

FOR WHOM THE GEESE TOLL: ABERRANT OR ADAPTIVE BEHAVIOUR IN ROSS'S *CHEN ROSSII* AND LESSER SNOW GEESE *CHEN CAERULESCENS CAERULESCENS*?

S M SLATTERY¹, G SAMELIUS¹, R I ALISAUSKAS^{1,2}, J R DANIELSON²
and F P MOORE³

¹ Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon, Saskatchewan, S7N 0W0, Canada.

² Canadian Wildlife Service, Prairie and Northern Wildlife Research Centre, 115 Perimeter Road, Saskatoon, Saskatchewan, S7N 0X4, Canada.

³ Box 1701, Claresholm, Alberta, T0L 0T0, Canada

*Breeding and non-breeding ducks commonly respond to terrestrial predators or novel moving objects by approaching or following such stimuli (Hochbaum 1955). This behaviour, called 'tolling' (Hochbaum 1955), has been exploited to capture ducks for consumption or research (McCabe & Mulder 1961, Kear 1990, Owen & Black 1990, Karelse 1994). The adaptive significance of tolling in waterfowl is unknown but may be a curiosity (Hochbaum 1955) or mobbing response (Kear 1990, Owen & Black 1990). To our knowledge, there are no published reports of tolling by geese on Arctic breeding grounds (but see Abraham 1980). We report observations of tolling in Ross's *Chen rossii* and Lesser Snow geese *Chen caerulescens caerulescens* (hereafter Snow Geese) and consider the potential adaptive basis for this behaviour.*

Keywords: Tolling, Ross's Goose, Snow Goose, Arctic Breeding Grounds.

We observed tolling by geese during nesting studies at the Egg River colony on Banks Island, NT (72° 25' N, 124° 32' W) in 1996 and at the Karrak Lake colony in Queen Maud Gulf Bird Sanctuary, NT (67° 14' N, 100° 15' W) in 1993, 1996 and 1997. These high-density colonies contained about 400,000 Snow Geese (Egg River, Samelius & Alisauskas 1996) and 600,000 Ross's and Snow Geese (Karrak Lake, Alisauskas, unpubl. data) in 1996. About half of our observations came from each colony, and all occurred during incubation before wing-moult. Interactions were observed throughout 24-hour daylight at ranges of 50 - 1,000 m and flock size was estimated to the nearest five or 10 birds.

Ross's and Snow Geese approached or followed resting or foraging Arctic Foxes *Alopex lagopus* ($n = 8$ incidents, mean flock size:

30 birds, range 15-60), a foraging Arctic Hare *Lepus arcticus* ($n = 1$, 15 birds), a swimming Wolverine *Gulo gulo* ($n = 1$, 15 birds), stationary and mobile humans ($n = 2$, mean 40 birds, range 30-50 and $n = 6$, mean 190 birds, range 60-300, respectively), and a ground-perched eagle (unknown species, $n = 1$, 20 birds). Geese initially walked toward or landed near stimuli, then slowly approached to within 30-75 m and formed loose flocks among nesting or foraging birds. Tolling geese then walked slowly behind mobile stimuli, moving when stimuli moved and stopping when stimuli either stopped or searched in a small area. Occasionally, geese flew to maintain distance from stimuli. Four marked geese followed researchers for about 500 m, 1,000 m and >1,750 m. Geese tolled the Wolverine over lake ice on foot, then took flight and landed in the water around the

Wolverine when it began to swim. On two occasions Arctic Foxes responded to tolling by charging into the flock and then running out of view as disturbed geese landed. Foxes did not capture any birds in these attacks. At least five interactions lasted over 1 hour, during which time geese remained predominantly in alert or foraging postures.

We suggest that tolling flocks were composed primarily of inexperienced, non-breeding geese. Although research activities covered the entire nesting area at each site, 14 of 19 observations occurred at the edge of colonies in wet sedge meadows. These locations and habitat typically have low nest densities and are associated with large numbers of non-breeding geese (Alisauskas, unpubl. data). In addition, of four individually neck-banded Ross's Geese in tolling flocks, all were marked as juvenile females by SMS and were observed as either yearling ($n = 3$) or two year-old birds ($n = 1$). Although no information exists for age of first breeding in Ross's Geese, few Snow Geese breed before three years (Cooke *et al.* 1995). Therefore, we assume that these marked Ross's Geese were non-breeders. Snow Geese in juvenile plumage also were observed within a tolling flock of 20 birds (proportion unknown), consistent with Abraham (1980) who observed marked juvenile Snow Geese following Arctic Foxes.

Because observations were made opportunistically, we have no measure of sampling effort and cannot accurately estimate prevalence of tolling in Ross's and Snow Geese. During 16.6 hours of observations on Arctic Foxes foraging at Karrak Lake, Bantle (1998) never knowingly observed tolling behaviour. However, his work was conducted primarily in the centre of the colony where fewer non-breeders may have been present compared to colony edges. Near the colony border, SMS was followed by at least six large flocks over a seven day period in 1996 (range: 6-300 birds, see mobile humans above).

Tolling behaviour initially appears maladaptive as geese move close to potential predators and increase risk of injury or death (Denson 1979, Curio & Regelman 1986, FitzGibbon 1994, but see Hennessy 1986). However, the frequency

of anatid tolling (Hochbaum 1955, McCabe & Mulder 1961, Kear 1990, Karelse 1994) suggests that this behaviour either has no survival risk or offers fitness benefits which offset risks. Kear (1990) and Owen & Black (1990) suggested that tolling by ducks was a mobbing response to predators. Mobbing typically involves conspicuous visual and (or) vocal displays near predators (Harvey & Greenwood 1978, Goodenough *et al.* 1993), eg Swans *Cygnus* sp. tolling fox *Vulpes* sp. erected neck feathers in mild threat (Kear 1990), Common Eiders *Somateria mollissima* emitted alarm calls (Schmutz *et al.* 1983) and, during migration, White-fronted Geese *Anser albifrons* maintained alarm posture while tolling feeding eagles and travelling canids (coyotes *Canis latrans*, fox) (Ely & Dzubin 1994). Similar to our sightings, White-fronted Geese swam within 15-30 m of stimuli and some occasionally followed canids for over 800 m. We observed no agonistic displays among geese, suggesting our observed tolling was not a classic mobbing response to predators. However, one instance of tolling directed towards a fox by nesting birds ended in concurrent antagonism by geese. In addition, Barnacle Geese *Branta leucopsis* pursue fox across agricultural fields while on foot and in flocks of up to several hundred birds (JM Black, *pers. comm.*). Therefore the tolling we observed may be subtle antipredator behaviour which reduces predation risk by signaling to a predator that it has been detected, allowing prey to monitor predator behaviour, and inducing predators to leave the area (Dugatkin & Godin 1992, FitzGibbon 1994). Breeding geese could potentially benefit by protecting themselves and their nests if tolling caused foxes to move on more quickly (*sensu* FitzGibbon 1994). We do not believe that non-breeders toll to protect nests of nearby kin. Although reduced predation is a viable hypothesis for tolling by non-breeding geese, we question whether this possibility would explain why marked birds tolled for nearly 2 km. We suspect that long-distance tolling by non-breeding geese may be inspection behaviour which serves a learning function, informing geese about the identity and behaviour of possible predators (*sensu* Shedd

1982, FitzGibbon 1984, Shettleworth 1984, Kear 1990, Dugatkin & Godin 1992).

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