

EGG PREDATION BY NORTHWESTERN CROWS: ITS ASSOCIATION WITH HUMAN AND BALD EAGLE ACTIVITY

NICOLAAS A. M. VERBEEK

Department of Biology, Simon Fraser University, Burnaby, British Columbia V5A 1S6, Canada

ABSTRACT.—Predation by Northwestern Crows (*Corvus caurinus*) on the eggs of Double-crested Cormorants (*Phalacrocorax auritus*), Pelagic Cormorants (*P. pelagicus*), Glaucous-winged Gulls (*Larus glaucescens*), and Pigeon Guillemots (*Cepphus columba*) was studied in the summers of 1976–1980. Crows took eggs to specific sites on their territories where they ate them and where we counted the shells. In 1980, the crows took 1,167 cormorant eggs, an estimated 22% of all eggs in first clutches. When Bald Eagles (*Haliaeetus leucocephalus*) were present, more cormorant eggs were lost to crows than on days when eagles were absent. More eagles were present on weekends than on weekdays, presumably because the local eagle population was kept inadvertently on the move by people seeking recreation on the water. Received 10 November 1980, accepted 1 September 1981.

Crows (*Corvus* spp.) are notorious predators on the eggs and young of other birds. This paper documents the predation of an island population of Northwestern Crows (*Corvus caurinus*) on the eggs of Double-crested Cormorants (*Phalacrocorax auritus*), Pelagic Cormorants (*P. pelagicus*), Glaucous-winged Gulls (*Larus glaucescens*), and Pigeon Guillemots (*Cepphus columba*). The study was conducted on Mandarte Island (48°38'N, 123°17'W), British Columbia. The cliffs on the southwest side of the island rise abruptly to a height of 10–30 m, and the island slopes downward to a height of 1–5 m along the northeast shore (Fig. 1). Pelagic Cormorants nest singly or in small, scattered groups on rocky ledges along the steep cliffs, while Double-crested Cormorants nest in tight colonies at the top of the cliffs. Gulls nest in the grass on either side of a strip of shrubs and trees that grow along the long, central axis of the island, and the guillemots nest in burrows under rocks and in crevices in the meadows and the cliffs, respectively. The crows nest in the shrubs and trees (Fig. 1).

METHODS

Starting about 1 h before sunset, my colleagues and I searched the island daily in May, June, and July 1978, 1979, 1980 and about three times per week in 1976 and 1977 for seabird eggs that had been preyed upon. In most cases we had no difficulty in deciding how many whole eggs were represented by the partial shells and fragments found. When in doubt, we guessed conservatively. We removed all the eggshells and shell fragments and either cached

them in places to which the crows had no access (1976–1979) or took them away in a plastic bag (1980). The crow territory on which the eggs were found was recorded. In 1978 and 1980 we distinguished between fresh eggs (taken on the day on which they were found) and old eggs (taken the previous day or earlier). We did not attempt to distinguish between the eggs of the two species of cormorant, because the eggs are similarly colored and shaped and overlap in size [Double-crested Cormorant: length 62.65 ± 1.85 mm, width 39.27 ± 1.16 , $n = 44$ (Verbeek MS); Pelagic Cormorant: length 58.85 ± 3.83 mm, width 37.37 ± 1.23 , $n = 20$ (Palmer 1976)], and many of the eggs were too fragmented to measure. The presence or absence of Bald Eagles was recorded daily in all 5 yr. In 1980 we also recorded how many times eagles flew over the island each day and whether or not they disturbed the gulls and the cormorants. The researchers on Mandarte Island carefully avoided disturbing the cormorants throughout this study.

RESULTS

Although the total number of cormorant eggs found varied among years, most were found in June each year (Table 1). Similarly, eggs of Glaucous-winged Gulls were found mostly in June (Table 2). The crows took few eggs of Pigeon Guillemots, presumably because their nests were concealed and difficult to enter. We may have misidentified some fragmented Pigeon Guillemot eggs as gull eggs.

A crow transports a whole cormorant egg in its bill (lengthwise) and takes it to a secluded spot on its territory to be stored or eaten (see also Montevecchi 1976). All storage sites were located within or at the outer edge of the

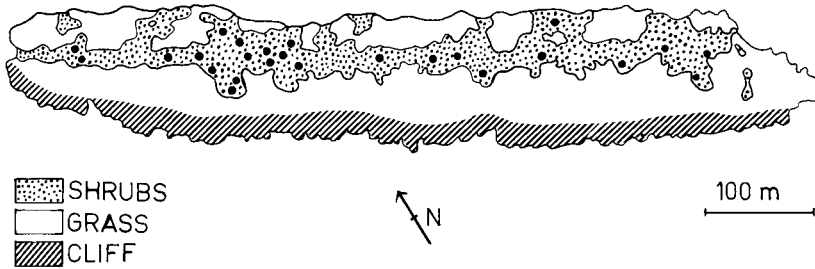


Fig. 1. Mandarte Island. The black dots represent the location of crow nests in 1980.

shrubs and trees. A pair of crows typically used the same site(s) throughout the season and usually the same sites were used each year. Sites were variable in nature, but all had some object that offered visual concealment from above. Eggs were hidden under a shrub, under a fallen tree trunk, among exposed tree roots, at the edge of small earth banks, under overhanging rocks, and inside an unused shed. The crows never took eggs to sites such as an open meadow where they would be in full view. A pair of crows thus could accumulate many eggs at the same site(s) in the course of a summer. It appeared that each pair of crows (and presumably each individual) had its own consistent way of opening an egg; some made a hole in the side of the egg and ate the contents through it; others fragmented the shell. Although some of the opened eggs contained some albumen when we found them, none contained yolk, and we rarely found cormorant eggs in advanced stages of incubation (blood inside the shell).

Cormorant eggs and young were taken from the nest by crows either during nest changeovers, when one incubating parent left the nest to be replaced by its partner (Drent et al. 1964, pers. obs.) or during disturbances when cormorants left their nests. Disturbances often occurred when adult Bald Eagles, which nested

on neighboring islands, and other nonbreeding eagles visited Mandarte Island. Bald Eagles prey on the adult gulls (pers. obs.) and their chicks (Hayward et al. 1977, pers. obs.), and they have been reported to take Pelagic Cormorants as well (Campbell 1969).

At the arrival of a Bald Eagle, gulls were the first birds to respond. If the eagle flew low over the island, the gulls would fly up, and, as the eagle continued to approach the birds, a wave of anxiety spread down the length of the island. At the first indication of an approaching eagle, the crows appeared in the tops of bushes and trees. As the excitement increased, the crows flew high into the air, which is a typical, direct response of the genus *Corvus* to potentially dangerous avian predators. It gave them the direct advantage of being above the predator and the indirect advantage of an overview of the island. Within seconds, crows from all over the island converged on the cormorant cliffs, where they soared in updrafts over the nests, dropping down swiftly to take an egg or young when the opportunity arose. We have seen incubating, female crows leave their nests during such disturbances to take an egg quickly, eat it on the territory, and return to incubate. During some disturbances, such as on 28 May 1976, we saw a crow bring an egg to its usual hiding place, deposit it there, then head

TABLE 1. The number of cormorant eggs found in Northwestern Crow territories by month and year.

Month	1976		1977		1978		1979		1980	
	Number	%	Number	%	Number	%	Number	%	Number	%
May	102	35	33	12	154	37	139	10	207	18
June	170	58	203	76	176	43	827	60	533	46
July	22	7	31	12	82	20	422	30	427	37
Total	294		267		412		1,388		1,167	

TABLE 2. The number of Glaucous-winged Gull (GWG) and Pigeon Guillemot (PG) eggs found in Northwestern Crow territories in 1978, 1979, and 1980.^a

Time	1978		1979		1980	
	GWG	PG	GWG	PG	GWG	PG
15-31 May	2	0	0	0	3	0
1-15 June	15	1	14	0	22	1
16-30 June	26	2	28	1	40	0
1-21 July	25	0	25	1	32	0

^a Comparable data were not collected in 1976 and 1977.

back immediately to get another one. After a single prolonged eagle disturbance on 21 June 1980, we found 17 recently laid eggs on one crow territory. There is little doubt that the eggs were brought in by a pair of crows, one after the other and eaten later when the disturbance was over. Some uneaten eggs were cached. When such eggs were left by us, they were eaten invariably within the next 2 days.

Not all Bald Eagles that visited the island caused disturbances. Some merely flew over the island en route elsewhere. Eagles, especially immatures, would rest on the island occasionally. They typically did this in the few trees on the island, but sometimes they rested near the top of the bare cliffs where the Double-crested Cormorants nested. In the latter case, the cormorants left their nests and continued to fly back and forth along the cliffs until the eagles departed. During such disturbances, the crows had unhindered access to the cormorant nests. The number of days in each month on which eagles were present on the island over the 5 yr is shown in Table 3. In 1976, 1977, and 1978, the percentage of days in each month that eagles were present declined from April to July, but in 1979 and especially

TABLE 4. Frequency of freshly taken cormorant eggs found on weekends (Friday to Sunday) and weekdays (Monday to Thursday).^a

Year	Weekends (3 days)		Weekdays (4 days)	
	Number of eggs	Percentage	Number of eggs	Percentage
1978	194 ^b	56	152	44
1980	525	59	373	41

^a Only in 1978 and 1980 did we distinguish daily between freshly taken cormorant eggs and those taken the previous day or earlier but not found by us.

^b In both years significantly more cormorant eggs were taken by crows on weekends than on weekdays (Chi square test, $P < 0.001$).

in 1980 eagles were present at about equal frequency throughout the season (Table 3). Visits of the eagles to the island were apparently more common during this study than they were in 1959 and 1960 (Drent et al. 1964).

Another source of disturbance was visits of small boats (sailing vessels, fishing boats, and sightseers) too close to the cormorant cliffs. In 1978 and 1980, when we distinguished daily between fresh eggs and old ones (see Methods), significantly more fresh eggs were found on weekends (including Fridays, as many small vessel operators appeared to start their weekends early) than on the remaining 4 days of the week (Table 4). The daily take of fresh cormorant eggs in 1980 is shown in Fig. 2. In addition, significantly more eagle scares also occurred on weekends than on weekdays, and many more cormorant eggs were taken on days with eagle scares than on days without scares, regardless of the time of the week (Table 5). In the absence of eagle scares, no significant differences existed between the number of eggs taken on weekends and on weekdays (Table 5).

The breeding populations of the two cor-

TABLE 3. The number of days people spent on Mandarte Island each month and the percentage of those days during which Bald Eagles were present.

Year	March		April		May		June		July	
	Days	%	Days	%	Days	%	Days	%	Days	%
1976	10	70	21	71	31	45	30	20	29	7
1977	4	75	19	75	31	55	30	47	29	41
1978	0	0	23	61	31	45	30	30	31	23
1979	6	67	29	62	31	65	30	70	22	23
1980	0	0	7	100	31	68	30	80	21	71

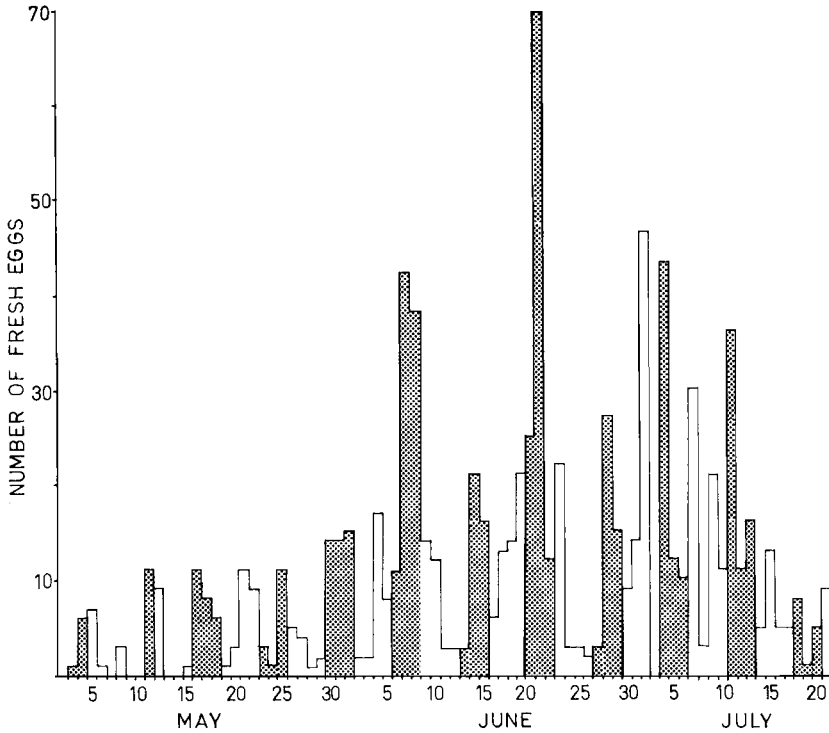


Fig. 2. The number of freshly taken cormorant eggs found in 1980. The shaded bars represent weekends and the unshaded bars represent weekdays as defined in Table 4.

morant species on Mandarte Island have increased since Drent et al. (1964) reported on them. In 1980 we counted 545 nests of Pelagic Cormorants and 794 nests of Double-crested Cormorants. These counts were made from a boat, and the count of Double-crested Cormorant nests may be an underestimate. The

mean clutch size for Pelagic Cormorants (3.83 eggs, $n = 52$) does not differ significantly from that of Double-crested Cormorants (3.94, $n = 109$, Robertson 1971). Thus, the cormorants on Mandarte Island potentially could have laid 5,200 eggs in 1980 (not counting replacement clutches), of which the crows took 1,167, or

TABLE 5. Relationship between presence or absence of Bald Eagle scares, time of the week, and the number of freshly taken cormorant eggs found in 1980.

	Weekends ^a			Weekdays			
	Number of days	Number of scares	Eggs taken	Number of days	Number of scares	Eggs taken	
With scares	23	68 ^b	451 ^c	With scares	24	46	270
Without scares ^d	13	0	74 ^e	Without scares	22	0	103

^a Weekends as defined in Table 4.

^b Significantly more eagle scares occurred on weekends than on weekdays (Chi-square test, $P < 0.05$).

^c Significantly more eggs were taken on weekends than on weekdays, (Chi-square test, $P < 0.001$), in the presence of eagle scares.

^d Eagles absent all day or present but flew over high or otherwise did not disturb the cormorants.

^e No significant difference exists between eggs taken on weekends and weekdays in the absence of eagle scares (Chi-square test, $P > 0.05$).

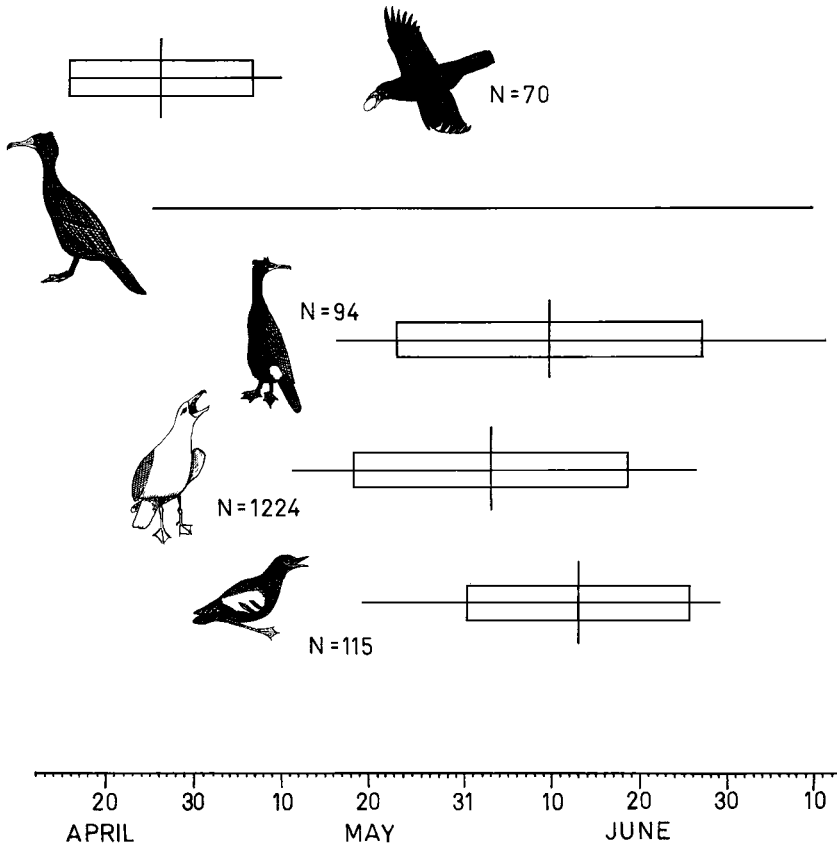


Fig. 3. The mean and standard deviation of clutch commencement of four avian species nesting on Mandarte Island. Only the range is shown for Double-crested Cormorants, because insufficient data were available. The data for cormorants and Pigeon Guillemots are based on Drent et al. (1964); those for crows and gulls are based on this study.

about 22%. About 2,200 pairs of Glaucous-winged Gulls nest on the island, the same as in 1962 (Vermeer 1963). The mean clutch size was 2.74 ($n = 1,027$, Verbeek MS). The crows took few of the eggs (Table 2). Drent et al. (1964) estimated the breeding population of Pigeon Guillemots at approximately 100 pairs, and they thought that the colony had reached maximum size. The mean clutch size was 1.91 ($n = 162$, Drent et al. 1964), so that a total of 191 eggs in first clutches was laid. The number of crows nesting on Mandarte Island increased from 13 pairs in 1976 to 25 pairs in 1980. Besides these breeding pairs, some nonbreeding yearlings (young of the previous year) were present, and some birds occasionally visited from neighboring islands. The number of yearlings and visitors was highest in April and ear-

ly May. Probably not more than 5–10 yearlings and visitors were involved in 1980. The mean dates and ranges of egg laying of the crows and the other species are shown in Fig. 3. The first cormorant eggs taken by crows on Mandarte Island were found on 30 April 1977, 25 April 1978, 29 April 1979, and 28 April 1980.

DISCUSSION

The Northwestern Crow on Mandarte Island nests early, well ahead of the seabirds whose eggs it eats (Fig. 3). We do not wish to imply, however, that early nesting in the crow has evolved in response to the nesting of the other species, because the Northwestern Crow nests early outside seabird colonies as well. Nevertheless, on Mandarte Island, the crow has cor-

morant eggs and those of other seabirds available to it from late April to late July (Fig. 3). The crow is mainly a predator of cormorant eggs, and I suspect mainly of Pelagic Cormorants. The Pelagic Cormorant nests tend to be isolated from one another, in contrast to those of Double-crested Cormorants, which nest in tight groups. The latter's colonies may be more difficult for a crow to enter, and perhaps the birds are less easily panicked. Additionally, Montevecchi (1976) has shown that crows prefer smaller eggs over larger ones. The apparent freshness of the eggs that were taken, even late in the season, suggests that perhaps a large proportion of the eggs were obtained from the same victims, which may have lost first as well as possible replacement clutches. It is possible that the cormorants flush easier from newly laid eggs than from those that have been incubated for some time.

Very few eggs of Pigeon Guillemots were taken (Table 2), as was shown also by Drent et al. (1964). Glaucous-winged Gulls also lost few eggs to Northwestern Crows. When an eagle caused the gulls to leave their nests temporarily, the crows on the island did not fly to the gull nests but to those of the cormorants. Gull eggs are not available otherwise, as the eggs are covered almost constantly. Most gull eggs that were taken by the crows were probably those that were abandoned after the others in the clutch had hatched. Table 2 shows that most of the gull eggs appeared on crow territories in the second half of June and into July, and we noticed that these eggs consistently smelled putrid, indicating that they had been spoiled for some time. I believe that most of the egg loss suffered by Glaucous-winged Gulls is due to intraspecific predation.

The increased predation of cormorant eggs in 1979 and 1980 (Table 1) is undoubtedly due in part to the increase in the crow population on the island, but more important, to the continued, frequent visits of eagles in June and July (Table 3). It is clearly shown in Table 5 that cormorants lose more eggs to crow predation on days with eagle scares than on days

without eagle scares. In addition, more eggs are lost on weekends (Table 4, Fig. 2) than on weekdays (Table 5). It appears that the weekend activity of people seeking recreation on the water and along the shores of islands surrounding Mandarte Island inadvertently stirs up the eagle population. People, then, are directly (sailing too close to the cormorant colony) and indirectly (stirring up the eagles) responsible for part of the egg loss suffered by the cormorants to Northwestern Crows.

ACKNOWLEDGMENTS

I thank Joan Morgan, Linda Graf, Loic Legendre, Jamie Smith, and Alan Stuart for their help. Financial support was provided by the Natural Sciences and Engineering Research Council of Canada. The Tseycum and Tsawout Indian Bands gave us access to their island. I appreciate the helpful comments I received from M. A. Howe, W. A. Montevecchi, C. D. Orr, and H. Richardson.

LITERATURE CITED

- CAMPBELL, R. W. 1969. Bald Eagle swimming in ocean with prey. *Auk* 86: 561.
- DRENT, R. H., G. F. VAN TETS, F. TOMPA, & K. VERMEER. 1964. The breeding birds of Mandarte Island, British Columbia. *Can. Field-Natur.* 78: 208-263.
- HAYWARD, J. L., JR., G. W. HUMPHREY, C. J. AMLANER, & J. F. STOUT. 1977. Predation on gulls by Bald Eagles in Washington. *Auk* 94: 375.
- MONTEVECCHI, W. A. 1976. Egg size and the egg predatory behaviour of crows. *Behaviour* 57: 307-320.
- PALMER, R. S. 1976. Handbook of North American birds. Vol. I. New Haven, Connecticut, Yale Univ. Press.
- ROBERTSON, I. 1971. The influence of brood-size on reproductive success in two species of cormorant, *Phalacrocorax auritus* and *P. pelagicus*, and its relation to the problem of clutch size. Unpublished M.Sc. thesis, Vancouver, British Columbia, Univ. British Columbia.
- VERMEER, K. 1963. The breeding ecology of the Glaucous-winged Gull (*Larus glaucescens*) on Mandarte Island, B.C. British Columbia Provincial Mus., Occ. Pap. 13.