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SHORT NOTE

Variation in house cat (*Felis catus*) predation sign at a black-fronted tern (*Sterna albostriata*) colony

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Black-fronted terns (*Sterna albostriata*) nest on the beds of braided rivers in the South I, New Zealand (Heather & Robertson 2000). They are classed as Endangered (Hitchmough *et al.* 2007; IUCN 2008; Miskelly *et al.* 2008). Predation by introduced mammalian predators and habitat loss appear to be the main causes of decline (O'Donnell 2000; Sanders & Maloney 2002; Keedwell 2004, 2005).

During the course of a study of the nesting behaviour of black-fronted terns in South Canterbury in spring 2006, we encountered a significant predation event at a colony of black-fronted terns near Arundel on the Rangitata River. We interpreted from field sign that the predator responsible was a house cat (*Felis catus*). We found a single set of cat footprints imprinted in sand in the colony, which we were able to follow from nest to nest, and 2 fresh scats that were characteristic of cat and contained tern feathers. These scats were found beside tern nests that had been preyed upon. We discounted the possibility that the cat was scavenging birds that had already been killed by another predator, because the birds were alive on the previous day at sunset and there was no sign of other predators being present. There is a possibility that the primary predator was an aerial predator (e.g., Australasian harrier *Circus approximans*), but we think this is unlikely because there were no bird-like scuff marks around the nests and we think the predation occurred at night because we arrived at the colony at first light.

Egg laying at the colony on an island on the Rangitata River commenced at the beginning of Nov 2006. At that time, river flows were steadily declining from a peak of *c.* 350 cumecs on 30 Oct to *c.* 140 cumecs on 2 Nov. We consider the island-colony was relatively well protected from incursion by terrestrial predators at the beginning of nesting because there were 2 river channels, each *c.* 30–50 m wide and containing *c.* 80% of the river flow to the south of the island, and 2 channels *c.* 9–15 m wide on the north side each containing *c.* 10% of the flow (Fig. 1a). On 2 Nov the colony contained only 2 nests, each with 2 eggs, but we found 20 newly created empty scrapes. By 7 Nov there were 29 nests (6 with 1 egg, 22 with 2 eggs, and 1 newly created empty scrape). By 9 Nov river flows had declined considerably to *c.* 100 cumecs, and the 2 river channels to the north of the island were much smaller and shallower (3–7 m wide, 80–160 mm deep, velocity <0.01 m/s; Fig. 1b).

On 9 Nov, when re-checking nest contents, we immediately came across carcasses of dead black-fronted terns. We systematically searched all 29 nests previously located and recorded their condition. Twelve nests (41%) showed direct signs of predation or interference. Six of these contained carcasses of dead adult birds (21%). We were able to determine where the cat first entered the colony as we could follow the direction of footprints left

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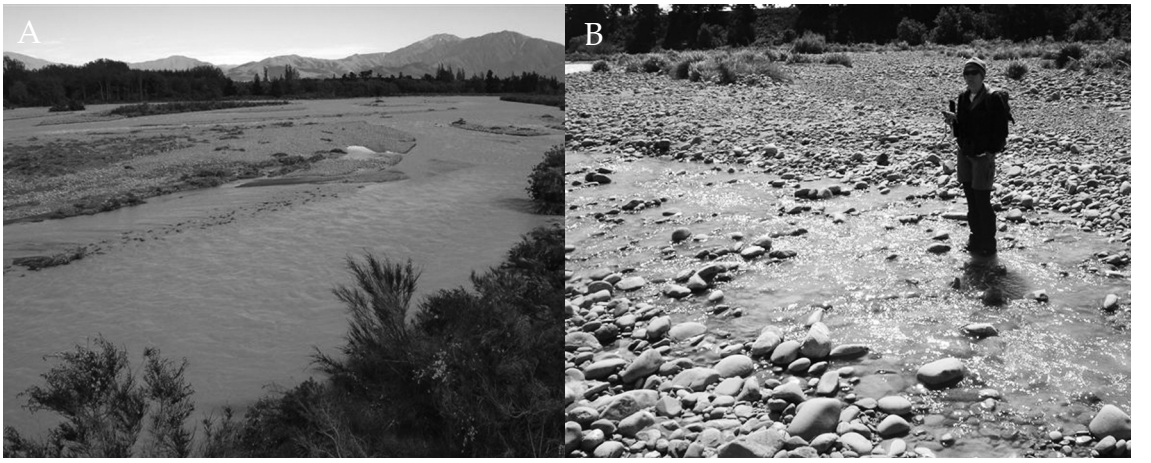

Fig. 1. A. The island (in the background) supporting the black-fronted tern colony when surrounded by high flows on 2 Nov 2006. **B.** The same channel from a different angle on the day that significant cat predation took place and after flows had declined (view looking back towards the mainland from the colony).

in the sand as it moved through the colony. By observing the sign it left behind we were able to see how the cat changed its feeding method as it progressed from nest to nest and to describe variation in the sign (Table 1). All that remained of the first 3 incubating birds encountered was their wings (Fig. 2a), presumably because the cat was at its hungriest when it first entered the colony. At the next 4 nests encountered there was no sign of the incubating adult, but eggs were missing from 3 of the 4 nests and there were loose feathers on the ground (Table 1, Fig. 2d). The fourth and fifth carcasses we found had no heads and their breast muscle and intestines were removed (Fig. 2b & c). Only the head of the last carcass we found had been removed and eaten.

Table 1. Details of variability in predation sign on black-fronted tern eggs and adults in the order in which the cat visited each nest.

Nest no.	Order of predation	Eggs	Adults
232	1	Both eggs crushed flat in nest, no yolk	Two wings beside nest scrape
229	2	Two eggs eaten, shells broken in half, no yolk (Fig. 3A & B)	Two wings and loose feathers beside nest scrape
226	3	One egg eaten, shell broken in half, no yolk (Fig. 3C), 1 egg intact	Two wings and loose feathers beside nest scrape (Fig. 2A)
234	4	Two eggs missing	Five feathers beside nest
227	5	One egg intact	Three feathers beside nest
225	6	One egg missing	No sign of adult, no loose feathers
220	7	One egg missing	No sign of adult, no loose feathers
218	8	Two eggs missing	Carcass beside nest, head missing completely, breast muscle and intestines removed (Fig. 2B)
219	9	Two eggs intact on nest	Partially plucked carcass beside nest, 1 wing separate from carcass, head missing completely, breast muscle and intestines removed (Fig. 2C)
217	10	Two eggs intact on nest	Numerous feathers on nest
216	11	Two eggs intact on nest	Carcass beside nest with only head removed, tiny chewed beak fragments around the nest, 1 wing detached from the body
215	12	Two eggs intact on nest	Five feathers beside nest (Fig. 2D)

Fig. 2. Variation in predation sign left by a feral cat. **A**. Only wings remaining. **B.** Most of body meat, intestines and head consumed. **C.** Partial consumption of breast meat and head. **D.** Feathers only: uncertain whether bird escaped or was consumed entirely.

The cat also preyed on eggs, although its consumption of eggs varied from nest to nest (Table 1). At the first 3 nests the contents of broken eggs appeared to be consumed entirely, although the amount of shell fragmentation varied considerably and 1 egg was left intact (Table 1, Fig. 3). Eggs were left intact on the last 4 nests that were disturbed (Fig. 2d) but there were numerous tern feathers scattered about the nests but no sign of the adult birds. On previous inspections there had been no feathers around these nests. We do not know if these birds escaped predation attempts or were consumed entirely, but we suspect the former.

Ten other nests in the colony that were situated away from the track the cat had made were found to still contain intact eggs. However, no adults were in attendance. On previous visits to this and other colonies there was always at least 1 bird in attendance at each nest site, and we suspected that these had been abandoned because of the presence of the cat. Thus, the overall impact from 1 visit by a cat to the colony may have been the loss of at least 76% of the colony's nests and 10% of the breeding adults.

We suspect that the cat gained access to the island only after river flows had declined following high flows in early Nov. We were unable to determine whether the cat had revisited the colony because on our next-scheduled visit we found that another flood had washed over the island and removed all signs of the tern nests.

Our findings are significant for 2 reasons; firstly the impact of the cat on the terns was considerable, and secondly, the predation sign was highly variable. Predation by introduced mammals on black-fronted terns has been recorded at several sites (Murphy & Dowding 1995; Sanders & Maloney

2002; Murphy *et al.* 2004; S. Cranwell, K. Steffens, *pers. comm*.). Feral cats and hedgehogs (*Erinaceus europaeus*) were major predators of black-fronted terns on the Ohau River where the most significant causes of nest failure were predation (24.6%) and desertion induced by predators (21.4%) (Keedwell *et al.* 2002; Keedwell 2005). Keedwell (2005) found that single predator visits can have a devastating impact on black-fronted tern colonies on the Ohau River, and our observations from the Rangitata River (76% of nests lost in a single visit) support Keedwell's findings.

Recording sign is a useful way of identifying predator species. Correct identification of predators ensures that limited conservation resources are targeted towards controlling predators that have the greatest impact. However, this example illustrates that caution is needed when trying to ascertain the cause of nest failure from sign. In our case, what was almost certainly a single predator, left varying amounts of egg fragmentation and prey consumption. The amount of each carcass consumed also varied from nest to nest. Variability in sign may have reflected the hunger level of the cat. Where it first entered the colony it ate almost all the carcasses of the adult birds it killed plus their eggs. As the cat moved through the colony it became more selective, leaving eggs untouched and consuming only a little meat off carcasses. The cat's treatment of eggs varied similarly. If we didn't know that 1 cat had created all the signs observed it might have been tempting to assume that the different types of sign resulted from different predator species. This suggests we need to be cautious when assigning predators based only on sign left about nests. In addition, it is likely that the disturbance caused birds to abandon many more of the nests than were actually preyed upon. The eggs in these nests would then have been vulnerable to scavenging by other predators not responsible for the initial nest losses and colony disturbance.

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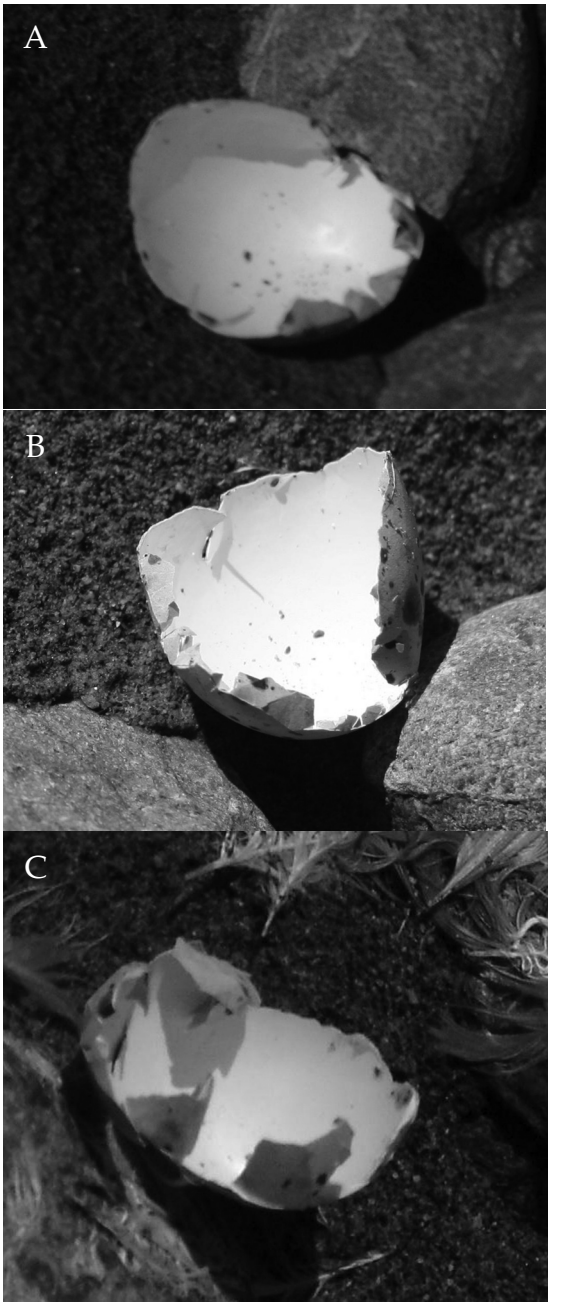

Fig. 3. Three **e**gg fragments (A – C) after consumption by the cat.

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