The Distribution and Reproductive Success of the Western Snowy Plover along the Oregon Coast - 2018

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Abstract

We monitored the distribution, abundance and productivity of the federally threatened Western Snowy Plover (Charadrius nivosus nivosus) along the central and south coast of Oregon from 3 April – 14 September 2018. We surveyed and monitored plover activity in a project area that included, from north to south, Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, Tenmile Creek, Coos Bay North Spit, Bandon Snowy Plover Management Area, New River HRA and adjacent lands, and Floras Lake. Our objectives for the project area in 2018 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, signs, exclosures), 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 489 individuals, an increase from the 2017 season. We monitored 490 nests in 2018. Overall apparent nest success was 49%. Nest failures were attributed to corvid depredation, unknown depredation, unknown cause, abandonment, mammalian depredation, one egg nests, overwashing, wind/weather, unknown avian depredation, harrier depredation, infertility, and human caused. We monitored 213 of 256 known broods, and documented a minimum of 316 fledglings. Overall brood success was 81%, fledging success was 49%, and 1.31 chicks fledged per sampled brood.
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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 29th year of monitoring the distribution, abundance, and productivity of Snowy Plovers during the breeding season from Sutton Beach in Lane County to Floras Lake in Curry County on the Oregon coast. We define the project area as coastal habitat between Sutton Beach and Floras Lake. In recent years, Snowy Plovers have extended to sites outside this project area; we did not monitor these new sites due to workload limitations. In cooperation with Federal and state agencies, plover management has focused on habitat restoration and maintenance at breeding sites, non-lethal and lethal predator management, and management of human related disturbances to nesting plovers. The goal of management is maintaining recent improvements in annual productivity, leading to a sustainable Oregon breeding population at or above recovery levels. Previous work and results have been summarized in annual reports (Stern et al. 1990 and 1991, Craig et al. 1992, Casler et al. 1993, Hallett et al. 1994, 1995, Estelle et al. 1997, Castelein et al. 1997, 1998, 2000a, 2000b, 2001, and 2002, and Lauten et al. 2003, 2005, 2006, 2006b, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017). Our objectives for the project area in 2018 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, signs, exclosures), 5) monitor a sample of broods to determine brood fate and plover productivity, and 6) use cameras and observational data to document predator activity at nests.

**Study Area**

Snowy Plover populations have increased in Oregon, and as a result plovers have begun to winter and nest at locations outside of areas traditionally monitored by ORBIC (USFWS, ORPD, and ORBIC unpublished data). Here we report on activities at sites intensively monitored by ORBIC in 2018: from north to south, Sutton Beach, Siltcoos River estuary, the Dunes Overlook, North and South Tahkenitch Creek, the South Umpqua beach to Tenmile Creek, Coos Bay North Spit (CBNS), Bandon Snowy Plover Management Area (SPMA), New River (extending from private land south of Bandon SPMA to the south end of the New River Area of Critical Environmental Concern (ACEC) habitat restoration area), and Floras Lake (Figure 1). At these breeding sites, we surveyed and monitored Snowy Plover activity along ocean beaches, sandy spits, ocean-overwashed areas within sand dunes dominated by European beachgrass (*Ammophila arenaria*), open estuarine areas with sand flats, a dredge spoil site, and several habitat restoration/management sites. A description of each site occurs in Appendix A. For the purposes of this report and for consistency with previous years’ data, we define Bandon Beach as the area from China Creek to the mouth of New River, and Bandon SPMA as all the state land from the north end of the China Creek parking lot south to the south boundary of the State Natural Area, south of the mouth of New River. Information on wintering and nesting at areas outside these sites is available from Oregon Department of Parks and Recreation (OPRD) and U.S. Fish and Wildlife Service (USFWS).
Methods

Window Surveys

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

Monitoring

Breeding season fieldwork was conducted from 3 April to 14 September 2018. Survey techniques, data collection methodology, and information regarding locating and documenting nests can be found in Castelein et al. 2000a, 2000b, 2001, 2002, and Lauten et al. 2003 and are in Appendix B. Some beach surveys, particularly to document brood success and to confirm fledglings, were conducted from a 4x4 truck using a window mounted scope. No other modifications to survey techniques were implemented in 2018.

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 (5 April through 14 September), and includes breeding birds, birds migrating through the area during that time, and wintering birds that may be present in the project area early or late in the season.

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

We tallied the number of individual banded and unbanded plovers by sex recorded at each nesting area within the project area throughout the 2018 breeding season. Data from nesting sites with a north and south component (Siltcoos, Overlook, Tahkenitch, and Tenmile) were combined because individual plovers use both sides of these estuaries. Data from CBNS nesting sites were aggregated for the same reason. We separated data from Bandon SPMA, New River 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, which is the number of successful nests divided by the total number of nests observed, for all nests and for each individual site. The cause of nest failure was recorded when identifiable.

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

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

We compared plover productivity in 2018 to average post-predator management hatch rate, fledge rate and fledglings per male for each nesting area. We also compared the average pre-predator management hatch rate, fledge rate, and fledglings per male to the post-predator management averages to continue to evaluate the success of the current predator management actions. Means are reported +/- standard deviation.

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

Nest exclosures are an option for protecting some nests from predation, particularly at sites with high levels of corvid predation and a relatively low number of plover nests (Appendix D). However, exclosures have rarely been used in recent years (Lauten et al. 2012, 2013, 2014, 2015, 2016 and 2017) because of the potential for adult mortality at exclosed nests (Lauten et al. 2010, 2011, 2012, and 2013), improved unexclosed nest success, increased numbers of nests at all sites, and an adult population that is over recovery goals. We continue to minimize the use of exclosures; only one exclosures was used in 2018.

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

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

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

Lethal predator management was conducted at all active nesting areas by USDA Wildlife Services (Bell et al. 2018). ORBIC monitors reported causes of nest failure and daily predator observations to Wildlife Services (WS) staff.

Results and Discussion

Window Surveys and Monitoring

During the May breeding window surveys, 311 plovers were observed in the project area, a slight increase from 2017 but lower than the high in 2016. Plovers were also detected during the window survey at locations north and south of the project area including the Clatsop Spit, Nehalem spit, Sitka Sedge State Natural Area, Bayshore Spit, and Elk River (USFWS pers. comm.). In addition, but outside of the window survey, plovers were documented attempting or successfully nesting at Clatsop Spit in Clatsop Co., Nehalem Spit and Bayocean Spit in
Tillamook Co., Sitka Sedge SNA, Agate Beach, South Beach State Park, Sandpiper Village and Driftwood State Park, and Patterson State Park in Lincoln Co., and the Elk River Spit and Bailey Beach in Curry Co. (OPRD unpublished data, USFWS pers. com.). All coastal counties in Oregon had documented nesting attempts in 2018; this is the first time nesting was documented in all coastal counties since plover monitoring began in Oregon, in the 1970s (ORBIC, unpublished data). The annual breeding window survey count for the project area and total number of plovers present are in Table 1.

There was an increase in the minimum number of plovers present in the project area in 2018 compared to 2017, resulting in the second highest total since monitoring began in 1990 (Table 1). Of the minimum number of plovers present during the 2018 breeding season, 437 (87%) were banded. The number of unbanded plovers estimated by the 10-day interval method was 65. During the breeding season we observed 220 banded males, 212 banded females, five banded adults with undetermined sex, 29 unbanded males, and 36 unbanded females.

Of the minimum number of plovers present in 2018, 372 plovers (74%) were documented nesting, slightly lower than the mean percentage for 1993-2017 (78%). A minimum of 177 banded males and 130 banded females nested, and a minimum of 65 unbanded adults (29 unbanded males and 36 unbanded females) nested. Due to high nest success in 2018, 70% of banded adults were confirmed nesting (low nest success typically results in fewer adults confirmed nesting). There were a total of 215 banded resident males, 204 banded resident females, and five banded resident plovers of uncertain sex present during the 2018 breeding season (15 April – 15 July). Using the minimum number of unbanded individuals estimated by the 10-day interval method, the minimum estimated Oregon resident plover population was 489. We believe this is the best estimate of the breeding population within the project area.

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

Overwinter Return Rate

Adult survival continues to be the most important parameter of population growth (Sandercock 2003, USFWS 2007, Dinsmore et al. 2010, Lauten et al. 2010, 2011, 2012, and 2013). Of the 408 banded adult plovers recorded in 2017, a minimum of 290 were recorded in 2018 in the project area. The overwinter return rate based on the minimum number of returning banded adult plovers was 71%, higher than the 1994-2018 mean of 66%, and higher than both 2016 and 2017 (69% and 67%, respectively). The adult male return rate was 74% and the adult female return rate was 69%, both considerably higher than in 2017 (70% and 62%, respectively; Lauten et al. 2017).

Of 290 fledglings produced in 2017 (Table 2), we observed 120 in the project area in 2018. The return rate was below the 1992-2018 average (Table 2), but higher than the previous two years. Survival of hatch year 2017 fledglings was higher than reported return rates because first year plovers that occupied other Oregon (ORBIC, OPRD, USFWS unpubl. data), Washington (Cyndie Sundstrom, pers. comm.), and northern California (Elizabeth Feucht, pers. comm.), beaches in 2018, but did not return to our project area, were not included in the calculated return rate. These additional hatch years plovers are important contributors to expanding plover populations at historic and new nesting locations in Oregon. Due to the high adult survival rate and reasonably good hatch year return rate, the population within the project area increased.

Of the returning HY17 birds, 56 (47%) were males, 58 (48%) were females, and six (5%) were unknown sex. Seventy of the HY17 returning plovers were confirmed breeding (58%).
During the 2018 season, we captured and rebanded 11 male and five female adult plovers with brood band combinations that needed to be updated to unique adult combinations. We banded two unbanded adult male plovers and 520 chicks.

**Distribution**

To show relative plover activity within our study area, we recorded total banded and unbanded adults present and the number of resident plovers at each site (Table 3). In 2018 Floras Lake and New River area had the lowest levels of activity, with fewer total birds present than in 2017 (n = 34 in 2017, Lauten *et al.*, 2017). Plovers on the New River HRA were using the south end from New River breach to Clay Island Breach only; there was no plover activity on the north side of the New River HRA (Croft Lake breach to the north end). Plovers concentrated their use around Clay Island breach, and the birds using Floras Lake essentially were the same group of birds as the New River HRA. The birds on New River private land were much further north and were more associated with the Bandon SPMA birds as they occupied the beach just south of the SPMA boundary. At Sutton Beach there was an increase in plover use from 2017, with twice as many total plovers recorded in 2018 compared to 2017 (n = 21). There was no increase in plover activity at Siltcoos, Overlook, and Tahkenitch in 2018 compared to 2017 (Lauten *et al.* 2017). There was an increase of 25 plovers at Tenmile in 2018, and a slight increase at CBNS (n = 10, Lauten *et al.* 2017). Bandon SPMA had a slight decrease in 2018 (n = 8, Lauten *et al.* 2017). The highest concentration of nesting activity, based on the presence of resident plovers, continues to be between Siltcoos and Bandon SPMA. Because plovers moved between sites and attempted to nest at more than one location, the total number of plovers in Table 3 is higher than the actual population estimate.

We documented plovers occupying available habitat adjacent to the traditional nesting areas in past reports (Lauten *et al.* 2010, 2011, 2012, 2013, 2014, 2015, 2016, and 2017). In 2018, plovers continued to fill in former nesting habitat and new sites outside the project area that had limited or no known nesting activity in the past. Plovers were found in every coastal county in 2018 and were documented nesting for the first time at Clatsop Spit in Clatsop Co., Agate Beach, South Beach State Park, and Patterson State Park in Lincoln Co., and the Elk River Spit and Bailey Beach in Curry Co. Plovers have now nested for two or more years at Nehalem Bay State Park and Sitka Sedge State Natural Area in Tillamook Co. (OPRD, unpublished data), and Sandpiper Village and Driftwood State Park in Lincoln County. Within the project area, five nests at Sutton Beach were found on the north side of Berry Creek (Figure 2); this is the second consecutive year with nesting in this area (Lauten *et al.* 2017). There was only one plover nest on the Sutton Creek spit in 2018 (Figure 2). At North Siltcoos, two nests were found along the foredune north of the spit (Figure 3). Plovers continue to occupy all the beach between South Siltcoos and North Tahkenitch (Figures 3 - 5). One nest and three broods were found at South Tahkenitch in 2018, with plover activity as far south as the Three Mile Creek trailhead. Plovers continue to push further north at North Tenmile, with four nests between parking lot two and three in 2018 (Figure 6). Plovers occupied the entire length of the beach south of the parking lots to the north spit (Figures 6 and 7). No activity was documented in the Horsfall Beach area in 2018, and only one nest was found north of the FAA towers at CBNS in 2018 (Figures 8 and 9). At Bandon SPMA in 2018 three nests were found north of China Creek and one nest was found on the China Creek spit north of the defined SPMA boundaries (Figures 10 and 11). Plovers occupied just the north end of the beach adjacent to private lands south of the Bandon SPMA to the New River HRA (Figure 12). The north end of the New River HRA had no nesting attempts and no plovers, the second year we have not documented plover activity in this area since it was created. All plover activity was south of the breach at Croft Lake, with all nesting attempts from Hammond Breach to south of Clay Island breach (Figure 13). There were four nest attempts at Floras Lake; two on or north of the Conservation Management Area (CMA) and two south along the foredune (Figure 14). Plovers will continue to utilize available habitat within the project area, and occupy sites along the other portions of the Oregon coast particularly once they successfully hatch nests at these sites.
Table 4 shows the number of nests and broods located during the 2018 nesting season (Figures 2-14). We found 58 fewer nests than in 2017, mostly because of a decline in nest numbers at Siltcoos, Overlook, and Tahkenitch. In particular Overlook had 50 fewer nests in 2018 compared to 2017. Alternatively Tenmile had 35 more nests in 2018 compared to 2017. The increase in nest numbers at Tenmile was due to higher rates of nest failure at this site. The decline in nest numbers at Siltcoos, Overlook, and Tahkenitch in 2018 may be due to multiple factors. There were similar numbers of plovers at Siltcoos, Overlook, and Tahkenitch in 2018 compared to 2017 (Lauten et al. 2017), but nest success was higher at Overlook and Tahkenitch in 2018 compared to 2017 while Siltcoos had similar nest success rates in both years (Lauten et al. 2017). Higher nest success typically results in fewer nest attempts. However, it is also possible that some nests were not found prior to being depredated resulting in fewer nests recorded. Nest numbers at CBNS, Bandon SPMA, and the New River/Floras Lake area were similar to 2017 except for New River private land where there was a decrease in nests found. We used one exclosure at North Tahkenitch in 2018 (Table 5). A second exclosure was erected at New River HRA but a camera on the nest indicated the nest was abandoned prior to the placement of the exclosure, and therefore we did not count that nest as exclosed since it had failed prior to exclosure use. Overall nest success in 2018 was slightly above average and higher than 2017 (Tables 5 and 6).

The first nests were initiated about 30 March (Figure 15). Nest initiation increased through mid-April but due to good nest success there was no decline in nest initiation until after the peak (n = 188) during the 31 May – 9 June time interval, the same peak nesting period as in 2016 and 2017 (Lauten et al. 2016 and 2017). The last nest initiation occurred on 17 July, earlier than most years. Good nest success resulting in many active broods may have contributed to an earlier than typical last initiation date.

Nest Failure

Predators were responsible for 60% of nest failures (Table 7) compared to 53% of failures in 2017 (Lauten et al. 2017). In 2018 there were nearly twice as many corvid (Corvus sp.) depredations compared to 2017 (35 in 2017 compared to 68 in 2018), but there were 43 fewer Northern Harrier (Circus cyaneus) depredations in 2018 compared to 2017. The number of mammal depredations was similar in 2018 compared to 2017 (20 versus 17, respectively); there were more red fox (Vulpes vulpes) and coyotes (Canis latrans) depredations in 2018 compared to 2017 (Table 7, Lauten et al. 2017), but very few depredations by other mammals.

In 2016 and 2017, Northern Harriers were the most frequently identified nest predator (Lauten et al. 2016 and 2017). In 2017 all 48 harrier depredations were at CBNS (Lauten et al. 2017); in 2018 there were no harrier depredations at CBNS (Table 7). The decline in harrier depredations was the likely result of removal of a pair of harriers late in 2017 at CBNS (Flory et al. 2017). Nesting data from CBNS shows that in years following the removal of harriers, there is a substantial increase in nesting success, indicating that removal of harriers targeting plover nests had a positive impact on nest success (Figure 16). A new pair of harriers did set up territory north of the nesting area at CBNS in 2018, but they did not hunt extensively over the nesting area and did not cause any identified nest depredations. There were at least five harrier depredations documented between Overlook and Tahkenitch (Table 7); there were no harrier depredations at these sites in 2017 (Lauten et al. 2017). We intend to continue to closely monitor plover nests and use cameras to document harrier activity where we find evidence of harrier depredations.

depredated 35 nests, mostly in a relatively short period of time in May. At CBNS in April, ravens caused four nest failures. Removal of these individuals resulted in improved nest success at these sites and a large reduction in corvid related nest failures. Also at CBNS American Crows (Corvus brachyrhynchos) depredated seven nests on the HRAs. These are the first documented crow related nest depredations on the nesting area at CBNS since prior to 2000 (ORBIC, unpubl. data). Depredations by crows ceased after their removal from the area. Due to the presence of both ravens and harriers at Overlook, nine failed nests could not be assigned to a specific predator other than avian depredation (Table 7). Evidence at these nests indicated avian depredation, but lack of tracks or other evidence made determining the predator difficult. At Bandon SPMA, there were a high number of unknown depredations. Despite only three confirmed corvid depredations and corvids being relatively uncommon while surveying these sites, we suspect that corvids were likely responsible for some of these depredations based on limited evidence. The New River HRA continues to have both raven and fox related issues due to its proximity to the adjacent sheep ranches. Plover numbers continue to decline in this area, likely due to the high predation pressure.

Coyote depredations increased from five in 2017 (Lauten et al. 2017) to nine in 2018 (Table 7), all between Siltcoos and Tahkenitch. While coyotes tend to be opportunistic predators and have not traditionally targeted plover nests, in recent years they have been using the nesting areas more. Coyotes may be responding to increased density of nesting plovers, or may be attracted to the smell of spilled yolk at nests depredated by other predators, resulting in increased awareness of nesting birds and thus increased depredations. At Bandon SPMA and New River, persistent fox activity resulted in nine nest depredations (Table 7). Despite repeated removal of fox from these sites, fox were present all summer and continue to fill in when any individual was removed. There was only one skunk (Mephitis sp.) and one raccoon (Procyon lotor) depredation documented in 2018, the only other mammal depredations for the year. Skunk activity seems reduced in past two years (Lauten et al. 2017). There were no known or suspected rodent depredations in 2018.

At CBNS in 2018 a vehicle accessed the beach near the jetty and drove north, breaking into the roped area and crushing two active nests. The vehicle exited and entered the roped area in three locations and continued north to the Horsfall Beach area. These are the first two vehicle-crushed nests we have recorded at CBNS since early in the 1990’s.

We continued to use cameras to document nest predators and assist in reducing the number of nest failures that have been ascribed to unknown depredation or unknown cause (Lauten et al. 2015). We placed Reconyx and Bushnell cameras at 25 nests in 2018. At nine nests cameras either failed to record the outcome of the nest due to battery or flash card related issues, or because pictures were lost due to a hard drive failure. Nine nests with cameras failed and the cameras clearly identified the cause of failure. At two of these failed nests, monitors’ assessment of the cause of failure matched what was shown on the camera. At the other seven failed nests, monitors were unable to identify the predator responsible for nest failure based on evidence left at the nest, but we were able to accurately identify the cause of failure based on camera data. Twelve of the nests with cameras hatched, so loss of data at these nests was irrelevant. One nest with a camera was never active after the first egg was laid; a second nest with a camera was abandoned; and a third nest with a camera failed but the camera failed to clearly record the cause of failure. One nest with lost camera data failed; monitors determined this nest failed to coyote but we were unable to verify. Use of cameras did not negatively affect nest success. Apparent success at nests with cameras was 48%, similar to the overall nest success (Table 5), and to apparent success of nests without cameras. However, for the first time we documented some evidence that ravens may have associated cameras with nests. At CBNS in early April we set up cameras on five nests. All five nests failed on the same day, and four of the five nests had photographic evidence of ravens depredating the nest. Photos from one of the cameras did not capture the cause of nest failure at this nest, but ravens are suspected. Assessment of the photos from the camera indicated that ravens came from behind each camera and walked around until finding the nest. Once these ravens were removed from CBNS, there were no more raven depredations for the remainder of the season. Based on the camera data, we believe the ravens became aware that the cameras were related to a food resource. We did not install cameras at CBNS for the remainder of the season, and nest success was very high (Table 5). We intend to continue to use cameras where they are feasible, as time is available, and where better documentation of the cause of nest failure is needed, as long as there is no evidence predators are targeting cameras.
While there were similar numbers of failed nests due to unknown depredations in both 2017 and 2018 (49 versus 45, respectively), there were 69 fewer nests that failed due to unknown causes in 2018. The decline in failed nests due to unknown causes was likely a result of overall fewer nest failures in 2018 (69 overall fewer nest failures) and better evidence of causes of nest failures. Nest depredations were classified as unknown because they had clearly been depredated, but the predator could not be identified. Of seven failed nests with cameras classified as unknown by monitors in the field, cameras recorded six raven depredations and one harrier depredation. Corvids, particularly ravens, are the dominant cause of known nest failure (Table 7, Lauten et al. 2017 and previous) and as camera data indicates, are the likely cause of many of the unknown depredations and unknown cause failures. Due to both corvid and harrier activity between Siltcoos and Tahkenitch, determination of unknown depredations and unknown avian depredations is more difficult, but monitors believe ravens out-compete harriers when both are present. Poor weather conditions often erased evidence of cause of failure at these sites. At Bandon SPMA and the New River area, there were a larger variety of predators making it difficult to suggest whether any particular predator is responsible for these unknown outcomes.

We continue to minimize the use of exclosures because of time limits, effective lethal predator management, a plover population well above recovery goals, and successful productivity. There is little justification for exposing adult plovers to increased risk of depredation in or around exclosures when predation is well managed. One exclosure was used on an active nest at Tahkenitch in 2018. Exclosure use was not necessary as overall nest success at all sites reasonably good in 2018 (Table 5). We will continue to have exclosures available for use when needed, but we will also minimize their use due to the overall success of the plovers under current management practices (see Appendix D for exclosure protocols).

**Productivity**

We sampled 213 broods from the 256 nests that were known to have hatched (83%), and these broods produced 279 fledglings (Table 8). We counted an additional 25 fledglings, both banded and unbanded, from broods that were not part of the sample, and an additional minimum of 12 unbanded fledglings from broods not sampled at CBNS (Table 9). The overall minimum number of fledglings we recorded for all broods was 316 (Table 9). The overall fledging success based on the sample broods (Table 8) was higher than the post-predator management average (Table 10). The overall brood success rate of sampled broods (Table 8) was well above the 1991 – 2018 average (68% +/- 10). We calculated the number of fledglings per male for each site using the number of resident males from Table 3 (Table 11). The mean number of fledglings per resident male for the project area was at recovery goals and higher than the previous two years but below the mean post-predator management average (Table 10). We report these mean fledglings per male for all sites for comparison with previous years, but because the number of resident males reported by site double counts birds that occur at multiple sites, the resulting overall mean number of chicks fledged per resident male is biased low. In 2018 the minimum number of fledglings counted was 316 (Table 9), and the total number of resident males was a minimum of 244. The number of fledglings per resident male based on these numbers was 1.30. This number is higher than our reported mean number of fledglings per resident male (Table 11) and similar to the number of fledglings per sampled brood (Table 8). We believe the most accurate estimate of productivity is the number of fledglings produced per sample brood, 1.31 (Table 8).

We used the breeding coefficient, the number of fledglings produced per number of eggs laid, as an alternate assessment of the overall productivity of each nesting site (Table 8, Lauten et al. 2017, Colwell et al. 2018). The breeding coefficient is a measure of productivity based on effort (eggs laid). Any site with a breeding coefficient of 0.20 and above was relatively successful for the amount of effort, while sites with a breeding coefficient below 0.15 are generally not very productive for the amount of effort.

**Sutton**

The number of nests at Sutton Beach (Table 4) was the second highest ever recorded for this site. Nest success improved in 2018 with 11 of the nests hatching (Table 5, Lauten et al. 2017). All 11 hatched nests were
used in the sample (Table 8) and six nests produced eight fledglings. This is the highest number of fledglings ever produced at this site (Table 9). The hatch rate was very good at Sutton Beach in 2018, 20 percentage points higher than 2017 (Lauten et al. 2017), and well above the average (Figure 17). Fledging success and the number of fledglings per resident male were much higher than 2017 (Lauten et al. 2017), well above average (Figure 18 and 19), and near recovery goals; these are very good improvements for this site which has the lowest reproductive parameters within the project area (Figures –17 to 19, Table 11). The breeding coefficient for Sutton Beach was much improved compared to 2017 (Table 8, Lauten et al. 2017) and reflected a productive year.

**Siltcoos**

Siltcoos had 17 fewer nests in 2018 compared to 2017 (Table 4). Nest success on the south side was higher than in 2017 (Table 5, Lauten et al. 2017) and overall two more nests hatched compared to 2017. The north spit had a larger decline in both number of nests and nest success compared to 2017 (Table 5, Lauten et al. 2017). Nest success at North Siltcoos was well below average in 2018 ($\bar{x} = 39\%$), while at South Siltcoos nest success was well above average (Table 5, $\bar{x} = 46\%$).

The hatch rate at Siltcoos in 2018 was above the post-predator management average (Figure 17). There were eight fewer broods at Siltcoos in 2018 compared to 2017 (Lauten et al. 2017), and they produced nine fewer fledglings (Table 9). South Siltcoos produced nearly the same number of fledglings in 2018 compared to 2017, but North Siltcoos produced 11 fewer fledglings. Fledging success was above the post-predator management average (Figure 18) and the number of fledglings per resident male was at recovery goals but below the post-predator management average (Figure 19, Table 11). The total number of fledglings was down at North Siltcoos due to fewer broods, but those broods had a very good fledging success rate and fledglings per brood resulting in a reasonably good breeding coefficient for North Siltcoos in 2018 (Table 8). South Siltcoos was very productive in 2018 with very good brood success, fledging success, and number of fledglings per brood, resulting in a very high breeding coefficient indicating a very successful year (Table 8).

**Overlook**

Despite having nearly the same number of plovers in 2018 as 2017 (Table 3, Lauten et al. 2017), Overlook had the largest decline in the numbers of nests in 2018 compared to 2017 (50 fewer nests, Table 4). While nest success was considerably higher in 2018 (Table 5) compared to 2017 (32%), it does not completely explain the large decrease in nest numbers compared to the previous three seasons (Table 4). Corvids, harriers, and coyotes were all problematic at Overlook in 2018 (Table 7), and may have been causing nest failures early in the incubation period before monitors found the nests. Based on the discovered nests, both North and South Overlook had above average nest success in 2018 (Table 5, $\bar{x} = 44\%$ and $40\%$, respectively), but this may be biased high if in fact many nests were depredated before being found.

The hatch rate and fledging success rate at Overlook in 2018 were above the post-predator management average (Figures 17 and 18). The number of fledglings per resident male was below the post-predator management averages (Figures 19, Table 11), but above recovery goals. Despite the reduction in the number of nests, North Overlook produced just two fewer fledglings in 2018 compared to 2017 and South Overlook produced just five fewer fledglings compared to 2017 (Table 9). The breeding coefficient for North Overlook was the same in 2018 as 2017 and indicated relatively poor productivity for the number of eggs laid at this site. The data indicate that the plovers are persistently attempting to nest at North Overlook but not producing many fledglings for the effort. Nests that do hatch have good fledging rates (Table 8), but overall productivity at this site in the last two seasons has been poor. Alternatively, South Overlook had a very good breeding coefficient (the same as 2017, Lauten et al. 2017), indicating that the plovers were much more productive than the north side and are producing good numbers of fledglings for the effort (Table 8).

**Tahkenitch**

There were nine fewer nests at North Tahkenitch in 2018 compared to 2017 (Table 4), the second consecutive year with fewer nests at this site. Nest success improved in 2018 (Table 5) compared to 2017 (Lauten et
and was near average ($\bar{x} = 40\%$). The improved nest success likely contributed to the lower nest numbers, as nearly the same number of plovers used this site in 2018 compared to 2017 (Table 3, Lauten et al. 2017). There was one successful nest found at South Tahkenitch in 2018, however three broods from undiscovered nests were found at this site indicating that more nest activity occurred than monitors recorded.

The hatch rate and fledging success rate at Tahkenitch in 2018 were similar to the post-predator management average (Figure 17 and 18). While the numbers of fledglings per brood (Table 8) were good, the number of fledglings per resident male was below average (Figure 19). This is partly due to the high number of males detected during the resident period for this site, which is frequented by both birds from Siltcoos, Overlook, and Tenmile. The overall number of fledglings produced from these two sites was similar to the last two seasons (Table 9). North Tahkenitch has fairly high levels of effort in terms of the number of nests and eggs laid, and the breeding coefficient at North Tahkenitch indicates reasonably good productivity. At South Tahkenitch the breeding coefficient was the highest of all sites, but this is based on a small size and all broods in the sample were productive, resulting in a high coefficient (Table 8).

**Tenmile**

Tenmile had 35 more nests in 2018 compared to 2017 (Table 4). While the increase of 25 plovers using the site in 2018 compared to 2017 (Table 3, Lauten et al. 2017) likely contributed to the increase in nest numbers, the increase was also due to a high rate of nest failure and subsequent renesting. In 2017 overall nest success was very high at 64%; in 2018 overall nest success was 41% (Table 5). Nest success at North Tenmile was average (Table 5, $\bar{x} = 45\%$), while nest success at South Tenmile was well below average (Table 5, $\bar{x} = 50\%$). Despite the lower nest success in 2018, the number of nests that hatched was identical to 2017 (Table 5, Lauten et al. 2017).

The hatch rate at Tenmile was near the post-predator management average (Figure 17), and the fledging success rate was above average (Figure 18). The number of fledglings produced in 2018 was nearly identical to 2017 (Table 9) and the highest number ever for this site. The number of fledglings per resident male was just below the post-predator management average for Tenmile (Figure 19). The breeding coefficients for Tenmile in 2018 were very good (Table 8). By all measures of productivity, Tenmile was very productive in 2018 and remains one of the most productive sites within the project area.

**Coos Bay North Spit**

There were slightly more plovers ($n = 10$) recorded at CBNS in 2018 compared to 2017 (Table 3, Lauten et al. 2017), and the number of nests at CBNS in 2018 was nearly the same as 2017 (Table 4). Nest success was considerably higher on South Spoil and the HRAs in 2018 compared to 2017, but was lower on South Beach (Table 5, Lauten et al. 2017). The higher nest success was attributed to the removal of a pair of harriers that were the main cause of nest failure at CBNS in 2017 (Lauten et al. 2017). While a new pair of harriers established a territory north of the nesting area in 2018, they did not hunt over the nesting area for much of the season and caused no nest failures (Table 7). Nest success on South Spoil was the highest of any site in 2018 (Table 5), and well above average ($\bar{x} = 61\%$). Nest success on the HRAs was also above average (Table 5, $\bar{x} = 50\%$), while on South Beach nest success was near average (Table 5, $\bar{x} = 59\%$). There were 30 more hatched nests in 2018 compared to 2017 (Table 5, Lauten et al. 2017).

The hatch rate at CBNS in 2018 was much higher than the previous two years (Lauten et al. 2016 and 2017) and above the post-predator management average (Figure 17). Fledging success and the number of fledglings per resident male were near average for CBNS in 2018 (Figure 18 and 19). In 2017 we noted that observations and data suggested that the harriers may have been depredating broods as well as nests (Lauten et al. 2017). Both South Spoil and the HRAs in 2017 had relatively poor breeding coefficients (Lauten et al. 2017); in 2018 the breeding coefficients for these two sites were very good and considerably higher than 2017. Harriers have been the only known predator on CBNS nesting areas in the past few years except early in the season when a few ravens are present before they were typically removed. In 2018, ravens were again removed in early April and no additional raven activity was noted at CBNS for the remainder of the season. The improved productivity on the nesting area at
CBNS in the absence of harrier activity indicates that harriers, when present, are detrimental to plover productivity in terms of both nest and brood failure, and successful removal of harriers has a positive impact on plover productivity. Due to the improved productivity, we counted a minimum of 34 more fledglings in 2018 compared to 2017 (Table 9). By all measures of productivity, plovers had a very successful year at CBNS (Table 8).

**Bandon SPMA**

There were slightly fewer plovers recorded at Bandon SPMA in 2018 compared to 2017 (Table 3, Lauten et al. 2017), and nearly the same number of nests (Table 4). Overall Nest success was lower in 2018 compared to 2017 (Table 5, Lauten et al. 2017), but near average ($\bar{x} = 41\%$). Nest success at Bandon Beach was 44%, while nest success on the New River spit was 30%. Bandon SPMA and New River area typically have low productivity due to the diverse predator community in the area, with corvids, gull, fox, raccoon, and skunk positively identified depredating nests in 2018 (Table 7).

Fewer eggs hatched in 2018 compared to 2017 resulting in a lower hatch rate but the hatch rate was equal to the post-predator management average (Figure 17). Despite the lower nest success and hatch rate, Bandon SPMA had a very successful year, with the highest number of fledglings produced since monitoring began (Table 9), a fledging success rate well above average (Figure 18), and the number of fledglings per resident male well above average (Figure 19) and recovery goals. The New River spit was much more productive than the previous two years (Table 9), resulting in much better productivity for the Bandon SPMA. The breeding coefficient at Bandon SPMA was also very good (Table 8). By all measures of productivity, Bandon SPMA had a very successful season.

**New River**

For consistency’s sake, we pooled data from New River private land with the New River HRA, as we have in past reports. In 2018, for the second consecutive year, no plover activity was recorded on the north end of the HRA; plovers on the HRA concentrated their activity around Hammond and Clay Island breaches (Figure 13), well south of private lands. Plovers using the private lands were concentrated just south of the New River spit and south of the Bandon SPMA boundary. However, for consistency’s sake, in 2018 we continued to pool the New River private land data with the New River HRA data.

There has been a continual decline of plovers using the New River HRA and adjacent areas in recent years (Lauten et al. 2017) and that trend continued in 2018 (Table 3). There was no plover activity on the north end of the HRA, and only five nests were found on private lands south of the Bandon SPMA boundary (Table 4, Figure 12). Predation pressure continues to be high at New River, particularly by ravens and red fox, likely due to the proximity of sheep ranches. Despite the predation pressure, nest success improved in 2018 compared to 2017 (Table 5, Lauten et al. 2017) but was still below average ($\bar{x} = 51\%$).

While the hatch rate improved at New River in 2018 compared to 2017 (Lauten et al. 2017), it was well below the post-predator management average (Figure 17). The New River HRA had reasonably good productivity for the small number of plovers present, but private lands were very unproductive (Table 8). The fledging success rate for the pooled data was well below the post-predator management average (Figure 18). There were a relatively high number of male plovers moving through the area during the resident period that were thus counted as resident, contributing to the very low and below average number of fledglings per resident male (Table 11, Figure 19). The breeding coefficients for the HRA and private lands were poor (Table 8), indicating that few fledglings were produced for the effort. The New River area, despite plentiful quality habitat, continues to be a challenging location for nesting plovers due to the diverse and persistent predator community.

**Floras Lake**

Despite the small number of plovers and four nests at Floras Lake in 2018 (Table 4), productivity at this site was excellent (Table 8). All three broods fledged two chicks each, resulting in the highest number of fledglings for this site since prior to 2000. The low density of plovers and nests at this site likely contributed to the success of this site, but all three broods moved north to Clay Island breach within the first week of hatching and were successfully
raised on the New River HRA, so most brood rearing did not actually occur at Floras Lake. Floras Lake in 2018 had the highest fledging success, fledglings per resident male, and the breeding coefficient of any site, indicating excellent productivity.

Summary

Overall productivity for 2018 was excellent with above post-predator management average nest success (Table 5, $\bar{x} = 43\%$), a minimum of 316 fledglings produced (Table 9) from approximately 244 resident males, above average fledging success (Table 10), 1.31 fledglings per sample brood (Table 8), and an overall breeding coefficient of 0.24 +/- 0.04. The number of fledglings per resident male was at recovery goals (Table 11) despite likely being biased low due to double counting of resident males per site. Maintaining good productivity at most sites, particularly sites with high plover usage (i.e., Siltcoos to Bandon SPMA), compensates for sites that may be receiving high predation pressure and thus are not as productive in any given year. Maintaining overall average nest success of 40%, fledging success of 40%, fledgling per male at approximately 1.00, and a 0.20 breeding coefficient should result in a stable to growing Oregon coast population.

Productivity Before and After Lethal Predator Management

Data from Floras Lake and Sutton Beach are very sparse. We did not include data from Floras Lake in the graphs of productivity analysis, and data from Sutton Beach is displayed solely for the purposes of 2018 comparisons.

The 2018 overall nest success was above the ten year (2009 – 2018) average of 41.0% +/- 11.5%, and within the mean observed and calculated success rates reported by Page et al. (2009) from multiple studies. During this period exclosure use has declined from a maximum of 67 in 2010, but the number of eggs hatched and chicks fledged has substantially increased (Figure 20). Nest success of unexclosed nests during this same period has averaged 38.3%+/−13.7, similar to the overall average of this period ($\bar{x} = 41\% +/- 11.6\%$). Post-predator management fledging success rates have improved at all sites except at Tahkenitch and Tenmile where they have remained relatively stable but above 40% (Figure 18). The post-predator management mean brood success rate for all sites (2004-2017; $\bar{x} = 73.2\%+/−7.6\%$) was higher than the pre-predator management brood success rate (1991-2001; $\bar{x} = 62.9\%+/−8.5\%$). The post-predator management number of fledglings per male has improved at all sites except Tenmile and CBNS where it has remained relatively stable and above 1.20 for Tenmile and 1.50 for CBNS (Figure 19). The overall productivity has increased in the post-predator management time period resulting in a substantial increase in the number of fledglings and the overall population of plovers both within the project area and on the Oregon coast in general.

Brood Activity

Sutton, Siltcoos, Overlook, and Tahkenitch

In 2018 there were two broods from nests north of Berry Creek; one of the broods successfully fledged one chick north of the creek. This is the first fledgling from this area since prior to 2000 (ORBIC, unpubl. data). Nine broods originated on the Sutton HRA, five of which were successful. All brood activity remained at the south end of the beach in and around the HRA.

There were only five broods at North Siltcoos in 2018 and all were successful. All broods originated from the spit and remained on the spit until they successfully fledged. Fourteen broods originated from spit and nesting areas at South Siltcoos. One brood originated from the beach south of Waxmyrtle Trail. This brood utilized the beach and moved south to North Overlook. One other brood from the spit moved south and fledged at North
Overlook. A third brood crossed Siltcoos River and moved to the north spit. This brood was recorded near the I-beam north of the access trail at North Siltcoos. All other broods remained on the south spit and adjacent areas.

There were 11 total broods from North Overlook, nine that hatched on the HRA and two that hatched north of the HRA along the beach. As in past years (Lauten et al. 2016 and 2017), there was brood activity along the beach from Waxmyrtle Trail to North Overlook. One brood moved south to South Overlook. There were 15 broods from South Overlook that originated on the HRA and one that originated on the beach near the access to the loop trail. Four of the broods, including the brood from near the loop trail, moved south along the beach to North Tahkenitch. One brood moved north to North Overlook and then returned to South Overlook. Plover broods now have more available habitat due to the continued expanding of the HRA at South Overlook.

North Tahkenitch had 18 broods in 2018; 13 broods were successful and originated on the HRA and spit. One unsuccessful brood originated from the beach north of the spit. All brood activity was on the HRA and adjacent beach. There were no known brood movements to the north or south of the spit. Four broods, one from a known nest and three from undiscovered nests successfully fledged on the South Tahkenitch side. These broods used the beach as far south as near the Three Mile Creek trailhead but spent most of the time from the I-beam sign to the spit area.

**Tenmile**

At North Tenmile in 2018 there was brood activity from just south of the second parking lot to the north spit. Five successful broods, four from known nests and one from an undiscovered nest, were utilizing the beach between parking lots 2 and 3. This is the most brood activity we have documented in this area. Fourteen broods originated from the beach from the vicinity of the Dellenbach trail. Most of these broods stayed along the beach, but at least one wandered south to the north spit. One brood was from a nest along the beach north of the HRA. Ten broods originated on the HRA or spit. Most of these broods remained at the south end of the beach, in and around the spit and HRA, however one brood moved as far north as the Dellenbach trail area. Eleven broods from South Tenmile originated on the HRA. Two broods moved south of the HRA along the beach, but all other brood activity was concentrated on the HRA, spit, and adjacent beach. One brood from an undiscovered nest was found on the beach south of the HRA, but no broods wandered as far south as the I-beam at the south end of the beach.

**Coos Bay North Spit**

Northern Harriers at CBNS have been a significant nest predator (Lauten et al. 2013, 2016, and 2017), and monitors suspect harriers are also negatively impacting broods (Lauten et al. 2017). Data indicates that removal of harriers has a positive effect on nest success (Figure 16). In 2018, after the removal of a pair of harriers in 2017, brood and fledging success on the HRAs was considerably higher than in 2017 (Table 8, Lauten et al. 2017) indicating that harriers were likely having a negative impact on broods. The beach tends to have the highest productivity at CBNS, likely due to food resources. Gaps have been created and maintained in the foredune, facilitating brood movement west to the beach. In 2018 we placed cameras in several gaps in the hopes of capturing photographic evidence of plover broods utilizing these gaps. We have yet to evaluate all the data that has been recorded. However, based on the location of broody males, we know some broods are moving west to the beach, and gaps in the foredune with little to no vegetation are likely facilitating brood movement to the beach.

In 2018 we did not document any brood movements north of the north gate or south of the south gate. There was only one nest north of the FAA towers (Figure 8). This brood moved south along the beach towards the FAA towers and the north I-beam before moving substantially farther south and fledging well within the restricted area of the beach. One brood that hatched just south of the FAA towers moved north and utilized the beach north of the I-beam before returning south to within the restricted area of the beach. Broods continue to use the beach that is open to vehicle use near the jetty. We documented brood tracks and chicks using the parking area near the jetty and adjacent dunes, jetty, and beach area. We did not see any evidence that any broods traveled north on the foredune road toward the bay. Adult plovers were noted using the bay beach east of the jetty area, but we saw no evidence that any broods moved to this area.
Bandon SPMA

The Bandon Beach side of Bandon SPMA had another very productive year in 2018. Fourteen of 17 broods successfully fledged. Two broods originated from north of China Creek, outside the SPMA. One brood crossed the creek and spent most of the brood period from the China Creek overwash area south to the HRA and successfully fledged. The other brood stayed north of China Creek and was active for about two weeks before failing. All other broods originated within the SPMA. Several broods were successfully raised along the foredune and beach south of the I-beam and the beginning of ropes and signs to the north end of the HRA. Brood activity occurred the length of the HRA, and four broods used the beach south of the HRA to the spit north of New River. Two of these broods spent most of their brood rearing time on the north spit of New River. In general there is substantial plover activity on this relatively short distance of beach (ca. 1.9 km).

The New River spit side of the Bandon SPMA was much more productive in 2018 compared to 2017 with at least 14 of 17 broods successfully fledging chicks (Table 8, Lauten et al. 2017). In 2017 we speculated that Great Horned Owls (*Bubo virginianus*) may have been detrimental to brood survival at the New River spit (Lauten et al. 2017). In 2018 one chick that hatched from a nest appeared to have been depredated by a Great Horned Owl as there were owl tracks over plover tracks near the recently hatched nest bowl. The male plover was present but never brooded a chick, and all indication was that this chick did not survive. One Great Horned Owl was incidentally trapped and removed from the area in 2018 (Bell et al. 2018). While there was evidence of a second individual hunting on the spit (based on tracks), we did not document any plover mortalities due to this owl. We did however note owl tracks with one meter of an active nests. WS made several attempts to trap a second individual, but due to time constraints and weather conditions, no other owls were removed from the area.

There was brood activity at the New River spit from the mouth of the river to the southern boundary of the SPMA. Broods used all available habitat including the beach, overwash areas, and the river side. One brood from the south end of the SPMA moved south of the SPMA and successfully fledged along private lands.

New River

Three broods originated on private land in 2018, two from known nests and one brood from an unknown nest that was discovered on private lands. Two broods originated on Bandon Biota property just south of the Bandon SPMA, but both did not successfully fledge. The brood from the undiscovered nest was found on the beach south of Bandon Biota lands and spend the brood period along the beach adjacent to private land. This brood did not travel south towards the north end of the HRA.

There was no brood activity on the north end of the New River HRA or the beach just north of the HRA. All brood activity occurred from just north of Hammond breach to south of Clay Island breach. Two broods originated from nest on Hammond breach. One brood moved south to Clay Island breach but did not successfully fledge. The second brood remained on and just north of Hammond breach. Two broods originated from the beach just south of Clay Island breach. One brood spent time on Clay Island breach and the beach south of Clay Island breach and successfully fledged two chicks. The second brood had just one chick and was never confirmed fledged. While there were only two successful broods from the New River HRA, all three broods from Floras Lake moved north to the Clay Island to Hammond breach area and successfully raised their broods (see below).

Floras Lake

There were three broods from nests at Floras Lake, one that hatched along the beach just north of the beginning of the restricted area, one at the north end of the CMA, and one further north of the CMA near Hansen breach. All three broods traveled north to the Clay Island breach area within a week after hatching. One brood remained on Clay Island breach and successfully fledged. One brood moved north and used the beach from the campground south to Clay Island breach and successfully fledged. The third brood moved north to Hammond breach and successfully fledged.
Immigrant Plovers

Thirty-six adult plovers banded in California and two adult plovers banded in Washington were observed in Oregon in 2018. Twenty-three were females and 15 were males. Nineteen females were resident plovers and four were present either early in the season or late in the season and were likely either wintering or visiting plovers. Thirteen males were resident plovers and two males were present briefly, one in early April and one in August.

Of the 36 plovers banded in California, four females and eight males originally hatched in Oregon and were subsequently rebanded at coastal nest sites in California. Two plovers were originally banded in Washington; all other plovers were originally banded in California.

Acknowledgments

We would like to extend a very special thank you to Laura Todd of USFWS for her years of dedication. She has been instrumental to the success of the plover project and we wish her the best in retirement – the plovers are extremely grateful for all she has done! Also a very special thank you to Crystal Mullins of USFS for her many years of work including maintaining signs and ropes, monitoring recreational activity and interacting with the public on the Dunes Recreation Area – her years of service have been much appreciated and we wish her well in retirement. We would like to thank Micah Bell, Patrick Flory, Joe Metzler, Chad Heffley and Paul Wolf of Wildlife Services for their assistance in the field and thoughtful insight about predators; RJ Rapelje, Ryan Parker, Chuck Littlejohn, of OPRD for their hours educating the public and monitoring recreational activity on the beach; Chrissy Asermely of BLM for monitoring recreational activity and logistical support at CBNS; Statia Ryder and Mary Spini of South Coast Watershed Association for their enthusiasm monitoring and educating recreationists and campers at New River and Floras Lake; Jamie Harrison, Laurie Karnatz, April Charney, Bill Isaacs, Vicki Penwell, of Siuslaw National Forest Valuing People and Places Field Rangers for their work monitoring and educating recreationists; volunteers Annette Smith, Beth Haley, Mary James & Pat Blue Heron, Jay & Susan Feagan, and Butch & Julie Fayal spent numerous hours educating the public at China Creek parking lot on Bandon Snowy Plover Management Area; Shane Presley of BLM Law Enforcement, Levi Harris and Jay Evans of Oregon State Police, Adam Slater and Deputy Patterson of Coos County Sheriff’s Department, Blake Dornbusch of Lane County Sheriff’s Department, Oliver Grover of the USFS Dunes National Recreation Area Law Enforcement; Madeleine Vander Heyden, Jeff Everett, David Leal, and Susie Tharrat of the USFWS; Mark Stern and Ken Popper of The Nature Conservancy; Stuart Love and Martin Nugent of ODFW; Charlie Bruce, retired ODFW volunteer; Kip Wright, Jenn Kirkland, Carol Aron, Jeanne Standley, Jenny Sperling, Megan Harper, Greg Bjornstrom, Eric Baxter and all the managers at Coos Bay BLM District whose support is invaluable; Lura Huff and Matt Chamberlain of BLM who disk and maintain the nesting areas at CBNS; Vanessa Blackstone, Laurel Hillman, Larry Becker, and Calum Stevenson of OPRD; Nick Schoeppner, Pete Hockett, Sharon Justice, Patrick Newhall, Chris Wiggins, Drew Witmer, Kendall Murphy, and Pete Tessling and all the staff at Bullard’s Beach State Park; Cindy Burns and Deanna Williams of the USFS Siuslaw National Forest; Kate Groth and Dominic Yballe of ACOE; Dave Williams of Wildlife Services; Roy Lowe, retired USFWS, for his interest and work with Lincoln Co. plovers; Sean McAllister in Humboldt Co., CA; big thanks to Elizabeth J Feucht and Mark Colwell at Humboldt State Univ., Arcata, CA who work closely with us on banding, distribution, and important plover biology topics, and to all Mark’s students at HSU for their dedication; Gary Page, Lynne Stenzel, Doug George, Kris Neumann, Carlson Eyster, and Dave Dixon of Point Blue Conservation Science; Amber Clark (Oceano Dunes), Matt Lau (Pt. Reyes), Jamie Miller (Vanderberg AFB), Regina Orr (Morro Bay), Kimberly Paradis (Guadalupe Dunes), Ben Pearl (SF Bay), and Travis Wooten (San Diego) for helping to coordinate and report plover band combinations in California; Gary Dawson for his kind contribution of making 3D printed plover eggs for the project; anyone and everyone who we may have accidentally forgotten – we sincerely appreciate the support, assistance, and input of all, without which the program would not be a success.


Department of Fish and Wildlife – Nongame Program, Portland, the Coos Bay District Bureau of Land Management, Coos Bay, and the Dunes Recreational Area, Reedsport.


Table 1. Minimum window survey counts and the minimum number of Snowy Plover present from Sutton Beach to Floras Lake, Oregon Coast, 2007-2018.

<table>
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<th>YEAR</th>
<th>WINDOW SURVEY</th>
<th># SNPL PRESENT</th>
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</tr>
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<td>2011</td>
<td>168</td>
<td>247</td>
</tr>
<tr>
<td>2012</td>
<td>206</td>
<td>293</td>
</tr>
<tr>
<td>2013</td>
<td>215</td>
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<td>277</td>
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</tr>
<tr>
<td>2016</td>
<td>375</td>
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<tr>
<td>2017</td>
<td>282</td>
<td>468</td>
</tr>
<tr>
<td>2018</td>
<td>311</td>
<td>502</td>
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</table>
Table 2. Number of Snowy Plover fledglings from previous year, number of previous year fledglings returning, and return rate from Sutton Beach to Floras Lake, Oregon coast, 1992 - 2018.

<table>
<thead>
<tr>
<th>Year</th>
<th># of fledglings from previous year</th>
<th># of HY birds from previous year sighted on OR coast</th>
<th>Return Rate (#HY/#Fled)</th>
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<tbody>
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<td>2018</td>
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<td>120</td>
<td>41%</td>
</tr>
<tr>
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<td>200&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69</td>
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<tr>
<td>2016</td>
<td>339</td>
<td>135</td>
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</tr>
<tr>
<td>2015</td>
<td>276</td>
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</tr>
<tr>
<td>2011</td>
<td>84</td>
<td>53</td>
<td>63%</td>
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<tr>
<td>2010</td>
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<td>54</td>
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<tr>
<td>2009</td>
<td>73</td>
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<tr>
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</tr>
<tr>
<td>1992</td>
<td>16</td>
<td>6*</td>
<td>38%</td>
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<table>
<thead>
<tr>
<th>Average Return Rate</th>
<th>46%</th>
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<tbody>
<tr>
<td>Standard Deviation</td>
<td>10%</td>
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</tbody>
</table>

* - minimum number sighted

<sup>a</sup> - adjusted from 285 to 290 based on banded hatch year returns
Table 3. Plover activity based on the number of adult plovers at each nesting site in the project area, 2018. Plovers move between nesting areas throughout the summer, therefore this is not a tally of the total number of plovers present.

<table>
<thead>
<tr>
<th>Site</th>
<th>Females</th>
<th></th>
<th>Males</th>
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<th>Total</th>
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<td>Unbanded</td>
<td>Banded</td>
<td>Unbanded</td>
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<tr>
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<td># residents</td>
<td># unbanded</td>
<td># residents</td>
<td># banded</td>
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<td>3</td>
<td>30</td>
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Table 4. Number of nests found in project area, 2008 – 2018. Cells tally nests only and not broods from undiscovered nests. The number of broods from undiscovered nests is totaled for each year only.

<table>
<thead>
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<td>12</td>
<td>32</td>
<td>19</td>
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</tr>
</tbody>
</table>

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

SU – Sutton, SI – Siltcoos, OV – Overlook, TA – Tahkenitch, TM – Tenmile, CBNS – Coos Bay North Spit (SB - South Beach, SS – South Spoil, BSPMA – Bandon Snowy Plover Management Area (BB - Bandon Beach, NR spit - New River Spit), NR HRA – New River HRA, NR other - private and other owned lands, FL – Floras Lake
Table 5. Apparent nest success of Snowy Plovers within monitored project area, 2018.

<table>
<thead>
<tr>
<th>Site</th>
<th>Nests Exclosed</th>
<th>Nests Not Excluded</th>
<th>Exclosed Nests</th>
<th>Nests Not Excluded</th>
<th>Overall Nest Success</th>
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<td>4</td>
</tr>
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<td>South</td>
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<tr>
<td>Combined</td>
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Table 6. Apparent nest success of exclosed and unexclosed Snowy Plover nests within monitored project area, 1990 - 2018.

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<th>Not Exclosed (%)</th>
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Average = 46.62
STDEV = 12.76
Table 7. Causes of Snowy Plover nest failure at survey sites within the project area, 2018.

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<th>Site Name</th>
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<th>Depredations</th>
<th>Other</th>
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<td>South Beach</td>
<td>32</td>
<td>14</td>
<td>2</td>
<td>2(^f)</td>
</tr>
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<td>1</td>
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</table>

\(^a\) – all coyote depredations  
\(^b\) – 7 fox depredations, 1 raccoon and 1 skunk depredation  
\(^c\) – fox depredation  
\(^d\) – avian depredations that were either corvid or harrier but unable to determine  
\(^e\) – 1 gull depredation  
\(^f\) – 2 nests crushed by same vehicle
Table 8. Number of broods sampled, brood success, fledging success, and breeding coefficient based on sample from Sutton Beach to Floras Lake, Oregon coast, 2018.

<table>
<thead>
<tr>
<th>Site Name</th>
<th># of broods in sample</th>
<th>% brood success</th>
<th># of eggs hatched in sample</th>
<th>% fledglings from sample</th>
<th>% fledging success</th>
<th>fledglings per sampled brood</th>
<th>breeding coefficient</th>
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<tr>
<td>Sutton Beach</td>
<td>11</td>
<td>55%</td>
<td>26</td>
<td>8</td>
<td>31%</td>
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<tr>
<td>North Siltcoos</td>
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<td>100%</td>
<td>11</td>
<td>6</td>
<td>55%</td>
<td>1.50</td>
<td>6/37=0.16</td>
</tr>
<tr>
<td>South Siltcoos</td>
<td>13</td>
<td>85%</td>
<td>35</td>
<td>18</td>
<td>51%</td>
<td>1.38</td>
<td>19/68=0.28</td>
</tr>
<tr>
<td>Overlook:</td>
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</tr>
<tr>
<td>North Overlook</td>
<td>9</td>
<td>89%</td>
<td>24</td>
<td>12</td>
<td>50%</td>
<td>1.33</td>
<td>17/149=0.11</td>
</tr>
<tr>
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<td>15</td>
<td>93%</td>
<td>43</td>
<td>25</td>
<td>58%</td>
<td>1.67</td>
<td>29/121=0.24</td>
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<tr>
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<td>72%</td>
<td>50</td>
<td>19</td>
<td>38%</td>
<td>1.05</td>
<td>19/119=0.16</td>
</tr>
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<td>3</td>
<td>100%</td>
<td>9</td>
<td>6</td>
<td>67%</td>
<td>2.00</td>
<td>7/12=0.58</td>
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<td>28</td>
<td>86%</td>
<td>72</td>
<td>40</td>
<td>56%</td>
<td>1.43</td>
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<td>6</td>
<td>75%</td>
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<td><strong>569</strong></td>
<td><strong>279</strong></td>
<td><strong>49%</strong></td>
<td><strong>1.31</strong></td>
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Table 9. Total number of young fledged from monitored sites on the Oregon Coast 2001-2018, includes fledglings from broods from undiscovered nests.

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<td>51</td>
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<tr>
<td>Total</td>
<td>32</td>
<td>31</td>
<td>60</td>
<td>108</td>
<td>78</td>
<td>110</td>
<td>124</td>
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<td>84</td>
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<td>180</td>
<td>104</td>
<td>276</td>
<td>370</td>
<td>200</td>
<td>290 b</td>
<td>316</td>
</tr>
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</table>

a – additional unbanded fledglings known to hatch
b - adjusted based on hatch year returns

SU – Sutton, SI – Siltcoos, OV – Overlook, TA – Tahkenitch, TM – Tenmile, CBNS – Coos Bay North Spit (SB - South Beach, SS – South Spoil, BSPMA – Bandon Snowy Plover Management Area (BB - Bandon Beach, NR spit - New River spit), NR HRA – New River HRA, NR other - private and other owned lands, FL – Floras Lake
Table 10. Fledging success and mean number of fledglings/male (+/- standard deviation) at monitored sites on the Oregon Coast, 2004 – 2018.

<table>
<thead>
<tr>
<th>Year</th>
<th>% Fledging Success</th>
<th>Mean # Fled/Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>55</td>
<td>1.73</td>
</tr>
<tr>
<td>2005</td>
<td>41</td>
<td>1.28</td>
</tr>
<tr>
<td>2006</td>
<td>48</td>
<td>1.56</td>
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<td>2007</td>
<td>54</td>
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<tr>
<td>2008</td>
<td>47</td>
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<td>2009</td>
<td>50</td>
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<td>2010</td>
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<td>2011</td>
<td>47</td>
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<tr>
<td>2012</td>
<td>44</td>
<td>1.41</td>
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<tr>
<td>2013</td>
<td>39</td>
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<tr>
<td>2014</td>
<td>48</td>
<td>1.68</td>
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<tr>
<td>2015</td>
<td>49</td>
<td>1.51</td>
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<td>2016</td>
<td>43</td>
<td>0.62</td>
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<td>2017</td>
<td>50</td>
<td>1.23</td>
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<tr>
<td>2018</td>
<td>49</td>
<td>1.17</td>
</tr>
<tr>
<td>’04-’18 mean</td>
<td>46.6 +/- 5.4</td>
<td>1.34 +/- 0.32</td>
</tr>
</tbody>
</table>
Table 11. Number of resident males, estimated number of fledglings, and number of fledglings per male in project area, 2018. 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. To account for variable numbers of males at each site, we calculate the overall mean number of fledglings per male using the total of the resident males and the estimated total number of fledglings. This overall estimate is biased low because the number of resident males double counts males that were present at multiple nesting areas during the breeding season.

<table>
<thead>
<tr>
<th>Site Name</th>
<th># of resident males</th>
<th>estimated # of fledglings</th>
<th>estimated # of fledglings/male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutton Beach</td>
<td>9</td>
<td>8</td>
<td>0.89</td>
</tr>
<tr>
<td>Siltcoos Spits</td>
<td>27</td>
<td>28</td>
<td>1.04</td>
</tr>
<tr>
<td>Dunes Overlook</td>
<td>39</td>
<td>42</td>
<td>1.08</td>
</tr>
<tr>
<td>Tahkenitch Creek</td>
<td>31</td>
<td>26</td>
<td>0.84</td>
</tr>
<tr>
<td>Tenmile Creek</td>
<td>57</td>
<td>67</td>
<td>1.18</td>
</tr>
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<td>Coos Bay North Spit</td>
<td>69</td>
<td>108</td>
<td>1.57</td>
</tr>
<tr>
<td>Bandon SPMA</td>
<td>36</td>
<td>47</td>
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<tr>
<td>New River</td>
<td></td>
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<td>HRA</td>
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<td>4</td>
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<td>Floras Lake</td>
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<tr>
<td>Overall</td>
<td>287</td>
<td>336</td>
<td>1.17</td>
</tr>
</tbody>
</table>
Figure 1. Snowy Plover monitoring locations along the Oregon Coast, 2018
Figure 2. Snowy Plover nest locations at Sutton/Baker Beach, Oregon, 2018.
Figure 3. Snowy Plover nest locations at Siltcoos Estuary, Oregon, 2018.
Figure 4. Snowy Plover nest locations at Dunes Overlook, Oregon, 2018.
Figure 5. Snowy Plover nest locations at Tahkenitch Creek, Oregon, 2018.
Figure 6. Snowy Plover nests on north side of Tenmile Creek, Oregon, 2018.
Figure 7. Snowy Plover nests at Tenmile Creek Estuary, Oregon, 2018.
Figure 8. Snowy Plover nests on north end of Coos Bay North Spit, Oregon, 2018.
Figure 9. Snowy Plover nests at Coos Bay North Spit, Oregon, 2018.
Figure 10. Snowy Plover nests at Bandon SPMA, north of the mouth of New River, Oregon, 2018.
Figure 11. Snowy Plover nests at Bandon SPMA, south of the mouth of New River, Oregon, 2018.
Figure 12. Snowy Plover nests at north end of New River Spit, Oregon, 2018. These nests are at the south end of the SPMA, and on private land.
Figure 13. Snowy Plover nest locations at south end of New River spit, Oregon, 2018.
Figure 14. Snowy Plover nest locations at Floras Lake, Oregon, 2018.
Figure 15. Number of active Snowy Plover nests within 10-day intervals within the project area, 2018. Bars represent +/- 2 standard deviations.
Figure 16. Nest success at CBNS 2012 -2018. A pair of Northern Harriers were removed after being identified as significant nest predator in 2013 and 2017. Nest success substantially increases in years after harriers were removed, indicating that harrier removal had a positive effect on plover nest success.
Figure 17. 2018 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 18.** 2018 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 19. 2018 fledglings per male, mean pre-predator management fledglings per male, and postpredator management fledglings per male for Sutton, Siltcoos, Overlook, Tahkenitch, Tenmile, CBNS, Bandon SPMA and New River, Oregon coast, with standard error bars.
Figure 20. The number of eggs hatched and the number of fledglings in the project area, 1992-2018.
APPENDIX A.

Study Area

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

**Sutton Beach**, Lane Co. (Figure 2). The beach north of Berry Creek south to the mouth of Sutton Creek.

**Siltcoos**: North Siltcoos, Lane Co. (Figure 3). The north spit, beach, and open sand areas between Siltcoos River mouth and the parking lot entrance at the end of the paved road on the north side of the Siltcoos River; and South Siltcoos, Lane Co. - the south spit, beach, and open sand areas between Siltcoos River mouth and south to Carter Lake trail beach entrance.

**Dunes Overlook Clearing**, Douglas Co. (Figure 4). The area directly west of the Oregon Dunes Overlook off of Hwy 101 including the beach from Carter Lake trail to the north clearing, and south to the Overlook trail south of the south clearing.

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

**Tenmile**: North Tenmile, Coos and Douglas Cos. (Figures 6 & 7). The spit and ocean beach north of Tenmile Creek, north to the Umpqua River jetty; and South Tenmile, Coos Co. The south spit, beach, and estuary areas within the Tenmile Estuary vehicle closure, and continuing south of the closure for approximately 1/2 mile.

**Coos Bay North Spit (CBNS)**, Coos Co. (Figures 8 & 9): South Beach - the beach from the north jetty north to the Horsfall area; and South Spoil/HRAs - the south dredge spoil and adjacent habitat restoration areas (94HRA, 95HRA, 98HRA).

**Bandon Snowy Plover Management Area**, Coos Co. (Figures 10 & 11): This site includes the Bandon SPMA and all nesting areas from north of China Creek to the south end of state land south of the mouth of New River.

**New River**, Coos Co. (Figures 12 & 13): 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 14). 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.
Nest Surveys

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

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

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

Population Estimation

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

Nest Monitoring

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

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

**Brood Monitoring**

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

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

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

**Banding**

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

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

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

2016 Brood sampling plan:

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

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

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

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

- Attempted to locate all nests.
- Estimated hatch date for all known nests based on number of eggs in nest when found, or by floating eggs (Westerkov 1950, Hays and LeCroy 1971, Dunn et al. 1979, Rizzolo and Schmutz 2007, Gary Page personal communication).
- Recorded fate of all known nests.
- Color banded all chicks from a sample of hatched nests. Our sample consisted of the first 5 known nests to hatch at each site in a given 10-day period (Table C-1). At sites with fewer than 5 hatched nests during an interval, we banded all broods from known nests (but see next bullet point). At sites with more than 5 hatched nests during an interval, we banded all chicks from the first 5 known nests that hatched. As in previous years, chicks did not receive unique color combinations; instead we used brood-specific combinations. Each chick received a USGS metal band wrapped with a brood-specific color tape combination on the left leg and a color band on the right leg (see Appendix B).
- It is not necessary to band chicks at sites with fewer than 3 breeding pairs (e.g. Floras Lake in recent years). At low-occupancy sites, even if birds nest simultaneously, the likelihood of all nests surviving to hatch at the same time is extremely low. Thus, the likelihood of these sites having multiple same-age broods is low, and monitors can track broods and determine fledging without banding, thus saving limited band combinations for more populated sites. Because there are not more than 5 nests hatching in a 10-day period at low-occupancy sites, all broods from these sites are included in the sample, whether banded or not.
• Broods from undiscovered nests that were not banded, were not included as part of the sample, and were not included in productivity estimates for the site. If a brood from an undiscovered nest was found and captured with all three chicks, this brood was used in the productivity calculations.
• Broods were selected for sampling based on actual hatch date, not on expected hatch date.
• If we incorrectly estimated the expected hatch date of a known nest, and the brood was out of the nest before we were able to band it, we skipped that brood and banded the next brood that hatched, up to a total of 5 broods per site per 10-day interval.
• Conducted approximately weekly surveys to relocate banded broods during the fledging period. Banded chicks observed were recorded, but status of very young broods was also confirmed based on adult behavior. As broods approached fledging age, we increased effort to count individual chicks. Chicks observed at or after 28 days after hatching were considered fledged (Warriner et al. 1986).
• The banded sample of broods and their attending male was used to report brood success, fledging success, and to calculate the number of fledglings per sampled brood. The banded sample of chicks that fledged was multiplied by a weighting factor (total broods/broods sampled) to give an estimated number of chicks fledged per site. The number of fledglings per male was then calculated from the estimated number of fledglings and the number of resident males for each site and overall. Standard deviations and 95% confidence intervals will be calculated on these estimates.

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

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

<table>
<thead>
<tr>
<th>Ten day intervals</th>
<th>Interval number</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1 - April 10</td>
<td>1</td>
</tr>
<tr>
<td>April 11 - April 20</td>
<td>2</td>
</tr>
<tr>
<td>April 21 - April 30</td>
<td>3</td>
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<td>May 1 - May 10</td>
<td>4</td>
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<tr>
<td>May 11-May 20</td>
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<td>May 21 - May 30</td>
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<td>May 31 - June 9</td>
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<td>June 10 - June 19</td>
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<td>June 20 - June 29</td>
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<tr>
<td>June 30 - July 9</td>
<td>10</td>
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<td>July 10 - July 19</td>
<td>11</td>
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<td>July 20 - July 29</td>
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</tr>
<tr>
<td>July 30 - August 8</td>
<td>13</td>
</tr>
<tr>
<td>August 9 - August 18</td>
<td>14</td>
</tr>
<tr>
<td>August 19 - August 28</td>
<td>15</td>
</tr>
</tbody>
</table>

Test of sampling plan using recent data

We used data from 2013 – 2015 to test how well this sampling plan would have estimated the number of fledglings in those years. We chose those years because prior to 2013 the population was small enough that these methods would have resulted in a sample nearly identical to the total number of broods banded and tracked (i.e. we would have sampled the full population under this plan). For this analysis, we only used nests for which we had a hatch date and known brood outcome, so the numbers of total broods and fledglings in this analysis are slightly lower than totals reported in our annual reports. Based on hatch dates, we identified the nests that would have been sampled under this proposed scheme, and recorded the numbers of chicks that fledged from these sampled nests. We then used the sample to estimate the number of...
chicks fledged by site and across all sites per year. We compared these estimates to the numbers from the full (unsampled) data set (Figure C-1).

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

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

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

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

Using the sample to estimate plover productivity

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

\[
f_{sy} \times k_y = E_y
\]

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

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

\[
\frac{E_y}{R_y} = F_y
\]

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

We calculated the estimated number of fledglings per male for each site. Since males can and do roam between sites, and can breed at more than one site in a given year, to estimate fledglings per male for the project area, we determined the total number of resident males within the project area, and divided that by the estimated number of fledglings produced for all known broods. We calculated a mean number of fledglings per male from all sites, and display the mean with the standard deviation (Table C-2).
Table C-2. Data used to calculate estimated number of fledglings by site in 2018.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>total # of known broods</th>
<th>broods in sample</th>
<th>% brood success of sample</th>
<th>total # of eggs hatched in sample</th>
<th>% fledging success from sample</th>
<th># of fledglings/brood sampled</th>
<th># of fledglings/brood sampled – combined</th>
<th># of resident males</th>
<th>estimated # of fledglings/a</th>
<th>estimated # of fledglings/male/b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sutton Beach</td>
<td>11</td>
<td>11</td>
<td>55%</td>
<td>26</td>
<td>8</td>
<td>31%</td>
<td>0.73</td>
<td>0.73</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Siltcoos:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Siltcoos</td>
<td>5</td>
<td>4</td>
<td>100%</td>
<td>11</td>
<td>6</td>
<td>55%</td>
<td>1.50</td>
<td>1.41</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>South Siltcoos</td>
<td>15</td>
<td>13</td>
<td>85%</td>
<td>35</td>
<td>18</td>
<td>51%</td>
<td>1.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overlook</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>North Overlook</td>
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<td>24</td>
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<td>1.33</td>
<td>1.54</td>
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<td>42</td>
</tr>
<tr>
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<td>15</td>
<td>93%</td>
<td>43</td>
<td>25</td>
<td>58%</td>
<td>1.67</td>
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<td></td>
</tr>
<tr>
<td>Tahkenitch</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Tahkenitch</td>
<td>18</td>
<td>18</td>
<td>72%</td>
<td>50</td>
<td>19</td>
<td>38%</td>
<td>1.05</td>
<td>1.19</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>South Tahkenitch</td>
<td>4</td>
<td>3</td>
<td>100%</td>
<td>9</td>
<td>6</td>
<td>67%</td>
<td>2.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenmile:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Tenmile</td>
<td>33</td>
<td>28</td>
<td>86%</td>
<td>72</td>
<td>40</td>
<td>56%</td>
<td>1.43</td>
<td>1.46</td>
<td>57</td>
<td>67</td>
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<tr>
<td>South Tenmile</td>
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<td>100%</td>
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<td>56%</td>
<td>1.56</td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>South Beach</td>
<td>18</td>
<td>17</td>
<td>76%</td>
<td>44</td>
<td>20</td>
<td>45%</td>
<td>1.18</td>
<td>1.26</td>
<td>69</td>
<td>108</td>
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<tr>
<td>South Spoil</td>
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<td>18</td>
<td>72%</td>
<td>43</td>
<td>19</td>
<td>44%</td>
<td>1.06</td>
<td></td>
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<tr>
<td>HRA</td>
<td>43</td>
<td>34</td>
<td>76%</td>
<td>97</td>
<td>47</td>
<td>48%</td>
<td>1.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandon SPMA</td>
<td>34</td>
<td>26</td>
<td>85%</td>
<td>68</td>
<td>36</td>
<td>53%</td>
<td>1.38</td>
<td>1.38</td>
<td>36</td>
<td>47</td>
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<td>New River</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HRA</td>
<td>4</td>
<td>3</td>
<td>67%</td>
<td>8</td>
<td>3</td>
<td>38%</td>
<td>1.00</td>
<td>1.00</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Other lands</td>
<td>3</td>
<td>2</td>
<td>0%</td>
<td>6</td>
<td>0</td>
<td>0%</td>
<td>0.00</td>
<td>0.00</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Floras Lake</td>
<td>3</td>
<td>3</td>
<td>100%</td>
<td>8</td>
<td>6</td>
<td>75%</td>
<td>2.00</td>
<td>2.00</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>TOTALS</td>
<td>256</td>
<td>213</td>
<td>81%</td>
<td>569</td>
<td>279</td>
<td>49%</td>
<td>1.31</td>
<td>1.31</td>
<td>287</td>
<td>336</td>
</tr>
</tbody>
</table>

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

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

60

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

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

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

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

- Exclosed nests appear to be only vulnerable to reptilian and small mammal predators while unexclosed nests are vulnerable to predators of all sizes (Mabee and Estelle 2000).
- No difference in fledging success between exclosed and unexclosed nests in four studies (Hardy and Colwell 2008, Pauliny \textit{et al.} 2008, Lauten \textit{et al.} 2004, Pearson \textit{et al.} 2016) and higher fledging success for exclosed nests in two
studies (Larson et al. 2002, Melvin et al. 1992). There was no difference in fledging success between exclosed and unexclosed nests for all studies involving Snowy Plovers.

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

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

- Since raptors appear to be the primary threat to adult plovers in exclosures, delay use of exclosures until peak raptor migration has passed. Currently, we have identified May 15 as a suitable cutoff, but this date could be altered as needed.
- Delaying exclosure use until May 15 allows field personnel time to assess causes of early nest failures, although weather conditions can make accurate assessment difficult. During this time, and contingent on funding, we recommend an owl survey be run at each site.
- If nests are being lost primarily to mice, exclosures will not help the problem, and may pose additional risk if the mice are being preyed upon by raptors. In this case exclosure use is not appropriate.
- If corvids and/or large mammals are identified as the main predator at a site, removal of the predators should be the primary goal with exclosures used as a supplemental measure to help protect nests.
- Any use of exclosures should be accompanied by close monitoring to evaluate their effectiveness (Hardy and Colwell 2008) and to detect predators of adult plovers early (Pauliny et al. 2008). Weather permitting, exclosed nests should be checked at least twice per week. If conditions do not allow checks twice a week, exclosure use should be seriously reconsidered.
- Adult predation associated with exclosures is often episodic (Castelein et al. 2000b, Lauten et al. 2006). Once adult predation is suspected, all exclosures should be removed from the site and their use discontinued for the season.
- To minimize the risk of episodic predation on adult plovers, additional caution should be used when placing exclosures within sight of each other (this puts multiple adults at risk).
- Exclosures should not be placed along the foredune.
- Exclosures should not be placed in a windy location that might result in nest drifting. Since the ME’s are 4 feet per side, the nest is only about 2 feet from each sidewall. If the nest begins to drift, it could come close to a sidewall, and a predator such as a raccoon could reach in and grab the eggs. If an exclosed nest is in a potentially windy location, it must be monitored frequently to ensure the safety of the nest and adults (especially on windy days).