Final Report: 2007 Snowy Plover Breeding in Coastal Northern California, Recovery Unit 2

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*Abstract.—2007 marked the seventh consecutive season of collaborative monitoring of a color-marked population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*) in coastal northern California, one of six recovery units designated by the United States Fish and Wildlife Service for this threatened shorebird. The number of breeding adult plovers (30; 16 males and 14 females) was the lowest recorded since monitoring began in 2001. This decline occurred subsequent to two events in the past year that negatively affected adult survival: 1) suspected depredation of eight adults incubating inside exclosures on Clam Beach during the 2006 breeding season; and 2) a prolonged period of cold weather in January 2007. Return rates of adult plovers (34% and 36% of males and females, respectively) were much lower than in previous years, further suggesting that mortality was high in 2006-07. At the end of 2006, we estimated apparent adult survival at 0.64±0.07 for males and 0.57±0.07 for females. Apparent survival of juveniles from fledging to approximately one year was 0.31±0.04. These estimates are lower than those reported for a population breeding around Monterey Bay, CA. A mark-recapture analysis of breeding adults indicated that the population of Snowy Plovers breeding in Humboldt County, CA is stable (λ=1.01). However, algebraic estimates of population growth based on the product of adult survival and fledging success indicate a declining population (λ=0.87), we conclude that the local population of Snowy Plovers is sustained by immigration.*

Plovers have nested at 18 locations in Humboldt County over the past seven years, including seven ocean-fronting beaches and eleven gravel bars along the lower Eel River. In 2007, we observed breeding plovers at only five of these sites, including one gravel bar and four beaches. River-breeding plovers averaged significantly greater reproductive success (1.67±0.58 fledglings per male) than those nesting on beaches (0.46±0.88). Breeding locations differed in indices of activity of humans and corvids (Corvus corax, C. brachyrhynchos).

Plovers breeding on LRSB/Clam Beach in 2005 and 2006 selected nest sites in more open, unvegetated habitats than random locations; the magnitude of the differences diminished with increasing plot size (10, 25, 50 and 100 m radius). Eight incubating female plovers approached by a human left their nest at a distance of 80±33 m, and returned to incubate 237±178 seconds after disturbance ceased. Collectively, these data guide restoration of dune habitats and the use of symbolic fencing to restrict human activities in the vicinity of nesting plovers.

This year (2007) was the first in which we did not use predator exclosures to manage predation on eggs of beach-breeding plovers. Analysis of the 420 nests initiated by plovers over the past seven years indicate that exclosures were an effective means of increasing hatching success. Nesting success at Clam Beach was especially low (6% apparent hatching success) in 2007, when we did not use exclosures to protect nests from predators. We suggest that alternative means of managing predators, including lethal methods, should be examined given that exclosures will not be used in the near future, and because beach-reared chicks survive poorly.

For the past four years (2004-07), the placement of a symbolic fence in an area of high human activity on Clam Beach resulted in an increase in the number of chicks fledged (37% of 41 chicks fledged) compared to three years (2001-03) when the fence was not in place (15% of 33 chicks). These data indicate that symbolic fencing is a useful and cost-effective tool for managing the negative effects of human activity on plover reproductive success in areas where breeding plovers and high human activity co-occur.

*Key words.—*Charadrius alexandrinus nivosus, *habitat quality, human disturbance, nesting success, predation, reproductive success, site fidelity, Western Snowy Plover.*

Introduction

For the seventh consecutive year, biologists of Humboldt State University (HSU) and Mad River Biologists (MRB) monitored and managed the Western Snowy Plover (*Charadrius alexandrinus nivosus*; hereafter plover) in coastal northern California (Del Norte, Humboldt and Mendocino counties; Recovery Unit 2). Beginning in the late 1990s, MRB biologists conducted surveys, monitored nests, erected predator exclosures, and banded adults and chicks (LeValley 1999, McAllister et al. 2001). In 2001, we began collaborating in order to enhance science-based management by understanding site fidelity of plovers (Millett 2005, Colwell et al. 2007b), quantifying survival of plover chicks in relation to behavioral development (Hall 2004, Hurley 2005, Colwell et al. 2007a), and elucidating nest survival in relation to egg crypsis along the Eel River (Meyer 2005). In 2004, we initiated a one-year study of female incubation behavior (Hoffmann 2005). In 2005, we addressed several new questions using data collected over the past six years. First, to what extent does social attraction influence the distribution of breeding plovers at several spatial and temporal scales (Nelson 2007, Nelson and Colwell in revision)? Second, what are the patterns of space use and movements of adults tending chicks (Wilson 2007)?

Finally, what are annual survival rates of adult males and females (Mullin 2006, Mullin et al. in review)? Each of these questions is critical to effective management and recovery of the plover locally and regionally along the Pacific coast. For example, the United States Fish and Wildlife Service (hereafter USFWS; 1993, 2001) identified an invasive species, European beach grass (*Ammophila arenaria*), as a factor contributing to the decline of the plover, with considerable effort and funding dedicated to restoring dune habitats. However, the extent to which individual plovers select breeding sites based on the presence of conspecifics (vs. habitat features associated with spread of *Ammophila*) has implications for the notion that habitat is limiting plover populations. On another note, Recovery Unit 2 sits near the northern extent of the species' distribution (Page et al. 1995). After seven years of monitoring a color-marked population, we have sufficient data to analyze adult and juvenile survival, and to understand the relative contributions that survival and productivity (i.e., number of young fledged annually per adult male) play in influencing population growth. The extent to which immigration bolsters the local population has implications for the proposed 4(d) rule issued by the USFWS (U.S. Department of Interior 2006). Specifically, if plover populations near the limit of the species' range are maintained by immigration from highly productive habitats elsewhere, then relaxation of federal restrictions at these highly productive sites would be counter-productive to population recovery throughout the listed population segment.

In this report, we summarize our findings for the 2007 breeding season and interpret results in light of the species' recovery plan (USFWS 2001), past conservation efforts in Humboldt County (LeValley 1999, McAllister et al. 2001, Colwell et al. 2006), current management practices, such as the use of exclosures and symbolic fencing to increase reproductive success of plovers, and decisions by the county to restrict vehicle access to Clam Beach during the plover breeding season. We conclude with specific management recommendations to enhance plover survival and reproductive success in Recovery Unit 2.

Background

In 1993, the federal government listed the coastal population of the Western Snowy Plover as a threatened population segment under the Endangered Species Act (USFWS 1993). In 1999, the USFWS designated critical habitat, an action that was renewed in 2004 following a lawsuit over failure to analyze the economic impacts of critical habitat designation. An economic analysis of the designation of critical habitat was produced in 2005. In 2001, the USFWS produced a draft recovery plan, which is now finalized (USFWS 2007). Finally, in 2006, the USFWS denied a proposal to de-list the plover based on a challenge to genetic distinctiveness of the population, despite contrary evidence (Funk et al. 2007). The USFWS did, however, propose a change to the management practices under the federal Endangered Species Act. The proposed 4(d) rule change would relax some management activities required by local jurisdictions for counties that exceeded (for 2 of 5 years) the number of breeding plovers as identified by the recovery plan.

The USFWS listed the plover based on evidence of a significant population decline, as well as a reduction in the number of breeding locations. The USFWS (1993, 2007) identified three limiting factors affecting low reproductive success and contributing to the plover's decline. These factors include: 1) increased human recreational use of beach habitats during the breeding season; 2) predation of eggs and young by corvids (*Corvus brachyrhynchos*, *C. corax*), gulls (*Larus* spp.), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*); and 3) degradation of nesting habitat by European beach grass. Prior to listing by the USFWS, Page et al. (1991) estimated the California population at 1386 plovers, down 11 percent from the 1565 estimated a decade earlier (Page and Stenzel 1981). The 2006 California statewide survey yielded an estimate of approximately 1900 plovers (J. Watkins, pers. comm.). This estimate remains well below the population size of 3000 birds listed as a recovery objective (USFWS 2007), although some local population sizes have surpassed recovery objectives for some areas (e.g., Monterey Bay). At the time of the publication of the species' draft recovery plan, plovers bred in coastal habitats (salt pans and levees, dredge spoil islands, river gravel bars, and ocean beaches) from the central Washington coast south to Baja, Mexico; many of these locations were in California (USFWS 2007).

In coastal northern California, plovers have bred and wintered along ocean beaches and gravel bars of the Eel River (Colwell et al. 2006). In 2001, the USFWS designated Mendocino, Humboldt and Del Norte counties as a discrete management unit (Recovery Unit 2). Surveys (Page and Stenzel 1981, Fisher 1992-94, LeValley 1999, McAllister et al. 2001, Colwell et al. 2006) indicate that most plovers in this area occur in Humboldt County. In 1977, Page and Stenzel (1981) observed 64 birds (18 nests) at seven Humboldt County locations and estimated that this represented 6% of coastal plovers breeding in California. At this time, Humboldt County had more plovers than any location north of Monterey. During the early 1990s, Fisher (1992-4) surveyed Humboldt County beaches and recorded 22-32 plovers and 17-26 nests annually. In 1999, LeValley (1999) recorded 49 birds and 23 nests at four locations. In 2000, this same area supported about 40 adults and 42 nests (McAllister et al. 2001). Over the past six years (2001-2006), we increased monitoring and estimated *ca.*

60 plovers nested in Humboldt County (Colwell et al. 2006). Based on these data, nearly all plovers breeding in Recovery Unit 2 (USFWS 2007) occurred in Humboldt County.

Until recently, plovers had not been observed nesting in habitats other than along coastal beaches of northern California. However, in 1996 plovers were first recorded nesting on gravel bars of the lower Eel River (Tuttle et al. 1997). The Eel River remains a unique and productive breeding habitat (Colwell et al. 2005a). With the onset of intensive monitoring in 2001, we showed that most plovers in Humboldt County nested on Eel River gravel bars (Colwell et al. 2005), although this pattern changed recently with several years (2003, 2005, and 2006) of high river flows in late spring (see below). Both hatching and fledging success are consistently higher for river- than beach-breeding plovers (Colwell et al. 2005a). In summary, over the past several decades the total number of nesting locations and breeding plovers in Humboldt, Mendocino and Del Norte counties has decreased (USFWS 2007). Recently, however, numbers in Humboldt County may have increased slightly with the discovery of plovers nesting on Eel River gravel bars (Tuttle et al. 1997). However, it is difficult to address local population trends since researchers surveyed different habitats with varying effort. Moreover, since plovers tend to disperse widely during the breeding season (Stenzel et al. 1994), it is likely that some individuals may be recorded as breeding in more than one location.

Study Area

We studied plovers from mid-March to late August 2007 in coastal northern California. Most intensive monitoring occurred at five locations with breeding plovers (Fig. 1) in Humboldt County: Little River State Beach and Clam Beach, Mad River Beach, South Spit, Eel River Wildlife Area, and the Worswick gravel bar of the lower Eel River. Volunteers and employees of state and federal agencies also monitored other sites with suitable habitat less frequently.

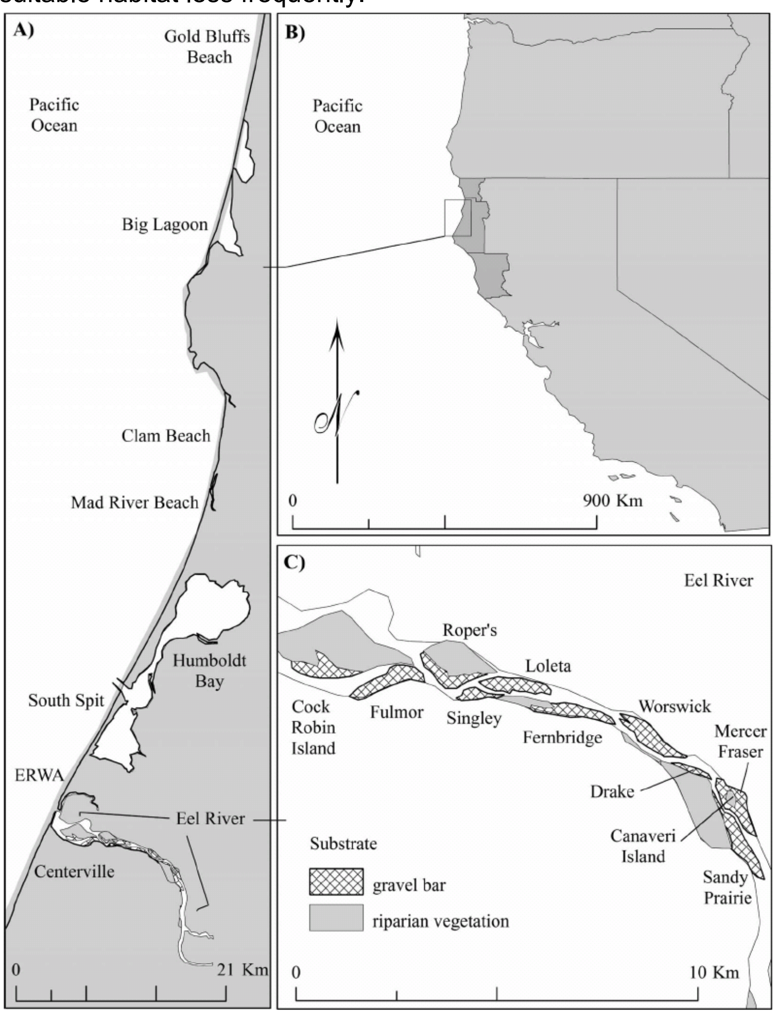

Fig. 1. Locations of principal study areas in Humboldt County, CA where biologists monitored breeding Snowy Plovers in 2007. Observers detected plovers at several other locations in coastal northern California (Brush Creek, Mendocino County; Centerville Beach, Humboldt County) during regular surveys but found no evidence of breeding. Little River State Beach/Clam Beach is managed by California Parks and Recreation and Humboldt County, respectively; South Spit is managed by the U.S. Bureau of Land Management; Eel River Wildlife Area is managed by California Department of Fish and Game; and the gravel bars of the lower Eel River are mostly privately owned, with the exception of one county-owned site (Worswick).

Methods

We conducted research under federal, state and university permits (United States Fish and Wildlife Service permit TE-823807-3; California Department of Fish and Game collecting permit #801059-03; Humboldt State University IACUC #04/05.W.17-A; USFWS Federal banding permit #22971).

Banding. We captured and marked adult plovers with a unique combination of plastic color bands and colored tape wrapped around a USFWS metal band (e.g., red, yellow, orange, green, violet, white or blue). At hatch, we marked chicks on the right leg with a single metal band wrapped with brood-specific colored tape to enhance knowledge of brood survival (Colwell et al. 2007a). When the hatching sequence of chicks was evident, we marked the colored tape attached to the metal band with the number 1, 2 or 3 denoting the order of hatch (and hence age) of chicks.

Surveys for Breeding Plovers. Beginning in mid-March and continuing into late August, we surveyed for plovers, searched for nests, and monitored broods in suitable habitat. Most effort occurred at the five main breeding sites, although we surveyed unoccupied sites a minimum of 9 times (at 7-10 day intervals) throughout the nesting season. Upon finding a nest, we noted the number of eggs in the clutch. For complete clutches, we floated eggs to determine stage of development and estimate hatching dates (Liebezeit et al. 2007). We recorded the location of each nest using a global positioning system (GPS).

Management Activities. For the first time since intensive monitoring and management began in 2001, we did not protect clutches from predators by erecting caged exclosures around beach nests. We made this decision when evidence accumulated that an avian predator at Clam Beach killed at least one adult near an exclosure, and seven other adults disappeared during incubation. On 10 March, we coordinated with federal, state, and county agencies to erect a symbolic fence for the fourth consecutive year in the area between the north and south parking lots accessing Clam Beach County Park; we deconstructed the fence on 7 September.

During surveys, we collected data on the identity of marked adults incubating eggs or tending young (e.g., brooding, performing a distraction display), and we used this information to determine clutch ownership and reproductive success. We regularly monitored the status of nests, noting whether a clutch had failed or not. In the event of clutch failure, we determined probable cause to be: 1) predation (eggs disappear prior to predicted hatch date, predator footprints occurred at a nest or egg shell fragments/yolk at nest); 2) drifting sand (coincident with strong winds, eggs partially or completely buried by sand); 3) high tide inundation (eggs displaced or absent from nest and recent high tide line situated above nest elevation); 4) human-caused (vehicle tracks or footprints pass directly over nest and eggs gone or egg remnants in nest cup); 5) dog-caused (tracks leading to nest cup and eggs gone); 6) abandoned (eggs untended as evidenced by absence of plover tracks over multiple days); or 7) unknown (eggs disappear from nest with no sign of causes listed above or we were unable to conclude the cause of failure because more than a day had elapsed since the last nest check). In the case of drifting sand, we could not discern when a clutch failed nor could we be certain that drifting sand caused failure. Moreover, in the case of incomplete clutches (i.e., found during the laying stage with 1 or 2 eggs), the general absence from the nest site of tending adults until the last egg was laid made eggs vulnerable to being covered by drifting sand. In some cases (but not in 2007), we uncovered the first egg in a clutch when plover tracks in the sand indicated that adults visited the nest vicinity and could not locate the eggs. In these cases, adults abandoned these buried (and then uncovered) eggs to initiate new nests. By contrast, during incubation, sand may drift over clutches when humans, dogs or vehicles disturb tending adults for long intervals. Therefore, we distinguished between clutches that were covered by sand during laying versus incubation.

Indices of Human Activity and Predation Danger. During regular surveys, we assessed human activity using two methods. First, we conducted instantaneous point counts at 20-min intervals, recording location (using GPS), number of humans, horses, dogs (on and off leash), and vehicles within 500 m. We also noted when these human activities were not in compliance with county ordinances (e.g., off-leash dogs away from the wave slope; vehicles exceeding 15 mph, involved in vehicle play or driving off the wave slope). At the same location, but within a 3-m radius circular (ground) plot, we conducted a second survey of tracks left within the last 24 h by vehicles, humans, dogs, and horses. We categorized a track as "fresh" if it appeared to have been left within the past 24 h. On occasion, especially during rainy periods, wet sand made it difficult to determine the age of tracks. Similarly, drifting sand quickly covered tracks during windy periods. However, these weather effects on tracks occurred uniformly across sandy habitats, and, hence, should not bias this index toward particular locations. However, ground plots were ineffective on gravel bars where firm substrates yielded little information on tracks. We monitored the danger posed by corvids to plover eggs and chicks by sampling the number of ravens, crows, and raptors during instantaneous 500-m point counts, and by recording the tracks of corvids, foxes, cats, dogs in 3-m ground plots.

Monitoring Space Use and Survival of Chicks. Upon hatch, we monitored survival and movements of chicks along with parental care behavior for 28 days, the typical fledging age of Snowy Plovers (Page et al. 1995). We monitored broods by relocating them at 1-4 day intervals and noting the number of chicks tended by adults. Upon locating a brood and tending adult(s), we minimized disturbance by observing them at distances >100 m. We also noted behaviors of the tending adult(s) such as calls, flights, tail dragging and broken wing displays.

Data Summary and Analysis. Since the locations at which plovers bred differed in habitat and management issues, we collated data separately by location. We defined (apparent) nest success as the number of nests that successfully hatched at least one chick divided by the total number of nests. From the number of broods hatched, we calculated brood success as the percentage of broods that successfully fledged at least one juvenile. Fledging success was the number of chicks that survived to 28 days divided by the total number that hatched. We calculated the number of fledged chicks per male to facilitate comparisons with population viability analyses published in the draft recovery plan (USFWS 2001). We present data as means (±1 SD). See Mullin (2006) for details on survival analysis and estimates of population growth.

Results and Discussion

Population Estimates. The population of breeding Snowy Plovers in Recovery Unit 2 was down dramatically from prior years (Fig. 2, Table 1). Observers detected 30 adult plovers during regular monitoring of breeding sites; two additional adult plovers (one male and one female) occurred as non-breeders until late June. Observers detected no breeding plovers in Mendocino or Del Norte counties. Observers tallied 26 breeding adults (14 males, 11 females, and one bird of unknown sex) during the window survey (20-26 May 2007). This estimate was down markedly from 2006 (45) and 2005 (41). In Humboldt County, the window survey tallied 23 of 31 adults identified through season-long monitoring efforts. The percentage of breeders detected during the window survey (74%) was slightly lower than the 79% (45/57) detection rate from 2006, but higher than in previous years (range: 54-72%). Window surveys probably did not detect all breeding individuals because: 1) observers occasionally failed to detect some resident breeders during the single visit to each site, which is the protocol for the window survey; and 2) the window survey occurs during a brief interval midway through the breeding season; hence, it fails to account for individuals that either breed early and depart to breed elsewhere (e.g., Oregon) or that arrive from elsewhere to breed late in the season.

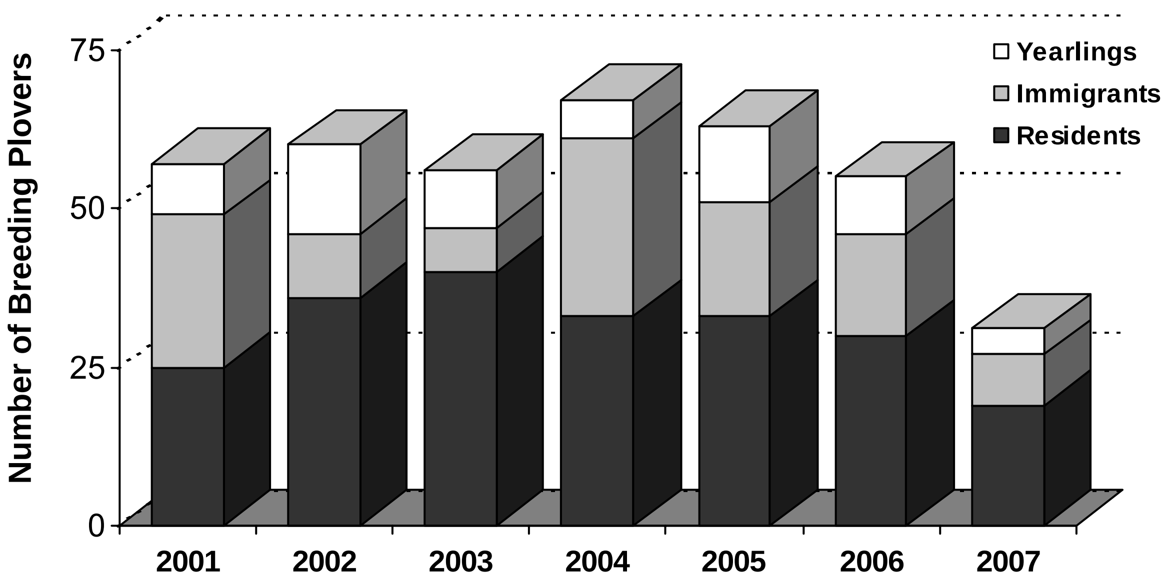

Fig. 2. Annual variation in number of breeding Snowy Plovers in Humboldt County, CA based on intensive monitoring of color-marked individuals. Yearlings are birds first marked as chicks in 2006, which returned to breed in Humboldt County; immigrants are unmarked breeding adults, assuming we captured all marked birds the previous year, and birds with color bands and known origins outside the study area; and residents are those individuals that nested in a previous year that returned to breed in 2007.

In 2000, prior to intensive monitoring, we began capturing plovers with the goal of marking all individuals in RU2 by the end of each breeding season. Table 1 shows annual variation in the composition of the breeding population over the past seven years, broken down into a) marked yearlings recruited from the local population, b) site-faithful adults marked in RU2 in a previous year, c) marked immigrants from elsewhere along the Pacific coast, and d) unmarked birds, which are presumed to be immigrants from outside RU2. Over the past six years

(2002-07; when we were confident that we had marked virtually all breeding plovers in the previous year), population size tended to increase with the percentage of immigrants in the population. The importance of immigrants to the RU2 breeding population was further supported by survival analyses (see below).

Table 1. Annual variation in the composition of the Snowy Plover population breeding in Recovery Unit 2. The 2007 total does not include two non-breeding adults, one male and one female.

	Males				Females				
Year	Returning (marked) Adults	Returning (marked) Yearlings	Immigrants Banded Elsewhere	Unbanded Immigrants	Returning (marked) Adults	Returning (marked) Yearlings	Immigrants Banded Elsewhere	Unbanded Immigrants	Total
2007	10	2	2	2	8	2	2	2	30
2006	16	6	4	3	13	4	4	7	57
2005	16	8	2	5	17	4	4	7	63
2004	17	5	4	11	16	4	6	11	74
2003	23	4	0	1	18	5	1	5	57
2002	17	8	0	5	19	6	1	4	60
2001	14	6	0	8	11	2	1	15	57
	16.1+3.9	5.6+2.1	1.7+1.8	5.0+3.5	14.7+3.8	3.9+1.5	2.7+2.0	7.3+4.4	

Philopatry and Site Fidelity. In 2007, 12 males and 10 females returned to RU2, either as yearlings or older birds (Tables 1 and 2). We confirmed that most (91%) of these plovers bred locally. We recorded two site-faithful adults (one male and one female) as a non-breeder, present for most of the breeding season. With the addition of a seventh year of data, the overall return rate of chicks to the population remained slightly male-biased. In total, 11% of females and 16% of males marked as chicks were philopatric (i.e., returned to breed in RU2). Comparable numbers of adult males (34%) and females (36%) returned to breed in RU2 (Table 2). For both sexes, these estimates are appreciably lower that the average (for the previous six years) return rates of 53+10% and 63+11% for females and males, respectively. Over seven years, the number of plovers breeding on gravel bars of the Eel River has decreased whereas the number breeding on beaches has increased.

Table 2. Annual variation in philopatry and site fidelity of Snowy Plovers in Recovery Unit 2.

		Females		Males	
	Year	Number Banded	Percentage Returned (n)	Number Banded	Percentage Returned (n)
Philopatry[a]	2007	28	7 (2)	28	7 (2)
	2006	35.5	11 (4)	35.5	17 (6)
	2005	38	11 (4)	38	16 (6)
	2004	30.5	13 (4)	30.5	20 (6)
	2003	34.5	14 (5)	34.5	12 (4)
	2002	46.5	13 (6)	46.5	17 (8)
	2001	29	7 (2)	29	24 (7)
	Total	242	11 (27)	242	16 (39)
Adult Site Fidelity[b]	2007	25	36 (9)	29	34 (10)
	2006	31	42 (13)	32	50 (16)
	2005	35	40 (14)	33	52 (17)
	2004	28	54 (15)	27	63 (17)
	2003	29	59 (17)	30	73 (22)
	2002	29	62 (18)	28	61 (17)
	2001	18	61 (11)	18	78 (14)

[a] Return of a locally banded chick to breed in Recovery Unit 2; assumes an equal sex ratio at hatch.
[b] Return of a breeding adult (with a known nest) to nest the next year. Individuals may be represented in multiple years; includes philopatric yearlings.

Patch Occupancy. Since 2001, plovers have bred at 18 different locations (see Fig. 1 for locations) in Humboldt County; in 2007, plovers bred at only five of these sites. Over the past seven years, plover occupancy (proportion of seven years in which at least one pair of plovers nested at a site) and abundance (average number of breeding plovers at a site) have varied greatly among sites (Fig. 3). Two locations, Clam

Beach and Worswick gravel bar, have had breeding plovers in each of the past seven years; these two sites also averaged the highest plover abundance in beach and river habitats, respectively. Average per capita reproductive success (number of fledged young per male) is consistently low at Clam Beach, and appreciably higher at the Worswick gravel bar. The various breeding sites differ greatly in indices of human activity and corvid abundance (Fig. 3). Clam Beach has consistently higher human use compared to most other beaches. Plovers breeding on gravel bars experience much lower levels of human activity. Indices of corvid activity also vary among sites. Gravel bars have higher corvid abundance than most beaches, the exception being Clam Beach and Mad River Beach.

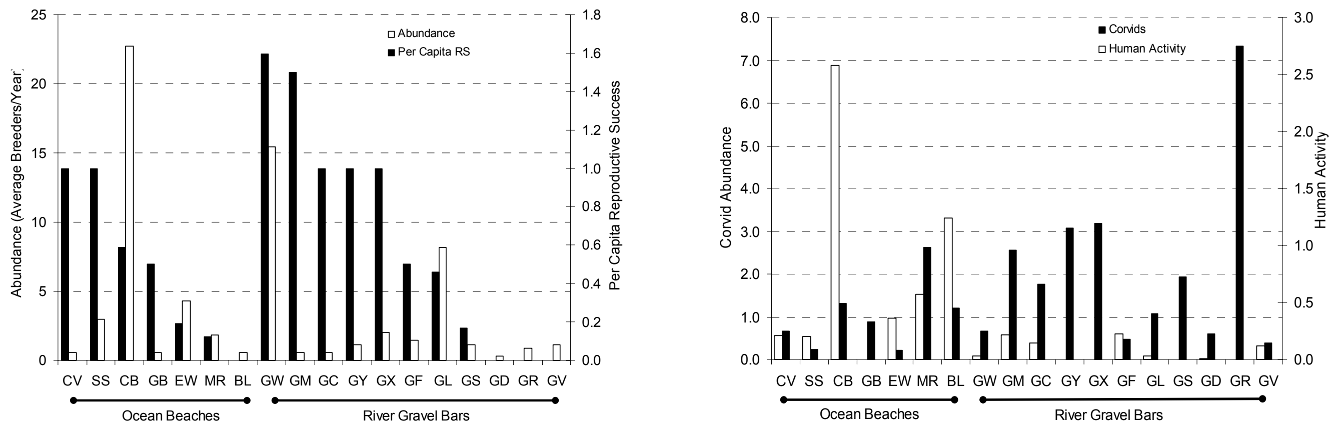

Fig. 3. Variation in abundance and per capita reproductive success of Snowy Plovers breeding at 7 beach and 11 gravel bar locations in Humboldt County, CA over 2001-07 (left); variation in corvid abundance and human activity at these same locations (right). Abundance is the average annual number of breeding adults. Per capita reproductive success is the average annual number of chicks fledged per male. Corvid abundance and human activity was based on 500 m point counts conducted from 2004-07.

Nest-site Selection. We analyzed the openness of habitat around 71 nests initiated over two years (35 in 2005 and 36 in 2006) at LRSB/Clam Beach to examine whether plovers selected nest sites that were in more open habitats than what was randomly available. This question has relevance to the size of restoration areas. We used a 2005 aerial image of the study site, and plotted nests based on GPS coordinates. We sampled openness (or percentage of area that was not vegetated by dense stands of *Ammophila*) by centering a circular plot with a radius of either 10, 25, 50 or 100 m on nests and random sites. Next, we used a point-intercept method to sample cover by overlaying a grid on the circular plot and counted the number of points intersecting an *Ammophila* patch to estimate percentage cover (or openness).

Plovers selected nest sites that were in more open, unvegetated habitats compared to random sites ($P<0.01$ at all spatial scales of analysis) (Fig. 4). The differences between nests and random sites were strongest at the 10 m plot scale; differences decreased with increasing plot size. Eight female plovers left their nests upon the approach of a human at distances averaging 80$\pm$30 m, and returned to incubate after 237$\pm$178 seconds.

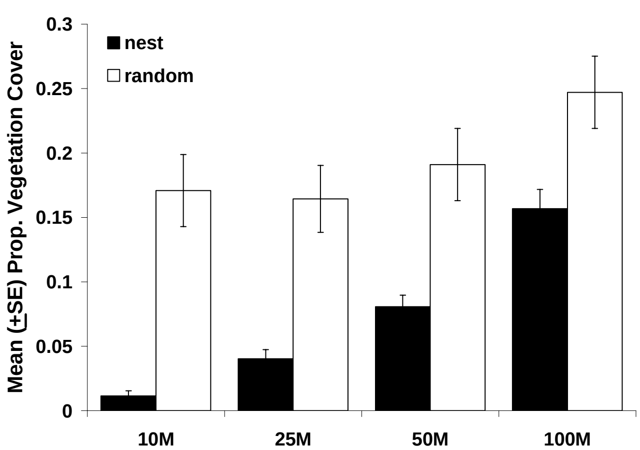

Fig. 4. Average ($\pm$SE) vegetative cover of *Ammophila* at Snowy Plover nests (■) and random sites (□) on LRSB/Clam Beach in 2005 and 2006. Plovers selected nest sites in significantly more open, unvegetated habitat than random locations, although the difference between nests and random sites diminished with increasing plot size.

Reproductive Success. In 2007, plover productivity was the lowest recorded in seven years in Recovery Unit 2 (Tables 3 and 4). Overall, plovers initiated 41 nests, from which hatched 22 chicks; a total of 11 juveniles fledged in the study area. The comparatively low productivity of the local population has resulted from a disproportionate number of breeding plovers established at Clam Beach/Little River State Beach, where reproductive success was poor. In total, 76% (31/41) of nests occurred at this site; only two nests hatched and two chicks fledged from Clam Beach/Little River State Beach in 2007. Conversely, there has been a steady reduction in number of plovers breeding in gravel bar habitats of the Eel River, where per capita reproductive success (fledglings per male) is consistently higher than on ocean beaches (Colwell 2005).

Table 3. Summary of Snowy Plover breeding in Recovery Unit 2 in 2007 with comparison to 2000-06.

Location		Females[a]	Males[a]	Number of Nests	Number Exclosed	% Nests Hatched[b]	# Chicks Hatched	# Chicks Fledged[c]
Del Norte County		0	0	0	-	-	-	-
Humboldt County		14	16	41	0	22	21	11
	Gold Bluffs Beach	0	0	0	-	-	-	-
	Big Lagoon	0	0	0	-	-	-	-
	North Clam Beach and LRSB	8	8	20	0	5	1	1
	South Clam Beach	4	4	11	0	10	1	1
	Mad River Beach	2	3	3	0	33	3	1
	South Spit Beach	1	1	1	0	100	3	3
	ERWA	2	2	2	0	100	5	0
	Centerville Beach	0	0	0	-	-	-	-
Eel River Gravel Bars (total)								
	Cock Robin Island	0	0	0	-	-	-	-
	Fulmor	0	0	0	-	-	-	-
	Roper's	0	0	0	-	-	-	-
	Singley	0	0	0	-	-	-	-
	Loleta	0	0	0	-	-	-	-
	Fernbridge	0	0	0	-	-	-	-
	Worswick	3	3	4	0	75	8	5
	Drake	0	0	0	-	-	-	-
	Canaveri Island	0	0	0	-	-	-	-
	Mercer-Fraser	0	0	0	-	-	-	-
	Sandy Prairie	0	0	0	-	-	-	-
	Hauk-Hansen[d]	-	-	-	-	-	-	-
	Leland	0	0	0	-	-	-	-
Mendocino County		0	0	0	-	-	-	-
	Brush Creek	0	0	0	-	-	-	-
	Tenmile River	0	0	0	-	-	-	-
	Virgin Creek	0	0	0	-	-	-	-
Totals	2007	14	16	41	0	22	21	11
	2006	28	29	58	19	34	55	20
	2005	31	32	57	27	47	71	28
	2004	37	35	70	28	43	76	39
	2003	27	27	74	23	38	64	32
	2002	30	33	75	25	40	76	23
	2001	31	29	57	13	68	97	46
	2000	--	--	42	18	64	58	--

[a] Based on histories of marked birds with known nests. Birds are assigned to a site based on where they spent most time; some individuals bred at multiple sites.
[b] Apparent nest success = number of nests that hatched at least 1 chick / total nests.
[c] Data for broods monitored continuously; several chicks may have fledged but were not monitored closely.
[d] Not surveyed in 2006 or 2007.

Apparent nesting success of plovers in Recovery Unit 2 has varied substantially over the seven years of monitoring (Table 4). Overall, 44% of 391 nests hatched at least one chick, but success varied annually from 34-68%. These values are high compared to other ground-nesting species of shorebird, especially for those taxa breeding at mid-latitudes (Evans and Pienkowski 1984). High nesting success is attributable to natural crypsis offered by gravel bar habitats (Meyer 2005, Colwell et al. 2005), and the use of exclosures to protect beach nests. However, predation remained the leading cause of nest failure (17.5%). This estimate is probably conservative as some instances of nest failure categorized as "unknown" involved clutches that disappeared without any clear sign of predators (e.g., corvid tracks) at the nest. Natural disturbances in the form of tidal over-wash, drifting sand and river flooding caused 10% of nests to fail. Plovers abandoned 8% of nests; the cause of abandonment was often difficult to ascertain, but may include the presence of humans nearby, exclosures, or mate loss owing to predation. Lastly, 5% of nests failed owing directly to human activities, including vehicles running over two nests on the Fernbridge gravel bar.

Table 4. Annual variation in Snowy Plover nesting success[a] and causes of clutch failure in Recovery Unit 2.

	2001		2002		2003		2004		2005		2006		2007	
Clutch Fate	N	%	N	%	N	%	n	%	N	%	n	%	n	%
Hatched	39	68	29	39	28	38	30	43	27	47	20	34	9	22
Failed and cause														
Predation	4	7	12	16	17	23	18	26	7	12	11	19	11	27
Abandoned	2	4	4	5	5	7	9	13	4	7	8	14	1	2
Sand covered	1	2	7	9	6	8	4	6	4	7	0	0	2	5
Tidal overwash	0	0	2	3	4	5	1	1	2	4	0	0	0	0
Human	0	0	7	9	5	7	3	4	0	0	3	5	2	5
River flood	0	0	0	0	5	7	0	0	4	7	0	0	0	0
Unknown	11	19	14	19	4	5	5	7	9	16	16	28	16	39
Total Nests	57		75		74		70		57		58		41	

[a] Apparent nesting success = 100[number of nests hatching at least one chick / total number of nests].

Male plovers breeding on ocean beaches continued to exhibit low fledging success (0.46 ± 0.88 fledglings per male) compared to those breeding on gravel bars of the Eel River (1.67 ± 0.58). Higher reproductive success ($t=2.24$, $df=14$, $P=0.04$) of river- vs. beach-breeding males continues a pattern that is evident in each of the previous six years (Colwell et al. 2005a, Colwell et al. 2006). Overall, males in Recovery Unit 2 fledged 0.69 ± 0.95 chicks, which is the lowest productivity of plovers recorded over the past seven years (1.7, 0.8, 1.1, 1.2, 0.9, and 0.7 for 2001-06, respectively).

Survival Estimates. Apparent survival was slightly higher for adult males (0.64 ± 0.07) than females (0.57 ± 0.07). Juvenile survival (from fledging to one year of age) was 0.31 ± 0.04. Adult survival estimates are comparable to those reported for the species in the literature (USFWS 2001, Sandercock et al. 2005, Stenzel et al. 2007). Juvenile survival estimates, however, were appreciably lower than other studies. Using Pradel models based on these survival estimates, we determined that the Humboldt County population was stable ($\lambda=1.01$). By contrast, algebraic calculation of population growth (based on the product of adult survival, juvenile survival and per capita fledging success) indicated that the population was declining ($\lambda=0.87$). Given the large influx of (marked and unmarked) immigrants each year, we conclude that the population in coastal northern California is maintained by immigration from productive populations elsewhere along the Pacific coast. Moreover, this finding has implications for the recently proposed 4(d) rule (USFWS 2006). Specifically, the proposed rule would relax management actions in those counties where the population of breeding plovers surpassed the breeding population goals for two of five years. Most of the known immigrants to RU2 originate from Monterey and Oregon, where active predator management has increased populations above recovery objectives (Neuman et al. 2004). The 4(d) rule would relax restrictive management activities in those counties that are source habitats for other groups of plovers breeding elsewhere along the coast. While the proposed 4(d) rule may be a valuable incentive to local governments to achieve recovery objectives, it makes little biological sense. Consequently, we oppose the 4(d) rule.

Nesting Success. Plovers initiated 432 nests in RU2 from 2001-2007. We estimated nesting success across the laying and incubation period (31 days) using the method described by Mayfield (1975) and Johnson (1979). We determined that plovers had abandoned one nest when we found it, and we located 11 additional broods near the time they hatched. Since we could not determine the exposure period for these nests, we excluded them from analysis; consequently, our sample size was 420 nests. Here, we distinguish between Mayfield estimates of nesting success and daily survival rates (DSR) of nests, and we compare DSR among years and between habitats using program CONTRAST (Sauer and Hines 1989).

Nesting success on gravel bars of the Eel River declined over the first six years of study, from 48% in 2001 to 15% in 2006, but DSR was similar among years ($P=0.22$). In 2007, however, nesting success for the few (3 males and 3 females) river-breeding plovers (71%) was the highest recorded over seven years, and DSR was significantly higher ($P=0.02$) than the average of the preceding six years.

Nesting success differed between beach and river habitats from 2001-2006, but in no consistent pattern. River nests were more successful than beach nests in some years (2002, 2003); beach nests were more successful in other years (2001, 2005, 2006); and in one year (2004) nests experienced similar success in the two habitats. Daily survival rates, however, did not differ between habitats in any year (all P>0.07). These comparisons are confounded by the use of exclosures to protect many beach nests from 2001-2006. In 2007, when we did not use exclosures, DSR of river nests was significantly higher (P<0.0001) than beach nests.

Use of Exclosures. This was the first year since intensive monitoring began in 2001 that we did not use exclosures to protect plover nests on beaches. We analyzed the effectiveness of exclosures in boosting nesting success by comparing hatching success and DSR between exclosed and unexclosed nests each year, and by comparing unexclosed beach nests in 2007 with data from the previous six years. Overall (exclosed and unexclosed nests combined), nesting success on beaches varied greatly among years, ranging between 71% (2001) and 18% (2002); DSR varied significantly among years (P<0.0001). Exclosed nests experienced higher success than both unexclosed beach nests and river nests in each year we used exclosures. Similarly, DSR for exclosed nests was higher in each year (all P<0.04). There was, however, significant annual variation in DSR for unexclosed beach nests (P=0.0001). Finally, DSR of exclosed nests was higher (2001: P=0.002; 2005: P=0.04), marginally higher (2003: P=0.06; 2004: P=0.07; 2006: P=0.05), or similar (2002: P=0.56) to river nests. In 2007, when we did not use exclosures, DSR of beach nests was significantly higher than the average for all beach nests (P=0.0007) and unexclosed nests (P=0.0001) in the previous six years. In 2007, most (67%; 4/6) nests at beach sites other than Clam Beach were successful, whereas most (94%; 29/31) Clam Beach nests failed.

Several points regarding this analysis should be noted. First, we erected exclosures around the majority of beach nests from 2001-2006, thus artificially increasing nesting success in beach habitats. Furthermore, exclosures were used as a management tool in RU2, rather than as part of a formal experiment. Consequently, the random assignment of exclosures to nests that would be present in an ideal experimental design is lacking. Additionally, many unexclosed nests failed early, before we could exclose them. As a result, estimates for unexclosed nests are likely to be biased low. Finally, while it is clear that predator exclosures can enhance nesting success, they do not protect plover chicks after they leave the exclosure. Moreover, use of exclosures may increase adult mortality (Isaksson et al. 2007). This last point is of particular concern when dealing with threatened species or populations (e.g., plovers in RU2), and this “trade-off” must be considered carefully.

Human Disturbance. The USFWS identified human activity and disturbance to breeding plovers as one of three factors limiting the population via low productivity (USFWS 2007). After seven years of monitoring Clam Beach, we have sufficient data to evaluate the effectiveness of a symbolic fence in managing humans in an area (between the two parking areas accessing county-managed beach) where plovers have consistently nested and reared young. In the three years (2001-03) when no fence existed in this area, 15% of chicks (n = 33) and 31% of broods (n=13) survived to 28 days (estimated day of fledging; Page et al. 1995). In the four subsequent years (2004-07) when the fence was in place, these numbers doubled, with 37% of chicks (n=41) and 60% of broods (n=15) surviving. This increase in success associated with the placement of the fence was significant for chicks (χ^2=4.26, df=2, P=0.04) and marginally so for broods (χ^2=2.39, df=2, P=0.13).

Seven-Year Synopsis

To guide management of the Snowy Plover in Recovery Unit 2 we draw on the following results accumulated over the past seven years. First, the breeding population of 30 adults represents *ca.* 50% decline compared to the 57-74 adults observed in the previous six years. The disappearance of eight incubating adults during 2006 and a sharp reduction in numbers of wintering adults coincident with a January 2007 cold snap are the likely cause of the decline in the local breeding population. The weather-related mortality emphasizes the continued need for active management to bolster the population via increased productivity. If density independent mortality (i.e. associated with cold weather) acts to reduce the population by 50% once every ten years on average, it will require substantial efforts to mitigate for the effects of limiting factors (i.e. invasive species, predation, and human disturbance) such that the population will be large enough to withstand such weather-related events.

Each year, immigrants comprise a significant portion of the breeding population, and their presence maintains the local population in most years. In other words, reproduction is well below the level necessary to sustain the population in RU2. Hatching success of river nests is always higher than unexclosed beach nests, but exclosures clearly increased hatching success on beaches to levels greater than river nests. Chick survival is consistently higher along the Eel River than on beaches; in both habitats, however, young are particularly vulnerable early in life and especially early in the breeding season (Colwell et al. 2007). Estimates of juvenile (0.31) and adult (0.65) survival are lower than those reported from Monterey Bay (Stenzel et al. 2007). In the past few years, the RU2 population has shifted away from high quality habitats of the Eel River gravel bars to beaches, where poor productivity is insufficient to maintain the population.

It is difficult to ascertain the relative impacts of various factors limiting productivity of plovers in RU2, but it is clear that treatment of this issue should be divided into factors limiting nesting and fledging success separately. In order of importance, predation, natural disturbance, and humans compromise nesting success (Table 4). We were effective at increasing nesting success using exclosures, but we recognize that this is a short-term management practice. We cannot manage natural disturbance of nests. Humans directly and indirectly compromise plover nesting success. For example, in 2004 humans removed eggs from two nests protected by exclosures; in 2003, humans vandalized an exclosure, which lead to clutch loss. On the gravel bars, vehicles caused multiple nest failures in some years. Humans also indirectly compromised plover breeding behavior, which may lead to nest abandonment. In a detailed study of incubation behavior, Hoffmann (2005) showed that incubating plovers on the north end of Clam Beach experienced seven times the human disturbance compared with plovers incubating on the south end of Clam Beach. Increasing productivity by managing fledging success is more difficult. Once nidifugous chicks hatch and leave exclosures they become vulnerable to predators and humans. Most chicks that die succumb in the first three days of life, and young plovers often disappeared together (Hurley 2005, Colwell et al. 2007). At all ages, chick survival is significantly higher in river habitats compared to beaches (Colwell et al. 2007). In both habitats, we have occasionally observed predation by corvids and a gull (*Larus delawarensis*). However, many chicks simply vanish with no known cause of mortality. Coincidental evidence suggests that fledging success is negatively affected by human activities on beaches. Chicks occasionally disappeared during periods of high human recreational activity associated with weekends or holidays (e.g., July 4th 2001), similar to reports elsewhere (Ruhlen et al. 2003). Using symbolic fencing over the past four years, we may have been successful in increasing fledging success on Clam Beach by establishing a refuge for adults tending young. Since 2001, reproductive success of plovers breeding in the study area has ranged from 0.7-1.7 fledglings per male. A population viability analysis (USFWS 2007) showed that 1.0 fledglings per male was needed to recover the population, assuming adult survival of approximately 75%.

Management Recommendations

The following recommendations are put forward as a result of our seven years of collaborative efforts in plover management on the north coast and in light of the recent release of the Snowy Plover Recovery Plan. Recovery goals for RU2 are 150 adult plovers. With our current population at about 30 adults and the population over the seven years less than 50 breeding adults, we are a long ways from reaching the recovery goal.

The USFWS (1993, 2007) identified predation, human disturbance, and habitat loss or degradation as the three factors that compromise reproductive success and, hence, limit local populations of the Snowy Plover along the Pacific coast. The 2007 breeding season marked a year of transition in management of breeding Snowy Plovers in RU2. Prior to this year, we used non-lethal methods of control (exclosures) to manage predation as one of three limiting factors affecting productivity of the local population. In 2007, we did not actively manage predation. Management of human disturbance continued with the use of symbolic fencing and education signage in some breeding areas, especially on Clam Beach, South Spit and the Eel River Wildlife Area. Docents working with the Snowy Plover Outreach Group of RU2 worked at Clam Beach in 2007 to increase the frequency of educational walks (twice monthly). We continue to monitor the use of restored habitats by breeding plovers. Below, we summarize results relevant to these three limiting factors in RU2 and address the effectiveness and utility of various management activities. We acknowledge differences may exist among recovery units in the relative strength of these limiting factors and effectiveness of management activities.

Predation. Productivity (per capita fledging success) of plovers is below that necessary to maintain the population; immigration of plovers from elsewhere appears to be sustaining the RU2 population (Mullin et al. in review). Low productivity stems from poor hatching success, which is mostly attributable to high clutch loss to predators. On beaches, predator exclosures have been used to increase hatching success to levels comparable to the high quality habitat of gravel bars. However, once eggs hatch on beaches chicks suffer high mortality, especially during the first three days after they hatch (Colwell et al. 2007). Consequently, while predator exclosures have increased nesting success, fledging success is low. Several unintended consequences of predator exclosures exist. First, incubating adults may be more susceptible to predation. Second, if individual decisions to disperse (or remain at a site) are based on success of hatching chicks but fledging success is low, then individuals may be opting to continue to nest in low quality breeding habitat. Both of these circumstances appear to apply to Clam Beach. Since non-lethal methods of predator management have not been successful at improving productivity and have compromised adult survival, and given the success of lethal control methods and increased plover productivity elsewhere in the species' range, we recommend:

1. Consideration of alternative methods of predator control, including lethal methods, at sites where the productivity of plovers is low and attributable to nest and brood failure by predators;

2. Monitor intensively the response of known predators of plover eggs and chicks, and adults to habitat restoration efforts.

Human Disturbance. The presence of humans in close proximity to breeding plovers has the potential to negatively influence productivity, either directly via nest failure or chick mortality, or indirectly, through subtle changes in the incubation and brooding behavior of adults. In each of the years we have monitored the population, productivity of plovers has been compromised by human activity. On beaches, humans have vandalized exclosures and destroyed nests, stepped on eggs or run over them with vehicles, disturbed incubating adults causing nest abandonment, and caused the death of newly hatched chicks owing to hypothermia during cool spring weather. On gravel bars of the Eel River, vehicles rank second to predation as a cause of nest failure. These observations indicate the need for increased education of visitors to plover habitats, and enhanced enforcement capabilities. Specifically, we recommend:

1. Enhanced efforts to educate the public about plovers, and the effects of humans on the assemblage of predators that impact plovers at breeding sites;
2. Increased public involvement through the use of docent and outreach programs (e.g., the Save our Shorebirds Program in Mendocino County, and efforts in Coal Oil Point in Santa Barbara County);
3. Restricted human access to breeding areas through the use of symbolic fences where high human activity coincides with breeding plovers;
4. Limited vehicle access to habitats where plovers breed from 1 March and 30 September;
5. Use of fenced corridors and signage to direct vehicles from beach access points to the waveslope;
6. Increased enforcement of illegal vehicle use at all beaches;
7. Increased measures to limit access and enforce regulations at the county-owned (Worswick) gravel bar where most river-breeding plovers nest.

Habitat Loss or Degradation due to Invasive Species. Plovers are social. They form post-breeding flocks at predictable beach locations. During the breeding season newly recruited plovers tend to settle at locations occupied by other plovers (Nelson 2007). Throughout RU2, seemingly suitable breeding habitat remains unoccupied in most years, both on gravel bars of the Eel River (e.g., Fulmor, Cock Robin Island) and along ocean-fronting beaches (e.g., Big Lagoon, Centerville). These observations suggest that the amount of habitat is not presently limiting the population. Rather, unoccupied sites may be a consequence of low population size. For example, the low number (five) of breeding sites occupied by plovers in 2007 may stem from the 50% reduction (30 breeding adults). Additionally, plovers tend to move widely in search of breeding opportunities amidst their dynamic breeding habitats (Stenzel et al. 1994). However, plovers have nested and reared chicks in recently-restored dune habitats (e.g., LRSB, South Spit). In most cases, plovers that used restored habitat did not have prior breeding experience in these areas, which suggests that they responded to changes in vegetation and landscape created by *Ammophila* removal, rather than simply returning to breed in an area where they have bred in a previous year. These observations suggest that it is unlikely that small-scale restoration projects alone will be effective in recovering the population when predation compromises plover productivity. While we support broader goals of restoring dune ecosystems, restoration efforts intended to improve productivity and recover the population of the Snowy Plover are likely to be most successful when implemented with predator management and public education. Consequently, we recommend:

1. Careful consideration of the role that habitat restoration plays in plover recovery;
2. The planning and implementation of large scale restoration efforts at suitable sites;
3. Projects that incorporate plover conservation within a broader context of native dune ecosystem restoration;
4. Consultation among personnel from county, state and federal agencies guiding restoration (for the purposes of plover recovery);
5. Intensively monitoring and testing the impact of restoration activities on both plovers and predators;
6. Investigating the relationship between habitat quality and breeding success to elucidate habitat features that can be manipulated to increase plover productivity.

Summary. To reach the recovery goal of 150 breeding adults in RU2, some major changes in management will be necessary. Clearly, many sites (e.g., Lanphere Dunes, Humboldt Bay North Spit, Stone Lagoon) historically occupied by plovers are currently unoccupied (LeValley, unpubl. data), and plovers bred at only five of 18 Humboldt County locations in 2007. It is difficult to determine whether this distributional pattern stems from a lack of suitable habitat or merely results from low population size and the tendency for plovers to breed at sites occupied by other plovers. Nevertheless, breeding habitat at some locations has been degraded by *Ammophila*, such that restoration could improve the quality of nesting and brood-rearing areas by creating more open habitats. At most breeding locations, however, productivity is compromised by predation of eggs and chicks, and to a lesser extent by human activity. Consequently, we advocate for increased habitat restoration coupled with lethal predator management, strengthened enforcement of county ordinances governing vehicle and pets in plover habitats, and continued public education about the conservation status of plovers in RU2.

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Appendix A. List of scientific papers, presentations of oral papers or posters at professional meetings, graduate theses, interpretive presentations and videos, reviews of public documents, and opinion pieces authored or in progress during 2006/2007 by authors of this report. Annual reports and publications of this project can be found at: http://madriverbio.com/wildlife/snowyploverproject/.

Scientific Papers

Colwell, M.A., S.E. McAllister, C.B. Millett, A.N. Transou, S. Mullin, & R.R. LeValley. 2007. Natal philopatry and dispersal of the Western Snowy Plover. Wilson Journal of Ornithology 119:378-385.

Colwell, M.A., S.J. Hurley, J.N. Hall, & S.J. Dinsmore. 2007. Age-related survival and behavior of Snowy Plovers chicks. Condor 109:638-647.

Hoffmann, A. & M.A. Colwell. Incubation behavior of female Snowy Plovers. Waterbirds (to be submitted Fall 2007).

Meyer, J.M., M.A. Colwell, S.E. McAllister, A.N. Transou, & R.R. LeValley. Egg crypsis and nest survival of Snowy Plovers breeding along the Eel River, CA. In revision.

Mullin, S., M.A. Colwell, & S.E. McAllister. Apparent survival of adult and juvenile Snowy Plovers in coastal northern California. In revision.

Presentations at Professional Meetings

Colwell, M.A. Patchy plover distributions. Oral paper at the annual meeting of the Western Section of The Wildlife Society, February 2007, Monterey, CA.

LeValley, R.R. Historical perspective on Snowy Plover distribution and abundance in coastal northern California (Recovery Unit 2). Oral paper at Western Snowy Plover recovery meeting, U. Oregon Marine Lab, Charleston, OR. January 2006.

Wilson, C.A. Overview of Snowy Plover research in coastal northern California. Oral presentation to Marin Rod and Gun Club, San Rafael, CA. September 2006.

Graduate Theses

Mullin, S.M. 2006. Apparent survival and population growth of Western Snowy Plovers (*Charadrius alexandrinus nivosus*) in Humboldt County, CA. M.Sc. thesis, Humboldt State University, Arcata, CA. May 2006.

Nelson, Z.J. Social attraction in breeding Western Snowy Plovers (*Charadrius alexandrinus nivosus*). M.Sc. thesis, Humboldt State University, Arcata, CA. May 2007.

Wilson, C. A. Space use and movements of male Snowy Plovers (*Charadrius alexandrinus nivosus*) tending chicks. M.Sc. thesis, Humboldt State University, Arcata, CA December 2007.

Honors Theses

Hardy, Michael. Evaluation of use of exclosures to increase nesting success of Snowy Plovers, a 7-year study.

Muir, Jordan. Habitat characteristics of Snowy Plover nests on Clam Beach, Humboldt County, CA.

Western Snowy Plover Training Sessions

LeValley, R. Snowy Plover Biology and Management Considerations for Beach Fisherman. 23 March 2007.

LeValley, R. Snowy Plover Biology and Management Training for Plover Surveyors and Managers. 16 May 2007.

LeValley, R. Snowy Plover Biology and Management Training for Plover Surveyors and Managers. 10 July 2007.

LeValley, R. Snowy Plover Biology and Management Considerations for Save Our Shorebirds Program, Mendocino County. 11 August 2007.

Other Presentations and Projects

Colwell, M.A. Wintering sandpipers and breeding plovers: Conservation implications based on monitoring individuals. Scholar of the Year presentation, Humboldt State University, 12 Sep 2007.

McAllister, S.E. Snowy Plover biology, management and conservation. Friends of the Dunes interpretive session. Moonstone Beach House, Mar 2006.

Colwell, M.A. Snowy Plover biology, management and conservation. Friends of the Dunes interpretive session. Moonstone Beach House, Apr 2006.

Goldenberg, W.P. Snowy Plover biology and conservation in coastal northern California. Western Section of The Wildlife Society annual meeing, Monterey, CA. Jan 2007.

LeValley, R. Shorebird Writings of William Leon Dawson featuring the Snowy Plover. Oregon Coast Shorebird Festival, Charleston OR, 2 September 2007.

LeValley, R. Shorebird Writings of William Leon Dawson featuring the Snowy Plover. Monterey Bay Birding Festival, Watsonville CA, 22 September 2007.

Reviews of Documents

Colwell, M.A. Draft economic analysis of critical habitat designation for Pacific Coast Population of Western Snowy Plover. Industrial Economics, Incorporated. Cambridge, MA.

Colwell, M.A. Comments on proposed 4(d) rule issued by United States Fish and Wildlife Service/Dept. of the Interior. Spring 2006.

LeValley, R. Peer Review, Proposed 4(d) rule for the United States Fish and Wildlife Service/Dept. of the Interior. February 2007.

Video

Goldenberg, Will. Ploverized. A 20-min video highlighting the conservation efforts directed at the Western Snowy Plover in Humboldt County.