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Impact Assessment of Oil Spilled from the New Carissa On the Western Snowy Plover along the Oregon Coast

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Abstract: On 4 February 1999 the 36,571 ton freighter New Carissa ran aground on the Oregon Coast approximately four km north of the Coos River, and beginning on 7 February and thereafter spilled an estimated 20,000-140,000 gallons of fuel oil into the ocean. Between 10 February and 16 April 1999, 62% (n=73) of the individually marked Western Snowy Plovers (*Charadrius alexandrinus nivosus*) observed along the Oregon coast between Cape Blanco and Heceta Head were sighted with some oiling. A majority of the oiling occurred within the first three weeks of the spill, and nearly all of the plovers that incurred more severe oiling did so in that same period. At the population level, both the abundance and productivity of breeding plovers breeding along the Oregon coast was not overtly affected by this incident. Population size in 1999 was essentially the same as 1998, while productivity as measured by the number of young fledged was higher than the past three years, and comparable to peak years of 1994 and 1995.

There may, however, have been impacts to specific sites and specific individuals. For example, there was no nesting and only a few instances of brood activity on the Coos Bay North Spit South Beach site for the first year since 1990, the area most directly affected by the incident. There were also several instances when marked plovers and at least one severely oiled unbanded plover disappeared unexpectedly under circumstances that may be associated with the incident. There may also have been sublethal impacts that impacted long-term fitness of individual plovers, but it is not possible to assess or quantify those potential impacts.

Seventeen plovers were oiled to such an extent that they were trapped, cleaned and rehabilitated at a mobile emergency care facility set up by the International Bird Recovery and Rescue Center. All 17 were released. Seven remained at sites on the Oregon coast to breed; five were observed after release, and then apparently dispersed to other breeding areas and then returned to the Oregon coast in late summer and early fall. Of the remaining five, the fate of four is unknown and suspect, including two which have not been observed since their release, and two others which have not been observed since 21 and 25 March 1999, respectively. The fifth plover was found dead on 21 April 1999. This fifth plover was necropsied by the U.S. Fish and Wildlife Service, but the results have not been released. Of the seven that bred on the Oregon coast, one was predated during the incubation period, and a second disappeared during incubation and presumed predated.

Nest success and fledging success was comparable among groups of non-oiled, slightly oiled and more moderately oiled plovers

INTRODUCTION

On February 4, 1999 the 36,571-ton freighter New Carissa ran aground on the Oregon Coast approximately 4 km north of the Coos River, and beginning on February 7 subsequently spilled an estimated 20,000-140,000 gallons of fuel oil into the ocean. Ocean currents and prevailing winds washed oil onto beaches on the adjacent Coos Bay North Spit, and as far north as Sutton Beach, near Florence. This spill area coincided with wintering and breeding sites for the Western Snowy Plover (*Charadrius alexandrinus nivosus*) on the Oregon coast. Snowy Plovers found here and along the Washington and California coast are part of the Pacific Coast Population of the Western Snowy Plover which is listed as threatened under the Endangered Species Act (Federal Register 1993). As part of an emergency response and natural resource damage assessment process orchestrated by State, Federal and Private entities we were contracted to investigate the effects of the oil spill on Snowy Plovers along the Oregon coast.

Our ability to assess impacts of this oil spill to Snowy Plovers breeding along the Oregon coast was facilitated by extensive baseline information generated from past research and monitoring of this population of Snowy Plovers at these same sites. Specifically, beginning in 1990, in cooperation with State and Federal agencies, we initiated what has become a long term monitoring program, tracking the distribution, abundance and productivity of this threatened species at sites on the Oregon coast during the breeding season. Results of this work has been summarized in annual reports (Stern et al. 1990, 1991, Craig et al. 1992, Casler et al. 1993, Hallett et al. 1994, 1995, Estelle et al. 1997, Castelein et al. 1997, 1998). As a part of previous field studies we trapped and placed various combinations of colored bands on 972 breeding adults and recently hatched chicks, and now have a marked population of Snowy Plovers where approximately 80-90% of the breeding population can be individually identified. These marked plovers allowed us to track and compare disappearance rates and productivity of individually oiled and non-oiled Snowy Plovers.

Our strategy for assessing potential impacts of the oil spill on Snowy Plovers was two-fold. First, we evaluated the abundance and productivity of this population of plovers along the Oregon coast for the 1999 breeding season within the context of comparable data sets from the past nine years as referenced above. Detailed information for the 1999 breeding season is provided in a companion report (Castelein et al. 2000), and forms the basis for this comparison. Second, we compared different metrics among groups of individually marked oiled and individually marked non-oiled plovers. Specifically, we determined (1) the number of plovers that were oiled, the degree of oiling each bird incurred, and the chronology of oiling following the incident; (2) the fate of the 17 plovers that were captured, cleaned, rehabilitated and subsequently released; (3) the disappearance rates of 33 marked adult birds, including 18 oiled and 15 non-oiled individuals, that were both present at the time of the incident and had nested in Oregon in

1998, and were thus expected to nest in Oregon again in 1999; and (4) we compared productivity of oiled and non-oiled plovers, and further assessed productivity associated with varying degrees of oiling. We also report on specific instances where individual plovers may have been affected by the incident.

METHODS

A description of the study area and a description of methods used to evaluate the 1999 breeding season for Snowy Plovers along the Oregon coast are provided in our companion report “Snowy Plover Nesting and Reproductive Success on the Oregon Coast – 1999 (Castelein et al. 2000). Sites surveyed for Snowy Plovers and the location of the New Carissa are illustrated in Fig. 1. Below we further describe key aspects of the methods used for the analysis describing potential impacts of the oil spill on Snowy Plovers.

We developed three methods to estimate population trend for the population of Snowy Plovers found breeding along the Oregon coast. One, each year the Oregon Department of Fish and Wildlife organizes a one to two day coast wide “window” survey of all coastal plover sites, typically conducted in May or early June. Two, by 1993 an estimated 70-90% of the adult Snowy Plovers present during the breeding season were individually marked. Accordingly, we developed an estimate of population size by determining the number of marked and unmarked plovers that were known to have nested during the year. For unbanded plovers, we divided the nesting season into ten day intervals, and determined the highest number of unbanded plovers associated with nests during any one ten-day interval. We subtracted from that number any adults that were subsequently associated with a nest and banded. Three, we developed a third estimate of population size by recording the total number of individually marked adult Snowy Plovers observed throughout each breeding season, and adding to that number an estimate of the number of unbanded Snowy Plovers observed throughout the breeding season. As described above, we estimated the number of unbanded plovers by reviewing survey data for all sites broken down into ten-day periods throughout the breeding season. We used the highest count of unbanded birds from all sites from a single 10 day period, and adjusted that number downward based on the number of adult plovers that were subsequently banded during that season. To further assess the reliability of these three indices of population, we used Pearson correlation coefficients to test for linear associations among the three methods of estimating the population size of Snowy Plovers on the Oregon coast for 1993-1999. Dunn-Sidak t-tests were used to maintain an alpha of 0.05 while simultaneously testing the significance of all three correlation coefficients. We further evaluated the 1999 survey data from two methods by developing a regression of total breeding season counts from the window survey for 1993-1998 and seeing whether the 1999 breeding season counts fell within the 95% confidence band for the regression.

We determined nest success using apparent nest success (number of successful nests divided by the total number of nests) and the Mayfield method of nest success (Mayfield

1961, Mayfield 1975, Johnson 1979). To compare differences in nest success associated with the use of predator exclosures, we determined the number of days under each treatment for each nest and summed these values for all nests for each year, and then using the Mayfield method, developed a daily survival rate that could be compared among exclosed and unexclosed nests (Johnson, pers. comm). For example, a nest found on day 10, exclosed on day 15, hatching on day 29 would have 5 days unexclosed, and 14 days exclosed, with no loss.

The following methods were more specific to the New Carissa incident. As a part of the emergency response and Natural Resource Damage Assessment, surveys for Snowy Plovers were conducted at all known areas of use beginning on 10 and 11 February 1999, approximately three to four days after the first indication that oil was being spilled from the New Carissa. During the ensuing 8 weeks, surveys were conducted daily, or as often as possible given various constraints, including weather, access to sites, availability of qualified surveyors, and a need to minimize disturbance to the plovers. For each survey, we recorded the number and sex of plovers observed, band combinations of individually marked birds, and the presence and extent of any oiling. We developed a scale for noting the degree of oiling on each plover, and thus categorized each plover accordingly. The scale is described here, from 0-IV with IV representing the maximum extent of oiling:

The Scale Classifying the Degree of Oiling of Snowy Plovers

Level 0 – no oil.

Level I – oiling on feet and/or legs; and/or trace amount of oil staining at base of legs on feathers; or any very light oil stain on any feathers less than or equal to the size of a penny (about 2cm diameter) or an equivalent linear stain; or oil flecks on plumage.

Level II – One or more patches of oil staining on feathers with a combined area of about 2cm (size of a penny) – 5cm (approx. diameter of two quarters) or a linear stain greater than 2cm; or a patch of oil on the feathers that is very dark and heavy.

Level III – One or more patches of oil staining on feathers with a combined total area covering more than 5cm but less than 50% of plumage; or a linear stain greater than 5cm.

Level IV – severe, heavy oiling on plumage, either as one large patch or in multiple patches covering greater than 50% of plumage.

For purposes of analysis, we divided our observations of oiled and non-oiled Snowy Plovers into two sub-groups; those observed from the time of the incident until 15 April, and those observed from 16 April through 30 September. This division, while somewhat arbitrary, coincides with a period when the plovers were, at least initially, exhibiting wintering behavior rather than breeding behavior, and during a time when a majority of the oil was spilled, and the surveys were conducted under the auspices of the Oregon Department of Fish and Wildlife. The second period occurred when the plovers were fully engaged in breeding behavior, and when comparatively little oil was released, and surveys were conducted by The Nature Conservancy's Oregon Natural Heritage Program. The rationale behind making such a distinction is that the group of wintering plovers include, at least in part, a different group of individual plovers compared to those plovers

that comprise the breeding population. Plovers wintering in Oregon tend to disperse in March; some remain at Oregon sites to breed and some migrate to Washington and California. Concurrently, other birds wintering in Washington and California return to breed in Oregon, some returning in April, others in May and June. Thus, the division in crude terms categorized birds into wintering birds and breeding birds.

RESULTS

Comparison of 1999 Breeding Season with Previous Years

Population Size: The three estimates of population size for Snowy Plovers during the 1999 breeding season on the Oregon coast, (a) the window survey, (b) the number of breeding Snowy Plovers and (c) the total number of Snowy Plovers recording during the breeding season were similar to those recorded in 1998 (Table 1). We used the Pearson linear correlation to assess the relationship between these three indices of abundance for the years 1993-1999. All three coefficient correlations are $> .90$, and all are highly significant according to the Dunn-Sidak t-tests ($n=7$ and $p<0.05$ for each comparison). The three methods provide independent estimates of population size, and continue to show the same population trends over the past six years.

As suggested from the correlation results, the regression of total breeding season counts on window counts for 1993-1998 was highly significant ($y=0.2693 + 1.6376X$, $r^2 = 0.96$, $p = 0.0007$). From the 1999 window count of 52 plovers, the regression predicts approximately 84 plovers would be observed during the breeding season. The actual number of breeding plovers recorded was slightly higher (95-96), but was within the 95% Confidence Intervals as predicted for this regression equation. This assessment supports the conclusion that the 1999 survey data and the methods used to develop the population estimates for 1999 follow the same patterns and relationships as has been observed for the previous six years.

Distribution: The distribution and relative abundance of Snowy Plovers at coastal sites in Oregon for 1999 was similar to what has been observed in past years, with a majority of the plovers occurring at sites within three stretches of beach (Table 2). The overall abundance, however, based on the window count was slightly lower in 1999 compared to 1998. However, as noted above, other estimates of population size indicate that the numbers for 1998 and 1999 were generally the same. Although the data for 1998 and 1999 for the Bandon-New River and New River-Floras Lake sites indicates a change in distribution, the difference is explained in that birds at the mouth of New River often use both sides, and in 1998 the birds, although nesting on south side of the river, were on the north of the river at the time of the count.

Nesting Activity: We characterized the seasonality of nesting activity each year by summing the number of active nests within each 10 day interval (Fig 2). Peak nest activity generally occurred from late May through early July. The timing and magnitude of nesting activity in 1999 was within the 95% confidence intervals of the previous six years, 1993-1998. The only noticeable difference was that the onset of nesting was

delayed by a couple weeks in 1999. Reasons for a slightly later onset of nesting in 1999 are unknown, but could be explained by any combination of reasons, including weather, inadequate food resources, disruption or impacts caused by the New Carissa incident and/or natural variability.

Nests: The total number of nests found in 1999 was identical to 1998; 78 nests in both years. Overall, the number of nests found from 1990-1999 parallels similar increases in population size, increasing steadily from 36 found in 1990 to a peak of 93 found in 1997. We caution, however that the number of nests found in any given year can be inflated by high rates of nest failure and repeated re-nesting attempts, and the number of nests alone is not a good measure of either abundance or productivity. The number of successful nests annually provides a better indication of productivity. Successful nests increased annually from 11 in 1990 to 51 in 1996, and then dropped slightly to 45 in 1997 and 1999, and 44 in 1998. The number of nests, successful nests and % apparent nest success for each site for 1990-1999 is provided in Table 3. Of note, no nests were found on the Coos Bay North Spit (CBNS) South Beach in 1999 for the first time since 1990. The South Beach nesting area was the closest to and most directly impacted by oil released from the New Carissa grounding as well as subsequent monitoring, cleanup and salvage activities.

Nest Success: Nest success for Snowy Plovers along the Oregon coast in 1999 was 56% based on apparent nest success (# nests found/# nests hatched = 44/78), and 61% using the Mayfield method (Johnson 1979). Overall nest success in 1999 was nearly identical to 1998; both 1998 and 1999 were higher than the 10 year mean but within the limits of one standard deviation ($44.9\% \pm 17.8\%$)(Table 3, Table 4). As in past years, nests exclosed from predators were more successful (61% vs. 40%) than unexclosed nests, however unexclosed nests had a comparatively high nest success compared to previous years. This occurred in part because we increased our effort and were able to exclose nests immediately upon locating the nest, or shortly thereafter, minimizing the exposure period of unexclosed nests to predation.

Apparent nest success in 1999 varied among sites (Table 3). For example, at the CBNS Habitat Restoration Area (HRA) and South Spoil, 13 of 14 nests hatched. In contrast, at South Siltcoos and New River Spit only 4/17 and 15/28 hatched, respectively. Nest success at New River Spit and South Siltcoos in 1999 was low compared to recent years, in part attributed to episodic predation events by corvids that claimed 11 nests. Nest success at other sites, however, generally follows patterns observed in previous years, especially when allowing for the smaller sample size of nests at a few of the sites.

Nest Failure: The primary cause of nest failure for 1999 was American Crows (*Corvus brachyrhynchos*), with 11 of 12 corvid predation incidents occurring at exclosed nests. This rate of corvid predation at exclosed nests is considerably higher than past years, but probably not related to impacts of the oil spill. Other causes of nest failure in 1999 include 7 nests which were abandoned, 5 covered by sand due to strong wind, 4 to unknown predators, 3 to unknown causes, 1 to predation of an adult, 1 had infertile eggs and 1 was overwashed by high tides. We specifically reviewed the rate of failure due to

abandonment and infertility because we felt these causes of failure might be affected by the oil spill. Infertile clutches were essentially a non-factor; we also reviewed the rate of infertile eggs within otherwise successful nests, but did not find any evidence that 1999 was different from other years. The rate of abandonment was also generally comparable to past years. Five of the seven instances of abandonment involved the laying of only a single egg, and no apparent effort to lay additional eggs or incubate. In 1998 there were also five instances of abandonment following the laying of only a single egg. The number of these abandoned one egg nests was slightly higher in 1998 and 1999 compared to past years; reasons for this are not apparent.

Fledging Success: Fledging success (# young fledged/eggs hatched) for the 1999 breeding season was 43%, and while slightly higher than the long term mean fledging success for 1991-1999 was within the 95% confidence interval (37.6 ± 7.8 , Table 5). The number of hatched eggs in 1999 was similar to past years. However, fledging success in 1999 was 12-15% higher than in the past three years, 1996-1998, approaching peak levels recorded in 1994 and 1995. Overall, the number of young fledged from known nests in 1999 was 51, slightly higher than the 95% Confidence Intervals associated with the annual mean from 1991-1999 (34.9 ± 13.2). Overall, the relatively high number of hatched eggs combined with a relatively high fledging success rate led to one of the more productive years for Snowy Plovers along the Oregon coast in 1999.

Fledging success, however, varied among sites in 1999 (Table 6). The Coos Bay North Spit HRA produced 20 young, and had a fledging rate of 69%. The CBNS South Spoil and South Tenmile contributed 5 and 7 young each, with 83% and 88% fledging success. In contrast, although 8 young fledged at the New River, fledging success was only 19%. Fledging success at the New River Spit continues to be suppressed compared to other sites. Reasons for low fledging success at New River Spit are unknown. Incidental observations of red fox (*Vulpes fulva*), however, have increased each year since 1995, and concurrently observations provided by the U.S. Department of Agriculture staff from predator trapping at New River in 1999 indicate the presence of an abundant fox population in that immediate area. Based on this information, we suspect that red fox populations may be increasing to the detriment of plover broods.

Overall, the number of young fledged in 1999, including those associated with broods from undiscovered nests, was 53. The Coos Bay North Spit HRA/South Spoil contributed 51% of all fledglings. The increase in the number of young fledged from 1 to 22 from 1998 to 1999 on the Coos Bay North Spit HRA effectively accounts for the 40% increase in the overall number fledged between 1998 and 1999 (Table 7). Again, the relatively high number of hatched eggs, combined with relatively high fledging success, resulted in 53 young fledged, 21 more than in 1998, comparable to peak years of 1994 and 1995. Notably, however, there were no young fledged on the Coos Bay North Spit at the South Beach for the first year since 1990.

Chronology and Number of Oiled Snowy Plovers.

Between 7 February and 15 April 1999 we observed 73 individually marked Snowy Plovers along the Oregon coast; 62% (45/73) of the banded plovers were oiled. In Table

8a, we report both the initial level of oiling, and the maximum level of oiling. The difference between the initial level and maximum level of oiling involves six plovers that were initially observed at Level I, and subsequently were reported with more severe oiling. Overall, the maximum level of oiling occurred as follows; 62% (28/45) of the oiled birds were classified with Level I degree of oiling; 24% (11/45) at Level II, and 13% (6/45) with Level III oiling (Table 8b). Some of the birds noted here with Level II and III oiling were also observed subsequently with Level I oiling, indicating that the oil was “wearing off” over time. Between 15 April and 31 December 1999, we observed an additional 8 plovers with oil; seven had Level I oiling, and one bird observed on 19 July 1999 had Level II degree of oiling.

A majority of the sightings 71% (32/45) of newly oiled banded plovers occurred within three weeks of the incident between 8-28 February 1999; all 17 plovers initially observed with Level II and Level III oiling prior to 15 April were also initially sighted within that same time interval (Fig 3).

It is more difficult, however, to determine the number of unbanded plovers that were oiled. For the period of observations prior to 15 April, we recorded 50 sightings of unbanded oiled plovers, with 82% (41/50) of the observations at Level I oiling, 14% (7/50) with Level II oiling, and 2% each (1/50) at Level III and IV oiling. These observations include multiple sightings of the same unbanded individuals. We estimate that 17-18 unbanded plovers were present on the Oregon coast at the time of the spill, including at least 7, and probably more, that were oiled. Of particular note is the one unbanded plover observed with Level IV oiling at Siltcoos on 16 February 1999. We returned to Siltcoos the following day planning to trap the bird for rehabilitation. Although the same flock of plovers was present, this severely oiled plover was not, nor was it observed subsequently. While it's possible that this plover either left the area or had it's oil “naturally” cleaned off from the 16th to the 17th, it is more plausible that this degree of oiling may have led to its death.

For the period of 8 February – 15 April 1999 we estimate that 57-58% (52/90 or 52/91) of all plovers were oiled. Subsequent to April 15th, we observed an additional 22 banded plovers; eight were oiled, including seven at Level I and 1 at Level II. For all of 1999, we observed 95 banded Snowy Plovers; 56% (53/95) were oiled. We also observed an estimated 12-13 additional unbanded plovers after 15 April; none of them were oiled.

Rehabilitated Plovers.

Seventeen oiled Snowy Plovers were captured and transported to a mobile rehabilitation center operated by the International Bird Rescue Recovery Center. The facility was stationed on the Coos Bay North Spit. Following treatment, seven plovers were released on 26 February 1999 on the beach near the South Umpqua parking lot on the Dunes NRA, and the remaining ten were released on 7 March 1999 at South Tenmile Spit. All plovers were free of oil and in healthy condition at the time of release. The capture location, degree of oiling, release location, release date and fate are summarized in Table 9.

In general the rehabilitated plovers were those that were more severely oiled. Specifically, of 17 banded plovers that were observed with a maximum of Level II or Level III oiling, 15 were rehabilitated. Only two were not. And of the 17 rehabilitated plovers, six had a maximum oiling of Level III, nine had maximum oiling of Level II, and two had maximum oiling of Level I. Therefore, as a group, the rehabilitated plovers represented the more severely oiled plovers.

Seven of the 17 rehabilitated plovers remained on the Oregon coast and nested. The productivity of these birds is presented subsequently. Five plovers were sighted multiple times through March and in some cases April, and then were not observed during May or June. Two of these five were resighted in July, and all five were resighted by the first week in September. We suspect these 5 plovers left the Oregon coast and nested elsewhere, and then returned to Oregon late in the summer.

The fate of the remaining five plovers is less promising. Two have not been observed since their release on 7 March. An additional two, although resighted several times shortly after their release, have not been observed since 21 and 25 March, respectively. The fate of these four plovers is unknown. It's possible they are "wintering" birds, and will re-appear sometime during the winter of 1999-2000, but through December 31st 1999 they have not been sighted, and it appears they may not have survived. A fifth plover was found dead on the beach at South Tenmile on 21 April 1999. This plover had been released on 26 February, and at that time had been the feistiest plover in captivity. The plover was resighted 10 times following its release. The dead bird was collected and turned-over to the U.S. Fish and Wildlife Service for necropsy. Results from the necropsy have not been released.

Presence/Absence of Oiled and Non-oiled Breeding Plovers.

We reviewed the presence and absence of marked plovers, using two comparisons as a means of assessing "disappearance" rates of oiled plovers compared to non-oiled plovers.

First, we reviewed data from our annual winter survey that had been conducted in the first week of January, 1999, approximately four weeks prior to the New Carissa incident. In these surveys, we accounted for 61 Snowy Plovers, including 44 banded individuals. Of these banded individuals, 41 were observed following the incident and were therefore accounted for. Three, however, have not been sighted since January 1999. Based on typical patterns of site fidelity and a tendency for plovers to "stay put" during the core winter months, it would be unusual for these three birds to have migrated or otherwise left the area in February. Given the intensity of the survey effort following the New Carissa incident, one would reasonably expect to have observed all three birds at least in February, if not there after. Of the three, two were hatch-year young from 1998, and one was an adult female. The adult female is of particular interest because it has a history of nesting successfully on the Coos Bay North Spit over the past three years (1996-1998), fledging 2, 1 and 1 young in each of those years, respectively, and would be expected to remain and nest on the CBNS again in 1999. During the January 1999 winter survey, this adult female was sighted on the beach at the Coos Bay North Spit along with five other marked plovers. This area was the most heavily impacted by the spill; the five other

marked plovers that were oiled as follows: three at Level I, and one each at Level II and III. These later two plovers were both rehabilitated birds. These five plovers have all been accounted for, but this female has not and is apparently “missing.” While we cannot rule out that the adult female and the other two plovers perished or disappeared sometime between our January 1999 survey and the February 8th New Carissa incident, their absence in February only 4 weeks later is conspicuous, and it’s possible, if not likely, that at least one if not all three plovers were fatally impacted immediately following the spill incident.

Second, we compared the presence and absence rates of oiled and non-oiled birds that we expected to be present during the 1999 breeding season. Specifically, of the 73 marked plovers observed between February 7th and April 15th, 33 nested in Oregon in previous years. Based on traditional patterns of annual fidelity to breeding sites (Page et al. 1995), if alive, a majority of these plovers would be expected to remain and breed on the Oregon coast in 1999. Of the 33, 18 were oiled, and 15 were not. Of the 18 oiled birds 14 nested in Oregon in 1999, three were present but were not associated with any known nesting, and one apparently left during the breeding season but returned in late July. In contrast, of 15 non-oiled plovers, 13 nested on the Oregon coast in 1999, and two were not sighted after 15 April and their fate is unknown. While survival of these 18 oiled birds through July was 100%, it is curious that three of the oiled plovers were apparently alive and present, but not nesting. Admittedly, these plovers might well have nested without us detecting them, though the increased level of field work for the 1999 field season makes this less likely. In contrast, all non-oiled plovers that were present were also known to have nested.

Productivity of Oiled and Non-Oiled Plovers-

We compared productivity of individually marked non-oiled, oiled and rehabilitated Snowy Plovers (Table 10). Rehabilitated plovers accounted for 15 of 17 marked birds that had the more severe extent of oiling at Levels II and III. Of the seven rehabilitated plovers that nested, two were at Level III, four were Level II, and one was Level I. For the oiled plovers, all were Level I. Thus, the comparison in Table 10 provides, at least in general terms, a comparison of productivity between not oiled, slightly oiled and more severely oiled

Generally, oiled and rehabilitated plovers performed equal to, or in some instances, better than non-oiled plovers. The only noticeable exception was % egg hatching where both male and female rehabilitated plovers, especially the female rehabilitated plovers, was less than that of non-oiled or oiled plovers. We point out, however, that this analysis of productivity of non-oiled, oiled and rehabilitated plovers, however, is based on individuals, and does not account for the mate of each of these plovers, which may have been either non-oiled or oiled. There were no instances of a rehabilitated bird breeding with another rehabilitated bird.

We also assessed productivity of oiled plovers looking more specifically at productivity associated with each Level of oiling (Table 11). There was no apparent difference in nest success among oiled and non-oiled plovers. Although the sample size is relatively small

for the Level III plovers, note that both Level III birds laid three egg clutches, but both nests failed. Reason for nest failure for each of these nests was due to one instance of known predation of the oiled plover during incubation, and one instance when the plover disappeared and was presumed to be predated while the clutch was under incubation. We cannot determine if the degree of oiling contributed in anyway to the predation and disappearance of these two adult plovers, but it is interesting to note that these two plovers, plus the one adult female found dead on April 21st, were all rehabilitated birds that incurred Level III oiling, and that these three plovers are the only documented and suspected deaths of plovers during the nesting season in 1999. Again, the association between the oiling event and the subsequent death of these individuals is unknown, but there are no similar cases for 1999 with non-oiled plovers.

To further examine productivity we classified each nest found in 1999 according to the degree of oiling of both adults. Each nest was categorized into one of six classes: (1) both adults not oiled, (2) one adult not oiled, one adult oiled, (3) both adults oiled, (4) one adult not oiled, one adult unknown, (5) one adult oiled, one adult unknown, and (6) both adults unknown. Nest success, egg hatching rates and fledging rates for nests of oiled and unoled plovers was comparable, and there was no discernable pattern that would suggest that oiling affected productivity (Table 11). In fact, the nest by nest analysis would suggest that “oiled” nests were more productive. This is an artifact, however, that most of the oiled plovers and consequently the “oiled nests” occurred on the Coos Bay North Spit, and as discussed previously, the CBNS sites generally had higher levels of productivity than other sites that received less direct impact from the oiling. Reasons for higher nest success and productivity at the Coos Bay North Spit may be at least partially due to the fence with 2x2 inch mesh that surrounds the HRA and the South Spoil, and keeps out some mammalian predators.

We then examined a subset of Category (3) (both adults oiled) and assessed productivity of those rehabilitated plovers that nested with another oiled plovers. There were four such nests involving three rehabilitated females, and one rehabilitated male. These four rehabilitated plovers had the following amount of oiling; one at Level I, two at Level II, and one at Level III; each of their mates was recorded as having Level I oiling. These four nests represent the most severe combination of nesting oiled birds. As portrayed in Category 7 of Table 11, both nest success and fledging success were equal or higher than non-oiled birds, but again the % egg hatching was lower.

Productivity of oiled and non-oiled plovers in 1998 and 1999

We also compared productivity of oiled and non-oiled plovers for a group of 29 individuals that nested in both 1998 and 1999. This group included 13 non-oiled (5 female, 8 males) and 16 oiled (5 females, 11 males) plovers (Table 12). There were differences, however, among the two groups of plovers in 1998, prior to the oiling. Specifically, the oiled plovers had lower nest success and lower egg hatching rates, but higher fledging rates. These differences are consistent with differences noted between the Coos Bay North Spit and New River, the two areas with the largest number of plovers and nests (Castelein et al. 1998), and is reflected here because most of the oiled plovers were found at the CBNS, and many of the non-oiled plovers were found at New River.

Be that as it may, in 1999, virtually all measures of productivity for oiled plovers were equal to or higher than for the non-oiled group, and contrast, the non-oiled plovers appeared to be more productive in 1998 than 1999, while productivity for the oiled plovers was higher in 1999 than 1998. Again, these relative differences in productivity appear to be associated with differences at individual sites rather than differences associated with patterns of oiling.

This comparison of productivity between 1998 and 1999, however, is based only on individual plovers, and does not account for different mates or the degree of oiling of different mates. To address this, we also looked more specifically at pairs of Snowy Plovers that nested together in both 1998 and 1999. There were, however, only two pairs that retained the same mate in both years. For one pair, neither plover was oiled. In 1998 this pair had 1 successful nest, with two eggs, both of which hatched, but neither nest fledged a chick. In 1999, this same pair had 2 successful nests, hatching 3 of 4 eggs, and fledging 3 of 3 chicks. For the second pair, the male was not oiled and the female was oiled. This pair one had successful nest each year, hatching two eggs with two fledglings in 1998, and 3 hatched eggs and no fledglings in 1999. The limited sample size thwarts any conclusion.

DISCUSSION

At the population level, the abundance and productivity of Snowy Plovers breeding at sites along the Oregon coast in 1999 was comparable to past years and at this coarse level did not appear to be impacted by the New Carissa incident. The abundance of breeding Snowy Plovers in 1999 was nearly identical to that of 1998, while productivity in terms of fledging success and the total number of young fledged was higher than in the past three years, and nearly equal to the highly productive years of 1994 and 1995.

There is evidence, however, that raises the issue of direct impacts to specific sites and individual plovers.

For the first time since 1990, there was no nesting by plovers or only extremely limited use by plover broods on the Coos Bay North Spit South Beach, the area most immediate to the New Carissa incident (Fig 4). The South Beach, located in the stretched of beach closest to the New Carissa and designated as N1 by the Unified Command, was one of the most heavily oiled areas, and was subject to both continuous cleanup and beach monitoring, as well as being proximal to ongoing salvage activities. These activities may have been mitigated by the closure of this area to the public, although public use here would have occurred in the lower wet sand portion of the beach, and the cleanup effort focused on the rack line. Also, it is worth noting that in qualitative terms, the South Beach area incurred more severe beach erosion and sand displacement during the winter of 1998-1999 compared to past years, and the available habitat for the 1999 breeding season may have been more limited. These differences may have reduced the attractiveness of this site to plovers for breeding. There was, however, nesting and brooding activity on the adjacent 1994 HRA and South Spoil sites which are located east of the beach, and many of the birds that nested on the South Beach in 1998 did breed

successfully on the 94HRA in 1999. It is not possible to determine if the absence of nesting and brooding activity on the South Beach was due to oiling and activities associated with the New Carissa, or if simply the habitat at the interior sites was preferred for other reasons, or some combination of both. It is however, notable, that no nesting or brooding activity by plovers occurred at the South Beach site for the first time in eight years, despite the presence of plovers at other immediately adjacent sites on the CBNS.

As reported, most of the oiling of plovers occurred within the first few weeks following the New Carissa grounding. The presence of individually marked plovers greatly facilitated our ability to track the fate of oiled and non-oiled plovers over time. For these plovers, longevity as measured primarily by presence and absence through the breeding season of known breeders of both oiled and non-oiled plovers was much the same. There is, however, some question about three marked plovers that were observed during the January 1999 winter survey but not thereafter. Although it's possible that these three plovers died of natural causes prior to the New Carissa incident, their absence is conspicuous, especially the adult female that had been sighted with six other plovers in January 1999 on the Coos Bay North Spit in the immediate vicinity of the oil release. These three plovers either perished of natural causes sometime between the January 1999 surveys and the February 4th grounding of the New Carissa, or if not that, then probably died of oil impacts inflicted immediately after the grounding.

Another indication of possible impacts concerns the sighting of a severely oiled (Level IV) unbanded plover as part of a large flock at North Siltcoos on 16 February 1999. We returned the following day in hopes of trapping this bird and taking it into captivity in order to clean it. Although the same flock of marked plovers was present at this site, the severely oiled unbanded plover was not, nor was it sighted subsequently. The fate of this plover is uncertain, but it's sudden disappearance is suspect, and we believe it may have died from impacts of the oiling.

The impacts of the oiling to the 17 plovers that were trapped, taken captive and cleaned of oil is variable. There may have been direct impacts to 4 or 5 of the birds. Two plovers released on 26 February have not been sighted since 21 and 25 March 1999 in Oregon, nor at breeding sites in Washington or California, and their fate is uncertain but questionable. Two other plovers released on 7 March 1999 have not been sighted since, and again their fate is very much circumspect. A fifth plover was found dead on 21 April 1999; results from a necropsy conducted by the USFWS have not been released.

Seven rehabilitated plovers remained in Oregon and nested. Nest success and fledging success for these seven plovers was equal to or better than non-oiled or less severely oiled plovers. The percent of egg hatching, however, was lower. Reasons for this reduced level of egg hatching are uncertain, but may or may not be related to impacts from the oiling and rehabilitation of these birds. Also, of note is that two of the rehabilitated plovers which incurred Level III oiling were either known to have been predated or suspected to have been predated during incubation. These two plovers plus the female found dead on 21 April 1999 constitute the only two confirmed deaths and one

suspected death of plovers noted this year, and all three were of the group of most severely oiled of any marked birds on the coast

The disappearance of these oiled birds raises questions about their fate, and reasons for their absence. It is difficult to determine if these missing birds perished due to natural causes, direct impacts from the oiling, or perhaps some combination of both where indirect or secondary affects of the oiling led to increased vulnerability to natural causes such as predation or starvation.

In summary, there are no overt indications of impacts from the New Carissa incident on the population size and productivity of Snowy Plovers breeding at sites along the Oregon coast in 1999. There is, however, indication that some undetermined number of individual plovers may have been directly impacted by oiling immediately following the release, including but necessarily limited to the individuals (Table 13): three marked plovers observed in January and not accounted for thereafter; the severely oiled unbanded plover sighted on 16 February and not thereafter; and at least two and perhaps as many of 4 of the rehabilitated plovers that have not been sighted either since their release or shortly thereafter. A fifth rehabilitated plover was also found dead, but the results from the necropsy have not been released. Two additional plovers with Level III degree of oiling were either known to have been predated or suspected to have been predated during the nesting season, while no other plovers incurred such fate this year. The first field surveys to look for oiled plovers did not occur on the Coos Bay North Spit until 11 February, four days after the oil spilled. We have documented that the most severe oiling occurred in the two weeks following the spill, and it is possible that some additional unbanded plovers were severely impacted in that four day period of time, but not accounted for thereafter. There may also have been or continue to be other sublethal effects that impact the fitness of individual Snowy Plovers, but it is not possible to assess or quantify this potential impact.

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Table 1

Table 2. Distribution and Abundance of Breeding Adult Western Snowy Plovers on the Oregon coast, 1990-1999 based on window surveys.

Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Bayocean Spit	10	0	0	2	0	6	0	0	0	0
Heceta Head-Siuslaw River	0	0	2	0	0	2	5	5	2	0
Siuslaw R.-Umpqua River	4	0	5	0	8	14	15	10	11	13
Umpqua R-Horsfal Beach	5	10	9	8	3	4	3	5	4	2
Horsfall Beach-Coos River	22	11	7	11	21	26	34	19	20	15
Bandon-New River	9	9	2	12	9	10	8	7	22	2
New River-Floras Lake	8	5	5	12	10	10	21	39	4	18
South of Heceta Head	2	0	0	0	0	0	0	0	0	0
Total	60	35	30	45	51	72	86	85	63	52

Table 3

Table 4. Nest Success (Mayfield Method) of Snowy Plovers on the Oregon coast, 1990-1999.

Year	% Nest Success			(N) ¹	(N) ²
	Overall ¹	Exclosed ²	Unexclosed ²		
1990	12	- ³	13	(36)	(29)
1991	19	77	4	(36)	(35)
1992	54	80	9	(36)	(34)
1993	55	77	22	(41)	(38)
1994	74	76	68	(51)	(51)
1995	43	62	5	(76)	(72)
1996	48	67	7	(89)	(86)
1997	43	52	22	(93)	(90)
1998	50	70	15	(78)	(72)
1999	51	61	40	(78)	(72)
X ± 1 STD	44.9 ± 17.8	69.1 ± 9.4	20.5 ± 20.0	(604)	(579)

¹Overall includes exclosed nests + unexclosed nests +infertile nests and nests with one egg that were subsequently abandoned.

²Does not include infertile nests or nests with one egg that were subsequently abandoned because the outcome of these nests was not affected by the presence or absence of an exclosure.

³Exclosed nests not included as multiple experimental designs were employed.

Table 5

Table 6

Table 7. Number of young western snowy plovers fledged for all sites on the Oregon Coast 1990-1999.

Site Name	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Sutton							0	1	1	0
Siltcoos:										
North Spit					1		0	0	2	4
South Spit					1	2	0	0	4	2
Overlook '98 clearing										3
Tahkenitch					1	12	8	7	1	1
Tenmile:										
North Spit					0	1	0	0	0	0
South Spit			14	7	3	3	4	4	3	7
Coos Bay North Spit:										
South Spoil	3	2	4	13	17	17	22	9	6	5
South Beach		11	9	2	6	2	2	7	2	0
Habitat Rest. Areas					7	2	1	1	1	22
Bandon		1	1	3	5	0	1	0	1	1
New River Spit			4	0	7	12	8	9	11	8
Floras Lake/ New River Overwash	0	2	1	11	9	6	1	3	0	0
TOTALS	3	16	33	36	57	57	47	41	32	53

Table8

Table 9

Table10

Table 11

Table 12

Table 13. Summary of potential Impacts to Snowy Plovers that may have been caused by the Oil Spilled from the New Carissa along the Oregon Coast, 1999.

1. No Nesting on South Beach of Coos Bay North Spit for first time since 1990
2. 62% (N=73) of all banded Snowy Plovers observed between 10 February and 16 April 1999 were oiled
3. One severely oiled Snowy Plover observed on 16 February 1999 could not be relocated on 17 February 1999 or thereafter, and may have perished.
4. 1-3 banded Snowy Plovers that were present in January 1999 were absent one month later following the spill, and may have perished due to impacts from the spill immediately following the incident
5. 2-4 Snowy Plovers that were oiled and rehabilitated were missing and not observed following their release.
6. 1 Snowy Plover that was rehabilitated was found dead
7. 2 Snowy Plovers that were oiled and rehabilitated were subsequently predated at the nest site in 1999
8. The spilling of oil began on 7 February 1999; surveys for oiled plovers began on 10 February, and it is possible that plovers were impacted during this time, but not accounted for.