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Dedicated beach surveys along the central Washington coast reveal a high proportion of unreported marine mammal strandings

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The goal for this study was to quantify the rate at which marine mammal mortalities were unreported and how this varied by season, species, and site on the central Washington outer coast. Data collected from marine mammal strandings have been known to provide valuable information for studies on distribution, mortality, and seasonal abundance (*e.g.*, Scheffer and Slipp 1948, Scordino 1991, Norman *et al.* 2004, Douglas *et al.* 2008, Norman *et al.* 2011). Cascadia Research Collective (CRC) and the Washington Department of Fish and Wildlife (WDFW) are members of the Northwest Marine Mammal Stranding Network in the United States and share response and investigational responsibilities for strandings that occur along Washington's central outer coast, where strandings of multiple marine mammal species occur (Scordino 1991, Norman *et al*. 2004), and response in this region largely relies on reports of stranded animals from the public. While responding to two separate stranding events in this area in early 2005, we found numerous strandings that had not been reported, including a dead gray whale (*Eschrichtius robustus*), a harbor porpoise (*Phocoena phocoena*), and several pinnipeds, suggesting a large discrepancy between reported and actual strandings. In order to better assess how accurately reported marine mammal strandings represent actual strandings, CRC and WDFW began conducting dedicated beach surveys on portions of the Washington outer coast.

A total of 49 beach surveys (33 dedicated and 16 opportunistic) were conducted between June 2006 and June 2011 (Table 1) at two sites along the central Washing-

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Table 1. Survey effort by year, 2006–2011.

Year	Number of surveys	Reported strandings	Unreported strandings	Total strandings
2006	1	1	1	2
2007	5	3	10	13
2008	5	1	9	10
2009	9	9	10	19
2010	17	11	22	33
2011	12	2	8	10
Total	49	27	60	87

ton coast, North and South (Fig. 1). The North site extends south from Moclips to the north jetty in Ocean Shores, Washington (entrance to Grays Harbor, approximately 34 km), and the South site extends from the south jetty in Westport, Washington (entrance to Grays Harbor) to Wash Away Beach in North Cove, Washington (entrance to Willapa Bay, approximately 23 km). These sites were chosen because

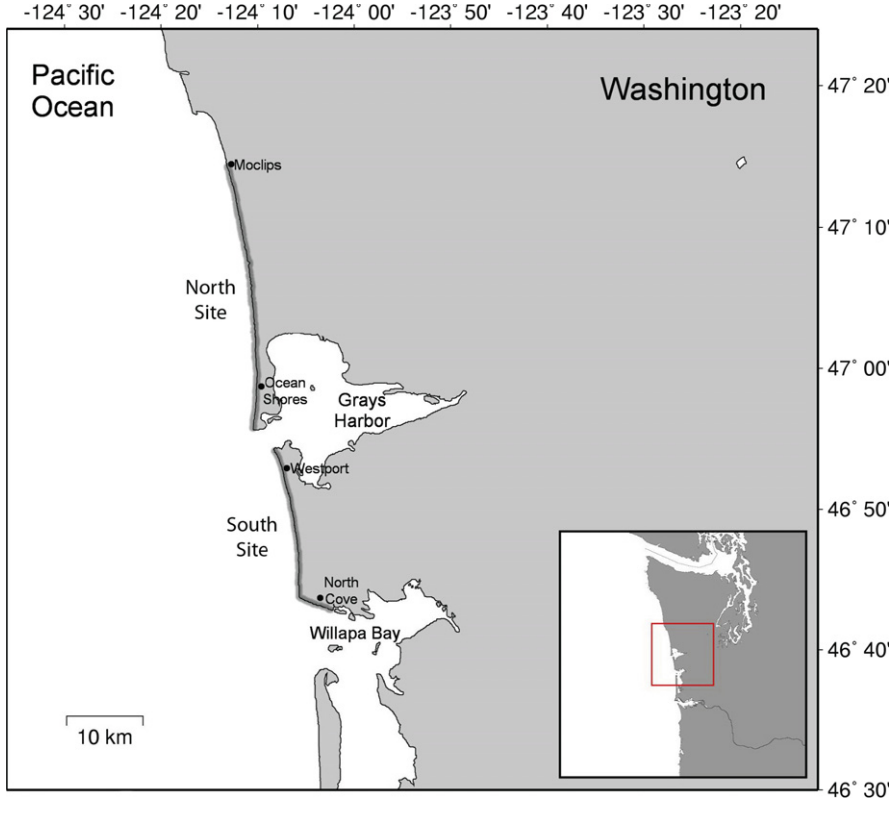

Figure 1. Map of study areas on the central Washington outer coast. Shaded areas indicate portions of coastline surveyed for each region.

they consist mostly of wide and sandy beaches, which easily lend themselves to comprehensive searches with a four-wheel drive vehicle, and both are open to public use. They are representative of the central and southern Washington coastline, but differ greatly from the more rugged, rocky, and less accessible coastline of northern Washington. The North was surveyed 30 times (20 dedicated and 10 opportunistic) while the South was surveyed 19 times (13 dedicated and 6 opportunistic, Table 2). Surveys occurred during all seasons with at least one every month except December. Seasons were defined for analyses as: Winter—January through March, Spring—April and May, Summer—June through August, Fall—September through November. Although searches occurred in all seasons, the majority took place during the spring and summer months (n = 16 and 20, respectively; Table 2), as these months represent peak stranding seasons for several local species (Norman *et al.* 2004; NMFS, unpublished data).

Dedicated beach surveys were timed to ensure broad seasonal representation and scheduled based on favorable weather and optimal tide windows to allow enough time to survey the entire beach and examine animals that were encountered. Opportunistic searches (while responding to a reported stranding) were conducted when field conditions allowed. Two to four personnel participated in each survey, which took approximately one day per region. Occasionally, searches of both sites were completed on the same day, if there was sufficient daylight or few animals found. Data collected for every marine mammal found on a survey included species, age class, sex, length, global positioning system (GPS) position, general location description, carcass condition, and photographs. Animals that were freshly deceased (condition code 2) and of a size that could be manageably transported were removed for detailed external and internal examination and collection of samples for life history, histopathology, contaminants, biotoxins, and genetics. Examinations of animals too large for transport or too decomposed for extensive sampling (condition codes 3–5) occurred at the stranding site and carcasses that remained on the beach were marked to prevent duplicate counts. All data for marine mammals encountered during a survey were compared with stranding records from the National Oceanographic and Atmospheric Administration (NOAA) regional office, which oversees stranding network activities in the states of Washington and Oregon, and other local stranding organizations to determine if they had been previously reported to another member of the stranding network.

Table 2. Surveys conducted and strandings found by season and location.

Beach	Season	Number of surveys	Reported strandings	Unreported strandings	Total strandings
North	Winter	2	1	5	6
	Spring	8	4	7	11
	Summer	14	10	28	38
	Fall	6	1	10	11
North total		30	16	50	66
South	Winter	2	0	0	0
	Spring	8	7	2	9
	Summer	6	2	6	8
	Fall	3	2	2	4
South total		19	11	10	21
Total, North and South		49	27	60	87

Our searches resulted in the finding of 87 stranded marine mammals, the majority of which (69%, $n = 60$) were unreported. There appeared to be an increase in reporting rates over time, from 20% of strandings reported prior to surveys occurring in 2006–2008 to 35% in 2009–2011 ($\chi^2 = 4.6$, $P = 0.054$, df = 1), likely due, in part, to a more consistent stranding network presence on the coast (supported by the John H. Prescott Marine Mammal Rescue Assistance Grant Program).

The proportion of unreported animals differed significantly by site ($\chi^2 = 5.9$, $P = 0.015$, df = 1; Table 2), with 76% of strandings unreported in the North and nearly equal numbers of reported and unreported strandings in the South. The highest reporting rates for both sites occurred during the spring (36% in the North, 78% in the South), and the lowest during the fall in the North (9%) and the summer in the South (25%).

Although a difference in overall reporting rates among seasons was not significant ($\chi^2 = 7.0$, $P = 0.07$, df = 3, Table 2), spring was the only season during which reported animals ($n = 11$) exceeded unreported ($n = 9$). However, we documented more stranded marine mammals during the summer months (2.3 per survey) than during the spring, fall, or winter (1.25, 1.6, and 1.5, respectively). Strandings in general tend to increase during the summer, usually due to seasonal animal movements into the NWR of some species and the birth of young, which are often highly represented in stranding summaries (Norman *et al.* 2004, 2011). While increased numbers of visitors to coastal areas during these same months would presumably lead to more frequent reporting, we found the highest reporting rate during the spring for both survey sites, indicating that the interest, motivation, and knowledge of beachgoers may play an important role in the number of unreported strandings.

A wide variety of marine mammals, including six pinniped, three cetacean, and one mustelid species was found during our surveys (Table 3). Due to the small sample size ($n = 2$), mustelids were grouped with pinnipeds for analyses. Pinnipeds, consisting primarily of harbor seals (*Phoca vitulina*, $n = 21$) and California sea lions (*Zalophus californianus*, $n = 18$), represented 79.3% ($n = 69$) of all stranded marine mammals found during this study. Other species included Steller sea lions (*Eumatopias jubatus*), northern elephant seals (*Mirounga angustirostris*), northern fur seals (*Callorhinus ursinus*), Guadalupe fur seals (*Arctocephalus philippii townsendi*), and six carcasses

Table 3. Stranded marine mammals found during beach surveys 2006–2011, by species.

	Year						
Common name	2006	2007	2008	2009	2010	2011	Total
Harbor seal	0	2	1	10	8	0	21
California sea lion	1	3	2	4	6	2	18
Steller sea lion	0	2	5	2	2	1	12
Guadalupe fur seal	0	3	0	0	4	0	7
Northern elephant seal	0	0	1	1	0	0	2
Northern fur seal	0	0	0	0	1	0	1
Unidentified pinniped	0	1	0	0	4	1	6
Sea otter	0	0	0	0	2	0	2
Harbor porpoise	1	1	1	1	5	3	12
Gray whale	0	1	0	1	1	2	5
Fin whale	0	0	0	0	0	1	1
Total	2	13	10	19	33	10	87

that could not be identified to species. Cetacean strandings (n = 18) were predominantly harbor porpoises (n = 12) and gray whales (n = 5); a partial fin whale (*Balaenoptera physalus*) of very advanced decomposition was the only other cetacean found.

The fraction of strandings that had been reported previously varied by species (Fig. 2) and illustrated differences in reporting by size and by type of marine mammal. There were significant differences (Fisher's exact test, P = 0.0005) in reporting rates among three groups: large whales (83% reported), small cetaceans (58% reported), and pinnipeds (22% reported). While the higher reporting rate for large whales makes sense due to their size and the public interest in whales, the difference in reporting rate was also significant between small cetaceans and pinnipeds (Fisher's exact test, P = 0.014), which had mean lengths (126 and 159 cm, respectively) that were not significantly different (t = –1.67, P = 0.10). This may reflect a public bias as to the relative importance of cetaceans and pinnipeds or, as many species of seals and sea lions routinely use shoreline habitat and are more frequently seen by the general public, their presence on the beach may be less noticeable or less exciting than a stranded cetacean.

Of the six pinniped species encountered in our searches, the most frequently stranded and most frequently reported (38%) was the harbor seal, a species prevalent in the Pacific Northwest and along the west coast of the United States. Harbor seals are known to use areas in and around our search sites for feeding, resting, and raising pups (Jeffries *et al.* 2003). Stranded harbor seals were found throughout the year, but the highest numbers (primarily pups) were encountered in early summer, which overlaps with the pupping season (mid-April through July, Scheffer and Slipp 1944) in this region. Although smaller in size, harbor seals were more often reported than the next most commonly encountered species, California and Steller sea lions. The three Guadalupe fur seals found in 2007 represented the first cases in an Unusual Mortality Event for this species that was declared for both Washington and Oregon later in the year and continued through 2009 (NMFS, unpublished data). Though they have been

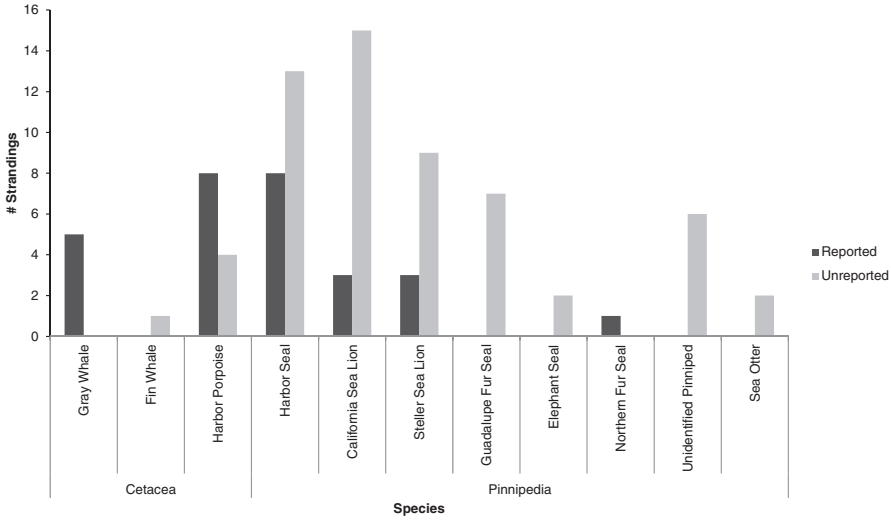

Figure 2. Reported *vs*. unreported strandings found during beach surveys, by species.

reported in northern and central California (Hanni *et al.* 1997), they are considered unusual or occasional inhabitants in the Pacific Northwest (Etnier 2002). None of the Guadalupe fur seals found had been previously reported, proving that active searches play an important role in identifying and documenting unusual stranding occurrences.

Carcass condition also significantly influenced the likelihood of reporting, with animals that were alive or in a fresher state of decomposition more often reported than those that were more decomposed ($\chi^2 = 12.65$, $P = 0.002$, df = 2; Fig. 3). Carcass conditions between codes 1 (alive) and 2 (fresh) accounted for 50% of all reported strandings ($n = 28$), condition codes 3–5 (moderate, advanced, and mummified/skeletal) accounted for the remaining 50%. Only 11.6% ($n = 7$) of unreported strandings ($n = 60$) were freshly deceased. Reporting of cetaceans did not appear to be as affected by level of decomposition as pinnipeds; reported outnumbered unreported in all but code 5 cetacean carcasses, while code 2 was the only decomposition code for which there was a higher number of reported pinnipeds.

Our results indicate that even in coastal areas of heavy public usage and easy access, many marine mammal strandings are not reported. In addition, only a fraction (typically <10%) of actual mortality is represented by reported strandings (DeGange *et al.* 1994, Moore and Read 2008, Williams *et al.* 2011, Peltier *et al.* 2013). Among killer whales in the Pacific Northwest, Barbieri *et al*. (2013) calculated a carcass recovery rate of 9% (24 recovered of 272 known mortalities) for northern and southern residents combined. The proportion of dead marine mammals that make it to

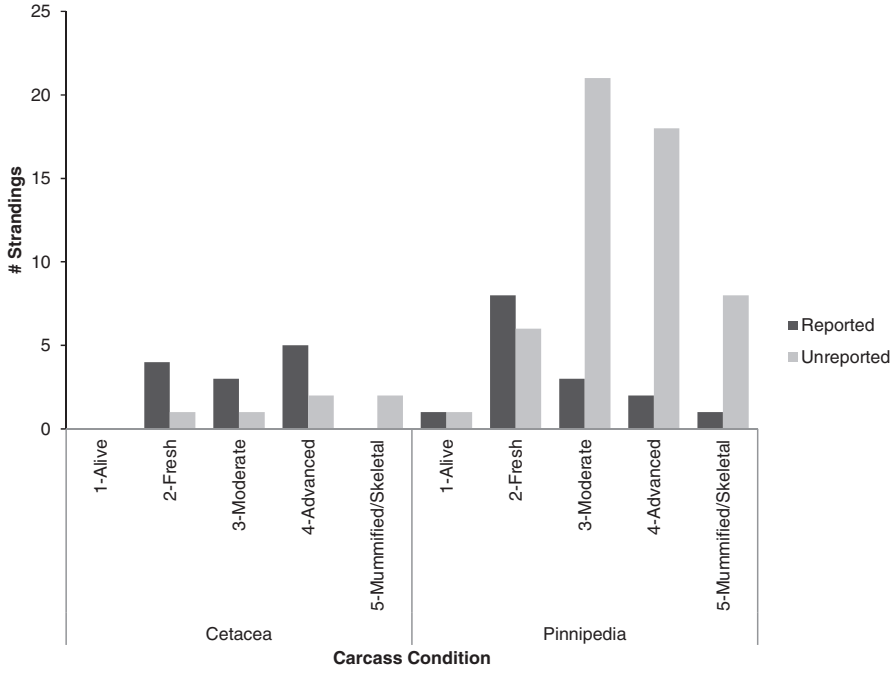

Figure 3. Reported *vs*. unreported strandings found during beach surveys by level of decomposition.

shore is likely affected by many factors, including currents, winds, tides, ocean bottom topography, proximity to the shore at time of death, shoreline geography, and at-sea scavenging, resulting in a large percentage of animals that do not wash up on the beach (Long and Jones 1996, Evans *et al.* 2005, Faerber and Baird 2010). Although the rates of unreported strandings we document may vary by region, they do demonstrate the degree to which strandings go unreported even under favorable conditions. While strandings can be valuable indicators, it is important to realize they represent a very small proportion of true mortality.

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