British Trust for Ornithology

BTO Research Report No. 208

A Study of the risk of collision with power lines by Common Terns at Shotton Steel Works, North Wales

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September 1998

A report by the British Trust for Ornithology to Scottish Power

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Registered Charity No. 216652

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ISBN 1-904870-64-3

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1. EXECUTIVE SUMMARY

1. At Shotton Steel Works, North Wales, 470 pairs of Common Terns breed within the industrial complex. A report by Henderson *et al.* (1994) investigated the risk of collision with power lines in relation to the stage of the breeding season and time demands on adults, the age of the birds, the significance of distance between the power lines and the breeding colony and climatic variables. The aim of this study was re-assess the risk of collision with power lines of terns crossing the 132 kV line.

2. Systematic observations were made of terns journeying to and from the estuary during the incubation and nestling stages of the breeding season. Their direction, flight pattern, behaviour in relation to breeding island and weather variables were recorded. Surveys were also made of the ground beneath the power lines in order to look for casualties. Poor weather in early summer caused high mortality amongst chicks, so few juvenile terns were available to study. In total, 6906 observations were made of terns crossing the wires.

3. The majority (85%) of terns crossed the power line above the top earth wire, and only a small proportion were recorded flying either through or beneath the power cables. On outward journeys, up to 4% of terns came within 1 m of the cables.

4. Terns from island 1 flew closer, on average, to the top earth wire on outgoing journeys than birds from island 2 which is a greater distance away from the power line. A higher proportion of terns from island 1 passed either through or under the cables than terns from island 2.

5. No terns were seen to hit the power lines during extensive observations and no casualties were found beneath the power lines during the ground search. In general, mortality rate of Common Terns due to collisions with wires was considered to be very low.

6. The impact of power lines on the mortality rate of Common terns at Shotton is discussed with suggestions for further study.

2. INTRODUCTION

For over 50 years there has been documented evidence of the threat that power lines may pose to birds (Borell 1939, Walkinshaw 1956). Birds have been at risk either from collision with power lines (Scott *et al.* 1972) or, in larger species, from electrocution where their wing-span can connect two parallel wires (Friedler & Wissner 1980), Orloff *et al.* 1992). The importance of mortality in birds due to collisions with power lines depends on the demography of the population (Rose & Baillie 1989). In species with high survival rates and relatively high reproductive rates (*e.g* many geese and swans) the problem is less pronounced than for species with high survival rates but low reproductive rates (*e.g.* many large raptors). A comprehensive review of the affect of power lines on mortality is provided by Henderson *et al.* (1994).

The Common Tern *Sterna hirundo* is a medium sized (200g) migratory species which arrives in Britain during April to breed. Most of the population breeds in widely dispersed colonies along the coast of Britain and Ireland, usually on bare shingle expanses but also on rocky inlets. The coasts of south-west England and mid south Wales are sparsely populated. Most inland colonies are in central and eastern England, east Scotland and central Ireland (Gibbons *et al.* 1993). Numbers of Common Terns in Britain and Ireland have declined this century, but their ability to occupy man-made sites such as purpose-built rafts and islands has probably prevented a greater decline (Lloyd *et al.* 1991). The majority of Common Terns winter on the western seaboard of Africa, principally west and southern Africa (Snow & Perrins 1998).

Common Terns forage for small, shallow water fish and in the absence of locally abundant sources of food they must travel some distance to forage, particularly where breeding colonies are inland. When provisioning young, the parents carry one, and rarely two, fish back to the colony and must make several journeys during the day in order to provide their nestlings with sufficient food (Cramp 1985).

At Shotton Steel Works, North Wales, Common Terns breed within the industrial complex and each journey from the breeding colony to the estuary means that the birds must negotiate two spans of power lines. They are agile species and small, agile and diurnal birds are probably considered less vulnerable to collisions with power lines than large birds or nocturnally migrating species.

In the present study, our aim was to update the previous study by Henderson *et al.* (1994) on the Common Terns using Deeside Industrial Park. Our aim was to determine how the risk of collision with power lines would vary in relation to the activity of the birds during the breeding season and the significance of the distance between the power lines and the breeding colony.

Manweb is proposing to construct a new 132kV power line within the Deeside Industrial Park parallel to an existing 132kV power line. The new power line will be located just to the south of the existing 132kV line and closer to the ornithological interest. In this study, fieldwork concentrated only on the existing 132kV power line and not the 400kV line too (*cf* Henderson *et al.* 1994).

The Common Tern is a convenient study species to observe the responses of birds to power lines, due to their being diurnal and because of the high frequency of their foraging journeys. This meant that continuous observations, carried out over long time spans and usually in good visibility, were possible, resulting in large sample sizes and an accurate assessment of collision frequency or collision risk.

3. METHODOLOGY

3.1 Study Site

The Common Tern colony of around 470 pairs (John Birch *pers. comm.*) is situated within the industrial complex of Shotton Steelworks, on Deeside, North Wales (OS 296 707). The artificially constructed nesting islands are immediately surrounded by water-filled lagoons and then wasteland which gives way to saltmarsh to the north and west (Fig 1.). Terns flying to and from the estuary need not cross any industrial construction, except for power lines. Two sets of power lines run more or less south-west from the National Power power station towards the River Dee and in doing so act as potential obstacles which the terns must cross on their journeys to and from the estuary (Fig. 2). The estuary is approximately 5 km to the north-west of the tern colony, or approximately 10 minutes flight time.

The nearest power line to the tern colony (line 1) is approximately 100 m from the nesting islands at its closest point. Line 1 carries 132kV on cables between 6.7m and 26m high (the height of the pylon). Line 1 comprises six groups of four closely held cables plus an earth cable running from the top of the pylon. The groups of cables are 2.8m apart.

Line 2 is a relatively new construction carrying 400kV and is approximately 200m away from the nesting island at its nearest point. It is almost twice as high as line 1 but carries fewer cables (three groups of two, plus an earth wire) with the 5.7m distance between cables groups. The pylons rise to 46m and at their lowest point the power cables are 7.6m above the ground. In the present study, observations of terns crossing line 2 were not recorded.

3.2 Data collection

Systematic observations were made of terns journeying to and from the estuary during the nestling and juvenile phases of the breeding season. The 1998 breeding season was heavily influenced by the poor weather conditions. Many of the early clutches and chicks perished in the cold, damp conditions during May and June, consequently some pairs laid replacement clutches.

The first visit (37 hours observations) was timed to coincide with the nestling period. The majority of terns were provisioning small chicks and some pairs still incubating. During the second visit (28 hours observations) terns were still provisioning young and there was a small number of fledged terns. Due to the early losses, the breeding season was generally later than expected and there were fewer fledged birds than in Henderson *et al.* 1994.

For each tern crossing line 1 we recorded the following criteria:

1. Direction of journey.

2. Whether the bird passed over, under or between the wires.

3. The estimated height in metres of the bird when crossing above the top earth wire.

4. Whether a bird approached the power line either level with, above (the top wire) or below (the lowest line) the cables at a distance of 6 m away from them.

5. Weather estimations: Wind speed (Beaufort estimate) and direction, visibility (metres), percentage cloud cover and rain (1 - barely raining, 2 - light rain, 3 - steady rain, 4 - heavy rain, 5 - storm).

6. Age of bird. Juveniles are easily separated from adults on their flight pattern (juveniles have a much quicker wing beat than adults) and on plumage features (Cramp 1985).

For a smaller number of birds we recorded which tern island (one or two) the tern flew to on an incoming journey or flew from on an outgoing journey. Island one was situated closer to power line 1 than island two (Figure 1).

3.3 Ground survey of casualties

The ground beneath power line 1 was walked on two occasions during each of the two visits (four times in total) in order to look for corpses and casualties which might have struck the power cables. As much of the ground as possible was covered to within 30 m either side of the outside wire using a zig-zag path through the grass or undergrowth. Not all of the ground was either accessible or visible.

4. RESULTS

4.1 Crossing height

A grand total of 6906 observations were made of birds crossing power line 1 (132 kV), either above the top earth wire, below the bottom wire or through the spans. In all, 5838 observations (85%) concerned birds crossing the top earth wire on either the outward or inward journey. Outgoing terns flew closer to the top earth wire than incoming terns (Table 1).

For adults and juveniles combined, 174 outward crossings were estimated at less than 1 m above the earth wire, this represents 4% of the total outward crossings made. More terns made crossings of less than 1 m over span 1 (n= 159) than span 2 (n= 15) (χ^2=41.82, df=1, $P < 0.001$).

A greater number of terns leaving island one (n= 44) than island two (n= 3) flew less than 1 m above the earth wire (χ^2= 13.25, df= 1, $P < 0.001$).

Common Terns were at greater risk crossing span 1 than span 2, especially birds nesting closer to the wire, from island 1.

4.2 Effect of tern islands on crossing patterns

From island 1 there was a significant difference between the number of departing birds crossing the earth wire of span 1 (n= 897) than span 2 (n= 208) (Table 2). However, more birds from island 2 crossed span 2 (n= 405) than span 1 (n= 132) on their outward journey. Incoming terns to islands 1 and 2 crossed span 1 in greater numbers than span 2.

Of all outgoing journeys made from the islands, 16% of terns passed through the power cables of line 1. Significantly more terns from island 1 passed through span 1 (n= 202) than span 2 (n= 29), in contrast more birds from island 2 passed through span 2 (n= 67) than span 1 (n= 16) (Table 2).

A small number (3%) of outgoing terns from islands 1 and 2 flew under the bottom wire of line 1. More terns from island 1 flew under span 1 (n= 32) than under span 2 (n= 15). Terns from island 2 flew under span 2 (n= 18) in greater numbers than under span 1 (n= 1) (Table 2).

Outgoing terns from island 1 flew closer to the earth wire (2.83m and 2.70m for spans 1 and 2 respectively) than terns from island 2 (3.88m and 3.31m). Incoming terns to island 1 flew over span 1 at a height of 7.57m and span 2 at 8.69m, whilst terns flew into island 2 at 9.14m above span 1 and 8.35m above span 2.

There was a tendency therefore for birds from the closer island (1) to attempt to climb over span 1 or pass under or through wires, thereby increasing risk of collision. Terns from island 2 had more time to adjust to the crossing trajectory.

4.3 Ground survey

No corpses of Common Terns were found during the systematic surveys of the ground beneath the power lines. The visible length covered was approximately 50% of the total area for spans 1 and 2.

5. DISCUSSION

Field observations resulted in just under 7,000 individual cases of terns crossing power line 1. No casualties were found during the extensive ground search and during the course of the study no birds were actually seen to strike the wires.

The aim of the study was to concentrate on the nestling and fledgling period of the tern's breeding cycle. Poor weather in May and June, particularly heavy rain in June caused terns to lose some of their early clutches of eggs, but more seriously there was a high level of mortality in chicks. A visit to the tern colony in mid-June found 320 dead chicks (John Birch *pers.comm.*). A proportion of the terns left the colony after losing their chicks and did not return. Some birds did relay clutches after suffering early egg losses, so during the first visit to the colony in late June there was a combination of terns incubating and collecting food for their chicks. During the second visit to the colony in mid-July, the majority of terns were provisioning chicks and there was a small number of recently fledged juveniles. Less than 1% of all observations made were of juvenile terns, so we were unable to test for differences between the behaviour of adult and juvenile terns.

Terns preferred to cross the top earth wire (85% of observations) on both outward and inward journeys. Fewer terns crossed through or under the wires. On outward journeys, more terns crossed span 1 than span 2, because for the majority of terns the most direct route to the Dee estuary would involve crossing span 1. Terns flew much closer to the earth wire on outward journeys than inward journeys, largely because terns leaving the colony have to climb more quickly to cross the earth wire and gained just enough height to cross safely. This was a result of the close proximity of the power lines to the breeding colony. Terns which crossed the earth wire on outward journeys at less than 1 m are termed 'near misses'. Terns choosing to take the more direct route to the estuary over span 1 had an increased risk of collision or 'near misses', this was particularly true of the closer island 1 (see below). On inward journeys, terns crossed the power line at a greater height and then dropped sharply into the colony.

Attempts were made to identify which tern raft or island terns flew from on outward journeys and flew to on inward flights. Island 1 is closer to span 1 than span 1 and is generally closer to the power line than island 2. Accurate counts of the number of breeding pairs on the two islands were impossible due to restricted viewing, but counts made by visiting bird ringers suggest more birds use island 1 than island 2 for breeding (John Birch *pers. comm.*).

On outward journeys, more terns from island 1 took the direct route to the estuary over span 1 than the longer route over span 2. Terns from island 1 flew consistently closer to the earth wire on outward flights than terns from island 2, a reflection of the close proximity of island 1 to the power line. A number of terns failed to cross the power line on the first attempt, so circled around to gain more height and made a second attempt. Of the terns from island 1 which passed through the wires or under the bottom wire, more passed through or under span 1 than span 2. On incoming journeys, terns flying to island 1 crossed span 1 in greater numbers than span 2, again taking the most direct route from the estuary to the colony. Incoming terns to island 1 crossed the power line at a greater height than on outward journeys, and descend quickly into the colony.

Terns from island 2 on outward journeys crossed span 2 in greater numbers than span 1. Island 2 is located further away from the power line than island 1 and there is no clear direct route to the estuary. The majority of terns from island 2 therefore chose the route which will give them maximum time to gain height and cross the power line safely. Only three 'near misses' were observed of terns leaving island 2 and crossing the power line (both spans). More terns from island 2 passed through or under the wires of span 2 than span 1, although there were far fewer instances than birds from island 1. Incoming terns from the estuary flew higher than on outward journeys and crossed span 1 in greater numbers than span 2. Terns crossing span 1 are able to glide more steadily down to island 2 rather than descend sharply like birds from island 1.

Terns breeding on island 1 are under greatest pressure when leaving the colony for the estuary, flying on average closer to the top earth wire and are more likely to cross through or under the power line than birds from island 2. The proximity of the power line to the breeding island is clearly an important factor.

It is proposed that the new 132 kV power line will run parallel to line 1, and will be located just to the south and closer to the tern colony. Terns from island 1 are most likely to be affected and an interesting area of study would be to see how the terns distribute themselves on the breeding islands and how they respond to the closer power line. Generally, the risk of collision to terns on island 1 would increase further.

As part of the mitigative measures agreed by Manweb a new area is to be prepared for the tern colony on land adjacent to the existing islands. This new nesting ground will be situated at a greater distance from the proposed overhead line than the present nesting grounds are from the existing lines.

On completion of the new overhead line construction further studies will be funded by Manweb to study the effect of the new line on the Common Tern colony.

ACKNOWLEDGEMENTS

This project was funded by Manweb. Many thanks to Colin Bennion and Jim Thomas at British Steel, Deeside for arranging permission to the tern colony. John Birch of Merseyside Ringing Group provided helpful advice on the numbers and breeding success of the Common Terns at Shotton. Many thanks to Ian Henderson for advice and comments on the analysis and report. We are also grateful to Jane Wells and Viv Hiom for computerising data.

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Table 1. Summary of the number of Common Terns crossing above the top earth wire on power line 1 on outward and inward journeys, mean height and Chi-Square Approximation.

	Span 1		Span 2		Median 1-Way Analysis (Chi-Square Approximation)
	n	Height (m)	n	Height (m)	
Outgoing Terns	2365	3.47	1076	3.25	χ^2=9.90 DF=1 P=0.0016
Incoming Terns	2076	7.46	321	7.28	χ^2=2.00 DF=1 P=0.1567 ns

ns = non significant

Table 2. Summary of the number of Common Terns crossing spans 1 and 2 on outward and inward journeys with regard to breeding islands.

Outgoing Terns						
Island	Over		Through		Under	
	Span 1	Span 2	Span 1	Span 2	Span 1	Span 2
1	n= 897	n= 208	n= 202	n= 29	n= 32	n= 15
	χ^2=428.36 DF=1 P<0.001		χ^2=128.06 DF=1 P<0.001		χ^2=5.45 DF=1 P<0.05	
2	n= 132	n= 405	n= 16	n= 67	n= 1	n= 18
	χ^2=137.76 DF=1 P<0.001		χ^2=30.12 DF=1 P<0.001		χ^2=13.48 DF=1 P<0.001	

Incoming Terns		
Island	Over	
	Span 1	Span 2
1	n= 327	n= 47
	χ^2=208.13 DF=1 P<0.001	
2	n= 132	n= 63
	χ^2=23.71 DF=1 P<0.001	

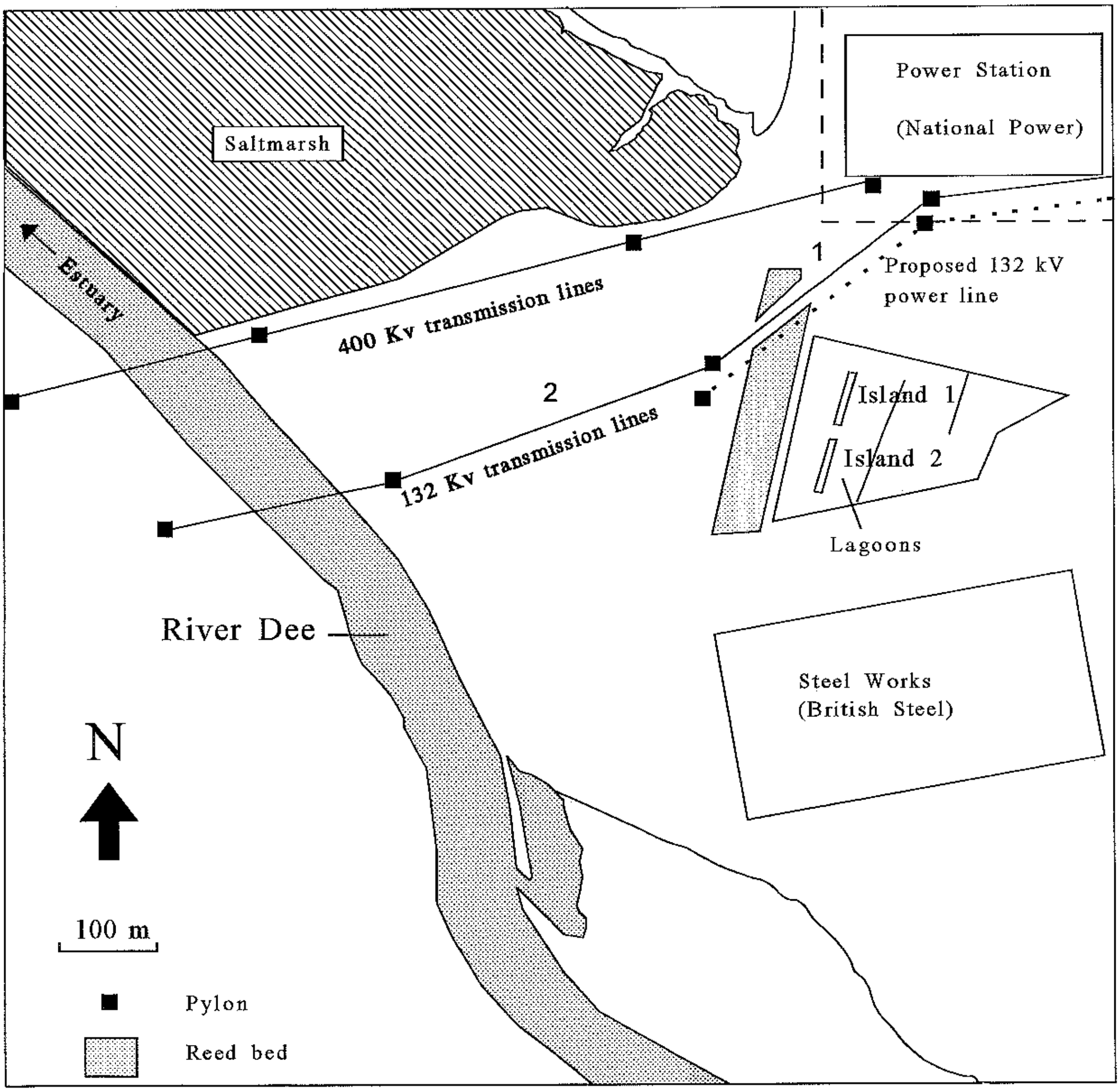

Figure 1 The study area and the position of the lagoons in relation to the power lines, industrial complex and estuary.

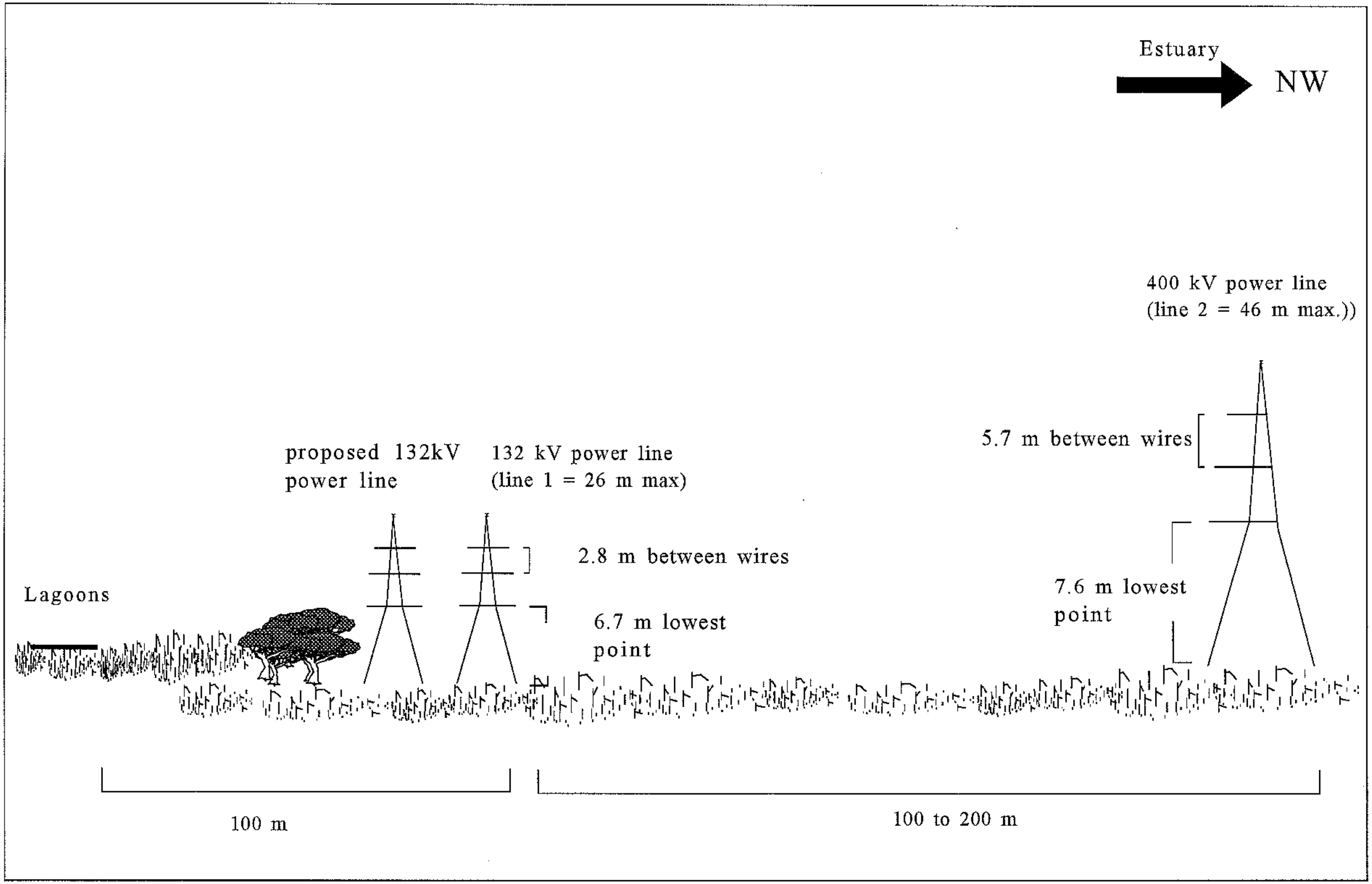

Figure 2 A profile view of the position and height of the pylons in relation to the freshwater lagoons.