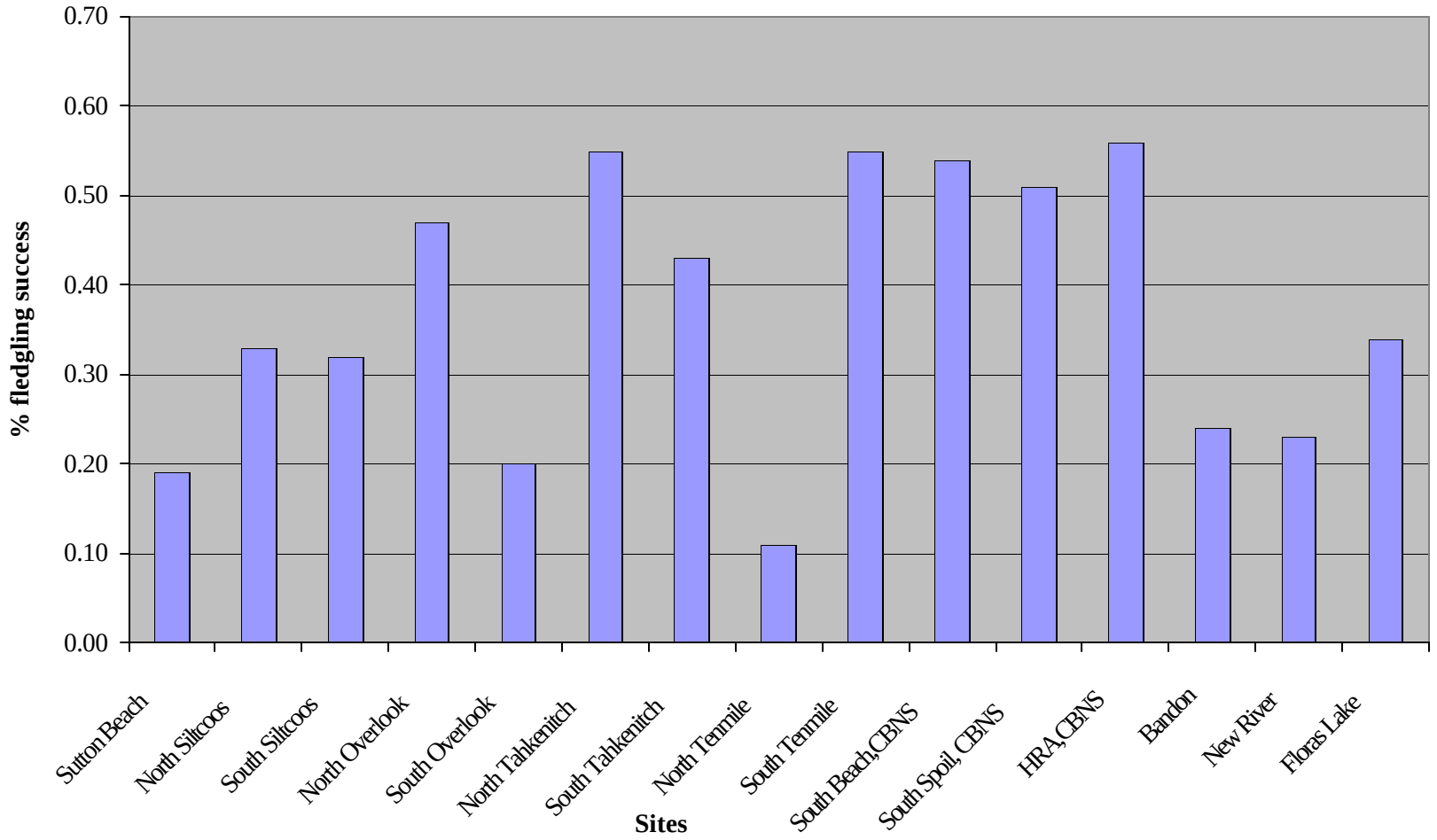
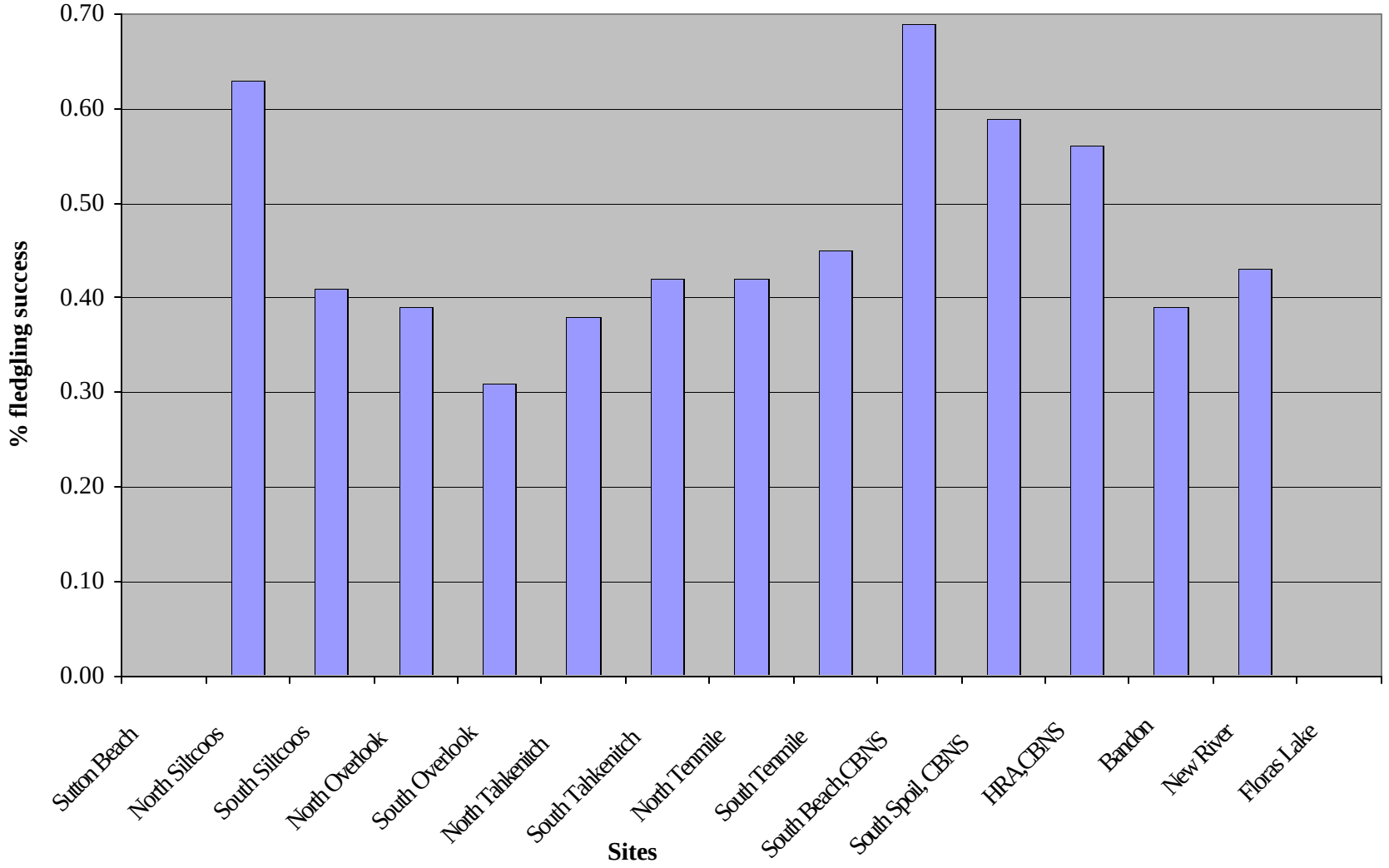


Figure 16. Fledgling success of Snowy Plovers along the Oregon coast, 2002-2006.



APPENDIX A. Study Area

The study area encompassed known nesting areas along the Oregon coast including all sites between Berry Creek, Lane Co., and New River, Coos 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 3). - 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 4). - the north and south areas cleared of beachgrass, beginning in 1998, directly west of the Oregon Dunes Overlook off of Hwy 101.

Tahkenitch Creek to the Umpqua River, Douglas Co. (Figure 5) - Tahkenitch North Spit - the spit and beach on the north side of Tahkenitch Creek; there was no habitat on the south side of Tahkenitch Creek due to erosion and the movement of the mouth of the creek.

Tenmile: North Tenmile, Coos and Douglas Cos. (Figure 6) - 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 7): 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 Beach, Coos Co. (Figure 8): the beach between China Creek and the location of the New River/Twomile Creek mouth, including the large habitat restoration area north of the mouth of Twomile Creek.

New River Spit, Coos Co. (Figures 9 and 10) - the beach and sand spit on the south side of the location of the mouth of New River/Twomile Creek, and the oceanside beach, overwashes and riverside deltas between the open spit and south to BLM lands, and the habitat restoration area (HRA) adjacent to the BLM boat launch at the Storm Ranch ACEC.

The following additional areas were either surveyed in early spring or the breeding window survey: Fort Stevens, Necanicum Spit, Nehalem Spit, Bayocean Spit,

Netarts Spit, Sand Lake Spit, Nestucca River Spit, Whiskey Run to the Coquille River, Elk River, Euchre Creek, and Pistol River.

APPENDIX B. Recommendations for Management of Recreational Activities and Habitat Restoration for sites with Snowy Plovers along the Oregon Coast - 2005.

Sutton:

- Continue to manage the nesting areas behind the foredune; consider spreading shell hash or woody debris to improve the nesting substrate.
- Implement predator management if plovers are nesting to reduce predation pressure on broods, particularly corvids.
- Continue roping and signing of dry sand from Sutton Creek to north of Berry Creek.
- Continue to sign the backside of the foredune in order to minimize pedestrian crossing of dry sand.
- Place signs on the south side of Sutton Creek notifying people that if they cross the creek dogs must be on leash at all times.

Siltcoos North and South Spits:

- Continue predator management to reduce the number of corvids using the nesting area. Continue to reduce the feral cat population in the area. Continue to monitor and possibly remove coyotes that are using and possibly denning near the nesting area.
- Continue to close the Estuary Trail. Continue signage along river, especially east of nesting area and on any "islands" that may develop to alert kayak/canoe users about plover management activities.
- Continue to post the area with updated maps of the estuary and beach at several locations. These areas include the Stagecoach Trailhead, the north parking lot, and both ends of the Waxmyrtle Trail.
- Erect ropes and signs prior to 15 March, to be as effective as possible. Place signs and ropes on east and south side of the north spit nesting area as well as continued signage to the west and north.
- Continue to prohibit dogs on the spits and near the estuary during nesting season.
- Continue the use of campground plover hosts/volunteers to educate people and keep them out of closed areas. Use hosts/volunteers, especially during peak periods on weekends, and stagger their hours to cover evenings. Have hosts/volunteers in contact with Law Enforcement Officers to improve enforcement of the closures, and have them engage people on the beach before violations occur.
- Continue to extend appropriate signing to both riverbanks, to prevent hikers from walking up the closed estuary.

Overlook:

- Continue predator management to control corvid use of the area.
- Continue to rope and sign both north and south closures for Snowy Plover nesting habitat by 15 March.

- Continue to improve and enlarge the restoration area, especially to the south towards Tahkenitch.
- Additional interpretive signing is recommended at the beginning of the Overlook trailhead (near viewing platforms). This signing is intended to provide more information on the ecology of the Snowy Plover and the reasoning for current management techniques and restricted areas.
- Continue to restrict all dogs to leashes adjacent to the Overlook nesting areas. It should be noted that many hikers with dogs are compliant while on-trail but often unleash their animals upon reaching the beach, therefore additional signing for clarification is highly recommended.

Tahkenitch:

- Continue to maintain and improve the habitat.
- Continue predator management to control corvid use of the area.
- Continue to rope and sign all suitable habitat. Place signs along east and south edge outside of the roped area to prevent hiking and camping near nesting area.
- Continue to restrict dogs to leashes adjacent to closure areas.

Tenmile North and South Spits:

- Continue predator management to control corvid use of the area; continue to monitor coyote use and possibly remove coyotes if warranted.
- Continue to maintain and improve the south side for nesting. Consider expanding and improving habitat on the north side.
- Continue to rope and sign plover nesting habitat on both north and south spits.
- Enforce vehicle closure to prevent violators from driving in the habitat restoration areas.

Coos Bay North Spit:

- Continue predator management of the area for corvids, feral cats, and skunks; monitor the coyote population and remove coyotes if warranted.
- Continue to improve and maintain the habitat restoration areas. Continue to spread shell hash to improve nesting substrate.
- Maintain gaps in the berm along the 95HRA to facilitate brood movement from the 94HRA and 98WHRA to the 95HRA and to the beach. Create small vegetation free gaps in the foredune to facilitate brood access to the beach without destabilizing the foredune.
- Continue to rope and sign the beach as early in the nesting season as possible.
- Clearly sign all entrance points on the spit that the beach is street legal vehicles only.
- The seasonal reroute of the foredune road continues to benefit plovers by reducing recreational activity, and thus disturbance, near the nesting area, and permits brood movements between the HRA's without any chance of harm from vehicle use. A permanent reroute of the foredune road would be ideal.

Bandon:

- Continue predator management to control fox and corvid populations.
- Continue to improve and maintain the habitat restoration area north of Twomile Creek.
- Sign and rope the entire beach from China Creek overwash to the habitat management area near to the mouth of Twomile Creek/New River before the nesting season.
- State Parks should continue to work with the administration of the Christian Camp to help explain the wet and dry sand restrictions to the public.
- All law enforcement agencies should again be informed as to the status of the vehicle regulations on the beach.
- Maintain enforcement of restricted areas and leash laws for dogs. Monitor hiker use from Bandon to Blacklock Point, and check the beach and HRA on weekends for illegal camping activity.

New River:

- Continue predator management to control fox and corvid populations.
- Continue to improve and maintain the habitat restoration area.
- Place interpretive signs on the east side of the river on the county land at the end of Lower Fourmile Road to inform the public of plover activity.
- Sign State Parks lands on the open spit south of the mouth of New River. Enforce dogs on leash rules. Consider use of an interpretive specialist to help monitor recreational activities in the area and explain the management efforts in the area.
- Work with the county to reduce disturbance of plovers from recreationists accessing from Lower Fourmile Road. Encourage continuing cooperation of county, state and federal law enforcement officers to monitor vehicle use of the area.
- Continue to close the gate at the Storm Ranch for 15 April- 15 September.

Floras Lake:

- Monitor the site for any plover activity.
- Enforce dogs on leash rules at all times.
- Continue to hire an on-site interpretive specialist, to contact the public, monitor the beach, and present slide shows.

Appendix C. Evaluation of Predator Management Activities on Snowy Plover Reproductive Parameters along the Oregon Coast, 1992-2006.

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Introduction

The Pacific Coast Population of Western Snowy Plover (*Charadrius alexandrinus nivosus*) was listed as Threatened on March 5, 1993 (Federal Register 1993) due to declines in population levels from habitat loss, predation pressure, and human related disturbance. In Oregon Snowy Plovers were once widespread on the coast, with at least 19 nesting areas reported in 1974 (Oregon Coast Conservation and Development Commission 1974). By 1990 the Snowy Plover population along the Oregon coast was estimated at 59, and in 1991 and 1992 the population estimate was at a low of 35 and 28 (Table 1). In 1990 The Nature Conservancy with the cooperation of state and federal agencies began a monitoring program of the coastal population of Snowy Plovers (Stern *et al.* 1990). Predation of plover nests was identified as a major factor affecting the plover population (Wilson-Jacobs and Meslow 1984, Stern *et al*. 1991). Use of predator deterrent exclosures was implemented in 1991 to increase the hatch rate of nests and provide the plovers with more opportunities to raise chicks. Nest exclosures have been very successful at increasing hatch rates and nest success (Table 5, Figure 14, Lauten *et al*. 2004), and with the increase in nest success plover populations began to increase (Table 1). By 1997 the plover population had increased to a maximum of 141, but then declined to about 100 individuals. The original decline in population was thought to be associated with a strong El Nino event and the associated winter storms that may have reduced overwinter survival rates (Castelein *et al*. 1998). The population then stabilized at around 100-110 plovers from 1997 to 2003 (Table 1).

Analysis of data collected from 1990 to 1998 indicated that while nest exclosures increased nest success and the overall population increased, some nesting sites had fledgling success rates that were very poor while other nesting sites had very good fledgling success rates (Figures 14 and 15). Nesting sites with good fledgling success rates were helping to maintain and increase the plover population, while other sites, even if they had relatively high numbers of nests, had poor fledgling success rates and therefore were not contributing many new fledglings to the overall population. Data also indicated that without nest exclosures, nests had very poor nest success, and the main cause of known nest failure was corvids (Lauten *et al*. 2004). Monitors also noted evidence of red fox (*Vulpes vulpes*) from Bandon Beach State Natural Area south to Floras Lake. Evidence included numerous tracks on the beach, den sites, and sightings of fox on the beach. Fox were so prevalent in the area, they were noted accessing nearby offshore rocky islands at Coquille Point, Bandon where numerous seabirds were nesting.

The fox apparently had decimated burrow-nesting seabirds and gulls nesting on the accessible offshore islands (USFWS, pers. comm.). In California, red fox were known to be a major predator on Snowy Plovers as well as several other species (USFWS 1993). Plover monitors in Oregon began to suspect that low fledgling success rates in the Bandon Beach to Floras Lake area were related to a high red fox population in addition to corvid predation. During the winter of 1998-99 ORNHIC staff began to recommend that red fox be removed and reduced in the Bandon Beach – New River – Floras Lake area. In early February of 1999 the New Carissa freighter grounded on the beach at Coos Bay North Spit, spilling thousands of gallons of oil (Stern *et al*. 2000). Remedial action from the spill included a recommendation that a predator management program be implemented particularly at Bandon Beach and New River targeting red fox with the goal of reducing the fox population and increasing fledgling success in this area. During the summer of 1999, 17 red fox were removed from the New River area (predator management was restricted to just the New River area) (Castelein *et al*. 2000a).

Due to the high number of red fox removed at New River, Castelein *et al*. 2000a recommended that a predator management program be implemented. Discussion with the Oregon Western Snowy Plover Working Group determined that a predator management program was needed and should include all predators that were targeting Snowy Plovers and their nests. The initial goals of the predator management program were to help reduce nest losses and increase fledgling success at sites that had low fledgling success rates, and in particular reduce the red fox population at Bandon Beach and New River. Since predator management was to be implemented on federal lands, the agencies had to abide by the National Environmental Policy Act (NEPA), which required an environmental assessment. Funding was required and secured during 2000, and an environmental assessment was written in 2001 and finalized in January 2002 (USFWS 2002).

Funding for the predator management was limited in the first two years, therefore priorities were determined to be management of red fox populations at Bandon Beach and New River, management of other mammalian predators at Bandon Beach, New River, and Coos Bay North Spit, and corvid management at Bandon Beach, New River, and Coos Bay North Spit. After each season an evaluation of the predator management program was completed, and refinements as to what species to target and how to target those species were determined. Additional funding was sought and secured each year to increase the level of predator management as well as expand the predator management program to all sites.

The Oregon Western Snowy Plover Working Group agreed that after five years of predator management an evaluation of the program would be required. The evaluation would assess whether the predator management program was successful at increasing the overall productivity of Snowy Plovers, and would make recommendations as to whether the program should be continued and what aspects of the programs were successful, and if not successful what further actions could be implemented to continue to improve the program. In this appendix we review five years of predator management along the Oregon coast with the objectives of summarizing the number of predators removed from

plover nesting areas, evaluating any changes in the reproductive parameters of Snowy Plovers breeding along the Oregon coast, and making necessary recommendations to the program.

Methods

Predator management is defined as lethal removal of predators by USDA–APHIS-Wildlife Services (WS) in and around the Snowy Plover breeding sites. Predator management began in 2002 at Bandon Beach and New River, and to a limited extent at Floras Lake, and has expanded to all sites and has continued through 2006. We exclude the removal of red fox at New River in 1999 from this analysis because only red fox were targeted, they were not targeted after 1999 until 2002, and the action was an emergency response to the New Carissa grounding and subsequent oil spillage. Non-lethal predator management techniques, specifically the use of nest exclosures, have been used consistently since 1991 (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). Due to limited funding in 2002 and 2003, predator management activities were confined to Bandon Beach, New River, and to a much lesser extent at Floras Lake. Beginning in 2004, all sites from New River to Siltcoos have had consistent predator management activities. Sutton Beach and Floras Lake have had very limited predator management activities and are excluded from the analysis. For specific methods and results of predator management for each site and year, see the annual reports by Wildlife Services (Little and Williams 2002, 2003, and 2004, Little 2005 and 2006).

We summarized the overall efforts reported by WS in their annual reports. We noted the annual start and end date and the total number of staff hours each year, and calculated a mean number of staff hours and the standard deviation. We summarized the total number of DRC-1339 treated eggs for each year except 2003 when WS did not report the total number of eggs used, and the total number of trap nights/days for each different type of trapping technique. We calculated means and standard deviations for number of DRC-1339 treated eggs used, and the number of trap nights/days for each trapping technique.

We summarized the total number of individual predators removed by WS for each year and for all years combined, and we calculated mean, median, and the standard deviation for each type of predator removed by WS. For corvids, we summarized the WS estimated number of American Crows (*Corvus brachyrhynchos*) and Common Ravens (*Corvus corax*) removed by DRC-1339 treated eggs, and the known number of American Crows and Common Ravens removed by other methods (shooting, trapping). We calculated a total estimated number of crows and ravens removed, and the mean for all years and a standard deviation. In 2005 and 2006, the number of corvids removed was estimated by two methods, the WS search method (Little and Williams 2002, 2003, and 2004, Little 2005 and 2006) and a USFWS line transect survey method (Seavey and Little 2006, USFWS 2006). We briefly compare the two estimates of corvid take.

While most of the nesting sites have been divided into north and south components or defined habitat restoration areas, these divisions are somewhat arbitrary and mainly used to help monitors and managers understand the location of nests and plover activity. Snowy Plovers using the nesting areas do not necessarily stay within the defined areas, particularly nesting sites near estuaries that have a north and south component. Plovers will regularly attempt to nest within a given year on either the north or south side of the nesting site, or both. Therefore in order to evaluate the overall productivity of plovers on the nesting sites, we pooled the data from each main nesting area. This permitted us to have larger sample sizes from each main nesting area, and to account for plovers moving between defined areas within a larger nesting site. Nesting sites with a north and south side include: Siltcoos, Overlook, Tahkenitch, and Tenmile. Nesting sites with multiple nesting areas are Coos Bay North Spit (CBNS) and New River. We did not use data from Sutton Beach or Floras Lake, which have had either very few or no nests over the past three to five years, and have had very limited predator management activities.

We calculated for each site and each year: the number of eggs laid, the number of hatched eggs, the hatch rate (the number of eggs hatched divided by the number of eggs laid), the number of fledged chicks, the fledgling success rate (the number of chicks fledged divided by the number of eggs hatched), a productivity index (the number of fledged chicks divided by the number of eggs laid; this is an index of productivity compared to overall effort) and the number of fledglings per male. For fledglings per male, we only used nests with known males. Broods from undiscovered nests were not included in the analysis. We eliminated the years 1990 and 1991 from the analysis because of limited data and limited use of exclosures. Data for each site reflects how many years plovers have been known to nest at that site; some sites have had nesting plovers since 1992 while other sites have fewer years of data. We pooled the data for each site into pre-predator management and post-predator management periods. The number of years of predator management at each site has varied: Siltcoos, Overlook, Tahkenitch, and Tenmile have had three years of predator management activity (2004-06), while CBNS, Bandon Beach, and New River have had five years of predator management (2002-06). We used ANOVA and the Tukey-Kramer procedure to compare the productivity parameters of the different sites, and whether the productivity parameters were different prior to predator management compared to after predator management. We used an alpha level of 0.05 to determine significance, however we believe that alpha levels of 0.10 are biologically significant.

Results

The earliest starting date for predator management activities was 20 January and the latest starting date was 11 March (Table 13). The earliest ending date for predator management activities was 2 August and the latest ending date was 2 September. An average of 1247.6 hours of staff time have been conducted each year, however this has ranged from a low of 744 hours in 2002 (only one staff employee) to a high of 1851 hours in 2005 (two staff employees).

Eggs treated with DRC-1339 were not used in 2002 and use of this corvicide was implemented in 2003, however WS did not report in their annual report the number of eggs used in that year (Little and Williams 2003). Since 2004, an average of 1121 DRC-1339 treated eggs were placed in the field each year, with a low of 855 in 2005 and a high of 1498 in 2004 (Table 13). In 2002, attempts were made to catch raptors at CBNS that were preying on adult plovers. There were a total of 54 raptor trap nights/days; no raptors were trapped.

WS has used three main trapping techniques for mammals: cage traps, padded leghold traps, and neck snare traps (Table 13). There was an average of 133.5 cage trap nights/days per year, with a low of 27 cage trap nights/days in 2005 and a high of 210 cage trap nights/days in 2003. Padded leghold traps have been used the most extensively, with an average of 1893 leghold trap nights/days per year. In 2002 there was a low of 1362 leghold trap nights/days and the high was in 2006 when there was 2933 leghold trap nights/days. There was an average of 275.4 neck snare trap nights/days, with a low of 99 neck snare trap nights/days in 2002 and a high of 405 neck snare trap nights/days in 2005.

A total of 194 individual mammalian predators have been captured since 2002 (Table 14). The most common species captured has been red fox with 77 individuals removed (40%), followed by raccoon (*Procyon lotor*) (n=39, 20%), striped skunk (*Mephitis mephitis*) (n= 32, 16%), and opossum (*Didelphis marsupialis*) (n=22, 11%). Seven gray fox (*Urocyon cinereoargenteus*) (4%) and four coyote (*Canis latrans*) (2%) have been removed. Nine feral cats (*Felis sylvestris*) (5%) and one domestic dog (*Canis familiaris*) have been captured; the cats have generally been in poor shape and not adoptable and have been euthanized and the dog was transported to a shelter. Three other species were captured although none have been targeted: one river otter (*Lutra canadensis*) that was relocated, one mink (*Mustela vison*) and one bobcat (*Lynx rufus*). Gray fox have only been removed from CBNS, the only site where their presence is known. No gray fox or raccoons were removed in 2005 or 2006 partly because of refinements in targeting predators. While raccoons are fairly common on the beach, data does not support the removal of these two species, as they seem to have little impact on plover productivity. Coyotes have only been removed in 2006. Prior to 2006 coyote populations around plover nesting areas were fairly low, however there has been an increase in coyote use of the nesting areas in the past couple of years (WS and ORNHIC field staff observations). In 2006, coyotes at Siltcoos were determined to be causing problems around exclosures, and therefore several were targeted for removal to reduce predation pressure on the plovers.

A total estimate of 545 Common Ravens and 373 American Crows have been removed from plover nesting areas (Table 14 and Table 15). The number of American Crows removed by methods other than DRC-1339 was 159, with a mean of 31.8 per year (Table 15). The low was 13 in 2003 and the high was 59 in 2006. The number of Common Ravens removed by methods other than DRC-1339 was 62, with a mean of 12.4 per year. The low was eight in 2003 and the high was 21 in 2006. The WS search method for corvids taken by DRC-1339 estimated a total of 214 American Crows

removed, with a mean of 53.5 per year. The low, excluding 2002 when no DRC-1339 treated eggs were used, was 25 in 2003 and the high was 77 in 2005. The WS search method estimated 483 Common Ravens were removed by DRC-1339, with a mean of 120.8 per year. The low was 78 in 2005 and the high was 142 in 2003. The line transect method of estimating corvid removal by DRC-1339 determined that in 2005 113 Common Ravens were removed and 22 American Crows were removed. In 2006 the estimates were 25 Common Ravens and 46 American Crows removed, however data from New River could not be used in the calculations due to a limited number of line transects completed, therefore the total estimate of corvids removed was known to be low.

At Siltcoos, (Table 16) the hatch rate from 1993 – 2003 was 34%, the fledgling rate was 30%, the productivity index was 10%, and plovers produced 0.65 fledglings per male. From 2004-2006 when predator management was implemented, the hatch rate increased to 42%, the fledgling rate was 60%, the productivity index was 25%, and plovers produced 2.00 fledglings per male.

Overlook has the most limited data because it was created before the 1999 nesting season (Table 17). The hatch rate was 43% pre-predator management compared to 48% post-predator management, the fledgling rate changed from 35% to 42%, and the productivity index changed from 14% to 18%. The number of fledglings per male increased from 0.71 before predator management to 1.33 after predator management.

At Tahkenitch (Table 18), the hatch rate has increased from 48% to 63% from pre-predator management to post-predator management, the fledgling rate has changed from 40% to 47%, and the productivity index increased from 19% to 31%. The number of fledglings per male increased from 0.89 prior to predator management to 1.50 after predator management.

At Tenmile (Table 19) the hatch rate has declined slightly from 54% to 49% from pre-predator management to post-predator management, the fledgling rate has nearly stayed the same (48% to 46%), and the productivity index declined slightly (26% to 23%). The number of fledglings per male has increased from 1.16 prior to predator management to 1.33 after predator management.

At CBNS (Table 20) the hatch rate declined slightly from 58% pre-predator management to 53% post-predator management. The fledgling rate increased from 52% to 59% and the productivity index remained relatively stable (30% to 31%). The number of fledglings per male increased from 1.58 to 1.75.

At Bandon Beach (Table 21) pre-predator management hatch rate was 41% and increased slightly to 45% post-predator management. Both the fledgling rate and the productivity index improved since predator management was implemented: 23% to 38% for the fledgling success rate and 9% to 17% for the productivity index. The number of fledglings per male more than doubled from 0.43 to 1.00.

At New River (Table 22), the hatch rate pre-predator management was 58% and declined slightly to 52% post-predator management. The fledgling success rate improved from 24% to 43%, and the productivity index also improved from 14% to 22%. The number of fledglings per male improved from 0.69 to 1.21.

The least square mean hatch rate for all sites prior to predator management was 0.51 and after predator management was 0.49 (Table 23). Least square mean hatch rates between nesting sites were not significantly different (Table 24, df = 6, F-value = 1.18, P = 0.3278) and there was no change in the least square mean hatch rate from before predator management and after predator management (df = 1, F-value = 0.12, P = 0.7337).

The least square mean fledgling success rate between sites was significantly different (df = 6, F-value = 3.84, P = 0.0020). Notably Bandon Beach had a significantly lower mean fledgling success rate than CBNS, Tenmile, and Tahkenitch (Table 24). The least square mean fledgling success significantly increased from 0.36 prior to predator management to 0.47 after predator management (Table 23, df = 1, F-value = 5.10, P = 0.0267).

There were significant differences in the mean productivity index between sites (df=6, F-value = 2.55, P = 0.0260). Particularly Bandon Beach had a significantly lower productivity index than CBNS (Table 24). The mean productivity index prior to predator management (0.20) was not significantly different to the mean productivity index after predator management (0.24) (Table 23, df=1, F-value = 1.47, P = 0.2295).

Productivity as measured as the mean fledglings per male was significantly different between sites (df=6, F-value = 5.04, P = 0.0002). Bandon Beach had significantly lower mean fledglings per male than CBNS, Tenmile, Tahkenitch, and Siltcoos, and CBNS had significantly higher mean fledglings per male than New River (Table 24). Productivity was also significantly different from prior to predator management to after implementation of predator management (df=1, F-value = 21.26, P < 0.0001). The overall mean productivity was 0.87 fledglings per male prior to predator management and 1.44 fledglings per male after predator management (Table 23).

Discussion

Non-lethal predator management (i.e., exclosure use) has increased nest success and hatch rates (Table 5, Figure 14) and lead to increases in the population of Snowy Plovers on the Oregon coast. However, non-lethal predator management does not protect chicks once they are hatched and has no impact on fledgling success and productivity rates. Despite increases in the population of plovers, analysis of data indicated that some sites had low fledgling success rates and poor productivity given the effort by the plovers at some nesting areas (Tables 15-22). Field observations of predators indicated that some sites had high levels of predators known to be detrimental to plover productivity, and it was believed that these predators were causing high depredation rates on chicks and therefore contributing to poor productivity at certain sites (Castelein *et al.* 1998, 2000a,

2000b, 2001, and 2002). Plover biologists believed that plover populations were not increasing partially due to poor productivity at some nesting sites associated with high predation rates. Furthermore, while exclosure use did increase nest success and hatch rates, exclosure use is very time consuming and has inherent negative aspects, such as increased depredation of adult plovers in and around the exclosures. Lethal predator management was proposed and initiated to reduce detrimental predator populations in and around the plover nesting areas, resulting in increases in fledgling success and overall plover productivity, and to reduce and potentially eliminate exclosure use

Due to funding constraints, implementation of predator management began at only CBNS, Bandon Beach, New River, and a lesser extent at Floras Lake in 2002. These sites were chosen as the original predator management areas partially because red fox were known at Bandon Beach, New River, and Floras Lake, and it was determined that removal of red fox was of high priority. Furthermore, productivity parameters, except for hatch rates, at these southern sites were generally very poor, and the Bandon Beach/New River area contained a substantial percentage of all the nests and plovers along the Oregon coast (Table 4). Although CBNS was known to have overall very good productivity parameters, predator management was implemented there partially because the main source of funding came from the Bureau of Land Management, which managed lands at CBNS as well as New River. In addition, reduction of corvid populations at CBNS was sought to reduce exclosure use and therefore reduce adult depredation problems associated with exclosures, particularly at this site. Predator management on Forest Service nesting areas (Siltcoos, Overlook, Tahkenitch, and Tenmile) began in 2004 when adequate funding was secured. The main focus of predator management on Forest Service lands has been corvids because red fox have not been found on those nesting areas and evidence indicates that corvids and not mammals are the main predators.

Starting dates for predator management have varied from year to year except in 2005 and 2006 because the predator subcommittee has attempted to refine the best time to begin predator management activities so they will have the most affect on plover productivity while taking into consideration field conditions (i.e., weather, storm tides, river levels). WS staff hours have varied somewhat due to funding levels as well as other work related responsibilities. The number of DRC-1339 treated eggs, as well as the number of trap nights/days, also has fluctuated due to WS staff's determination of effort needed to remove the targeted predators.

While 13 different species have been either captured, removed, or relocated (Table 14), six species are the main target: red fox, opossum, striped skunk, feral cats, Common Raven, and American Crow. Data indicate that corvids are the main source of nest depredation (Lauten *et al*., 2004), and red fox are known plover predators (USFWS 1993). Opossum has been consistently removed because they are a known egg predator, but also because of to their non-native status, ODFW regulations require termination of any captured animals. Striped skunks have been consistently targeted because they are a known egg predator and the evidence of skunk activity on the nesting areas indicates that they are actively hunting. Feral cats have been targeted because of their non-native status

as well as being well known predator of birds and eggs. We targeted raccoons from 2002-2004, but since 2005 we have not targeted raccoons. Raccoons are fairly common on the beach, but while raccoons have depredated a few nests, the number is extremely small and not significant enough to justify targeting them. Raccoons do cross the nesting areas, but evidence indicates that they are generally passing through and not hunting, and mostly spend their time in the wrackline foraging at night. There is no evidence that raccoons have had a negative impact on plover productivity since they were dropped as a target species. Coyotes have also not been targeted until late in 2006. It appears that evidence of coyote use is increasing on the nesting areas, however to date there is little evidence that they are targeting plovers. We intend to continue to closely monitor coyote activity as plover populations increase, and we will address any issues if and when they arise.

The number of red fox removed from the Bandon Beach/New River area has averaged 15 per year and ranged from 6 to 27 (Table 14). The efforts of WS to remove red fox have been very successful based on the change in red fox evidence in the field. Prior to red fox management, plover biologists noted that the beach was routinely covered with fox tracks. Since fox management, evidence of fox hunting the beaches has greatly declined, and when tracks do appear WS staff is able to respond to any individual hunting around the nesting areas. The consistent number of fox removed each year indicates that the surrounding habitat has a large population of red fox. When the fox are removed from the plover nesting areas, other fox eventually move into the available and now unoccupied habitat. Therefore it is essential to continue to manage red fox populations each year because cessation of fox management will lead to high fox populations in and around the plover nesting areas. The only potential method of permanently reducing red fox populations in the Bandon Beach/New River area would be to expand fox management onto all surrounding habitats, which is not likely feasible due to the size of the surrounding habitat, the level of effort and staff time it would require, and the amount of funding required for a large fox management program.

Corvids continue to be the main cause of nest depredations (Tables 7 and 8) and are the two species most targeted by predator management (Table 15). Estimates of corvid take by DRC-1339 treated eggs remains difficult to assess due to the fact that carcasses cannot be located and counted. The two methods of estimating corvid take each have their own inherent problems, with the WS search method likely being robust and the line transect method more conservative. Despite the problems with estimating take, neither method has approached the level of Common Ravens permitted to be taken by the Migratory Bird Treaty Office permit (300), and in no year has raven take been estimated to be greater than 150. We believe that we are well within the confines of the permit. Corvids will need to be continually managed on Snowy Plover nesting areas, because we cannot control their movements into the area, and as with red fox, corvids are abundant on surrounding habitat. We do not anticipate needing to remove more corvids than have been estimated each year. The predator subcommittee continues to work on refining methods to estimate take of corvids by DRC-1339 treated eggs, however the best method to understand corvid behavior and the impacts of corvid management would be to conduct a telemetry based study of the local corvids that would lead to finding, counting,

and evaluating carcasses of corvids. A corvid telemetry study would be expensive, time consuming, and would need a contingent of biologists to conduct which under the current situation and funding levels is not likely feasible.

While some sites have had improvements in hatch rate (Tables 16-22), overall the hatch rate has not changed (Table 23) and remains relatively high. This is a function of exclosed nests having much higher hatch rates than unexclosed nests (Figure 14). The effect of predator management on hatch rates has not been significant because we continue to use exclosures on most nests. One objective of predator management was to improve hatch rates of unexclosed nests, and data indicates that unexclosed hatch rates are improving (Table 5). Further evidence of improvements in unexclosed nest success is the number of days nests are left unexclosed compared to the number of days nests are exclosed. From 1992 to 2001 the number of days unexclosed ranged from 73 to 410 with a mean of 173. From 2002 to 2006 the number of days unexclosed ranged from 282 to 1110 with a mean of 641. The number of days unexclosed has increased with each year of predator management: 282 in 2002, 474 in 2003, 521 in 2004, 820 in 2005, and 1110 in 2006. In 2006, the number of days unexclosed was almost equal to the number of days exclosed (n=1149), the only year when these numbers were nearly equal.

Fledgling success rates on all sites except Tenmile have improved since predator management was implemented (Tables 16-22, Figure 15 and 16). At Tenmile, the fledgling success rate only declined two percentage points and the fledgling success rate at this site was already very good prior to predator management (Table 19). Sites that had poor fledgling success rates prior to predator management have had excellent improvements in fledgling success. At Siltcoos, fledgling success has improved from 30% to 60% (Table 16), at Bandon Beach fledgling success has improved from 23% to 38% (Table 21), and at New River fledgling success has improved from 24% to 43% (Table 22). Only Bandon Beach has a post-predator management fledgling success rate of lower than 40%. Overall the mean fledgling success rate has significantly improved since implementation of predator management (Table 23).

Fledgling success rates are not always the best measure of how productive plovers are because the fledgling success rate does not take into account the effort of the plovers to produce fledglings. For instance, one site might have a fledgling success rate of 50% from producing two fledglings from four hatched eggs, while a second site might have a fledgling success rate of 40% from producing eight fledglings from 20 hatched eggs. However if the first site had actually 30 eggs laid and the second site had 24 eggs laid, then the overall effort at the first site was relatively high compared to the second site, but the outcome of the effort was actually much lower for the first site than the second site. The productivity index, or the number of fledglings produced divided by the number of eggs laid, is a measure of the overall effort of the nesting plovers at each site. This number indirectly takes into account the number of adult plovers and directly takes into account the number of eggs laid on a given site, and therefore measures how productive the plovers were given the amount of effort. Based on pre-predator management data, sites that were productive (CBNS and Tenmile) had productivity indices of greater than 20% (Tables 19 and 20) while sites that were not productive had productivity indices of

less than 15% (Siltcoos, Overlook, Bandon Beach, and New River, Tables 16, 17, 21, and 22). Since implementation of predator management, only Tenmile has had a decline in the productivity index, and at Tenmile the productivity index has declined only three percentage points and remains above 20% (Table 19). At CBNS the productivity index has essentially remained the same and continues to be the highest on the coast (Table 19). All other sites have seen improvements in the productivity indices and all are above 15% since predator management was implemented (Tables 16, 17, 18, 21, and 22). While the overall productivity index improved (Table 23), the change was not significant. We do believe that predator management has had a positive effect on improving productivity given the effort, especially at sites where the productivity index was very low prior to predator management (Siltcoos, Bandon Beach, and New River).

One of the stated goals of the draft recovery plan is for plovers to produce an average of one fledgling per male. One of the objectives for predator management was to improve the productivity of plovers especially at sites where the plovers were not averaging one fledgling per male. All nesting sites have had improvements in the number of fledglings per male and all sites have averaged at least one fledgling per male since the implementation of predator management (Tables 16-22). CBNS and Tenmile were the only sites with greater than one fledgling per male prior to predator management (Tables 19 and 20), and both sites had slight improvements in the number of fledglings per male. All other sites had average fledglings per male of less than one prior to predator management, and all have had excellent improvements in the number of fledglings per male since predator management (Tables 16, 17, 18, 21, and 22). The overall fledglings per male has significantly improved since predator management was implemented from below 1.00 to 1.44 (Table 23).

Recommendations

Plover management entails three main aspects: recreational management, habitat management, and predator management. Recreational management activities have been in place for years (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) and have generally not changed. The placement of ropes and signs and the restricting of plover nesting areas have been effective at limiting recreational disturbance to nesting plovers. While habitat management and improvement continues on a yearly basis, the amount of available habitat for plovers has not drastically increased in the past five years nor has improvement of nesting areas been substantial or evenly completed on all nesting areas. The main management activity that has changed since 2002 has been the implementation of lethal predator management. The data indicates that lethal predator management has had an overall positive effect on plover productivity. While predator management can be costly and time consuming, we believe that predator management in conjunction with continuing recreational and habitat management is an essential and critical aspect of plover management. The predator subcommittee meets several times each year to evaluate the predator management program, and as WS and ORNHIC staff continue to work with the predators, we continue to refine what predators are detrimental to plover productivity and whether and which predators need to be

targeted. Due to the nature of ingress of predators into the nesting areas each year, we recommend that corvids and red fox continue to be removed from plover nesting areas. We recommend managing agencies continue to fully fund the predator management program at all sites. While we understand that there are limitations to estimating the number of corvids removed each year, we believe that the overall number of corvids removed is not great enough to impact the population levels of these species in the greater area. We recommend the predator subcommittee continue to refine corvid survey techniques to better estimate corvid take, however, we believe that to fully understand corvid take a large scale corvid project would need to be funded and initiated.