

EVIDENCE OF DOUBLE-CLUTCHING BY BRANDT'S CORMORANTS ON ALCATRAZ ISLAND, CALIFORNIA

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ABSTRACT: Double clutches of eggs in the same season are rare among seabirds and, to our knowledge, never recorded heretofore in Brandt's Cormorant (*Phalacrocorax penicillatus*). We report here seven cases of second clutches for this species observed at a colony recently established on Alcatraz Island in San Francisco Bay, California. Chicks hatched from two of the seven second clutches, but no chicks survived to fledge. Over eight years of observation (1997–2004), second clutches were laid from 2000 to 2003 only.

Laying of a second clutch following successful fledging of a first brood, or double-clutching, is rare in seabirds, most of which require several months to complete one nesting cycle. Owing to seasonality of food or photoperiod, not enough time is usually available for the birds to complete more than one cycle (Johnsgard 1993, Hamer et al. 2002). Among the Phalacrocoracidae, only the European Shag (*Phalacrocorax aristotelis*; Wanless and Harris 1997) and possibly the Great Cormorant (*P. carbo*) in Japan (Brazil 1991) have infrequently produced second clutches. Other species, including the Double-crested Cormorant (*P. auritus*; Rauzon et al. 1989), Guanay Cormorant (*P. bougainvillii*; Murphy 1936), King or Rough-faced Shag or Cormorant (*P. carunculatus*; Nelson 1971), and Pied Cormorant (*P. varius*; Lalas 1979), are suspected of occasional double-clutching.

To our knowledge, second clutches have not been observed previously in Brandt's Cormorant. No second breeding attempts have been recorded during 34 years of monitoring of the world's largest colony of Brandt's Cormorant on Southeast Farallon Island, California (Boekelheide et al. 1990, Nur and Sydeman 1999, PRBO unpubl. data).

From 1997 to 2004, we observed Brandt's Cormorants and other seabirds breeding on Alcatraz Island, San Francisco Bay, as part of a long-term monitoring program. Here we present evidence of seven cases of second clutches among Brandt's Cormorants on Alcatraz Island from 2000 to 2003.

METHODS

Alcatraz Island (37° 49' N, 122° 25' W), located near the mouth of the San Francisco Bay estuary (Golden Gate), is home to a breeding colony of over 1000 Brandt's Cormorants, as well as several other marine birds. We monitored clutch size and chick productivity at 59–89 Brandt's Cormorant nests per year on Alcatraz from 1997 to 2004. These numbers represented 19–38% of the island's population of breeding Brandt's Cormorants, estimated as a count of the number of active nests. We recorded nest contents twice weekly from blinds, using 10 × 42 binoculars, from March through September each year. Actual laying may have taken place up to four days

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earlier than reported. Neither adults nor chicks are marked on Alcatraz because of the inaccessibility of nesting areas and sensitivity of the species to human disturbance (Boekelheide et al. 1990, Wallace and Wallace 1998).

RESULTS

On the basis of three assumptions, we observed what we interpreted as seven cases of double clutches between 2000 and 2003: (1) nest building and courtship associated with pair bonding between two new mates occurs before egg laying (Williams 1942, pers. obs.), (2) adult Brandt's Cormorants of both sexes are territorial and defend the nest site from other conspecifics (Williams 1942, Boekelheide et al. 1990), and (3) Brandt's Cormorants identify and feed only their own chicks (Carter and Hobson 1988).

In each of these seven cases, a second clutch was laid in a nest bowl from which parents had successfully fledged at least one chick. In one instance, a second clutch was laid 14 days before the first brood left the territory permanently; it is often difficult to ascertain exactly when Brandt's Cormorant chicks fledge, as they remain in the vicinity after they no longer frequent the actual nest and continue to be fed by parents. Presumed parents continued to occupy the nest bowl between clutches, indicating that a new pair had little opportunity to take over the nest. No new nest building (besides regular maintenance) or courtship displays were observed before the laying of second clutches. The absence of these normally observed behaviors suggests that the pairs at these nests had already bonded and that observed second clutches were likely laid by the same previously successful parents. In all cases, chicks from first clutches appeared dependent upon the parents for food during initiation of the second clutch, as we regularly observed incubating parents feeding fully feathered chicks at these nests.

We observed one case of double-clutching each year in 2000, 2001, and 2003, and four cases in 2002. The size of second clutches ranged from one to four eggs. Of seven second clutches, only two hatched (both in 2002), and no chicks fledged from them. The size and success of first clutches varied from two to four eggs, and from one to three chicks fledged. The chronology of all cases of double-brooding was similar. Pairs that laid second clutches began laying eggs earlier than the average date for both the colony as a whole and their particular subcolony (Table 1). These pairs were often the first to lay in the entire colony. Females began laying second clutches between 60 and 97 days after beginning first clutches (mean 79 days). In the single case of double-clutching in 2003, the second clutch was laid, and lost, before the single chick of the first brood fledged (Figure 1). All nests of pairs that produced second clutches were located very close to one another, in the oldest section of the Alcatraz colony. In each year that they occurred, the second clutches were the last eggs laid among observable nests in the colony.

DISCUSSION

Unlike successful second broods of European Shags (Wanless and Harris 1997), the rare second clutches we report here did not confer any fitness

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Table 1 Characteristics of Seven Second Clutches Laid by Brandt's Cormorants on Alcatraz Island, California

	2000	2001	2002			2003	
Colony mean lay date	24 Apr (n = 59)	21 Apr (n = 79)	18 Apr (n = 88)			5 May (n = 62)	
Date first clutch laid	6 Apr	27 Mar	22 Mar	22 Mar	29 Mar	5 Apr	5 Apr
First-clutch eggs laid (n)	2	3	4	4	3	≥ 3	4
First-brood chicks fledged (n)	1	3	2	2	2	1	1
Date first brood last observed	2 Jul	21 Jun	13 Jun	16 Jun	23 Jun	30 Jun	28 Jun
Date second clutch laid	15 Jun	14 Jun	27 Jun	20 Jun	20 Jun	16 Jun	4 Jun
Second-clutch eggs laid (n)	1	2	3	2	1	4	3
Second-brood chicks hatched (n)	0	0	3	0	0	1	0



Figure 1. An adult Brandt's Cormorant stands over a second clutch, along with a large chick from the first clutch, on Alcatraz Island, California, 5 June 2003.

Photo by Benjamin L. Saenz

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advantage to the pairs that laid them. Decreasing food resources, decreasing day-length, decreasing colony attendance, or other cues may have triggered abandonment of these second clutches and broods. The simultaneous duties of provisioning chicks from the first brood and incubating a second clutch represent a high level of energy expenditure by the parents. Provisioning the first brood may have interfered with incubation, contributing to the failure of the second clutch or brood. In contrast to most seabirds, Brandt's Cormorants lay large clutches composed of relatively small eggs (Boekelheide et al. 1990), and on Alcatraz pairs regularly fledge two to four chicks (Saenz et al. 2006). Therefore attempting a second brood may not represent a costly life-history strategy in this species.

The location of Alcatraz in the productive waters of San Francisco Bay as well as favorable oceanographic conditions may have triggered the extra reproductive effort seen by these pairs of Brandt's Cormorants. Years of cold water (Boekelheide et al. 1990) and associated high recruitment of juvenile rockfish (Nur and Sydeman 1999) have been positively correlated with the breeding success of Brandt's Cormorants in our study area. During 2001 and 2002 in particular, waters off the California coast were cold and highly productive (Thomas et al. 2003). These oceanographic conditions likely allowed Alcatraz Brandt's Cormorants to begin the breeding season in prime breeding condition. In addition, Brandt's Cormorants on Alcatraz routinely begin breeding earlier than those on Southeast Farallon Island, 48 km offshore from Alcatraz (PRBO unpubl. data), presumably because of favorable conditions offered by the San Francisco Bay. Brandt's Cormorants are able to exploit a variety of benthic and pelagic habitats when foraging (Ainley et al. 1981), and we often observed them foraging in San Francisco Bay near Alcatraz. The large amount of accessible benthos and other productive habitats available to cormorants foraging near Alcatraz may have contributed to early laying of first clutches and may have allowed birds to remain in breeding condition long enough to lay second clutches.

The conditions under which second clutches were laid on Alcatraz are similar to those reported for other seabirds. Ainley et al. (1990) proposed that conditions early in the breeding season are a principal determinant in whether Cassin's Auklets (*Ptychoramphus aleuticus*) lay second clutches on the Farallon Islands, and Wanless and Harris (1997) came to a similar conclusion concerning double-brooding European Shags. Likewise, we suggest that Brandt's Cormorants on Alcatraz Island attempted second clutches because of early or extended favorable breeding conditions.

ACKNOWLEDGMENTS

This study was supported by the Golden Gate National Recreation Area under cooperative agreement 1443-CA-8140-96-003 between the national recreation area and PRBO. The Osher Foundation provided generous support for intern field assistants. We thank the U.S. National Park Service, Golden Gate National Recreation Area, Alcatraz rangers and staff, the Golden Gate National Parks Association, and Blue and Gold Fleet personnel for providing logistical support and transportation. Bill Sydeman provided helpful advice during preparation. We thank reviewers Ron LeValley and Mark Rauzon for valuable comments on drafts of the manuscript. Jerry Nusbaum constructed the blind used for Brandt's Cormorant observations. Special thanks to

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Nathan Fairman, David Gardner, Ingrid Harrald, Maya Hayden, Roger Hothem, T. Colleen Murray, and Jason Yakich. This is PRBO contribution number 1128.

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Accepted 6 September 2006