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The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2022

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Coos Bay District Bureau of Land Management
1300 Airport Way
North Bend, Oregon 97459

Siuslaw National Forest
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Corvallis OR, 97333

U.S. Fish and Wildlife Service

Recovery Permit ES39372B-3

Oregon Department of Fish and Wildlife
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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 1 April – 15 September 2022. 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 Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit, Bandon Snowy Plover Management Area, New River Habitat Restoration Area (HRA) and adjacent lands, and Floras Lake. Our objectives for the project area in 2022 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 508 individuals, the first decline since 2016. We monitored 529 nests in 2022. Overall apparent nest success was 24%. Nest failures were attributed to unknown depredation, unknown cause, corvid depredation, unknown avian depredation, harrier depredation, abandonment, mammalian depredation, one egg nest, wind/weather, overwashing, gull depredation, and infertility. We sampled 90 of 125 known broods that produced 96 fledglings and estimated 130 total fledglings. Overall brood success was 72%, fledging success was 44%, and based on the overall number of resident males, 0.49 chicks fledged per resident male.

Contents

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 33rd year 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 (Figure 1). 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 adequate annual productivity, leading to a sustainable Oregon breeding population at or above recovery levels. Previous work and results have been summarized in annual reports that are available at https://inr.oregonstate.edu/biblio. Our objectives for the project area in 2022 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

Due to the large plover population in the project area, in 2022 ORBIC intensively monitored plover activities, from north to south, at Siltcoos River estuary, the Dunes Overlook, North Tahkenitch Creek, the South Umpqua beach to the north spit at Tenmile Creek, Coos Bay North Spit (CBNS), Bandon Snowy Plover Management Area (SPMA), and New River Area of Critical Environmental Concern (ACEC) (Figure 1). Monitoring was limited at Sutton Beach, South Tenmile, New River private land from the south end of Bandon SPMA to the New River ACEC, and Floras Lake. Additional habitat at South Tahkenitch to the North Umpqua jetty (North Umpqua) was monitored by US Forest Service (FS) biologists. At intensively monitored 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. Sites that were less intensively monitored had limited survey visits, with reduced nest monitoring and little to no sampling of broods. 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. We report summaries of the number of nests found outside intensive monitoring areas as reported to us by 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). All historic nesting areas were searched during the breeding window survey in 2022: Clatsop Spit, Camp Rilea, Necanicum Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sand Lake Spits and Sitka Sedge State Natural Area (SNA), Nestucca Spit, Salmon River Spit, Salishan Spit, Agate Beach, Yaquina Point, South Beach State Park, Bayshore Spit, South Alsea Bay, Whisky Run to Coquille River, Sixes River, Cape Blanco to the Elk River, Elk River, Euchre Creek, Otter Point, Myers Creek to Pistol River, and Crissy Field.

Monitoring

Breeding season fieldwork was conducted from 1 April to 15 September 2022. Survey techniques, data collection methodology, and information regarding locating and documenting nests can be found in Appendix B. Some beach surveys, particularly to document brood success and to confirm fledglings, were conducted from a 4x4 vehicle using a window mounted scope. Some surveys conducted on the Dunes National Recreation Area (DNRA; encompasses sites from Siltcoos to Tenmile, Figure 1) and Sutton Beach were completed with a single observer. No other modifications to survey techniques were implemented in 2022.

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 (1 April through 15 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.

Many adults are banded and thus uniquely identifiable, while 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 used the highest number of unbanded adults at each site during the resident period to estimate the number of unbanded resident plovers for each site. We added this number of unbanded birds to our count of banded resident adults for a total estimate of resident birds. We believe the number of resident plovers is the best 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 2022 breeding season. We combined data from the north and south side of estuaries (Siltcoos, Overlook, and Tenmile) because individual plovers use both sides of these estuaries. Data from CBNS nesting sites were aggregated as plovers move freely between the beach and the nesting area. 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.

Lauten *et al*. (2016, 2017, 2018, 2019, and 2020) documents brood sampling techniques for the previous five years. During this time period we attempted to intensively monitor a sample of approximately 80% of all known broods to determine brood fate. Due to the continued increasing plover population and the limits of monitoring capabilities, in 2021 we revised our sampling scheme (Appendix C). In 2022, we continued to attempt to sample a minimum of 50% of all known broods at Siltcoos, Overlook, North Tahkenitch, North Tenmile, CBNS, Bandon SPMA, and New River ACEC. We reduced sampling efforts at Sutton Beach, South Tenmile and New River private land. There were no broods at Floras Lake. Sampling techniques were the same as previous years except for the reduced effort (Appendix C).

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 covered in colored tape on the right leg. Many nesting adults that tended broods were already color banded. We did not attempt to band any additional unbanded adults, nor did we attempt to reband any adults in 2022, due to health and safety concerns regarding avian flu. 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 of 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 2022 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 recorded banded adults and chicks that return to the project area in Oregon from previous seasons and calculated 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. Banded

plovers detected along the Oregon coast outside of the project area were not included in return rate calculations to maintain consistency with previous years' calculations.

Nest Failure

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, gull, coyote, fox, skunk, 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) on a small number of nests 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 CBNS in 2022. 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 ten 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. 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.

Predator management was conducted at all active nesting areas by USDA Wildlife Services (USDA-APHIS-Wildlife Services 2022). ORBIC monitors reported causes of nest failure and daily predator observations to Wildlife Services (WS) staff.

Results

Window Surveys and Monitoring

During the May breeding window surveys, 437 plovers were observed in the project area, lower than 2021 and the first decline in plover numbers since 2017. An additional 46 plovers were detected during the window survey at sites outside the project area including the Clatsop Spit, Nehalem Spit, Bayocean Spit, Netarts Spit, Sand Lake and

Sitka Sedge State Natural Area, Nestucca Spit, Agate Beach, Yaquina Point, Bayshore Spit, Blacklock Point to Cape Blanco, and Elk River (USFWS pers. comm.). There were a total of 483 plovers detected on the window survey in Oregon, and a total of 541 for Recovery Unit 1 (Washington and Oregon), 83 fewer plovers than counted in 2021 (n = 624), which was the highest count for a window breeding survey in this recovery unit. The annual breeding window survey count for the project area and total number of plovers present are in Table 1.

There was an overall decrease of 72 plovers in the minimum number of plovers present in the project area in 2022 (Table 1). Of the minimum number of plovers present during the 2022 breeding season, 369 (68%) were banded, 91 fewer adult banded plovers compared to 2021. The maximum number of unbanded plovers estimated by the 10-day interval method was 173, higher than the estimate of unbanded plovers in 2021 (n = 153). During the breeding season we observed 186 banded males, 176 banded females, seven banded adults of undetermined sex, 88 unbanded males, and 85 unbanded females.

We documented 118 color banded adults that attempted to nest, 56 males, 61 females, and one adult of uncertain sex (49% of banded plovers). Due to the increasing number of unbanded adults in the population, it is difficult to determine how many individuals attempted to nest. A minimum of 56 nests had an unbanded female, and a minimum of 47 nests had an unbanded male. Due to sampling and the large number of nests, there has been a decrease in the number of documented nesting plovers because monitors cannot positively identify all adult plovers associated with nests. In addition, because of high rates of nest failure in 2022, we were not always able to identify the associated adults before the nest failed. There was a total of 177 banded resident males, 166 banded resident females, and seven banded adults of uncertain sex present during the 2022 breeding season (15 April – 15 July). Using the minimum number of unbanded individuals estimated by the 10-day interval method during the resident period (n = 158), the minimum estimated resident plover population in the project area was 508, 96 fewer individuals than in 2021. We believe this is the best estimate of the breeding population within the project area. Using the 46 plovers tallied on the window survey from the north coast of Oregon, there were at a minimum 554 adult plovers present in Oregon during the resident season.

The overall plover population in Oregon continues to be substantially higher than recovery goals set for the state (U.S. Fish and Wildlife Service 2007).

Overwinter Return Rate

Of the 466 banded adult plovers recorded in 2021, a minimum of 306 were recorded in 2022 in the project area. The overwinter return rate based on the minimum number of returning banded adult plovers was 66%, slightly below the 1994-2022 mean of 67% and considerably lower than 2021 (75%). The adult male return rate was 67%, substantially lower than 2021 (79%, Lauten *et al.* 2021), and the adult female return rate was 64%, also much lower than 2021 (73%, Lauten *et al.* 2021). Return rates indicate low over winter survival. Adult survival is the most important parameter of population growth (Sandercock 2003, USFWS 2007, Dinsmore *et al.* 2010, Gaines 2019). The low over winter return rates were the main cause of the population decline in 2022.

There was a very low return rate for hatch year 2021 plovers in 2022. Of 162 banded fledglings produced in 2021 (Table 2), we observed 37 in the project area in 2022. The return rate was well below the 2012-2022 average (Table 2) and about half that of the previous six years. Survival of hatch year 2021 (HY21) fledglings was likely 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 2022, but did not return to our project area, were not included in the calculated return rate. These additional HY21 plovers are important contributors to expanding plover populations at historic and new nesting locations in Oregon. Based on return rates, low adult survival combined with very low hatch year return rates was the main factor resulting in a decline in the plover population within the project area and in RU1 in 2022.

Of the returning HY21 birds, 15 (41%) were males, 20 (54%) were females, and two were of uncertain sex. Fourteen of the HY21 returning plovers were confirmed breeding (38%).

During the 2022 season, only one adult male was captured and rebanded due to a foot injury. We did not band any unbanded adult plovers. We banded a total of 174 chicks, considerably fewer than in 2021 (n = 264), partly due to very poor nest success at Siltcoos, Overlook, and Tahkenitch.

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 ends of the project area. We did not survey South Tahkenitch/North Umpqua area in 2022, and thus do not have an estimate of the number of plovers using this section of beach. There was a substantial increase in the number of plovers using Sutton Beach in 2022 (Table 3, n = 16 in 2021, Lauten *et al.* 2021). Some of the increase in plover numbers at Sutton Beach was due to plovers being detected outside the resident time period, however there were also over twice as many plovers detected during the resident time period compared to 2021. While low nest success in 2022 at Siltcoos, Overlook, and Tahkenitch may have contributed to higher plover numbers at Sutton Beach as plovers attempted to find suitable locations to renest after repeated failures, the high number of plovers using Sutton Beach both during the resident period and throughout the entire season indicate a real increase in plover use at this site. Plovers were noted using the entire beach from Sutton Creek area north to the Holman Vista trail and north to the Berry Creek area.

The number of plovers using the Siltcoos estuary in 2022 was slightly lower compared to 2021 (Table 3, n = 77 season-long, and 61 residents in 2021, Lauten *et al.* 2021 vs. 64 season-long and 56 residents in 2022). There has been a decline in the number of plovers overwintering at Siltcoos in the past several years (ORBIC, USFWS unpubl. data) and the number of resident plovers has declined slightly for the past four years (Table 3, n = 67, 62, and 61 for 2019, 2020, and 2021 respectively, Lauten *et al.* 2019, 2020, and 2021). Overlook was one of two sites that had the greatest decline in plover numbers. There were 31 fewer plovers detected at Overlook and 23 fewer resident plovers in 2022 compared to 2021 (Table 3, n = 139 detected plovers and 112 residents in 2021, Lauten *et al.* 2021 vs. 108 detected plovers and 89 residents in 2022). Very low nest success and quick nest failure at Overlook in 2022 likely contributed to fewer plovers being detected at this site. North Tahkenitch had an increase in both plovers detected and resident plovers in 2022 (Table 3, n = 100 plovers detected and 92 residents in 2021, Lauten, *et al.* 2021 vs. 119 plovers detected and 101 residents in 2022). Higher numbers of plovers at this site in 2022 suggest that high nest failure at Overlook, just north of Tahkenitch, likely resulted in plovers moving from Overlook to Tahkenitch and likely other sites searching for suitable nesting habitat. Despite the low nest success at Overlook, population estimates did indicate fewer adults present in 2022 (Table 1).

There was an increase in the total number of plovers detected and resident plovers at Tenmile in 2022, the largest increase of any site in 2022 (Table 3, n = 97 plovers detected and 93 residents in 2021, Lauten *et al.* 2021 vs. 124 plovers detected and 116 residents in 2022). The increase in plovers detected at this site is likely a result of low nest success at Siltcoos to Tahkenitch, causing plovers to move to alternative sites to attempt to find suitable locations to renest. In addition, higher nest success at Tenmile in 2022 likely resulted in more plovers being detected at this site. USFS biological staff did detect plovers using South Tahkenitch to North Umpqua beaches (pers. comm., USFS staff), indicating that plovers are occupying all available habitat on the Dunes NRA. Plovers will move between these sites searching for potential nesting locations.

There was a decline in plovers detected and resident plovers at CBNS in 2022 compared to 2021 (Table 3, n = 144 plovers detected and 138 residents in 2021, Lauten *et al.* 2021 vs. 132 plovers detected and 127 residents in 2022). This is the second year in a row of declining plover numbers at CBNS (Lauten *et al.* 2020 and 2021). While

there was an overall decline in the plover population (Table 1), declining plover numbers at CBNS may be due to carrying capacity, persistent harrier depredations on the nesting area, and/or declining available habitat on South Beach. It is possible that plover nesting density on the nesting area at CBNS is at maximum density and additional plovers may be attracting predators (particularly Northern Harriers (*Circus hudsonius*)) resulting in higher nest failures. Higher nest failures due to persistent presence of harriers may result in plovers, particularly newly recruited plovers, abandoning the nesting area in search of safer alternative nesting locations. High nest failure results in fewer fledglings and thus fewer potential individuals available to return to a given site. Beachgrass growth in a westerly direction results in less habitat in front of the foredune, particularly at South Beach. This, combined with increasing sea level rise, may also result in lower plover numbers or nest attempts due to insufficient available habitat. The combination of these factors may result in lower plover numbers at CBNS. Plovers continue to seek available and adequate nesting locations at CBNS. Plovers were found nesting on the beach at the north jetty, directly in front of the vehicle access point. Multiple nests were found north of the FAA towers and between the three vehicle access points north of the FAA towers, and a brood was noted on the beach north of the north most vehicle access point and south of the Horsfall area. In addition, local birders noted plovers consistently using the beach just south of the I-beam at the south end of Horsfall Beach area at the end of the season. We expect plovers to continue to occupy and attempt to nest at these locations outside of the plover management area.

The Bandon SPMA had the largest decline in both plovers detected and resident plovers in 2022 (Table 3, n = 128 plovers detected and 109 residents in 2021, Lauten *et al.* 2021). While annual survival is the most important factor in population growth, persistent low nest success, low fledgling output and low recruitment rates may be contributing to lower plover numbers at Bandon SPMA. Consistent Great Horned Owl (*Bubo virginianus*) presence at the site in 2022 may contribute to low survival rates. Plovers continue to nest on the beach north of China Creek, partly because of poor and limited available habitat south of the creek to the New River mouth. There is much sufficient habitat from the mouth of New River to the southern boundary of the SPMA, however, nest burial is common due to wind-blown sand, and much of the habitat south of the open spit has increasing dunes, dune height, and beachgrass growth that is slowly degrading habitat and reducing available habitat. Plover use on private land continues to decline due to beachgrass growth that has encroached into overwash areas, resulting in loss of habitat. In addition, persistent human use with dog activity along private land likely results in disturbance. There were slightly lower numbers of plovers at both New River HRA and Floras Lake in 2022 compared to 2021 (Table 3, Lauten *et al.* 2021). Plover activity on the New River HRA was concentrated on the north side of Croft Lake breach, on the south spit of Croft Lake breach south to the New Lake breach area, and on Clay Island breach. Plover activity at Floras Lake was concentrated on and north of the Cooperative Management Area. 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.

Plovers have successfully reestablished populations in every coastal county in Oregon. In 2022, for the fifth consecutive year, plovers were documented nesting at Clatsop Spit and Necanicum Spit in Clatsop Co., and Nehalem Bay State Park, Bayocean Spit, and Sitka Sedge State Natural Area and Sand Lake in Tillamook Co., Yaquina Bay State Park, Fox Creek, and Bayshore Spit in Lincoln Co., and Paradise Point in Curry Co. (OPRD, unpublished data, USFWS, pers. comm.). Plovers should be expected to continue to occupy available habitat along the entire coast of Oregon and may be found at unexpected locations with sufficient habitat along the coast.

Nest Activity

Table 4 shows the number of nests located during the 2022 nesting season in our study area (Figures 2-12). We found 183 fewer nests than in 2021, and 70 fewer nests hatched (Lauten *et al.* 2021). Overall nest success in 2022 was well below the average (Tables 5 and 6) and well below the average of the last 10 years ($\bar{x}$ = 38%). We

detected more plovers at Sutton Beach in 2022 (16 in 2021 vs. 60 in 2023, Table 3, Lauten *et al.* 2021) and found more nests (11 in 2021 vs. 21 in 2022; Table 4). There was a slight increase in the number of nests at Siltcoos, with slightly higher numbers at North Siltcoos (21 in 2021 vs. 29 in 2022) and slightly lower numbers at South Siltcoos (29 in 2021 vs. 25 in 2022; Table 4). Higher number of nests in 2022 at Siltcoos were a result of high nest failure and thus renest attempts. There was a drastic decline in nest numbers at North and South Overlook (75 nests at North Overlook in 2021 vs. 24 in 2022, and 80 nests at South Overlook in 2021 vs. 39 in 2022; Table 4). There were lower numbers of plovers at Overlook in 2022 (139 in 2021 vs. 108 in 2022; Table 3, Lauten *et al.* 2021), however low nest numbers may also have been a product of very high, rapid nest failure and thus monitors were not able to document some nest attempts before they failed. North Tahkenitch had similar numbers of nests in 2022 compared to 2021 (75 nests in 2021 vs. 76 in 2022; Table 4). Tenmile had a decline in nest numbers despite an increase in numbers of plovers (97 plovers and 115 nests in 2021 vs. 124 plovers and 92 nests in 2022; Tables 3 & 4, Lauten *et al.* 2021); the decline in nest numbers was a result of higher nest success and thus fewer renesting attempts. There was a decline in nest numbers at CBNS in 2022 compared to 2021 (125 nests in 2021 vs. 102 nests in 2022; Table 4). Overall nest success at CBNS was similar to 2021 (Table 5, Lauten *et al*, 2021), suggesting that the decline in nest numbers was due to a decline in the plover population at this site (144 birds in 2021 vs. 132 birds in 2022; Table 3). There was a decline in nest numbers at Bandon SPMA (145 nests in 2021 vs. 96 in 2022) and New River HRA (24 nests in 2021 vs. 14 in 2022); both sites had fewer plovers than in 2021 (128 plovers at Bandon SPMA in 2021 vs. 90 in 2022, and 31 plovers at New River HRA in 2021 vs. 25 in 2022). Floras Lake had slightly more nests in 2022 (3 nests in 2021 vs. 6 in 2022), despite having fewer adults present (9 adults in 2021 vs. 6 adults in 2022).

The first nests were initiated about 1 April (Figure 13). Nest initiation then declined to well below average through the middle of May. The low number of nests during April and May was due to cold and wet weather. Peak nesting occurred during 10 June to 19 June time period, one time period later than the average peak nesting period. The last nest initiation occurred on 27 July.

An additional 85 nests were documented outside our study area (Table 7, including S Tahkenitch and N Umpqua, Anholt 2022, Courtney Gabriel pers. com.), fewer than were found in 2021 (n = 108, Lauten *et al.* 2021). In Clatsop Co., 18 nests were documented at Clatsop Spit and Necanicum Spit, and 26 nests were found at Tillamook Co sites (Table 7). Thirteen of these successfully hatched (29%). In Lincoln Co., 29 nests were documented, the majority at Bayshore Spit, with one nest at Fox Creek and two found failed at Yaquina Bay State Park (Table 7). Five of these nests were successful (17%). Seven nests were found by FS technicians at S Tahkenitch (n = 2) and N Umpqua (n = 5) (Courtney Gabriel pers. com.). Four of the nests at N Umpqua successfully hatched (57%). Five nests were documented at Paradise Point State Recreational Area, Curry Co.; none were known to have hatched. Eleven chicks were estimated to have fledged from Clatsop Co., eight fledglings were produced from Tillamook Co., and seven fledglings were produced from Lincoln Co. It is unknown if any chicks survived to fledging at N Umpqua (Anholt 2022, Courtney Gabriel, pers.com.).

Nest Failure

Predators were the main cause of nest failure and were responsible for 71% of nest failures (Table 8), similar to 2021 (73%, Lauten *et al.* 2021). Common Ravens (*Corvus corax*) were the most commonly identified predator (20% of known depredations). Ravens were responsible for 54 of the 57 corvid depredations (95%), nearly the same number of known raven depredations as 2021 (n = 55 in 2021, Lauten *et al.* 2021). Northern Harriers were identified as the predator at 22 nests, less than in 2021 (Table 8, n = 32 in 2021, Lauten *et al.* 2021). We were unable to positively identify the cause of 34 failures at these sites. While evidence clearly indicates an avian predator was the cause of these nest failures, tracks at the nest were inconclusive to determine whether they were

corvid or harrier depredations. In 2021 a Western Gull (*Larus occidentalis*) was responsible for numerous depredations at Bandon SPMA until it was removed (Lauten *et al.* 2021). In 2022 we only documented two gull depredations at Bandon SPMA, and both occurred at the end of the breeding season. We had no evidence that a gull was depredating nests prior to these two depredations. Bandon SPMA is the only nesting site where we have documented gulls depredating plover nests. Coyote depredations have been increasing in recent years particularly at Overlook and Tahkenitch (Lauten *et al.* 2019, 2020, and 2021). In 2022 we documented 11 nests depredated by coyotes, but only three at Overlook and Tahkenitch (Table 8), much lower than in 2021 (n = 38, Lauten *et al*, 2021). Coyotes were still present at these sites. The reduction in coyote depredations was most likely the result of persistent raven and harrier activity. Ravens and harriers are very efficient at locating and depredating plover nests and they likely depredated most nests much faster than coyotes could locate them. Skunks (*Mephitis* sp.) caused four nest failures. There were no documented fox depredations in 2022. Gray fox (*Urocyon cinereoargenteus*) continues to be present at Bandon Beach. Red fox (*Vulpes vulpes*) numbers continue to diminish in the Bandon Beach/New River area, due to persistent efforts to remove them. Evidence of fox activity is mostly restricted to south of the Croft Lake breach, and they are most common in the Floras Lake area.

Corvids continue to be the most commonly identified nest predator on the study area (see previous reports at https://inr.oregonstate.edu/biblio). In 2022, Common Raven depredations were low at Tenmile and CBNS. These two sites had successful raven removal by WS staff in 2022, and had the highest nest success (Table 5). At Siltcoos, Overlook, Tahkenitch, Bandon SPMA, and New River HRA, raven activity was persistent all season and they were not successfully removed, resulting in extremely poor nest success particularly at Siltcoos, Overlook, Tahkenitch and Bandon SPMA. This is the second consecutive year that Overlook and Tahkenitch had persistent raven activity and very low nest success (Table 8, Lauten *et al.* 2021). Data continues to show that failure to remove problematic ravens is associated with poor nest success and productivity. Removal of corvids at all sites remains high priority. See the APHIS-Wildlife Services report for details concerning predator management (USDA-APHIS-Wildlife Service 2022).

We continue to document annual predation activity by Northern Harriers. Harriers were the second most commonly identified predator (Table 8) and were documented depredating nests at Siltcoos, Tahkenitch, Tenmile and CBNS. We did not positively identify harrier depredation at Overlook, but harriers were present and nests failed to either raven and/or harrier at this site. At CBNS, WS documented harriers hunting the nesting area as early as March. At least one pair of harriers were noted attempting to nest just north of the plover nesting area. The majority of harrier identified nest failures occurred at CBNS (Table 8), and harriers were the only known avian predator to depredate nests at CBNS. WS removed two female harriers and one male harrier from CBNS, which resulted in improved nest success on the nesting area. However, another pair of harriers, likely from further north on the spit, eventually began to hunt the nesting area. Data indicate depressed fledgling output from the broods on the nesting area (Table 9). Lauten *et al*. (2019, 2020, and 2021) documents the negative impact of harriers at CBNS on nest success, brood success, fledgling success, and fledglings per brood, and how removal of harriers has a positive effect on these reproductive parameters. In 2022, nest success on the nesting area of CBNS was low due to the presence of harriers (Table 5), and reproductive output from the nesting areas was also depressed with a low breeding coefficient (Table 9) indicating the plovers had low output for the effort. When plovers moved to the beach later in the season, nest success (Table 5) and reproductive output increased substantially. The annual documentation of failed nests due to harriers as well as the widespread harrier activity at most of the nesting sites clearly indicate that harriers are a regular annual predator of plover nests, chicks, and adults, and management of harrier impacts is important to help maintain and sustain plover nesting success.

Lauten *et al*. (2020 and 2021) discusses Great Horned Owl presence at Bandon SPMA, likely resulting in low reproductive output and possibly adult mortalities. In 2022 we documented owl activity at the New River spit, and

WS incidentally trapped two Great Horned Owls on the New River spit, and one additional one at the New River HRA. One of these owls was removed from the site, but the others were released unharmed. We have not documented any nest failures due to the owls' presence, and in 2022 broods from hatched nests had relatively good success (Table 9). We continue to be concerned that the owls may be having a negative impact on adult and fledgling plovers, but due to the nocturnal nature of the owls and the difficulty of documenting owl depredations, conclusive evidence is elusive.

In 2021 we documented a Western Gull depredating a significant number of plover nests (Lauten *et al.* 2021). This gull was eventually removed by WS, and in 2022 we had no evidence of gull depredations until 1 Aug when we found evidence of gull depredation at two nests. No gulls were removed in 2022 due to the late date of these nest failures.

The highest causes of nest failure were unknown depredation and unknown cause (Table 8), similar to 2021 (Lauten *et al.* 2021). The main reason for unknown outcomes was windy and/or wet weather conditions that wiped away tracks. In addition, reduced coverage at some nesting sites results in longer time periods between some nest visits which increases the likelihood that evidence at the nest site will be destroyed. For unknown depredations, we determined that a predator was the cause of the failure, but there was a lack of evidence as to which predator. Our observations from each site suggests the proportion of predators responsible for these unknown depredations. On the Dunes NRA (Forest Service sites), the majority of known nest failures were caused by ravens, and therefore the large number of unknown depredations in this area were likely the result of ravens, however harriers likely were responsible for some of the failures. At CBNS, most of the unknown depredations were likely caused by harriers. At Bandon SPMA, the large number of unknown depredations were most likely caused by ravens, as they were the most commonly known predator. At New River HRA, the main cause of failure is likely the persistent raven activity from the nearby ranches.

Nest failures are categorized as due to unknown cause because there is no evidence at the nest site of what may have happened. These nests frequently are in places where windy conditions drastically change the landscape, overwashing could have occurred, predation may have occurred before or after wind or overwashing, or human activity may have contributed to the outcome. Bandon SPMA had the largest number of nests failed to unknown causes (Table 8) due to windy conditions and high levels of human activity, especially on the Bandon Beach side, resulting in high numbers of unknown-cause failures. Currently there is also little available habitat along the foredune, where plovers are nesting in fairly high densities, which results in close interaction with recreational activity.

We placed Reconyx cameras at 20 nests in 2022 to document nest predators. At three nests the camera failed to capture definitive images; one camera was spun away from the nest by wind, rain obscured the images at another camera, and a third camera malfunctioned. Two of these nests failed to unknown depredation, and the third nest had an inconclusive outcome. A total of 12 nests hatched; overall nest success for camera nests was 60%, higher than the overall apparent nest success for all nests (Table 5), suggesting the use of cameras did not negatively affect nest success. A total of five nests failed. Three nests failed to raven, one to harrier, and one to coyote. Monitors correctly identified the predator at one nest (a harrier depredation). Monitors concluded three nests were unknown depredation and one nest may have hatched; cameras revealed that the three nests failed to raven, and the nest thought to have hatched failed to coyote. 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 nests with cameras.

Productivity

We sampled 90 broods from the 125 nests that were known to have hatched (72%), 50 fewer broods than we sampled in 2021 (Lauten *et al.* 2021). The sample produced 96 fledglings (Table 9). The overall fledging success based on the sample broods (Table 9) was slightly lower than the post-predator management average (Table 10). The overall brood success rate of sampled broods (Table 9) was near the post-predator 2004 – 2022 average ($\bar{x}$ = 74% +/- 7%). Using the data from sampled broods, we estimated the total number of fledglings for each site by multiplying the number of fledglings per sampled brood by the total number of broods hatched at each site (Table 5). Table 11 shows the estimated total number of fledglings produced in 2022, the lowest total since 2013. We calculated the number of fledglings per resident male for each site within the project area (Table 12). The average number of fledglings per resident male for the project area was the lowest since prior to 2004, well below recovery goals and below the mean post-predator management average (Table 12). We believe the estimate of productivity based on the number of fledglings produced per sample brood (1.07, Table 9) is a good estimate of reproductive output of successful males within the project area. However, based on the total male population size within the project area (ca. = 265) and the estimated number of fledglings produced (Table 11, 130/265 = 0.49 fledglings per resident male), overall productivity was below recovery goals of 1.00 fledgling per male.

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 9, 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. In 2022, only three sites were productive: North Tenmile, South Beach at Coos Bay North Spit, and the New River HRA. Both North and South Siltcoos, North and South Overlook, North Tahkenitch, South Tenmile, Bandon SPMA, and Floras Lake had very poor breeding coefficients and thus were very unproductive.

Sutton

We documented more nests at Sutton Beach in 2022 compared to 2021, but a similar number compared to the previous five years (Table 4). Nest success in 2022 (Table 5) was slightly higher than the average for this site ($\bar{x}$ = 20%); nest success at Sutton Beach is historically low due to windy conditions and persistent raven activity. Four broods were used in the sample (Table 9) and all four successfully fledged one chick. There were a total of six known broods from Sutton Beach and they produced an estimated six fledglings, higher than in 2021 (Table 11). The hatch rate was similar to 2021 (Lauten *et al.* 2021) and was above the post predator management average (Figure 14). Fledging success was higher than 2021 (Lauten *et al.* 2021) and well above the post predator management average (Figure 15), indicating that broods were reasonably successful once nests hatched. The number of fledglings per resident male was similar to 2021 (Lauten *et al.* 2021) and equal to the post predator management average (Figure 16). The number of fledglings produced was higher than in 2021 (Table 11). Sutton Beach historically produces low number of fledglings (Table 11), has low fledging success rates (Figure 15), low fledglings per male (Figures 16), and a low breeding coefficient (Table 9) indicating that this site has consistently poor reproductive output for the effort.

Siltcoos

There were four more nests at Siltcoos in 2022 compared to 2021 (Table 4), however only one nest hatched, resulting in extremely poor nest success (Table 5), well below the average for both sides of the estuary ($\bar{x}$ = 36% for the north side, $\bar{x}$ = 44% for the south side). The hatch rate was therefore also extremely low at Siltcoos in 2022 and well below the post-predator management average (Figure 14). There was only one brood at Siltcoos in 2022

and it produced one fledgling (Table 11). Fledging success was near the post-predator management average (Figure 15), but the sample was extremely small. Due to the low fledgling output, the overall number of fledglings per resident male was well below the post-predator management average for this site (Table 12, Figure 16). The breeding coefficient on both sides of the river was extremely low (Table 9), indicating very poor output for the effort. In 2022, Siltcoos had one of the lowest reproductive outputs since monitoring was initiated.

Overlook

We found 92 fewer nests at Overlook in 2022 compared to 2021 (Table 4) partly due to persistent predator pressure that resulted in nests being depredated before documentation by monitors. Of the nests documented, only one hatched (Table 5), resulting in extremely low nest success, well below the averages for these sites ($\bar{x} = 42\%$ for North Overlook and $\bar{x} = 39\%$ for South Overlook). This is the second consecutive year with low nest success (Lauten *et al.* 2021).

Due to predation pressure, the hatch rate at Overlook in 2022 was extremely low and well below the average (Figure 14). Overlook produced just one fledgling, the lowest since 2013 and well below recent years (Table 11). While fledging success was above the post predator management average for this site (Figure 15), there was only one brood sampled. The number of fledglings per resident male was well below the post-predator management average (Table 12, Figure 16). Similar to Siltcoos, Overlook had extremely low breeding coefficients resulting in one of the poorest reproductive outputs since monitoring was initiated (Table 9).

Tahkenitch

We found four more nests at North Tahkenitch in 2022 compared to 2021 (Table 4), but only eight hatched resulting in very low nest success (Table 5), well below the average for this site ($\bar{x} = 40\%$). Due to high rates of nest failure, the hatch rate at Tahkenitch in 2022 was well below the post-predator management average (Figure 14). We sample six of eight of the broods (Table 9); each brood fledged at least one chick resulting in a fledging success rate higher than post predator management average (Table 9, Figure 15). The number of fledglings per resident male was well below the post predator management average (Table 12, Figure 16) due to the large number of resident males at this site. The number of fledglings produced was similar to 2021, but the lowest since 2013 and well below most recent years (Table 11). The breeding coefficient was very low for the second consecutive year indicating very poor productivity for this important breeding site (Table 9).

For the past two years Siltcoos, Overlook, and Tahkenitch had poor productivity despite high numbers of plovers using these sites (Table 3, Lauten *et al.* 2021). Increasing predation pressure by ravens and harriers, and to a lesser extent coyotes, has resulted in very poor reproductive output. Improved predator management at these sites may result in improved productivity.

Tenmile

There were 14 fewer nests found at North Tenmile and nine fewer nests found at South Tenmile in 2022 compared to 2021 (Table 4). The lower number of nests at North Tenmile was partly due to higher nest success (Table 5, Lauten *et al.* 2021). Fewer nests at South Tenmile was partly due to monitors inability to sufficiently cover this site. Nest success at South Tenmile was similar to 2021 (Table 5, Lauten *et al.* 2021), but well below average for this site ($\bar{x}$ = 47%). Nest success at North Tenmile was higher than the average for this site (Table 5, $\bar{x}$ = 43%). Successful predator management at this site resulted in higher nest success than other FS sites to the north. The hatch rate at Tenmile was near the post predator management average (Figure 14).

We sampled 26 of 40 broods at North Tenmile and one of four broods at South Tenmile (Table 9). The fledging success rate and fledglings per male were below average for these sites (Figure 15 and Figure 16). The number of fledglings produced was only about half the previous year (Table 11). The breeding coefficient at North Tenmile was reasonable, but very low at South Tenmile (Table 9). Higher fledging success and fledglings per sampled brood at North Tenmile would have resulted in a higher breeding coefficient (Table 9).

Only 53 fledglings were produced from the Dunes NRA in 2022 (Siltcoos to Tenmile), a very low output for these important breeding sites (Table 11). Low nest success, and thus low fledgling numbers from Siltcoos to Tahkenitch, had a large negative impact on the overall reproductive output within the project area. Better reproductive output at these important nesting sites is essential to sustaining the plover population.

Coos Bay North Spit

We found 23 fewer nests at CBNS in 2022 compared to 2021 (Table 4), partly due to fewer plovers being present in 2022 (Table 3, Lauten *et al.* 2021). The largest decline in the number of nests occurred on the HRAs (Table 4), which may partly be a result of persistent presence of harriers. Nest success on South Spoil and the HRAs was well below average for both these sites (Table 5, $\bar{x}$ = 59% and $\bar{x}$ = 49% respectively). Plovers moved to South Beach later in the season where nest success was substantially higher than on the nesting area and well above average (Table 5, $\bar{x}$= 61%). Due to relatively low nest success on the nesting area, the overall hatch rate for CBNS was below average (Figure 14). We sampled 23 broods from South Beach and 13 from the CBNS HRA nesting area (Table 9). Brood success, fledging success and fledglings per male were all lower on the CBNS HRA nesting area, where harriers are routinely noted hunting. The estimated number of fledglings produced was 26 fewer than in 2021 (Table 11). South Beach had the highest productivity of any site in 2022 based on the breeding coefficient (Table 9).

The overall fledging success was below average for all of CBNS (Figure 15). The number of fledglings per male was well below average for CBNS (Figure 16), however this number may be biased low due to the large number of male plovers that visit this site during the residency season, and are thus counted as breeding residents, but may not have attempted nesting. The breeding coefficient on the CBNS HRA nesting area was low (Table 9) and suggests that harriers, the most common predator on the nesting area, are having a negative impact on plover productivity. Harriers are generally not present on the beach and therefore the breeding coefficient was considerably higher there (Table 9). In 2022, harriers were present near the HRAs from the beginning of the season and had a negative impact on nests on the nesting area (Table 8). Three harriers were removed, and nesting success increased on the nesting area, however, harriers again appeared on the nesting area during brood rearing and data indicates the broods on the nesting area were not as successful as the broods on the beach.

Lauten *et al*. (2020 and 2021) document that both illegal recreational vehicle use of South Beach and degradation of habitat on the beach due to beachgrass and western movement of the foredune were likely having a negative effect on both nest and brood success. In 2022 we continued to note regular vehicle violations of the closed area, including repeated driving high on dry sand, including behind ropes and signs. Loss of habitat has resulted in a narrowing of available nesting and brooding areas on the beach, and has reduced any buffer between recreational activity on the beach and nesting and brooding plovers. The loss of habitat and illegal recreational vehicle use and violations of the closed area are detrimental to plover productivity.

Bandon SPMA

There were 46 fewer nests at Bandon SPMA in 2022 compared to 2021 (Table 4), mostly due to a decline in the number of plovers using this site (Table 3, Lauten *et al.* 2021). Similar to 2021 (Lauten *et al.* 2021), nest success was very low (Table 5) and well below the average for this site ($\bar{x}$ = 39%). Data indicate that ravens were most

common predator (Table 8) and were likely the main reason for the poor nest success, however the large open spit south of the New River mouth was susceptible to windy conditions that often results in nest burial. On the Bandon Beach side of the river, continued lack of habitat maintenance has resulted in the loss of habitat and plovers nesting in a very narrow dry sand section of beach leaving them susceptible to detrimental weather conditions, predation, and disturbance from recreation. Nest success at Bandon Beach was 12%, lower than 2021 (19%, Lauten *et al.* 2021), and nest success on the New River spit was 11%, slightly higher than in 2021 (7%, Lauten *et al.* 2021). The few broods that hatched were reasonably successful (Table 9), however only 16 fledglings were produced, fewer than in 2021 (Table 11) and the lowest since 2016.

The hatch rate at Bandon SPMA was well below the post-predator management average (Figure 14) but the fledging success rate was above average (Figure 15). Due to the high number of males utilizing this site and the low number of successful nests, the number of fledglings per male was well below average (Figure 16). The breeding coefficient was very low (Table 9), indicating very poor productivity for the effort. There have been low breeding coefficients at Bandon SPMA since 2019 (Lauten *et al.* 2019, 2020, and 2021) mostly due to a variety of predators at this site. Improved habitat and predator management at this site may lead to higher reproductive output.

New River

Only one nest was documented south of the Bandon SPMA boundary area on New River private land in 2022 (Table 4, Figure 10); the nest was successful and fledged two chicks.

We found nine fewer nests on the New River HRA in 2022 compared to 2021 (Table 4). There was a slight decrease in plover numbers at this site (Table 3, Lauten *et al.* 2021). Nest success was identical to 2021 (Table 5, Lauten *et al.* 2021) and below the average for this site ($\bar{x}$ = 51%). Data indicate that the decrease in nest numbers was due to fewer plovers and fewer nest attempts. Plover activity was most concentrated on the north side of the HRA from the north end to Croft Lake breach, and from Croft Lake to breach to the New Lake area. Two nests were also found on Clay Island breach (Figure 11). The hatch rate was below average for this site (Figure 14). Fledgling success was above average (Figure 15) and the number of fledglings per male was below average (Figure 16), but the number fledglings per sample brood was very good (Table 9) indicating once broods hatched they were fairly successful. The breeding coefficient was good indicating that plovers were reasonably successful for the effort at this site (Table 9). There was low red fox activity on the HRA in 2022; red fox presence has been declining in recent years, suggesting that predator management efforts have been successful at reducing the fox population and the impacts on nesting plovers at the New River HRA. Raven activity continues to the be the main source of nest failure (Table 8); ravens continue to be abundant in the area due to the proximity to sheep and cattle ranches along New River.

Floras Lake

There were only six nests at Floras Lake in 2022 (Table 4) and none were successful; all failed due to corvid or unknown depredations (Table 5).

Summary

In 2022, overall nest success was well below the post-predator management average (Table 5, $\bar{x}$ = 41%) and below the level we believe is needed for a sustainable population (~ 40%; Gary Page, Lynne Stenzel pers. comm.). Based on the brood sample, productivity once broods hatched was at sustainable levels, with brood success near post predator management average (Table 9, $\bar{x}$ = 74%), fledging success near post predator management levels (Table 10), and the number of fledglings per sampled brood above recovery goals (Table 9). However, the

estimated number of fledglings produced was 130, the lowest since 2013 (Table 11). Due to the relatively high number of male plovers detected during the residency period (15 Apr – 15 July, n ≈ 265), the overall number of fledglings per male (0.49) was well below recovery goals. The data indicated that low nest success was the main cause of a decline in fledgling production, as the sample indicated that once broods hatched, they fared relatively well. Higher nest success may have resulted in higher reproductive output that was closer to recovery goals. The overall breeding coefficient (0.09 +/- 0.09) was much lower than in 2021 (0.15 +/-0.08, Lauten *et al.* 2021), indicating the poor reproductive output for the effort. Productivity at Sutton Beach, Siltcoos, Overlook, Tahkenitch, South Tenmile, the HRAs at CBNS, Bandon SPMA and Floras Lake was very poor, resulting in reproductive output that would not sustain the plover population long term. Extremely poor reproductive output at Siltcoos to Tahkenitch and Bandon SPMA, where a substantial number of plovers reside, had an important negative impact on the overall success of the plovers in the project area in 2022. Higher fledgling production at these sites is critical to sustaining the Oregon coastal plover population. The data indicate that poor nest success, with many eggs laid but very few hatched and very few resulting fledglings, was the main cause of poor plover production in 2022.

Lauten *et al*. (2020) shows that sites between Siltcoos and Bandon SPMA are responsible for nearly 90% of all the eggs laid, eggs hatched, and fledglings produced in the project area since the early 1990s. Management should continue to focus its efforts on enhancing and maintaining good productivity at these sites (Siltcoos, Overlook, North Tahkenitch, CBNS and Bandon SPMA) which will lead to sustainable plover populations within the project area while supplementing and assisting to sustain populations along the Northern California coast, the Northern Oregon coast, and Washington. Maintaining overall average nest success of 40%, fledging success of 40%, fledgling per male at approximately 1.00 (Gaines 2019), and a breeding coefficient over 0.15 should result in a stable to growing plover population along the Pacific Northwest coast.

Productivity Before and After Predator Management

Data from Floras Lake and Sutton Beach are 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 2021 comparisons.

The 2022 overall nest success (Table 5) was much lower than the ten-year (2013 – 2022) average of 38.0% +/- 13%, and lower than 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 Tahkenitch, Tenmile and CBNS where they have remained relatively stable but above 40% (Figure 15). The post-predator management mean brood success rate for all sites (2004-2022; $\bar{x} = 73.6\%$+/-7.0) 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 male has improved at all sites except Tenmile and CBNS where it has remained relatively stable at nearly 1.20 for Tenmile and over 1.40 for CBNS (Figure 16). 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 17), however there have been two consecutive years of declining reproductive output. Despite the recent declines, the overall population of plovers both within the project area and on the Oregon coast in general remains well above recovery goals (Table 1).

Discussion and Recommendations

Lauten *et al*. (2021) discusses our efforts to balance our ability to sufficiently monitor the nesting sites while collecting adequate data to estimate reproductive parameters. In 2021 we sampled 65% of hatched nests, lower than the approximate 80% sampled in the previous five years (Lauten *et al.* 2016, 2017, 2018, 2019, 2020, and 2021). In 2022, we sampled 72% of hatched nests, higher than our target of 50%. The percentage sampled was

relatively large due to the low numbers of hatched nests (Table 5), thus we were able to attend to more hatchings. The sample-provided estimates of brood success, fledging success and fledglings per sample brood were all similar to 2020 and 2021 (Lauten *et al.* 2020 and 2021), with brood success and fledging success near the 10-year average, suggesting that the sample yielded representative reproductive data.

Lauten *et al*. (2021) discusses the deficiencies associated with calculating the number of fledglings per male, an important recovery criterion, and how the breeding coefficient is a more robust assessment of reproductive effort and output. We continue to report different estimates of plover productivity (Tables 9, 10, and 11). In 2022, the estimated number of fledglings produced was less than half the estimated number of resident males, clearly indicating low productivity. The breeding coefficients also reflected the low reproductive output, with only three sites having coefficients higher than 0.15 (Table 9), the base level of good reproductive output. We anticipate further reductions in banding efforts, due to work load, staff experience, and concerns with avian flu. Reductions in banding and sampling will result in less accurate data or absence of data needed to calculate reproductive parameters. We believe that an assessment of fledglings counted on surveys and known numbers of hatched eggs will provide a breeding coefficient that can be used to estimate reproductive output and success.

Predator management continues to be a crucial aspect of a sustainable plover population. Due to the large number of plovers and widespread nesting areas, focusing management actions at nesting sites with high potential output is likely necessary. Lauten *et al*. (2020) details which nesting sites have contributed most to productivity and the increasing plover population and we recommend that future management focus efforts at these nesting sites because they will continue to contribute the most to a sustainable plover population.

Sutton Beach and the Dunes NRA

Sutton Beach continues to have low average reproductive parameters (Figures 14-16), however there was an increase in plover numbers at this site in 2022 (Table 3, Lauten *et al.* 2021) and reproductive parameters were higher than the post predator management average at this site. Due to the remote location of the site and the generally low plover population and low reproductive output, monitors and WS agents have had limited available time to visit this site. If Dunes NRA sites have low reproductive success, we expect plovers to search for alternative sites such as Sutton Beach to attempt to nest. We expect plovers to continue to occupy this site, but due to the predator community at this site (particularly ravens) and windy conditions, we expect relatively low plover numbers and reproductive output.

South Siltcoos to North Tahkenitch have contributed substantially to annual and long-term plover populations (Table 4 and 11, Lauten *et al.* 2020). In the last two years, reproductive output at these sites has been very low (Table 9 and 11, Lauten *et al.* 2021), with only 12% of the fledglings produced in 2022 coming from these sites despite high plover numbers (Table 3). The substantial decline in productivity has been due to very poor nest success (Table 5, Lauten *et al*, 2021) and relatively poor fledgling success caused by persistent predator pressure. Efforts to improve nest success and predator management are needed to increase reproductive output at these important plover nesting areas.

We expect plovers to continue to utilize available habitat at South Tahkenitch and North Umpqua, especially if traditional nesting sites at Siltcoos to North Tahkenitch fail to have sufficient nesting success. We recommend continued monitoring of this area to document plover activity in this area.

The beach from South Umpqua to Tenmile estuary continues to be a very important plover nesting area with the second highest total plover use (Table 3) and high reproductive output (Table 9 and 11). Effective predator management, particularly on the North Tenmile spit to South Umpqua has been critical in maintaining high reproductive output. Due to limited time, monitor workload, and relative difficulty accessing South Tenmile, data

from this side of estuary has been limited. Data and observations indicate that Northern Harriers are consistently present at South Tenmile and are likely the cause of poor reproductive output (Table 8 and 9). Reduction in harrier activity at this site may have a positive effect on plover productivity. Unfortunately, there is limited time available to better monitor this site, especially since plover numbers on this site are lower than North Tenmile and other Dunes NRA sites. Tenmile is an extremely important nesting site for both the Dunes NRA and for the Oregon coast, and continued predator management will be an important tool to maintain productivity at this site. We recommend efforts to reduce recreational disturbance from the South Umpqua area, as we regularly document human, dogs and occasional vehicle use near nesting plovers.

As noted in Lauten *et al*. (2020), the Dunes NRA is critical to maintaining and growing plover populations. Substantial numbers of plovers occupy these sites, and large numbers of nests and fledglings have been produced at these sites (Table 4 and 11). Effective predator management from Siltcoos to South Tenmile continues to be a critical management action resulting in successful plover productivity.

Coos Bay North Spit

Previous reports have documented and discussed Northern Harrier impacts on reproductive success at CBNS (Lauten *et al.* 2020 and 2021). As in 2021 (Lauten *et al.* 2021), harriers were observed hunting and were documented depredating plover nests by early April. Three harriers were removed from CBNS in 2022 (WS report, 2022), alleviating some predation pressure on plovers, however, additional harriers moved in later in the season and continued to negatively impact plover productivity. We expect harriers to be an annual presence at CBNS and other sites and their presence will have a negative impact on plover productivity. We recommend that management efforts focus on removing harriers from plover nesting areas as soon as evidence indicates they are actively hunting the nesting sites.

Lauten *et al*. (2020 and 2021) discussed the loss of habitat at CBNS due to westward encroachment of beachgrass and rising sea levels. We continue to note substantial loss of habitat in front of the foredune. For example, the I-beam near the jetty formerly was west of the foredune by a substantial distance. As of 2022, the foredune north of the I-beam is further west than the I-beam, and vegetation is nearly surrounding the I-beam. Wave action along much of beach is up to the edge of the foredune, creating a vertical foredune face leaving no room for nesting, or ropes and signs (some ropes and signs were installed on top of the foredune). Vegetated foredunes and loss of the wave slope has reduced critical habitat, limited nesting locations, and leaves nests more susceptible to human violations and disturbance. Plovers are thus forced to search for adequate nesting habitat that often is in suboptimal habitat, including south of the I-beam by the north jetty and in direct path of vehicles accessing the beach, or north of the north I-beam on beaches open to vehicle use and all recreational activity. Some plovers are also moving north towards Horsfall Beach, and area not monitored or protected. As in 2021, we continue to document numerous vehicle violations, often east of carsonite signs or ropes. Ropes along the entire beach are important to preventing most violations, however due to encroachment of beachgrass to the west, ropes and signs are often at or in the high tide surf, leaving no room for recreational activity, and encouraging vehicle and human violations of the high dry sand. Reduction of recreational violations could be achieved by removing vegetation in front of the stable, tall foredune and having a vegetation-free wave slope where plovers can safely nest, ropes can be safely installed, and recreational activity is allowed further west of nesting plovers. We would also recommend installation of security cameras both on the beach and/or along the foredune to help monitor when vehicle violations occur, and potentially capture violators. We also recommend that maintaining vegetation free corridors through the foredune maintains paths for plover broods to either access the beach for foraging and avoiding harrier hunting activity on the nesting area, or to exit the beach and move onto the nesting area away from vehicle and recreational activity on the beach.

CBNS continues to be the most productive nesting site north of central California (Lauten *et al.* 2020). Effective predator management at CBNS is essential to maintain high reproductive output at this critical site. CBNS and the Dunes NRA continue to be the most productive nesting sites on the Oregon coast, and are largely responsible for maintaining plover population in the entire recovery unit.

Bandon SPMA

Bandon SPMA has some of the most extensive natural habitat on the coast and harbors a large plover population (Table 3). In 2021 and 2022, brood success, fledging success and the number of fledglings per brood all improved compared to 2020 (Table 9, Lauten *et al.* 2020 and 2021), however the breeding coefficient was very low in all three years, indicating that there is very poor productivity for the effort (Table 9, Lauten *et al.* 2020 and 2021). On the Bandon Beach side, the beach continues to be eroded by the northward movement of the mouth of New River, and lack of any habitat management at this site for over five years has reduced the available nesting habitat to a very narrow strip in front of the foredune. Plovers however continue to nest at this site in relatively high densities (Figure 9). Due to limited available habitat, plovers are susceptible to predation, windy conditions, and recreational activity. Lack of habitat management also has pushed some plovers north of the restricted section of beach, and north of China Creek, into marginal habitat that is exposed to more recreational activity. To improve reproductive output, this section of beach needs extensive habitat restoration that would give the plovers good nesting options away from recreating public and windblown sand, and reduce the cover for predators. Bandon Beach is a very important nesting beach due to the density of plovers present; improved habitat and predator management would benefit plover reproductive success at this site.

Plovers again struggled to be successful on the long open spit south of the mouth of New River. Plovers nesting in this area are exposed to windy conditions and drifting dunes. Due to the windy conditions, it is often difficult for monitors to determine whether nests are being depredated or simply buried by drifting sand. Lack of evidence at failed nests also affects predator management, as it is difficult to know what predators to target, where to target them, and limits what methods can be used as traps are often completely buried or exposed by drifting sand. Further south, extensive dunes continue to grow and fill in overwash areas, reducing available habitat and leaving cover for predators. In addition, evidence that owls are present (consistent tracks and accidental captures) as well as the only site with recurring gull depredations, in addition to raven activity, complicates conditions for successful plover reproduction. Despite these complex issues, New River spit still has extensive available habitat and is occupied by numerous plovers. Improved nest success at this site could lead to better productivity as once plovers hatched nests, reproductive parameters were reasonably good (Table 9). Bandon SPMA has the lowest hatch rates, fledge rates, and fledglings per male of all sites with large number of plovers (Figures 14-16). Efforts to improve and maintain habitat at both Bandon Beach and New River spit, and removal of predators including owls would likely lead to improvements in reproductive success. We continue to recommend State Park staff monitor Bandon SPMA to manage recreation activities as it reduces violations and disturbance to plovers.

New River

Small numbers of plovers continue to utilize private lands at New River (Table 3) where habitat has degraded. The only known nest on private land was just south of the southern boundary of the Bandon SPMA, and this brood spent most of the brood rearing period on state lands. One other brood wandered south onto private land, but plover activity along this section of beach was minimal. We expect small numbers of plovers to continue to utilize this section of beach, but due to habitat loss and dog presence from local land owners, plover use of this area will be limited.

Plover use of the New River HRA has been relatively consistent based on the number of nests (Table 4) and plovers present (Table 3). There is much adequate habitat on the New River HRA due to the extensive management of the land by BLM. It is likely that persistent predator activity, particularly ravens from the nearby ranches, is limiting the number of plovers using this area. Red fox have been a persistent presence at New River HRA, and while there are still fox present, the number of fox has been greatly reduced after many years of predator management, a positive development for plovers. As in 2021 (Lauten *et al*. 2021), much of the plover activity on the HRA was north of the Croft Lake breach, and habitat at Croft Lake breach has improved due to several years of breaching on the same area. Plovers also utilized the beach south of Croft Lake breach to the New Lake breach area, and plovers continue to utilize Clay Island breach (Figure 11). Maintaining habitat at the New River HRA benefits adjacent nesting areas at Bandon SPMA by reducing vegetation cover that red fox and other mammalian predators inhabit, and also provides alternative nesting locations for plovers nesting within the Bandon to Floras Lake system.

Floras Lake

Floras Lake continues to have small numbers of plovers (Table 3) and nests (Table 4). There were no successful nests in 2022 (Table 5). Limited habitat, high predator activity due to the proximity of sheep and cattle ranches, and recreational activity all contribute to low plover activity at this site. We expect plovers to continue to occupy this site in low densities.

Conclusion

In 2022 we continued to reduce our sampling plan and sufficiently measured plover productivity. Overall plover numbers declined but were still well above recovery goals (Table 1). Productivity was very poor at most sites (Table 9), and plovers produced fairly low numbers of fledglings (Table 11). Low productivity was due to very poor nest success, particularly at Siltcoos, Overlook, Tahkenitch, and Bandon SPMA (Table 5). Once nests hatched, broods were reasonably successful (Table 9). Successful production of plovers within the project area is critical to populations from Washington to Mendocino Co., CA, and effective predator management is important to the success of the plovers (Gaines *et al*. 2020). Management should focus efforts on sites with high plover densities and potential for high reproductive output. Plovers produced within the project area are responsible for the recolonization of former nesting areas particularly along the Oregon coast. Plover productivity within the project area will continue to contribute to stable and sustainable populations in Washington, northern Oregon, and northern California sites. We recommend continued efforts at habitat management, predator management, and recreation management.

Immigrant Plovers

Twenty-five adult plovers banded in California were observed in Oregon in 2022. Sixteen were females and nine were males. Twelve females and nine males were resident plovers and five females were present outside of the breeding season and were likely either wintering or visiting plovers.

Of the 25 plovers banded in California, three females and one male originally hatched in Oregon and were subsequently rebanded at coastal nest sites in California. All other immigrant plovers were originally banded in 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, 2011-2022.

YEAR	WINDOW SURVEY	# SNPL PRESENT
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
2020	403	563
2021	481	614
2022	437	542

Table 2. Number of banded Snowy Plover fledglings, number of previous year fledglings returning, and return rate along the Oregon coast in the ORBIC-monitored area, 2012 - 2022.

Year	# of banded fledglings from previous year	# of HY birds from previous year sighted in project area	Return Rate (#HY/#Fled)
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
2020	274	124	45.2
2021	231	93	40.3
2022	162	37	22.8
		AVERAGE =	46.4
		STDEV =	10.7

Table 3. Plover activity based on the number of adult plovers at each ORBIC-monitored nesting area on the Oregon Coast, 2022. Plovers move between nesting areas throughout the breeding season, 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	22	14	10	6	16	7	12	12	60	39
Siltcoos	34	19	14	12	34	15	12	10	64	56
Overlook	47	35	12	12	35	28	14	14	108	89
Tahkenitch N	52	40	16	12	34	32	17	17	119	101
Tenmile	38	32	28	28	36	34	22	22	124	116
CBNS	41	38	21	21	51	49	19	19	132	127
Bandon SPMA	38	28	13	10	23	19	16	16	90	73
New River private	3	2	0	0	5	4	2	2	10	8
New River HRA	6	6	5	5	10	9	4	2	25	24
Floras Lake	1	1	2	2	2	2	1	1	6	6

Table 4. Number of nests for ORBIC-monitored sites on the Oregon Coast 2012 – 2022. 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	12	13	14	15	16	17	18	19	20	21	22
SU	0	1	2	8	19	21	20	15	20	11	21
SI:											
North	10	13	6	8	15	25	15	12	13	21	29
South	22	30	18	23	42	31	24	29	24	29	25
OV:											
North	28	33	35	46	48	61	24	38	52	75	24
South	31	28	23	42	56	47	34	35	50	80	39
TA											
North	36	52	32	61	74	56	47	49	62	75	79
South		6	4	2	0	2	1	8	8	6	n/a
TM:											
North	17	19	26	29	34	40	66	52	103	90	76
South	29	17	21	32	59	24	33	26	33	25	16
CBNS:											
SB	7	36	20	41	48	33	32	29	52	26	33
SS	15	12	13	20	38	27	29	27	20	19	17
HRAs	39	58	43	66	97	74	67	78	61	80	52
BSPMA											
BB	48	44	28	40	57	32	36	51	39	62	33
NR spit	12	20	54	48	73	49	43	70	92	83	63
NR HRA	17	9	15	27	14	11	10	16	12	24	15
NR other	1	3	4	8	18	11	5	7	1	3	1
FL	2	0	2	0	1	3	4	9	8	3	6
Tot nst	**314**	**381**	**346**	**501**	**693**	**547**	**490**	**551**	**650**	**712**	**529**
Tot brd[a]	**11**	**8**	**12**	**32**	**19**	**9**	**15**	**25**	**13**	**22**	

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

Table 5. Apparent nest success of Snowy Plovers on the Oregon Coast within the ORBIC-monitored area, 2022.

Site	Total #	Hatch	Fail	Unknown	App Nest Success
Sutton	21	6	12	3	29%
Siltcoos					
North	29	0	27	2	0%
South	25	1	24	0	4%
Combined	54	1	51	2	2%
Overlook					
North	24	0	24	0	0%
South	39	1	38	0	3%
Combined	63	1	62	0	2%
Tahkenitch					
North	79	8	70	1	10%
Tenmile					
North	76	40	34	2	53%
South	16	4	11	1	25%
Combined	92	44	45	3	48%
CBNS					
South Beach	33	28	5	0	85%
South Spoil	17	5	10	2	29%
HRAs	52	15	37	0	29%
Combined	102	48	52	2	47%
Bandon SPMA	96	11	85	0	11%
New River					
HRA	15	5	10	0	33%
Other Lands	1	1	0	0	100%
Floras Lake	6	0	6	0	0%
Totals	529	125	393	11	24%

Forest Service total = 60/309=19% (DNRA=54/288=19%)

Table 6. Apparent nest success of Snowy Plover nests on the Oregon coast in the ORBIC-monitored area, 2013 - 2022 with ten-year average and 1990 - 2022 overall average.

2013	0.24
2014	0.60
2015	0.48
2016	0.25
2017	0.42
2018	0.49
2019	0.41
2020	0.40
2021	0.27
2022	0.24
average '13-'22	0.38
stdev	0.125
average '90-'22	0.45
stdev	0.130

Table 7. Snowy Plover nests reported from outside the ORBIC intensively monitored area in 2022.

Site Name	County	Nests found	Hatched	Failed	Nest success
Clatsop Spit	Clatsop	15	8	7	53%
Necanicum Spit	Clatsop	3	1	2	33%
Nehalem Spit	Tillamook	9	2	7	22%
Bayocean Spit	Tillamook	14	2	12	14%
Netarts Spit	Tillamook	0			
Sitka Sedge	Tillamook	2	0	2	0%
Sand Lake	Tillamook	1	0	1	0%
Agate Beach	Lincoln	0			
Bayshore	Lincoln	26	5	21	19%
Beachside SP	Lincoln	0			
Collins Creek	Lincoln	0			
Driftwood SP	Lincoln	0			
Fox Creek	Lincoln	1	0	1	0%
Sandpiper Village	Lincoln	0			
South Beach SP	Lincoln	0			
Sunset Street	Lincoln	0			
Yaquina Bay SP	Lincoln	2	0	2	0%
S Tahkenitch/N Umpqua	Douglas	7	4	2	57%
Paradise Point	Curry	5	0	5	0%
Total		85	22	62	26%

Table 8. Causes of Snowy Plover nest failure at survey sites along the Oregon coast within the ORBIC-monitored area, 2022.

Site Name	Tot Nsts	# Fail	Depredations					Other					
			Corvid	Unk	Mammal	Harrier	Avian	Wind	Over-wash	Abandon	One Egg Nest	Infer	Unk cause
Sutton	21	12		5				1		3			3
Siltcoos:													
North	29	27	5	10		1	3	1			1		6
South	25	24	7	9			6						2
Overlook													
North	24	24	5	12	1 [b]		3				2		1
South	39	38	11	19			4	1					3
Tahkenitch													
North	79	70	9	30	2 [b]	1	10			1	5		12
Tenmile:													
North	76	34	3	8	2 [b]		7	1	1	6	3		3
South	16	11		2	3 [b]	3	2			1			
Coos Bay													
North Spit:													
South Beach	33	5			1 [b]					2			2
South Spoil	17	10		3		7							
HRAs	52	37		14	4 [c]	10	1			2	1	1	4
Bandon													
SPMA	96	85	11	28	2 [d]		2 [e]	7	1	3	1		30
New River													
HRA	15	10	3	5	1 [d]				1				
Other lands	1	0											
Floras Lake	6	6	3	3									
TOTALS	529	393	57 [a]	148	15	22	38	11	3	18	13	1	66

[a] – 54 raven depredations, 1 crow depredation, 2 unknown corvid
[b] – coyote depredations
[c] – 2 coyote depredations, 1 skunk depredation, 1 unknown mammal
[d] – skunk depredation
[e] – 2 gull depredations

Table 9. Number of broods sampled (number successful in parenthesis), brood success, and fledging success based on sample from Sutton Beach to Floras Lake, Oregon coast, 2022.

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	4 (4)	100%	11	4	36%	1.00	6/55=0.11
Siltcoos:							
North Siltcoos	0	-	-	-	-	-	0/60=0.00
South Siltcoos	1 (1)	100%	2	1	50%	1.00	1/53=0.02
Overlook							
North Overlook	0	-	-	-	-	-	0/41=0.00
South Overlook	1(1)	100%	3	2	67%	2.00	2/85=0.02
Tahkenitch							
North Tahkenitch	6 (6)	100%	17	10	59%	1.67	13/187=0.07
Tenmile:							
North Tenmile	26 (14)	54%	62	22	35%	0.85	34/206=0.17
South Tenmile	1 (1)	100%	3	1	33%	1.00	3/44=0.07
Coos Bay N. Spit							
South Beach	23 (18)	78%	51	23	45%	1.00	28/87=0.32
South Spoil/HRA	13 (9)	69%	29	12	41%	0.92	19/181=0.10
Bandon SPMA	10 (7)	70%	25	14	56%	1.40	17/250=0.07
New River HRA	5 (4)	80%	13	7	54%	1.40	7/38=0.18
Floras Lake	0	-	-	-	-	-	0/15=0.00
Total	90 (65)	72%	216	96	44%	1.07	

Table 10. Fledging success and estimated number of fledglings/male (+/- standard deviation) from the ORIBC-monitored sites on the Oregon Coast, 2004 – 2022.

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	1.07
2020	42	0.79
2021	44	0.62
2022	44	0.35
’04-’22mean	46.5 +/- 5.3	1.17 +/- 0.40

Table 11. Total number of young fledged from ORBIC-monitored sites on the Oregon Coast 2011-2022, includes fledglings from broods from undiscovered nests.

Site Name	11	12	13	14	15	16	17	18	19	20[a]	21[a]	22[a]
SU				1	3	2	2	8	8	8	3	6
SI:												
North	4	1	2	0	4	3	17	6	0	5	13	0
South	8	16	4	9	25	20	16	18	11	19	18	1
OV:												
North	27	22	3	18	26	33	17	15	40	36	10	0
South	23	27	0	25	39	16	30	25	45	39	12	2
TA:												
North	20	26	9	25	49	28	28	19	40	42	14	13
South			3	0	0		0	7	9	1	0	
TM:												
North	1	5	15	35	26	14	41	46	31	21	61	34
South	5	5	8	27	21	27	24	20	10	8	10	3
CBNS:												
SS	6	10	2	14	13	9	10	20	8	8	9	7
SB	22	16	18	28	24	12	38	20	32	39	13	28
HRAs	28	34	3	49	46	12	10	49	18	26	51	12
CBNS					51		9	12	21			
BSPMA												
BB	16	11	8	12	12	8	28	21	18	9	15	6
NR spit	5	1	14	22	19	6	9	21	26	22	6	10
NR HRA	7	4	12	3	10	4	3	3	12	16	11	7
NR other	0	0	3	6	2	5	4	0	6	0	2	2
FL	0	2		2	0	1	4	6	9	0	2	0
Total	**172**	**180**	**104**	**276**	**370**	**200**	**290**	**316**	**344**	**299**	**250**	**130**

[a] – numbers are estimated number of fledglings based on number of broods and # of fledglings per sampled brood

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 12. Number of resident males, estimated number of fledglings, and number of fledglings per male from the ORBIC-monitored sites on the Oregon Coast, 2022. 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	19	6	0.32
Siltcoos Spits	25	1	0.04
Dunes Overlook	42	2	0.05
Tahkenitch Creek	49	13	0.27
Tenmile Creek	56	37	0.67
Coos Bay North Spit	68	47	0.69
Bandon SPMA	35	16	0.46
New River			
HRA	11	7	0.64
Other lands	6	2	0.33
Floras Lake	3	0	0.00
Overall			0.35+/-0.26

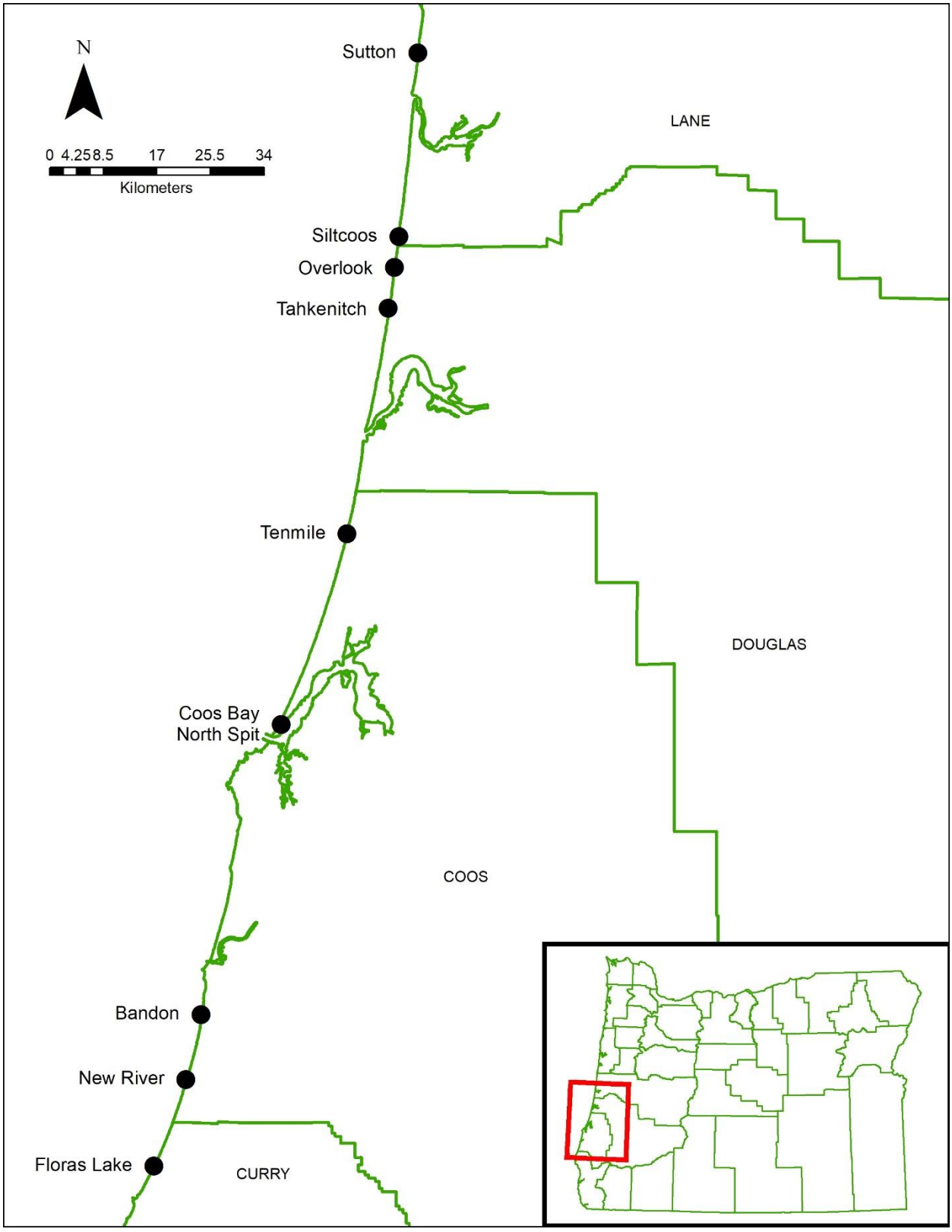

Figure 1. Snowy Plover ORBIC-monitored locations along the Oregon Coast, 2022.

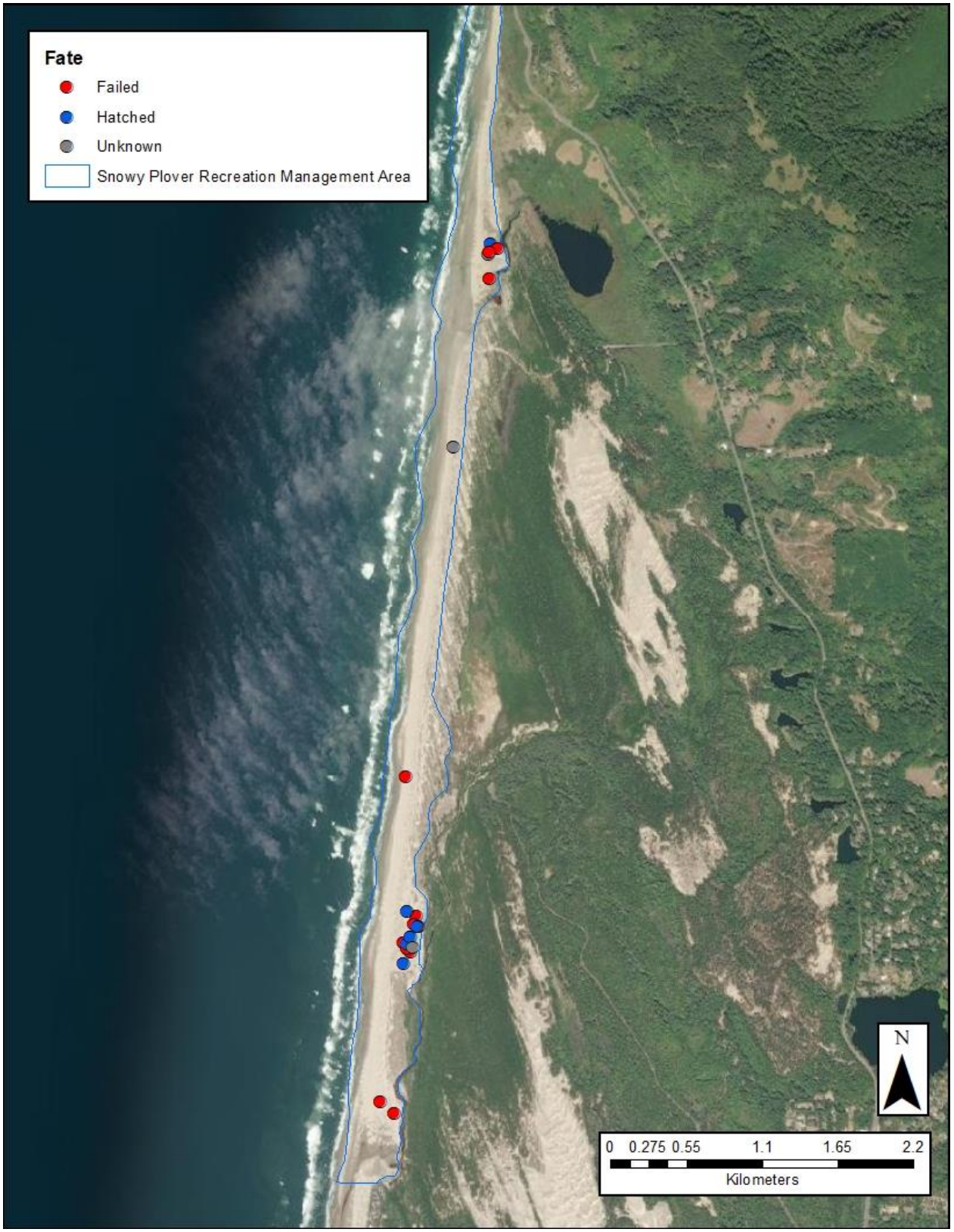

Figure 2. Snowy Plover nest locations at Sutton/Baker Beach, Oregon, 2022.

Figure 3. Snowy Plover nest locations at Siltcoos Estuary, Oregon, 2022.

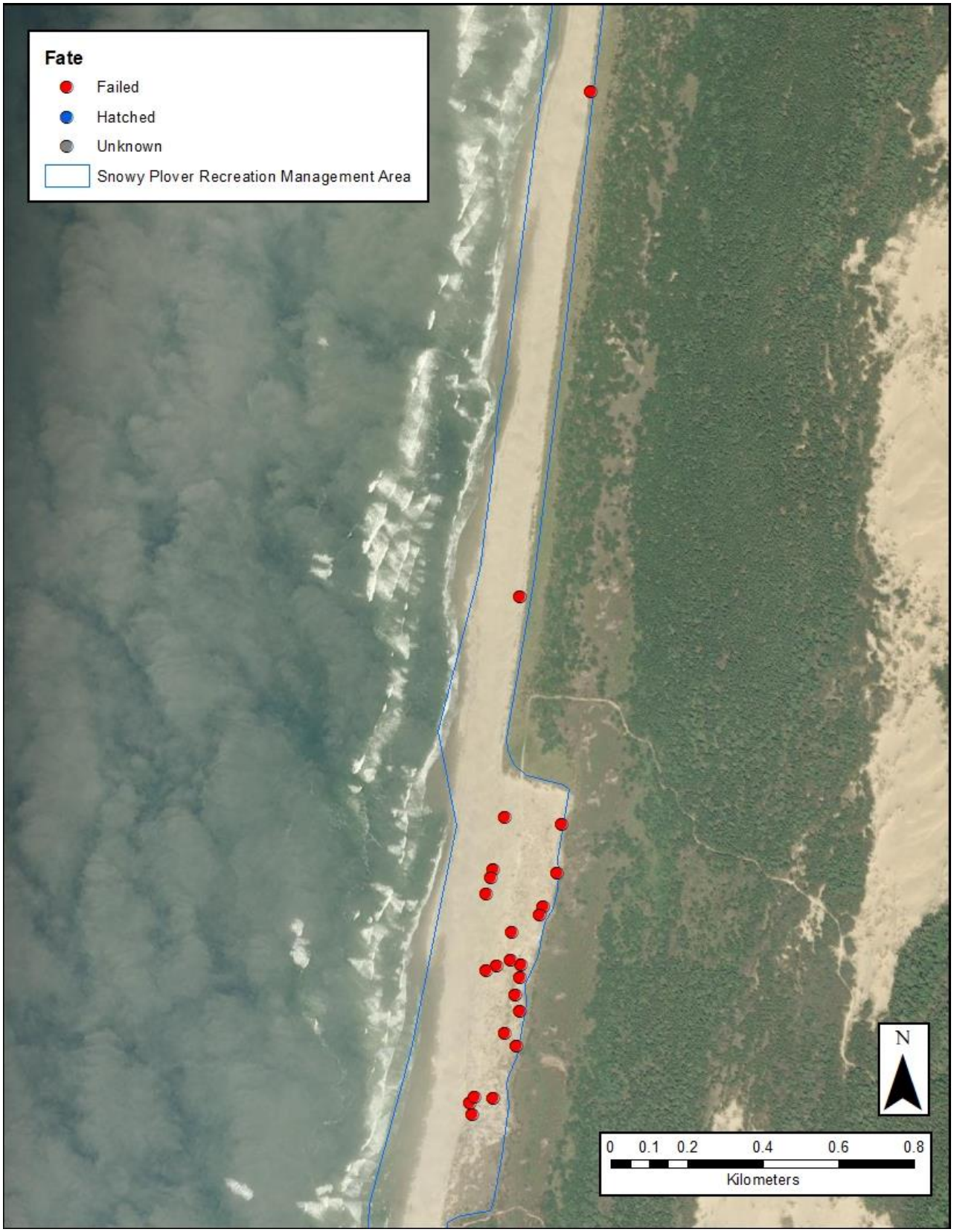

Figure 4. Snowy Plover nest locations at Dunes North Overlook, Oregon, 2022.

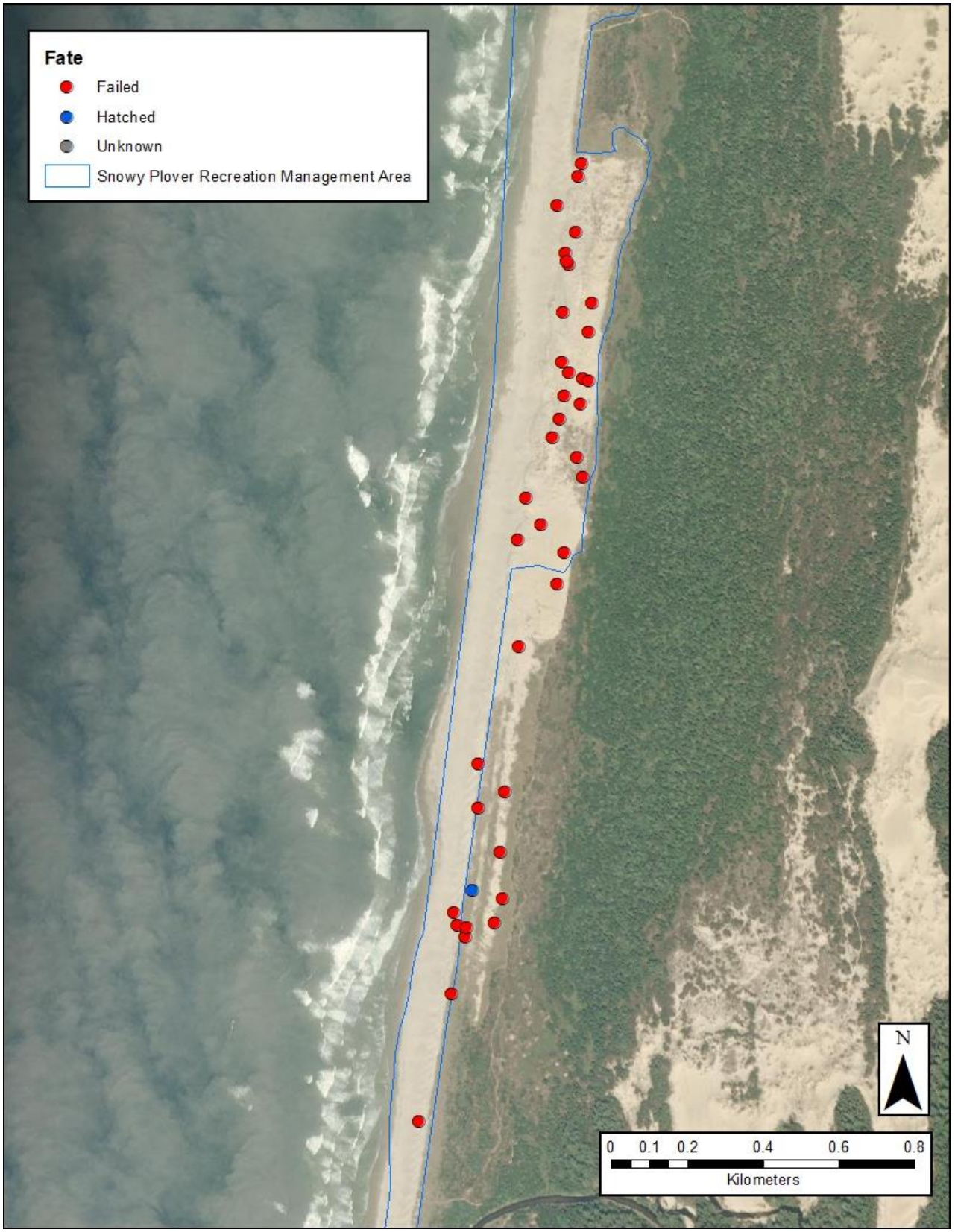

Figure 5. Snowy Plover nest locations at Dunes South Overlook, Oregon, 2022.

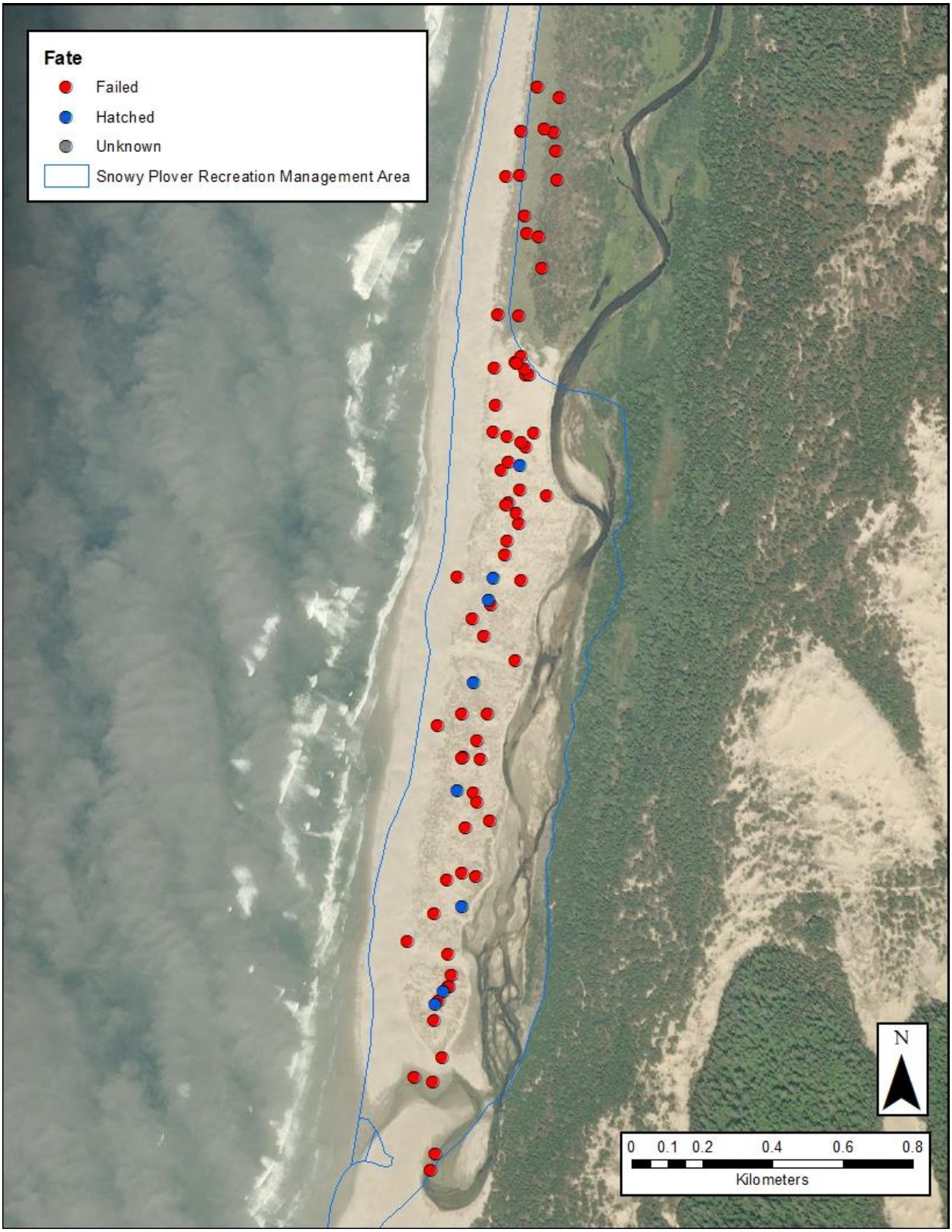

Figure 6. Snowy Plover nest locations on north side of Tahkenitch Creek, Oregon, 2022.

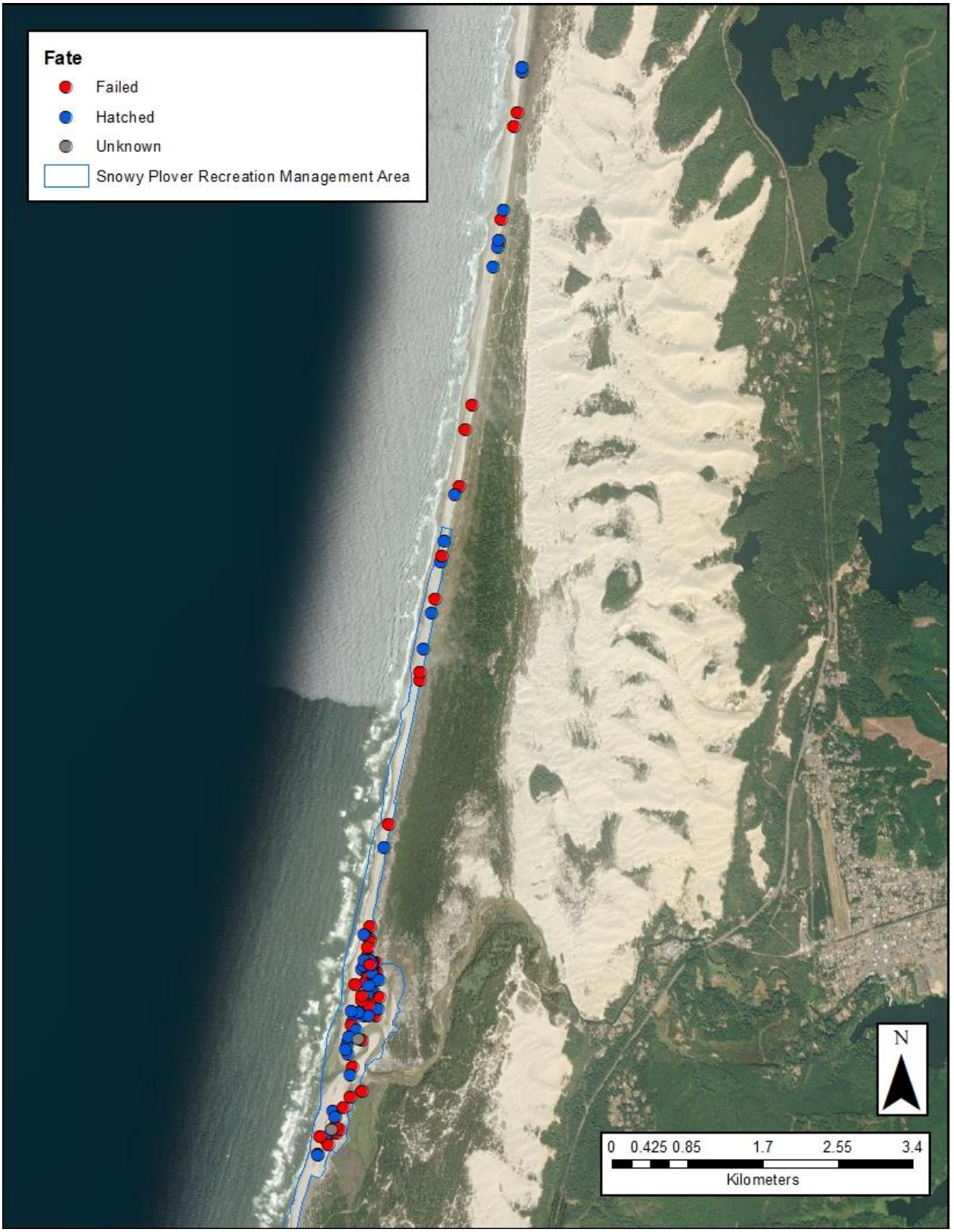

Figure 7. Snowy Plover nests on north and south sides of Tenmile Creek, Oregon, 2022.

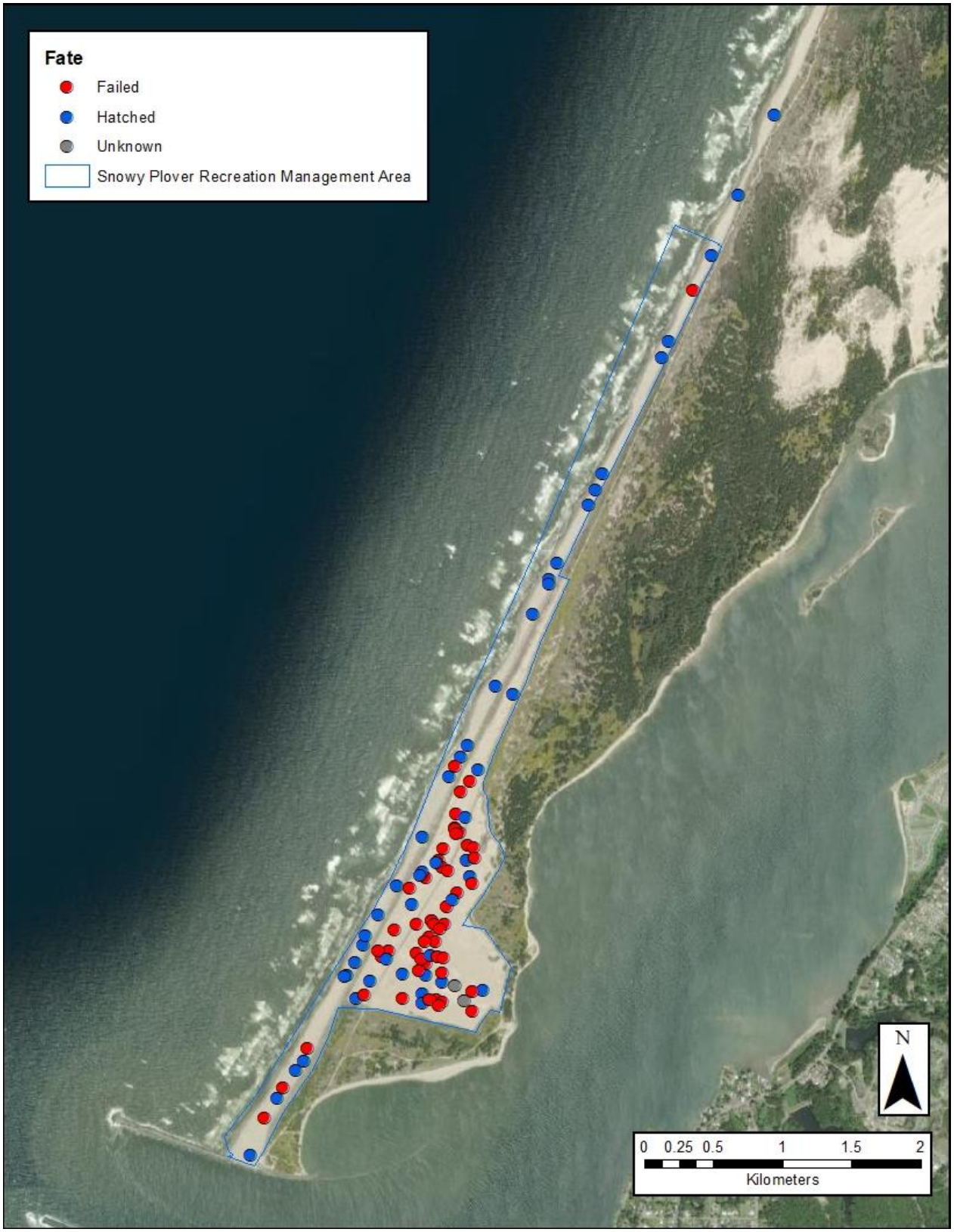

Figure 8. Snowy Plover nests on Coos Bay North Spit, Oregon, 2022.

Figure 9. Snowy Plover nests at Bandon SPMA north of the mouth of New River, Oregon, 2022. Note that the river mouth has moved north since this image. The southern-most 4 nests are actually south of the river mouth. The southern-most 3 nests also appear in Figure 10.

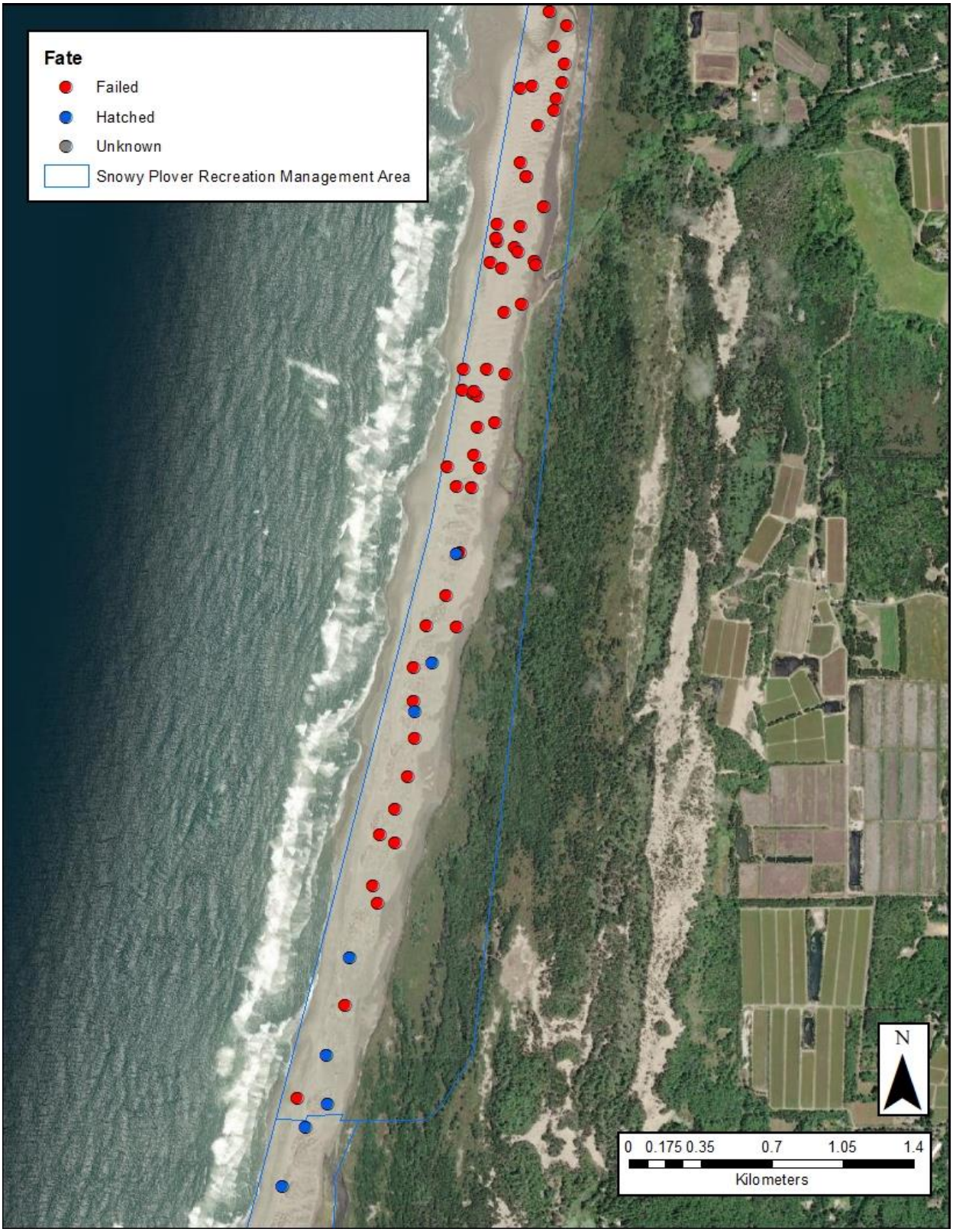

Figure 10. Snowy Plover nests at Bandon SPMA, south of the mouth of New River, Oregon, 2022. The 3 northern-most nests also appear in Figure 9. The southern-most nest is on private land.

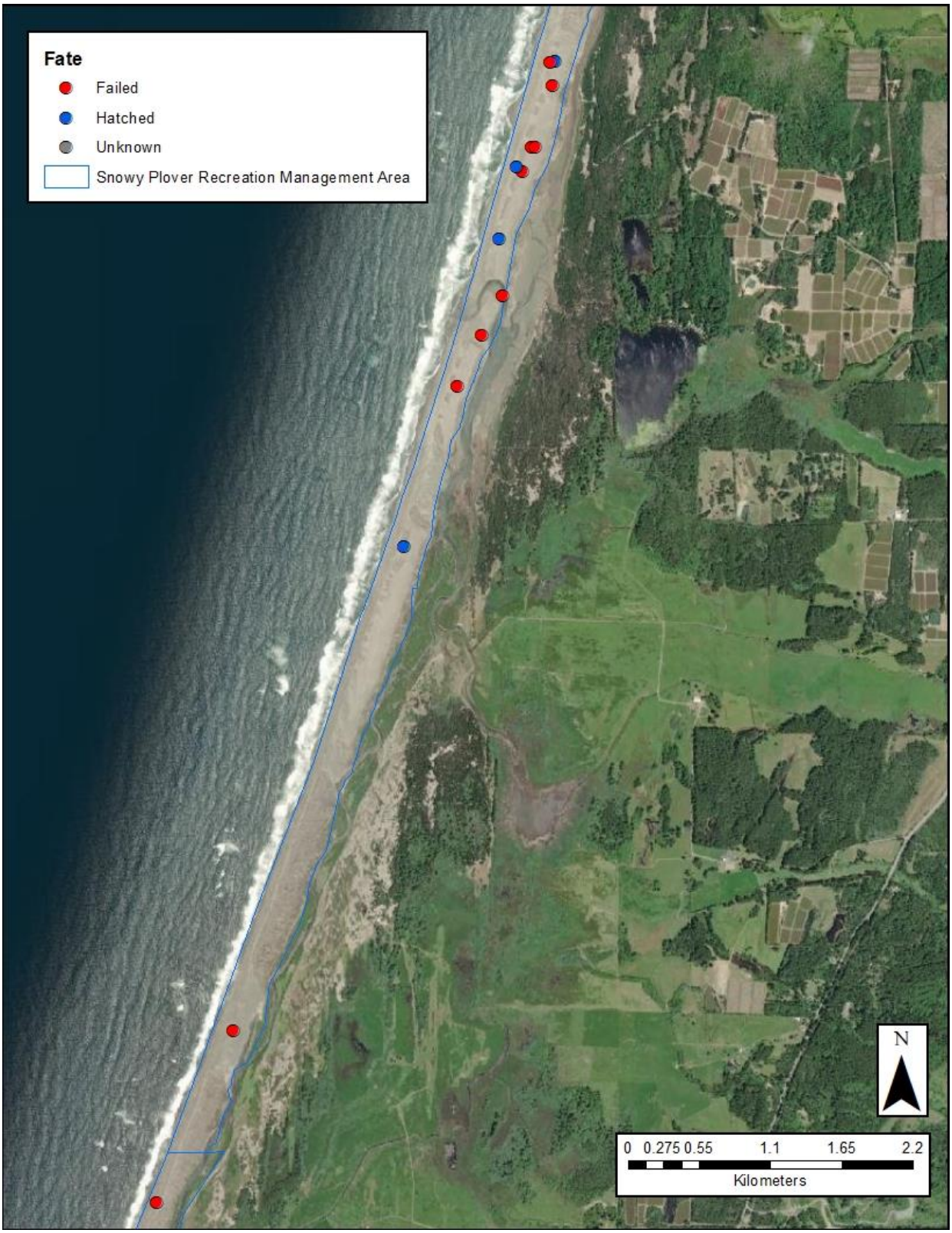

Figure 11. Snowy Plover nests at New River Habitat Restoration Area, Oregon, 2022.

Figure 12. Snowy Plover nest locations at Floras Lake, Oregon, 2022.

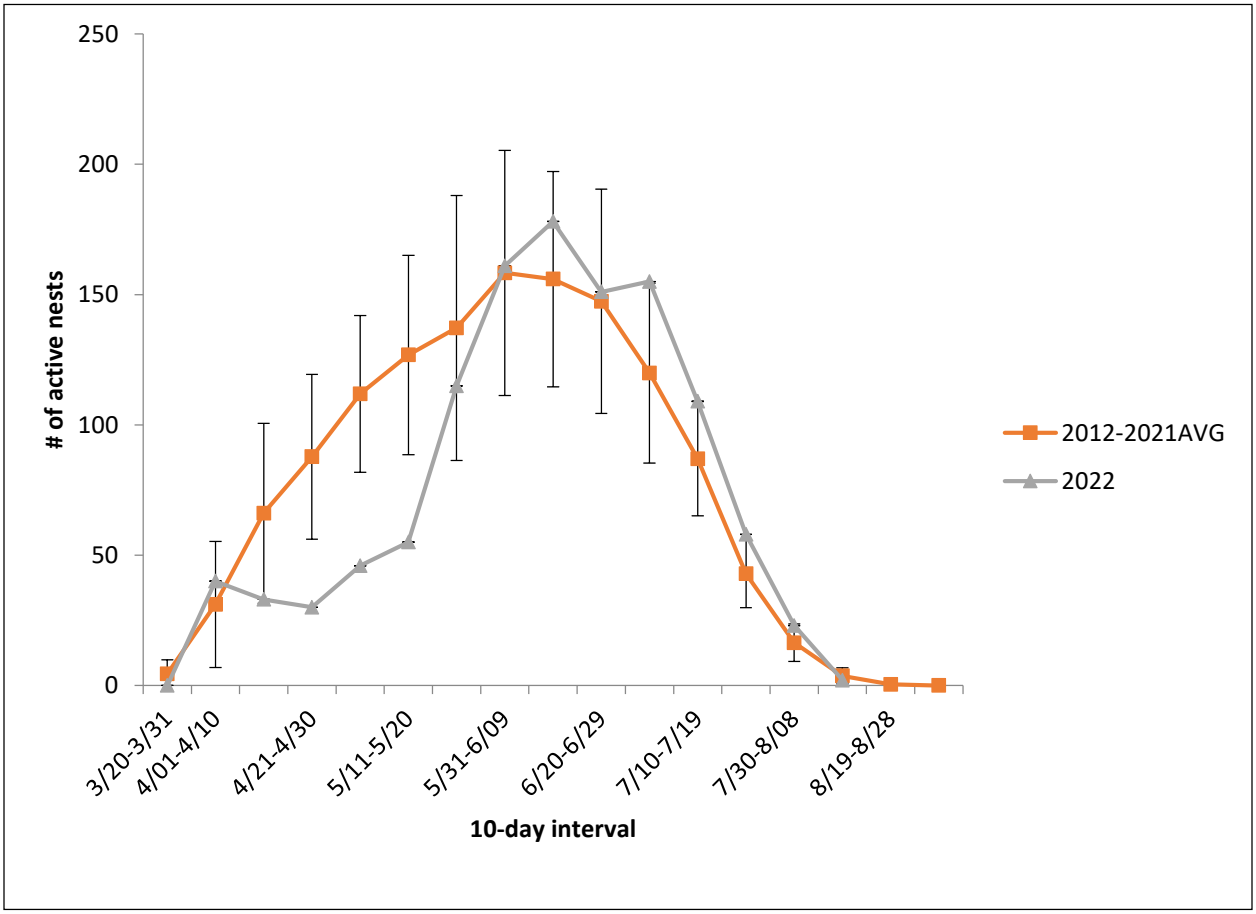

Figure 13. Number of active Snowy Plover nests at ORBIC-monitored sites, within 10-day intervals on the Oregon coast, 2022. Dashed lines represent +/- standard deviation.

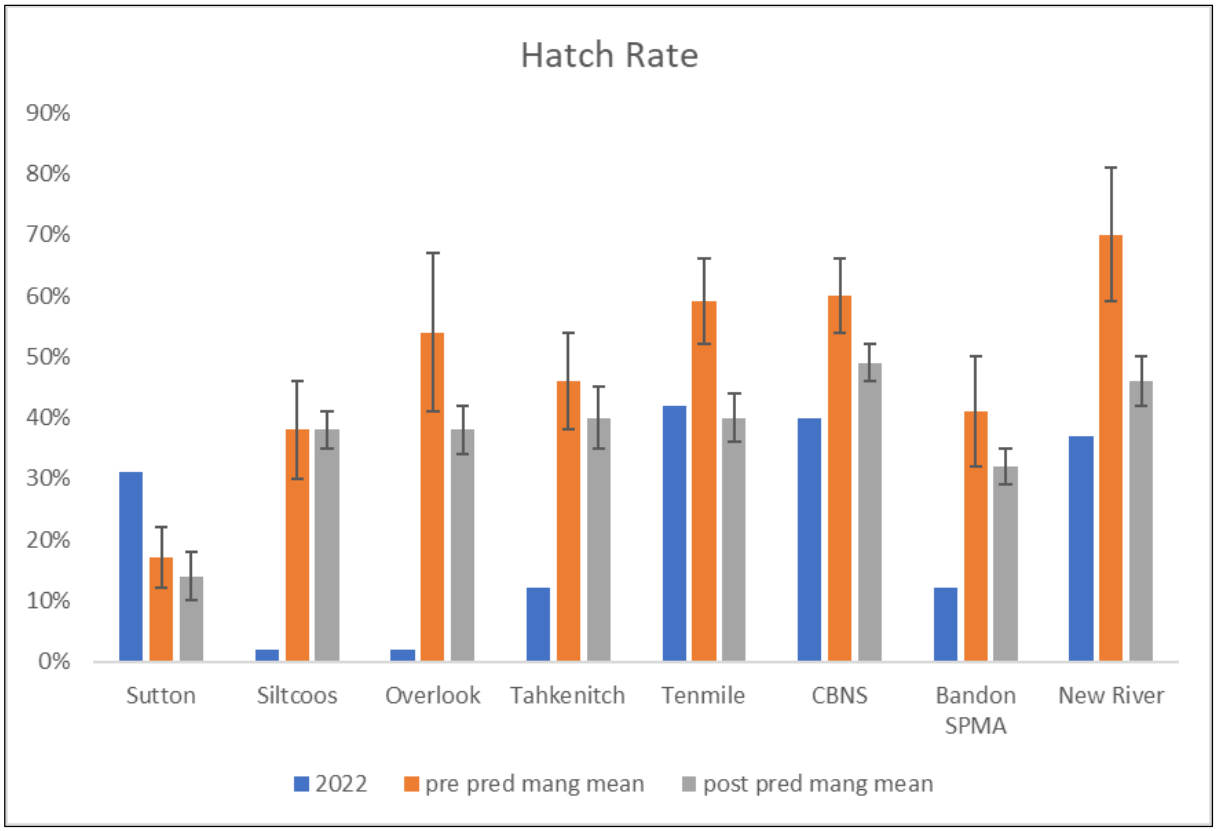

Figure 14. 2022 hatch rate, mean pre predator management hatch rate, and mean post predator management hatch rate for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

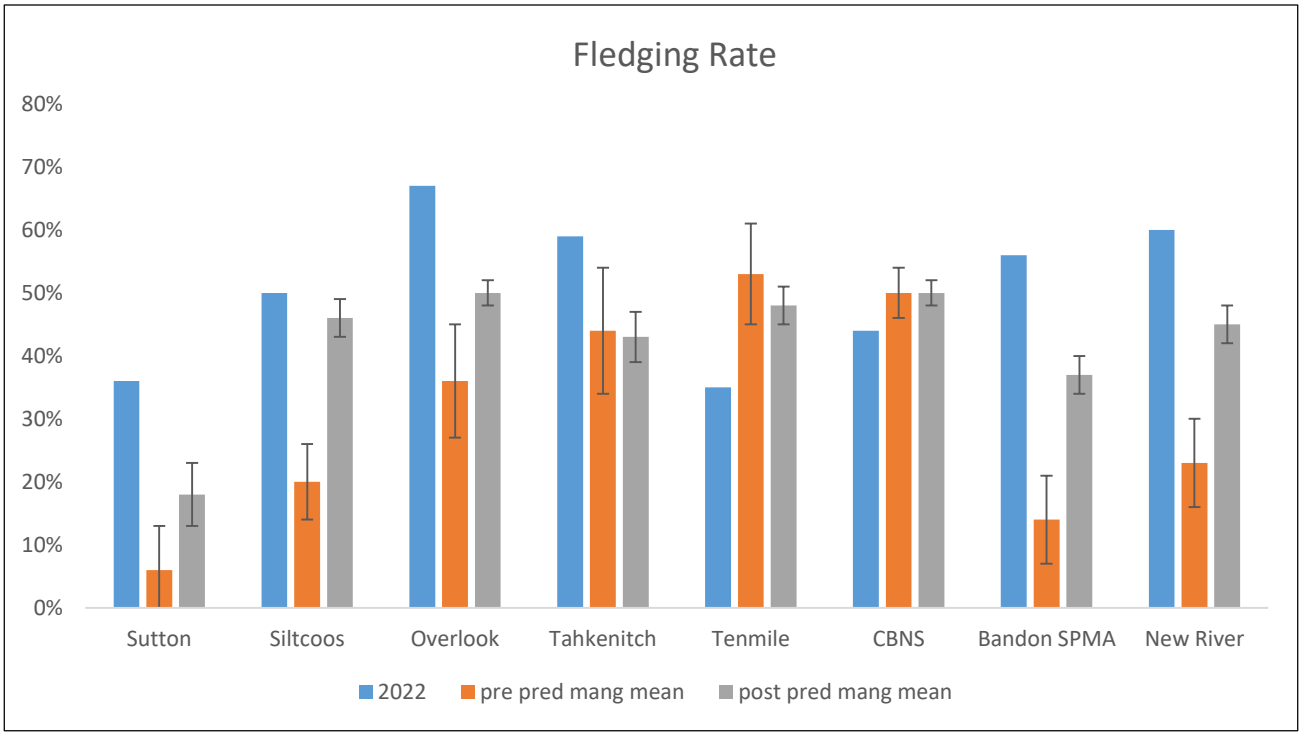

Figure 15. 2022 fledge rate, mean pre predator management fledge rate, and mean post predator management fledge rate for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

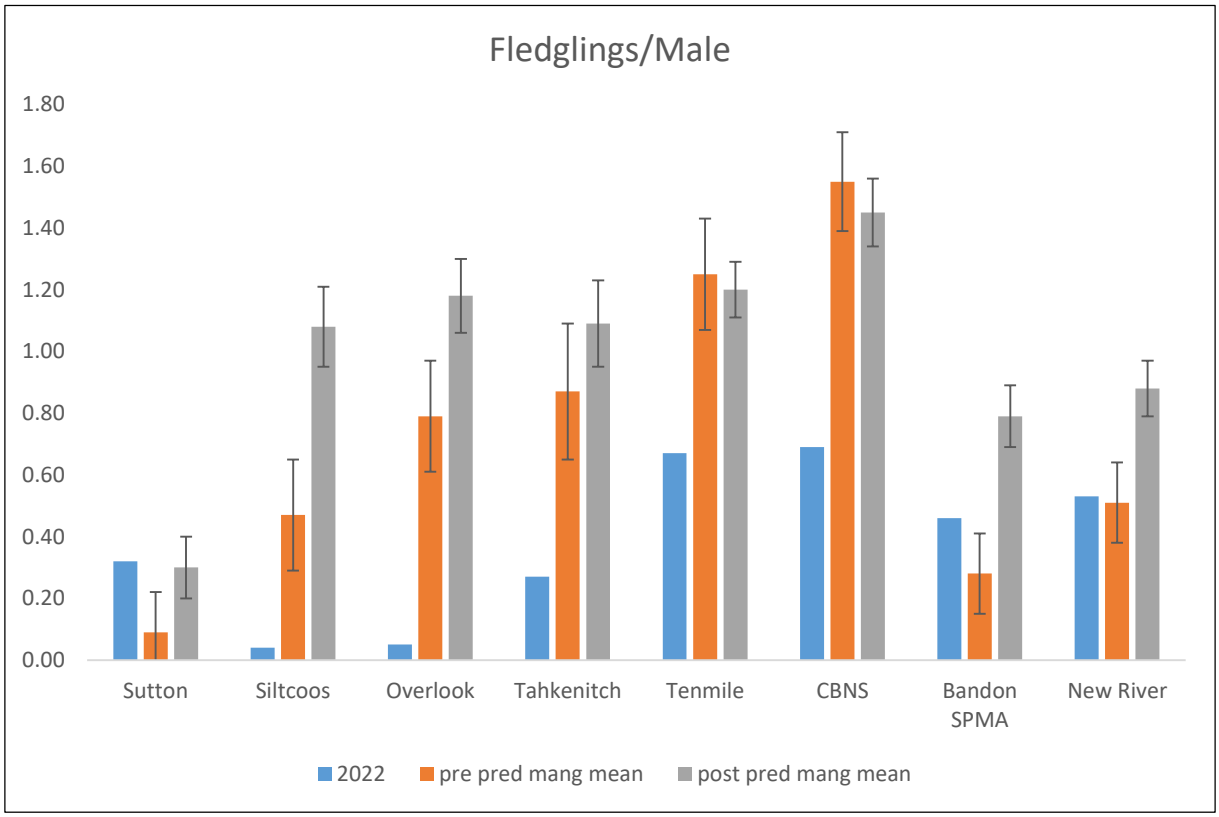

Figure 16. 2022 fledglings per male, mean pre predator management fledglings per male, and post predator management fledglings per male for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.

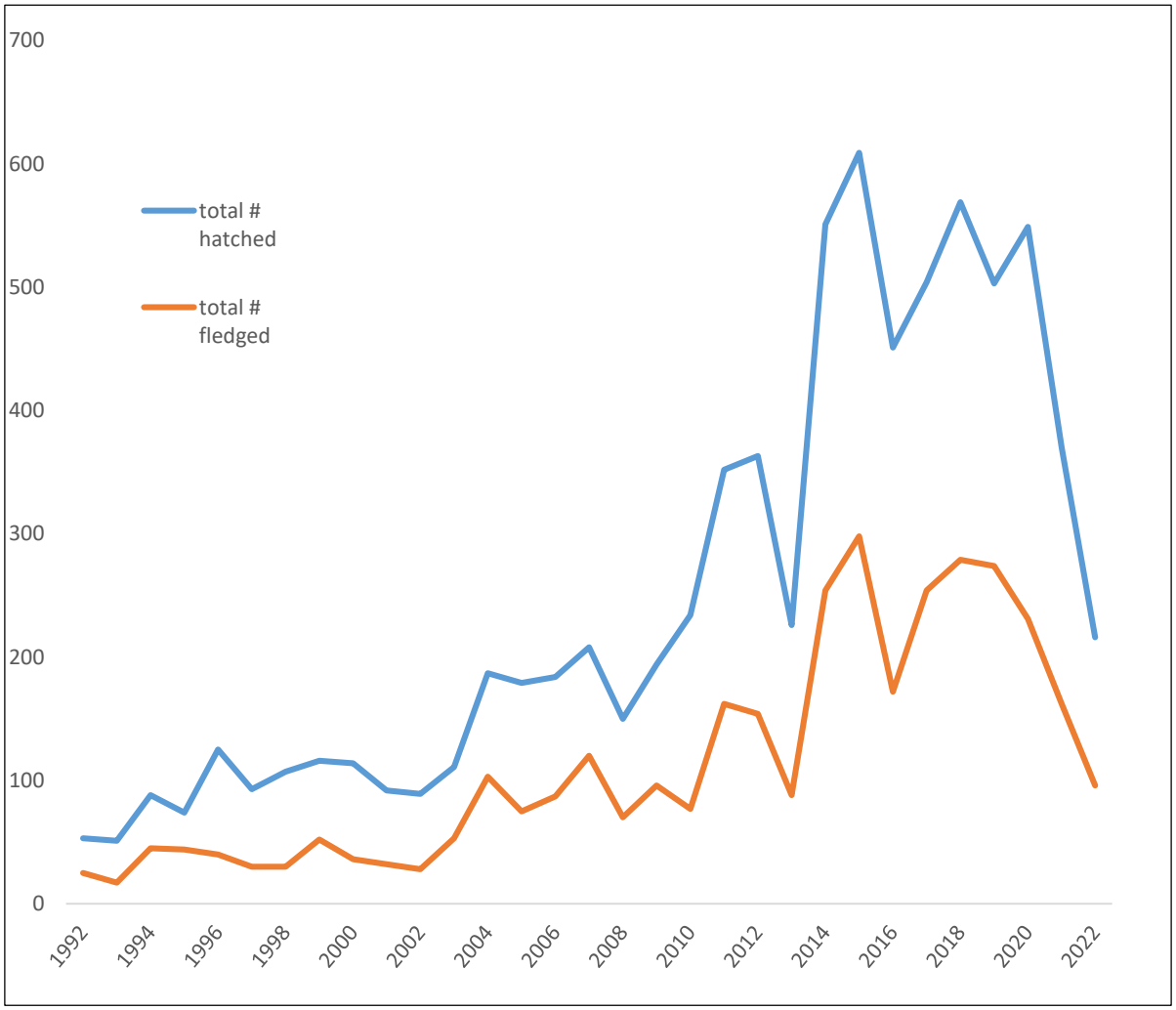

Figure 17. The number of eggs hatched and the number of fledglings from ORBIC-monitored sites on the Oregon coast, 1992-2022.

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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. This site is managed by the Siuslaw National Forest.

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. This site is part of the Dunes NRA.

Dunes Overlook Clearing, Douglas Co. (Figures 4 and 5). 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. This site is part of the Dunes NRA.

Tahkenitch Creek, Douglas Co. (Figure 6) 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. This site is part of the Dunes NRA.

Tenmile: North Tenmile, Coos and Douglas Cos. (Figure 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. This site is part of the Dunes NRA.

Coos Bay North Spit (CBNS), Coos Co. (Figure 8): 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 9 & 10): This site includes the Bandon SPMA and all nesting areas from north of China Creek to the south end of state land south of the mouth of New River.

New River, Coos Co. (Figure 11): 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 12). The beach and overwash areas west of the confluence of Floras Creek and the beginning of New River, north to Hansen Breach.

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

APPENDIX B

Snowy Plover Monitoring Methods

Nest Surveys

Monitoring began the first week in April and continued until all broods fledged, typically by mid-September. We used two teams of biologists; one two-person team covering Tenmile and sites north, and a two-person team covering Coos Bay North Spit and sites south (Fig. 1). 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 plovers 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 lily pad trap and snare 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. Snare carpets are 4" x 30" lengths of hardware cloth covered with small fishing line loop snares. Plovers walk over the carpets and the loops 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, and in 2021 we reduced the number of sampled broods to approximately 50%. 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 – 2021

Statement of problem:

Prior to 2016, Oregon Snowy Plover monitors 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 experienced the same problems at sites they monitor. 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.

Lauten *et al.* (2016, 2017, 2018, 2019, and 2020) documents efforts to sample approximately 80% of monitored broods. Continued increases in the plover population, as well as staff and workload limitations, made this goal unreachable by 2021. For the 2021 field season we worked with Point Blue Conservation Science to further adjust the sampling plan to provide adequate productivity information (Lynne Stenzel, pers. comm.). Sampling techniques remained the same except for a reduction in the percentage of broods sampled, and a reduction in the number of sites that would have sampled broods.

2021 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 (Lauten *et al.* 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.

From 2016 to 2020 we addressed site variation in fledging success (Dinsmore *et al*. 2017) by sampling broods from all currently occupied nesting sites in the project area. 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).
- 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. For 2021, we continue to follow the basic outline of the sampling technique, except we reduced the percentage of sampled broods from 80% to 50%. We also did not sample any broods with banding techniques at Sutton Beach, South Tahkenitch to North Umpqua, South Tenmile, and New River private lands. At Sutton Beach and Floras Lake, small numbers of broods from successful nests were sufficiently monitored without banding to use for sample calculations.

Table C-1. Ten-day intervals used to determine brood sample. 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

Summary

From 2016 to 2020 the sampling plan resulted in sufficient estimates of productivity (Lauten *et al.* 2016, 2017, 2018, 2019, and 2020). The Oregon Snowy Plover population has continued to increase (Lauten *et al.* 2020). The reduction in sampling effort will result in a lower percentage of hatched nests being sampled, and will increase variability estimates. However, we believe the estimates will be sufficient to estimate productivity while alleviating workload issues. This method will also allow monitors more time to search for and monitor nests.

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 12).