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Monitoring Western Snowy Plovers at Point Reyes National Seashore, Marin County, California

2012 Annual Report

Natural Resource Technical Report NPS/SFAN/NRTR—2013/825



ON THE COVER
Western snowy plover (*Charadrius alexandrinus nivosus*) fledglings, 37 days post hatch.
Photograph by: Tim Paine (2012)

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Abstract

This report details the results of the 23rd year of the western snowy plover (*Charadrius alexandrinus nivosus*) monitoring program within Point Reyes National Seashore (PORE), Marin County, California. The goal of the 2012 monitoring effort was to determine abundance, distribution, and breeding success of snowy plovers nesting on federal lands within PORE. The report provides an overview of the 2012 snowy plover monitoring program on federal lands and summarizes the results of the data collected during the field season.

In 2012, there were 137 surveys conducted between Kehoe Beach and North Beach parking lot, 14 in the 2011 Dune Restoration Area, 4 from North Beach parking lot to the Lighthouse, 7 on Limantour Spit, and 1 on Drakes Spit. A minimum estimate of nine plovers bred in PORE. Exclosures were placed around five of seven nests located in 2012, two of the exclosed nests failed to hatch. Five of seven nests hatched at least one egg and 15 of 21 total eggs hatched. Nine of 15 chicks survived for at least 28 days after hatching, for a 60% fledging rate. The number of fledglings per egg was 0.43, compared to 0.24 in 2011 and an average of 0.30 since exclosures were first used in 1996. This season resulted in a better than average hatch rate and the highest number of chicks fledged per egg since 1999, but the overall number of fledges remained well below average for the fifth year in a row.

The large habitat restoration area created in 2011 was maintained diligently by the PORE coastal dune restoration team. Additional restoration efforts continued in 2012. Since 2001, over 250 acres of plover and rare plant habitat have been restored through the removal of invasive European beach grass (*Ammophila arenaria*) and iceplant (*Carpobrotus edulis*) near Abbotts Lagoon. This area was utilized by snowy plovers in the 2012 breeding season.

The Western Snowy Plover Docent Program remains an important tool to educate park visitors about the plight of the western snowy plover and to minimize potential negative impacts from visitors, especially those with dogs. Docents made 4,742 visitor contacts on weekends and holidays in 2012. Efforts this season focused on Abbotts Lagoon trailhead, Abbotts Lagoon shoreline, and Kehoe Beach. Park managers recommend continuation of the docent program in future breeding seasons and a full-time seasonal docent coordinator is needed to recruit, organize, and lead the volunteer docents.

To reach the US Fish and Wildlife Service recovery goal of 64 breeding birds on Point Reyes beaches, efforts to improve habitat on all current and historic breeding beaches and reduce the impacts of human recreation and natural predators on nesting plovers should be continued and expanded at PORE.

Acknowledgments

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T. Bernot, L. Brudney, T. Ellis, L. Hughey, W. Johnson, L. Michl, T. Paine, M. Razi, and E. Schultz helped conduct surveys, provided transportation, capture plover images, hike in gear, and/or set up symbolic fencing and exclosures. Biological Technician J. Khudyakov was irreplaceable in her role of field assistant, providing good humor and positivity throughout the season. Docent Coordinator J. Aliberti was a great addition to the docent team and filled the role with extraordinary enthusiasm. PRBO Conservation Science biologists L. Stenzel and G. Page were tremendous resources throughout the season, providing guidance and additional surveys during the breeding season. The Abbotts Lagoon Dune Restoration Team was extremely accommodating to the nesting snowy plovers and assisted in many ways. Park staff N. Gates and D. Press provided technical supervision and support thought the season. Volunteer docents logged almost 500 hours of volunteer time and contacted 4,742 visitors on weekends and holidays throughout the 2012 plover nesting season. J. Rolka and J. Wilkinson proved once again to be invaluable resources to the Snowy Plover Docent Program, logging the most volunteer hours and continue to be extremely dedicated.

Introduction

Western snowy plover (*Charadrius alexandrinus nivosus*) populations have declined throughout the species'entire range over the last century (USFWS 2007). Along the California coast, breeding and wintering populations declined significantly from the late 1970s to 2000 (Page and Stenzel 1981; USFWS 1993, 2007). The populations of snowy plovers that nest along the Pacific coast of North America from southern Washington to Baja California were declared threatened by the U.S. Fish and Wildlife Service (USFWS) in March 1993 (USFWS 1993, 2007). The reasons for decline and degree of threats vary by geographic area; however, the USFWS has identified the primary threat as habitat destruction and degradation (1993, 2007). Habitat degradation is primarily caused by human disturbance, urban development, introduced European beach grass (*Ammophila arenaria*), and expanding predator populations.

Within Point Reyes National Seashore (PORE), the USFWS recovery plan for the Pacific coast population of the western snowy plover (USFWS 2007) sets a goal of 50 adult birds on Point Reyes Beach, 10 on Limantour Spit, and 4 on Drakes Spit (32 pairs total). Despite aggressive management actions to recover PORE snowy plover populations since 1996, the population estimate of only nine breeding plovers during the 2012 breeding season was the lowest on record.

Snowy plovers were initially monitored at PORE in the 1970s by Point Reyes Bird Observatory (PRBO), and a similar monitoring protocol was implemented from 1986 to 1989, and again in 1995 when declines were significant across the species' range and in particular at PORE beaches. In 2008, PORE, with assistance from the San Francisco Bay Area Network Inventory and Monitoring Program, took over full responsibility for monitoring plovers within PORE boundaries, consulting with PRBO as needed. At PORE, the reproductive success of this species is affected by both human disturbance and natural factors, requiring close monitoring to determine the relative importance of each factor in any given year and over the long-term. Beach visitors to PORE have also been observed approaching active nests, which has been documented as a threat to nesting snowy plovers, especially when accompanied by a dog (Page et al. 1977).

The use of predator exclosures around snowy plover nests was initiated in 1996 on all survey areas on Point Reyes Beach and Limantour Spit to raise the percentage of clutches hatching. PORE worked with PRBO to refine the exclosure design to maximize protection but minimize set up time and the amount and weight of materials. The round exclosures are 6-ft. in diameter, 5-ft. tall fencing with 2-inch×4-inch openings to allow entrance and departure of plovers while keeping out mammalian predators; 4-inch×4-inch opening crow-mesh netting is used on top to prevent access by avian predators. These exclosures have been effective at keeping predators away from nests. The percentage of clutches hatching increased from an average of 14.9% prior to exclosure use (1986–1989) to 69.7% (1996–2012).

PORE has undertaken habitat restoration to recover western snowy plovers to recovery levels. In 2001, PORE began a three-year dune restoration project focused on removing non-native European beach grass and iceplant from areas on North Beach, in particular near Abbotts Lagoon. Additional restoration funding from the SS *Cape Mohican* oil spill allowed new restoration and follow up work to be continued through 2005. In 2003, the park found two plover nests in areas of non-native beach grass removal (Peterlein and Roth 2003). From 2006 to 2008

there were four nests each year in the restored areas (Peterlein 2009). In 2011 , a large-scale mechanical removal of 90 acres of non-native European beach grass and iceplant occurred just south of Abbotts Lagoon. The large-scale restoration created a 250 acre natural dune environment. Additional efforts to remove non-natives and maintain the restored area were performed in 2012. In 2011 one nest was located in the foredunes in front of this project area and three broods were observed utilizing the restoration area on multiple occasions. In all, 46% of all the snowy plover chicks fledged within PORE in 2011 spent time in the restored dunes. In 2012, one nest was located within the restored area and one in the foredunes in front of the restoration area. Only the nest in front of the foredunes hatched, the brood was observed continuously observed utilizing the restoration area. Continued restoration has the potential to greatly increase the coastal dune area available for snowy plover nesting, feeding, and chick rearing activities.

Despite increased clutch success and promising results from the restored dune habitats, the snowy plover population at PORE has not recovered to previous levels. The annual breeding population size has declined from a high of 50 individuals in 1987 to only nine in 2012. In 1987, 74 nests were discovered, while in 2012 only seven nests were found. Snowy plovers have not nested at Limantour Beach since 2000. Despite good hatch rates with the use of exclosures, the PORE snowy plover population is hindered by low fledgling success rates. In 2012, 9 out of 15 chicks (60.0%) survived to fledgling, the highest since 1998.

Current Monitoring Objective

The overall goal of the western snowy plover monitoring program is to determine trends in the estimated breeding population size, distribution, and reproductive success of snowy plovers at known breeding beaches in PORE.

Methods

Study Area

Snowy plovers have historically used Point Reyes Beach, Drakes Spit and Limantour Spit for nesting within PORE (Figure 1). Point Reyes Beach is separated into five beach survey sectors:

- Kehoe Beach entrance to Abbotts Lagoon (K)
- Abbotts Lagoon (including the southwest shore of the lower pond of Abbotts Lagoon) to North Beach parking lot (NP)
- The restored back dune habitat south of Abbotts Lagoon and adjacent to North Beach (RA; added as a separate survey area in 2011)
- North Beach parking lot to South Beach parking lot (NB)
- South Beach parking lot to Lighthouse Beach (SB).

Limantour Spit (L) refers to the beach area from the Limantour Beach parking lot west to the end of Limantour Spit. Although Limantour has not been used by plovers during a breeding season since 2000, it continues to be surveyed. Drakes Spit (D) refers to the beach to the west side of the mouth to Drakes Estero (Figure 1).

On Kehoe (K) and North Beach (NP) sectors, there are two areas where European beach grass was removed from 2004 to 2005. Survey data from these newly available plover habitat areas are included in the respective sectors from 2004 to the present. An additional survey sector (RA) was created during the 2011 season to acknowledge the much larger area of plover habitat restored over the spring and summer of that year (Figure 1). For more details on study area, see also Adams et al. (In review).

Heavy winter storms, particularly during ENSO (El Niño-Southern Oscillation) years, can significantly alter beach profiles at high-energy beaches such as at Point Reyes (White and Allen 1999). ENSO years may also result in more rain during the spring, at the start of the snowy plover breeding season. These combined negative impacts resulted in a 10 to 30 percent range wide decline in the western snowy plover breeding population following the ENSO winter of 1997/1998 (USFWS 2007). For this reason, annual ENSO predictions from the National Oceanic and Atmopheric Administration/National Weather Service are considered during the monitoring seasons and in reporting our annual data.



Figure 1. Locations of monitoring sectors, including: Kehoe Beach entrance to Abbotts Lagoon (K); Abbotts Lagoon to North Beach parking lot (NP); 2011 Abbotts Lagoon Dune Restoration Project Area (RA); North Beach parking lot to South Beach parking lot (NB); South Beach parking lot to Lighthouse Beach (SB), Limantour Spit (L), and Drakes Spit (D).

Field Surveys

Breeding season surveys begin March 15th and continue until all broods have fledged in mid-September. Kehoe Beach (K) and North Beach (NP), sites are each surveyed at least twice a week. The 2011 Restoration Area is surveyed approximately once a week depending on the activity level in the area; for example, more frequently when broods might be utilizing the area. Limantour Beach (L) is surveyed twice a month, though this season it was surveyed less in April. Drakes Beach(D), North Beach (NB), and South Beach (SB) sectors are each surveyed once per season. The back-dunes along the southwest shore of Abbotts Lagoon are surveyed approximately two times per week in conjunction with the NP survey sector, though the frequency of surveys in this area may need to be adjusted based on future observations of plovers in this newly restored area.

During surveys, observers walk just below the high tide line, crossing above the line only when necessary to see the full width of the beach. Observers stop every 50 to 100 m as necessary to scan up to 100 m ahead for plovers. When a plover is located, observers may approach as close as 10 m to determine age, sex, and color band combination if bands are present, though this is rarely done unless the adult is already standing and not involved in any nest building, incubating, or brood tending activities. Date, location (GPS coordinates), and the time of sighting are recorded on datasheets. Observers then walk around the bird(s) to prevent flushing. Upon return to the office, all data is entered into a Microsoft Access database.

Nest Searching

Nests are located using three methods: 1) systematically searching microhabitats in which plovers are likely to nest; 2) watching potential breeding adults from a concealed position; and 3) following plover footprints in fine sand (Adams et al., In review). Once a nest is located, it is exclosed with a round fence with a diameter of 6 feet as soon as possible unless it is determined that high tide will threaten the nest. The 2-inch × 4-inch fence openings allow entrance and departure of plovers while keeping out most predators. On the top of the exclosures, mesh netting is used to prevent access by avian predators. Exclosures are removed from the beach after the chicks have hatched and left the nest. The UTM coordinates of all nests are determined using GPS units and maps are produced at the end of each season (Appendix E).

Nests are checked two to four times per week to verify if they are still active. If a nest is not active during a particular visit, then cause of loss is determined using the criteria outlined in Appendix A. If a nest is abandoned by the adult plovers or has failed to hatch in over 35 days, the plover biologist will collect the unhatched eggs. The eggs are stored in a freezer at PORE with the collection information until they can be transferred to an appropriate facility for methyl mercury and/or fertility testing (Miles et al. 2009). If a nest remains active through its projected hatching date, checks are made more frequently at that time to determine the precise hatch day.

Adults and chicks are searched for on follow up visits. Once found, the number of chicks and location are recorded. If chicks are determined to be lost, then the criteria outlined in Appendix B are used to determine timing and cause of loss. If chicks survive 28 days after hatching, then they are considered fledged and are no longer monitored.

Predator Counts

Frequent predator population surveys are conducted to monitor changes in local predator populations and distributions near plover habitat. Predator surveys are conducted in conjunction with daily plover surveys. All predators are recorded as they pass observers at a 90° angle on the beach or up to 75 meters into the dunes. Predators that flush in any direction from a stationary position in response to observers are also counted. However, predators that pass the observer and then immediately reverse direction are not counted. A GPS unit is used to record location of the observer when he/she is adjacent to the location of the predator at first sighting. Results are entered in a Microsoft Access database.

Minimum Population Estimate

Due to the small size of the plover population at PORE, it is possible to obtain an accurate estimate of the minimum population size without banding. A minimum population estimate is determined using the steps outlined in Appendix D and corroborated with the results of the annual Snowy Plover Breeding Bird Window Survey, which is coordinated by the USFWS. The window survey involves surveying all current and historic PORE breeding sites during a pre-defined time period that includes the typical peak of nesting season. Since past monitoring data shows that the peak nesting period of the PORE plover population is typically outside this time period, the criteria listed Appendix D are used to determine a more accurate minimum estimate.

Western Snowy Plover Docent Program

To educate park visitors about the plight of the western snowy plover and to minimize potential negative impacts from visitors, especially those with dogs, the Western Snowy Plover Docent Program was established in 2003. Volunteer docents are stationed at trailheads leading to snowy plover habitat on all weekends and holidays between Memorial Day and Labor Day. Docents educate visitors about snowy plovers and the entire coastal dune ecosystem through one-on-one contacts, educational flyers, and guided observations of snowy plovers on the beach. Docents also serve an important role in addressing and reporting law enforcement violations conducted in and near snowy plover habitat, particularly visitors in closed areas.

A full-time, seasonal docent coordinator organizes and supervises the snowy plover docents.. In 2012, the position was filled after being vacant in 2011. Great efforts were made this season to recruit new volunteers.

Results

Number of Surveys

During the 2012 snowy plover breeding season (March 12th-August 28th), monitoring staff conducted 137 surveys between Kehoe Beach and North Beach parking lot (K, NP), 14 in 2011 Dune Restoration Area (RA), 4 from North Beach parking lot to the Lighthouse (NB, SB), 7 on Limantour Spit (L), and 1 survey on Drakes Spit (D).

Number of Nesting Plovers and Nests

A minimum estimate of nine plovers bred in PORE 2012 (five males, four females; see Appendix D for estimation criteria). The USFWS Breeding Bird Window Survey resulted in a minimum estimate of 12 adults (6 males, 6 females), a higher estimate than the minimum estimate calculated for PORE. In 2011 and 2010, there were 14 breeding plovers at PORE, compared to a total of 24 plovers that bred here in 2009 (Table 1, Figure 2).

Maximum numbers have not been reported since 2009 due to variability in observer detection and the adoption of a new methodology to determine the number of nesting plovers at PORE (Appendix D). See Adams et al. (In review) for an explanation of methodology used to determine minimum and maximum numbers before 2009.

Of the seven nests located in 2012, five were between Abbotts Lagoon and North Beach parking lot and two between the Kehoe Beach entrance and Abbotts Lagoon (Appendix E). For the 12th consecutive year, no nests were found on Limantour Spit (Table 2, Figure 3). The hardpan area immediately north of the North Beach parking lot had been used in the last three years for nesting, but although one scrape was located, no nesting occurred here in 2012.

Table 1. Number of western snowy plovers nesting at PORE, 1986–1989 and 1995–2012.

Year	Females	Males	Total[1]	ENSO Events (June – Nov)
1986	22-23	19-21	41-44	
1987	25-26	25-28	50-54	Yes
1988	21-22	19-20	40-42	
1989	18-20	16-17	34-37	
NO DATA	–	–	–	
1995	6	6	12	
1996	5-6	5	10-11	
1997	12	13	25	Yes
1998	7	9	16	
1999	9	11	20	
2000	17-18	14-19	31-37	
2001	13-19	14-17	27-36	
2002	17-19	17-18	34-37	Yes
2003	11-12	12-13	23-25	
2004	17-18	17-18	34-36	Yes
2005	9-10	10-11	19-21	
2006	14-15	16-17	30-32	Yes
2007	14-15	16-17	30-32	
2008	11-12	12-13	23-24	
2009[1]	11	13	24	Yes
2010	6	8	14	
2011	5	9	14	
2012	4	5	9	

[1]In 2009, alternative methodology was developed to determine the number of nesting plovers at PORE. See Appendix D for further explanation.

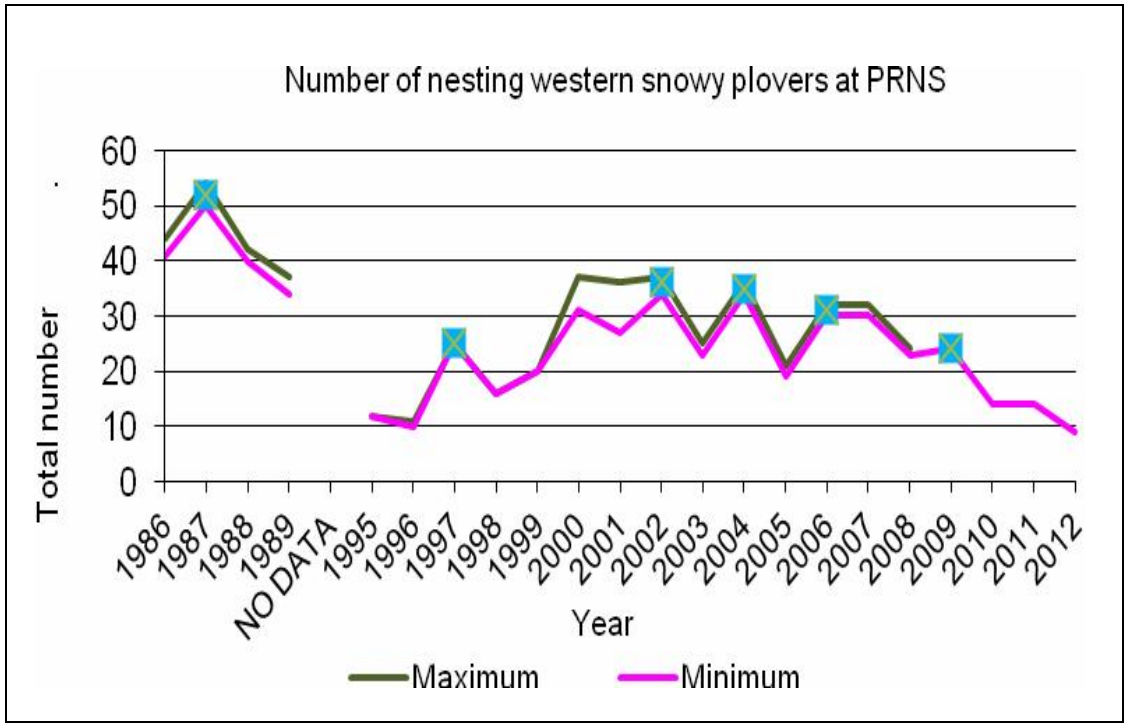


Figure 2. Number of nesting western snowy plovers at PORE and occurrence of El Niño (ENSO) events, 1986–1989 and 1995–2012. Square data points indicate ENSO events occurred between June and November of specified year.

Table 2. Number of western snowy plover nests at PORE, by survey sector, 1986–1989 and 1995–2012.

	Number of nests by beach survey sector[1]					
Year	**K**	**NP**	**NB**	**SB**	**L**	**Total**
1986	5	29	1	2	4	41
1987	9	48	6	11	1	75
1988	5	41	7	12	0	65
1989	6	42	7	6	0	61
NO DATA	–	–	–	–	–	–
1995	4	11	5	0	0	20
1996	0	8	0	0	1	9
1997	0	18	0	0	7	25
1998	2	10	0	0	2	14
1999	0	16	0	0	5	21
2000	10	15	0	0	3	28
2001	8	26	0	0	0	34
2002	6	24	0	0	0	30
2003	6	16	0	0	0	22
2004	21	16	0	0	0	37
2005	4	15	0	0	0	19
2006	11	13	0	0	0	24
2007	14	14	0	0	0	28
2008	11	10	0	0	0	21
2009	9	12	0	0	0	21
2010	7	8	0	0	0	15
2011	3	12	0	0	0	15
2012	2	5[3]	0	0	0	7
[2]Mean	7	14	0	0	1	22

[1]K = Kehoe Beach to Abbotts Lagoon, NP = Abbotts Lagoon to North Beach parking lot, NB = North Beach parking lot to South Beach parking lot, SB = South Beach parking lot to Lighthouse Beach, L = Limantour Spit

[2]Mean is from years with exclosures (1996-2012)

[3]One nest was located in the RA sector

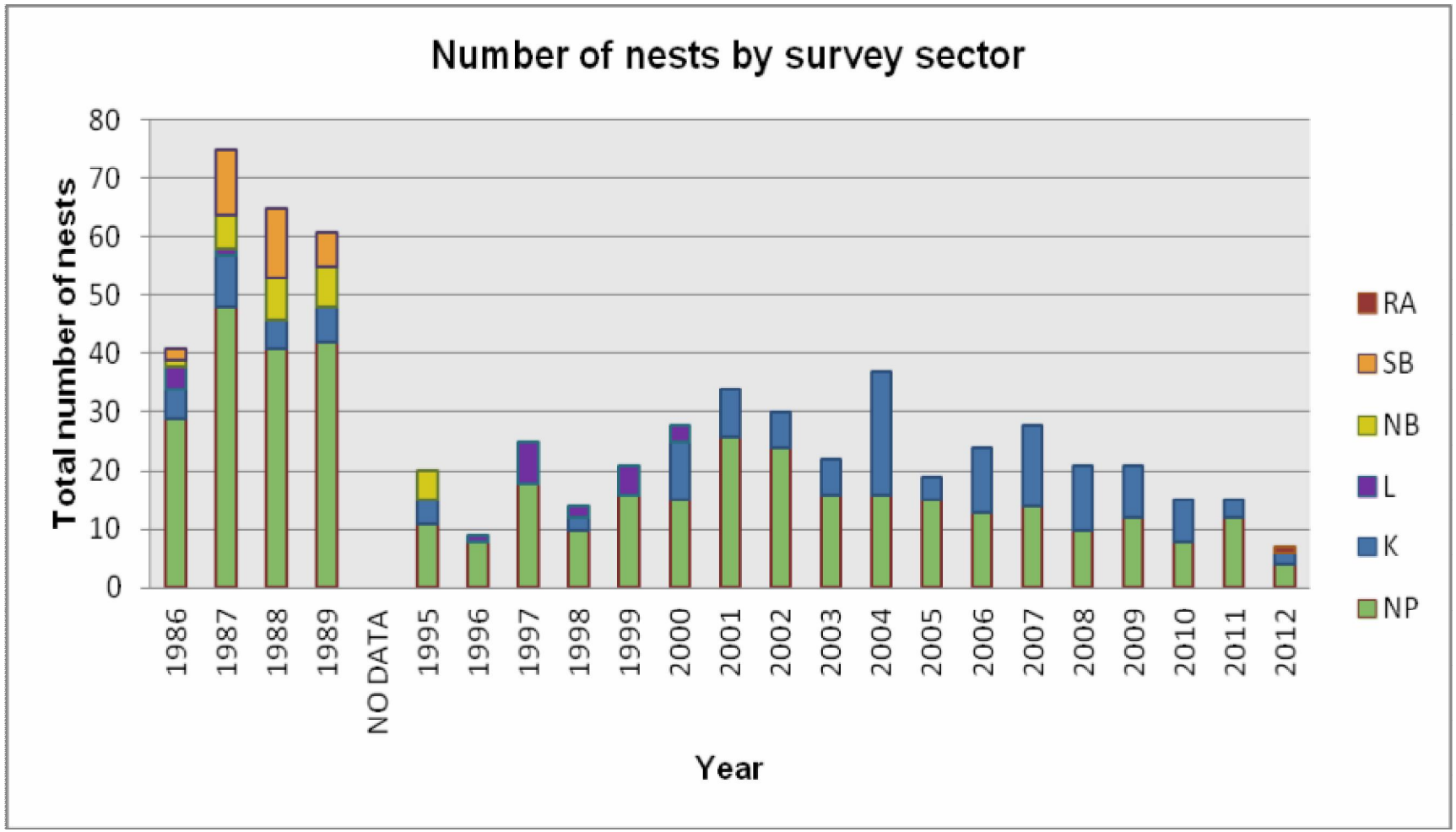


Figure 3. Number of western snowy plover nests at all surveyed beaches, 1986–1989 and 1995–2012. RA = 2011 Restoration Area, SB = South Beach parking lot to Lighthouse Beach, NB = North Beach parking lot to South Beach parking lot, L = Limantour Spit, K = Kehoe Beach to Abbotts Lagoon, NP = Abbotts Lagoon to North Beach parking lot.

Nest Success

Exclosures were placed around five of the seven nests in 2012. Overall, five of seven nests hatched at least one egg and 15 of 21 eggs hatched (Table 3, Figure 4). The two nests that failed to hatch were exclosed. The cause of loss for one of nest was determined to be wind (Table 4). The other failed nest was abandoned following a possible depredation event of one of the incubating adults (Figure 5). The carcass of an adult was never recovered but the disturbance evidence inside the exclosure suggested depredation.

See Appendix A for an explanation of criteria used to determine nest loss and Appendix C for details on the fate of all nests found in 2012.

Table 3. Western snowy plover nest success on Point Reyes Beach, 1986–1989 and 1995–2012. Includes Kehoe (K) and North Beach (NP) survey sectors only.

	Nests		Eggs			Chicks		
		%		Number	%	Number	%	Fledged
Year	Number	Hatched	Number	Hatched	Hatched	Fledged	Fledged	Per Egg
1986	35[1]	31.4	99	31	31.3	8	25.8	0.08
1987	74	19.0	198	35	17.7	15	42.9	0.08
1988	65	7.7	161	11	6.8	5	45.5	0.03
1989	61	1.6	146	3	2.1	1	33.3	0.01
NO DATA	–	–	–	–	–	–	–	–
1995	20	10.0	55	5	9.1	4	80.0	0.07
1996	8	75.0	24	16	66.7	14	87.5	0.58
1997	18	72.2	44	33	75.0	20	60.6	0.45
1998	12	100.0	36	35	97.2	21	60.0	0.58
1999	16	87.5	47	39[2]	83.0	22	56.4	0.47
2000	25	56.0	72[3]	41	57.3	14	34.1	0.20
2001	34	26.5	86[4]	25	29.1	10	40.0	0.12
2002	30	50.0	76	41	53.9	17	41.5	0.22
2003	22	77.2	63	43	68.3	19	44.2	0.30
2004	37	78.3	107	86	80.4	19	22.1	0.18
2005	19	63.1	53	33	62.3	17	51.5	0.32
2006	24	79.2	69	51	73.9	23	45.0	0.33
2007	28	82.1	83	64	77.1	24	37.5	0.29
2008	21	52.3	55	30	54.5	5	16.1	0.09
2009	21	66.7	60	38	63.3	8	21.0	0.13
2010	15	60.0	42	21	50.0	7	33.3	0.17
2011	15	86.7	45	36	80.0	11	30.5	0.24
2012	7	71.4	21	15	71.4	9	60	0.43
[5]Mean	21	69.7	58	38	67.2	15	44	0.3

[1] 37 nests were located in 1986 but only 35 were monitored for success.

[2] 38-40 eggs hatched

[3] 71-72 eggs laid

[4] 85-87 eggs laid

[5] Mean includes data from first year exclosures were used in 1996 through 2012.

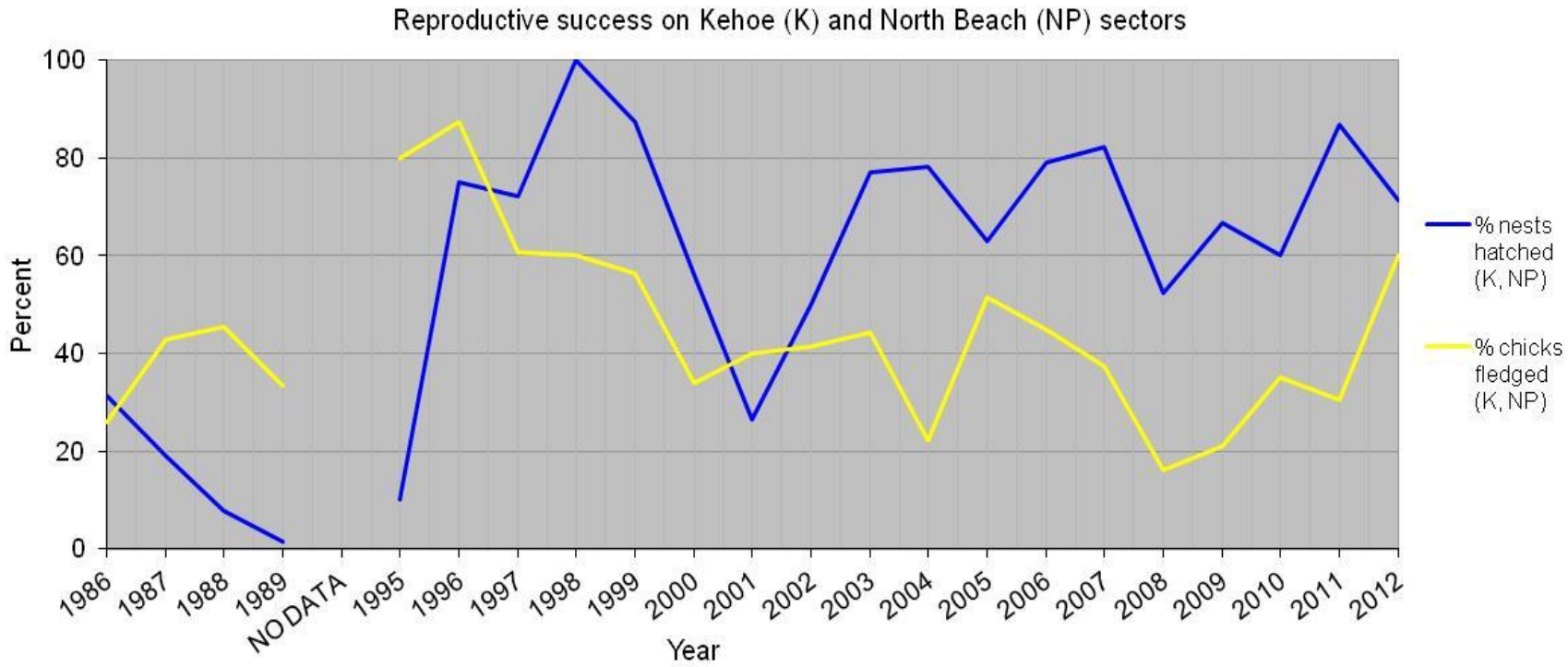


Figure 4. Comparison of reproductive success parameters on Point Reyes Beach (K, NP), 1986–1989 and 1995–2012.

Table 4. Causes of western snowy plover complete nest loss on Point Reyes Beach, 1996–2012. Includes Kehoe (K) and North Beach (NP) survey sectors only.

	Total	Nests	Raven		Wild Canid[1]		Bob-cat		Other Predator[2]		Unidentified Predator		Unknown		Abandon-ment		Environ-mental[3]		Unhatched Eggs	
Year	Nests	Exclosed	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E	N	E
1996	8	7	1													1				
1997	18	13	3										2							
1998	12	12																		
1999	16	16						1						1				1		
2000	25	25												1		5		1		4
2001	34	16	11		2					1			2			8	1			
2002	30	20	5		1					1	2					3	2	1		
2003	22	22														2		3		
2004	37	32			1										1	1		5		
2005	19	16			2	1										2	2			
2006	24	23				1										2				2
2007	28	22	1										3					1		
2008	21	18	2										3					5		
2009	21	19	1							1			1	1				3		
2010	15	15										2				3				1
2011	15	13											1			1				
2012	7	5														1		1		

N = Nest was not exclosed, E = Nest was exclosed

[1] "Wild Canid" includes coyotes and foxes

[2] "Other Predator" includes other avian species, rodents, mustelids, etc.

[3] "Environmental" includes wind and tides

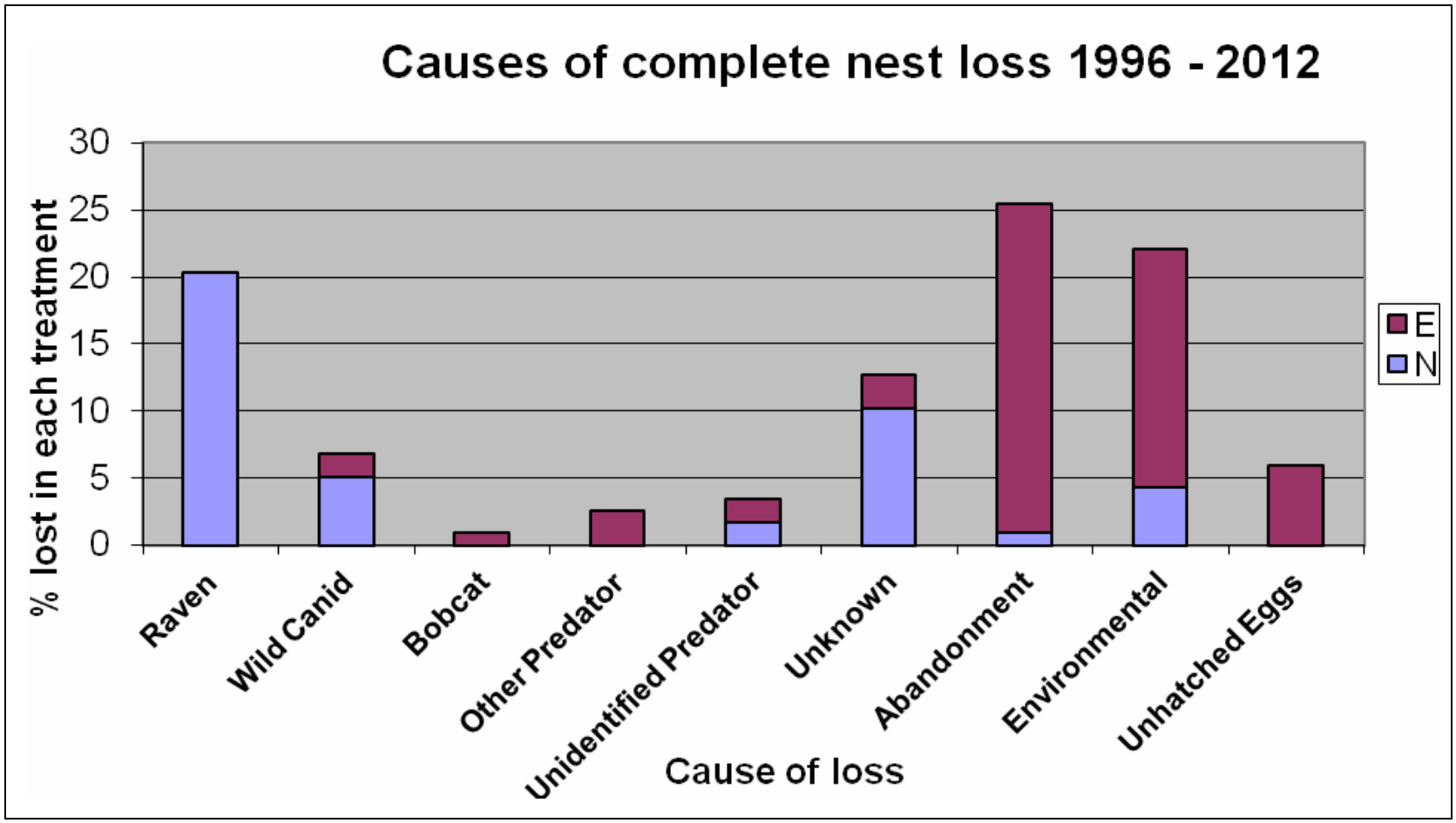


Figure 5. Percent of total nests lost for exclosed nests (E) and non-exclosed nests (N) from 1996–2012.

Fledging Success

Nine of 15 chicks survived to fledging (for at least 28 days) after hatching, a 60% fledging rate (Table 3). Of the estimated five breeding males in 2012, four successfully fledged two or more chicks (80%) compared to 78% in 2011 and 75% in 2010. No chicks fledged from the hardpan area immediately north of the North Beach parking lot (Appendix E). One chick was fledged from this area in 2011 and 2010 and two chicks in 2009, which was the first year snowy plovers were recorded using this area for nesting. Overall, the 2012 fledging rate was at least 1.8 chicks per male, the second consecutive year that a rate above 1.0 has been achieved since 2007 (Figure 6). The USFWS has set a recovery goal of maintaining fledge rates of at least one chick per male to attain a sustainable population (USFWS 2007).

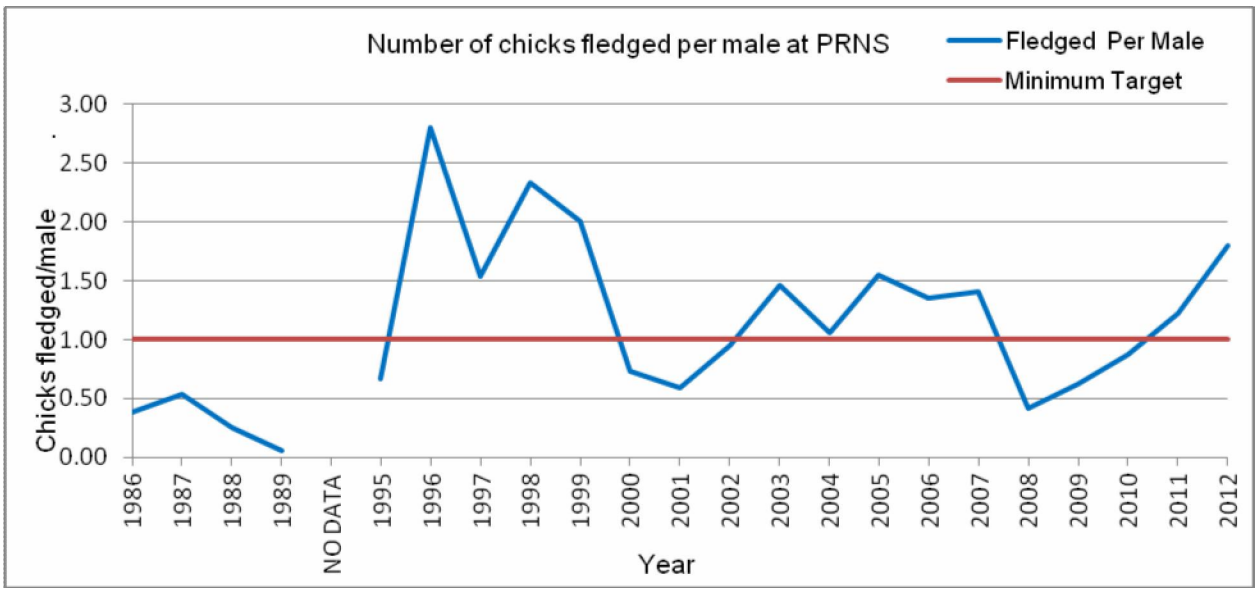


Figure 6. Total number of chicks fledged per male, 1986–1989 and 1995–2012.

Timing of Chick Loss

The timing of chick loss was determined for all six chicks lost in 2012 (using criteria in Appendix B). Of the three chicks that failed to fledge on North Beach, one was lost on a weekend/holiday, and two on weekdays. On Kehoe Beach, all three losses occurred on weekdays. Overall, 17% of chicks lost were lost on weekends/holidays, which constituted 29% of all days that chicks were on the beach. The weekend/holiday chick loss of 17% is the lowest percentage of chicks lost on weekends and holidays since 2005 (Figure 7). In 2012, 67% of chicks that failed to fledge disappeared by the age of 10 days, 33% from ages 11-20 days, and no chicks were lost from ages 21-28 days (Figure 8).

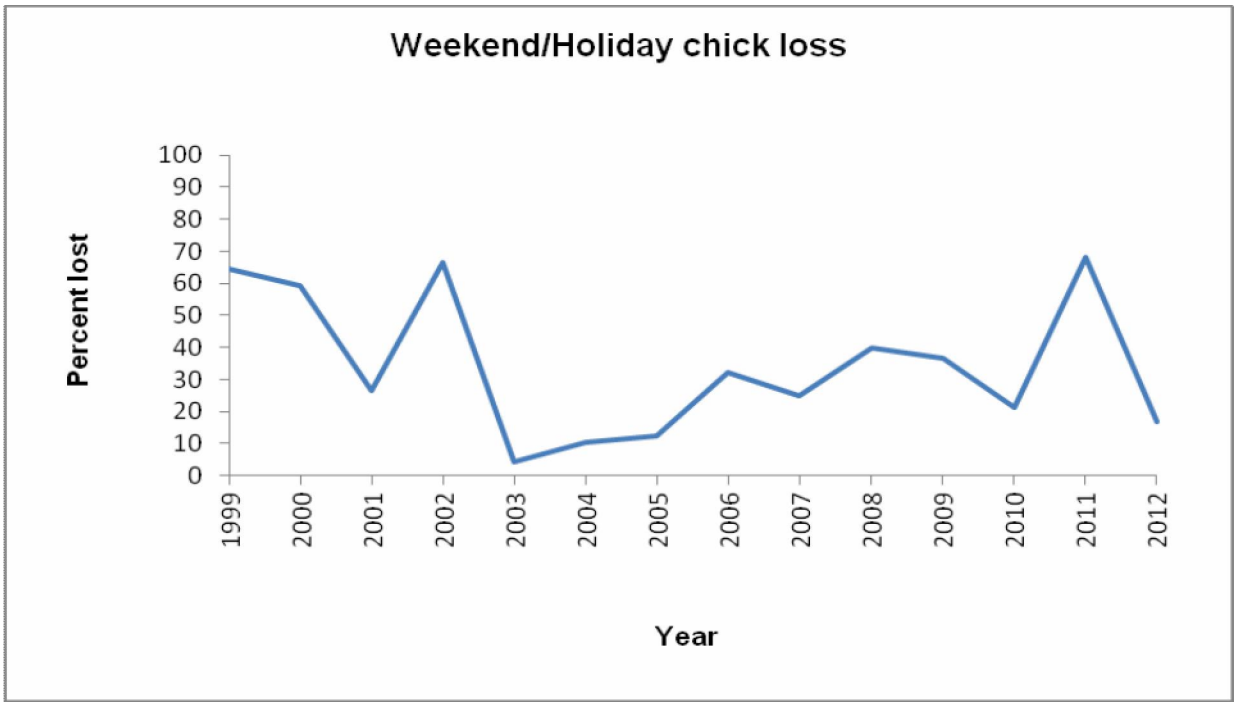


Figure 7. Percent of pre-fledge chicks lost on weekends/holidays from 1999 to 2012.

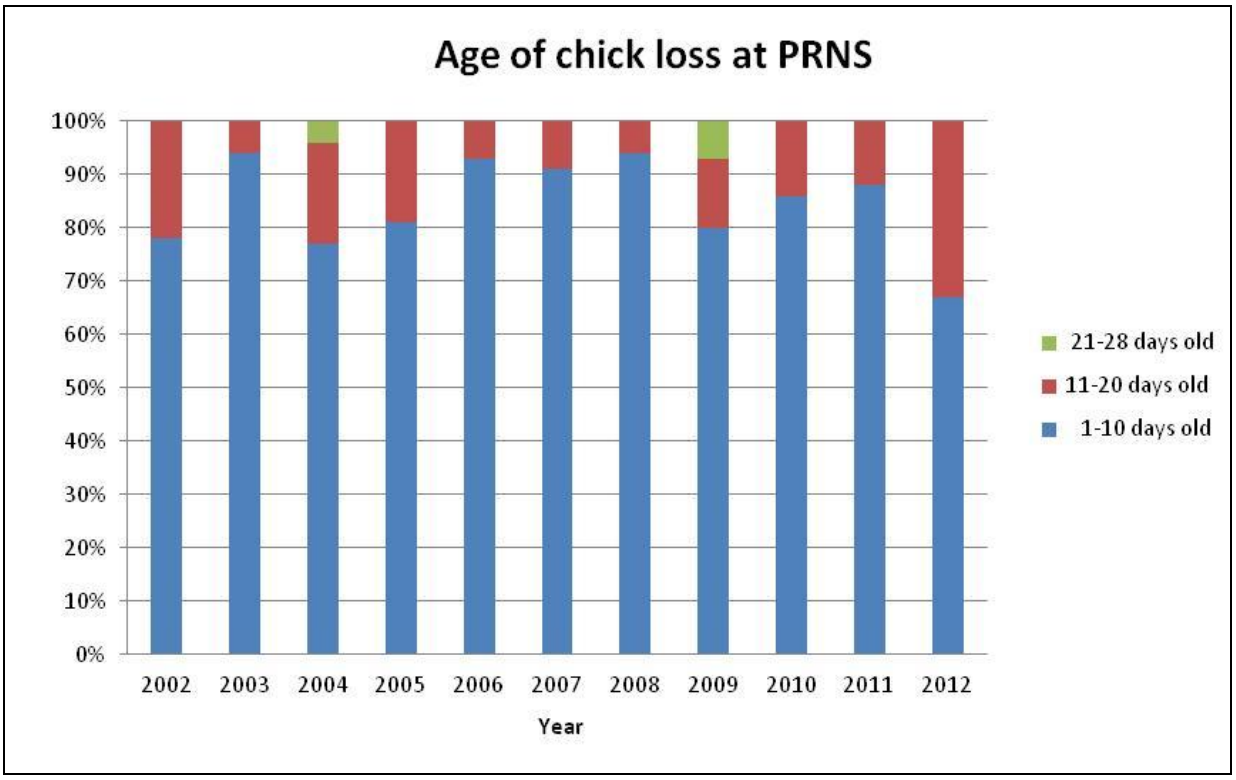


Figure 8. Percent of chicks lost in each age category from 2002 to 2012.

Plover Use of Restored Habitat

Between 2011 and 2012, approximately 250 acres of dune habitat has been restored to native plant communities. European beach grass and iceplant have been removed through a combination of mechanical treatment, herbicide, and hand-pulling in the NP sector (RA sector, Figure 1) in order to restore native dune habitat. It should be noted that excavation of beach grass was occurring in this area through July 2011, so nesting during the 2011 season may have been discouraged by restoration activity. Additionally, beach grass was removed from two areas on NP and K sectors in 2004 and 2005, although only the restored area on Kehoe (K) has been maintained over time. Thus, beach grass on North Beach (NP) has returned to pre-restoration levels, making assessment of use of this "restored" habitat of limited value. Therefore, we only report data for the area restored in 2004 and 2005 for the Kehoe sector.

One nest in the 2012 season was located in the 2011 restoration area (RA sector). Of the four nests on North Beach, one was located in the foredunes in front of the RA sector. Of two nests on Kehoe Beach, one was on the beach near the 2004 and 2005 restored area.

No chicks were fledged from any restored areas on Kehoe in 2012. Although, the three chicks that fledged from Kehoe were observed using the restored area after fledging. Two chicks fledged from the nest in front of the 2011 restoration area and regularly utilized the foredunes of 2011 restoration area.

Raven Occurrence

Common ravens have been a constant presence on PORE beaches since monitoring began in 2002. On Kehoe Beach in 2012, ravens were detected on 47% of surveys, averaging 1.85 birds per survey hour. In comparison, raven were detected on 65% of surveys and an average of 3.3 birds per survey hour in 2011, and 81% of surveys and an average of 2.9 birds per survey hour in 2010 (Figure 9, Table 5). On North Beach in 2012, ravens were detected on 29% of surveys, averaging 0.28 birds per survey hour. In comparison, ravens were detected on 50% of surveys averaging 0.77 birds per survey hour in 2011 and 62% of surveys, averaging 0.94 birds per survey hour in 2010 (Figure 9, Table 5).

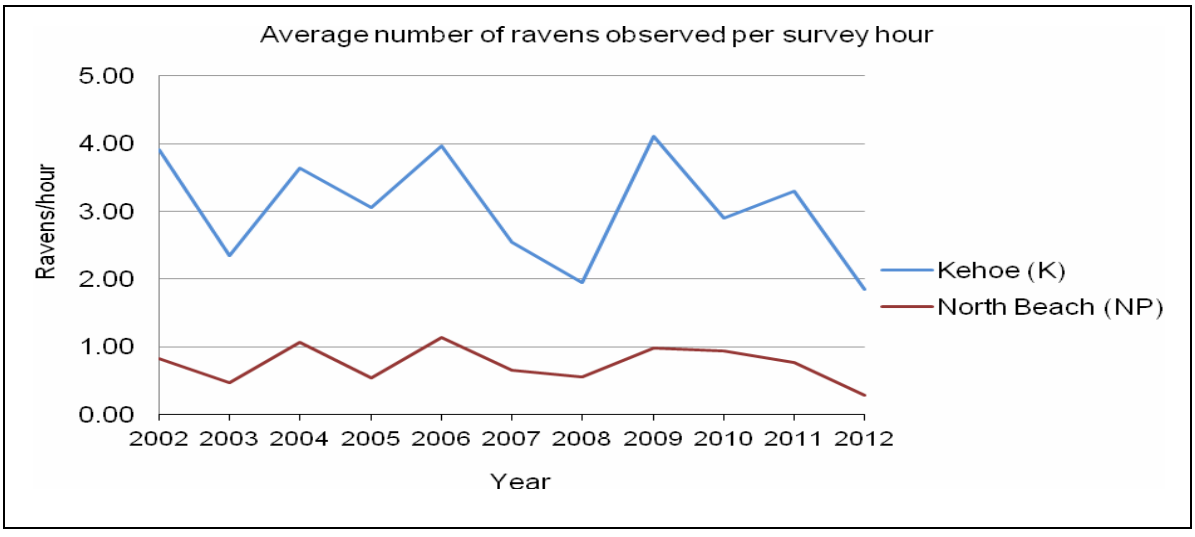


Figure 9. Average number of ravens observed per survey hour from 2002 to 2012.

Table 5. Occurrence of common ravens on surveys from 2002 to 2012.

Year	No. of Surveys	Total Survey Hours	Surveys with Ravens	Total Raven Sightings	% Surveys with Ravens	Average Ravens per Survey	Average Ravens per Survey per Hour
Kehoe (K)							
2002	47	120	39	470	83	10.0	3.91
2003	41	128	22	300	54	7.3	2.34
2004	72	292	66	1062	92	14.8	3.64
2005	40	95	34	291	85	7.3	3.05
2006	76	211	68	836	89	11.0	3.97
2007	78	312	71	795	91	10.2	2.55
2008	86	344	64	666	74	7.7	1.94
2009	50	125	49	512	98	10.2	4.11
2010	68	132	55	449	81	8.0	2.90
2011	57	125	37	412	65	7.2	3.30
2012	60	125	28	231	47	3.9	1.85
Average	**61**	**183**	**48**	**548**	**78.1**	**8.9**	**3.05**
North Beach (NP)							
2002	57	172	31	141	54	2.5	0.82
2003	72	231	20	108	28	1.5	0.47
2004	62	150	25	158	40	2.6	1.06
2005	68	121	18	65	27	1.0	0.54
2006	76	204	48	230	63	3.0	1.13
2007	70	350	68	228	97	3.3	0.65
2008	61	305	45	169	74	2.8	0.55
2009	45	165	30	194	67	4.2	0.98
2010	58	143	36	160	62	4.0	0.94
2011	64	199	32	154	50	2.4	0.77
2012	75	227	22	63	29	0.8	0.28
Average	**64**	**206**	**34**	**152**	**53.7**	**2.5**	**0.74**

Discussion

Number of Nesting Plovers

The minimum estimate of nine nesting snowy plovers at PORE in 2012 compares with a mean of 23.4 (SD = 8.0) individuals in the 16-year period from 1996 to 2011, during which exclosures have been used to protect nests. Nine nesting snowy plovers is the lowest estimated minimum number of nesting plovers since 1996 (Table 1). The low number of nesting adults could be related to the low number of fledglings from PORE in the past four years, which could reduce the number of returning nesting adults for the 2012 season.

Additionally, the possible impacts of ENSO winter storm events continue to be considered since the resultant beach erosion could be a contributing factor in reducing available nesting habitat. It may also affect over winter survival rates of potential breeding adults, thus causing a decline in breeding population the following summer. A recurring pattern of decreased total number of breeders in years following ENSO events has been observed (Figure 2). Although, the winter of 2011-2012 was not classified as an ENSO event, snowy plover population at PORE decreased from 2011 to 2012.

Several pairs of snowy plovers were observed displaying territorial behaviors and scraping but no nest was ever located. With no nest on record for the snowy plover pairs they could not be included in the minimum estimate of nesting snowy plovers. Additionally, an egg that resembled the shape, size and coloring of a plover egg was located in the back dunes of the NP sector. The egg was partially buried and sun bleached. The egg was not associated with any known nest since there was no occurrence of a single egg loss from a nest. It is possible the egg came from a nest predated before it was located. However, since the origin and date could not be determined, the adults responsible for the egg could not be included in the minimum estimate of nesting snowy plovers.

Nest Hatching Rate

The 71.4% clutch hatching rate in 2012 compares with a mean of 69.6% (SD = 17.9) from 1996 to 2011. Post-management hatch rates (1996-2012) have increased compared to pre-management hatch rates (Figure 4). This is likely due to the success of predator exclosures at protecting nests until their hatch date.

Nest abandonment was the cause of one nest loss this season. The nest was discovered unattended several days after being exclosed. There were still three eggs present, although one was rolled out of the scrape and cracked. Predation of the nest could not be classified as the cause since the eggs still remained. Predation of one of the adults was a possibility, but due to strong winds prior to discovery, little track evidence remained at the nest. Because the cracked egg was found in the exclosure in the opposite direction of the prevailing northwest wind, wind was determined not to be the cause.

Abandonment was the cause of one nest loss in 2011 and the primary cause of nest loss in 2010 (20% lost). Abandonment was a recurring cause of nest loss from 2000 to 2006. However, no nests were lost to abandonment from 2007 to 2009. The reasons for most of the recorded abandonment events at PORE are unknown, but the relationship between prolonged exclosure use and increased snowy plover adult mortality rates has been documented in Monterey Bay

(Neumann et al. 2004). In Neumann et al. (2004), abandonment at exclosed nests was often linked with the disappearance and presumed death of a banded adult, suggesting that the abandonment was caused by adult mortality associated with the exclosure.

Annually, we evaluate the use of exclosures at PORE, and thus far have concluded that predation pressures on unprotected nests at PORE remain too high to warrant a reduction in exclosure use. However, in the 2012 breeding season, two nests were not exclosed at PORE and both hatched three eggs successfully. The first was not exclosed because it was discovered late into the incubation phase and it was determined unnecessary. The second was located under a log making exclosure placement impossible. In the future, cases of nest abandonment will continue to be closely investigated.

Chick Fledging Rate

In 2012, the 60.0% fledging rate at PORE was higher than the 43% (SD=19.6) average of the previous 16 years (Table 3). The rate has climbed steadily since falling to an all-time low in 2008 (16.1%). The 2012 fledging rate was the highest since 1998 (60.0%). The high fledgling rate may have been attributed to reduced raven use of the K and NP sectors, where the raven detection rates were well below average (see raven occurrence section below).

The USFWS uses the chick fledgling rate to gauge progress towards a sustainable coastal population of western snowy plovers, and aims to have at least one chick fledged per male in order to achieve this goal (USFWS 2007). From 1995 to 2007, Point Reyes Beach (SB, NB, NP, and K combined) surpassed that goal by producing an average of 1.42 chicks per male. However, in 2008, only 0.42 chicks were fledged per male. Since 2008, the number of chicks per male has steadily increased and this was the second season in row in which more than one chick was fledged per male since 2007 (Figure 6).

Timing of Chick Loss

As in the past eight years, most chick losses occurred during the first third of the fledging period (67%; Figure 8). Though chicks as old as 21-28 days old have been lost in the past, no chicks were lost in that age group this year.

In the 2012 season, only 16.7% of the chicks were lost on weekends and holidays. This is lower than the average (36%) of the years the metric has been recorded since 1999 (Figure 7). The continued docent program in 2012 may have contributed to low weekend and holiday chick loss.

Of the chicks lost on weekends between 2009 and 2012, a greater proportion has been lost on North Beach (59%) versus Kehoe Beach (12%). Since the portion of North Beach used by nesting plovers is much closer to areas of high visitation than Kehoe Beach, it is possible that human (and dog) presence continues to be a significant factor in young chick mortality.

Use of Restored Dune Habitat

No nests were initiated in the restored dunes of sector K this season. However, one nest was located adjacent to the restored area. Despite extensive efforts to reduce human disturbance through symbolic fencing, signage, and the docent program, no nests have ever been established in this area since its restoration in 2005. However, several adults were seen in the area during the beginning of the breeding season and several nests have been established adjacent to this site

throughout the years. Additionally, wintering groups are frequently sighted feeding and roosting in this area during early and late nesting season.

The lack of nesting in the portion of restored habitat nearest to sector K may be attributed to the consistent presence of large groups of ravens that roost on the hill adjacent to this site. Previous attempts to deter ravens from this area included use of bald eagle decoys, hazing, and lethal removal of territorial pairs. While bald eagle decoys and hazing were not used this year, lethal removal was employed to reduce corvid impacts to plovers in this area.

Of the four nests on North Beach (NP), one nest was located in front of the RA sector. Two out of three chicks fledged from this nest and fledged chicks were often seen utilizing the restored foredunes, these chicks accounted for 22% of the fledglings in 2012.

One nest was located inside the RA sector in the 2012 season. Unfortunately, the nest was abandoned, possibly due to adult predation and failed to hatch. Plover pairs were seen scraping in the RA sector and the adjacent area; however, no nests were located.

Raven Occurrence

The number of ravens observed per survey hour on Kehoe (1.85) and North Beach (0.28) in 2012 was below average (3.05, 0.74 respectively) for the 11 years ravens have been monitored at PORE (Table 5, Figure 9). Sixty surveys were conducted for ravens on Kehoe Beach in 2012 and ravens were present on 47% of those surveys. On North Beach, where ravens have historically been seen in comparatively lower numbers, they were detected on 29% of the 75 surveys; the lowest percentage recorded. No nests loses could be attributed to ravens in 2012 (Table 4). Reduced predator pressure by ravens may have contributed to increased snowy plover fledging success in 2012.

Lethal removal was used as a predator management strategy for corvids for the eighth consecutive year at PORE. When used in combination with non-lethal predator control strategies, targeted removal of territorial pairs has been shown to have a large, positive effect on hatching success of the target bird species (Côté et al. 1997). Lethal removal at PORE was used only those corvids either identified as responsible for depredation of snowy plovers or observed actively hunting in snowy plover nesting areas.

Vandalism

Since 2008, occurrences of vandalism have remained relatively infrequent. There have been up to three instances of vandalism per year since 2008. This season, there were no major occurrences of vandalism. No valuable property was lost but there were several instances of paper signs and fencing removed. This compares to 19 instances of vandalism in 2007 and 24 in 2006. The dramatic decrease in vandalism may be largely attributed to the placement of permanent "No Dogs" signs along Kehoe Trail and at the entrance to the beach from North Beach parking lot. This signage has likely communicated a more official message than the temporary signage used in the past and is likely more difficult to vandalize than the laminated signs on wooden posts that are easily removed and vandalized.

Although biologists, park employees, and docents were present on the beaches during busy weekend times, human footprints were still seen inside symbolic fencing and leading up to

exclosures, especially near nests visible from the area of Abbotts Lagoon. Additionally, there were multiple instances of people entering the closed area near North Beach parking lot.

Research Activities and Recommendations

Continue Current Monitoring

It is critical to continue monitoring the breeding population of snowy plovers at PORE. The recovery plan (USFWS 2007) sets a goal of 50 adult birds on Point Reyes Beach (K, NP, NB, and SB; there were nine in 2012), ten on Limantour Spit (L; there were zero in 2012), and four on Drakes Spit (D; there were zero in 2012). The plan also recommends that a reproductive rate of one fledged chick per male is the minimum required to sustain the population (2012 rate was 1.8 chicks per male, Figure 6).

Continued monitoring will help to determine if these population goals are being met and allow managers to respond to new and increasing threats in a timely manner. Implementation of a banding program may be an important step in achieving these goals by offering insight into survivorship rates, site fidelity and improving the quality of data collected at PORE.

It may also be important to analyze historic nesting data with regards to efficacy of exclosures at increasing fledgling survival. Recent reports from Oregon suggest that exclosure use may increase hatch and fledge success up to the first several years of use, but that over time, increasing adult and chick depredation events near exclosures may actually decrease fledge success (Lauten et al. 2010). The implementation of a banding program will assist in determining if exclosures are associated with adult depredation in PORE.

Predator Data Collection and Analysis

Improved methods for predator data collection were tested in 2011 and continued in 2012 in response to peer review comments on the draft monitoring protocol (Adams et al., In review). The previous methods were not considered adequately systematic or standardized to assess how fluctuations in predator abundance, especially common ravens, relate to snowy plover nest success and productivity. The new, draft methods better quantify the time spent searching for predators and utilize a line transect method for collecting predator data. Using distance sampling techniques (Buckland et al. 1993), the data should allow for calculations of predator abundance and density that can be assessed in regards to the recovery of snowy plovers at PORE. These methods are still being further refined, require peer-review, and will be formally incorporated into the snowy plover monitoring protocol.

In the future, predator monitoring data should be assessed for correlations with land management practices at the local and regional scale. For example, any seasonal trends across the plover breeding season that correlate with nearby agricultural activities are important to document. Subsidized feeding from dairy operations is a likely cause of raven increases in the PORE area in the past decade (Kelly et al. 2002).

Peregrine falcons may also be an important plover predator and a pair was first observed nesting and feeding in the historic plover nesting area around Abbotts Lagoon in 2009. Peregrines were observed on approximately 5% of surveys in both 2009 and 2010 and 16% of surveys in 2011. In the 2012 season, peregrines were seen approximately 7% of the surveys. A nest was located on the Kehoe cliffs north of the trailhead. Additionally, a peregrine fledgling was seen multiple times around Abbotts Lagoon, though not during a formal predator survey. No instances of depredation on snowy plovers were recorded, but the likelihood of detecting such an event is

low. Thus, further monitoring of peregrines is warranted to monitor and mitigate impacts to nesting plovers in this area. Monitoring the effects on peregrine falcons of bald eagle decoys and effigies is also recommended to determine efficacy of such methods is deterring peregrine presence around plover nesting areas.

Project Staff

Interns and volunteers provide invaluable assistance in the field, so efforts to recruit and compensate them should be continued and expanded. Hiring a part-time, seasonal field monitoring intern provides the added benefit of a trained and skilled observer. Since 2010, the intern has been listed on the USFWS Threatened and Endangered Species Permit, which enabled the field team to conduct surveys on multiple beaches in the same day and allowed data to be collected in the absence of the lead biologist. Efforts should continue to be made at the beginning of each season to include the intern on the USFWS permit.

Since monitoring plovers requires a significant amount of training to become familiar with field techniques, the program would greatly benefit from retaining the same field technician from year to year. If this is infeasible, at least one field season of full time snowy plover monitoring should be a prerequisite for employment.

Education and Outreach

The educational and informational visitor contacts on weekends and holidays by park employees and volunteer docents appears to be effective in increasing understanding and compliance of habitat closures. One measure of success is the 28% decrease in average percent chick loss over weekends and holidays that has been observed since the docent program started in 2003 (Figure 7). Weekend/holiday chick has been variable however over the last three years, with a 21% loss in 2010, a 68% loss in 2011 and a 17% loss in 2012. Therefore, increased law enforcement beach patrols, clear and durable signage, public outreach as well as a strong docent presence at trailheads and on beaches are continued priorities for the plover management program.

Management Activities and Recommendations

Habitat Restoration

The 2004 to 2007 breeding seasons indicated that the removal of beach grass has a positive effect on the raising of plover chicks. Data from these seasons shows increasing numbers chicks being reared in these areas immediately following removal of European beach grass. One nest was located in the RA sector in 2012, and the high proportion of fledged chicks from sector RA in 2011 and 2012 further supports habitat restoration.

However, the lack of plover activity in the restored dunes of sector K and the unmaintained dunes of sector NP restored from 2004 to 2007, also emphasizes the range of variables that must be considered in any habitat restoration endeavor. Thus, appropriations for predator management and the maintenance of restored sites should continue to be made in order to maximize benefits from the initial restoration effort.

Predator Management

To attain a sustainable plover population, predator management recommendations are outlined below. Where feasible, the effectiveness of all implemented management actions should be assessed through monitoring.

- implementation of agricultural operation Best Management Practices (covering feeding troughs)

- reducing, over time, silage harvesting in fields adjacent to plover breeding areas and rescheduling remaining silage harvesting to reduce attraction of ravens during plover breeding season

- enforcing current restrictions on dairy ranch permittees concerning disposal of cow carcasses and afterbirths, thus reducing food subsidization of corvids

- managing “problem” ravens (i.e., ravens seen attacking plovers or nests, or perching regularly near nests or broods) throughout the breeding season, but especially within the first month of the season (April)

- focusing avian predator management efforts in dune restoration areas

- continue testing use of bald eagle decoys and, where appropriate, raven effigies, in strategic locations along the dunes, to deter patrolling by avian predators

- further reduce *European beach grass* coverage through dune restoration within plover breeding habitat to reduce cover for terrestrial predators.

Visitor Education and Restrictions

The Snowy Plover Docent Program continues to be a key element for successful protection of breeding plovers. In addition to continuing the program, the park should consider extending the docent season to include the month prior to nesting (March) and the month of September until all chicks are fledged. This could reduce disturbance to early nesting pairs that initiate courtship up

to 30 days before actually laying a nest (USFWS 2007) and contribute to increased fledging success for late season nesters.

It is also highly recommended that a full-time seasonal docent coordinator be on staff to recruit, organize, and lead the volunteer docents. This position was filled this season after being vacant during the 2011 season. The program had great returning volunteers but lacked significant recruitment of new volunteers. The Abbotts Lagoon contact station was staffed every weekend and holiday due to the dedication of a handful of volunteers. Efforts to request visitors to keep dogs on leash and outside of the closed plover habitat areas on Kehoe Beach were also increased this season. This proved to be a valuable contribution with added contacts made and the plover brood closest to the Kehoe Trail fledged all three chicks. Efforts should be made to continue to staff the docent coordinator position to help sustain consistency in the program, increase recruitment, and help keep the program up to date.

Wilderness Awareness

Much of Point Reyes Beach lies within federally designated wilderness as set forth in the Point Reyes Wilderness Act of 1976. In 2012, efforts were made to minimize motorized vehicle use associated with the plover project in compliance with the Wilderness Act. In the past, a utility terrain vehicle was used to distribute and collect the fencing and exclosure gear throughout the beach. At the start of this season, however, all fencing and exclosure gear was distributed by foot through the wilderness areas, thus reducing the impact the monitoring activities have on snowy plovers and on Wilderness values at Point Reyes Beach. Additionally, all temporary fencing established in Wilderness areas was recorded with the GPS to document our presence on Point Reyes Beach. At the peak of the season 1.68 miles of fencing was present.

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Appendix A. Criteria and evidence for determining fate of snowy plover clutches.

Hatched

- Tapping or cracks observed in eggs one to two days before eggs disappeared – not fail safe.
- Eggs disappear close to estimated hatch date with no signs of predation
- Indication of a newly hatched brood in the immediate vicinity (direct observation, broody behavior exhibited by nearby adult).
- Flattened scrape with tiny egg shell fragments located in scrape.

Not hatched

Depredated - Unknown Predator:

- Direct evidence that eggs were destroyed, including:
    - Substrate cemented together by egg contents, or
    - Egg shell fragments intact but damaged eggs found well before estimated hatch date.
- Eggs gone well before estimated hatch date, no predator tracks to nest, but wind or tide would not have destroyed nest. Evidence may include:
    - Scrape intact or still discernible, or substrate stable or level enough such that wind would not cause clutch to be buried or eggs to roll out of scrape, or
    - Substrate too firm for imprint of predator tracks.
- Unidentified potential predator tracks directly to and at nest site (if potential predator tracks are observed leading towards nest site but gait is unchanging directly past nest site, that predator is not associated with clutch loss).

Depredated - Known Predator:

- Identified predator tracks directly to the nest site.
- Timing of lain predator tracks coincides with nest loss, as indicated by substrate conditions.

Tide:

- Tide has washed over the original nest location leaving no evidence of the eggs or nest scrape, and there is no indication of a newly hatched brood in the vicinity
- Eggs located near original location or nest washed over by the tide but no indication eggs being incubated.

- Tide has washed over nest location, eggs located near original nest location and being incubated well past estimated hatch date.

Non-viable Eggs:

- Intact eggs of full clutch remain well after estimated hatch date along with evidence that there is consistent adult activity at nest location. Adult activity can be determined by presence of adult on nest, egg position changing from survey to survey. Nests should be monitored until adult activity ceases.

Abandoned:

- Intact eggs of clutch remain but evidence of adult activity at nest ceased well before the estimated hatching date. No evidence nest was washed over by tides or ever buried by wind blown sand or other debris.

Wind:

- Eggs not being incubated and one of the following:
    - Intact eggs located outside of scrape, eggs not being incubated, and no indication that any other species may have moved eggs, or
    - Eggs in scrape and covered by wind-blown sand or other debris.

*Note: Distinction between the above three categories (non-viable eggs, abandoned, and wind) can be difficult and may require additional information.

Trampled:

- Eggs found destroyed (not depredated) and tracks of a larger species directly through nest location.

Destroyed – Human:

- Human footprints directly next to or on the nest location and:
    - one or more eggs missing from the clutch, or
    - evidence that eggs were destroyed including shell fragments or contents.
- Human footprints near nest with evidence that something was dragged over, dropped or placed on nest.

Failed Unknown:

- Eggs gone well before estimated hatch date, but absence of clear evidence of depredation, wind loss, tide, or trampling.

Unknown:

- Eggs gone close to estimated hatch date, but evidence of hatch would have been obscured by weather conditions or other factors.

Appendix B. Criteria for determining snowy plover brood fate.

Determining hatch date:

- Make notes of when bird activity first started.
- When was the first egg laid?
- When was the clutch complete (usually 3-5 days)?
- Nests should be checked daily at 25 days past known clutch completion.
- If exact clutch completion date cannot be determined, nest checks should be made more frequently at 20 days past estimated completion. Your field notebook should provide good clues to bird activity around the nest site making it possible to closely estimate hatch dates.

Monitoring broods:

- Once a nest has hatched, chicks should be checked daily to determine timing of any loss that may occur.
- Approach the area where the brood was last seen slowly and cautiously.
- Are there adults present? And if so, are they displaying broody behavior (flying, vocalizing or feigning injury)?
- Can you easily see the chicks? Often, chicks are within a few meters of the adult.
- If a brood is located immediately, count the number of chicks present, location, and behavior. Record this information in your field notebook. Leave the area quickly, particularly if the tending adult is agitated.
- If the brood is not immediately located, move away to a concealed position and wait for the birds to resume undisturbed behavior. Again, count the number of chicks present, location, and behavior in your notebook.
- Once the brood is located and counted, leave the area. Any additional notes should be written well away from the site.
- If additional data collection is required (disturbance study or better aging) do so from a concealed area where your presence is not a factor and the birds are not disturbed further.
- First, determine what information is needed. For example, is it important to know the exact time of loss? Or, does general knowledge of loss suffice for your study area?
- When needing to determine the difference between weekday and weekend loss, all broods should be checked on Friday afternoon and again on Monday morning. If chicks

are present on Friday but not on Monday morning, this is considered a weekend loss and should be recorded in your field notebook and data sheets as such.

- When trying to determine whether chick loss occurs in the day, at night, or at dusk or dawn, checks must be made within each of those time periods. For example, if chicks are present at 7 pm and at again at 9 pm, but not present at 5 am, the loss event would be recorded as occurring at night (take into consideration changing hours of sunrise and sunset).

- Determining the timing of chick loss events can be time consuming and somewhat difficult. Remember that most brood checks cause some disturbance to the birds and should only be done at a minimum frequency required to answer your research questions.

- If exact date of chick loss cannot be determined, the midpoint between 2 brood checks when a reduction in brood size is determined should be used as the date of loss.

Appendix C. Fate of snowy plover nests at PORE in 2012.

Nest & Location[1]	Date Found	Exc.[2] Yes/No	Female ID[3]	Male ID[3]	Eggs Laid	Eggs Hatched	Clutch Fate	Final Status
NP01	4/30/2012	YES	U	U	3	0	FAIL	WIND
NP02[4]	4/30/2012	YES	U	U	3	0	FAIL	ABANDONED
NP03	5/30/2012	NO	U	U	3	3	HATCH	FLEDGE 2
NP04	6/18/2012	NO	lg:yo	U	3	3	HATCH	FLEDGE 2
NP05	7/1/2012	YES	wl:oo	U	3	3	HATCH	FLEDGE 2
K01	6/18/2012	YES	:Oy	U	3	3	HATCH	FLEDGE 3
K02	6/24/2012	YES	U	U	3	3	HATCH	FLEDGE 0

[1]K = Kehoe Beach to Abbotts Lagoon; NP = Abbotts Lagoon to North Beach parking lot (including shore of the lagoon);

[2]Exc.=exclosure.

[3]U=unknown.

[4]NP02_2012 = located in the 2011 Restoration Area

Appendix D. Criteria for determining minimum numbers of western snowy plovers breeding at PORE.

In 2009, it was determined that maximum estimates will no longer be appropriate due to the subjectivity involved in analyzing behavioral characteristics, as was required by the original methodology (Adams et al., In review). The advent of seasonally changing staff and a need for objective, repeatable methodology resulted in adoption of the following method for determining a minimum estimate:

1. Determine the time period when the maximum number of simultaneously active nests and broods were present on the beach during the breeding season and use data from this period to calculate the minimum number of breeders using the methods below:

    a. An active nest represents the presence of 1 male and 1 female (count = 1 male, 1 female).

    b. If one or more chicks of a brood are known to be alive and less than 3 weeks old, one male is inferred (count = 1 male).

    c. If a male is present with a brood greater than 3 weeks old, that male is probably with a new mate who may have initiated a new nest. This nest, if found, would result in counting of 1 male and 1 female. Therefore, males with broods of over 3 weeks are not counted (count = 0 male)

        i. However, if it is possible to determine that there are no available (unpaired) females within the vicinity, one male may be counted (count=1 male).

    d. One day prior to the estimated initiation date of a nest represents the presence of one male and one female which are about to nest (count=1 male, 1 female).

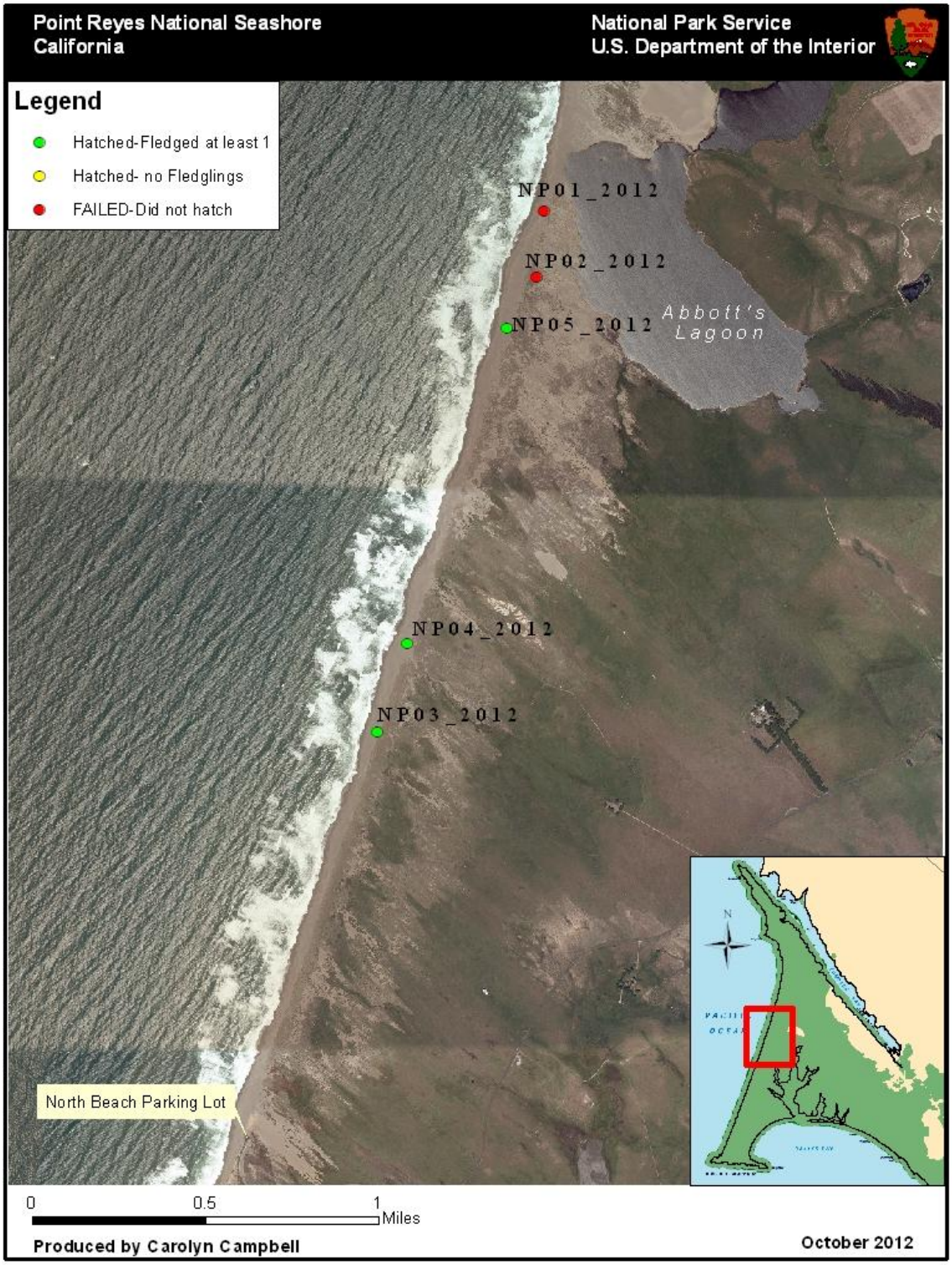
        i. This step is only relevant if a pair initiates a nest one day after the last day of the peak number of nests present on the beach.

    e. If any banded birds had confirmed nests outside of the peak window, add 1 male and 1 female (count = 1 male, 1 female).

Given the relatively small number of birds and few banded ones at PORE, this method has been determined to be the best possible *minimum* estimate. However, years with a high rate of nest loss could result in inaccurate estimates since all of the birds won't have active nests. Therefore, results of the window survey for that year should also be reported as further corroboration of minimum numbers.

Appendix E. Western snowy plover nest locations at PORE, April 2012-August 2012.

North Beach (NP) sector:



Kehoe (K) sector:



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