The effect of wind on the foraging behaviour of Black-winged Stilts in SE Australia

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We compared the distribution and foraging behaviour of Black-winged Stilts *Himantopus himantopus* in calm and windy conditions on a shallow freshwater wetland in SE Australia. In strong winds, stilts avoided feeding in open water, concentrating in areas of short aquatic vegetation. When feeding among short vegetation, their peck rates, success of pecks, capture rates and step rates were lower in windy conditions than in calm conditions. Wading depths were also less when it was windy. The frequency of aggressive interaction increased under windy conditions, probably as a consequence of the higher density of birds in the vegetated habitat. It is argued that increased problems of light reflection and refraction of light rays at the water surface under windy conditions made prey location and capture more difficult and that these problems were greatest in areas of open water that were more exposed to wind action.

INTRODUCTION

Weather is known to affect the foraging of waders in a number of ways. For example, low temperatures in wintering areas can cause an increase in feeding time through increased energy demands for maintenance or additional fat storage (Kersten and Piersma 1987, Swann and Etheridge 1989, Wiersma and Piersma 1994). At low temperatures the activity of some prey can be lowered or their burrowing depth altered, leading to reduced prey capture rates and switches to other prey (Goss-Custard 1969, Dare and Mercer 1973, Esselink & Zwarts 1989, Zwarts & Wanink 1989). The direct effects of other weather factors such as rainfall and wind have been studied less. Wind speed had no effect on the rates at which a tactile forager, the Red Knot *Calidris canutus*, probed for prey, or on its distribution over the feeding area with respect to cover (McGowan *et al.* 2002). However, in shallow brackish and hypersaline lagoons in the Sivash, Ukraine, wind strength and direction influenced the extent of foraging areas and the availability of some prey for Dunlin *C. alpina* and Curlew Sandpiper *C. ferruginea* (Verkuil *et al.* 1993).

In this study we compare the distribution and foraging behaviour of Black-winged Stilts *Himantopus himantopus* under windy and calm conditions on a shallow temporary wetland in SE Australia.

METHODS

The study area was a section of Fivebough Swamp (400 ha) in southern New South Wales, Australia (34°32'S 146°25'E). Fivebough Swamp, a Ramsar site, is a shallow temporary wetland, which floods from rainfall during winter and dries between October and December/January. It is situated in a dry continental part of SE Australia with a long-term average annual rainfall of only 430 mm. Rain days and days with strong winds are infrequent.

An extensive area of about 150 × 75 m was used to quantify the distribution of Black-winged Stilts across major habitats and a smaller intensive area of 40 × 20 m was used to quantify details of foraging behaviour. Although natural in origin the wetland has been modified by human activity and the study section was managed by the use of cattle grazing to create areas of open water, sections of short vegetation less than 5 cm tall and a few areas of taller vegetation from 0.2 to1.5 m. The short vegetation was almost entirely Water Couch *Paspalum distichum*, which formed a loose sward of plants with numerous small, open patches of water among them. Taller vegetation was mainly Spike-rush *Eleocharis acuta*, Cumbungi *Typha orientalis* and *Bolboschoenus caldwellii*. Water depths were less than 20 cm across all of the extensive and intensive study areas.

Observations were made on 7 Oct 2004 when an unusually strong weather front with no associated rainfall passed through the area. From dawn until 1030h, wind speed averaged 30–40 km/h, with gusts over 60 km/h. After 1030h wind speed dropped to 0–5 km/h. Observations under windy conditions were made from 0900 to 1030h and under calm conditions, from 1200 to 1300h. Over the extensive study area, five counts were made during each period at 10–15 minute intervals of the number of birds feeding in open water and among short vegetation. Five counts of the number feeding in the intensive study area of short vegetation were also made during each period. In the latter area, birds were selected randomly and observed for 1-minute sample periods during which the number of pecks and captures were recorded as well as foraging depth. Depth was judged in relation to the birds' legs using a tarsus length of 12 cm (Marchant & Higgins 1993). The number of steps taken per 15 seconds was estimated for a separate set of samples during

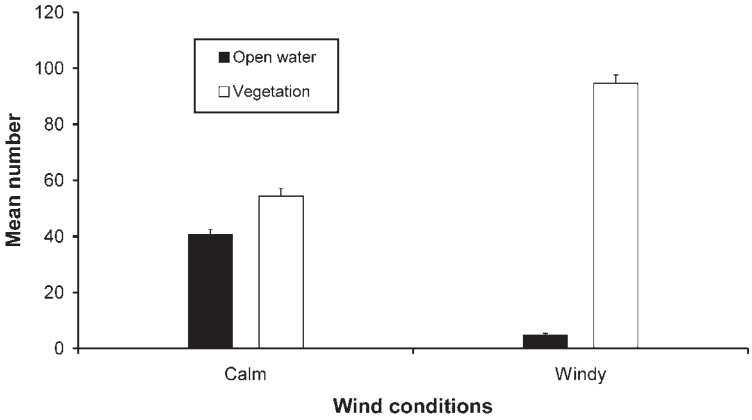

Fig. 1. Comparison of the number (±SE) of Black-winged Stilts feeding in open water areas and among short vegetation in calm (0–5 km/hr) and windy (30–40 km/hr) conditions at Fivebough Swamp. (N = 5 counts in each).

each period. The number of aggressive encounters during each sample period was also recorded. These were defined as aggressive calling, running or flying towards other birds or running from other birds.

RESULTS

Under windy conditions the stilts were concentrated mostly in the short vegetation and avoided feeding in areas of open water, whereas under calm conditions they were widely dispersed over the area including short vegetation and open water (χ^2_1 = 39.3, $p < 0.001$, Fig. 1). None fed among the taller vegetation.

All of the prey taken by the stilts were less than 3–4 mm in length and could not be identified when captured. Examination of the foraging areas immediately after observations were made showed chironomid larvae and water boatmen (Corixidae), to be the main potential prey within the water column with small adult flies (Diptera) of several species the main invertebrates on the water surface. For birds feeding in the open water, prey capture rates under different conditions could not be quantified as the few that fed in this habitat when windy were too distant from the observers and could not be approached closely without disturbance. In the blustery conditions it was impossible to see the success of their pecks with certainty.

Birds feeding in the short vegetation had significantly lower peck rates ($t_{1, 31}$ = 2.98, p = 0.006, variances not assumed equal) and capture rates ($t_{1, 28}$ = 5.97, $p < 0.001$, variances not assumed equal) when feeding in windy compared with calm conditions (Fig. 2). The decrease in capture rate was more the result of a decrease in the success of pecks than in the rate of pecking. Success, defined as the percentage of pecks that resulted in captures, was 70.5% (n = 302) under calm conditions and only 34.8% (n = 382) when windy (χ^2_1 = 85.5, $p < 0.001$). In calm conditions, the birds waded at significantly greater depths than in windy conditions (Mann-Whitney U, Z = –4.24, $p < 0.001$, Fig. 3) and their mean step rate (±SE) was also significantly greater:

42.4±2.4/minute in calm,

26.8±1.6 when windy ($t_{1, 42}$ = –4.11, p = 0.007, variances not assumed equal). The mean number (±SE) of stilts feeding in the smaller study section was 16.4±0.9 (n = 5) in calm conditions and 49.4±1.1 (n = 5) when windy, which represents an increase in mean density from 2.1 to 6.2 per 100 m².

The aggressiveness of the birds also decreased under calm conditions. Interactions consisted of aggressive calling and short runs or flights towards other birds. None were contested

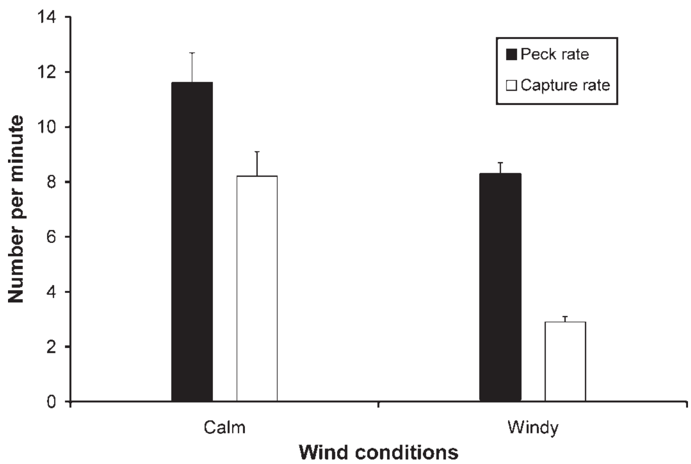

Fig. 2. Comparison of mean peck and prey capture rates (±SE) of Black-winged Stilts in short vegetation habitat in calm (0–5 km/hr) and windy (30–40 km/hr) conditions at Fivebough Swamp. (N = 26 for calm; 46 for windy conditions).

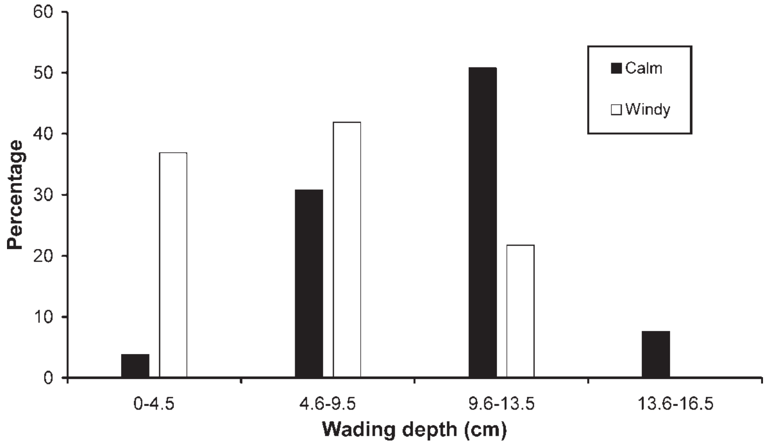

Fig. 3. Wading depths of Black-winged Stilts among short vegetation in calm (0–5 km/hr) and windy (30–40 km/hr) conditions at Fivebough Swamp. (N = 26 for calm; 46 for windy conditions).

and most lasted for less than 5 seconds. Under calm conditions, encounters were recorded in only 1 out of 26 minute sample periods (3.8%), whereas when windy this increased to 14 of 36 sample periods (30.8%, $\chi^2_1 = 10.1$, $p < 0.01$) with an average of 0.5 encounters per minute.

DISCUSSION

This was a preliminary study and it was only possible to compare the birds' behaviour under relatively calm and strong wind conditions. A more detailed quantification to determine the exact nature of the relationship between wind speed and prey capture rates is desirable. This proved impractical at the study site because of the scarcity of days with significant wind speeds at the time of the study, but it would be interesting to repeat these observations at other sites or with other visually foraging wader species.

The most likely explanation for the avoidance of the open water habitat during strong winds is that it was more difficult for the stilts to locate prey within the water column under such conditions. The stilts foraged visually and probably had to overcome similar problems of prey location to those faced by plunge divers such as terns whose capture rates also decline with increasing wind speed (Dunn 1973, Taylor 1983) and by herons and egrets that feed in similar ways to stilts (Katzir & Intrator 1987, Katzir *et al.* 1989, Lotem *et al.* 1991, Katzir 1994, Karzir *et al*. 1999). Light rays are reflected at the water surface causing glare, which becomes more disruptive as the water surface becomes rippled (Lythgoe 1979). In addition, light rays from underwater prey are refracted at the water surface so that their perceived positions differ from their real positions and the birds presumably have to learn to compensate for the difference. As the water surface becomes more disrupted by wind action, the extent of the discrepancy between real and apparent positions becomes greater and shifts constantly and determination of the real position becomes more difficult. Also, the deeper an object is below the surface the greater the difficulty in predicting its real position (Horvath & Varju 1990). Taylor (1983) suggested that light refraction at the water surface and its exaggeration with depth was the main reason for the decline in the success of plunges of terns and their use of shallower dives as wind increased.

The vegetated area of Fivebough Swamp consisted of a semi-continuous mat of Water Couch with many small open water areas among it. These were better protected from wind action than the large expanse of open water. The water surface between patches of plants was rippled when it was windy but less so than in the open water areas. Thus, the vegetated areas probably offered better feeding conditions. Nevertheless, prey capture rates still fell by almost 65% in this habitat, from 8.2 to 2.9 items per minute. The reduced success of capture attempts at higher wind speed, which was the main reason for the decrease in capture rates, is consistent with an increasing failure to locate prey accurately arising from increased light refraction at the water surface. The birds' selection of shallower wading depths as wind speed increased is consistent with the idea that deeper prey should become increasingly more difficult to locate. With the very small size of prey taken by the stilts this problem would be particularly acute. It is also possible that some of the prey may have reacted to increased wind by moving deeper into the water column.

Support for a detrimental effect of wind on foraging was provided in a study of the closely related Black-necked Stilt *H. mexicanus*, in Puerto Rico (Cullen 1994). This species increased the use of sweeping, a tactile foraging method similar to that used by avocets *Recurvirostra* (Hamilton 1975), as wind speed increased, which suggests that prey location by visual means became more difficult. Black-winged Stilts were not seen to use sweeping at Fivebough Swamp and have only been seen to use the technique in Australia in wetlands with high turbidity and no vegetation or other material in the substrate which would inhibit the sweeping action (Taylor & Taylor, unpubl.).

Some of the reduction in prey capture rates in the vegetated habitat may have resulted from the increased densities of stilts feeding there. Aggressive interactions increased in frequency, probably as a result of the increased density of birds, but these tended to be short-lived and would have reduced the birds' foraging time by less than 2–3%. It seems more likely that increased disturbance of prey may have been a bigger problem than the time lost in interactions. Many chironomid larvae live in burrows and may retreat when disturbed, in a similar way to the amphipod *Corophium volutator* in the presence of high Redshank *Tringa totanus* densities (Goss-Custard 1969). Other potential prey such as water boatmen were seen to swim deeper and to seek cover in vegetation at the approach of a human observer so presumably would also have done so in response to stilts. It is possible that the decline in peck rates with increasing wind speed may have been caused partly by such changes in prey behaviour. However, the overall decline in capture rates with increasing wind was caused mostly by a drop in the success of capture attempts and this is more consistent with problems of inaccurate prey location than of interference competition.

It is interesting to speculate on the possible wider implications of the findings of this study. Is the geographical distribution of Black-winged Stilts influenced by the frequency of windy conditions? Would the effect of wind be strong enough to reduce overall prey intake rates and hence, reduce survival or reproductive success, in wind prone areas? Within Australia, for example, Black-winged Stilts are most numerous in areas that experience mainly calm weather conditions for most of the year and occur only rarely in places such as Tasmania (Blakers *et al.* 1984, Marchant & Higgins 1993, Barrett *et al.* 2003) where windy days are frequent, even though there seem to be areas of suitable habitat.

One of the predicted consequences of global climate change is an increase in the frequency of windy conditions and storms. If correct, would this be enough to have an adverse effect on the foraging efficiency and survival of visual foragers such as Black-winged Stilts?

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