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RHINOCEROS AUKLET BURROW USE, BREEDING SUCCESS, AND CHICK GROWTH: GULL-FREE VS. GULL-OCCUPIED HABITAT

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Abstract.—The effect of Glaucous-winged Gulls (*Larus glaucescens*) on the breeding of Rhinoceros Auklets (*Cerorhinca monocerata*) was studied by installing 20 artificial burrows each, in gull-occupied and gull-free level nesting areas on Protection Island, Washington. The burrows were monitored from 1989 to 1991. The presence of gulls did not affect auklet burrow use, breeding success or egg-laying dates. Analysis of weight/wing composite growth curves showed that auklet chicks from gull-free areas grew significantly faster than chicks from the gull colony throughout this study. Adult auklets, delivering fish to their young, are presumably more prone to kleptoparasitism by gulls when nesting in level areas, where they have to run across open ground to their burrows. On Protection Island only a small percentage of auklets nest in level areas occupied by gulls.

UTILIZACIÓN DE MADRIGUERAS, ÉXITO REPRODUCTIVO Y CRECIMIENTO DE POLLUELOS DE *CERORHINCA MONOCERATA* EN HABITATS OCUPADOS POR GAVIOTAS Y HABITATS LIBRE DE ÉSTAS

Sinopsis.—Se estudió, en la Isla Protection de Washington, el efecto de la gaviota *Larus glaucescens* en la reproducción de alcacillas (*Cerorhinca monocerata*). El trabajo se llevó a cabo instalando 20 madrigueras en una localidad ocupada por gaviotas y 20 adicionales en otra libre de estas. Las madrigueras fueron monitoreadas desde el 1989 a 1991. La presencia de gaviotas no afectó el uso de las madrigueras por parte de las alcacillas, ni tampoco el éxito reproductivo o la fecha de puesta de huevos. El análisis de curvas de crecimiento, tomando en consideración peso/tamaño del ala, demostró que los polluelos crecían significativamente más rápido en lugares libres de gaviotas, que en las que éstas, estaban presentes. Las alcacillas, que llevan comida a sus polluelos, son más suceptibles (presumiblemente) a kleptoparasitismo por parte de las gaviotas cuando anidan en lugares poco accidentados; en éstos, tienen que correr a través de áreas abiertas para tener acceso a sus madrigueras. En la Isla Protection, un bajo porcentaje de las alcacillas, viven en localidades abiertas que están además ocupadas por gaviotas.

In Washington and British Columbia populations of Glaucous-winged Gulls (*Larus glaucescens*) have increased during the last decades (Reid 1988). As a result of this increase, on several islands, gull colonies have expanded into areas that were formerly only used by breeding Rhinoceros Auklets (*Cerorhinca monocerata*). Watanuki (1990) has studied the behavioral interactions of Rhinoceros Auklets and Black-tailed Gulls (*Larus crassirostris*) in Japan, and several authors (Vermeer 1979, Wilson and Manuwal 1986) have reported that Glaucous-winged Gulls occasionally kleptoparasitize Tufted Puffins (*Fratercula cirrhata*) and Rhinoceros Auklets, which are also a species of Puffin (Storer 1945). As the only quantitative studies on the effects of gulls on the breeding of puffins come from

the Atlantic (Harris 1984; Nettleship 1972; Pierotti 1983; Rice 1985, 1987), I decided to investigate the effect of Glaucous-winged Gulls on Rhinoceros Auklet reproduction on Protection Island, where large numbers of gulls and Rhinoceros Auklets coexist (Wilson and Manuwal 1986).

METHODS

This study was conducted on Protection Island (48°08′N, 122°56′W), Washington. The island has an estimated breeding population of >17,000 pairs of Rhinoceros Auklets (Wilson and Manuwal 1986), and over 7000 pairs of Glaucous-winged Gulls (J. Galusha, pers. comm.). Artificial Rhinoceros Auklet burrows were used to study auklet breeding success. The burrows were constructed and maintained according to Wilson (1986). In March 1988, 20 artificial burrows were installed in the gull colony above the south cliffs of the island. The burrows were spread over a distance of 300 m and were located along the level bluff edge so that erosion did not pose a threat to the burrows for several years. The average Glaucous-winged Gull density in this area was 4.1 pairs per 100 m^2, and was determined from nest counts in eight randomly spaced 10 × 10 m quadrats in 1991. Similarly, another 20 artificial burrows were installed in gull-free habitat at the NW and SE ends of the island. I monitored the burrows during the 1989–1991 breeding seasons. By 1989 the excavation scars had grown over so completely that the burrows could only be located from their numbered stakes. At the onset of each breeding season in March, I made sure that the entrances had not filled in with soil during the winter. At this time I also provided each burrow with fresh soil. The burrows were then left undisturbed until most chicks had hatched. Auklet use of burrows without chicks was determined from the presence of fecal deposits, feathers and nesting material. The chicks found in the burrows were weighed with a 300 g or 500 g Pesola scale (depending on chick size) and their wing chords were measured with a 200 mm ruler. In 1989 and 1991 chicks were weighed and measured three times, whereas in 1990 measurements were taken on four occasions. Measuring intervals varied between 7 and 13 d. The chicks were aged by comparing their initial wing measurement with wing growth data from Wilson (1977). Chick growth was analyzed by regressing weight on wing length during the linear phase of their weight increase. Measurements of chicks that had just hatched (wing length <30 mm) or were near fledging (wing length >155 mm) were excluded. By using the repeated measurements of the chicks, I constructed a composite growth curve, similar to Ricklefs and White (1975), for each habitat type and breeding season. The growth of the chicks from the two areas were then compared, by comparing the slopes and elevations (Y intercepts) of the linear regressions fitted to the data sets, as described in Zar (1984). I decided to use wing length as the independent variable, instead of age, because Rhinoceros Auklet chicks cannot be accurately aged from their wing chords (Wilson 1977). All data from the gull colony burrows were compared with data from the burrows in gull-free habitat.

RESULTS

Rhinoceros Auklet use of the burrows was not influenced by the presence of gulls. Between the two habitats, there was no significant difference in the number of burrows entered by auklets in 1989 and 1990 (χ^2 = 0.360, P = 0.548 and χ^2 = 0.229, P = 0.633, respectively), and in 1991 the numbers were identical. Of the artificial burrows in the gull colony, 18 were used in 1989 and 1990, and 19 in 1991. In the gull-free area, 19 burrows were used in 1989 and 1991, and 17 in 1990. Similarly, the numbers of burrows with chicks were not significantly different in 1989 (χ^2 = 0.404, P = 0.525) and were identical both in 1990 and 1991. In the gull colony, 12 burrows produced chicks in 1989 and 1991, while 11 had chicks in them in 1990. Of the burrows in the gull-free area, 10 had chicks in them in 1989, 11 in 1990, and 12 in 1991. Breeding chronologies of auklets in gull-free and gull-occupied habitats also appeared very similar, because the ages of the chicks of the two habitat types were not significantly different during this study (Mann-Whitney U test; 1989: U = 53, P = 0.849; 1990: U = 81, P = 0.826; 1991: U = 66, P = 0.729).

Linear regression analysis of the composite growth curves, constructed from the weight/wing data, showed that the curves of the chicks reared in gull-free habitat were significantly different from the curves of the chicks from the gull colony (Fig. 1). In 1989 the gull-free curve had a significantly greater slope and elevation (Y intercept) than the gull colony curve (t = −1.988, df = 59, P < 0.05, and t = −2.308, df = 60, P < 0.025, respectively). Similarly, in 1990, the gull-free curve had a significantly greater slope (t = −2.448, df = 91, P < 0.01), and in 1991 the elevation of the gull-free curve was significantly higher than the gull colony curve (t = 1.995, df = 59, P < 0.05).

DISCUSSION

The only difference between Rhinoceros Auklets from the two habitat types was in the chick weight/wing composite growth curves. As wing growth is less sensitive to nutritional variation than weight (Ricklefs and White 1975), one can assume that weight/wing growth curves to some extent depend on how well chicks are provisioned. Thus, throughout this study, chicks in gull-free habitat grew faster than nestlings from the gull colony. Rice (1985) suggested that gull kleptoparasitism had an effect on Common Puffins (*Fratercula arctica*) when food was abundant, and that the effect was absent when feeding conditions were poor. On Protection Island, in contrast, auklet growth curves had the steepest slopes in 1991 (Fig. 1), presumably because of good feeding conditions, although differences in chick growth between the two habitat types showed a smaller significant difference in 1991 than either in 1989 or 1990. As the nocturnal Rhinoceros Auklet provides its young with fewer and relatively larger food loads than do diurnal Common Puffins, the loss of a food load to gulls during poor feeding conditions may have a greater overall impact on Rhinoceros Auklet chicks. Clearly the relationships between food avail-

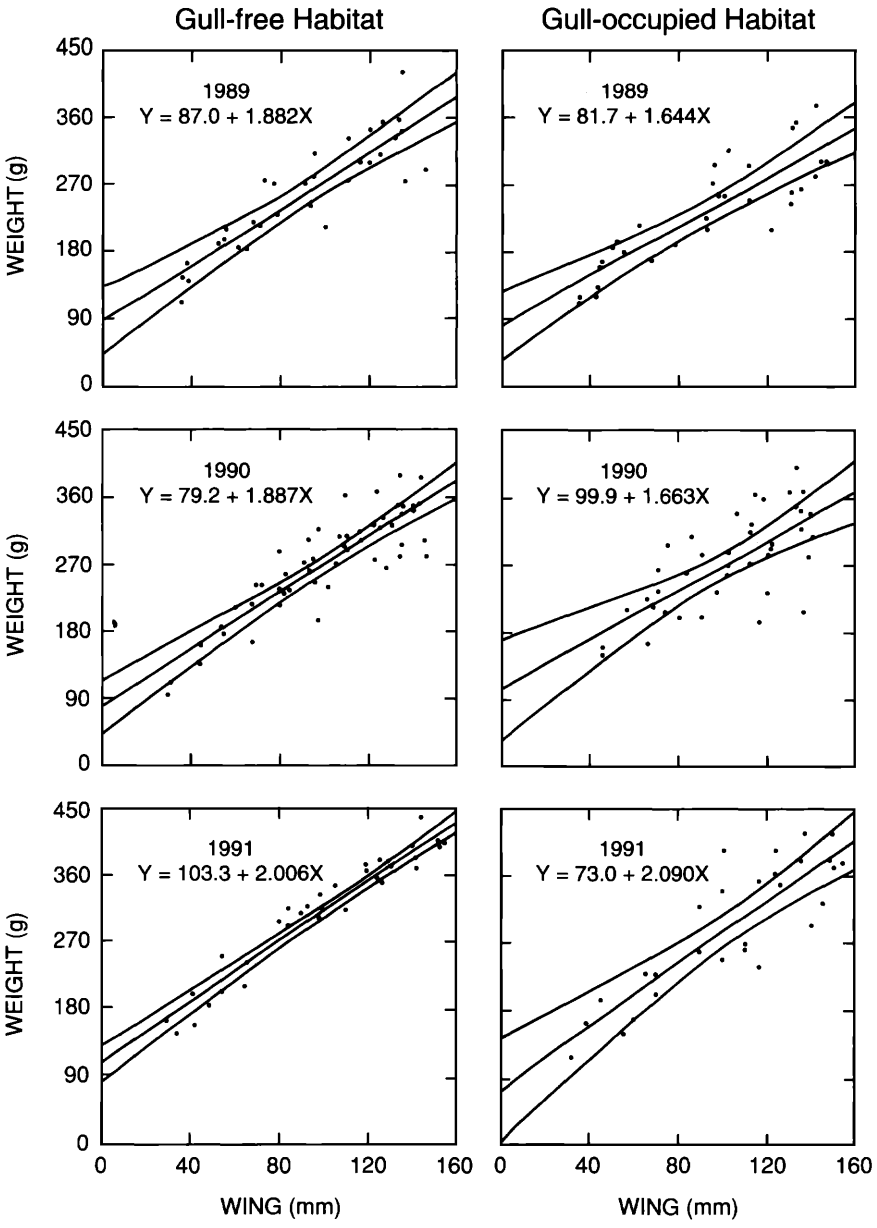

FIGURE 1. Linear regression estimates, with 95 percent confidence limits, of Rhinoceros Auklet chick growth in gull-free vs. gull-occupied areas, Protection Island, Washington, 1989–1991.

ability, occurrence of kleptoparasitism, and chick provisioning rates are complex and poorly understood and require further study. Bertram et al. (1991) also concluded that the manner in which Rhinoceros Auklet parental provisioning was affected by changes in ocean production was not clear.

The findings that Rhinoceros Auklet chicks grew faster in gull-free areas may not be inconsistent with the views of Pierotti (1983) and Rice (1985), that gulls have little effect on puffin reproduction. It is important here to point out that their studies were conducted on puffins that nested on grassy slopes. Harris (1984), who also shares their view, points out that chicks of Common Puffins nesting on level ground or in areas where landings are difficult, grow more slowly. By having to run from their landing spot to their burrows, the adults were exposed to opportunistic gulls. Such is also the case for this study, because all artificial burrows were located on level ground. It was not uncommon for a gull nest to be located within 1 m of an artificial burrow entrance. On Protection Island only 11% of the auklets nest in level areas (Wilson and Manuwal 1986), and only about one third of these birds breed in areas occupied by gulls. The preference of Rhinoceros Auklets for slope habitat may be due to the risk of kleptoparasitism and slow chick growth in level areas.

The fact that auklet burrow use, nesting success and breeding chronologies did not differ significantly between the two habitat types, and that only a small portion of the auklets nest on level ground in the gull colony, suggests that the Protection Island Rhinoceros Auklet population is not seriously threatened by Glaucous-winged Gulls.

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