Site Fidelity and Reproductive Success of Black Oystercatchers in British Columbia

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Abstract.—We compared reproductive success and territory fidelity in Black Oystercatchers (*Haematopus bachmani*) in the Strait of Georgia, British Columbia. Twenty-four of 34 nesting pairs hatched eggs in at least one year of the study, and of which 16 pairs raised chicks that fledged. Mean fledging production for 34 pairs in 1996 and 1997 was 0.44 fledglings per breeding pair per year. Thirty of the 34 pairs observed used the same territory in 1996 and 1997. Of the 30 pairs that occupied the same territory in both years, 16 pairs failed to raise chicks in both years, seven pairs fledged chicks in one year and seven pairs fledged chicks in both years. Oystercatchers showed stronger site fidelity to territories where chicks were fledged than territories where they failed to raise young. *Received 23 October 2000, accepted 23 February 2001.*

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An important fitness decision for birds is when and where to reproduce. European Oystercatchers (*Haematopus ostralegus*) nesting in shoreline territories adjacent to feeding areas raised more offspring than those that nested inland (Ens *et al.* 1992). Shoreline territories were strongly defended by nesting pairs of oystercatchers, whereas inland sites were widely available. Consequently, some non-territorial individuals waited years for an opportunity to nest on the shoreline while others settled earlier at inland sites where they reproduced less well than pairs along the shore (Ens *et al.* 1992).

Studies of the breeding biology of the Black Oystercatcher (*Haematopus bachmani*) across its North Pacific coast range in North America (Webster 1941; Kenyon 1948; Hartwick 1974; Nysewander 1977; Groves 1982; Purdy 1985; Vermeer *et al.* 1992; Andres 1996) indicated that habitat selection also plays an important role in the reproductive success of this oystercatcher. At the territory level, Vermeer *et al.* (1989) showed that oystercatchers in southern British Columbia preferred small, unforested islands inhabited by nesting gulls, where they placed nests close to logs or rocks. Andres (1998) demonstrated that oystercatchers in Alaska selected small flat islands in preference to steep-sloped islets. A general feature of European Oystercatchers is a propensity for pairs to return to territories where chicks were raised to fledging age (Harris 1967; Ens *et al.* 1992), and the same pattern was suggested for the Black Oystercatcher (Hartwick 1974). These studies suggest that features of territories are an important component of reproductive success among oystercatchers. Moreover, these studies suggest that reproductive success plays an important role in future use of a breeding territory. In this paper, we compare reproductive success and site fidelity in Black Oystercatchers in British Columbia.

STUDY AREA AND METHODS

Breeding Black Oystercatchers were studied from 21 April to 10 August 1996, 1 May to 5 August 1997, and marked individuals from previous years were searched for during June 1998 in the southern Gulf Islands in the Strait of Georgia, British Columbia (48°35'N, 123°15'W). The Gulf Islands are an archipelago of 284 islands and islets in the Strait of Georgia, between Vancouver Island and the mainland of British Columbia (Fig. 1). Our study area included 21 Gulf Islands and islets near Sidney, British Columbia (Fig. 1). All islands in the study site, regardless of size or forest cover, were searched between 21 April and 30 May 1996 for breeding pairs of Black Oystercatchers. All islands were circled by motorboat and searched on foot for evidence of nesting on all islands with oystercatchers. A territory was considered occupied if it held eggs, or an adult feigned a broken wing or fake brooded (Nol 1985; Purdy and Miller 1988).

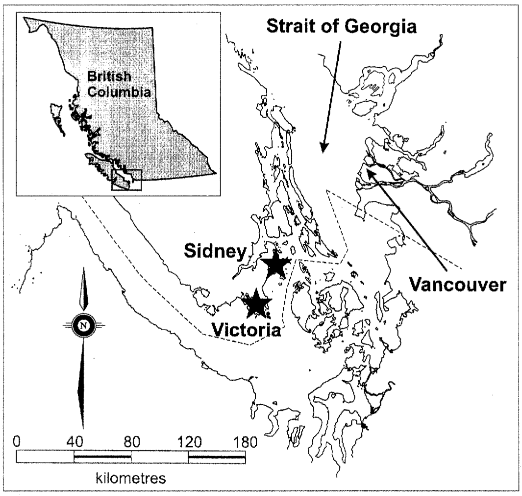

Figure 1. Black Oystercatcher study site in the southern Gulf Islands, Strait of Georgia, British Columbia.

Each of 34 breeding territories was visited in 1996 and 1997 about every five days until the oystercatcher breeding attempt failed, or chicks could fly. Reproductive failure was assumed to have occurred when no replacement clutch was laid within 14 days after the eggs were lost, or when chicks or both adults were absent from a territory on two consecutive visits. Reproductive measures include the number of eggs laid in the first clutch and replacement clutch size, brood size at hatching, hatching success (percent eggs hatched), fledging success (percent hatchlings fledged) and annual fledgling production (number fledglings per breeding pair). Most female oystercatchers lay their eggs in May in the southern Gulf Islands (Drent *et al.* 1964). Clutch size of the first clutch in a season was the number of eggs laid in a nest before 30 May or known to be the first clutch. The rate of egg loss to predators can be high and single eggs lost from a clutch were not replaced (Hartwick 1974; Vermeer *et al.* 1992; Andres and Falxa 1995; Andres 1996), so our estimate of clutch size is conservative. Some pairs that lost all of their eggs early in the season laid a replacement clutch. Therefore, we used the total number of eggs laid by each pair when calculating hatching success (Ens *et al.* 1992). Chicks were considered to have successfully fledged when they survived to 35 days or were capable of flight (usually 38-40 days) (Andres and Falxa 1995).

Twenty-two breeding adults were trapped on nests during the incubation period in 1996. Each adult was banded with a 1cm tall yellow plastic leg band with unique alpha-numeric coding for individual identification. Hatchlings were marked first with non-toxic waterproof ink on the tarsus until they were about ten days old, after which age they were large enough to hold a plastic leg band.

RESULTS

We found breeding oystercatchers on 38 territories over the two years of our study. Thirty of the 34 territories occupied in 1996 were also occupied in 1997. Four sites not used in 1996 were occupied in 1997. Thus, 34 breeding pairs were present in the two years and they used 38 sites over two seasons. Of 34 breeding pairs, 24 hatched eggs and 16 fledged young in at least one of the two years. Mean hatching success was 44% in 1996 and 33% in 1997 (Table 1). Mean fledging success was 39% in 1996 and 60% in 1997 (Table 1). Mean fledgling production for 34 oystercatcher pairs breeding in the southern Gulf Islands in both years was 0.44 fledglings/breeding pair/year (Table 1).

Egg loss during the incubation period always involved complete clutch loss during our study (N = 41 cases). However, single eggs frequently disappeared during the hatching period. Of 22 eggs that disappeared or did not hatch close to the hatch period in 1996 and 1997, seven went missing during hatch and were presumed to have been predated, nine failed to hatch, and six were damaged at the time of hatching or the chicks died soon after hatching. Plotting the daily survival of eggs and chicks on a logarithmic scale reveals the hatching period as the stage with the greatest rate of egg and chick loss, while daily survival of incubated eggs and older chicks were similar (Fig. 2). To demonstrate that this pattern does not only represent possible addled and infertile eggs, we removed the 15 unhatched eggs from the dataset. Excluding the possible addled eggs, the rate of egg loss at hatch is still striking (Fig. 2).

Fledgling productivity on a territory was consistent between years. Of the 30 breeding pairs that used the same territory in both

Table 1. Number of Black Oystercatcher breeding pairs, eggs and chicks observed in the southern Gulf Islands, Strait of Georgia, British Columbia in 1996 and 1997.

	1996	1997	Total
No. breeding pairs	34	34	68
No. first clutches	30	31	61
No. replacement clutches	8	8	16
No. eggs laid	86	75	161
No. pairs hatching young	21	15	36
No. eggs hatched	38	25	63
No. pairs fledging young	12	11	23
No. chicks fledged	15	15	30

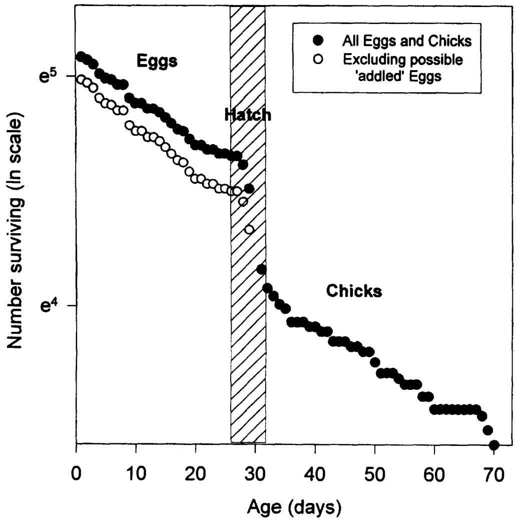

Figure 2. Daily survival of Black Oystercatcher eggs and chicks in the southern Gulf Islands, British Columbia in 1996 and 1997 (day 0 = start of incubation). The bar indicates the hatching period.

years over half (N = 16; 53%) failed to produce young in both years. Seven pairs (23%) fledged at least one young in one season and an additional seven pairs (23%) fledged at least one young in both years. There was a significant probability that a pair fledging young on a territory in 1996 also successfully fledged oystercatcher young on the territory in 1997 (Fisher's Exact Test, $\chi^2_{28} = 7.2$, $P < 0.05$). Nearly half (47%) of the 63 oystercatcher hatchlings fledged over the two seasons.

None of the fledglings from 1996 were seen in the study area during the 1997 breeding season or during June 1998. However, naturalists in British Columbia and parts of Washington reported four chicks between 12 and 29 months after banding. These sightings were made in La Conner, Anacortes and Victoria, 20 to 80 km from the natal site.

Twenty-one (96%) of 22 adults marked in 1996 returned to the study area in 1997, of which 20 (91%) returned to the same territory occupied in 1996. After clutch predation, eight of 16 (50%) replacement clutches were laid in the same scrape. Returning pairs exhibited high nest-scrape fidelity, with 24 of 30 (80%) pairs laying in the same scrape in both years. Four of the 19 breeding pairs that failed to raise young in 1996 moved to new territories that were unoccupied in 1996. The mean distance to a new territory was 1.98 km (SD ± 0.9 km). Three of the four pairs that moved failed to hatch eggs and the remaining pair lost their only chick. Failed breeders were observed intruding and being driven off territories held by pairs that successfully raised fledglings. Pairs on territories occupied in both years had significantly higher hatching success (Wilcoxon test: Z = 1.97, P < 0.05) than pairs occupying a territory for only one year, however there was no significant difference between fledging success or fledgling productivity (Table 2).

DISCUSSION

Black Oystercatchers exhibited stronger site fidelity to territories that produced chicks to fledging age compared to pairs on territories that failed to produce chicks. We also showed that individuals that failed to raise chicks attempted to nest in new sites and to intrude on pairs on territories with chicks. Our findings concur with those of the European Oystercatcher in which the same nesting pairs occupy the best territories and

Table 2. Comparison of hatching success, fledging success and fledgling productivity between breeding Black Oystercatcher pairs that occupied territories in both seasons and pairs that occupied a territory for one season. The mean success over two years is given for pairs that occupied territories in both seasons.

	Occupancy							
	One year			Both years				
	Mean	SE	N	Mean	SE	N	Z	P
Hatching success	17%	5%	8	39%	2%	30	1.97	<0.05
Fledging success	50%	25%	2	50%	2%	22	0.01	n.s.
Fledgling productivity	0.25	0.06	8	0.60	0.02	30	1.31	n.s.

that poor territories are occupied somewhat sporadically (Harris *et al.* 1987; Safriel *et al.* 1984; Ens *et al.* 1992).

Annual fledgling productivity and other reproductive estimates in our study area were similar to estimates from other sheltered coastlines of British Columbia and Alaska (Vermeer *et al.* 1992; Andres 1996). In our study, reproductive success on territories was consistent between years with most pairs failing to produce young in both years, and relatively few pairs fledging chicks in both years. The daily survival of incubated eggs and chicks were similar, however daily survival plummeted during the hatching phase and during the first days after hatch. This pattern could reflect the proportion of addled and infertile eggs, but is still very apparent when the known unhatched eggs are removed from the dataset. Groves (1984) and our study shows that egg/chick mortality was highest during hatch and the first week post hatch. Hence, it appears that the hatching stage is the critical period determining differential success in Black Oystercatchers, differing from the European Oystercatcher, where the chick-rearing stage is the period of high mortality (Harris 1967; Ens *et al.* 1992; Kersten and Brenninkmeijer 1995).

Although 30 oystercatcher chicks survived to fledging in both years of our study, only four were observed in the Strait of Georgia within one to two years after hatching. The mortality rate for birds in their first year of life is unknown for this species, however Kersten and Brenninkmeijer (1995) showed high mortality for hatch-year European Oystercatchers, where mortality rates are higher in colder winters (Kersten and Brenninkmeijer 1995). Alternatively, Black Oystercatchers might not return to the natal area for a number of years, until they reach the age of first breeding, a pattern also documented in the European Oystercatcher, where young birds exhibit high levels of philopatry (Kersten and Brenninkmeijer 1995).

Two previous oystercatcher studies in British Columbia addressed breeding site fidelity of marked oystercatchers (Hartwick 1974; Groves 1982). Our combined results reveal a very high level of territory fidelity. Oystercatchers during our study occupied sites described over three decades ago by Drent *et al.* (1964). The accumulation of data from marked individuals, along with the observation of strong site fidelity to some islands, provides evidence that breeding Black Oystercatchers exhibit both strong territory and nest scrape fidelity. This finding concurs with studies of other oystercatcher species and probably is characteristic of the genus (Harris 1967; Harris *et al.* 1987; Ens *et al.* 1992; Nol and Humphrey 1994).

Many studies have found a positive relationship between reproductive success and duration of territory use (Ens *et al.* 1992 and references therein). Territory fidelity of Black Oystercatchers was high, although a few pairs attempted to breed at other near-by sites. The four pairs that changed territories had failed to reproduce in the previous season. Pairs on territories occupied in both years had significantly higher hatching success than pairs that occupied territories only once in the two year period. This pattern suggests that the differential reproductive success of Black Oystercatcher breeding pairs observed may be in part due to territory quality, a pattern documented in other oystercatc;her species, particularly the European congener (Nol 1989; Harris *et al.* 1987; Ens *et al.* 1992). Although reproductive success of Black Oystercatcher breeding pairs is extremely variable, this paper demonstrates that success of the individual breeding pairs plays a role in future use of the territory.

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