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Corella, 1996, 20(1): 13–16

HABITUATION TO HUMAN DISTURBANCE BY BREEDING BRIDLED TERNS *Sterna anaethetus*

J. N. DUNLOP

162 Swansea St East, East Victoria Park, Western Australia 6101

Received 24 March, 1995

Bridled Terns *Sterna anaethetus* breeding on Penguin Island in south-western Australia allow much closer human approach than they do on remote Bridled Island off the Pilbara coast. This difference in behaviour is attributed to the gradual habituation of Penguin Island terns to the regular presence, and relatively predictable activity, of people at that colony. The management implications for planning human visitation to seabird colonies are discussed.

INTRODUCTION

Wildlife managers such as the Australian Nature Conservation Agency are developing guidelines to control the effect of human visitation to seabird islands. The concept of "critical distance" is prevalent in the literature; that is the distance at which breeding seabirds could be approached without eliciting escape or anti-predator behaviour.

Erwin (1989) measured critical distances in a variety of colonial waterbird species breeding at coastal sites in Virginia and North Carolina. This

worker recommended approach distances of 100 m for Least *Sterna antillarum* and Royal Terns *Sterna maxima* and 200 m for Common Terns *Sterna hirundo* and Skimmers *Rhyncops niger*.

In this study Erwin found little relationship between critical distance and the stage of the breeding cycle. However, it is likely that this is an important factor particularly in species which do not return to their previous nest positions and have only tentative affinities with former colony areas, such as in Crested Terns *Sterna bergii* (Dunlop 1987). In terns employing this strategy site tenacity is weak in the pre-laying and early incubation stages, increases markedly through the incubation period and is strong around hatching (Dunlop 1987, pers. obs.).

Erwin acknowledges that habituation to human intruders is another factor which might be significant, citing some work on gulls (Burger and Gochfeld 1983). Habituation is more likely to develop in species with higher nest site/area fidelity such as the Bridled Tern *Sterna anaethetus* (Dunlop and Jenkins 1992).

A recent review of seabird conservation in Australia (Blaber *et al.*, in press) suggested that Bridled Terns *Sterna anaethetus* were prone to abandon colonies if subjected to human disturbance. This study describes the response of this species to human intrusion at two Western Australian colonies with contrasting levels of human visitation.

STUDY AREAS

Approach distances between breeding Bridled Terns and humans were measured at colonies at Penguin Island (32°17′S, 115°41′E) near Fremantle in south-western Australia and Bridled Island (20°43′S, 115°30′E) in the Lowendal Group 135 km off Karratha on the Pilbara coastline. On both islands Bridled Terns nest in large numbers in dispersed colonies at similar densities. Nesting habitats were comparable with nests being concealed in limestone crevices or cavities and under low vegetation.

Penguin Island has been inhabited and/or regularly visited by people since at least 1918 with the pressures increasing markedly since the mid-1970s (Conservation and Land Management 1992). Today the 12.5 ha island gets an estimated 80 000 visitors during the period from September to April, which coincides with the Bridled Tern breeding season. The terns started nesting on Penguin Island sometime after 1950 and a progressive expansion in the area of the colony and in the number of birds has been documented from 1983 to the present (Dunlop and Jenkins 1994).

An estimated 1 200–1 500 pairs of Bridled Terns now breed in three main sub-colonies which currently occupy less than half the available area (Dunlop and Jenkins 1994).

In February 1995, Bridled Island had an estimated 3 000–4 000 breeding pairs nesting all over an available land area of about 10 ha. The island is remote and rarely visited. Before this field study, the colony had not been subjected to research activities; except infrequent, short duration monitoring visits by government and petroleum company personnel.

METHODS

Observations on approach distances were made on 4 February 1995 on Penguin Island and 10 February 1995 on Bridled Island. In both cases observations were carried out between 1500 and 1800 hr. On Penguin Island most adults were tending chicks more than four weeks old including some fledglings. A few late downy young were also present. The situation on Bridled Island was not as advanced with adults tending chicks less than three weeks old and some pairs still incubating.

On both islands an observer walked slowly and steadily towards a pre-selected, settled, site-holding tern. On Penguin most terns were approached from the shorelines or along the boardwalks whilst on Bridled Island terns were also selected in central colony areas. Incubating birds (Bridled I) were not approached but individuals involved in paired ground displays were included in the sampling. Approaches were abandoned or discounted where alarm calls or dread notes (Serventy *et al.* 1971) were given by terns other than the subject individual, as escape behaviour may have been precipitated by events not related to the observer. During each approach, the subject tern was observed until it was flushed from its station. Where the tern allowed an approach to within 1 m the observer's arm was slowly extended towards the subject until it flew off or moved away. At the moment of flushing, the nearest position of the observer was marked and the distance to the subject's station was then measured. The distance was paced out where it was greater than 5 m and within 5 m a tape measure was used. In all, 35 approach distances were measured on Penguin Island and 39 on Bridled Island.

RESULTS

Generally site tenacity in terns can be expected to decline as the chicks become more mobile and this would have favoured shorter approach distances on Bridled Island. However, approach distances were much shorter and less variable on Penguin Island (Fig. 1). On this island the modal approach distance fell in the 1.1–2 m class and all site-holding terns allowed approach to within 4 m (Fig. 1). By contrast, on Bridled Island no terns tolerated approach within 2.5 m and the modal approach distance was the 5.1 to 6 m class. Approach distances recorded on Bridled Island ranged to 27 m.

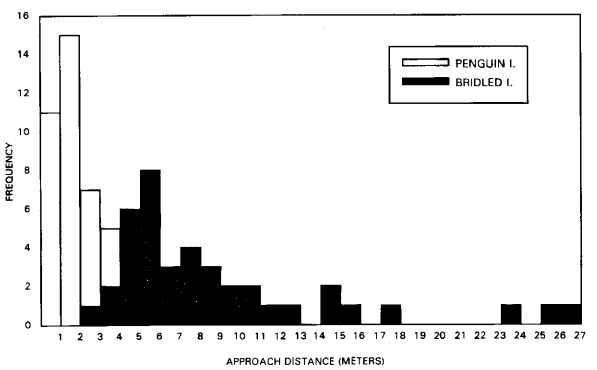

Figure 1. *Stack frequency distributions of approach distances recorded at Bridled Tern colonies on Penguin Island (n = 35) and Bridled Island (n = 39).*

The median approach distances for the two distributions were significantly different (Mann-Whitney U = 685.5; one tailed $P < 0.05$).

DISCUSSION

The number of breeding Bridled Terns has increased on Penguin Island over several decades despite constant recreational activity at the colony during the breeding seasons (Dunlop and Jenkins 1994). Human activities and patterns of movement around the island have always been relatively predictable and have become more so since the walkways were established, (beginning in 1983). Indeed, over the last five years the colony has expanded into the recreational area on the tombolo which is subjected to the greatest visitor concentration (Dunlop and Jenkins 1994).

The pattern of escape responses recorded on Bridled Island have also been observed in smaller colonies of 70–150 pairs in the Dampier Archipelago, where human visits are also infrequent. The contrasting behaviour exhibited by Bridled Terns in these relatively remote areas demonstrates the extent to which Penguin Island Terns have habituated to the continuous presence of benign human intruders. This habituation has apparently dampened inappropriate escape responses. Some pairs subject to very high exposure to human activity have also become noticably more aggressive in defence of nest sites. Similar comparisons are evident with the Silver Gull *Larus novaehollandiae* breeding colonies on the two study islands.

The implications for the management of public access to seabird islands are the antithesis of the critical distance guidelines approach (Erwin 1989; Blaber *et al.*, in press). Assuming that the islands in question are large enough to allow seabirds to adjust to the presence of humans, and that a decision has been made to allow passive public access , then the priority is to establish a human presence gradually. It is imperative that management creates a predictable pattern of human movement, consistent group sizes and reliable behaviour patterns. This can be achieved by both active (barriers, signage, supervision) or passive (education, walkways and amenities) techniques. Surface nesting seabirds can then establish appropriate species-specific approach distances in response to an established and rigorously maintained human regimen.

The results of a similar management approach, in an ecotourism context, were documented for White Terns *Gygis alba* nesting near walkways on Cousin Island in the Seychelles (Diamond 1985).

ACKNOWLEDGMENTS

This study was conducted with assistance in the field from Shirley Hewett, Katie Dunlop, Mark Gager and Rebecca Yeates. Dhanu River and Mike Slack-Smith provided computing expertise in preparing the figure. Access to Bridled Island was attained whilst monitoring seabirds in the Lowendal Group during a project funded by Apache Energy. The Department of Conservation and Land Management granted permission to carry out seabird research on Penguin and Bridled Islands.

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Corella, 1996, 20(1): 16–19

THE GUT PASSAGE RATE OF SILVEREYES AND ITS EFFECT ON SEED VIABILITY

KRISTINE FRENCH

Department of Ecology and Evolutionary Biology, Monash University, Clayton, Vic. 3168
Present address: Department of Biological Sciences, University of Wollongong, Wollongong, NSW 2522

Received 25 May, 1995

The gut passage rate of Silvereyes *Zosterops lateralis,* was measured with fruits of *Coprosma quadrifida*. The rate of passage of seeds was measured when fed to birds whose guts were empty and compared to the rate when fed to birds that had eaten previously. Gut passage rates ranged from six to 28 minutes but was significantly slower when birds had consumed food.

The viability of the ingested seeds was measured using tetrazolium. There was no significant difference in the viability of seeds that had passed through an empty gut versus a gut with food. However, the viability of seeds that had passed through Silvereyes was significantly lower than the viability of fresh seeds.

This study has shown that food availability will influence the speed of passage through the gut and therefore the distance seeds are dispersed. It also suggests that laboratory trials that use starved birds can give erroneous speeds. Although there was little evidence that time spent in the gut affected viability, passage through the gut was clearly disadvantageous for seed viability. However, this may be counteracted by advantages in dispersal distance.

INTRODUCTION

Seeds dispersed by vertebrates often travel through the gut of the vertebrate, an environment that is naturally lethal to the embryo within the seed (Janzen 1983). The viability of the embryo after transit is likely to be influenced by the protective coating surrounding the seed and the length of time the seeds are exposed to the digestive secretions of the gut. Studies on the effect on germination of passage through the gut have sometimes shown enhanced germination and at other times reduced or no effect on germination (Krefting and Roe 1949; Noble 1975; Stocker and Irvine 1983; Lieberman and Lieberman 1986; Barnea *et al.* 1990; Izhaki and Safriel 1990). If seeds do not germinate it is difficult to distinguish between chemical destruction of the embryo in the gut and seed dormancy. Tetrazolium is a chemical that stains respiring tissue red. It is used