Reuse of Nest Sites by Pelagic Cormorants in North-Central California

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REUSE OF NEST SITES BY PELAGIC CORMORANTS IN NORTHERN CALIFORNIA

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ABSTRACT: We photographed nests of Pelagic Cormorants (*Phalacrocorax pelagicus*) on cliff ledges at two colonies in Mendocino and Sonoma counties, California, from 1986 to 1996. In 135 comparisons of the positions of nests in different years, we found that 92% of the nests shifted by <25 cm (approximate diameter of a Pelagic Cormorant nest), and in 24% of comparisons the shift was <5 cm. Some nests were placed within a few centimeters of previous sites for as long as nine years. The rate of reuse of nest sites was high on both small ledges and on large shelves where the nest could have readily been shifted. At sites where substantial rock substrate sloughed off the cliff face in the previous year, nests were placed precisely at former sites. This high rate of nest reuse is striking because many apparently suitable sites on these cliffs remain unused.

Nest-site fidelity, the tendency for birds to return to and reuse a previous nest site, has been noted in many species, both migrants and residents, and among songbirds, waterfowl, seabirds, and birds of prey (Badyaev and Faust 1996). The pervasiveness of nest-site fidelity suggests the behavior has an adaptive significance and increases reproductive success (Greenwood and Harvey 1982). Within a colony, the site fidelity of seabirds nesting on cliffs and slopes is often strong (Aebischer et al. 1995, Fairweather and Coulson 1995). For example, Ollason and Dunnett (1978) found 91% of breeding pairs of the Northern Fulmar (*Fulmarus glacialis*) to reunite at approximately the same nest site, and Huyvaert and Anderson (2004) detected no measurable shift in placement of Nazca Booby (*Sula granti*) nests in successive years.

The Pelagic Cormorant (*Phalacrocorax pelagicus*) is a long-lived seabird that usually nests on ledges on high, steep, inaccessible rocky cliffs facing the sea (Hobson 1997). These nest sites provide protection from predators (Aebischer et al. 1995), although they expose the nest to cold winds, sea mist, and ocean waves, which occasionally destroy active nests (Schall pers. obs.). Siegel-Causey and Hunt (1986) reported that nest sites used persistently over several years are those that are most strongly defended. Here we document reuse of nest sites by Pelagic Cormorants at two breeding colonies in northern California over 10 years. Our goals were to measure differences in nest placement on ledges by year and between the two colonies. We observed that all nests were washed off the cliff ledges during winter storms, so we used photographs to locate the precise previous sites of nests on the basis of the cliffs' landmarks.

METHODS

In 1986 we selected two colonies for study. The Point Arena colony is located 2 km north of the town of Point Arena, Mendocino County (observation locations were within 0.32 km north and south along the cliffs from 38.9289° N, 123.7293° W). Since 2004, this section of coast has been included within the Stornetta Public Lands managed by the U.S. Bureau of Land Management. The Sea Ranch colony is 24 km south of the Point Arena study site and 10 km south of the town of Gualala, Sonoma County (observation locations within 0.70 km north and south along the cliffs from 38.7190° N, 123.4646° W). This area has been privately owned as a planned unincorporated community since 1963. At each location, the coast is thrown into a series of convolutions with many narrow inlets that allow an observer to sit on the cliff edge above one cliff face and look into the nests on the opposite face (see satellite photographs of the two locations, Figure 1).

We took color photographs (35-mm slides) of cormorant nests during the early to mid breeding season (May to July) in 1986, 1987, 1988, 1989, 1994, 1995, and 1996. Only active nests (with adult birds attending eggs or hatchlings) are included in the analysis. That is, we excluded nests that had been constructed in April and early May, then abandoned with no eggs laid. We examined the slides by scanning them into digital format for viewing on a flat computer monitor. We compared the nests' locations by year by the use of landmarks on the cliff face such as overhangs, ledges, distinctively shaped rocks, or clumps of vegetation. We drew lines between the nest and appropriate landmarks and estimated the vertical and horizontal difference in nest placement at each location over different years (see Figure 2). Nests varied in size and shape, so we scored their location from the center top of the forward rim; this point is visible even when the nest contained incubating adults or nestlings. The distance from camera to nest and the camera lens used differed from year to year, so we needed a benchmark in each photograph to determine distance. This we achieved by measuring the wing length of an attending adult in every photograph, using the average chord for the Pelagic Cormorant of 25 cm as the reference scale (Hobson 1997).

We analyzed the data by nonparametric methods in JMP 3.0.2 and Statview 5.0.1, setting the significance level at $P = 0.05$.

Figure 1. Aerial photographs (from Google Earth, 7 January 2014) of the two study sites, Point Arena (A, centered at 38.9289° N, 123.7293° W) and Sea Ranch (B, centered at 38.7190° N, 123.4646° W).

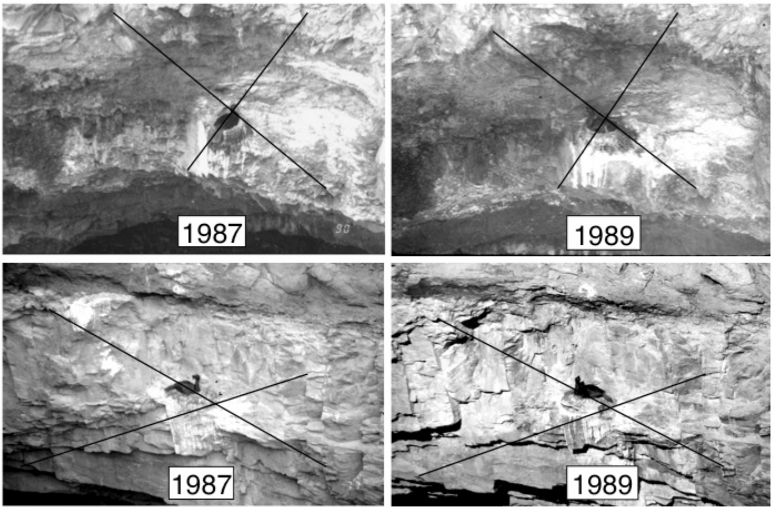

Figure 2. Reuse of nest sites by Pelagic Cormorants after loss of rock substrate at Point Arena. The two pairs of figures show use of the same two nest sites before (1987) and after (1989) loss of surrounding rock substrate.

RESULTS

Over the 10-year period, we made 135 comparisons at 44 nest sites. A nest was not active (egg laid) at each site each year; 57 one-year comparisons were possible. The longest periods observed between placement of nests at a specific site on the cliff ledge were 9 (n = 60) and 10 (n = 1) years. The distribution of distances between nests at individual sites is shown in Figure 3. We found no significant difference in nest-site reuse over multiple years at the two colonies (an unequal number of observations allowed comparison for an interval of one year only; Point Arena n = 22, Sea Ranch n = 35, U test, P = 0.362). Therefore, we pooled the data for the two colonies for subsequent analysis.

Estimated differences in placement of nests at individual sites ranged from 1 cm (essentially no difference between location of the nest from year to year; a few centimeters of vertical difference could be accounted for by variation in the height of the nest rim) to 43 cm. Vertical shifts in nest placement did not differ from horizontal shifts (Wilcoxon signed-rank test, P = 0.873). Only 8% of the measured differences were greater than 25 cm, the length of the Pelagic Cormorant's wing chord and the approximate diameter of the nest, and 24% were less than 5 cm (Figure 3). In comparisons for one-year intervals only, there was no effect of year on the distance between nest sites (Kruskal–Wallace test, P = 0.073); that is, the distance nest sites shifted did not change over the observation period. The number of years between measures over the 10-year period was weakly positively related to distance between placement of the nests (Spearman rank correlation, r_s = 0.194; P = 0.027, n = 133) (Figure 4), but this correlation vanished if the four greatest shifts were removed from the analysis.

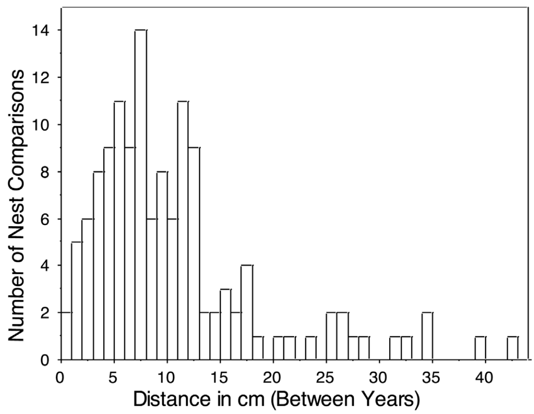

Figure 3. Shifts in nest sites of Pelagic Cormorants in successive years at two breeding colonies in northern California.

The cliff ledges were durable through our study, so we could readily find large and small landmarks for locating nest sites with precision. However, at two Point Arena nest sites, a large amount of ledge material (rock and minimal vegetation) fell off during the stormy winter of 1987–1988. We were able to ascertain the location of the original nest sites by using landmarks far from the site and lines drawn between these distant landmarks (Figure 2). Cormorants constructed nests on these two sites, even with very little apparent horizontal area remaining after the loss of cliff material and precisely at the site of the previous nest.

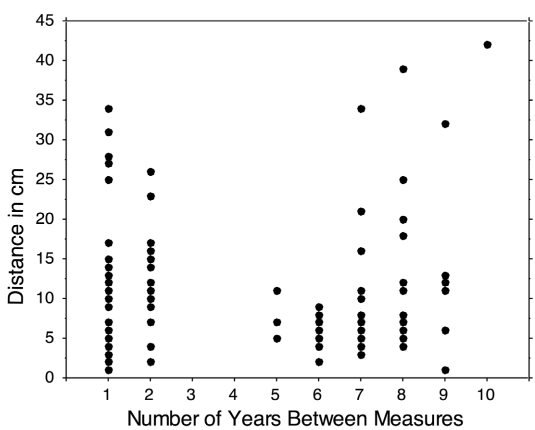

Figure 4. Number of years between recorded shifts in sites of Pelagic Cormorant nests at two breeding colonies in northern California.

DISCUSSION

At two breeding colonies in northern California, Pelagic Cormorants' rate of reuse of nest sites over a 10-year period was high. Only 8% of comparisons revealed a shift greater than or equal to 25 cm, the approximate diameter of a nest. Therefore, in 92% of comparisons, the nest was placed with at least some overlap with the site occupied in another year. In approximately a quarter of the comparisons, nests shifted 5 cm or less, including some comparisons made eight or nine years apart. This small shift was likely to be within the method's margin of error, so many nests may have been placed precisely at a previous site. Not all sites were used each year, but even comparisons over more than one year showed very little shift. In some cases, the ledge on the cliff face appeared through a telescope to be equal to or even smaller than the size of a Pelagic Cormorant nest, so precise placement of a nest there year after year is not surprising. However, inspection of the cliff faces with the telescope revealed a great many other similarly sized ledges, including many near the observed nests.

Although we could not assess all factors related to nest-site selection, choice of specific small ledges does not seem to be a result of scarcity of suitable ledges. In many cases the ledge was more of a shelf, and large enough to allow the birds to build a nest at a variety of sites on it, yet even in such places nests were placed at the same site year after year. And, most striking, at sites of substantial rock slides from the cliff face over the winter, changing the cliff's appearance, birds returned to build nests at precisely the same site seen in previous years. One of these nests was placed at a site that seemed to have little or no horizontal surface but was within a few centimeters of the site used in previous years. It is not known how Pelagic Cormorants find previous nest sites, although memory of landmarks and access as well as position in relation to other nest sites likely are involved. We pinpointed the nest locations by use of sketch maps and photographs, but at places where material had fallen off the cliff ledges during winter storms, extremely detailed study of photographs was required.

Cliff nesting offers the Pelagic Cormorant many advantages including the ability to breed near foraging areas at many points along the mainland coast, as well as on islands (Carter et al. 1984, Siegel-Causey and Hunt 1986). The species' high fidelity to specific cliffs likely increases an individual's efficiency in finding food, as the birds are familiar with the distribution of prey nearby (Siegel-Causey and Hunt 1986). Cliffs are also advantageous because they limit the access of avian and mammalian predators. During our study, Common Ravens (*Corvus corax*) patrolled the two study locations, with 0.3 passes per hour at Point Arena and 0.5 per hour at Sea Ranch, and ravens were observed to take eggs or small nestlings from nests (Cannon 1990).

Although cliff nesting itself has advantages, why are the cormorants so loyal to specific nest sites? A specific site may offer better protection from the elements, including rain from above and sea waves and mist from below, and may be sloped to prevent eggs from rolling into the sea (Lengagne et al. 2004). Small differences, not apparent to the human eye, may also reduce attack by foraging ravens. If specific nest sites are of higher quality, then we may expect the birds to compete for them. Competition among Pelagic

Cormorants for nest sites appears most intense early in the breeding season, especially for sites used over several previous years (Siegel-Causey and Hunt 1986). At our study locations, Cannon (1990) observed numerous attacks by adult cormorants on the nestlings of other birds throughout the nesting season. Cannon also found that early nesters were more successful and used nest sites away from other cormorants.

Studies of cliff-nesting seabirds that share many of the characteristics of the Pelagic Cormorant, including longevity and coloniality, indicate that reuse of nest sites may promote site defense, ensure distance from conspecific nesting pairs, facilitate mate acquisition or retention, and aid in the rapid replacement of a lost mate (Ollason and Dunnett 1988, Boekelheide and Ainley 1989, Pyle et al. 2001, Huyvaert and Anderson 2004). Nest-site reuse may be especially important in cliff-nesting species, in which mate acquisition does not involve choice among a dense group of the species at the colony early in the reproductive season (Vergara et al. 2006), although Pelagic Cormorants can form dense groups at roosts near colonies. Nest-site reuse has been found an efficient way for individuals or pairs to continue breeding at a successful cliff colony in the Common Murre (*Uria aalge*) and Black-legged Kittiwake (*Rissa tridactyla*) (Kokko et al. 2004, Naves et al. 2006). Pelagic Cormorants may not breed every year, and they breed in colonies relatively small and scattered in comparison to those of many other seabirds, so returning to the same nest site may be an important means of finding a previous mate (Siegel-Causey and Hunt 1986). In the Black-legged Kittiwake, which also nests on steep rocky sea cliffs, mate retention dropped significantly when nests were located more than 0.3 m from previous sites (Fairweather and Coulson 1995). In birds in general, breeding success increases fidelity to mate and nest site, and in socially monogamous seabirds replacement of a mate has been shown to exact a cost in reproductive fitness (Bried et al. 2003, Ismar et al. 2010).

In our long-term study, we demonstrated great precision in the Pelagic Cormorant's reuse of nest sites. Unfortunately, as the birds we studied were not marked, we have no information on the identity of individuals returning to nest sites over the years, so we cannot discern whether this reuse of nest sites was caused by individual birds returning to the same site year after year. However, such precision in nest-site reuse does suggest a high rate of nest-site fidelity, which may imply a stable or increasing population. Further study of these two Pelagic Cormorant colonies including banding of adults and chicks would be needed to clarify individuals' fidelity to nest site and colony as well as the species' population dynamics. Additional study of these colonies also promises to shed light on the environmental variables most important for nest-site selection.

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LITERATURE CITED

Aebischer, N. J., Potts, G. R., and Coulson, J. C. 1995. Site and mate fidelity of Shags *Phalacrocorax aristolelis* at two British colonies. Ibis 137:19–28.

Badyaev, A. V., and Faust, J. D. 1996. Nest site fidelity in female Wild Turkeys: Potential causes and reproductive consequences. Condor 106:389–401.

Boekelheide, R. J., and Ainley, D. G. 1989. Age, resource availability, and breeding effort in Brandt's Cormorant. Auk 106:389–401.

Bried, J. L., Pontier, D., and Jouventin, P. 2003. Mate fidelity in monogamous birds: A re-examination of the Procellariiformes. Anim. Behav. 65: 235–246.

Cannon, D. M. 1990. Behavioral correlates of nesting success of the Pelagic Cormorant, *Phalacrocorax pelagicus*. M.S. thesis, University of Vermont, Burlington, VT.

Carter, H. R., Hobson, K. A., and Sealy, S. G. 1984. Colony-site selection by Pelagic Cormorants (*Phalacrocorax pelagicus*) in Barkley Sound, British Columbia. Colonial Waterbirds 7:25–34.

Fairweather, J. A., and Coulson, J. C. 1995. Mate retention in the kittiwake, *Rissa tridactyla,* and the significance of nest site tenacity. Anim. Behav. 50:455–464.

Greenwood, P. H., and Harvey, P. H. 1982. The natal and breeding dispersal of birds. Annu. Rev. Ecol. Syst. 13:1–21.

Hobson, K. A. 1997. Pelagic Cormorant (*Phalacrocorax pelagicus*), in The Birds of North America (A. Poole and F. Gill, eds.), no. 282. Acad. Nat. Sci., Philadelphia.

Huyvaert, K. P., and Anderson, D. J. 2004. Limited dispersal by Nazca Boobies *Sula granti*. J. Avian Biol. 35:46–53.

Ismar, S. M. H., Daniel, C., Stephenson, B. M., and Hauber, M. E. 2010. Mate replacement entails a fitness cost for a socially monogamous seabird. Naturwissenschaften 97:109–113.

Kokko, H., Harris, M. P., and Wanless, S. 2004. Competition for breeding sites and site-dependent population regulation in a highly colonial seabird, the Common Guillemot *Uria aalge.* J. Anim. Ecol. 73:367–376.

Lengagne, T., Harris, M. P., Wanless, S., and Slater, P. J. B. 2004. Finding your mate in a seabird colony: Contrasting strategies of the Guillemot *Uria aalge* and King Penguin *Aptenodytes patagonicus.* Bird Study 51:25–33.

Naves, L. C., Monnat, J. Y., and Cam, E. 2006. Breeding performance, mate fidelity, and nest site fidelity in a long-lived seabird: Behaving against the current? Oikos 115:263–276.

Ollason, J. C., and Dunnett, G. M. 1978. Age, experience, and other factors affecting the breeding success of the fulmar, *Fulmarus glacialis*, in Orkney. J. Anim. Ecol. 47:961–976.

Pyle, P., Sydeman, W. J., and Hester, M. 2001. Effects of age, breeding experience, mate fidelity and site fidelity on breeding performance in a declining population of Cassin's Auklets. J. Anim. Ecol. 70:1088–1097.

Siegel-Causey, D., and Hunt, G. L. 1986. Breeding site selection and colony formation in Double-crested and Pelagic Cormorants. Auk 103:230–234.

Vergara, P., Aguirre, J. I., Fargallo, J. A., and Davila, J. A. 2006. Nest-site fidelity and breeding success in White Stork *Ciconia ciconia*. Ibis 148:672–677.

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