The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2019

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Abstract

We monitored the distribution, abundance and productivity of the federally threatened Western Snowy Plover (*Charadrius nivosus nivosus*) along the central and south coast of Oregon from 3 April – 24 September 2019. We surveyed and monitored plover activity in a project area that included, from north to south, Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit, Bandon Snowy Plover Management Area, New River HRA and adjacent lands, and Floras Lake. We also completed limited survey work at North Umpqua and Cut Creek, Bullard's Beach State Park. Our objectives for the project area in 2019 were to: 1) estimate the size of the adult Snowy Plover population, 2) locate plover nests, 3) determine nest success, 4) implement nest protection as appropriate (e.g. ropes and signs), 5) monitor a sample of broods to determine brood fate and plover productivity, and 6) use cameras and observational data to document predator activity at nests.

We estimated the resident number of Snowy Plovers in Oregon at 502 individuals, a slight increase from the 2018 season. We monitored 552 nests in 2019. Overall apparent nest success was 41%. Nest failures were attributed to unknown depredation, corvid depredation, mammalian depredation, unknown cause, abandonment, wind/weather, one egg nests, unknown avian depredation, harrier depredation, overwashing, and infertility. We monitored 194 of 229 known broods, and documented a minimum of 344 fledglings. Overall brood success was 81%, fledging success was 54%, and based on the overall number of resident males, 1.32 chicks fledged per resident male.

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Introduction

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

Oregon Biodiversity Information Center (ORBIC, formerly Oregon Natural Heritage Information Center) completed our 30th year of monitoring the distribution, abundance, and productivity of Snowy Plovers during the breeding season from Sutton Beach in Lane County to Floras Lake in Curry County on the Oregon coast. We define the project area as coastal habitat between Sutton Beach and Floras Lake. In recent years, Snowy Plovers have extended to sites outside this project area; we did not monitor these new sites due to workload limitations. In cooperation with Federal and state agencies, plover management has focused on habitat restoration and maintenance at breeding sites, non-lethal and lethal predator management, and management of human related disturbances to nesting plovers. The goal of management is maintaining recent improvements in annual productivity, leading to a sustainable Oregon breeding population at or above 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, 2006a, 2006b, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018). Our objectives for the project area in 2019 were to: 1) estimate the size of the adult Snowy Plover population, 2) locate plover nests, 3) determine nest success, 4) implement nest protection as appropriate (e.g. ropes and signs), 5) monitor a sample of broods to determine brood fate and plover productivity, and 6) use cameras and observational data to document predator activity at nests.

Study Area

Snowy Plover populations have increased in Oregon, and as a result plover have begun to winter and nest at locations outside of areas traditionally monitored by ORBIC (USFWS, ORPD, and ORBIC unpublished data). Here we report on activities at sites intensively monitored by ORBIC in 2019: from north to south, Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, the South Umpqua beach to Tenmile Creek, Coos Bay North Spit (CBNS), Bandon Snowy Plover Management Area (SPMA), New River (extending from private land south of Bandon SPMA to the south end of the New River Area of Critical Environmental Concern (ACEC) habitat restoration area), and Floras Lake (Figure 1). We also monitored some nests found at locations within the project area but outside of traditional nesting areas. These sites include the beach south of South Tahkenitch to the North Umpqua jetty (North Umpqua), Cut Creek at Bullard's Beach State Park, and Johnson Creek along Bandon Beach. At these breeding sites, we surveyed and monitored Snowy Plover activity along 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. A description of each site occurs in Appendix A. For the purposes of this report and for consistency with previous years' data, we define Bandon Beach as the area from China Creek to the mouth of New River, and Bandon SPMA as all the state land from the north end of the China Creek parking lot south to the south boundary of the State Natural Area, south of the mouth of New River. Information on wintering and nesting at areas outside these sites is available from Oregon Department of Parks and Recreation (OPRD) and U.S. Fish and Wildlife Service (USFWS).

Methods

Window Surveys

Annual breeding season window surveys were coordinated by USFWS in late-May. Breeding season window surveys were conducted at both currently active and historic nesting areas (Elliott-Smith and Haig 2007). Historic nesting areas searched during the breeding window survey included: Clatsop Spit, Gearhart Beach, Necanicum Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sitka Sedge State Natural Area (SNA), Nestucca Spit, Salmon River spit, Agate Beach, Yaquina Bay North Jetty, South Beach State Park, Bayshore Spit, Patterson State Park, and Elk River. There were no surveys or incomplete surveys at Salishan Spit, Whiskey Run to Coquille River, Sixes River, Euchre Creek, Myers Creek to Pistol River and Crissy Field.

Monitoring

Breeding season fieldwork was conducted from 3 April to 24 September 2019. Survey techniques, data collection methodology, and information regarding locating and documenting nests can be found in Castelein *et al.* 2000a, 2000b, 2001, 2002, and Lauten *et al.* 2003 and are in Appendix B. Some beach surveys, particularly to document brood success and to confirm fledglings, were conducted from a 4x4 truck using a window mounted scope. No other modifications to survey techniques were implemented in 2019.

We report three separate measures of adult population size: resident birds, the minimum number of birds present, and the breeding window survey. Resident plovers are defined here as any adult plover detected during the peak breeding period (between 15 April and 15 July). Plovers present during this period had the potential to attempt to nest. Not all plovers recorded during the summer are Oregon breeding plovers; some are only recorded early or late in the breeding season, suggesting that they are either migrant or wintering birds. These plovers are not included in the tally of resident plovers. The minimum number of Snowy Plovers present includes all adult birds observed within the project area during the field season (3 April through 24 September), and includes breeding birds, birds migrating through the area during that time, and wintering birds that may be present in the project area early or late in the season.

Most adults are banded and thus uniquely identifiable, but unbanded birds are difficult to accurately count because they move within and between sites. To avoid over counting unbanded birds, we recorded the number of unbanded plovers observed at each site within 10-day intervals from April through late July. We selected this period because it encompasses the period of maximum nesting effort and minimum movement between sites. For each 10-day interval we subtracted the number of adults that were subsequently banded during the breeding season and selected the 10-day interval with the highest remaining count. This number was added to our count of banded adults present, resulting in the minimum number of adults present. We also added this number of unbanded birds to our count of banded resident adults for a total estimate of resident birds. Based on nesting records and daily observation data, this method underestimates the actual number of unbanded plovers present, but it provides a minimum number of unbanded plovers present (Castelein *et al.* 2001). We believe the number of resident plovers is the most accurate estimate of the total breeding population because it only includes birds present during the peak breeding period.

We tallied the number of individual banded and unbanded plovers by sex recorded at each nesting area within the project area throughout the 2019 breeding season. Data from Siltcoos, Overlook, and Tenmile were combined because individual plovers use both sides of these estuaries. In past years we have combined data from North and South Tahkenitch because plovers will use both sides of this estuary also. However, in 2019 we split South Tahkenitch and North Umpqua from North Tahkenitch to show the increasing numbers of plovers using this section of beach. Data from CBNS nesting sites were aggregated for the same reason. We separated data from Bandon SPMA, New River private lands, New River HRA, and Floras Lake because of different management at these sites, despite plovers frequently moving between these areas. The total number of individual plovers recorded

at each site indicates the overall use of the site, including where plovers congregate during post-breeding and wintering. We also report the number of resident female and male plovers for each site, which indicates the relative level of nesting activity for each site. Because some birds used multiple sites within a season, a tally of the birds at each site does not reflect the total population size.

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

Prior to 2016 we attempted to monitor all nests and broods. As the plover population has grown within the project area, the increase in numbers of nests and broods have made it difficult to monitor all broods with existing staff and available funding. In 2016, in conjunction with Point Blue Conservation Science (Lynne Stenzel, pers. comm.), we developed a strategy to monitor a spatially and temporally distributed sample of broods (Lauten *et al.* 2016). Under this sampling design we attempted to band the first five nests to hatch at each site in within fixed 10-day periods. This sampling scheme is detailed in Appendix C, and results in approximately 80% of all broods being monitored. In 2018 and 2019, many nests hatched synchronously. Under the sample design, banding only the first five broods to hatch would have resulted in far fewer than 80% of all broods being included in the sample. Thus, as in 2018 (Lauten *et al*., 2018), at some sites we banded more than five broods at each site within a given 10 day period to ensure at least 80% of broods were banded.

All known nests were monitored to determine fate and cause of failure. To track sampled broods, we banded chicks with a USGS aluminum band covered in color taped on the left leg and a colored plastic band on the right leg. Most nesting adults that tended broods were already color banded. For some unbanded adults, we attempted to trap and mark the tending parent with a combination of a USFWS aluminum band covered with colored taped and colored plastic bands. Trapping techniques are described in Lauten *et al.* 2005 and 2006 (Appendix B). We monitored broods and recorded brood activity or adults exhibiting broody behavior at each site approximately weekly (Page *et al.* 2009). Chicks were considered fledged when they were observed at least 28 days after hatching. Using the sample of banded chicks, we calculated brood success, the number of broods that successfully fledged at least one chick; fledging success, the number of chicks that fledged divided by the number of eggs that hatched from the sample; and the number of fledglings per sampled brood for each site. Using the estimate of the number of fledglings per sampled brood and the total number of known hatched nests, we calculated an estimated number of fledglings produced for each site. We used the number of estimated fledglings per site and the number of resident males to calculate the estimated number of fledglings per resident male for each site and the project area. See Appendix C for further details regarding calculation of the number of fledglings per male. We also calculated a breeding coefficient for all known nests (Colwell *et al.* 2017) that measures the level of productivity based on the number fledglings produced per egg laid; high numbers of eggs laid indicate high effort at a particular site. If the numbers of fledglings produced is large compared to the number of eggs laid, the high breeding coefficient indicates that site was very productive. Alternatively, few fledglings relative to a high number of eggs laid results in a low breeding coefficient.

We compared plover productivity in 2019 to average post-predator management hatch rate, fledge rate and fledglings per male for each nesting area. We also compared the average pre-predator management hatch rate, fledge rate, and fledglings per male to the post-predator management averages to continue to evaluate the success of the current predator management actions. Means are reported +/- standard deviation.

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

Nest Failure

Exclosures have rarely been used in recent years (Lauten *et al.* 2012, 2013, 2014, 2015, 2016, 2017, and 2018) because of the potential for adult mortality at exclosed nests (Lauten *et al.* 2010, 2011, 2012, and 2013), improved unexclosed nest success, increased numbers of nests at all sites, and an adult population that is over recovery goals. In addition, recent modeling of plover data shows that widespread exclosure use is associated with lower adult survival, the vital rate that contributes most to population growth (Gaines 2019). No exclosures were used in 2019.

We monitored all nests we found until they were determined hatched or failed. Failed nests were carefully inspected for signs of cause of failure. Where evidence was present, we categorized failures as either depredations or non-depredated causes. If a failed nest was determined to be caused by predation, we attempted to determine the predator based on the evidence present. Failures caused by predators were generally categorized as corvid, harrier, unknown avian, mammalian, or unknown depredation. Failures not caused by predators were categorized as wind/weather, overwashed, human caused, abandoned, one egg nests (never completed clutch), infertile, or unknown cause.

We used Reconyx PC900 cameras (Reconyx Inc., Holmen, WI) and Bushnell Aggressor Trophy Cam HD (Bushnell Outdoor Products, Overland Park, KS) to observe predator activity at plover nests and identify causes of nest failure. Cameras were placed two to four meters from the nest, depending on local conditions (terrain, vegetation height). In general, we placed cameras as far from the nest as possible while keeping the nest visible in the camera's field of view. Cameras were camouflaged with a sand or brown-colored outer case or typical green hunter camouflage painting, and were installed as low to the ground as possible to avoid providing a perch for predators. Cameras were used at Siltcoos, Overlook, Tahkenitch, Tenmile and Coos Bay North Spit in 2019. We placed cameras at nests that were well beyond the view of the public to reduce the potential for camera theft, and to avoid creating an attractive nuisance.

Cameras employed a "no glow" infrared illumination system which eliminates glow or flash from the camera that can alert predators to its presence. Images taken during the day are in color; those at night are monochrome. Depending on the suite of suspected predators at a site, some cameras were set to operate 24 hours per day, taking one image every 60 seconds, and a burst of three to four images every second when the motion sensor was triggered. Other cameras were set up to take one image per minute from just prior to dawn to just after dusk, and set to only motion sensor trigger at night. Bushnell cameras took only motion sensor triggered pictures. Predator activity at the nest triggered the motion sensor, but plovers were generally too small to trigger the cameras.

We placed cameras at active nests that were already being incubated (Snowy Plovers generally do not incubate until the clutch is complete). After cameras were installed, we ensured that plovers returned to the nest. Batteries and data cards were replaced approximately weekly. Cameras were typically left in place until the fate of the nest was determined. Upon visiting failed nests, we recorded the cause of failure based on evidence at the site, before looking at camera data. We compare cause of failure based on evidence at the nest site with the cause of failure as recorded by the cameras.

Lethal predator management was conducted at all active nesting areas by USDA Wildlife Services (Metzler et *al.* 2019). ORBIC monitors reported causes of nest failure and daily predator observations to Wildlife Services (WS) staff.

Results and Discussion

Window Surveys and Monitoring

During the May breeding window surveys, 356 plovers were observed in the project area, an increase from 2018 and the second highest window survey count since monitoring began in 1990. Plovers were also detected during the window survey at locations north and south of the project area including the Clatsop Spit, Sitka Sedge State Natural Area, South Beach State Park, Bayshore Spit, Patterson State Park, and Elk River (USFWS pers. comm.). In addition, but outside of the window survey, plovers were documented attempting or successfully nesting at Clatsop Spit in Clatsop Co., Nehalem Spit in Tillamook Co., Sitka Sedge SNA, South Beach State Park, and Sandpiper Village and Driftwood State Park in Lincoln Co. (OPRD unpublished data, USFWS pers. com.). For the second consecutive year, all coastal counties in Oregon had documented nesting attempts in 2019. The annual breeding window survey count for the project area and total number of plovers present are in Table 1.

There was a slight increase in the minimum number of plovers present in the project area in 2019 compared to 2018, resulting in the second highest total since monitoring began in 1990 (Table 1). Of the minimum number of plovers present during the 2019 breeding season, 450 (87%) were banded. The number of unbanded plovers estimated by the 10-day interval method was 67. During the breeding season we observed 221 banded males, 227 banded females, two banded adults with undetermined sex, 42 unbanded males, and 25 unbanded females.

Of the minimum number of plovers present in 2019, 353 plovers (68%) were documented nesting, lower than the mean percentage for 1993-2018 (78%). A minimum of 156 banded males and 130 banded females nested, and a minimum of 67 unbanded adults (42 unbanded males and 25 unbanded females) nested. In 2019, 64% of banded adults were confirmed nesting. There were a total of 219 banded resident males and 216 banded resident females present during the 2019 breeding season (15 April – 15 July). Using the minimum number of unbanded individuals estimated by the 10-day interval method, the minimum estimated Oregon resident plover population was 502. We believe this is the best estimate of the breeding population within the project area.

The overall plover population within the project area was more than double the recovery goal set for the state (U.S. Fish and Wildlife Service 2007), and does not include birds that were present in Oregon outside the project area.

Overwinter Return Rate

Adult survival continues to be the most important parameter of population growth (Sandercock 2003, USFWS 2007, Dinsmore *et al.* 2010, Lauten *et al.* 2010, 2011, 2012, and 2013, Gaines 2019). Of the 437 banded adult plovers recorded in 2018, a minimum of 318 were recorded in 2019 in the project area. The overwinter return rate based on the minimum number of returning banded adult plovers was 73%, higher than the 1994-2019 mean of 67% and similar to 2018 (71%). The adult male return rate was 72% and the adult female return rate was 75%, similar to or higher than in 2018 (74% for males, and 69%, respectively; Lauten *et al.* 2018).

Of 270 banded fledglings produced in 2018 (Table 2), we observed 109 in the project area in 2019. The return rate was well below the 2010-2019 average (Table 2). Survival of hatch year 2018 fledglings was higher than reported return rates because first year plovers that occupied other Oregon (ORBIC, OPRD, USFWS unpubl. data), Washington (USFWS, unpubl. data), and northern California (Elizabeth Fuecht, pers. comm.), beaches in 2019, but did not return to our project area, were not included in the calculated return rate. These additional hatch years plovers are important contributors to expanding plover populations at historic and new nesting locations in

Oregon. While hatch year return rates were below average, high adult survival rates resulted in a slightly higher plover population within the project area in 2019.

Of the returning HY18 birds, 55 (50%) were males, 52 (48%) were females, and two (2%) were unknown sex. Sixty-five of the HY18 returning plovers were confirmed breeding (60%), similar to 2018 (58%).

During the 2019 season, we captured and rebanded six male and seven female adult plovers with brood band combinations that needed to be updated to unique adult combinations. We banded one unbanded adult female plover and 488 chicks.

Distribution

To show relative plover activity within our study area, we recorded total banded and unbanded adults and the number of resident plovers at each site (Table 3). The areas with the lowest plover activity are at the north and south end of the project area, and the South Tahkenitch/North Umpqua area, which plovers have just recently started to occupy. Sutton Beach had no increase in plover use from 2018 (Lauten *et al*., 2018). Plover activity was concentrated in the Sutton Creek area north to the HRA and on the Berry Creek spit. Plover activity at Siltcoos in 2019 was similar to 2018 (n = 63, Lauten *et al*., 2018). Plover activity increased from Overlook,to Tahkenitch. Overlook had 31 more plovers detected in 2019 compared to 2018, and the increase in plover activity was evident in the number of plovers using Tahkenitch (Table 3, see Lauten *et al*., 2018) and the distribution of plovers to South Tahkenitch and North Umpqua area. This was the first season we documented successful nesting north of the North Umpqua jetty. There was a decrease in the number of plovers detected at Tenmile in 2019 compared to 2018 (n = 112, Lauten *et al*., 2018). The changes in numbers of plovers on the Dunes NRA reflects natural movement of plovers attempting to find adequate habitat to nest or renest, and while there was a slight overall increase in plover numbers in 2019 (Table 1), the total number of plovers using the Dunes NRA was similar to 2018 (Lauten *et al*., 2018). CBNS had nearly identical number of plovers in 2019 compared to 2018 (n = 136, Lauten *et al.* 2018). The Bandon SPMA had an increase in plover activity compared to 2018 (n = 93, Lauten *et al*., 2018). Plover number on New River private land were relatively stable (Lauten *et al*., 2018). Plover activity on New River private lands was concentrated in the Bandon Biota area just south of the Bandon SPMA. The New River HRA had the same number of plovers in 2019 compared to 2018 (Lauten *et al*., 2018). Most plover activity on the New River HRA was concentrated from the Hammond breach area south to Clay Island Breach and the beach south of the breach. There was some plover activity on the north side of the New River HRA (Croft Lake breach to the north end) early in the season, but after early season nest attempts failed, plovers did not use this area. In 2019 Floras Lake had an increase in plover activity with ten more plovers detected compared to 2018 (Lauten *et al*., 2018). Plovers used the beach from just south of plover management area, north along the beach including the Cooperative Management Area (CMA), to Hansen breach. The highest concentration of nesting activity, based on the presence of resident plovers, continues to be between Siltcoos and Bandon SPMA. Because plovers moved between sites and attempted to nest at more than one location, the total number of plovers in Table 3 is higher than the actual population estimate.

We documented plovers occupying available habitat adjacent to the traditional nesting areas in past reports (Lauten *et al.* 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018). In 2019, plovers continued to nest at north coast sites outside the project area. For the second consecutive year, plovers were found in every coastal county and were documented nesting at Clatsop Spit in Clatsop Co., Nehalem Bay State Park and Sitka Sedge State Natural Area in Tillamook Co., South Beach State Park, Sandpiper Village, and Driftwood State Park in Lincoln Co. (OPRD, unpublished data). Within the project area, plovers have now nested north of Berry Creek at Sutton Beach (Figure 2) for three consecutive years (Lauten *et al.* 2017 and 2018). Plovers also nested on the Sutton Creek spit in 2019 (Figure 2), and one brood was found on the south side of Sutton Creek. Plovers continue to occupy all the beach between South Siltcoos and North Overlook and south of South Overlook to North Tahkenitch (Figures 3 - 5). Nesting activity increased at South Tahkenitch in 2019 (Figures 5), and broods were found active north of the North Umpqua jetty late in the season. Plovers continue to use the entire beach from South Umpqua to the North Tenmile spit (Figure 6). Three nests and one brood were found north of the FAA towers at CBNS in 2019

(Figures 8 and 9). Early in the season several plovers and one nest were found at Cut Creek, Bullard's Beach State Park, north of the Coquille River, for the first documented nesting attempt at this location (Figure 10). One nest was also found at Johnson Creek, along Bandon Beach north of China Creek; this was the first known nesting attempt at this location (Figure 11). At Bandon SPMA in 2019, eight nests were found north of China Creek and one nest was found on the China Creek spit north of the defined SPMA boundaries (Figures 11 and 12). There was an increase in plover activity in this area partly due to degraded habitat south of China Creek. Plovers continue to occupy private lands south of the Bandon SPMA to the New River HRA (Figures 13 and 14). The north end of the New River HRA had two nesting attempts in 2019 (Figure 13). All nesting attempts on the south end of the New River HRA were from south of New Lake breach to south of Clay Island breach, with the majority of activity between Hammond Breach and Clay Island Breach (Figure 14). There were nine nest attempts at Floras Lake; four along the foredune south of the CMA (Figure 15). Plovers continue to fill available habitat within the project area, and appear to have successfully reoccupied historical sites along the northern coast.

Nest Activity

Table 4 shows the number of nests and broods located during the 2019 nesting season (Figures 2-15). We found 62 more nests than in 2018. The largest increase in nest numbers occurred at Bandon SPMA where we found nearly 40 more nests in 2019 compared to 2018. Most other sites had similar numbers of nests in 2019 compared to 2018 (Lauten *et al*., 2018). Fluctuations in nest numbers between sites was the result of normal variations in nest failures between years and sites. Overall nest success in 2019 was slightly below the overall average (Table 5 and 6) but the same as the last 10 year average ($\bar{x}$ = 41%).

The first nests were initiated about 4 April (Figure 16). Nest initiation increased through mid-June. Peak nesting occurred during the 10 June to 19 June time interval, one time period later than last three years (Lauten *et al.* 2016, 2017, and 2018). The last nest initiation occurred on 22 July.

Nest Failure

Predators were responsible for 71% of nest failures (Table 7) compared to 60% of failures in 2018 (Lauten *et al.* 2018). Corvids were responsible for 17% of the known depredations, and ravens were responsible for 25 of the 38 corvid depredations. Northern Harrier (*Circus hudsonius*) was identified as the predator at nine nests, however harriers were likely responsible for more depredations but could not be positively identified due to lack of positive evidence at the nest site. At Bandon SPMA a harrier was identified as the cause of nest failures after many nests had failed to unknown depredation. After the harrier was removed from this site, nest success increased, suggesting the harrier was the likely cause of many of the depredations. At Siltcoos, Tahkenitch, and Tenmile, the presence of both corvids and harriers made determination of some nest failures difficult. While the evidence indicated an avian predator, there was a lack of unequivocal evidence to indicate what species. Harriers may have been responsible for some of these depredations. There was an increase in the number of mammal depredations in 2019 compared to the previous two years (n = 20 in 2018 and n ==17 in 2017, Lauten *et al*., 2017 and 2018). Coyote depredations have been increasing on the Dunes NRA over the past several years (Lauten *et al*., 2017 and 2018). In 2019, coyotes were documented depredating 30 nests on the Dunes NRA, nearly three times more than in 2018 and the highest number of coyote depredations since monitoring began in 1990. Coyotes were responsible for the most known depredations, the first time since monitoring began that an avian predator was not the most documented nest predator. However, corvids were likely responsible for a large percentage of the unknown depredations and are likely still the main cause of nest depredations. While red fox (*Vulpes vulpes*) were present along the New River HRA and Floras Lake area, we did not document any nest depredations by fox in 2019. Red fox were unusually scarce at Bandon SPMA in 2019. There were very few other mammalian depredations in 2019 (Table 7).

We have repeatedly documented Northern Harriers as a nest predator of plovers (Lauten *et al*., 2013, 2014, 2015, 2016, 2017, and 2018). In 2019 we again documented harriers depredating nests (Table 7). For the first time

since monitoring began, in 2019 a harrier was documented depredating nests at Bandon SPMA and was subsequently removed. Data from CBNS shows that after removal of nest-depredating harriers, nest success increases in the following years (Figure 17). At CBNS in 2019, a harrier nest was found within 100 meters of the north end of the 98WHRA. We did not document any nest depredations from harriers at CBNS in 2019, but we did note that the harriers were hunting over the nesting area while plover broods were active and we were concerned that harriers were also impacting plover brood success. After the harrier nest successfully fledged, WS and BLM staff found a hatch year plover band in a harrier pellet at the nest site, confirming that harriers are depredating plover chicks (WS and BLM, pers. comm.). Productivity data from CBNS in 2019 (Table 8) shows that broods on the HRAs had much lower brood success, fledging success, fledglings per brood, and breeding coefficients than broods from South Beach. Broods from South Spoil were also more successful than the HRA, but the breeding coefficient was poor. Figures 18-20 shows fledging success, brood success, and fledglings per broods data from the HRAs, South Spoil, and South Beach at CBNS. The data indicate that when harriers are present, productivity is suppressed, but after removal, productivity tends to increase. This was particularly true on the HRAs and South Spoil. South Beach appears to be less impacted by harriers and their removal, likely because harriers spend less time hunting over the beach compared to east of the foredune. The data suggests that removal of harriers from nesting areas results not only in improvement of nest success, but likely has a positive effect on plover productivity.

Corvids have traditionally been the most commonly identified nest predator on the study area (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, 2006a, 2006b, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2018). While corvids were not identified as the main cause of nest depredations in 2019, they are still the dominant predator when present. More Common Ravens (*Corvus corax*) were removed at CBNS in 2019 than in many of the previous years (Metzler *et al.* 2019, Table 7). American Crows (*Corvus brachyrhyncos*) were documented depredating nests at CBNS for the second consecutive year (Lauten *et al*., 2018). Ravens continue to be persistent predators at Sutton Beach and the Dunes NRA, and when present likely out-compete harriers as they tend to be more efficient nest predators. Although we did not document corvids depredating nests at Tenmile, their presence suggests that they were likely responsible for some of the unknown depredations. Due to harrier presence and evidence of harrier depredations, many nest failures could not be definitively categorized. Raven activity at Bandon SPMA was fairly low in 2019. While there were a high number of unknown depredations, depredations substantially declined after the removal of the harrier suggesting the harrier was likely responsible for many nest depredations. The New River HRA continues to have both raven and fox activity due to its proximity to the adjacent sheep ranches.

There has been a steady increase in coyote depredations over the last several years on the Dunes NRA. Coyotes appear to be responding to increased density of nesting plovers, or may be attracted to the smell of spilled yolk at nests depredated by other predators, resulting in increased presence on the nesting areas. We suspect that the coyotes will continue to be problematic in the future.

We continued to use cameras to document nest predators (Lauten *et al.* 2015). We placed Reconyx and Bushnel cameras at 18 nests in 2019. At two nests cameras either failed to record the outcome of the nest due flash card related issues or because the camera shifted position away from the nest. Seven nests with cameras failed and the cameras clearly identified the cause of failure. At four of these failed nests, monitors' assessment of the cause of failure matched what was shown on the camera. At two other failed nests, monitors were unable to identify the predator responsible for nest failure based on evidence left at the nest, but we were able to accurately identify the cause of failure based on camera data. At one nest the monitors determined harrier was the cause, but the camera failed to confirm exactly what avian predator depredated the nest. Nine of the nests with cameras hatched. Use of cameras did not negatively affect nest success. Apparent success at nests with cameras was 50%, higher than the overall nest success (Table 5). Unlike 2018 (Lauten *et al*., 2018), there was no evidence that cameras attracted ravens or any other predator; in fact cameras did not document any corvid depredations. We intend to continue to use cameras where they are feasible, as time is available, and where better documentation of the cause of nest failure is needed, as long as there is no evidence predators are targeting cameras.

The number of nests that failed to unknown depredations increased substantially in 2019 compared to the previous two years (n = 45 in 2018 and n = 49 in 2017). This increase in unknown depredations largely occurred at Dunes NRA and Bandon SPMA. On the Dunes NRA, the complex of predators, including corvids, harriers, and coyotes made determination of the cause of nest failures difficult, particularly at Overlook, Tahkenitch and Tenmile. At Bandon SPMA, evidence at many of the depredated nests was lacking until clear evidence of harrier was finally documented. Once the harrier was removed, depredations ceased suggesting that the harrier was the main cause of nest failure at this site. When present, corvids continue to be the dominant predator.

We continue to minimize the use of exclosures because of time limits, effective lethal predator management, a plover population well above recovery goals, and successful productivity. Exclosure use was not necessary in 2019, as overall nest success at all sites was reasonably good (Table 5).

Productivity

We sampled 191 broods from the 229 nests that were known to have hatched and an additional three broods from undiscovered nests (84%), and these broods produced 274 fledglings (Table 8). We estimated an additional 70 fledglings that were not part of the sample (Table 9). Across all sites, the minimum number of fledglings recorded for all broods was 344 (Table 9). The overall fledging success based on the sample broods (Table 8) was higher than the post-predator management average (Table 10). The overall brood success rate of sampled broods (Table 8) was well above the 1991 – 2019 average (68% +/- 10). We calculated the number of fledglings per male for each site using the number of resident males from Table 3 (Table 11). The mean number of fledglings per resident male for the project area was at recovery goals and higher than the previous three years, but below the mean post-predator management average (Table 10). We report these mean fledglings per male for all sites for comparison with previous years, but because the number of resident males reported by site double counts birds that occur at multiple sites and may include males that were present but did not attempt to nest, the resulting overall mean number of chicks fledged per resident male is biased low. In 2019 the minimum number of fledglings counted was 344 (Table 9), and the total number of resident males was a minimum of 261. The number of fledglings per resident male based on these numbers was 1.32. This number is higher than our reported mean number of fledglings per resident male (Table 11) and similar to the number of fledglings per sampled brood (Table 8). We believe the most accurate estimate of productivity is the number of fledglings produced per sample brood, 1.41 (Table 8).

We used the breeding coefficient, the number of fledglings produced per number of eggs laid, as an alternate assessment of the overall productivity of each nesting site (Table 8, Lauten *et al.* 2017, Colwell *et al.* 2017). The breeding coefficient is a measure of productivity based on effort (eggs laid). Any site with a breeding coefficient of 0.20 and above was relatively successful for the amount of effort, while sites with a breeding coefficient below 0.15 are generally not very productive for the amount of effort.

Sutton

The number of nests at Sutton Beach (Table 4) declined compared to the previous two years. Nest success declined in 2019 with just three of 15 nests hatching (Table 5, Lauten *et al.* 2018). Two of three broods were used in the sample (Table 8) and both successfully fledged one chick. Due to the discovery of three broods from unknown nests, the number of total fledglings for this site was the same as 2018 and the highest number of fledglings ever produced at this site (Table 9). The hatch rate was much lower than in 2018 (Lauten *et al.*, 2018) and just above the post predator management average (Figure 21). Fledging success was higher than in 2018 (Lauten *et al.*, 2018) and well above the post predator management average (Figure 22). The number of fledglings per resident male was lower than 2018 (Lauten *et al.* 2018) but above average (Figure 23). While the reproductive parameters at Sutton Beach continue to be the lowest within the project area (Figures –21 to 23, Table 11), the eight fledglings produced from this site for the second consecutive year is an improvement. However, the breeding coefficient for Sutton Beach was very low, (Table 8) indicating poor reproductive output for the effort.

Siltcoos

There were similar numbers of nests at Siltcoos in 2019 compared to 2018 (Table 4). Nest success was very poor on the north side with only one nest hatching (Table 5). The south side had higher nest success but was still well below the previous year (Table 5, Lauten *et al*., 2018). Nest success was well below average for both sites in 2019 (Table 5, for North Siltcoos $\bar{x}$ = 37%, for South Siltcoos, $\bar{x}$ = 46%).

The hatch rate at Siltcoos in 2019 was well below the post-predator management average (Figure 21). There were eight fewer broods at Siltcoos in 2019 compared to 2018 (Lauten *et al.* 2018), the second consecutive year with fewer broods. There were 13 fewer fledglings produced at Siltcoos compared to 2018 (Table 9). There were no fledglings produced at North Siltcoos for the only the second year since 2003. The number of fledglings from South Siltcoos has been generally declining since a high in 2015 (Table 9). Fledging success was just below the post-predator management average (Figure 22) and the number of fledglings per resident male was very low and well below the post-predator management average (Figure 23, Table 11). The number of fledglings per resident male was also low because of the high number of males that are recorded at Siltcoos during the breeding season. While all these males are considered resident, it is likely that not all of them attempted to nest, but their presence results in a low fledgling per male calculation. The number of fledglings per sampled brood (Table 8) is likely more reflective of plover productivity at this site. No fledglings were produced on the north side, and the breeding coefficient reflects the poor productivity (Table 8). The breeding coefficient at South Siltcoos was not particularly good nor was it very poor, indicating that plovers were not overly productive at Siltcoos in 2019 (Table 8).

Overlook

There was an increase in the number of nests at Overlook in 2019, compared to 2018 (Table 4), however only the north side had a substantial increase in number of nests. Nest success was considerably higher on both sides in 2019 (Table 5) compared to 2018 (47%, Lauten *et al*., 2018) with 20 more nests hatching in 2019 compared to 2018. Both North and South Overlook had well above average nest success in 2019 (Table 5, $\bar{x}$ = 45% and , $\bar{x}$ = 41%, respectively).

The hatch rate and the fledging success rate at Overlook in 2019 were well above the post-predator management average (Figures 21 and 22). The number of fledglings per resident male was also above the post-predator management averages (Figure 23, Table 11). Due to the high hatch rate, fledging rate, and fledgling per male, both sites produced the highest number of fledglings since monitoring began in 1990, well above the previous year's total (Table 9). A total of 85 fledglings were produced from Overlook in 2019. The high productivity is reflected in the breeding coefficients which are well above 0.20 (Table 8). Both sides had much higher breeding coefficients than the previous two years (Lauten *et al*., 2017 and 2018), indicating that overall productivity at Overlook in 2019 was excellent, and plovers produced many fledglings for the effort at these sites.

Tahkenitch

There was a similar number of nests at North Tahkenitch in 2019 compared to 2018 (Table 4), but there was an increase in nests at South Tahkenitch resulting in the highest number of nests found at this site since 1997. In addition, two broods from unknown nests were found north of the north jetty of the Umpqua river, further expanding the area plovers are using for nesting. Nest success improved in 2019 (Table 5) compared to 2018 (Lauten *et al.* 2018), with nests at South Tahkenitch being particularly successful. Nest success was well above average ($\bar{x}$ = 41% for North Tahkenitch and $\bar{x}$ = 54% for South Tahkenitch).

The hatch and fledging success rates at Tahkenitch in 2019 were well above the post-predator management average (Figure 21 and 22). The number of fledglings per resident male was well above average (Figure 23) and much higher than in 2018 (Lauten *et al*., 2018). Due to the above average hatch rate, fledging rate, and fledglings per resident male, the overall number of fledglings produced from these two sites was nearly twice as large as 2018 (Table 9). Both North and South Tahkenitch had high breeding coefficients indicating excellent productivity for the effort and the number of plovers present (Table 8).

The population of plovers utilizing Siltcoos to South Tahkenitch is dynamic, with plovers moving between sites throughout the breeding season, frequently responding to predation pressure and nest failure. In 2019, the productivity at Overlook and Tahkenitch, and to a lesser extent South Siltcoos, was excellent, resulting in an impressive 145 fledglings from these sites (Table 9).

Tenmile

There were 21 fewer nests found at Tenmile in 2019 compared to 2018 (Table 4). There were 28 fewer plovers detected at Tenmile in 2019 compared to 2018 (Table 3), indicating that the decline in nests may be related to fewer plovers at this site. Nest success was slightly lower than in 2018 (Table 5, Lauten *et al*., 2018), also suggesting that the decline in nest numbers was not due to higher nest success and thus fewer nest attempts. Nest success at North Tenmile was below average (Table 5, $\bar{x}$ = 44%), and at South Tenmile was well below average (Table 5, $\bar{x}$ = 50%). Due to fewer nests and lower nest success, 13 fewer nests hatched at Tenmile in 2019 (Table 5, Lauten *et al*., 2018).

The hatch rate at Tenmile was also slightly below the post-predator management average (Figure 21), but the fledging success rate was above average (Figure 22). The number of fledglings per resident male was near average and well above recovery goals (Table 11, Figure 23). Due to fewer broods there was a decline in the number of fledglings produced in 2019 (Table 9). While the fledging rate and fledglings per male were reasonably good at Tenmile, the breeding coefficient for South Tenmile in 2019 was poor (Table 8). The breeding coefficient at North Tenmile was higher than the south side, but was still below 0.20 (Table 8). These results indicate that the plovers had high effort at Tenmile in 2019 but did not have high success. The total number of fledglings produced on the Dunes NRA was 186 (Table 9).

Coos Bay North Spit

There was slight increase in the number of nests at CBNS in 2019 (Table 4). The number of plovers recorded at CBNS was nearly identical to 2018 (Table 3, Lauten *et al*., 2018), so the increase in nests was due to lower nest success on the nesting areas early in the season (Table 5). Corvids were responsible for the decrease in nest success, and after removal, nest success increased. After plovers moved to South Beach later in the season, nest success was excellent (Table 5), higher than average ($\bar{x}$= 60%), and the highest of any site in 2019. Nest success at South Spoil and the HRAs was well below average for each site (Table 5, $\bar{x}$ = 61% and $\bar{x}$ = 50%, respectively). Despite higher numbers of nests in 2019 (Table 4), 25 fewer nests hatched in 2019 compared to 2018 (Table 5, Lauten *et al*., 2018).

The hatch rate at CBNS in 2019 was well below the post-predator management average (Figure 21). Fledging success was below average for this site (Figure 22), but still well above 40%. The number of fledglings per resident male was well below average for CBNS (Figure 23). While South Beach had excellent nest success, brood success, fledging success, fledglings per brood, and breeding coefficient, South Spoil, and particularly the HRAs, had poor reproductive parameters for these sites (Table 8). We noted in 2017 observations and data suggesting that the harriers may have been depredating broods as well as nests (Lauten *et al.* 2017). As noted above in the predator section, 2019 data from CBNS indicate that nests and broods are negatively impacted by local nesting harriers (Figures 17 - 20). Due to the high number of plovers and nests, and the poor fledging success particularly on the HRAs, the breeding coefficients for South Spoil and the HRAs was very low (Table 5), and this contributed in a decline of 31 fledglings from CBNS in 2019 compared to 2018 (Table 9). Due to the limited number of predators at CBNS in most years, it is apparent that when harriers are being detected hunting in and around the nesting area, they are very likely having a negative effect on plover productivity.

Bandon SPMA

A combination of higher plover numbers (Table 3, Lauten *et al*., 2018) and lower nest success (Table 5, Lauten *et al*., 2018) resulted in 42 more nest attempts at Bandon SPMA in 2019 compared to 2018 (Table 4). Overall nest success was well below average (Table 5, $\bar{x}$ = 41%). Nest success at Bandon Beach was 24%, much

lower than 2018 (44%, Lauten *et al*., 2018), and nest success on the New River spit was 31%, similar to the previous year (30%, Lauten *et al*., 2018). Low nest success was partly due to a harrier; nest success improved after the harrier was removed.

The hatch rate at Bandon SPMA was below the post-predator management average (Figure 21). Despite the lower nest success and hatch rate, the fledging success rate well above average (Figure 22). Fledging success at Bandon Beach was 59%, and the fledging success rate on the New River spit was 53%. Due to the high fledging success, Bandon SPMA produced the highest number of fledglings since monitoring began in 1990 (Table 9). The number of fledglings per resident male was above average (Figure 23) and at recovery goals. Due to the high number of nests at the SPMA and the low nest success, the breeding coefficient at Bandon SPMA was low (Table 8). Plovers had a reasonable productive season at Bandon SPMA, however the breeding coefficient indicates that there was great effort for the results.

New River

At New River in 2019, plovers occupied private lands along New River just south of the SPMA, and two nests were found early in the season on the north end of the New River HRA. Most plover activity on the HRA concentrated around Hammond and Clay Island breaches (Figure 14), well south of private lands. There was a slight increase in the number of birds using New River private land (Table 3, Lauten *et al*., 2018), and there was an increase in nest attempts at both private land and the HRA (Table 4). The New River area continues to be a challenging place to nest due to the diversity and number of predators in the area. Despite the predation pressure, nest success improved at both private lands and the HRA in 2019 compared to 2018 (Table 5, Lauten *et al.* 2018), and was near average for the combined area ($\bar{x}$ = 51%).

The hatch rate improved at New River in 2019 compared to 2018 (Lauten *et al.*, 2018), and it was near the post-predator management average (Figure 21). Both private lands and the HRA had excellent fledging success rates and fledglings per brood (Table 8), and fledging success was well above average for the combined sites (Figure 22). The number of fledglings per resident male was above average and just below recovery goals (Figure 23), however this number is biased low due to relatively high number of male plovers moving through the area during the resident period that were thus counted as resident. Productivity from the sampled broods indicates the plovers had a very successful season at New River, with very high fledglings per brood. The good productivity at New River resulted in the highest number of fledglings since 2009 (Table 9), and plovers had very good return for their effort at both sites (Table 8).

Floras Lake

The number of nests (Table 4) and plovers (Table 3) at Floras Lake in 2019 increased compared to 2018 (Lauten *et al*., 2018). While nest success declined, the actual number of nests that hatched was the same as 2018 (Table 5, Lauten *et al*., 2018). For the second consecutive year, brood success, fledging success, fledglings per brood and the breeding coefficient were all excellent. All four broods successfully raised fledglings, producing nine fledglings (Table 9), the highest number of fledglings for this site since monitoring began in 1990. All data indicate Floras Lake had a very productive season.

Summary

Overall productivity for 2019 was excellent. Overall nest success was near the post-predator management average nest success (Table 5, $\bar{x}$ = 43%); overall fledging success was well above average (Table 10); overall fledglings per sample brood was 1.41; overall breeding coefficient was 0.23 +/- 0.04; and a minimum of 344 fledglings were produced (Table 9), the second highest total since monitoring began in 1990. The number of fledglings per resident male was at recovery goals (Table 11) despite likely being biased low due to double counting of resident males per site. Maintaining good productivity at most sites, particularly sites with high plover usage (ie., Siltcoos to Bandon SPMA), compensates for sites that may be receiving high predation pressure and thus are not as productive in any given year. Maintaining overall average nest success of 40%, fledging success of 40%,

fledgling per male at approximately 1.00, and a 0.20 breeding coefficient should result in a stable to growing Oregon coast population.

Productivity Before and After Lethal Predator Management

Data from Floras Lake and Sutton Beach are very sparse. We did not include data from Floras Lake in the graphs of productivity analysis, and data from Sutton Beach are displayed solely for the purposes of 2019 comparisons.

The 2019 overall nest success was near the ten-year (2010 – 2019) average of 42.0% +/- 11.3, and within the mean observed and calculated success rates reported by Page et al. (2009) from multiple studies. Post-predator management fledging success rates have improved at all sites except at Tenmile and CBNS where they have remained relatively stable but above 40% (Figure 22). The post-predator management mean brood success rate for all sites (2004-2019; $\bar{x} = 73.6\%$+/-7.6) was higher than the pre-predator management brood success rate (1991-2001; $\bar{x} = 62.9\%$+/-8.5). The post-predator management number of fledglings per resident male has improved at all sites except Tenmile and CBNS where it has remained relatively stable and above 1.20 for Tenmile and 1.50 for CBNS (Figure 23). The overall productivity has increased in the post-predator management time period resulting in a substantial increase in the number of hatched eggs and fledglings (Figure 24) and the overall population of plovers both within the project area and on the Oregon coast in general.

Brood Activity

Sutton, Siltcoos, Overlook, and Tahkenitch

There were six total broods at Sutton in 2019. One brood originated from a nest north of Berry Creek; this brood was confirmed fledged on the HRA, but spent most of the brood period on the Berry Creek spit. This is the second consecutive year that Berry Creek produced a fledgling (Table 9). Four broods originated from the HRA or the Sutton Creek spit, and remained near the HRA and the spit area. One brood from an unknown nest was discovered south of Sutton Creek, the first known brood and nest from this area. This brood fledged two chicks.

There was only one brood at North Siltcoos in 2019 and it failed very soon after hatching. At South Siltcoos, eight of 10 broods originated on the spit and HRA and remained there throughout the brood period. Two broods hatched along the beach south of Waxmyrtle trail and north of Carter Lake trailhead. These broods remained along the beach until they fledged.

Four broods from North Overlook originated along the beach from south of Carter Lake to the HRA and successfully fledged chicks along this stretch of beach. Three more broods from unknown nests were discovered near or south of the Carter Lake trailhead, and all successfully fledged chicks along the beach. Eighteen other broods originated from the HRA at North Overlook. All brood activity remained on the HRA or adjacent beach, and no broods wandered far from the nesting area. Twenty-three of 27 broods at South Overlook originated from the HRA. Three broods moved south along the beach to North Tahkenitch, including one female who had four eggs in her nest, successfully hatched all four chicks, and moved all four south to North Tahkenitch. She eventually fledged two chicks; this is the first successful nest with more than three eggs we have ever documented. One other brood moved north to North Overlook. The remaining broods all remained on or adjacent to the HRA area. Two other broods originated from nests south of the HRA along the beach. Both broods remained on the beach with one brood moving south to North Tahkenitch.

Two nests were along the beach north of North Tahkenitch in 2019; both of these broods remained along the beach until they fledged. The remaining 26 broods originated from the spit and HRA area. Most brood activity

remained on the HRA or adjacent beach, however two broods crossed Tahkenitch Creek and move to South Tahkenitch where both fledged chicks. There were six broods at South Tahkenitch in 2019. Three broods originated near the I-beams, two near the Tahkenitch Creek trailhead, and one from north of Three Mile Creek. One brood crossed the creek to North Tahkenitch and fledged. Three broods remained along the beach between the I-beam area and the trailhead, and the brood north of Three Mile Creek stayed in the vicinity of the nest. Late in the season two broods from undiscovered nests were found south of Three Mile Creek and north of the North Umpqua jetty. These are the first known broods from this area. Both broods successfully fledged.

Plovers continue to nest at North Tenmile as far north as north of the second parking lot south of the Umpqua River (Figure 6). In 2019 there was brood activity from the second parking lot to the north spit, however the majority of activity was from the area near the county line south to the north spit, where disturbance and recreational activity is much lower than near the parking lots. At South Tenmile most of the brood activity was concentrated on or adjacent to the HRA, with some broods moving south from the HRA along the beach. No broods were known to have moved south of the I-beam.

Coos Bay North Spit

At CBNS, broods that originate on the nesting area tend to be well protected from human disturbance. Some broods will remain on the nesting area for the brood rearing period while other broods, especially broods from the 95HRA typically move west to the beach. As data indicates (Figures 18 - 20), it is likely harriers have a negative impact on brood success, so facilitation of brood movement west to the beach where food resources and success rates are higher is important. Vegetation free corridors have been established through the foredune to create access paths for plover broods. However new growth of invasive beachgrass continues to move westward, reducing available habitat for nesting and brood rearing on the beach. Due to sea level rise and beachgrass encroachment, plovers have reduced available habitat on the beach, which results in closer contact with recreational activity, and subjects nests to increased possibility of overwashing during high tide or storm events. Reduction of lost habitat and restoration of quality habitat west of the foredune would benefit both nesting and brooding plovers.

At CBNS, broods at the far north and south end of the beach tend to experience more recreational activity and conflicts. In 2019 three broods originated from nests north of the FAA towers; one brood from an unknown nest was found in this vicinity. Ropes and signs were extended north from the FAA towers to the first access point. Unfortunately, two of the nests were due west of the old New Carissa landing, which resulted in some recreational interactions, including ropes cut and taken down, and posts and signs removed. Fortunately, most recreationists were cooperative and walked around the roped area, and the two nests in the vicinity successfully hatched. These two broods and a third north of the FAA towers all moved south fairly quickly after hatching and raised their broods within the closed section of beach. The brood from the undiscovered nest likely originated from a nest north of the first access north of the FAA towers. This brood was found shortly after hatching, and spent most of the brood rearing time north of the FAA towers, despite vehicle and human recreation. It successfully fledged two chicks. At the south end of the beach near the jetty, we did not find any nests south of the I-beam in 2019. There was brood activity south of the I-beam, with broods noted using the edge of the jetty, the dunes east of the jetty, and the road system around the jetty area. Tracks from one brood indicated they either wandered out of the south gate to the jetty, or meandered up the road to the south gate and back again. Use of the foredune road in this area clearly is not beneficial to brood success. When we encounter broods on the foredune road, or east of the jetty near the parking area, we typically try to encourage them back onto the beach and north into the closed area.

Bandon SPMA

Eleven broods originated from the Bandon Beach side of the Bandon SPMA, and one additional brood originated from a nest at Johnson Creek, north of China Creek and the SPMA. The brood from Johnson Creek hatched two chicks and the male remained near the nest site and along the edge of the dunes just north of Johnson Creek. The brood was often noted on the wet sand early in the morning before many people and dog walkers would arrive, and then retreat to a small, signed area along the foredune. Two chicks were consistently noted with the male until one chick disappeared at around three weeks old. The male successfully fledged one chick, and soon after, both headed south to the SPMA. Three broods originated from north of China Creek, outside the SPMA. Two

of these broods crossed the creek and moved south into the SPMA. We witnessed one brood with two chicks cross the creek the morning after they hatched; this brood then spent the brood period within the SPMA and successfully fledged one chick. The other brood crossed the creek within a week of hatching and also successfully fledged within the SPMA. The third brood remained north of China Creek, often within the signed area, for three weeks before finally crossing the river and fledging within the SPMA. All other broods originated within the SPMA, with brood activity along the foredune and beach south of the I-beam and north of the HRA, and all along the HRA and beach to the mouth of New River. One brood that originated from a nest along the foredune at the south end of the beach, spent the entire brood period on the small spit on the north side of the New River mouth. No broods crossed New River to the south side.

The majority of nests and broods were found on the open spit and in the dunes just south of the spit, and most brood activity remained in this area. Two broods, one from a known nest and one from an unknown nest, crossed New River to the Bandon Beach side and spent their brood period on Bandon Beach where they successfully fledged. One other brood originated from the south end of the SPMA and remained at the south end of the SPMA. Broods used all available habitat including the beach, overwash areas, and the river side.

New River

Three broods originated on Bandon Biota private land in 2019. One brood remained on Bandon Biota land for the brood period until it fledged. A second brood remained near Bandon Biota lands, but meandered south along the foredune. The third brood wandered south along the foredune towards BLM lands until it fledged.

All brood activity on the New River HRA occurred from south of Croft Lake breach to south of Clay Island breach. One brood originated from Hammond breach and remained on or near Hammond breach until it fledged. Four broods originated from Clay Island breach. One brood utilized the beach from the campsite south of Hammond breach to Clay Island breach. A second brood moved north to the Hammond breach area and utilized the HRA north of the breach until it fledged. One brood wandered south and was recorded on Hansen breach north of Floras Lake, and then returned to the Clay Island breach area where it fledged. The fourth brood moved from Clay Island breach to north of New Lake breach within six days of hatching, and then spent the next two weeks on Croft Lake breach. Unfortunately, the two three-week-old chicks disappeared and were never confirmed fledged. Three other broods originated from nests along the foredune just south of Clay Island breach. All three of these broods remained along this section of beach for the majority of the brood period. During the last week of its brood period, one of these broods suddenly moved north, was able to cross the recently closed breach at Croft Lake, and fledged on BLM lands north of the north section of the HRA.

Floras Lake

There were broods from three known nests and one unknown nest at Floras Lake in 2019. In 2018 all broods from Floras Lake moved north to Clay Island Breach on the New River HRA (Lauten *et al*., 2018). In 2019, all four broods remained at Floras Lake. Two broods originated on or just north of the CMA. One brood remained on the CMA for the brood rearing period, and the second brood eventually moved south to the roped area along the foredune at the south end of the plover management area, and remained within the roped area until it fledged. The third nest to hatch originated from just south of the south end of the plover management area, and moved north into the closed area and behind the roped section of beach where it remained until it fledged. A fourth brood from an undiscovered nest was found on the CMA. This brood meandered south to the roped area along the foredune at the south end of the plover management area, but wandered more than the other broods, moving back north to Hansen breach and then back south to the roped section where it fledged.

Immigrant Plovers

Thirty-two adult plovers banded in California and three adult plovers banded in Washington were observed in Oregon in 2019. Twenty-one were females and 14 were males. Twenty females were resident plovers and one

was present late in the season and was likely either a wintering or visiting plover. Thirteen males were resident plovers and one male was present in early April only.

Of the 32 plovers banded in California, three females and three males originally hatched in Oregon and were subsequently rebanded at coastal nest sites in California. All other immigrant plovers were originally banded in Washington or California.

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Table 1. Minimum window survey counts and the minimum number of Snowy Plover present from Sutton Beach to Floras Lake, Oregon Coast, 2008-2019.

YEAR	WINDOW SURVEY	# SNPL PRESENT
2008	98	188
2009	136	199
2010	158	232
2011	168	247
2012	206	293
2013	215	304
2014	228	338
2015	277	458
2016	375	529
2017	282	468
2018	311	502
2019	356	517

Table 2. Number of Snowy Plover fledglings from previous year, number of previous year fledglings returning, and return rate from Sutton Beach to Floras Lake, Oregon coast 2010 - 2019.

Year	# of banded fledglings from previous year	# of HY birds from previous year sighted on OR coast	Return Rate (#HY/#Fled)
2010	105	54	51.4
2011	84	53	63.1
2012	161	92	57.1
2013	162	91	58.7
2014	98	54	56.3
2015	260	146	56.2
2016	305	135	44.4
2017	171	69	40.4
2018	245	120	48.9
2019	270	109	40.3
		AVERAGE =	51.7
		STDEV =	7.9

Table 3. Plover activity based on the number of adult plovers at each nesting area from Sutton Beach to Floras Lake, Oregon Coast, 2019. Plovers move between nesting areas throughout the summer, therefore this is not a tally of the total number of plovers present.

	Females				Males					
	Banded		Unbanded		Banded		Unbanded		Total	
Site	# banded	# residents	# unbanded	# residents	# banded	# residents	# unbanded	# residents	# plovers	# residents
Sutton	27	15	2	2	16	9	2	2	47	28
Siltcoos	50	38	4	4	35	24	1	1	90	67
Overlook	55	50	6	6	52	47	12	12	125	115
Tahkenitch	48	40	2	2	32	26	7	7	89	75
S Tahkenitch/NUmp	21	11	1	1	18	17	2	2	42	31
Tenmile	35	34	5	5	40	39	6	6	86	84
CBNS	62	56	6	6	61	59	10	10	139	131
Bandon SPMA	51	43	6	6	46	41	6	6	109	96
New River private	8	8	1	1	9	6	1	1	19	16
New River HRA	8	8	3	3	11	11	2	2	24	24
Floras Lake	6	5	3	3	5	5	1	1	15	14

Table 4. Number of nests for selected sites from Sutton Beach to Floras Lake, Oregon Coast, 2008-2019. Cells tally nests only and not broods from undiscovered nests. The number of broods from undiscovered nests is totaled for each year only.

Site Name	09	10	11	12	13	14	15	16	17	18	19
SU	0	1	0	0	1	2	8	19	21	20	15
SI:											
North	14	17	13	10	13	6	8	15	25	15	12
South	9	24	21	22	30	18	23	42	31	24	29
OV:											
North	9	21	29	28	33	35	46	48	61	24	38
South	5	16	28	31	28	23	42	56	47	34	35
TA											
North	6	7	23	36	52	32	61	74	56	47	49
South					6	4	2	0	2	1	8
TM:											
North	13	13	15	17	19	26	29	34	40	66	52
South	41	30	35	29	17	21	32	59	24	33	26
Horsefall								1	1	0	
CBNS:											
SB	19	17	16	7	36	20	41	48	33	32	29
SS	16	14	15	15	12	13	20	38	27	29	27
HRAs	30	33	26	39	58	43	66	97	74	67	78
Cut Creek											1
BSPMA											
BB	31	26	28	48	44	28	40	57	32	36	51
NR spit	10	12	9	12	20	54	48	73	49	43	70
NR HRA	27	27	29	17	9	15	27	14	11	10	16
NR other	3	3	2	1	3	4	8	18	11	5	7
FL	3	0	0	2	0	2	0	1	3	4	9
Tot nst	**236**	**261**	**289**	**314**	**381**	**346**	**501**	**694**	**548**	**490**	**552**
Tot brd[a]	**8**	**2**	**4**	**11**	**8**	**12**	**32**	**19**	**9**	**15**	**25**

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

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

Table 5. Apparent nest success of Snowy Plovers from Sutton Beach to Floras Lake, Oregon Coast, 2019.

Site	Total #	Hatch	Fail	Unknown	App Nest Success
Sutton	15	3	12		20%
Siltcoos					
North	12	1	11		8%
South	29	10	19		34%
Combined	41	11	30		27%
Overlook					
North	38	22	16		58%
South	35	25	9	1	71%
Combined	73	47	25	1	64%
Tahkenitch					
North	49	25	23	1	51%
South	8	6	2		75%
Combined	57	31	25	1	54%
Tenmile					
North	52	20	27	5	38%
South	26	8	17	1	31%
Combined	78	28	44	6	36%
CBNS					
South Beach	29	23	6		79%
South Spoil	27	11	15	1	41%
HRAs	78	27	48	3	35%
Combined	134	61	69	4	46%
Cut Creek	1	0	1		0%
Bandon SPMA	121	34	85	2	28%
New River					
HRA	16	8	8		50%
Other Lands	7	3	4		43%
Floras Lake	9	3	6		33%
Totals	552	229	309	14	41%

Table 6. Apparent nest success of exclosed and unexclosed Snowy Plover nests within monitored project area, 1990 - 2019.

Year	All nests (%)	Exclosed (%)	Not Exclosed (%)
1990	31	*	28
1991	33	75	9
1992	67	85	11
1993	68	83	27
1994	75	80	71
1995	50	65	5
1996	56	71	10
1997	48	58	14
1998	56	72	8
1999	56	64	0
2000	38	48	0
2001	35	68	0
2002	44	66	6
2003	51	77	9
2004	62	85	8
2005	48	72	14
2006	47	66	32
2007	42	71	35
2008	34	49	30
2009	33	76	25
2010	35	72	23
2011	50	71	48
2012	45	86	42
2013	24	83	21
2014	60	50	60
2015	48	50	48
2016	25		25
2017	42	89	42
2018	49	100	49
2019	41		41
Average=	46.43	71.56	24.70
STDEV=	12.58	13.05	18.94

* Multiple experimental designs used, data not included

Table 7. Causes of Snowy Plover nest failure at survey sites from Sutton Beach to Floras Lake, Oregon Coast, 2019.

Site Name	Tot Nsts	# Fail	Depredations					Other					
			Corvid	Unk	Mammal	Harrier	Avian	Wind	Over-wash	Abandon	One Egg Nest	Infer	Unk cause
Sutton	15	12	5	4			2				1		
Siltcoos:													
North	12	11	1	5			2			1	1		1
South	29	19	2	3	6[a]		3				3		2
Overlook													
North	38	16	2	1	8 [a]				1	2		1	1
South	35	9		3	3[a]				1	2			
Tahkenitch													
North	49	23	3	7	5 [a]		2				3	1	2
South	8	2			1 [a]					1			
Tenmile:													
North	52	27		12	2 [b]	2		2	5	1	1		2
South	26	17		5	6[a]	4	1			1			
Coos Bay North Spit:													
South Beach	29	6						1	1		1	1	2
South Spoil	27	15	9	5								1	
HRAs	78	48	9	35						2	2		
Cut Creek	1	1											1
Bandon SPMA	121	85	4	41	1[c]	3	1	12	1	5			17
New River													
HRA	16	8	2	5									1
Other lands	7	4		1			1[d]				1	1	
Floras Lake	9	6	1	2									3
TOTALS	552	309	38[e]	129	32	9	12	15	9	15	13	5	32

[a] – all coyote depredations (29 total coyote depredations)
[b] – 1 coyote, 1 rodent depredation
[c] – raccoon depredation
[d] – gull depredation
[e] – 6 crow depredations all at CBNS; 7 unknown corvid depredations; 25 raven depredations

Table 8. Number of broods sampled (number successful in parenthesis), brood success, and fledging success based on sample from Sutton Beach to Floras Lake, Oregon coast, 2019.

Site Name	# of broods in sample	% brood success	# of eggs hatched in sample	# of fledglings from sample	% fledging success	fledglings per sampled brood	breeding coefficient
Sutton Beach	2 (2)	100%	5	2	40%	1.00	3/39=0.08
Siltcoos:							
North Siltcoos	1 (0)	0%	2	0	0%	0.00	0/30=0.0
South Siltcoos	9 (7)	78%	23	10	43%	1.11	11/79=0.14
Overlook							
North Overlook	20 (17)	85%	54	33	61%	1.65	36/106=0.34
South Overlook	22 (19)	86%	63	38	60%	1.73	44/100=0.44
Tahkenitch							
North Tahkenitch	22 (18)	82%	60	34	57%	1.55	39/134=0.29
South Tahkenitch	6 (5)	83%	15	9	60%	1.50	9/18=0.50
Tenmile:							
North Tenmile	14 (13)	93%	40	22	55%	1.57	22/121=0.18
South Tenmile	5 (4)	80%	11	6	55%	1.20	6/65=0.09
Coos Bay N. Spit							
South Beach	20 (17)	85%	51	29	57%	1.45	30/80=0.38
South Spoil	8 (6)	75%	16	8	50%	1.00	8/73=0.11
HRA	19 (9)	47%	49	16	33%	0.84	18/208=0.09
Bandon SPMA	31 (27)	81%	72	40	56%	1.29	40/326=0.12
New River							
HRA	8 (7)	88%	21	12	57%	1.50	12/48=0.25
Other lands	3 (3)	100%	9	6	67%	2.00	6/18=0.33
Floras Lake	4 (4)	100%	12	9	75%	2.25	9/25=0.36
Total	**194**	**81%**	**503**	**274**	**54%**	**1.41**	

Table 9. Total number of young fledged from select sites from Sutton Beach to Floras Lake, Oregon Coast, 2008-2019, includes fledglings from broods from undiscovered nests.

Site Name	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
SU	0	0	0	0	0	0	0	0						1	3	2	2	8	8
SI:																			
North	0	0	0	7	2	11	7	5	8	4	4	1	2	0	4	3	17	6	0
South	0	0	2	5	7	7	4	3	11	4	8	16	4	9	25	20	16	18	11
OV:																			
North	1	2	3	3	5	8	12	3	7	12	27	22	3	18	26	33	17	15	40
South	1	0	0	3	2	0	1	0	2	7	23	27	0	25	39	16	30	25	45
TA:																			
North	4	1	3	6	8	5	2	0	1	3	20	26	9	25	49	28	28	19	40
South	4	5	2	0	0	0	0	0					3	0	0		0	7	9
TM:																			
North	0	3	1	3	6	12	13	3	2	3	1	5	15	35	26	14	41	46	31
South	4	3	9	9	5	7	14	6	19	13	5	5	8	27	21	27	24	20	10
CBNS:																			
SS	4	2	7	13	9	11	7	17	4	2	6	10	2	14	13	9	10	20	8
SB	1	1	3	0	8	1	10	7	17	13	22	16	18	28	24	12	38	20	32
HRAs	6	8	14	22	6	19	9	16	10	5	28	34	3	49	46	12	10	49	18
CBNS															51		9	12	21
BSPMA																			
BB	1	0	4	16	11	12	13	2	6	6	16	11	8	12	12	8	28	21	18
NR spit	0	0	1	10	0	3	12	2	1	0	5	1	14	22	19	6	9	21	26
NR HRA	3	3	7	5	1	7	16	7	17	12	7	4	12	3	10	4	3	3	12
NR other	3	3	4	6	8	7	4	2	2	0	0	0	3	6	2	5	4	0	6
FL	0	0	0	0	0	0	0	0	0	0	0	2		2	0	1	4	6	9
Total	**32**	**31**	**60**	**108**	**78**	**110**	**124**	**73**	**107**	**84**	**172**	**180**	**104**	**276**	**370**	**200**	**290**	**316**	**344**

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

Table 10. Fledging success and mean number of fledglings/male (+/- standard deviation) from Sutton Beach to Floras Lake, Oregon Coast, 2004-2019.

Year	% Fledging Success	Mean # Fled/Male
2004	55	1.73
2005	41	1.28
2006	48	1.56
2007	54	1.60
2008	47	1.13
2009	50	1.33
2010	35	0.97
2011	47	1.61
2012	44	1.41
2013	39	1.04
2014	48	1.68
2015	49	1.51
2016	43	0.60
2017	50	0.90
2018	49	1.03
2019	54	1.08
’04-’18 mean	47.1 +/- 5.5	1.27 +/- 0.33

Table 11. Number of resident males, estimated number of fledglings, and number of fledglings per male from Sutton Beach to Floras Lake, Oregon Coast, 2019. Plovers move between nesting areas throughout the summer, therefore the number of resident males is not a tally of the total number of plovers present.

Site Name	# of resident males	estimated # of fledglings	estimated # of fledglings/male
Sutton Beach	11	6	0.55
Siltcoos Spits	25	14	0.56
Dunes Overlook	59	88	1.49
Tahkenitch Creek	33	52	1.58
Tenmile Creek	45	54	1.20
Coos Bay North Spit	69	70	1.01
Bandon SPMA	47	46	0.98
New River			
HRA	13	12	0.92
Other lands	7	6	0.86
Floras Lake	6	9	1.50
Overall			1.07 +/- 0.37

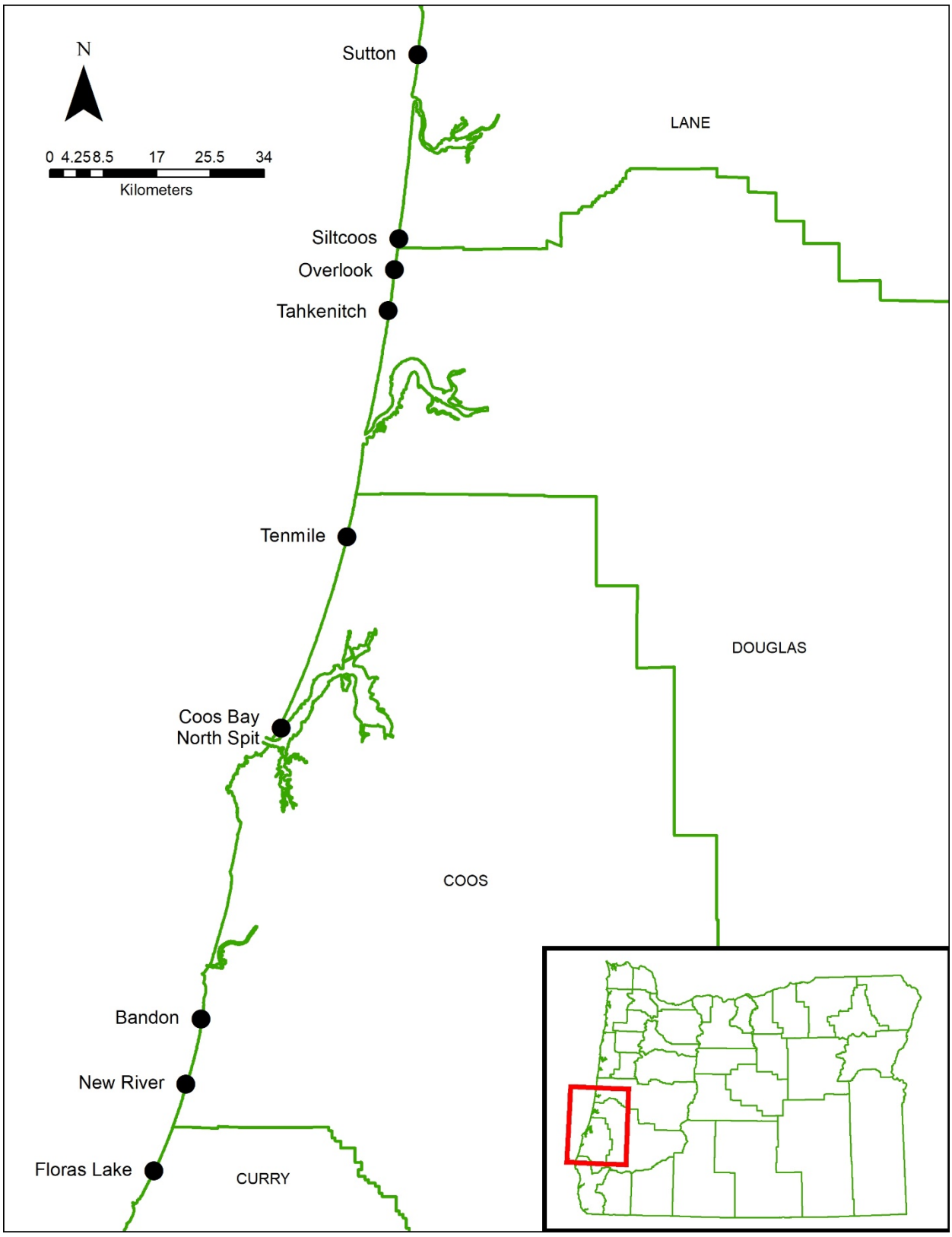


Figure 1. Snowy Plover monitoring locations along the Oregon Coast, 2019

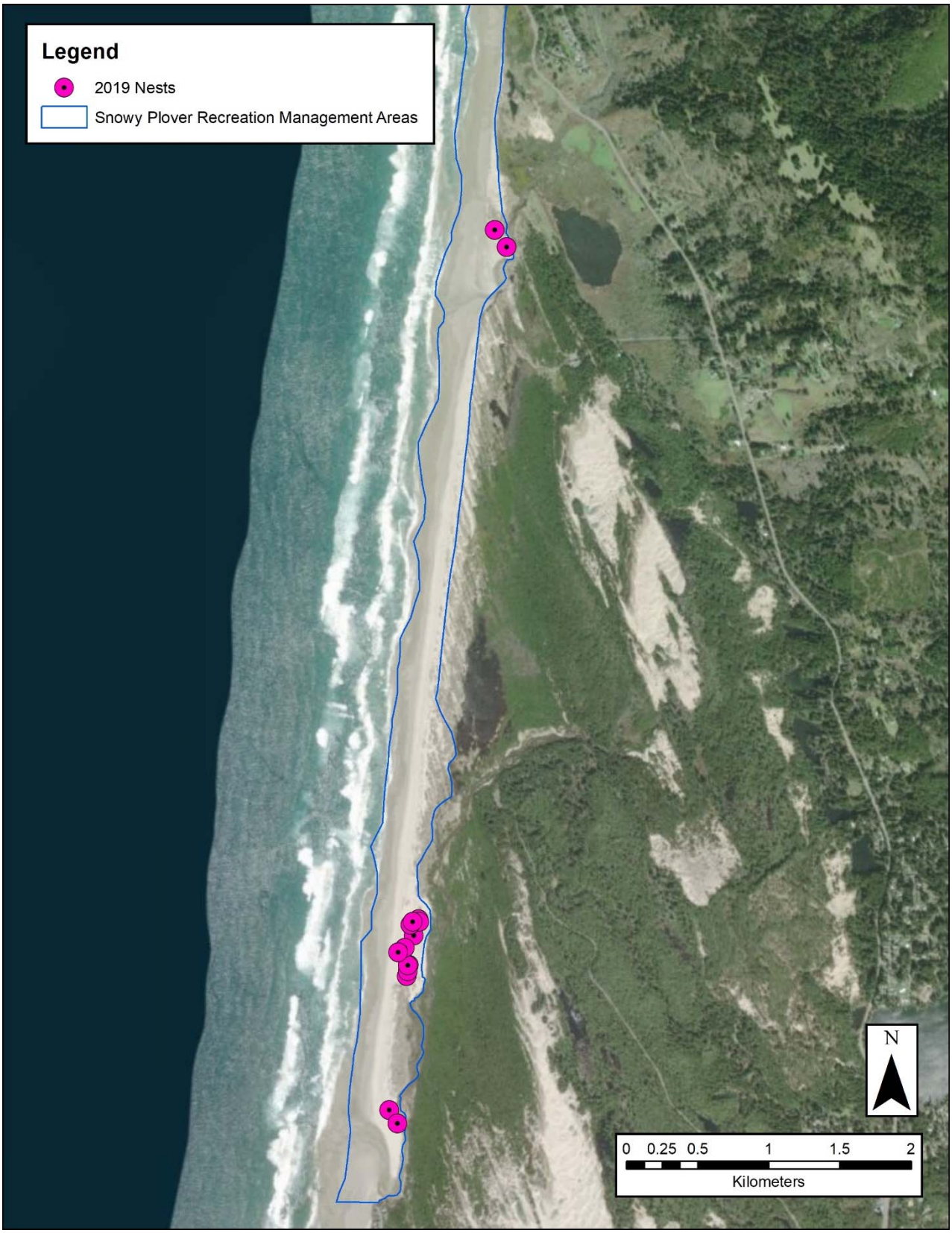


Figure 2. Snowy Plover nest locations at Sutton/Baker Beach, Oregon, 2019.

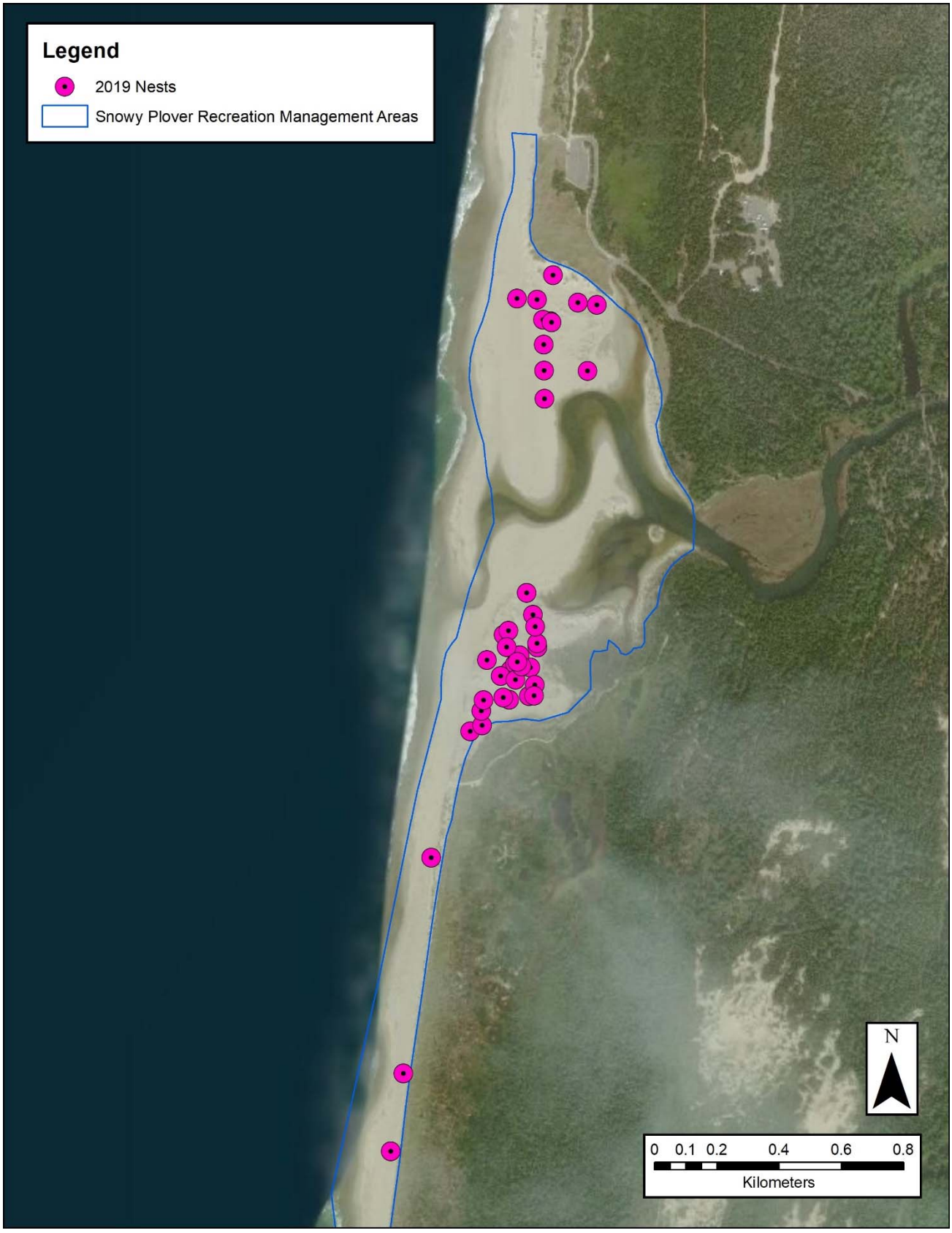


Figure 3. Snowy Plover nest locations at Siltcoos Estuary, Oregon, 2019.

Figure 4. Snowy Plover nest locations at Dunes Overlook, Oregon, 2019.

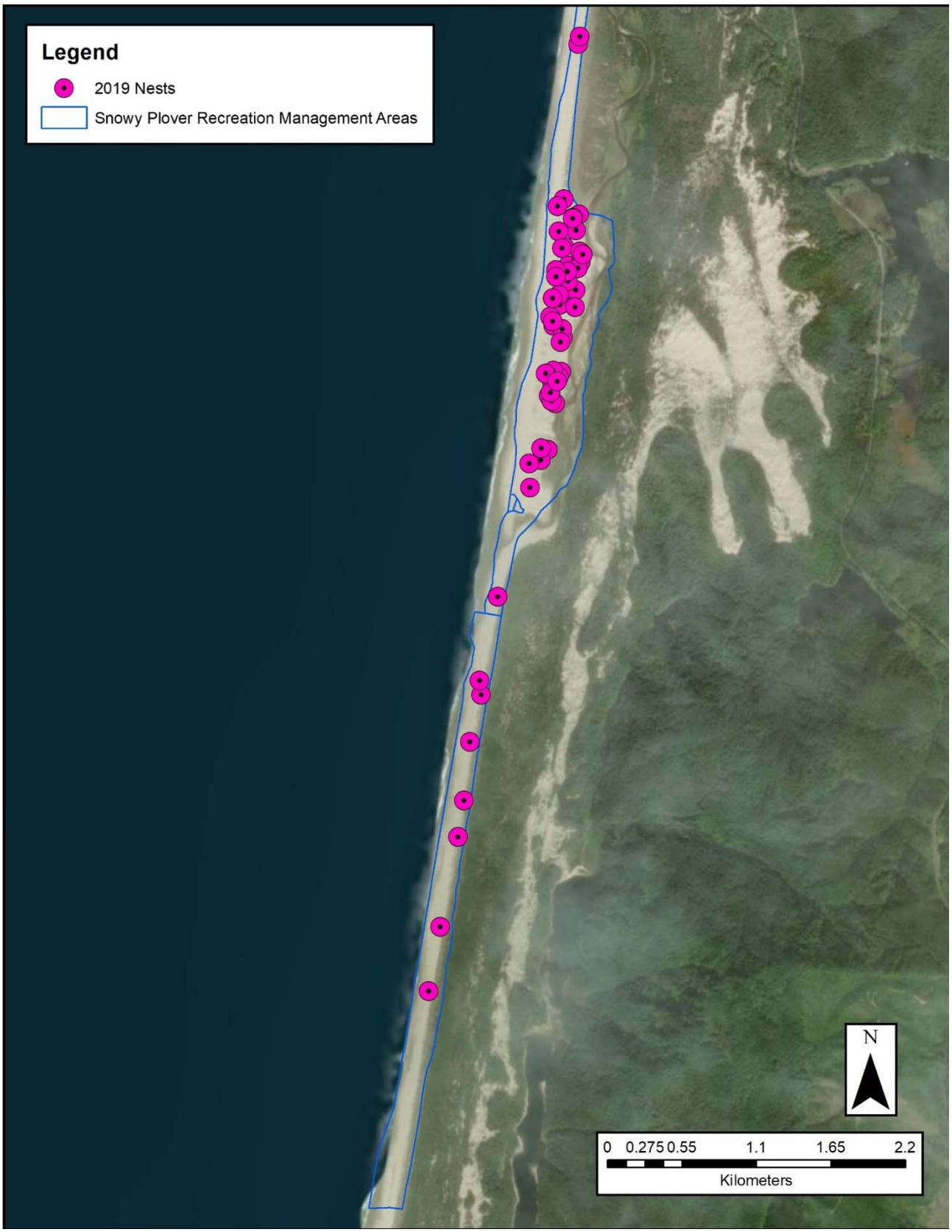


Figure 5. Snowy Plover nest locations at Tahkenitch Creek, Oregon, 2019.

Figure 6. Snowy Plover nests on north side of Tenmile Creek, Oregon, 2019.

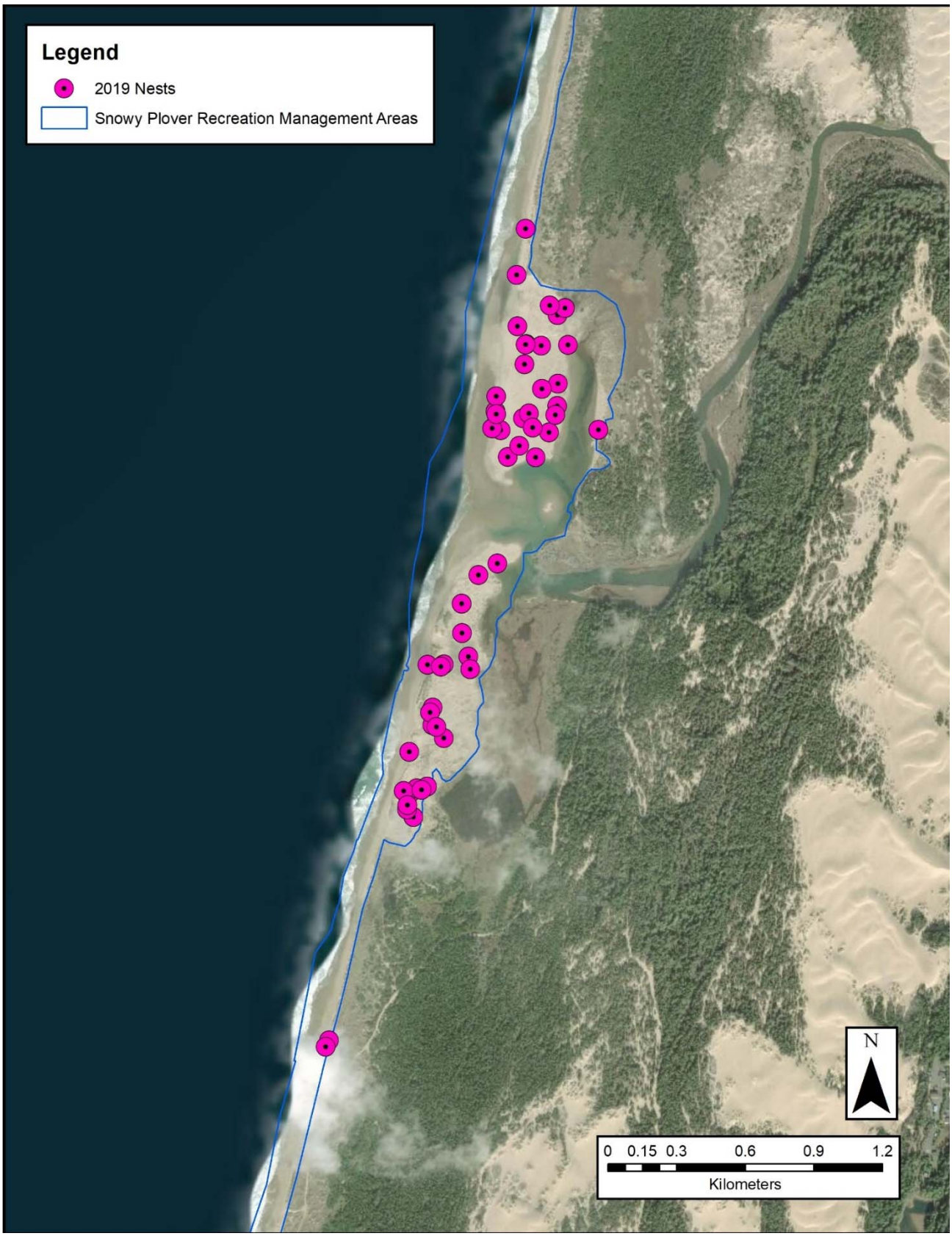


Figure 7. Snowy Plover nests at Tenmile Creek Estuary, Oregon, 2019.

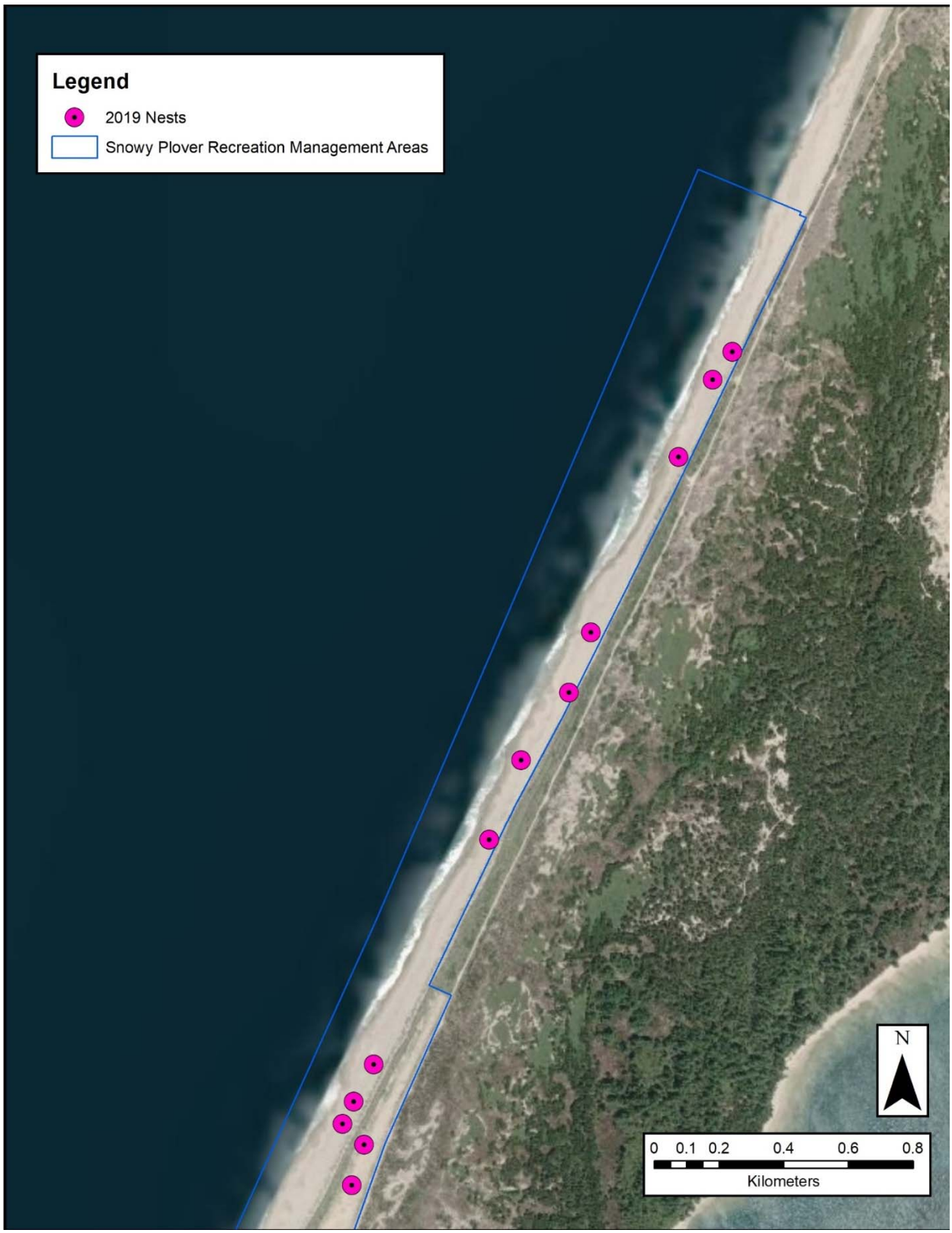


Figure 8. Snowy Plover nests on north end of Coos Bay North Spit, Oregon, 2019.

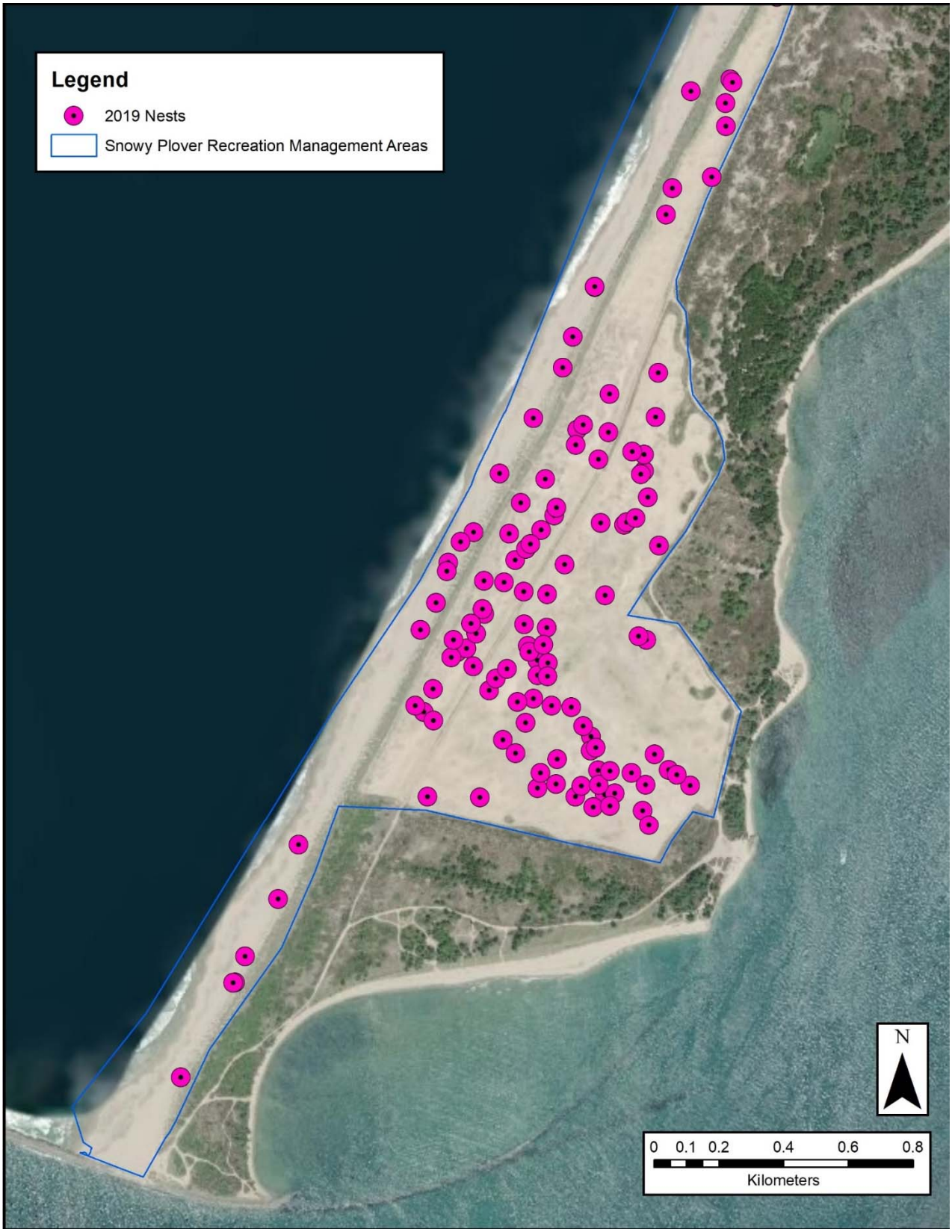


Figure 9. Snowy Plover nests at Coos Bay North Spit, Oregon, 2019.

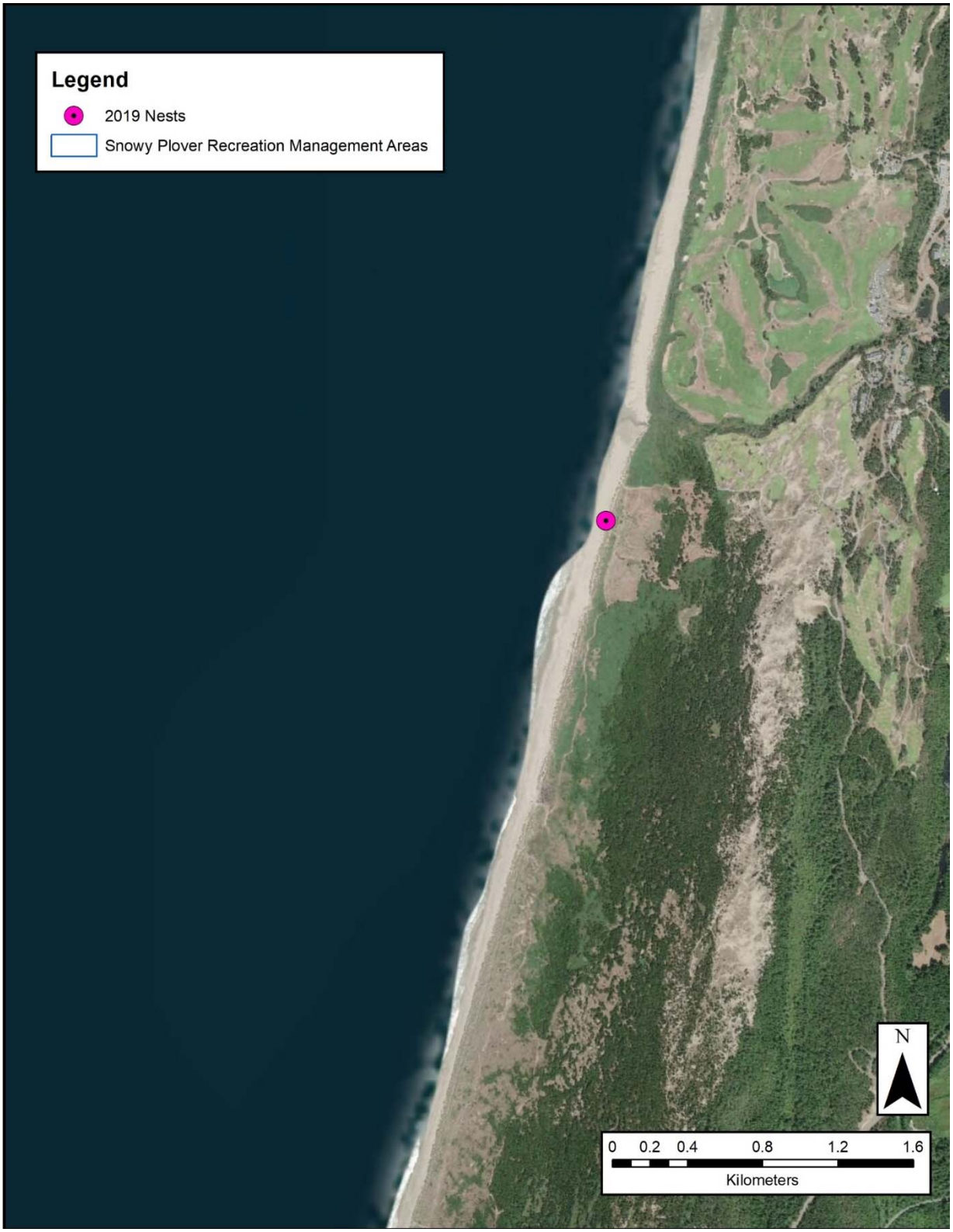


Figure 10. Snowy Plover nest at Cut Creek, Oregon, 2019.

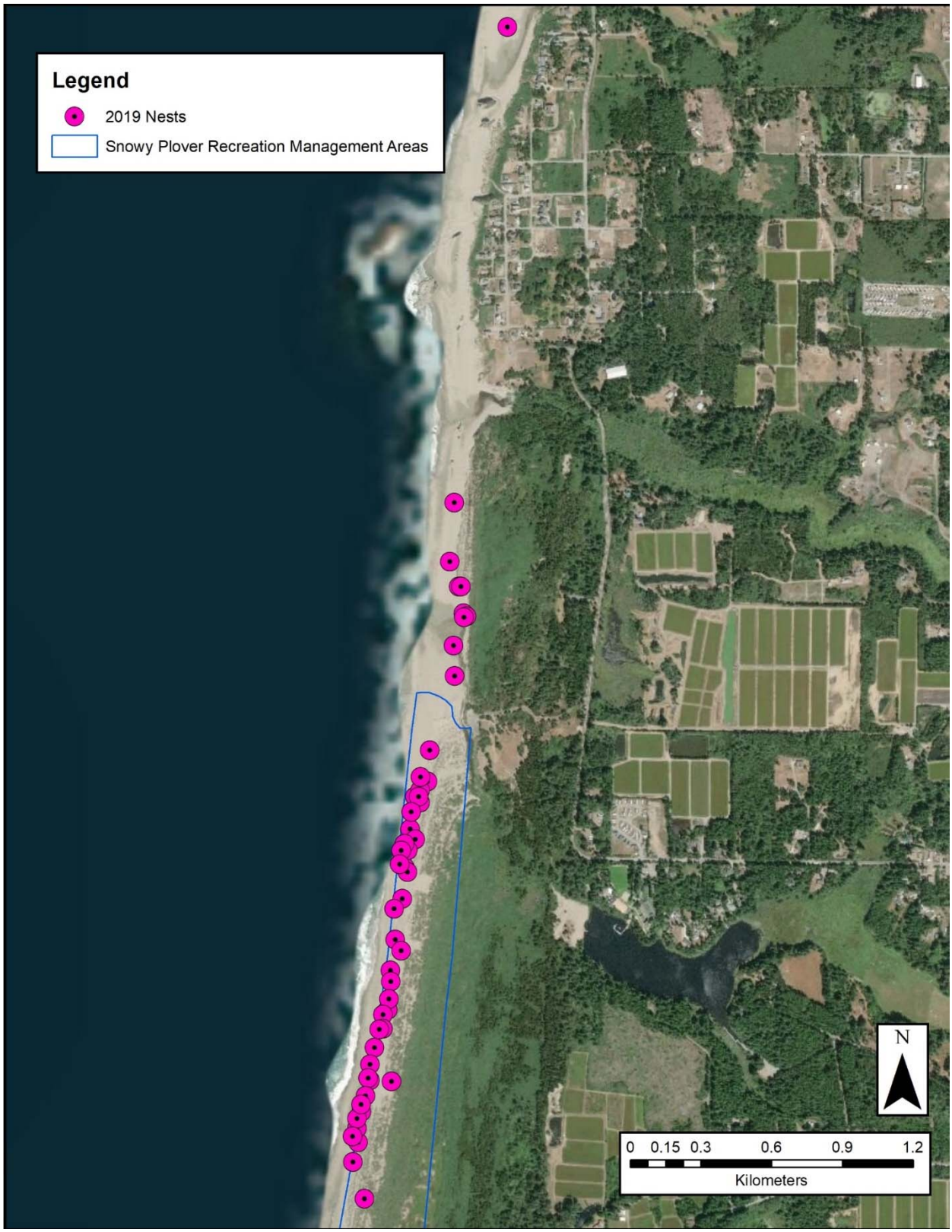


Figure 11. Snowy Plover nests at Bandon SPMA, north of the mouth of New River, Oregon, 2019.

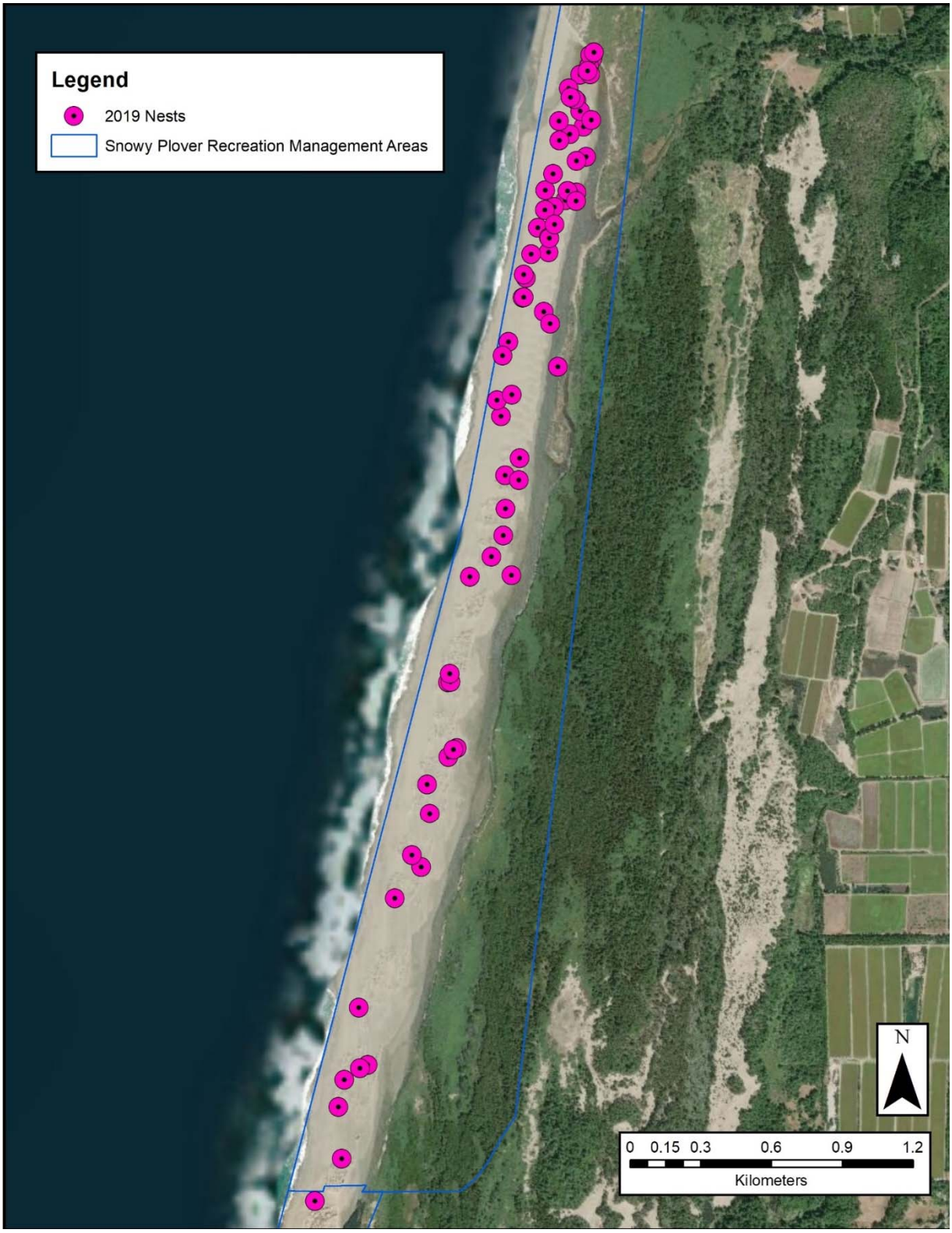


Figure 12. Snowy Plover nests at Bandon SPMA, south of the mouth of New River, Oregon, 2019.

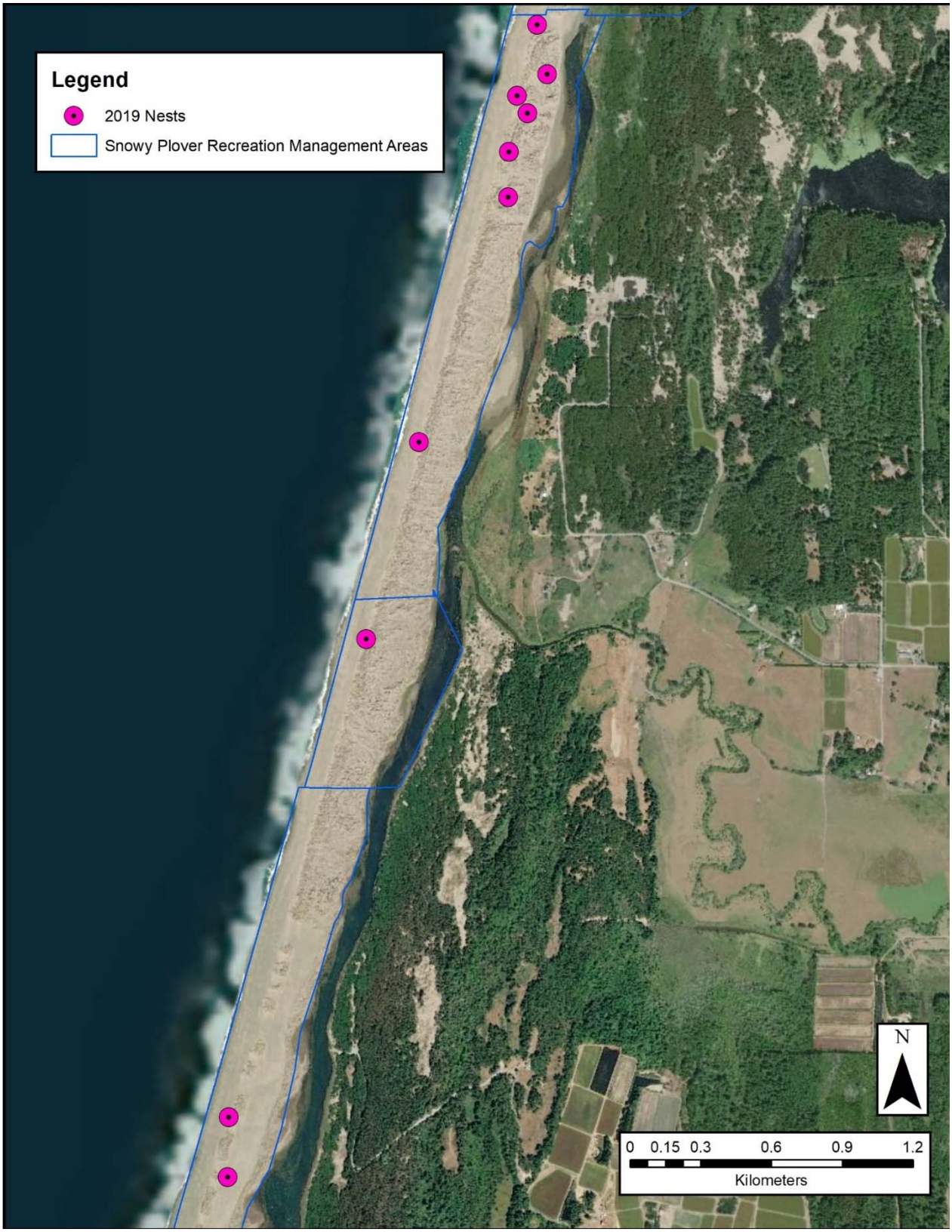


Figure 13. Snowy Plover nests at north end of New River Spit, Oregon, 2019. These nests are at the south end of the SPMA, on private land, and on BLM land.

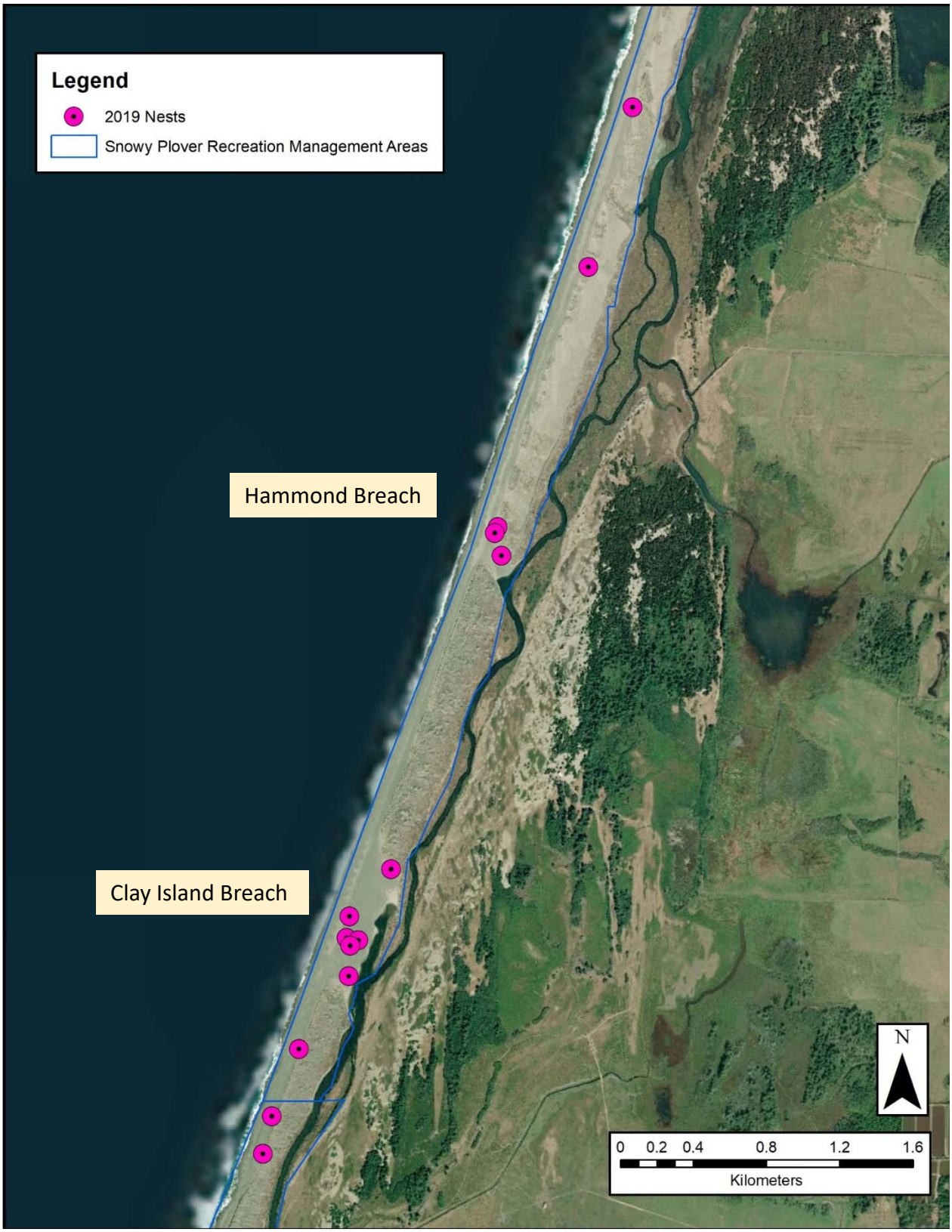


Figure 14. Snowy Plover nest locations at south end of New River spit, Oregon, 2019.

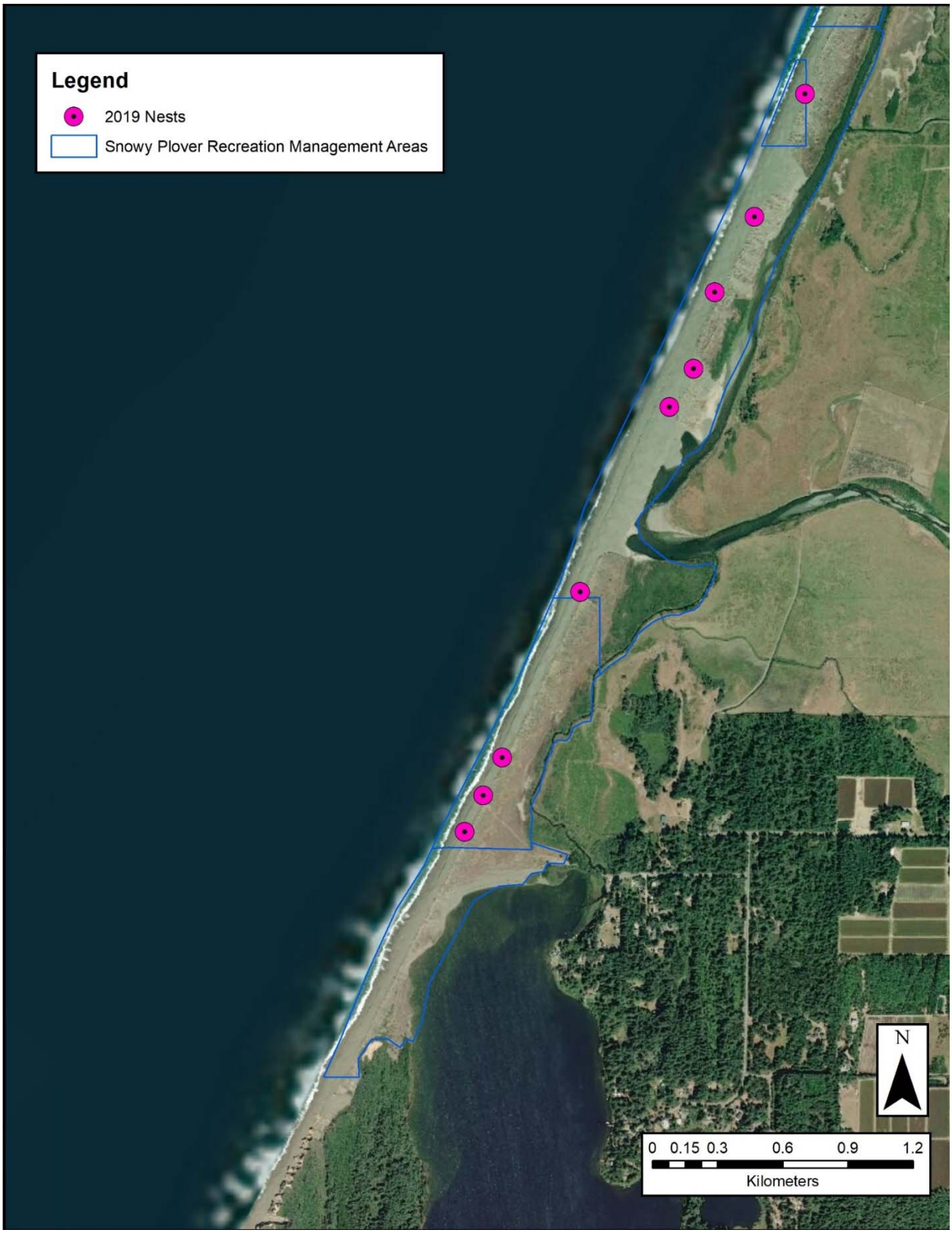


Figure 15. Snowy Plover nest locations at Floras Lake, Oregon, 2019.

Figure 16. Number of active Snowy Plover nests within 10-day intervals from Sutton Beach to Floras Lake on the Oregon coast, 2019. Dashed lines represent +/- standard deviation.

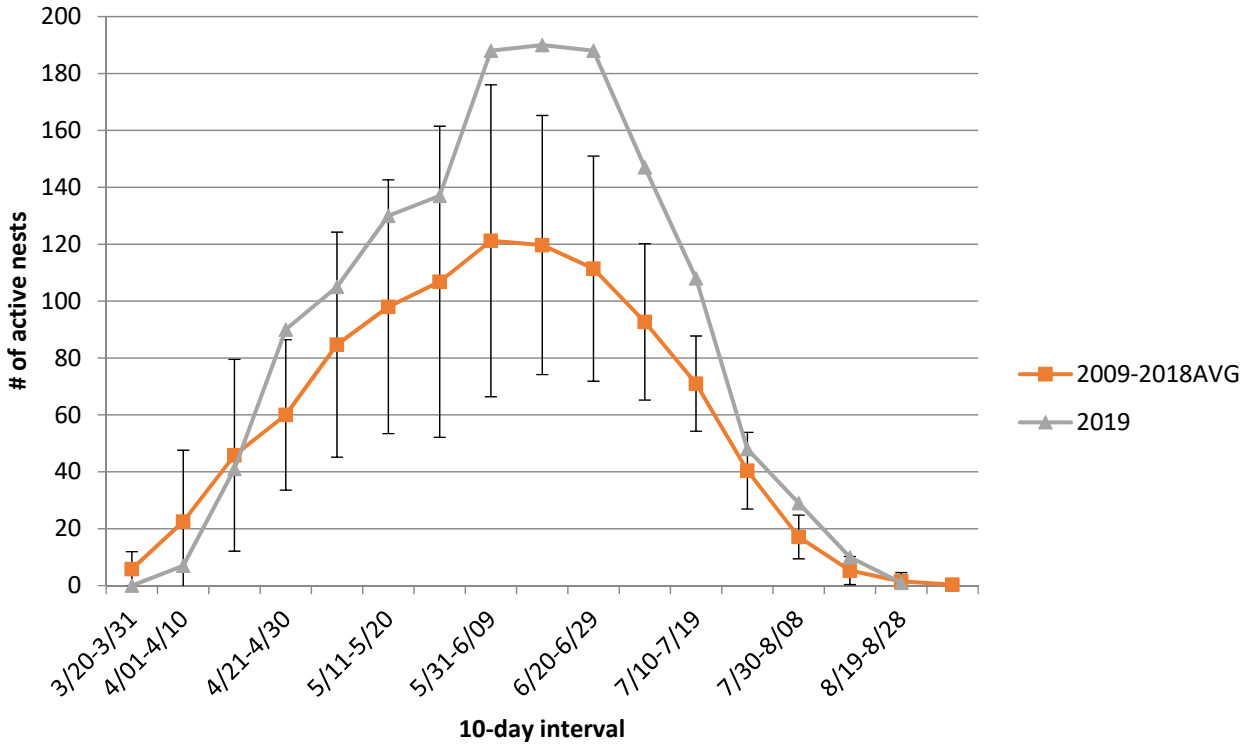


Figure 17. Nest success at CBNS 2012 -2019 A pair of Northern Harriers were removed after being identified as significant nest predator in 2013 and 2017. Note how nest success substantially increases in years after harriers were removed, indicating that harrier removal had a positive effect on plover nest success.

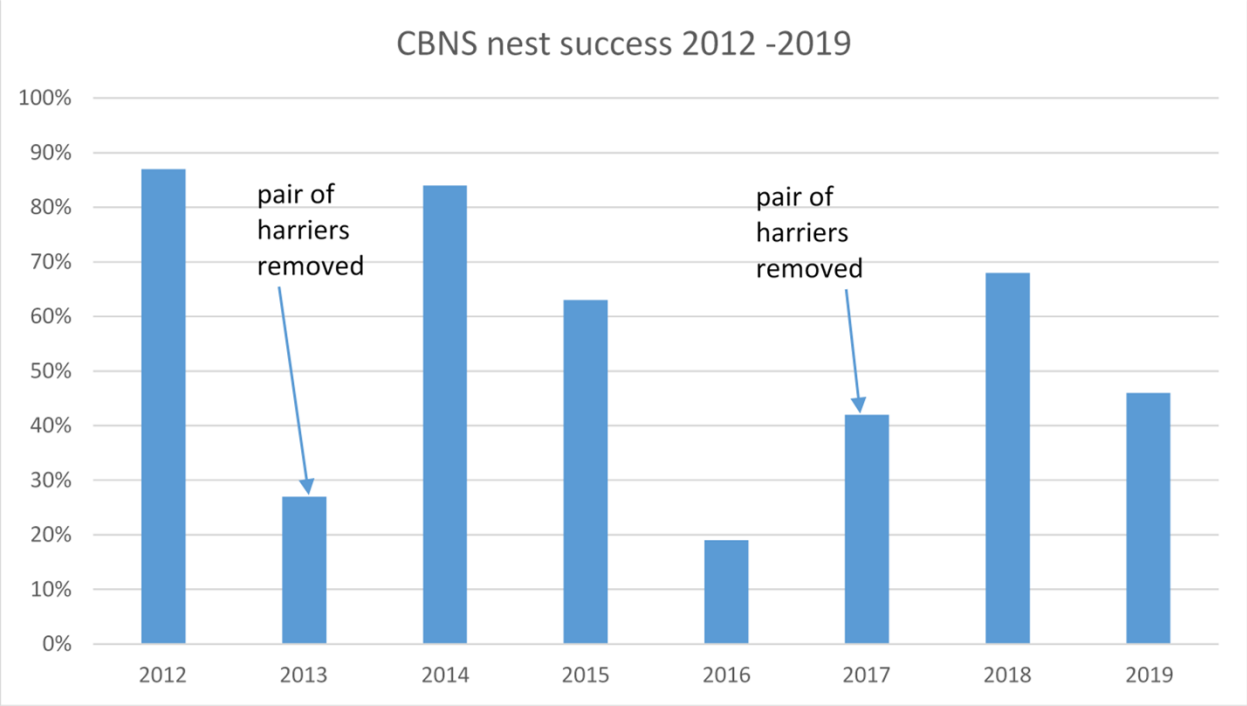


Figure 18. Fledging success, brood success, and fledglings per male for the HRAs at Coos Bay North Spit, 2012-2019. Northern Harriers were removed in 2013 and 2017. Reproductive parameters improved after harrier removal.

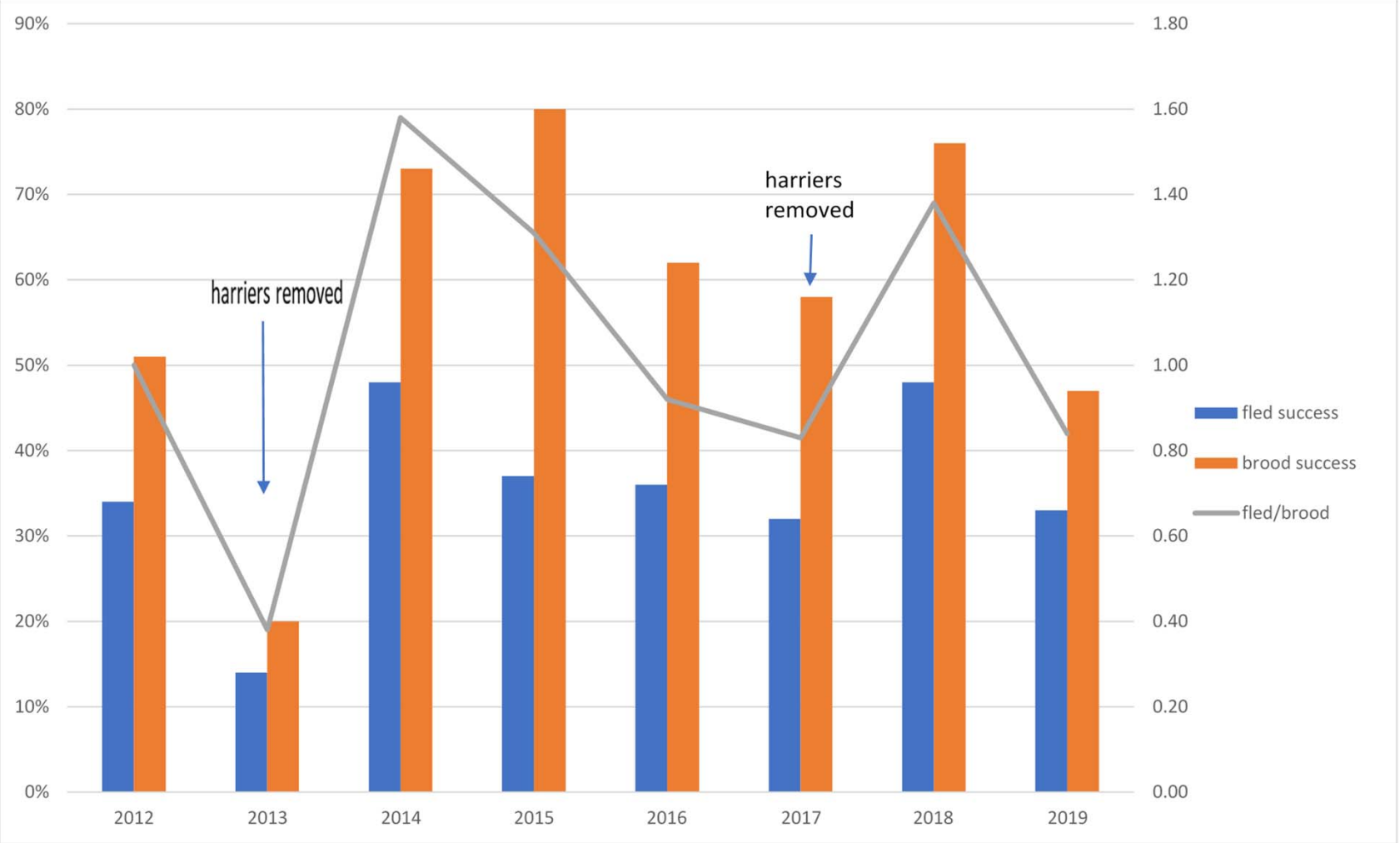


Figure 19. Fledging success, brood success, and fledglings per male for South Spoil at Coos Bay North Spit, 2012-2019. Northern Harriers were removed in 2013 and 2017. Reproductive parameters improved after harrier removal.

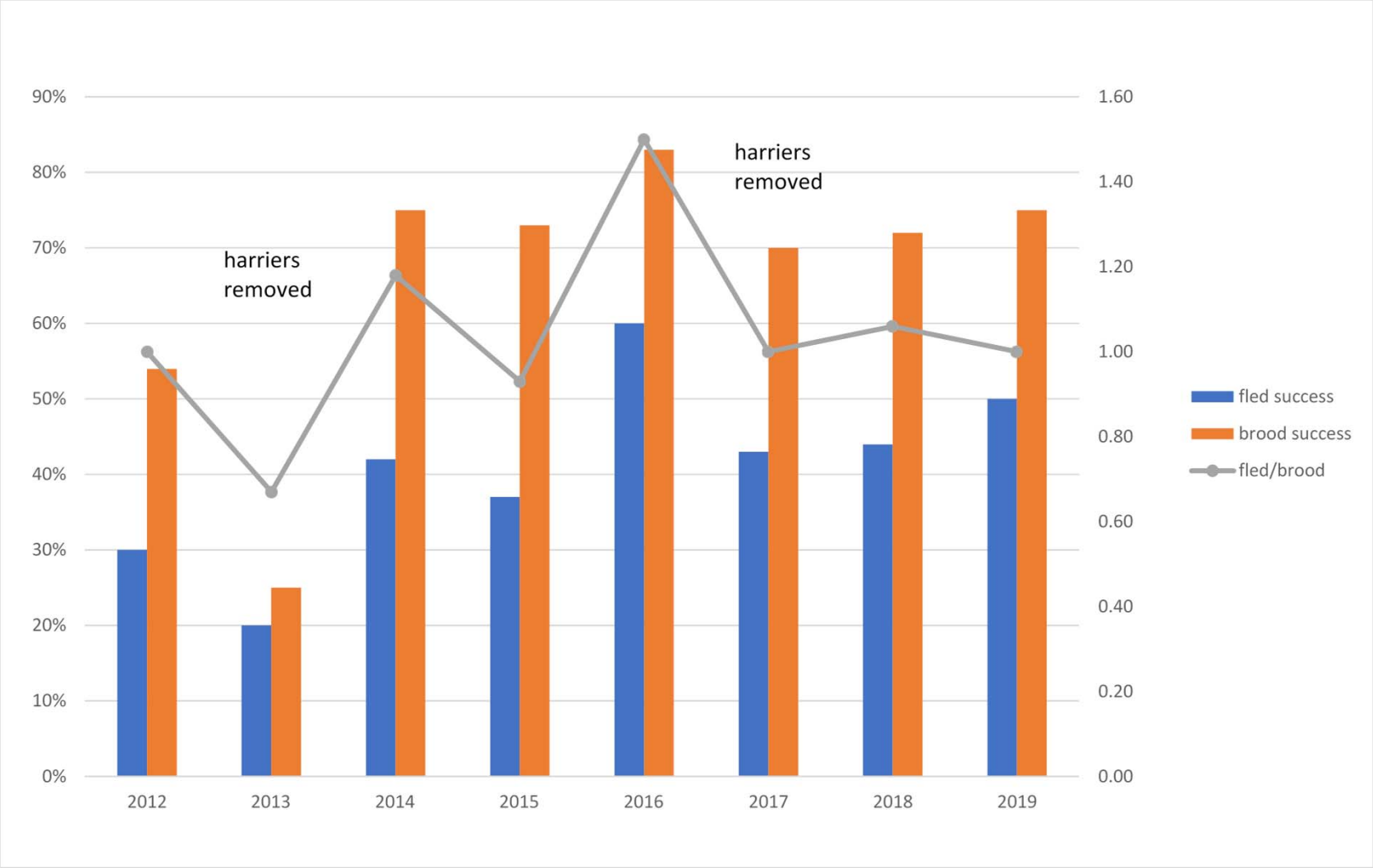


Figure 20. Fledging success, brood success, and fledglings per male for South Beach at Coos Bay North Spit, 2012-2019. Northern Harriers were removed in 2013 and 2017. Reproductive parameters are not as impacted by harriers on South Beach.

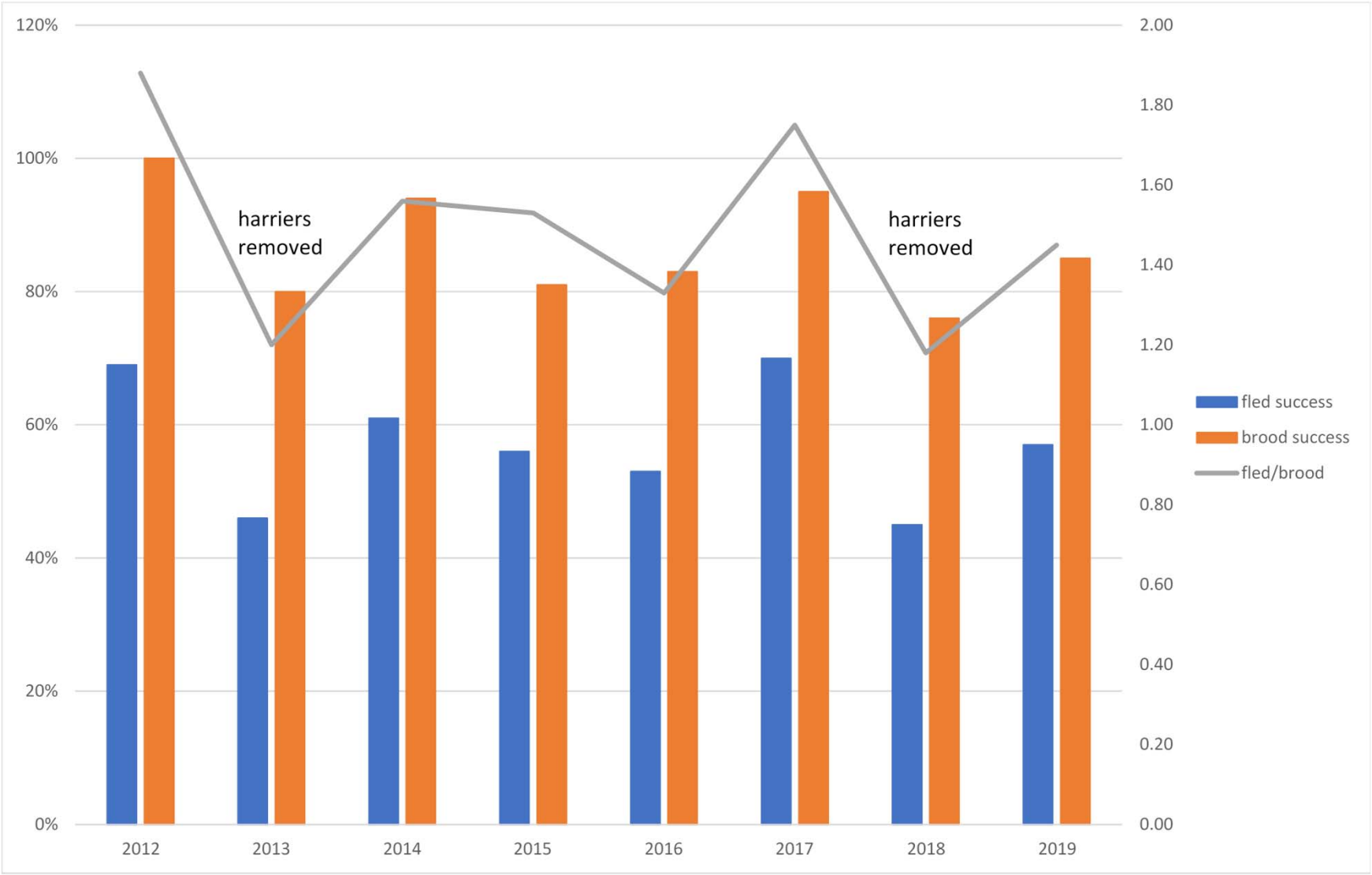


Figure 21. 2019 hatch rate, mean pre predator management hatch rate, and mean post predator management hatch rate for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

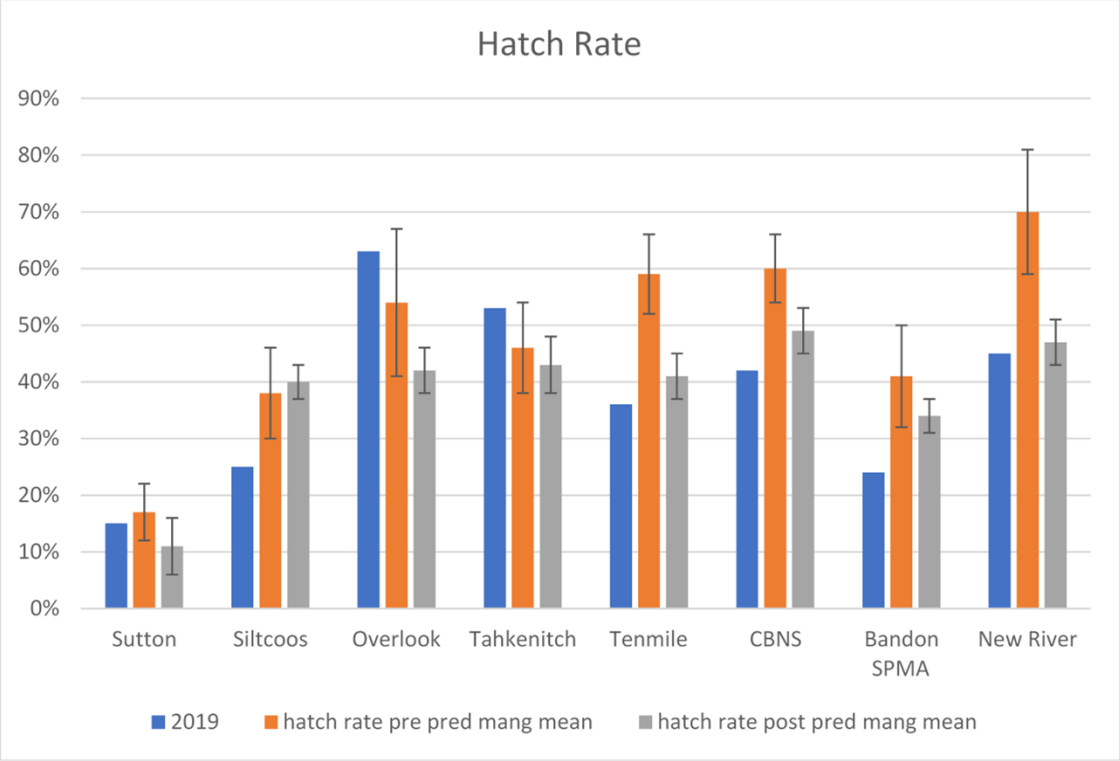


Figure 22. 2019 fledge rate, mean pre predator management fledge rate, and mean post predator management fledge rate for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

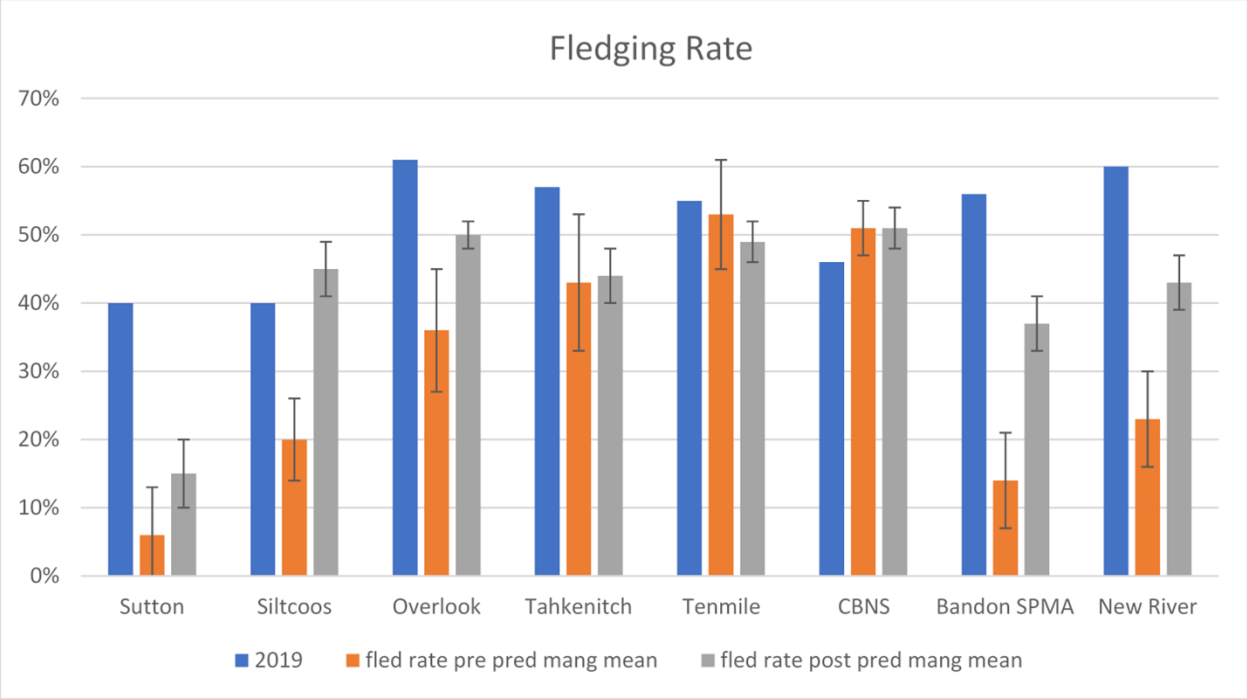


Figure 23. 2019 fledglings per male, mean pre predator management fledglings per male, and post predator management fledglings per male for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

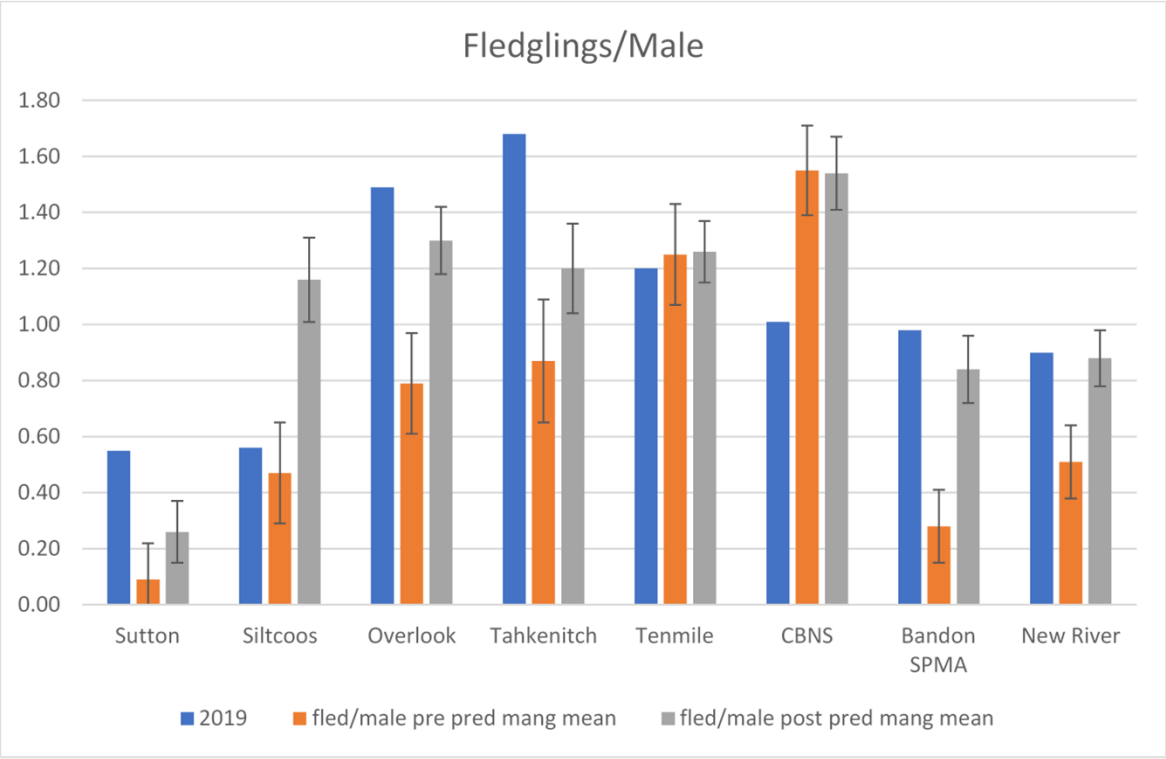
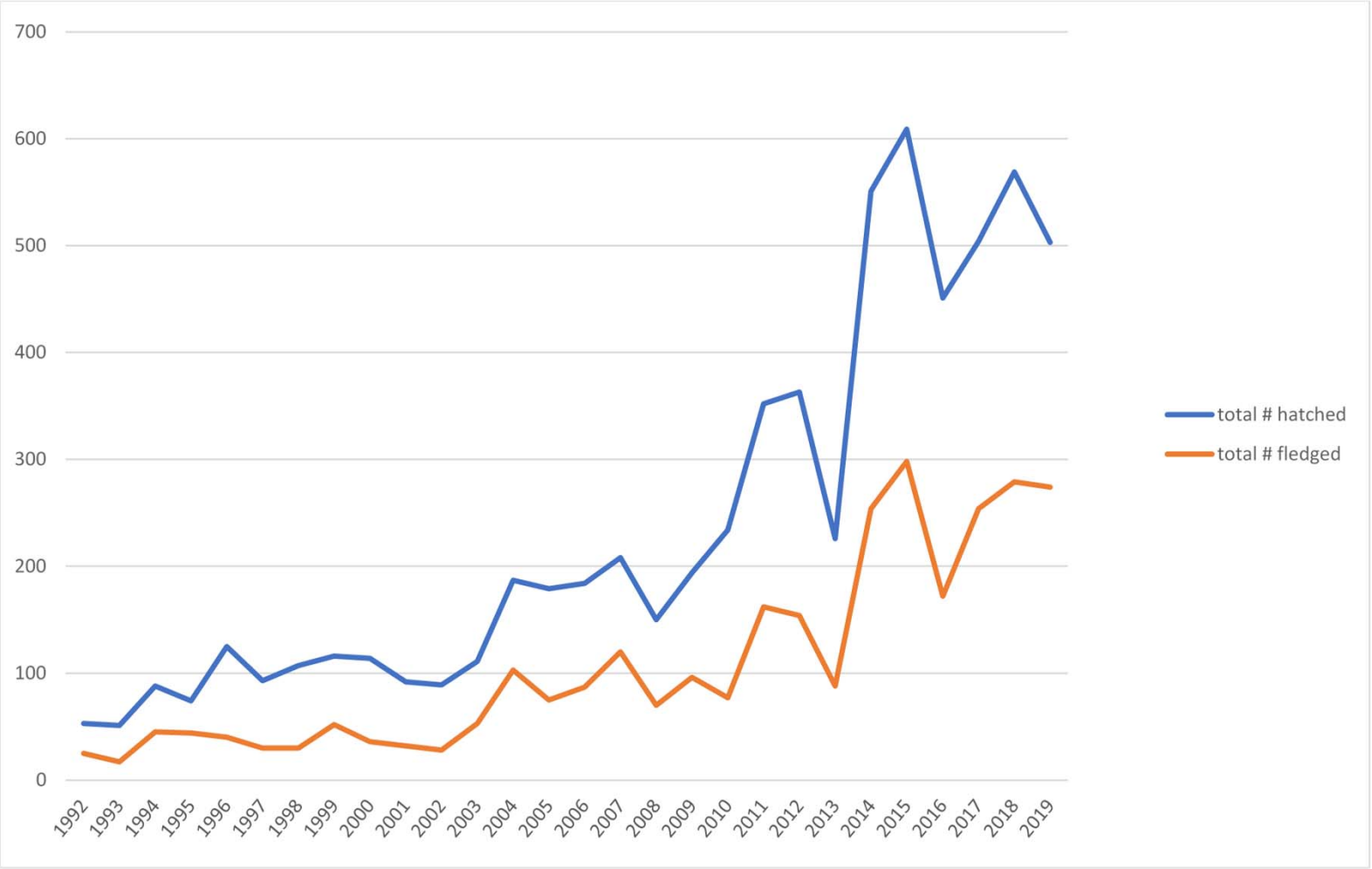


Figure 24. The number of eggs hatched and the number of fledglings from Sutton Beach to Floras Lake on the Oregon coast, 1992-2019.



APPENDIX A.

Study Area

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

Sutton Beach, Lane Co. (Figure 2). 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 area directly west of the Oregon Dunes Overlook off of Hwy 101 including the beach from Carter Lake trail to the north clearing, and south to the Overlook trail south of the south clearing.

Tahkenitch Creek, Douglas Co. (Figure 5) Tahkenitch North Spit - the spit and beach on the north side of Tahkenitch Creek including the beach north to Overlook trail; and South Tahkenitch – from the south side of Tahkenitch Creek to south of Threemile Creek north of the north Umpqua River jetty.

Tenmile: North Tenmile, Coos and Douglas Cos. (Figures 6 & 7). 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. (Figures 8 & 9): South Beach - the beach from the north jetty north to the Horsfall area; and South Spoil/HRAs - the south dredge spoil and adjacent habitat restoration areas (94HRA, 95HRA, 98HRA).

Bandon Snowy Plover Management Area, Coos Co. (Figures 11 & 12): This site includes the Bandon SPMA and all nesting areas from north of China Creek to the south end of state land south of the mouth of New River.

New River, Coos Co. (Figures 13 & 14): The privately owned beach and sand spit south of Bandon Snowy Plover Management Area south to BLM lands, and the BLM Storm Ranch Area of Critical Environmental Concern habitat restoration area (HRA).

Floras Lake, Curry Co. (Figure 15). The beach and overwash areas west of the confluence of Floras Creek and the beginning of New River, north to Hansen Breach.

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

APPENDIX B

Snowy Plover Monitoring Methods

Nest Surveys

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

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

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

Population Estimation

We estimated the number of Snowy Plovers in the project area by counting the number of individually color banded adult Snowy Plovers recorded during the breeding season, and then adding an estimated number of unbanded Snowy Plovers. To arrive at an estimate of the number of unbanded birds present, we counted the number of unbanded birds recorded during each 10-day interval across all sites. We selected the 10-day interval with the highest number of unbanded adults and subtracted the number of unbanded adults that were captured and banded during the breeding season. We added this minimum number of unbanded adults present to the count of banded adults to arrive at the minimum number of adults present during the breeding season. We also determined the number of plovers known to have nested at the study sites, including marked birds and a conservative minimum estimate of the number of unbanded plovers.

Nest Monitoring

We located nests using methods described by Page *et al.* (1985) and Stern *et al.* (1990). We found nests by scoping for incubating plovers, and by watching for female plovers that appeared to have been flushed off a nest. We also used tracks to identify potential nesting areas. We defined a nest as a nest bowl or scrape with eggs or tangible evidence of eggs in the bowl, i.e. egg shells. We predicted hatching dates by floating eggs (Westerskov 1950) and used a schedule, developed by G. Page based on a 29-day incubation period (Gary Page, pers. comm.). We attempted to monitor nests once a week at minimum. We checked nests more frequently as the expected date of hatching approached. We defined a successful nest as one that hatched at least one egg. A failed nest was one where we found buried or abandoned eggs,

infertile eggs, depredated eggs, signs of depredation (e.g. mammalian or avian tracks or eggshell remains not typical of hatched eggs or nest cup disturbance) or eggs disappeared prior to the expected hatch date and were presumed to have been predated. In some instances we found nests with only one egg; often there was no indication of incubation or nest defense, and it was uncertain to what extent the nest was abandoned, or simply a "dropped" egg. Because it was difficult to make this determination, we considered all one egg clutches as nest attempts, and classified them as abandoned when there was no indication of incubation or nest defense. Data recorded at nest checks included:

- nest number
- number of eggs in nest
- adult behavior
- description of area immediately around nest
- whether or not the nest is exclosed
- GPS location

Brood Monitoring

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

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

See Appendix C for information on brood sampling in 2016 and later years.

Banding

Adults were normally trapped for banding on the nest, during incubation, using a lilly pad trap and noose carpets. Lilly pad traps are small circular traps made of hardware cloth with a blueberry net top. The traps have a small door that the plover will enter. Noose carpets are 4" x 30" lengths of hardware cloth covered with small fishing line nooses. Plovers walk over the carpets and the nooses snag their legs. We limited attempts to capture adults to 20 minutes per trapping attempt. Chicks were captured for banding by hand, usually in the nest bowl. Banding was completed in teams of two to minimize time at the nest and disturbance to the plovers. As the Oregon plover population has grown, it has become impossible to band all broods. In 2016 we attempted to band approximately 80% of broods, spread over all sites and across the nesting season. See Appendix C for brood sampling methods.

Adults were banded with a four-band combination of a USFWS aluminum band covered with colored taped and colored plastic bands. We banded broods with a brood-specific two-band combination of USFWS aluminum band covered in colored taped on the left leg and a colored plastic band on the right leg.

APPENDIX C.

Sampling Plan for Banding– Oregon – 2016 to 2018

Statement of problem:

In past years, Oregon Snowy Plover monitors have attempted to band all chicks, to allow accurate estimates of number of chicks fledged per male at each site. As the population has grown this has become impossible with existing staff because of limited time and limited band combinations. Banding chicks at the nest is time-intensive because it often requires multiple visits as the anticipated hatch date approaches. Point Blue is experiencing the same problems at sites they monitor. Recovery Unit 1 (Oregon and Washington) is working on developing a sampling plan through structured decision making that will address survival and productivity estimates for the growing Oregon population, but this plan was not ready for the 2016 field season. Thus, ORBIC worked with Lynne Stenzel at Point Blue Conservation Science and Laird Henkel at California Department of Fish and Game to develop a plan to band a spatially and temporally representative sample of broods starting in 2016.

2016 Brood sampling plan:

Plover productivity is a function of nest success (percent of nests that hatch at least one egg) and fledging success (percent of chicks that survive at least 28 days). We identify nest success by determining the fate of all known nests (see Appendix B). In reality, a small proportion of nests are not located each year, but under this plan we will continue to attempt to locate all nests. This intensive effort to locate nests informs adult population estimates and allows us to provide land management agencies and Wildlife Services with timely information on nest predation.

Starting in 2016, we modified our field methods (see Appendix B) to limit banding and brood tracking to a spatially and temporally representative subset of broods. We used this sample of broods to identify fledging success and chicks fledged per male.

We addressed site variation in fledging success (Dinsmore *et al*. 2017) by sampling broods from all currently occupied nesting sites. We incorporated potential temporal variation in fledging success by banding across the season, dividing the nesting season into 15 10-day periods (Table C-1). Other plover populations exhibit seasonal variation in survival to fledging (Colwell *et al*. 2007, Brudney *et al*. 2013, Saunders *et al*. 2014, Catlin *et al*. 2015). We have not documented this in Oregon (Dinsmore *et al*. 2017), but a 10-day interval allows us to collect data that will be comparable with sampling being done in Recovery Unit 3 (Lynne Stenzel, pers. comm.).

For each 10-day period, at each site, we:

- Attempted to locate all nests.
- Estimated hatch date for all known nests based on number of eggs in nest when found, or by floating eggs (Westerskov 1950, Hays and LeCroy 1971, Dunn et al. 1979, Rizzolo and Schmutz 2007, Gary Page personal communication).
- Recorded fate of all known nests.
- Color banded all chicks from a sample of hatched nests. Our sample consisted of the first 5 known nests to hatch at each site in a given 10-day period (Table C-1). At sites with fewer than 5 hatched nests during an interval, we banded all broods from known nests (but see next bullet point). At sites with more than 5 hatched nests during an interval, we banded all chicks from the first 5 known nests that hatched. As in previous years, chicks did not receive unique color combinations; instead we used brood-specific combinations. Each chick received a USGS metal band wrapped with a brood-specific color tape combination on the left leg and a color band on the right leg (see Appendix B).
- It is not necessary to band chicks at sites with fewer than 3 breeding pairs (e.g. Floras Lake in recent years). At low-occupancy sites, even if birds nest simultaneously, the likelihood of all nests surviving to hatch at the same time is extremely low. Thus, the likelihood of these sites having multiple same-age broods is low, and monitors can track broods and determine fledging without banding, thus saving limited band combinations for more populated sites. Because there are not more than 5 nests hatching in a 10-day period at low-occupancy sites, all broods from these sites are included in the sample, whether banded or not.

- Broods from undiscovered nests that were not banded, were not included as part of the sample, and were not included in productivity estimates for the site. If a brood from an undiscovered nest was found and captured with all three chicks, this brood was used in the productivity calculations.
- Broods were selected for sampling based on actual hatch date, not on expected hatch date.
- If we incorrectly estimated the expected hatch date of a known nest, and the brood was out of the nest before we were able to band it, we skipped that brood and banded the next brood that hatched, up to a total of 5 broods per site per 10-day interval.
- Conducted approximately weekly surveys to relocate banded broods during the fledging period. Banded chicks observed were recorded, but status of very young broods was also confirmed based on adult behavior. As broods approached fledging age, we increased effort to count individual chicks. Chicks observed at or after 28 days after hatching were considered fledged (Warriner et al. 1986).
- The banded sample of broods and their attending male was used to report brood success, fledging success, and to calculate the number of fledglings per sampled brood. The banded sample of chicks that fledged was multiplied by a weighting factor (total broods/broods sampled) to give an estimated number of chicks fledged per site. The number of fledglings per male was then calculated from the estimated number of fledglings and the number of resident males for each site and overall. Standard deviations and 95% confidence intervals will be calculated on these estimates.

This proposed design is flexible; if the population decreases, the sample would return to a census because fewer than 5 nests would hatch within a given interval at a site. We incorporated this plan as a pilot in 2016. We hope that by the 2017 field season a comprehensive sampling plan will have been developed through the strategic decision making process.

Table C-1. Ten-day intervals used to determine brood sample in 2016 and 2017. Within each interval, the first five hatched broods were banded and tracked to fledging.

Ten day intervals	Interval number
April 1 - April 10	1
April 11 - April 20	2
April 21 - April 30	3
May 1 - May 10	4
May 11-May 20	5
May 21 - May 30	6
May 31 - June 9	7
June 10 - June19	8
June 20 - June 29	9
June 30 - July 9	10
July 10 - July 19	11
July 20 - July 29	12
July 30 - August 8	13
August 9 - August 18	14
August 19 - August 28	15

Test of sampling plan using recent data

We used data from 2013 – 2015 to test how well this sampling plan would have estimated the number of fledglings in those years. We chose those years because prior to 2013 the population was small enough that these methods would have resulted in a sample nearly identical to the total number of broods banded and tracked (i.e. we would have sampled the full population under this plan). For this analysis, we only used nests for which we had a hatch date and known brood outcome, so the numbers of total broods and fledglings in this analysis are slightly lower than totals reported in our annual reports. Based on hatch dates, we identified the nests that would have been sampled under this proposed scheme, and recorded the numbers of chicks that fledged from these sampled nests. We then used the sample to estimate the number of

chicks fledged by site and across all sites per year. We compared these estimates to the numbers from the full (unsampled) data set (Figure C-1).

This approach used observed data and simulated samples to characterize the population estimates and the accuracy of the estimates. Based on a review of the data and sample variances associated with the historical data it is clear that the sample weights are low and in many cases equal one (and thus are representative of the entire population [i.e. a census]). Confidence intervals are extremely small. In all cases, over 80% of the broods were sampled. Figure C-1 shows that estimates of the number of fledglings derived from this example closely track the observed number of fledglings.

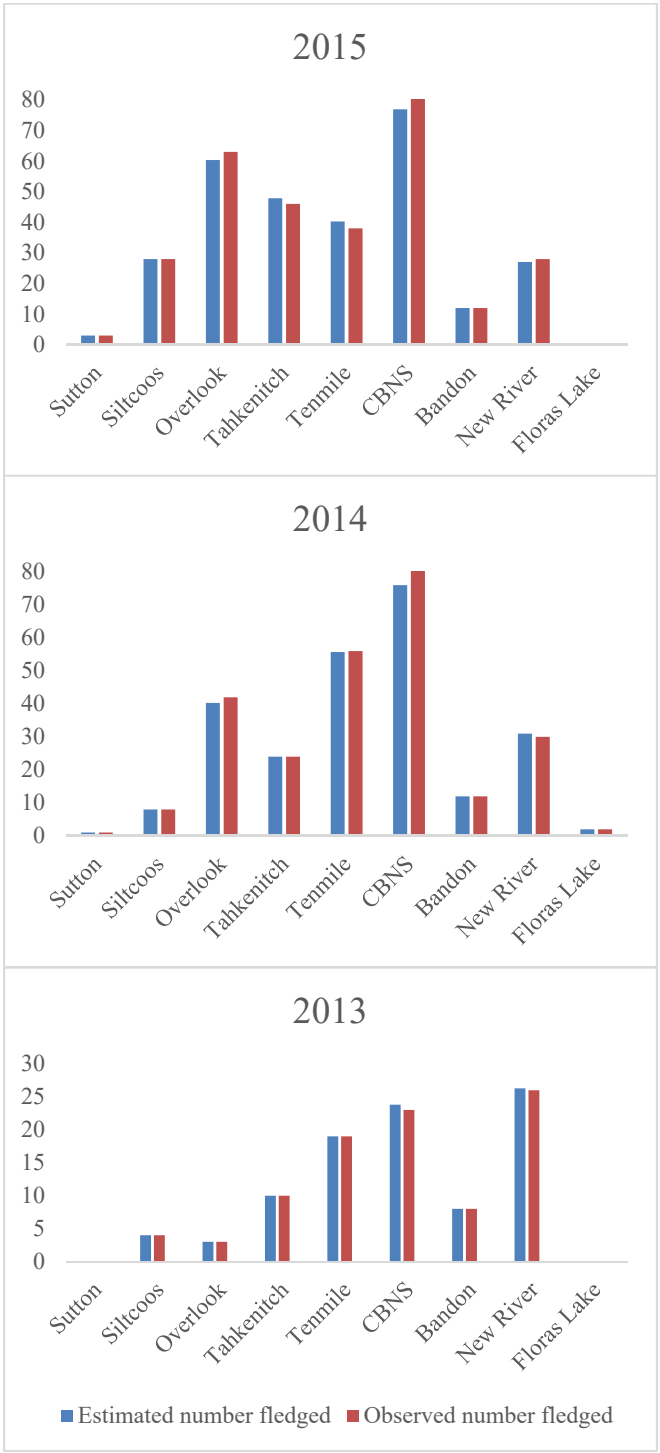


Figure C-1. Comparison of estimated number of fledglings from sample to observed data for 2013 – 2015.

Summary

This conservative sampling plan is intended to continue banding and tracking a large percentage of the plover population to ensure continued highly accurate productivity estimates with associated confidence intervals while using repeatable methods. If the Oregon Snowy Plover population continues to grow, and increased numbers of nests hatch, the percentage of hatched nests sampled will decline and variability estimates may increase. However, as shown in the above review of historic data, variance is small and the estimates are close to the observed data. If the population declines and/or nest success is low, this sampling plan will by design approach a full census.

This sampling plan will save monitors time by allowing them to track a subset of broods through fledging. In 2015, this sampling plan would have reduced the number of broods tracked by 42. Time savings will occur once 5 nests have hatched in a 10-day interval at a site because at that point monitors need only document a nest's fate; they will not have to be physically present while it is hatching. Being present at hatchings is time intensive because monitors may have to make repeated visits to a nest to band all chicks. Timing of these visits is not flexible, affecting monitors' ability to complete other tasks efficiently. Documenting fate of a nest can be determined via camera or by visiting the nest once. After nest fate is determined monitors do not need to return. This plan would allow monitors to skip a small and clearly identified portion of nest hatchings.

Using the sample to estimate plover productivity

Using the sample, we calculated brood success for each site (the number of broods that successfully fledged at least one chick). Based on the number of eggs and fledglings counted from the sample, we calculate fledging success for each site (the number of chicks fledged/the number of eggs laid). In order to determine fledglings per male for each site and the entire project area, we treated each sampled brood as an independent unit and used the sample to calculate the estimated fledglings per sampled brood. Not all males on each site are sampled. To estimate the number of breeding males for each site, we use the survey data to determine how many males were resident at each site. Males were considered resident if they were present at a site between 15 April and 15 July and therefore had an opportunity to attempt to nest. Using the number of fledglings produced per sampled brood, we calculated an estimated number of fledglings produced for all broods at each site:

$$f_{sy} * k_y = E_y$$

where f_{sy}= the number of fledglings per sample brood at site y; k_y = total number of known broods at site y; and E_y = the estimated number of fledglings for site y.

We then divided E_y by the number of resident males for site y (R_y):

$$\frac{E_y}{R_y} = F_y$$

So that F_y is the estimated number of fledglings produced per male for site y.

We calculated the estimated number of fledglings per male for each site. Since males can and do roam between sites, and can breed at more than one site in a given year, to estimate fledglings per male for the project area, we determined the total number of resident males within the project area, and divided that by the estimated number of fledglings produced for all known broods. We calculated a mean number of fledglings per male from all sites, and display the mean with the standard deviation (Table C-2).

Table C- 2. Data used to calculate estimated number of fledglings by site in 2019.

Site Name	total # of known broods	broods in sample	% brood success of sample	total # of eggs hatched in sample	# fledged from sample	% fledging success from sample	# of fledglings/brood sampled	# of fledglings/brood sampled – combined	# of resident males	estimated # of fledglings[a]	estimated # of fledglings/male[b]
Sutton Beach	6	2	100%	5	2	40%	1.00	1.00	11	6	0.55
Siltcoos:											
North Siltcoos	1	1	0%	2	0	0%	0.00	1.20	25	14	0.56
South Siltcoos	11	9	78%	23	10	43%	1.11				
Overlook											
North Overlook	25	20	85%	54	33	61%	1.65	1.69	59	88	1.49
South Overlook	27	22	86%	63	38	60%	1.73				
Tahkenitch											
North Tahkenitch	26	22	82%	60	34	57%	1.55	1.54	33	52	1.58
South Tahkenitch	8	6	83%	15	9	60%	1.50				
Tenmile:											
North Tenmile	27	14	93%	40	22	55%	1.57	1.47	45	54	1.20
South Tenmile	10	5	80%	11	6	55%	1.20				
Coos Bay N. Spit											
South Beach	24	20	85%	51	29	57%	1.45	1.13	69	70	1.01
South Spoil	11	8	75%	16	8	50%	1.00				
HRA	27	19	47%	49	16	33%	0.84				
Bandon SPMA	36	31	82%	72	40	56%	1.29	1.29	47	46	0.98
New River											
HRA	8	8	88%	21	12	57%	1.50	1.50	13	12	0.92
Other lands	3	3	100%	9	6	67%	2.00	2.00	7	6	0.86
Floras Lake	4	4	100%	12	9	75%	2.25	2.25	6	9	1.50
TOTALS	**254**	**194**	**81%**	**503**	**274**	**54%**	**1.41**	**1.41**			1.07 +/- 0.37

a – number of fledglings/brood sampled x the total number of known broods = estimated number of fledglings produced

b – number of estimated fledglings/number of resident males = estimated number of fledglings per male