Interaction of predators and manmade object causes potentially significant mortality in a wintering shorebird population

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We repeatedly observed Dunlin *Calidris alpina pacifica* (*n* = 30) killed by collisions with a fence wire following raptor attacks at a single winter roost at Humboldt Bay, California, USA. If raptor-related collisions occurred at the observed rate over an entire winter, fatalities at the site represented approximately 4% of the local Dunlin population. The regularity of collisions may have promoted specialized behavior in individual avian predators (Peregrine Falcon *Falco peregrinus*) and scavengers (Western Gull *Larus occidentalis*) to exploit the situation. We are unaware of other reports of significant shorebird mortality resulting from the interaction of raptor attacks and a manmade object.

Key words: *Calidris alpina*, Dunlin, collision, mortality, predators, wire

INTRODUCTION

Recent reviews of anthropogenic avian mortality suggest that collisions with stationary manmade objects (e.g., power lines, buildings, wind turbines, and communication towers) may account for hundreds of millions of avian deaths annually in the United States alone (Erickson *et al.* 2005, Hunting 2002). Fast-flying and high wing-loaded birds such as shorebirds and waterfowl appear particularly prone to collisions, and shorebird mortality related to telephone and power lines has been recognized for more than a century (Cohen 1896, Emerson 1904). Although the likelihood of collisions may be influenced by landscape features (Bevanger 1994) or environmental conditions (e.g., darkness, fog, or wind) that decrease visibility or maneuverability (Anderson 1978, Brewer & Ellis 1958, Scott *et al.* 1972), we generally consider collision mortality to be passive; that is, there is no proximate cause other than the birds flying from one point to another. In this paper, we present observations from a single site in coastal northern California, USA, illustrating how interspecific interactions (attacks by avian predators) may interact with passive dangers (the presence of a manmade object) to result in potentially significant mortality in a wintering population of Dunlin *Calidris alpina pacifica*.

STUDY AREA AND METHODS

Humboldt Bay, a Western Hemisphere Shorebird Reserve Network site in coastal northern California, USA, consists of three basins, the largest and northernmost of which is Arcata Bay (Fig. 1). Comprised of tidal flats bordered by intertidal saltmarsh and cattle pastures, Arcata Bay supports a wintering population of 10,000–12,000 Dunlin from October to March (Conklin & Colwell unpubl. information).

In this paper, we report observations recorded opportunistically in the second year (24 Nov 2003 to 11 Mar 2004) of a three-year study of roost use by radio-tagged Dunlin in Arcata Bay (Conklin & Colwell 2007). Observations occurred during a 2-hr period bracketing diurnal high tides, when Dunlin, as well as small numbers of Western Sandpipers *C. mauri* and Least Sandpipers *C. minutilla*, often roosted in a grazed pasture next to a small tidal slough and separated from the bay by a levee (Fig. 1). Near the roost, an electric cattle fence runs perpendicular to the slough, with a single 2-mm diameter steel wire about 1.7 m above the water level, extending across the slough to connect the two sections of the fence. The electric fence is typically turned off; the mortality we describe resulted from simple collision, rather than electrocution. Next to the slough stands an electrical tower approximately 25 m tall, from which Peregrine Falcons *Falco peregrinus* often launch attacks on roosting shorebird flocks.

To represent potential diurnal Dunlin use of the site across the season, we calculated the total number of minutes, from 30 min prior to sunrise to 30 min after sunset, in which verified tides (National Oceanic Atmospheric Administration data) exceeded 1.6 m (at which the Arcata Bay tidal flat is inundated) between 25 Nov 2003 and 25 Feb 2004. At Arcata Bay, diurnal high-tide use of pastures by Dunlin is strongly associated with precipitation (Conklin & Colwell unpubl. information); correspondingly, Dunlin did not roost at the site after 25 Feb. Assuming that wire collisions occurred at the same rate when we were not present, we calculated the potential fatalities occurring at the site across an entire season.

RESULTS

On 86 diurnal high tides between 25 Nov 2003 and 25 Feb 2004, an observer visited the site for a total of 34.7 hrs (mean = 24 min/day, range = 2–70 min). Dunlin flocks (150–6,300 individuals) roosted at the site on 54 (63%) visits.

On 43 (50%) visits, we observed likely avian predators of Dunlin, including Peregrine Falcon (32 observations), Northern Harrier *Circus cyaneus* (26), Merlin *F. columbarius* (six), and Prairie Falcon *F. mexicanus* (one). On 34 (40%) visits,

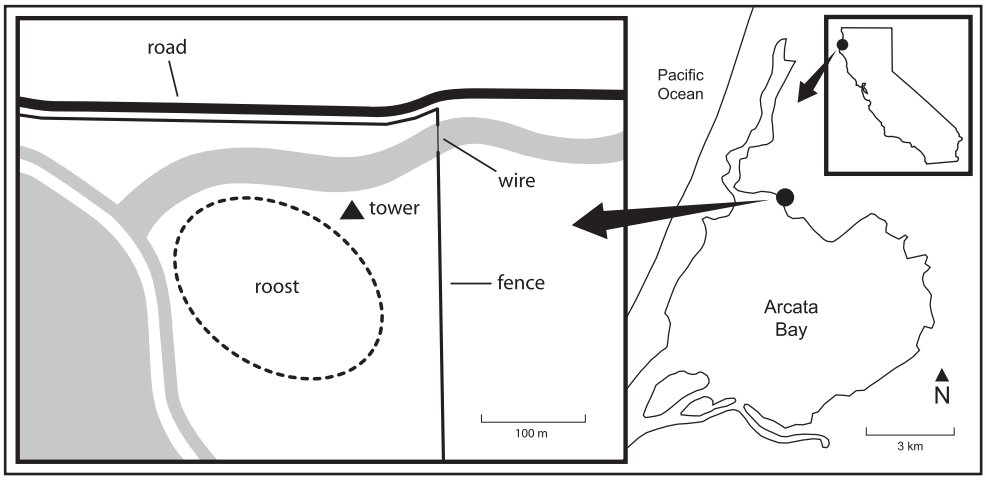

Fig. 1. Study site at Arcata Bay, California, USA, showing relative position of Dunlin roost, cattle fence, and electrical tower.

we observed Dunlin flocks flushing as a direct result of low, aggressive approaches by raptors. On nine occasions, we observed shorebirds (eight Dunlin and one Western Sandpiper) being captured or eaten by Peregrine Falcon (six), Merlin (two), or Northern Harrier (one) subsequent to attacks at the roost. In addition, we observed the following incidents of indirect Dunlin mortality subsequent to raptor attacks.

On 25 Jan, a Peregrine Falcon unsuccessfully attacked the roost from atop the tower. When 150 of the 200 flushing Dunlin flew up the slough, three birds struck the wire and dropped into the water. As the falcon circled and returned to the tower, a Western Gull *Larus occidentalis* standing on the slough bank lunged into the water, seizing and swallowing one of the Dunlin. The gull then grabbed a second Dunlin, which was alive but had lost a wing, and began picking it apart on the shore. The third Dunlin regained its senses and began to take off from the water. The gull gave brief chase, but could not catch the Dunlin, which rejoined the flock nearby.

On 27 Jan, a falcon again launched an unsuccessful attack from the tower. As before, 200 Dunlin broke off from a flushing flock of 2,800 and flew directly toward the wire. Five birds struck the wire and dropped into the water, two with broken wings and one with a fractured culmen. A Western Gull, once again waiting on the bank, grabbed a Dunlin from the water within five seconds of the collision. The falcon then swooped and snatched another Dunlin from the water, returning to the tower to eat it. Three minutes later, one more Dunlin struck the wire as a flock of 60 flew up the slough. The gull, having swallowed the first Dunlin, grabbed another from the water. Then the falcon returned, making an unsuccessful attempt to snatch another bird from the water. The remaining three Dunlin, apparently dead, floated down the slough.

Upon the observer's arrival at the site on 30 Jan, approximately 3,000 Dunlin were flushing over the pasture as a Northern Harrier unsuccessfully stooped through the flock. There were no Western Gulls present, but a Peregrine Falcon was eating a small sandpiper atop the tower. As a small group of Dunlin broke off from the flock and flew up the slough, one bird hit the wire, but quickly recovered and flew off. Four minutes later, when another 600 Dunlin broke off from the still-flushing flock, six struck the wire and dropped into the slough. Two minutes later, ten more hit the wire as a flock of 800 flew by. Another minute later, the harrier actively chased another flock up the slough, and six more hit the wire. The falcon then dropped from the tower and picked up one of the 22 Dunlin floating in the slough. The observer left the area and returned 20 minutes later, to find one Western Gull circling overhead while ten Common Ravens *Corvus corax* picked apart Dunlin carcasses on the shore.

Later on 30 Jan, we returned to the site and installed an 8-mm diameter white rope, with brightly-colored flagging for increased visibility, across the slough alongside the wire. For the remainder of that season and the next, we saw no more evidence of collisions with the wire. On numerous occasions, we observed Dunlin flocks flush up the slough and easily negotiate over the wire and rope. The flagging eventually deteriorated, but the rope itself remains and appears to be sufficiently visible to prevent collisions. After the rope installation, we observed a single Western Gull standing on the slough bank near the wire on three of the next four diurnal high tides. Subsequently, we never observed Western Gulls at that site.

On two occasions prior to the events described above, we observed one Western Sandpiper (15 Dec) and one Dunlin (13 Jan) swimming in the slough after attacks by a falcon and harrier, respectively. Although not witnessed in these cases, collision with the wire seems the likely explanation, in retrospect. Both birds survived the events, but the Western Sandpiper suffered a broken wing and probably did not survive long after walking away from the slough.

At the rate of 30 wire-related Dunlin fatalities in 28.0 hrs of observation prior to rope installation, we project an estimated 432 fatalities at the site across an entire season (403.4 daylight hours the bay was inundated between 25 Nov 2003 and 25 Feb 2004), representing approximately 3.6–4.3% of the local population of 10,000–12,000.

DISCUSSION

Although direct predation by raptors is a significant source of non-breeding mortality in many migratory shorebird populations (Cresswell & Whitfield 1994, Page & Whitacre 1975, Townshend 1984, Whitfield 1985), we know of no previous accounts of repeated mortality in shorebirds resulting from the interaction of raptor attacks and a manmade object. We have no reason to believe that wire collisions at this site developed recently, precipitated by changes in the

fence, pasture, or Dunlin use of the site; it is possible that collisions have occurred unnoticed for years or decades. However, Dunlin use of Arcata Bay pastures varies with precipitation (Colwell & Dodd 1997, Conklin & Colwell unpubl. information), and consequently there is substantial annual variation in use of the site. In addition, raptor attacks on Arcata Bay Dunlin have likely increased in recent decades due to the post-DDT recovery of Peregrine Falcon populations (White *et al.* 2002). Although our calculated 4% annual mortality is a very coarse estimate, it suggests that raptor-related wire collisions at this particular site are a potentially significant source of mortality for the local Dunlin population. However, lacking winter survival data for the system, we cannot estimate the proportion of total annual mortality represented by collisions.

It is difficult to completely separate raptor-related wire collisions from "baseline" collisions (those resulting from regular local Dunlin movements). We often observed Dunlin flocks continuously flushing for 2–10 min subsequent to a raptor attack, even after the raptor was well out of the vicinity, and the duration of this period generally increased with the size of the flock. If the flock never settled after the attack, we considered ensuing collisions to be raptor-induced. By this standard, we observed no baseline collisions, although they presumably may occur. The physical layout of the site (Fig. 1) may be particularly conducive to raptor-related collisions: birds flying low to the north and east from the roost are met with a fence, with an apparent gap over the slough, where the wire is nearly invisible from most angles. Presumably, the confusion resulting from an attack substantially increases the likelihood of wire collisions in this "gap trap." We suspect that such circumstances are rare in the landscape.

Some proportion of the collision mortality can be considered compensatory, since falcons unsuccessful in direct attacks occasionally scavenged Dunlin after a wire collision. Although Peregrine Falcons often take live prey off the surface of water, scavenging is quite uncommon (White *et al.* 2002), and suggests behavioral specialization by local individuals to exploit a unique food source. Whether the positive feedback from wire collisions is sufficient to impel falcons to actively drive Dunlin toward the gap trap is a matter for speculation.

Conversely, most mortality from the collisions should be considered additive. Although Larids can effectively capture healthy adult birds in some circumstances (Peralta-Gallegos *et al.* 2004, Ryan 1990, J. Conklin pers. obs.), they are not important predators of Dunlin outside the breeding season (Warnock & Gill 1996). Western Gulls in Arcata Bay are not generally found in pastures; that one waited on the bank near the wire is evidence that collisions were common and predictable enough to warrant individual specialization in this species as well. Abandonment of the site by gulls once collisions stopped, and the appearance of ravens coincident with high Dunlin mortality, both reflect the flexibility of these opportunistic species.

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