Report

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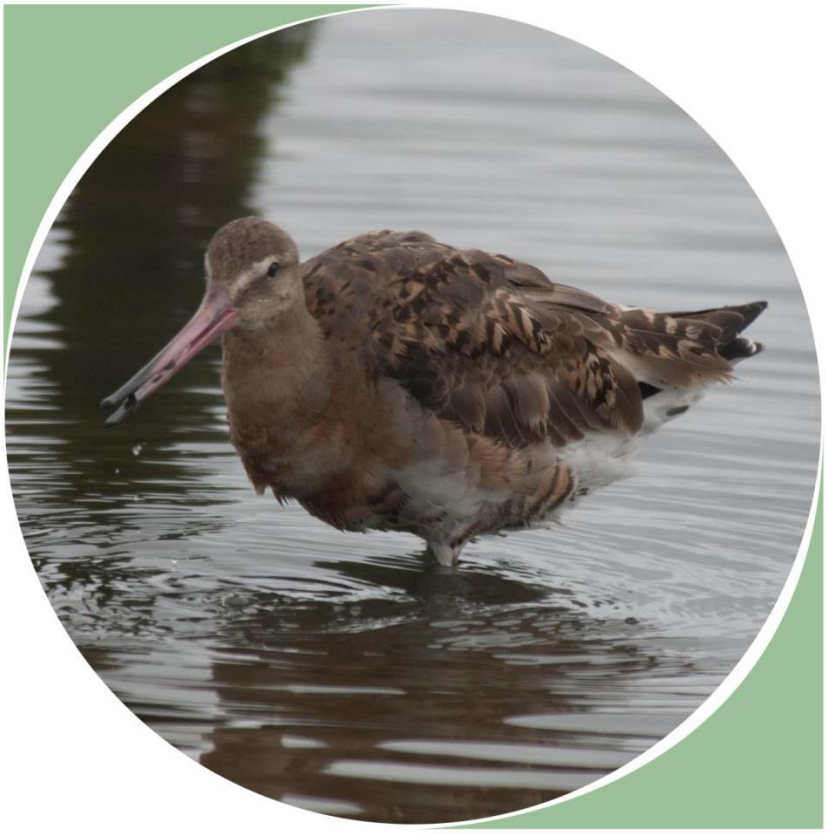
Humber Winter Bird Disturbance Study



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Summary

Fieldwork was undertaken at ten locations around the Humber Estuary to record levels of human activity, counts of birds and responses of birds to disturbance. Each location was visited a total of 8 times, with survey effort evenly split between October 2013 and January 2014 and evenly split between weekends and weekdays. Each survey visit lasted 1 hour and 45 minutes. During this time a 'diary' was maintained of all human activities and other events taking place within a 200m radius of a pre-determined focal area. If birds were present within the focal area and within 200m (or the birds were disturbed) then the diary record was considered a potential disturbance event. For all potential disturbance events species specific observations involved recording how the birds responded, the distances at which they responded, how far they flew if flushed and a range of other information. At the end of each visit a count was made of the birds present in the focal area – this count was then considered in relation to the levels of access recorded during the survey period.

In total, 1,304 diary entries were recorded. These involved 2,280 individual people and 839 dogs (655 off lead, 184 on lead). Dog walking was the most commonly (44.9%) recorded activity and one third of all activity recorded involved dog walkers with dogs off leads. Walkers without dogs accounted for 28% of diary entries. A wide range of other activities and events were recorded, but all other categories/types of event were less than 10% of records.

The majority of activities occurred on the shore (76.5%). Water-based activities only accounted for 1.5% of records and were restricted to two sites, Chowder Ness (location 9) and Faxfleet (location 10).

Cleethorpes Leisure Centre was by far the busiest location. Humberston Fitties was the next busiest (less than a quarter of the events recorded at Cleethorpes Leisure Centre). Across all sites, there was a significant negative relationship between the number of birds counted at the end of each survey visit and the number of people recorded during the survey. This indicates that localised flushing is causing birds to temporarily vacate particular areas.

The response of birds to potential disturbance events was recorded as one of five categories: no response, alert, walk/swim, minor flight or major flight (where birds were displaced more than 50m). Across all sites and both months, 69% of observations resulted in no response and 14% of observations involved a major flight.

There was marked variation between sites in the proportion of events that resulted in birds taking flight. At Cleethorpes less than 5% of the events recorded resulted in birds taking flight, by contrast at Saltfleet 76% of observations involved birds being flushed. Wildfowling, birds of prey, air-borne activities and 'other' were the potential disturbance events with the highest proportion of major flights. These were all relatively uncommon (compared to other activities), for example there were just six species-specific observations of wildfowling where birds were present (and in all cases major flight was recorded). Accounting for the frequency of occurrence, dog walking stands out as the activity resulting in the most behavioural responses from the birds. Dog walkers with dogs off leads accounted for just under a third (31%) of all species-specific observations, yet caused 40% of all the flight responses recorded. Compared to all other human activities, dog walkers accounted for over

half of all the flight events (i.e. birds being flushed) that were recorded – as much as all the other activities combined.

Numbers of birds flushed varied between points. The numbers of birds flushed was highest at Welwick (where predominantly attributed to birds of prey). The numbers of birds flushed were relatively low at Cleethorpes, Humberston Fitties, Pyewipe and to some extent at Saltfeet.

Whether birds were flushed or not varied according to a range of factors:

- There were significant differences between sites, with Saltfleet notable in having a high probability of access resulting in birds being flushed
- There was a higher probability of an event resulting in birds being flushed in January compared to October
- There was a higher probability of birds being flushed when temperatures were low (unless below freezing, when there was a low probability of birds taking flight)
- The probability of birds being flushed at low tide was lower than at high tide
- The probability of birds being flushed declined with distance (i.e. how far away the activity was from the bird), such that the probability of birds being flushed when activities are beyond 100m away is very low.
- Foot/bike activities had the lowest probability of causing birds to take flight.
- Considering the grouping of people on foot or bike, there was a significantly higher probability of birds being flushed if dogs were present. For foot/bike activities the probability of birds being flushed increased with the number of dogs off a lead, but the number of dogs on a lead was not significant.
- There was a significantly higher proportion of flight responses on weekend survey days, compared with weekdays.
- The proportion of flight responses was greater in larger flock sizes.

The implications of the results in terms of management of access on the Humber are discussed.

Contents

Acknowledgements

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1 Introduction

1.1 The Humber Management Scheme (HMS) is a partnership project focussed on the sustainable management of the Humber European Marine Site. The HMS have commissioned this report to look specifically at bird disturbance at selected points around the Humber Estuary.

Balancing Recreation and Nature Conservation

1.2 Balancing recreation demands and nature conservation are increasingly a challenge at many UK sites. The human population in the UK is growing and access to the countryside for recreation tends to overlap with the key sites for nature conservation. There is increasing understanding and acceptance in the conservation sector of the multiple roles played by nature reserves and designated sites, and an increased willingness to take into account the desires and needs of different user groups. Access brings considerable benefits, including to the local economy (Rayment *et al.* 2000; Firbank *et al.* 2013; Bateman *et al.* 2014), people's well-being (Morris 2003; Pretty *et al.* 2005), and physical/health (Bird 2004; Maller *et al.* 2006; Pretty *et al.* 2007; Park *et al.* 2011). The importance of access to the countryside for children is now widely recognised (Moss 2012). There is also evidence to suggest that an emotional affinity with nature plays a role in individuals' motivation to protect nature (Kals, Schumacher & Montada 1999; Nisbet, Zelenski & Murphy 2009) and that increasing people's connection to the natural environment may be more effective than establishing laws and rules (Kaplan 2000).

1.3 Access to the countryside can also have an impact, often linked to the sheer volume of use rather than single individuals. Disturbance has been identified by Natural England as a generic issue across many European Marine Sites (see Coyle & Wiggins 2010) and disturbance to birds, in particular wintering and passage waterfowl, is a particular concern.

1.4 Disturbance to wintering and passage waterfowl can result in:

- A reduction in the time spent feeding due to repeated flushing/increased vigilance (Fitzpatrick & Bouchez 1998; Stillman & Goss-Custard 2002; Bright *et al.* 2003; Thomas, Kvitek & Bretz 2003; Yasué 2005)
- Increased energetic costs (Stock & Hofeditz 1997; Nolet *et al.* 2002) due to birds taking flight, changing behaviour etc.
- Avoidance of areas of otherwise suitable habitat, potentially using poorer quality feeding/roosting sites instead (Cryer *et al.* 1987; Gill 1996; Burton *et al.* 2002; Burton, Rehfisch & Clark 2002)
- Increased stress (Regel & Putz 1997; Weimerskirch *et al.* 2002; Walker, Dee Boersma & Wingfield 2006; Thiel *et al.* 2011)

1.5 The combined effects of these impacts are difficult to appreciate, particularly at a site level. The impacts of disturbance can relate to site conditions that vary temporally such as

weather or prey abundance (Goss-Custard et al. 2006). Birds may also only be vulnerable at particular times, such as staging during migration (Bechet, Giroux & Gauthier 2004; Yasué 2005). As such, disturbance impacts may therefore occur only at certain times or when particular circumstances coincide. Impacts of disturbance may therefore be difficult to detect.

1.6 It is also difficult to record both the level and intensity of disturbance impacts (besides birds simply taking flight) and there is contention about the best approaches (Gill, Norris & Sutherland 2001; Gill 2007). Recording whether birds take flight or not, or how often they are flushed are simple measures of disturbance, but may not necessarily indicate vulnerability to disturbance (Beale & Monaghan 2004a; Møller, Nielsen & Garamzegi 2008; Møller 2008; Møller & Erritzøe 2010). It is therefore difficult for those responsible for the management of sites to make sensible decisions on the relative impacts of access and the need to resolve any impacts through management of access.

The Humber

1.7 The Humber is internationally important for nature conservation. The estuary is designated as a Special Protection Area (SPA), reflecting its importance for passage, wintering and breeding birds of European Importance. In addition the Humber is classified as a Special Area of Conservation (SAC), reflecting its importance for non-avian wildlife/habitats of European interest and the estuary is also listed as a Ramsar site, in recognition of the international wetland importance under the Ramsar Convention[1].

1.8 In addition to the European designations, the Humber is designated as a SSSI, reflecting the nature conservation importance at a national level. The SSSI is notified for a series of habitats that include the estuary itself (i.e. mudflats, sandflats and coastal saltmarsh) and the associated saline lagoons, sand dunes and standing waters. The site is also of national importance for the geological interest at South Ferriby Cliff (Late Pleistocene sediments) and for the coastal geomorphology of Spurn. The SSSI citation refers to nationally important numbers of 22 wintering waterfowl and nine passage waders, and a nationally important assemblage of breeding birds of lowland open waters and their margins. The SSSI is also nationally important for a breeding colony of grey seals *Halichoerus grypus*, river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, a vascular plant assemblage and an invertebrate assemblage.

1.9 The designations reflect the importance of the sites for birds, plants and invertebrates. Disturbance is, of course, a particular issue for birds and is therefore relevant to the SPA and Ramsar designations. The site qualifies[2] for the following species :

Breeding

[1] Convention on wetlands of international importance especially as waterfowl habitat, Ramsar, Iran, 2/2/71 as amended by the Paris protocol of 3/12/92 and the Regina amendments adopted at the extraordinary conference of contracting parties at Regina, Saskatchewan, Canada 28/5 – 3/6/87, most commonly referred to as the 'Ramsar Convention.'

[2] Qualification under article 4.1 or 4.2 of the Directive (79/409/EEC); details from the SPA citation

- Little Tern *Sterna albifrons*,
- Avocet *Recurvirostra avosetta*
- Bittern *Botaurus stellaris*,
- Marsh Harrier *Circus aeruginosus*.

Wintering

- Avocet *Recurvirostra avosetta,*
- Bittern *Botaurus stellaris*,
- Hen Harrier *Circus cyaneus,*
- Golden Plover *Pluvialis apricaria*,
- Bar-tailed Godwit *Limosa lapponica,*
- Black-tailed Godwit *Limosa limosa,*
- Dunlin *Calidris alpina*,
- Knot *Calidris canutus*,
- Redshank *Tringa totanus*,
- Shelduck *Tadorna tadorna.*

On passage

- Ruff *Philomachus pugnax,*
- Redshank *Tringa totanus*,
- Black-tailed Godwit *Limosa limosa,*
- Dunlin *Calidris alpina*,
- Knot *Calidris canutus*,
- Sanderling *Calidris alba*.

1.10 The SPA designation also qualifies for its 'waterfowl assemblage', supporting species including: Dark-bellied Brent Goose *Branta bernicla bernicla*, Shelduck *Tadorna tadorna*, Wigeon *Anas penelope*, Teal *Anas crecca*, Mallard *Anas platyrhynchos*, Pochard *Aythya ferina*, Scaup *Aythya manila,* Goldeneye *Bucephala clangula*, Bittern *Botaurus stellaris*, Oystercatcher *Haematopus ostralegus*, Avocet *Recurvirostra avosetta* Ringed Plover *Charadrius hiaticula*, Golden Plover *Pluvialis apricaria*, Grey Plover *Pluvialis squatarola*, Lapwing *Vanellus vanellus*, Knot *Calidris canutus*, Sanderling *Calidris alba*, Dunlin *Calidris alpina alpina*, Ruff *Philomachus pugnax,* Black-tailed Godwit *Limosa limosa*, Bar-tailed Godwit *Limosa lapponica*, Whimbrel *Numenius phaeopus,* Curlew *Numenius arquata*, Redshank *Tringa totanus*, Greenshank *Tringa tetanus* and Turnstone *Arenaria interpres*.

1.11 The conservation objectives for the SPA are described by Natural England[3] and are:

"Avoid the deterioration of the habitats of the qualifying features, and the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive.

Subject to natural change, to maintain or restore:

The extent and distribution of the habitats of the qualifying features;

[3] http://www.naturalengland.org.uk/Images/UK9006111-Humber-Estuary-SPA_tcm6-32298.pdf

The structure and function of the habitats of the qualifying features;

The supporting processes on which the habitats of the qualifying features rely;

The populations of the qualifying features;

The distribution of the qualifying features within the site."

1.12 Previous work relating to disturbance and the estuary has included a desk-based study (Cruickshanks *et al.* 2010). Detailed visitor work was conducted in 2012, and included interviews with visitors and detailed counts of people and vehicles around the estuary (Fearnley, Liley & Cruickshanks 2012).

Project aims and objectives

1.13 The project was commissioned to supplement the visitor and desk based work with detailed ornithological fieldwork. In some parts of the Humber Estuary we know birds are often well away from any sources of disturbance and access levels in some locations are very low. Rather than attempt to cover the entire estuary, resources were targeted at particular locations selected for their importance for birds and where it was recognised there could be access issues, i.e. areas where access and birds overlap.

1.14 The specific objectives of the project are:

- To determine which activities cause a disturbance to birds
- Identify the severity of different potential disturbance activities
- To measure the response of birds to human activities at different times of the day, week, tidal cycle and year (October or January).
- To propose and assess how potential management measures may work to mitigate any observed disturbance issues.
- To consider this information in line with requirements of regulatory and statutory authorities (i.e. to maintain favourable condition of features and avoid adverse impacts)

2 Methods

2.1 Field survey work was conducted to collect data on the following:

- Human activity levels through a diary of observations
- Standardised bird count data at the survey locations
- Behavioural observations reflecting the response of birds

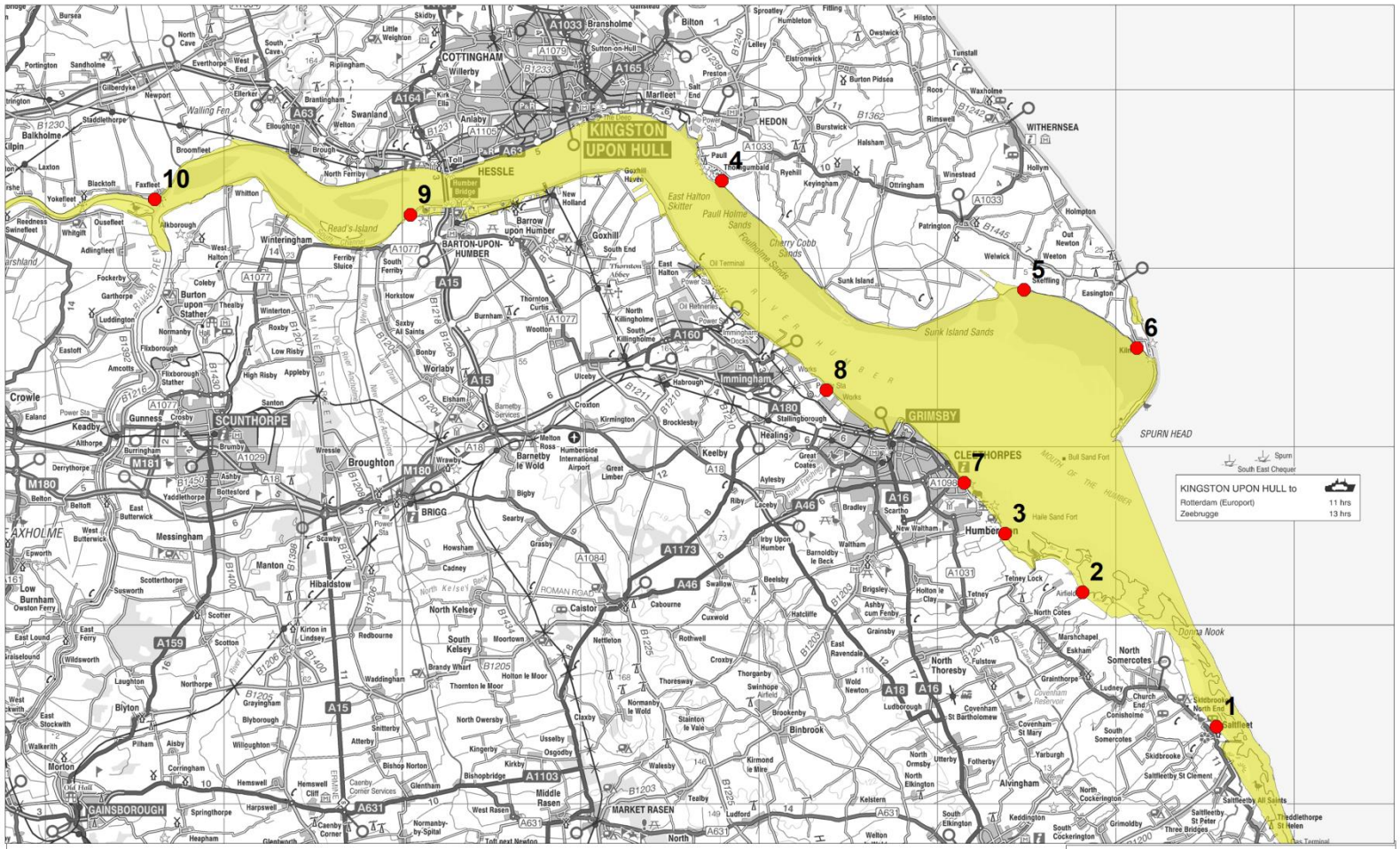
Survey methodology

2.2 Detailed observation of birds and their responses to disturbance were conducted at 10 survey points (see Map 1) within the Humber Estuary SPA. Details of the 10 survey points are provided in Table 1. These survey points were identified through previous work as sites where access and birds coincide.

2.3 Each survey point was visited 4 times in October and 4 times in January. This timing was chosen to reflect the autumn period when bird numbers build up, but the weather is generally mild enough for a range of recreational activities; and January is potentially cold, but bird numbers peak. In addition, both months occur within the wildfowling season.

2.4 The number of visits was split evenly between weekdays and weekends. Each visit lasted for 1 hour and 45 minutes and occurred at similar times of day at each location. At certain locations (see Table 1) visits were timed to coincide with particular tide states to ensure birds were likely to be present within the recording area. When multiple sites were covered in a single day the order in which they were visited was varied on different days. At least two visits at Welwick were close to dusk, allowing some anecdotal recording of disturbance to roosting raptors at this location. Overall, 70 hours of survey effort occurred for each month surveyed and 140 hours were conducted in total.

2.5 The vantage points and focal areas for each survey location were defined prior to commencement of fieldwork. The surveyor remained motionless at a fixed vantage point from which the entire focal area could be viewed. Vantage points were approached carefully at the commencement of fieldwork to avoid disturbance by the surveyor. Focal areas encompassed all areas used by birds within 500m of the survey point. This generally included all visible areas of intertidal habitat below mean high water (MHW), within a 500m radius. The 500m radius was the maximum distance at which surveyors could confidently count birds, reliably estimate the distance between the birds and disturbance sources, and record human activity levels. The focal areas generally included high tide roosts and key high tide feeding areas, but the precise area covered at each site varied according to visibility, lines of site and ease of viewing. The focal areas of sites where creeks, headlands or jetties obscured views of the intertidal tended to have more complex shapes. Furthermore, the focal area was extended at certain sites to encompass important grazing or roosting areas that occurred beyond the MHW mark. Maps of the defined areas are shown in Appendix 1.



Map 1: Survey locations.

Survey locations

SPA area

Table 1 Details of the ten surveys points (ID numbers cross reference with Map 1)

ID	Location	Details	Tide/Visit Details	Parking
1	Saltfleet	Survey point at end of road, on seawall with good view over saltmarsh	All tide states	Parking at carpark, very close to survey point.
2	Horseshoe Point	Survey point on bank above carpark - pill box number 5.	All tide states	Parking at survey point
3	Humberston Fitties	Survey point at edge of dunes below sailing club.	All tide states	Parking close to survey point, in carpark by lagoon.
4	Paull Holme Strays	Survey point at bend, in sea wall, short walk south east from car park	All tide states	Short walk from car park. (Car park signposted with brown reserve sign and a picture of a duck).
5	Welwick	Survey point at bend in seawall, just to east of ditch. Around 20 mins walk from nearest parking	All tide states. At least two visits to cover period up to dusk for roosting raptors/se owl	Closest parking to west, accessed via Humber Lane in Welwick, driving south past Humber Farm. Road heads pretty much due south and at the end turns into a track running WNW. It is possible to park along the edge of this track. It is then a short walk to the sea wall (where YWT gate and sign) and then a walk east along sea wall.
6	Spurn	Survey point south of Crown and Anchor pub along sea wall. In line with ditch and in front of sluice (small square fence on sea wall with EA signs).	Avoid lows, survey only on high tides or rising/falling (close to high tide)	At Crown and Anchor - a short walk
7	Cleethorpes Leisure Centre	Survey point in corner of car park at leisure centre	Spring highs avoided	Park at survey point
8	Pyewipe	Survey point by metal gate at kink in seawall, providing view of intertidal and fields	All tide states	Parking at survey point (possible to access seawall with car c. 1.2km to north of survey point, following track to west and north of terminal – the start of the track is by waste plant and has traffic lights). Alternatively possible to park a short walk to north of survey point off sea wall.
9	Chowder Ness	Survey point just by car park and overlooking saltmarsh and managed realignment area	All tide states	Parking adjacent to survey point
10	Faxfleet	Survey point at bend in bank, overlooking reedbed and pools on both sides of sea wall. Some view of mudflats too.	All tide states	Parking a short walk along seawall to east

Diary of recreational activity

2.6 During each 1 hour and 45 minutes survey, all activities and events observed at the site were recorded in a diary. Events included any human related activities (recreation, industrial, vehicle etc.) that occurred within 200m of the focal area or were seen to evoke a behavioural response from birds present. Activities were recorded regardless of whether birds were present at the site or not, to allow comparison of relative activity levels between survey points and dates. Events included observations of birds of prey. Details of each event were recorded, such as activity type, group size, duration of disturbance, and location (on the shore, intertidal or water), along with bird behavioural responses (see paragraph 2.11 and Table 3).

2.7 Activity type was recorded using a set of standardised codes, shown in Table 2. Where the codes were not relevant then the surveyor simply described the activity, ensuring that all disturbance events were recorded. In some cases, more than one code was used to describe a single event (e.g. jogger with dog off lead).

2.8 Prior to analysis, cases where multiple codes had been ascribed to single events were simplified under the following criteria, to ensure the methodology was consistent with that used in previous surveys:

- human activities were prioritised (e.g. 'jogger with dog off lead' becomes 'jogger')
- dog walkers that had dogs off and on lead these were classified as the category likely to cause the greatest disturbance (dog off lead)
- the "Other" category was used to describe disturbance events that did not fit into any of the specified categories, or unidentified sources of disturbance

Table 2 Standardised codes used for describing potential disturbance events.

Description	Code
Air-borne (microlights, helicopters, planes etc)	AB
Person working on boat (boat stationary)	B
Bait digger (use for crab tiling, cockle raking or bait digging – but use notes to specify)	BD
Birdwatcher	BR
Person accessing boat or water (inc e.g. windsurfers walking across mudflat)	BW
Cycling	C
Canoe on water	Ca
Dog walker	dw
Dog on lead	dl
Dog off lead	dx
Fishing (from shore)	F
Horse riding	HR
Jogger	J
Jet Ski on water	JS
Kids playing (with or without parents)	KP
KiteSurfer on water	KS
Large boat on outboard motor	LMb
Moderate – large sailing boat, not running motor	LS
Metal Detecting	MD
Motor vehicle	MV
Picnic	P
Raptor	R
Rowing boat	RB
Rib or similar fast small boat	SMb
Small sailing boat (e.g. Laser / dinghy)	SS
Swimming	SW
Walking / rambling (without dog)	W
Wildfowling	WF
Windsurfer on water	WS
Water skiing	WSk
Other	OT

Standardised bird counts and behavioural observation

2.9 Counts of all waterbirds (including gulls, terns, waders, wildfowl, herons, grebes and divers) were conducted within the focal areas at the end of each 1 hour and 45 minutes of survey work. Counts included the total number of birds within the focal area, recorded at the end of the study period.

Additional data collection

2.10 Data on important environmental factors, such as tidal exposure and weather, were recorded at the same time as the bird count data. In addition, anecdotal information on observed activities that could potentially affect the bird behaviour on that particular survey day (such as military training or wildfowling activities) was recorded.

Recording bird disturbance

2.11 Recreational activities (and other events, such as presence of raptors) were classed as 'potential disturbance events' if they occurred within 200m of birds within the focal area or elicited an observable response from birds within the focal area. The choice of 200m reflects previous studies by Footprint Ecology (e.g. Liley, Stillman & Fearnley 2010; Liley et al. 2011; Liley & Fearnley 2011) and represents a distance well beyond the distance at which birds are likely to respond. However in a few occasions, birds may respond at distances beyond 200m. For all potential disturbance events, whether or not the birds did respond, additional data were recorded:

- **Count** of birds of each species that were present and within 200m of the focal area
- **Response** of birds to the disturbance, recorded using simple categories outlined in Table 3
- Number of birds that responded as either a minor flight or major flight, to determine **'flush rates'**
- **Behaviour** of birds immediately prior to the disturbance event, categorised as "F" (feeding) or "R" (roosting/preening/loafing)
- **Distance** between the potential disturbance event and the bird (if birds were disturbed this was measured as the straight line distance from the birds to the disturbance event at the point of disturbance; if the birds were not disturbed, it was recorded as the minimum distance from the potential disturbance event to the nearest individual bird of that species).
- **Displacement distance**, i.e. the estimated distance that disturbed birds moved from their original location following a disturbance event. In cases where it was not possible to record the displacement distance of the birds (e.g. if the birds flew out of sight), the response was left blank.
- **Duration of disturbance,** measured as the time until birds resumed their pre-disturbance behaviour
- Any other notable observations

2.12 For some potential disturbance events, multiple observations were recorded if multiple species were present within the focal area.

Table 3 Response categories for birds following potential disturbance events

Response	Code
No response	NR
Alert, heads up, no change in birds' position	A
Alert, birds walked/swam short distance and resumed previous behaviour	W
Birds flew short distance (<50m) and resumed previous behaviour in general area	f
Birds took flight and flew more than 50m	F

2.13 The following measures were taken to ensure consistency and accuracy in recording estimates of bird counts and distances:

- surveyors were trained and provided with aerial photographs or maps of each survey location, in which navigable landscape features such as creeks, buoys and marker posts were visible. The maps were overlaid with distance bands
- laser rangefinders were used to check distances to key landscape features
- at the end of each survey period, distances were paced out or triangulated in cases where they were difficult to estimate (for example, due to angles between the observer, birds and disturbance event)

3 Results

Recreational activity

3.1 In total, 1,304 events were recorded in the diary. These events involved 2,280 individuals and 839 dogs (655 off lead, 184 on lead). The total survey time was 140 hours, across ten sites and two survey periods (October and January). Therefore, on average 16.3 people and 6.0 dogs visited per hour across all survey sites.

3.2 Dog walking was the most commonly recorded activity, accounting for 45% of all records (of these, the number of dogs off the lead was over three times the number of dogs on the lead). The second most commonly recorded activity was walking without dogs (366 records), accounting for 28.1% of the records. Other activities that were observed less frequently included cycling (7% of records), birdwatching (5% of records) and jogging (4% of records). Table 4 summarises the locations at which activities occurred, as either on the shoreline, on the intertidal zone or on the water. Dog walking was the most commonly recorded activity on both the shoreline (418 records) and intertidal (192 records). In Table 4 the "Dog walker" activity category includes on-lead and off-lead dogs plus one additional record that was not classified as on- or off- lead.

3.3 Map 2 shows the zones where activities were taking place (shoreline, intertidal or water). The majority of activities occurred on the shore (77%). Water-based activities only accounted for 1.5% of records and were restricted to two sites, Chowder Ness (location 9) and Faxfleet (location10). The site with the highest proportion of activities occurring on the intertidal was Humberston Fitties (location3), with 51% of its activities occurring on the intertidal. A high proportion of activities occurring on the intertidal were also observed at Horseshoe Point (30%) and Cleethorpe Leisure Centre (20%).

Table 4: The zone in which different were activities recorded (on the shore, intertidal zone or water, or unclassified). Note: Not all activities were categorised by location and some activities may be counted more than once if they occurred at more than one location, hence sum of totals may not correspond to total number of survey records.

Activity	Number (%) of events recorded on shore	Number (%) of events recorded on intertidal	Number (%) of events recorded on water	Number (%) of unclassified events	Total number (%) of survey records
Dog walker Dog off lead Dog on lead	413(70.6) 288(65) 124(87.9)	188(32.1) 171(38.6) 17(12.1)	0(0) 0(0) 0(0)	2(0.3) 1(0.2) 1(0.7)	585(44.9) 443(34) 141(10.8)
Walking / rambling (without dog)	333(91)	31(8.5)	1(0.3)	2(0.5)	366(28.1)
Cycling	92(100)	0(0)	0(0)	0(0)	92(7.1)
Birdwatcher	60(93.8)	4(6.3)	0(0)	0(0)	64(4.9)
Jogger	48(82.8)	10(17.2)	0(0)	0(0)	58(4.4)
Motor vehicle	26(78.8)	7(21.2)	0(0)	0(0)	33(2.5)
Bird of Prey	5(18.5)	4(14.8)	0(0)	18(66.7)	27(2.1)
Large boat on outboard motor	0(0)	0(0)	14(100)	0(0)	14(1.1)
Wildfowling	9(69.2)	2(15.4)	0(0)	2(15.4)	13(1)
Other	3(27.3)	0(0)	0(0)	8(72.7)	11(0.8)
Air-borne (microlights, helicopters, planes etc)	0(0)	1(9.1)	0(0)	10(90.9)	11(0.8)
Bait digging, crab tilling or cockle raking	0(0)	7(100)	0(0)	0(0)	7(0.5)
Horse riding	1(16.7)	4(66.7)	0(0)	1(16.7)	6(0.5)
Fishing (from shore)	3(60)	2(40)	0(0)	0(0)	5(0.4)
Kids playing (with or without parents)	2(50)	2(50)	0(0)	0(0)	4(0.3)
Rib or similar fast small boat	0(0)	0(0)	4(100)	0(0)	4(0.3)
Metal detecting	1(33.3)	2(66.7)	0(0)	0(0)	3(0.2)
Picnic	1(100)	0(0)	0(0)	0(0)	1(0.1)
Totals	**997 (76.5)**	**265 (20.3)**	**20 (1.5)**	**44 (3.4)**	**1304 (100)**

Map 2: Number of activities recorded on the intertidal, water and shore at each survey location.

3.4 Figure 1 shows the proportion of each type of activity occurring on weekdays vs weekends (left) and in October vs January (right). Numbers in brackets represent the total number of observations of each activity type. Certain activity types occurred more frequently at weekends, such as birdwatching, and other activities were more common during the week, such as cycling, jogging and wildfowling. Dog walking activity levels were similar during weekends and weekdays.

3.5 There were more activities recorded in October (793 records) compared with January (511 records). In addition, the number of individuals observed partaking in activities was more than twice as high in October (1,562 individuals) compared with January (718 individuals). However, there was less variation in the number of dogs observed in October (450 dogs) and January (389 dogs), suggesting that dog walking occurs at a relatively constant level through the winter.

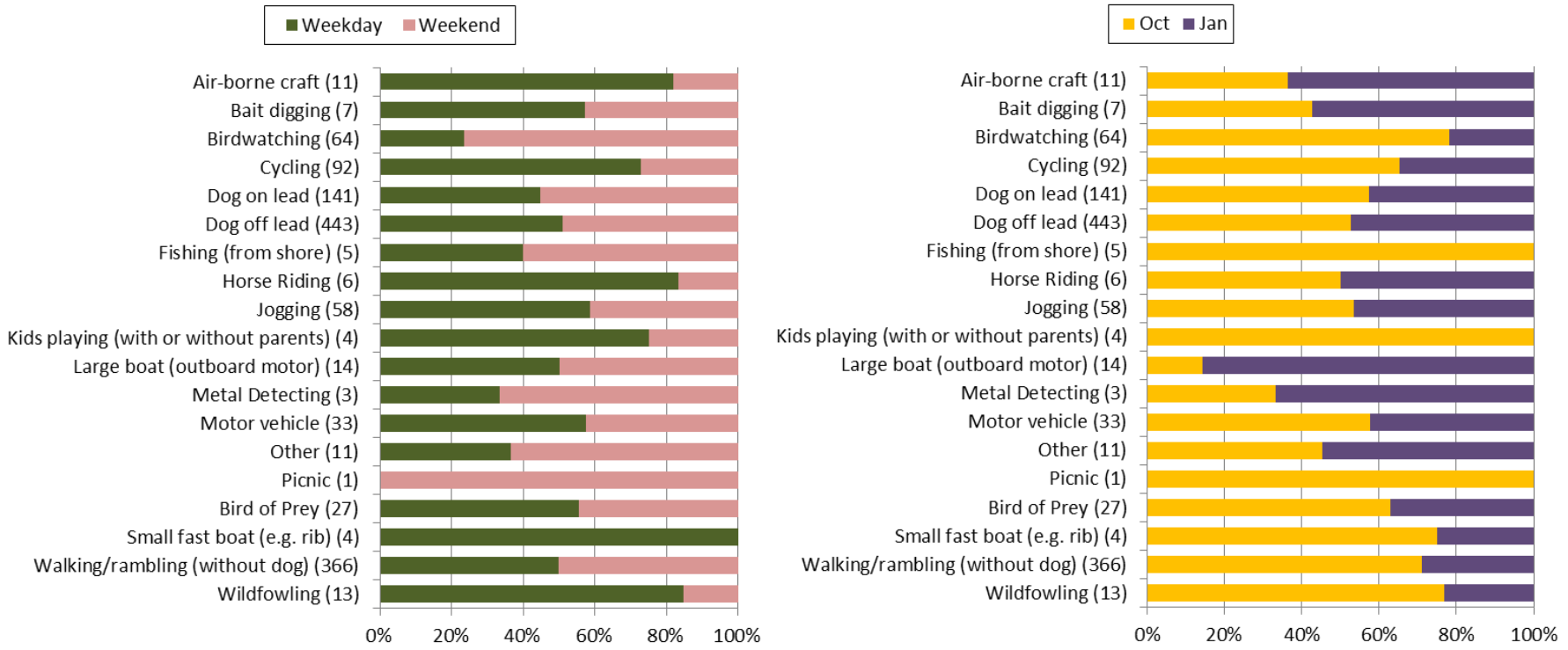


Figure 1: The proportion of each type of activity occurring on weekdays vs weekends (left) and in October vs January (right). Numbers in brackets represent the total number of observations of each activity type

3.6 Figure 2 and Table 5 show the activity records by site. These data are also presented spatially in Map 3. There were significant differences in the activity levels between survey sites ($F=3.01$, $df(9)$, $p=0.002$). Cleethorpes Leisure Centre (location 7) was by far the busiest site with 674 recorded activities. The next busiest site, Humberston Fitties (location 3) had less than a quarter as many activity records (157). The site with the least activity was Welwick (location 5) with only 14 records (9 of which were birds of prey).

3.7 Dog walking was the most frequently recorded activity at 7 of the 10 survey locations and was observed at every survey location. There were at least 10 instances of dog walking recorded at every site except Welwick (which had 1) and Pyewipe (which had 2). The proportion of dog walking activities that were on or off lead is presented in Map 4. More than 70% of dogs were off the lead at all sites except Welwick and Spurn.

3.8 At locations where dog walking was not the most popular activity, the most popular activities were birdwatching (at Spurn, location 6), cycling (at Pyewipe, location 8) and 'other' (at Welwick, location 5).

3.9 Figure 3 shows the proportion of activities occurring on weekdays vs weekends and in October vs January at each site. Most sites had similar activity levels between weekends and weekdays, except Welwick and Spurn, which were busier at the weekend (though note the very low level of activity at Welwick). At 7 of the 10 sites, the number of activity records was higher in October compared with January. The exceptions were Horseshoe Point (location 2), in which the number of records was the same in both months; Humberston Fitties (location 3), at which there was roughly twice as many activity records in January; and Chowder Ness (location 9), in which there was roughly a quarter more records in January.

3.10 There were few recorded observations of "harvesting" activity, occurring at 5 different locations. These included 5 records of fishing activity and 7 records of bait digging. Fishing activity was limited to October, but bait digging was observed during both months. Bait digging was most commonly observed at Humberston Fitties (4 records). The majority of wildfowling records were observed at Faxfleet (11 of 13 records). Six of the 13 wildfowler observations related to a single date in October, when a wildfowler lost his gun in the marsh and a series of other wildfowlers (and police) arrived to search for the weapon.

3.11 The vast majority (89%) of water-based activities were observed at Chowder Ness and Faxfleet (locations 9 and 10), at the inland end of the estuary. Two additional instances of water-based activities were observed at Paul Holme Strays and Spurn (locations 4 and 6). All but one instances of water-based activity involved motorised boats, including 13 large boats with outboard motors and 4 small motorised boats.

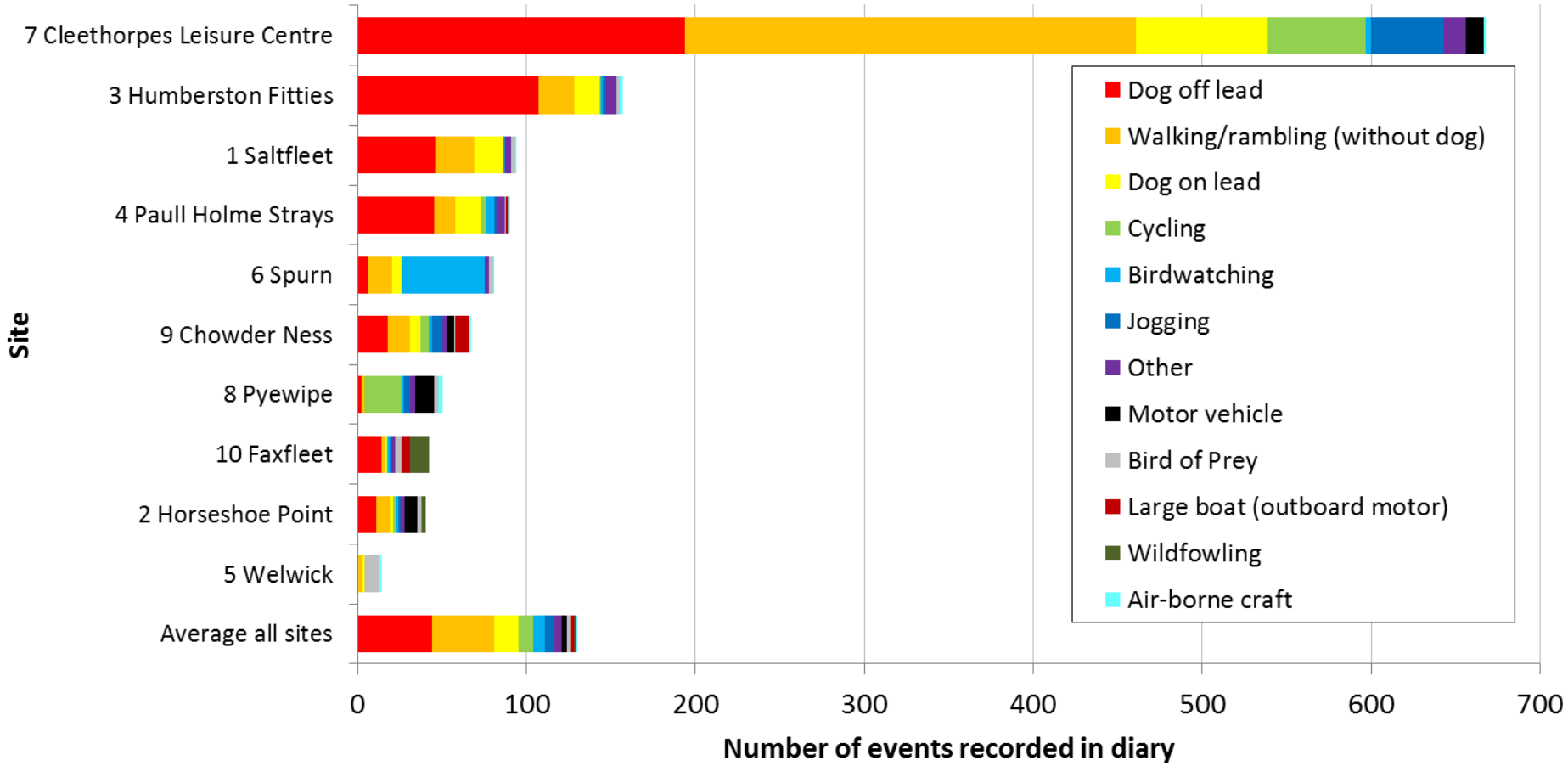
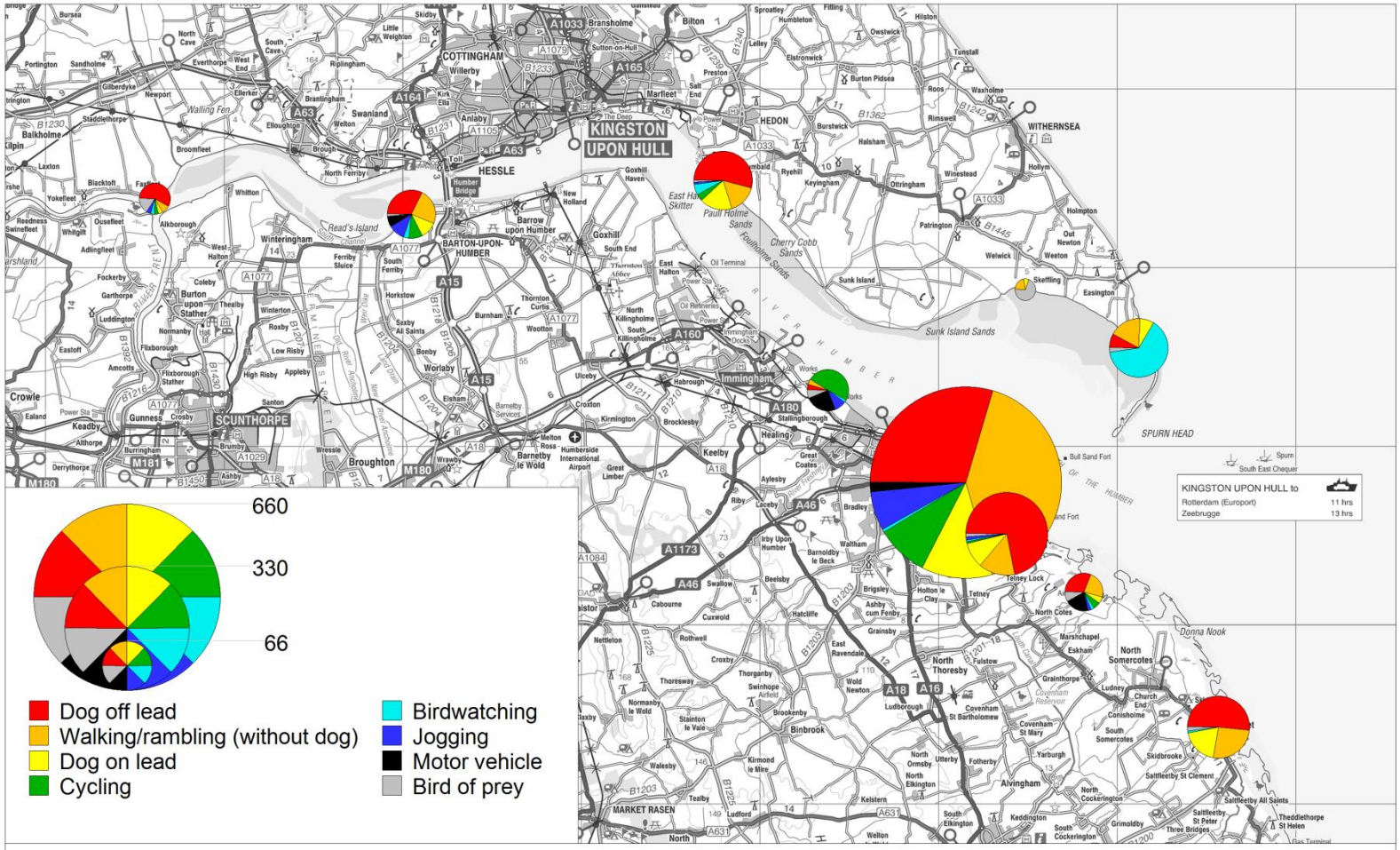


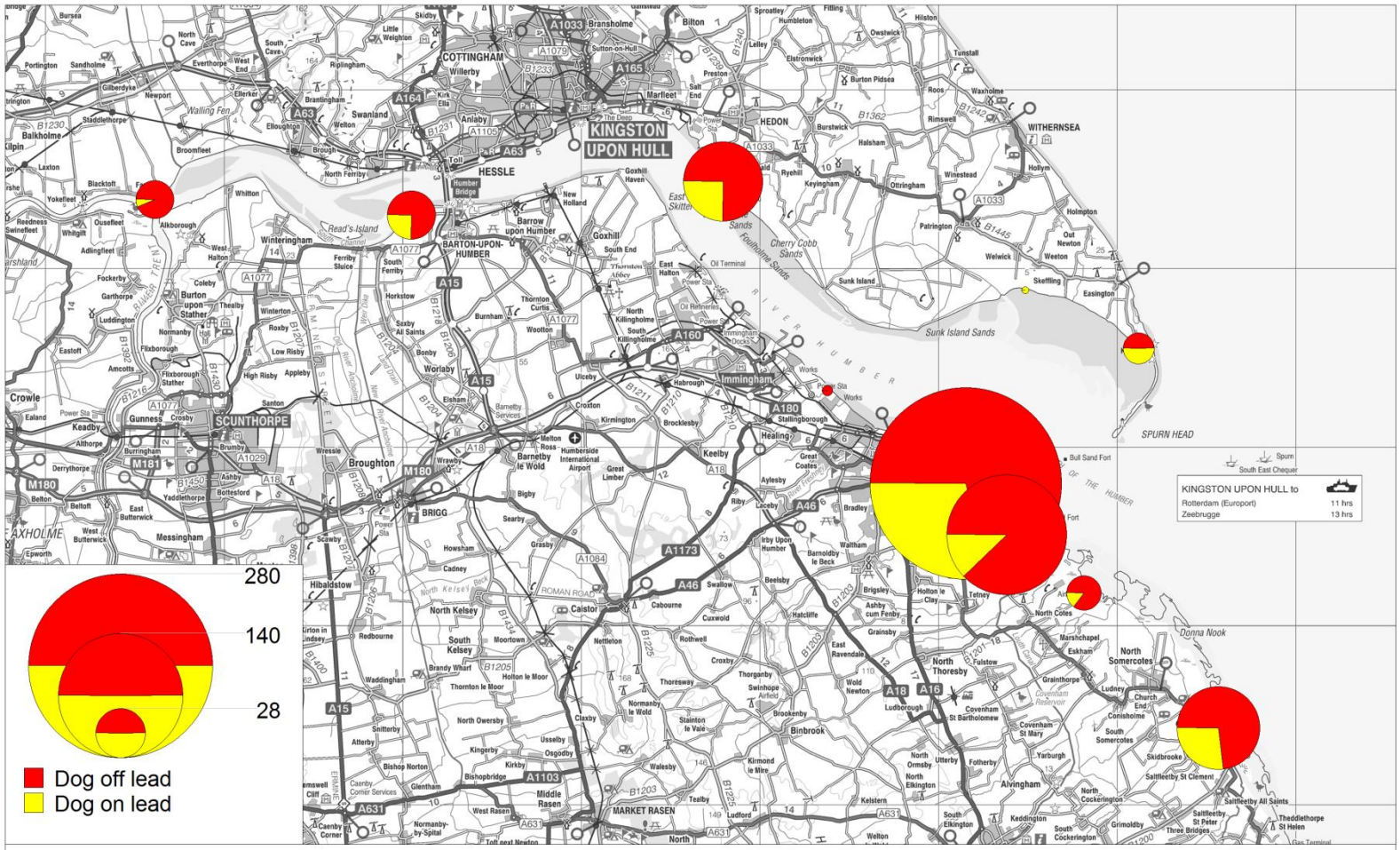
Figure 2 Total number of events recorded in the diary by survey site. Only activities with at least 10 observations in total were included in the figure. The 'other' category included those activities with fewer than 10 observations, and activities that were not categorised (see methods). Survey effort for each site was 14 hours.

Table 5: Number (%) of diary events by site. Percentages are by site and exclude birds of prey.

	7 Cleethorpes Leisure Centre	3 Humberston Fitties	1 Saltfleet	4 Paull Holme Strays	6 Spurn	9 Chowder Ness	8 Pyewipe	10 Faxfleet	2 Horseshoe Point	5 Welwick
Dog off lead	194 (29)	107 (69)	46 (50)	45 (51)	6 (8)	18 (27)	2 (4)	14 (36)	11 (30)	0 (0)
Walking/rambling (without dog)	267 (40)	21 (14)	23 (25)	13 (15)	14 (18)	13 (20)	2 (4)	2 (5)	8 (22)	3 (60)
Dog on lead	78 (12)	15 (10)	17 (18)	15 (17)	6 (8)	6 (9)	0 (0)	1 (3)	2 (5)	1 (20)
Cycling	58 (9)	1 (1)	0 (0)	3 (3)	0 (0)	5 (8)	22 (47)	1 (3)	2 (5)	0 (0)
Birdwatching	3 (0)	1 (1)	1 (1)	5 (6)	49 (62)	2 (3)	1 (2)	1 (3)	1 (3)	0 (0)
Jogging	43 (6)	2 (1)	0 (0)	1 (1)	0 (0)	6 (9)	4 (9)	1 (3)	1 (3)	0 (0)
Other	13 (2)	6 (4)	4 (4)	5 (6)	3 (4)	3 (5)	3 (6)	2 (5)	3 (8)	0 (0)
Motor vehicle	11 (2)	0 (0)	0 (0)	0 (0)	0 (0)	4 (6)	11 (23)	0 (0)	7 (19)	0 (0)
Large boat (outboard motor)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	8 (12)	0 (0)	5 (13)	0 (0)	0 (0)
Wildfowling	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	11 (28)	2 (5)	0 (0)
Air-borne craft	1 (0)	2 (1)	1 (1)	1 (1)	1 (1)	1 (2)	2 (4)	1 (3)	0 (0)	1 (20)
Other	10 (1)	1 (1)	3 (3)	1 (1)	1 (1)	3 (5)	2 (4)	2 (5)	0 (0)	0 (0)
Total human activities	**668 (100)**	**155 (100)**	**92 (100)**	**89 (100)**	**79 (100)**	**66 (100)**	**47 (100)**	**39 (100)**	**37 (100)**	**5 (100)**
Bird of Prey	0	2	2	1	2	1	3	4	3	9
Total events	**668**	**157**	**94**	**90**	**81**	**67**	**50**	**43**	**40**	**14**



Map 3: Number of activity records at each survey location for activities with >15 observations.



Map 4: Number of dogs on and off the lead at each survey location.

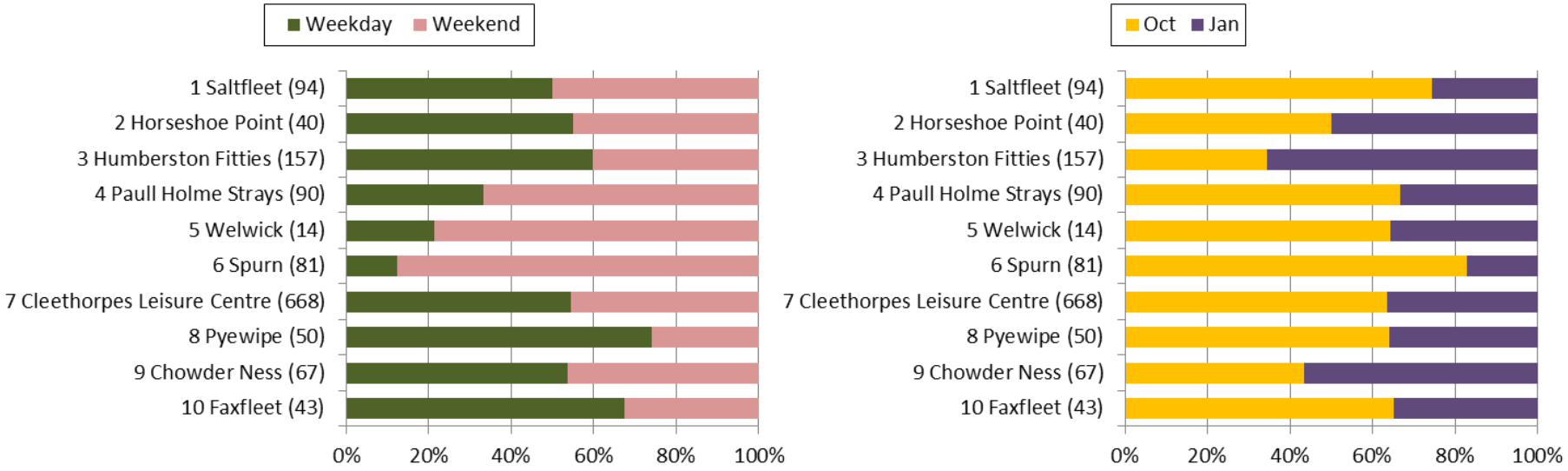


Figure 3: The proportion of activities occurring at each site on weekdays vs weekend (left) and in October vs January (right). Numbers in brackets represent the total number of observations for each site

Bird Counts

3.12 In total, 29 bird species were recorded within the focal areas (excluding species that were not waders, wildfowl, divers or grebes). These included 13 species of wader, 12 wildfowl and 4 other species (Table 6). The most widespread species were redshank, curlew and shelduck, which were recorded at all survey points. The species occurring in highest numbers across all sites were golden plover (14,361 birds) and knot (14,368 birds). The number of species found at each location varied from 9 at location 1 to 28 at location 10. The mean number of species found at all survey points was 18.

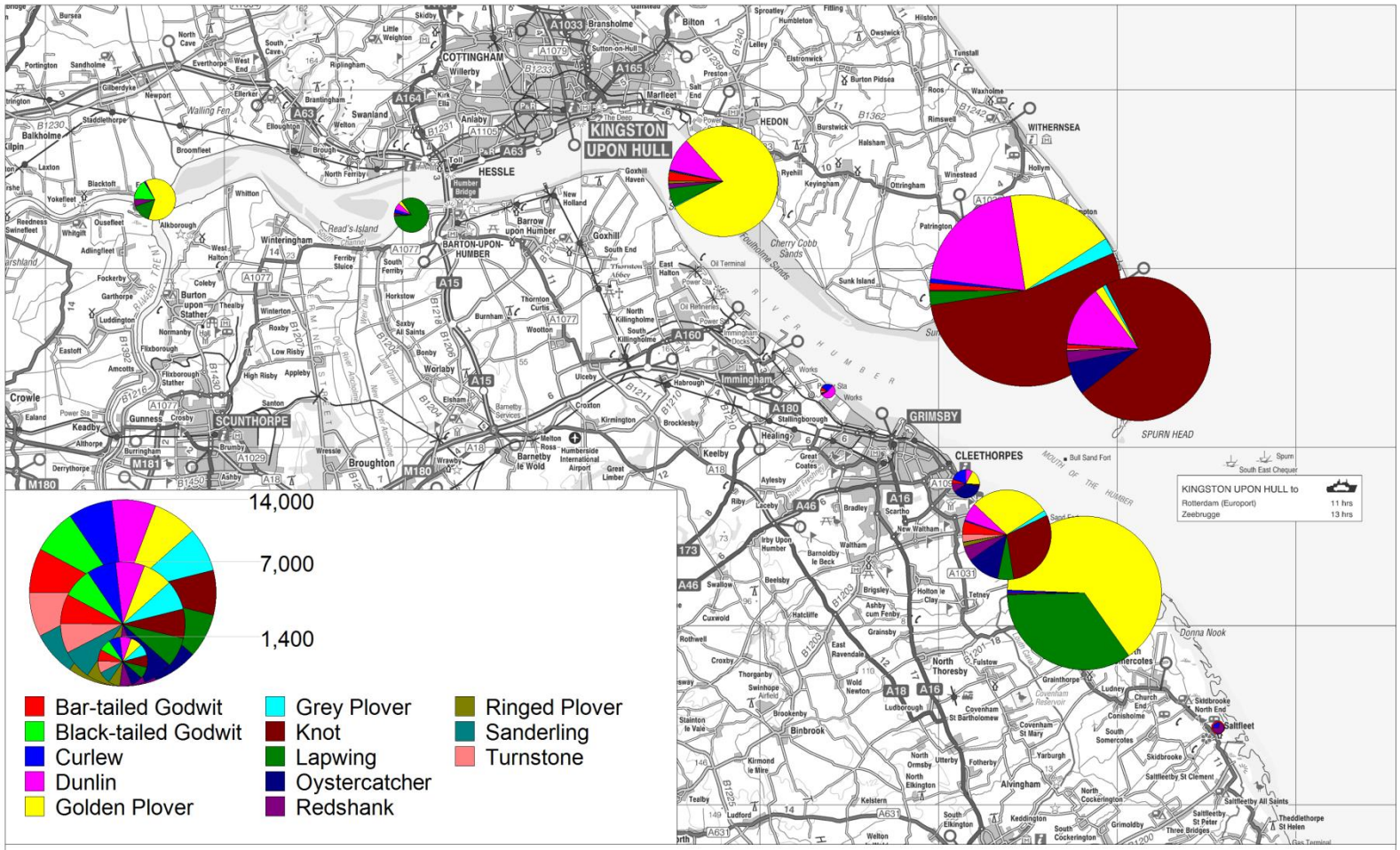
3.13 The maximum counts for each species are presented in Map 5 (waders) and Map 6 (wildfowl). The sites with the highest wader counts were Horseshoe Point and Paull Holme Strays, which were dominated by golden plover, and Humberston Fitties, Welwick and Spurn, which were dominated by knot. The wildfowl assemblages at locations in the west of the site, Faxfleet, Chowder Ness and Paull Holme Strays, were dominated by teal; whereas the remaining locations were dominated by brent goose and/or Shelduck. Wildfowl numbers did not vary between sites as much as wader numbers did.

3.14 Figure 4 shows the variation in average bird numbers observed for visits made in October and January. Wader numbers were higher in January at 7 of 10 sites, particularly so at Horseshoe Point and Welwick. Wildfowl numbers were higher in January at 6 of 10 sites, but high numbers were observed in October at Horseshoe Point and Paull Holme Strays.

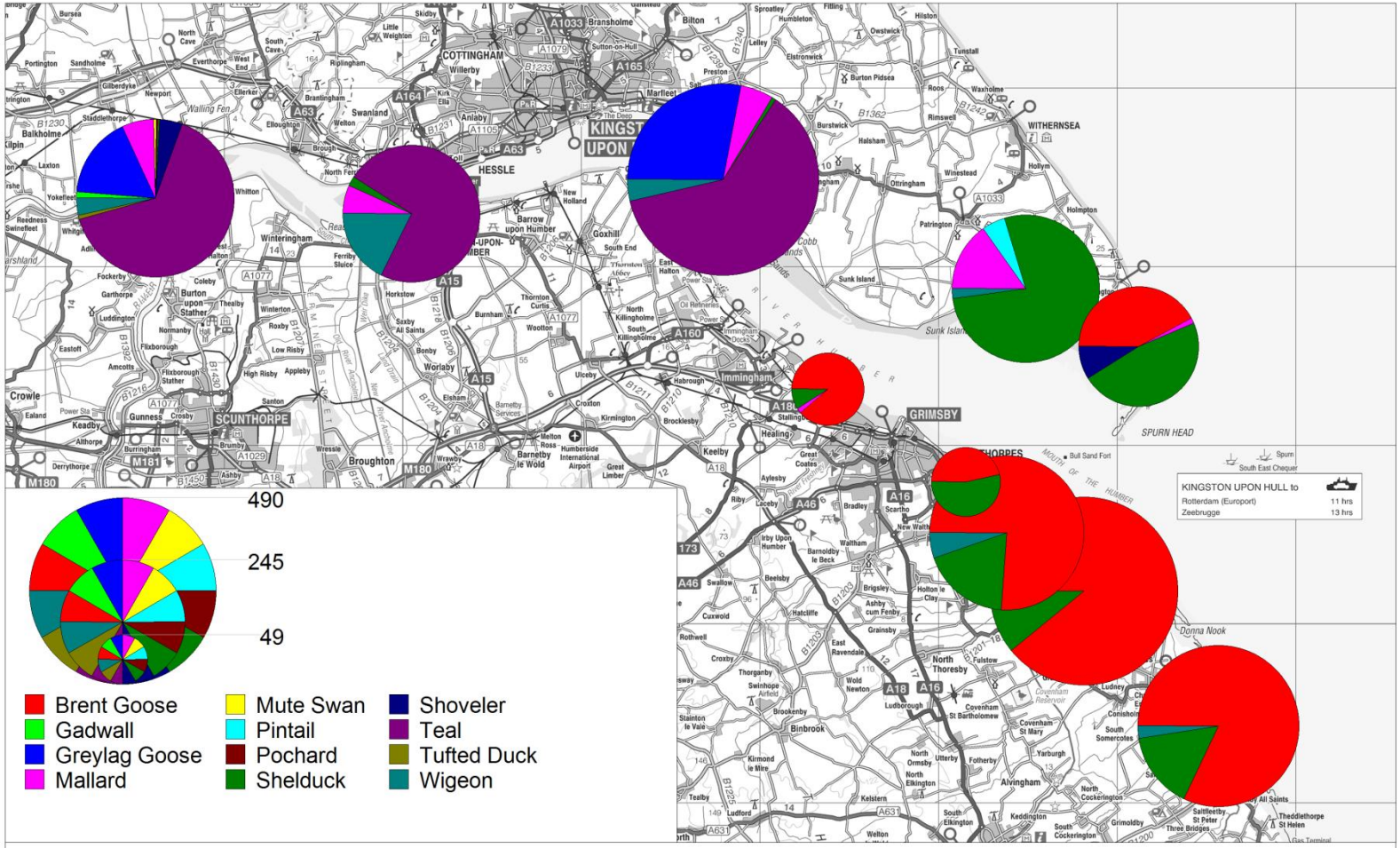
Table 6 Summary of species recorded within focal areas. Data represent maximum counts from of all survey periods.

	Species	No. locations recorded	Survey location										Total all sites
			1	2	3	4	5	6	7	8	9	10	
Waders	Bar-tailed Godwit	7	0	0	172	142	170	72	24	11	9	0	600
	Black-tailed Godwit	3	0	0	0	7	0	0	1	0	0	142	150
	Curlew	10	25	47	18	21	90	17	98	37	26	8	387
	Dunlin	8	0	0	246	507	2800	1150	39	66	45	6	4859
	Golden Plover	8	0	6000	1050	4000	2500	162	83	0	22	544	14361
	Grey Plover	9	0	1	68	19	364	62	2	1	4	3	524
	Knot	4	0	0	1060	0	7300	6000	8	0	0	0	14368
	Lapwing	6	0	3200	207	274	324	0	0	0	560	126	4691
	Oystercatcher	7	0	2	435	1	1	624	176	1	0	0	1240
	Redshank	10	57	36	196	73	22	225	51	3	8	49	720
	Ringed Plover	6	0	0	58	39	3	13	0	2	0	1	116
	Sanderling	1	0	0	5	0	0	0	0	0	0	0	5
	Turnstone	3	0	0	98	0	0	33	0	6	0	0	137
	Total waders	**10**	**82**	**9286**	**3613**	**5083**	**13574**	**8358**	**482**	**127**	**674**	**879**	**42158**
Wildfowl	Brent Goose	6	286	414	251	0	0	88	37	76	0	0	1152
	Gadwall	1	0	0	0	0	0	0	0	0	0	4	4
	Greylag Goose	2	0	0	0	136	0	0	0	0	0	57	193
	Mallard	6	0	0	0	27	47	3	0	2	18	22	119
	Mute Swan	1	0	0	0	0	0	0	0	0	0	2	2
	Pintail	1	0	0	0	0	16	0	0	0	0	0	16
	Pochard	1	0	0	0	0	0	0	0	0	0	1	1
	Shelduck	10	54	51	61	3	239	98	42	8	6	1	563
	Shoveler	2	0	0	0	0	0	19	0	0	0	16	35
	Teal	3	0	0	0	300	0	0	0	0	196	218	714

	Species	No. locations recorded	Survey location										Total all sites
			1	2	3	4	5	6	7	8	9	10	
	Tufted duck	1	0	0	0	0	0	0	0	0	0	3	3
	Wigeon	6	9	0	18	18	7	0	0	0	48	12	112
	Total wildfowl	**10**	**349**	**465**	**330**	**484**	**309**	**208**	**79**	**86**	**268**	**336**	**2914**
Other species	Bittern	1	0	0	0	0	0	0	0	0	0	1	1
	Cormorant	3	0	0	5	0	0	0	5	0	0	1	11
	Little Egret	6	3	7	3	0	3	0	6	0	0	1	23
	Little Grebe	1	0	0	0	0	0	0	0	0	0	3	3
	Total other species	**6**	**3**	**7**	**8**	**0**	**3**	**0**	**11**	**0**	**0**	**6**	**38**
	Number of species		**6**	**9**	**17**	**15**	**15**	**14**	**13**	**11**	**11**	**22**	**29**
	Total all species		**434**	**9758**	**3951**	**5567**	**13886**	**8566**	**572**	**213**	**942**	**1221**	**45110**



Map 5: Maximum wader counts at each survey location.



Map 6: Maximum wildfowl counts at each survey location.

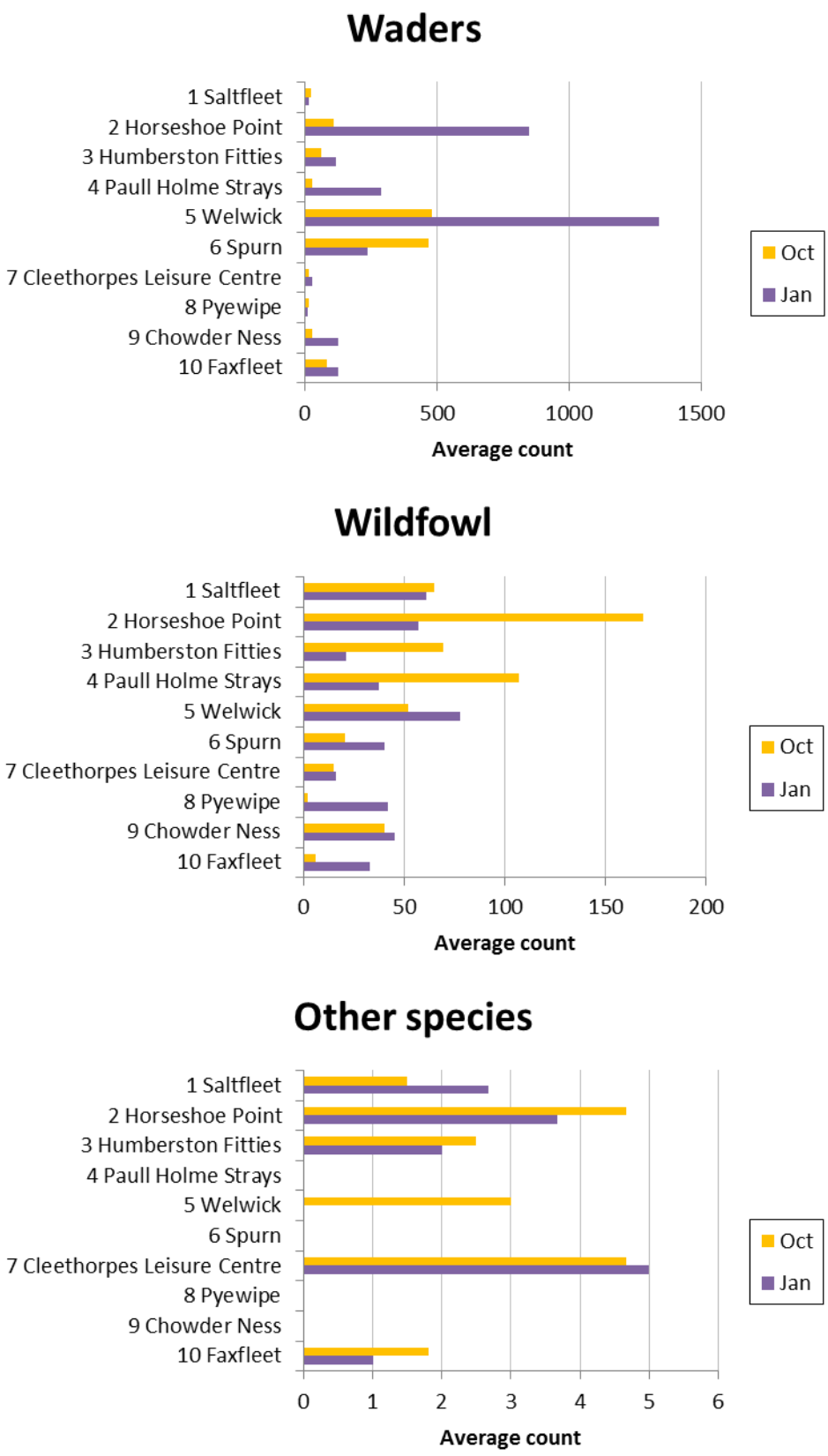


Figure 4: Average bird counts of 4 visits in October and 4 visits in January, for all wader species (top graphs), wildfowl species (middle graph) and other species (bottom graph) at each survey location.

Bird disturbance

3.15 Figure 5 shows how bird density at each survey location varied according to how many disturbance events occurred at the site per hour. If disturbance affects bird distribution, we might expect to see lower bird counts at busy sites. Bird numbers were converted to densities using the total focal area (top row of graphs) and the area of mudflat present within the focal area (bottom row of graphs). The site with the highest numbers of disturbance events per hour was Cleethorpes Leisure Centre (48 events per hour), and as this point occurs in the bottom right hand corner of the waders and wildfowl graphs this indicates this site had relatively low bird densities compared with other sites. In contrast, Welwick had the highest wader densities and a very low hourly rate of disturbance (and this primarily from birds of prey). Cleethorpes is a clear outlier compared to the other sites and given the limited number of points it is difficult to identify a clear pattern with access levels and the maximum counts.

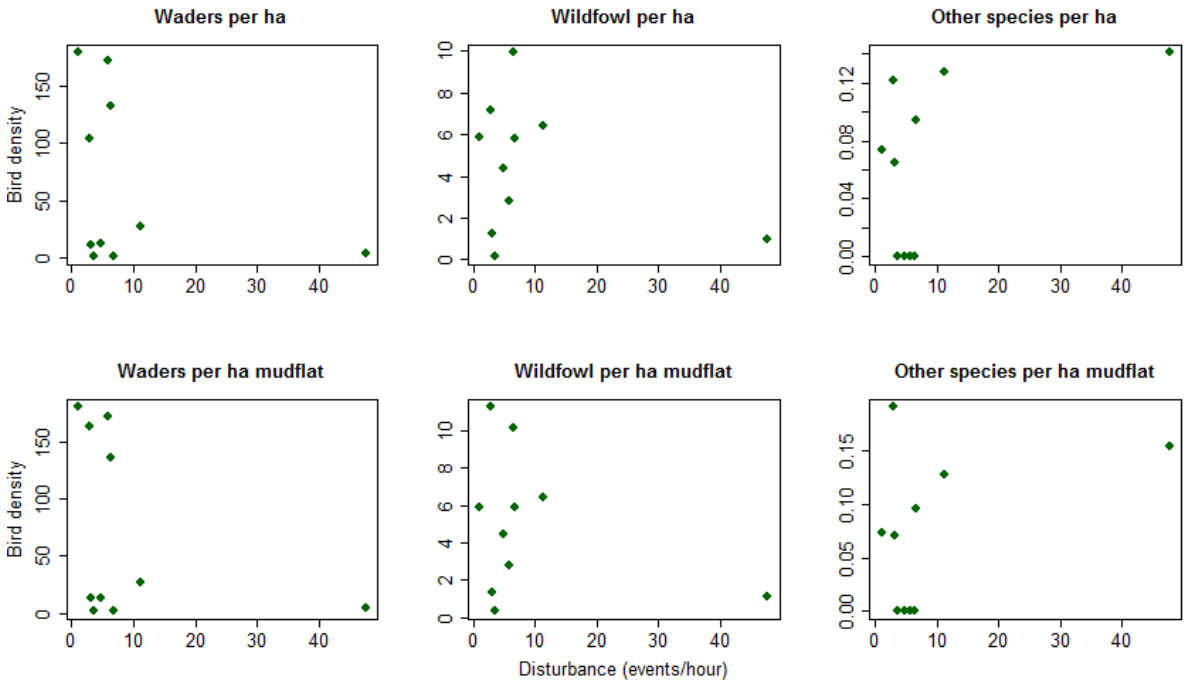


Figure 5: Maximum counts of birds at each location, converted to density (top row entire focal area; bottom row density calculated based on area of mudflat within each focal area) in relation to disturbance levels at each survey point (events per hour). Disturbance event per hour included non-human sources of disturbance to birds, including birds of prey.

3.16 To determine whether or not there was a relationship between bird numbers and disturbance in the short term (i.e. whether birds tend to vacate foraging areas when they are disturbed, rather than avoid them all together), we looked at the counts of birds at the end of each visit in relation to the number of groups of people observed during that visit. To test whether there was any relationship between the number of birds and the number of groups of people observed during each, we used a generalized linear model (GLM) with poisson error structure and logarithm link function.

3.17 This showed a significant negative relationship between the number of birds and the number of groups of people for both waders and wildfowl. These results suggest that during busy times (in terms of recreation) birds temporarily vacate the area. There was a weak positive effect of groups of people on numbers of other species (bittern, cormorant, little egret and little grebe).

Model	Effect size±standard error	F	p
Waders vs Groups of People	-0.05± 0.0005	-99.31	<0.0001
Wildfowl vs Groups of People	-0.03±0.0014	-19.39	<0.0001
Other species vs Groups of People	0.006 ±0.0030	2.04	0.04

3.18 In Figure 6 the data are displayed coloured according to the tidal state at the time of observation (low, rising, high, falling) and the survey location. Including tide and location as factors in the GLM showed that both these factors were also significant in determining the number of birds present for waders, and location (but not tidal state) was significant for wildfowl and other species. In other words, the numbers of birds counted at each location (the dependent variable) relates to the level of access (over the preceding hour and 45 minutes), the location and (for waders) the tide state. It is likely that the effect of location is largely driven by the consistently high disturbance and relatively low bird numbers observed at Humberston Fitties.

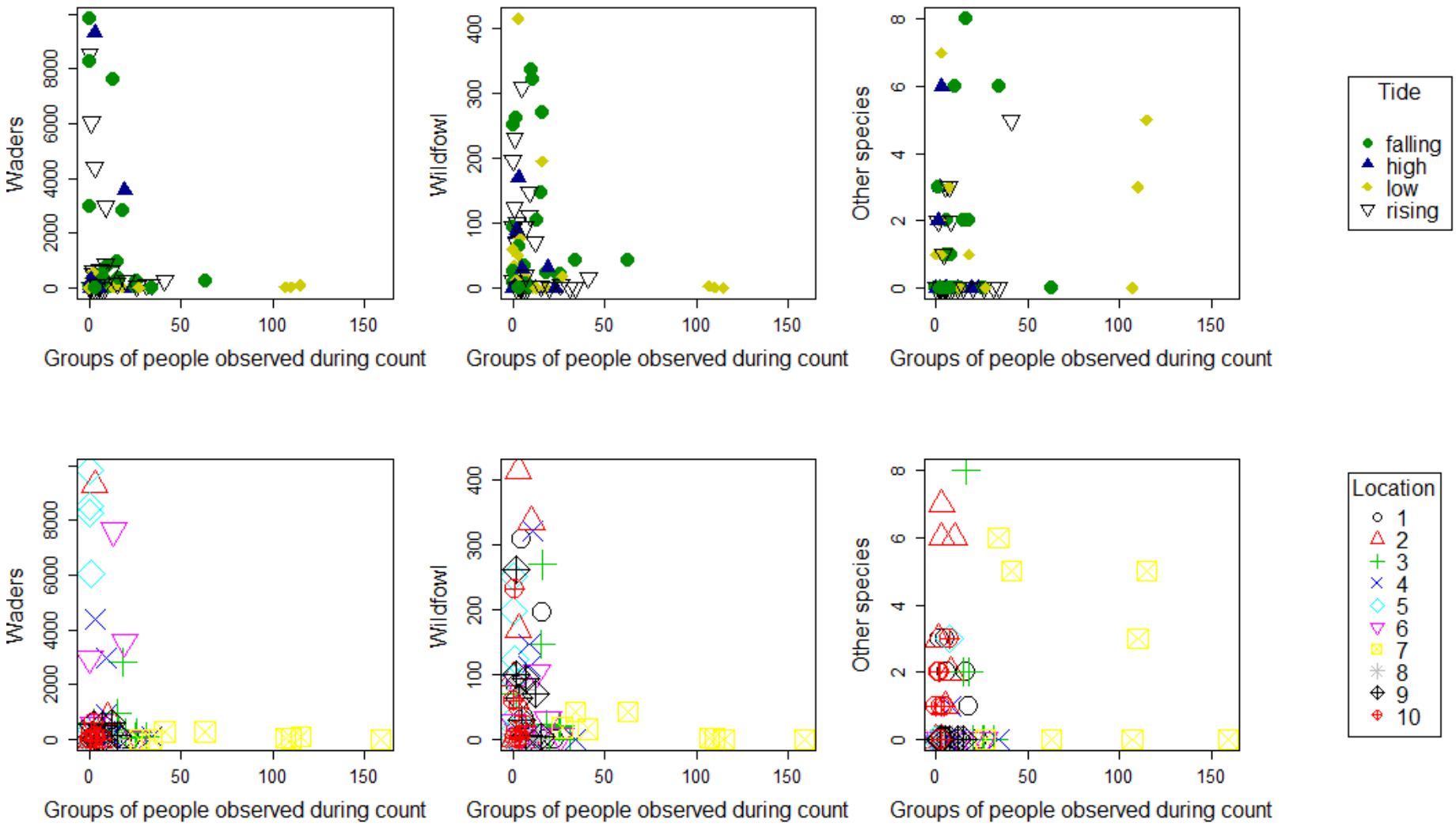


Figure 6: Scatterplots bird counts for waders (left), wildfowl (middle) and other species (right) at the end of each survey in relation to numbers of groups of people observed during the same survey. The points in the top graphs are coloured according to the state of the tide at the time of the count (rising, high, falling, low) and the points in the bottom graphs are coloured according to the survey location.

Bird behavioural responses to disturbance

3.19 Potential disturbance events were recorded in a diary during each survey period whether or not birds were present within the focal area. Whenever birds were present, the response of birds to each disturbance event was recorded. As different species may respond differently to sources of disturbance, if more than one species was present during a potential disturbance event, the response of each species was recorded separately. Thus, for each potential disturbance event, there may be multiple responses recorded, and each disturbance event was treated as a unique observation.

3.20 In total, there were 1,304 events recorded in the diary. Of these, 841 occurred when birds were present within the focal areas. Multiple responses were recorded for some of these potential disturbance events if multiple species were present in the focal area during the event. Therefore, these 841 events generated 2,633 species specific observations.

3.21 The response of birds to potential disturbance events was recorded as one of five categories: no response, alert, walk/swim, minor flight or major flight. Table 7 shows the number of responses recorded in each category, for the whole survey and split into October and January survey dates. In total, 1,851 observations (69.2%) resulted in no visible response from birds. In the remaining 30.8% of observations, birds elicited some form of response ranging from being alert (2.6% of observations), walking or swimming (7.7% of observations), a minor flight (6.7% of observations) or a major flight (13.8% of observations). The proportion of 'no response' recordings was higher in October (74.4%) compared with January (60.7%). And while the proportion of 'major flight' responses was similar between months, the proportion of 'minor flight' responses was higher in January (12.4%) compared with October (3.2%).

3.22 Using the data from all survey locations and time points (140 hours of survey effort), there was an average of 6.0 potential disturbance events per hour. The number of responses (i.e. any response category other than 'no response') from any species resulting from this disturbance rate was 5.6 per hour. The rate of flight responses (i.e. major or minor flight) was 3.9 per hour.

Table 7 Summary of response data. In cases where single events caused a range of responses (e.g. major flight for one species but no response for other species) the event was categorised according to the most extreme response.

Response	Number (%) of species-specific disturbance events		
	Total	October	January
No response	1851 (69.2)	1232 (74.4)	619 (60.7)
Alert	70 (2.6)	34 (2.1)	36 (3.5)
Walk/Swim	205 (7.7)	109 (6.6)	96 (9.4)
Minor flight	179 (6.7)	53 (3.2)	126 (12.4)
Major flight	370 (13.8)	228 (13.8)	142 (13.9)
Total	**2633 (100)**	**1626 (100)**	**1007 (100)**

Responses of bird by activity type

3.23 The response of birds according to each type of activity is shown in Figure 7. The number of responses recorded for each activity type is shown in brackets, and in total 2633 responses to potential disturbance events were recorded. The results are ordered by the proportion of 'major flight' responses for each activity, so activities at the top of the graph with a large proportion of red bar elicited the highest proportion of major flight responses. The number of flight responses for each activity type are also summarised in Table 8.

3.24 All six observations involving wildfowling led to major flight responses from the birds (responses from Little Grebe, Curlew, Lapwing, Pink-footed Goose and Mallard) and in at least five cases it was gunfire that caused the birds to respond. A high proportion of major flight responses were also recorded for the presence of birds of prey or airborne craft (airborne craft which caused major flights included an RAF jet, a police helicopter, low-flying helicopters, low-flying planes and a radio-controlled plane). The activities towards the bottom of the graph which had higher proportion of green bar were activities that caused little or no response from the birds. Picnicking and children playing elicited no response from birds on all occasions they were recorded (although it should be noted that the sample size for both these activities was low). Cycling, walking with dog on the lead or without a dog and motor vehicles all elicited relatively low numbers of responses from birds. Walking with the dog off the lead created proportionally more major flight responses than walking with the dog on the lead or without a dog.

3.25 In Table 8 data are summarised to show the overall percentage of flight events observed for each type of activity. It can be seen that dog walkers with dogs off leads accounted for just under a third (31%) of all the observations, yet caused 40% of all the flight responses recorded. Dog walkers (with either dogs on or off lead) accounted for 40% of the observations and 44% of all flight events. If birds of prey are omitted from the totals then dog walkers accounted for over half of all the flight events observed, in other words as many flight events as all the other human activities put together. Walking (without a dog) was the other commonly observed activity, and while walking without a dog accounted for 29% of the observations, only 10% of flight events were attributed to this activity.

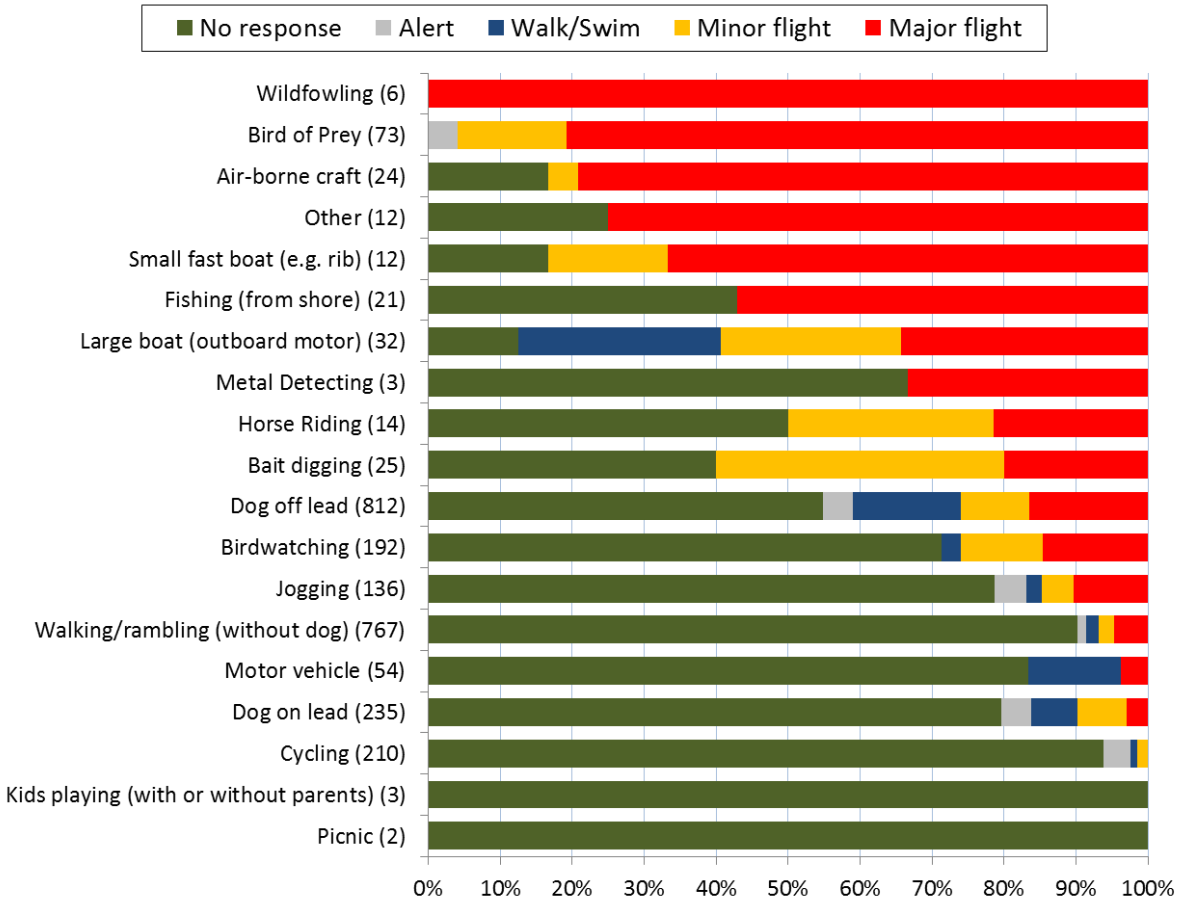


Figure 7: Response by activity. Plot shows the percentage of responses in each category (no response, alert, walk/swim, minor flight or major flight), for each activity. The numbers in brackets indicate the total number of observations of each activity.

Table 8: Number (%) of responses to different potential disturbance events. Percentages are calculated for each column rather than row.

	Number of observations	No response	Minor flight	Major flight	All Flights
Dog walker, dog off lead	812 (31)	445 (24)	77 (44)	134 (38)	211 (40)
Walking/rambling (without dog)	767 (29)	692 (37)	17 (10)	36 (10)	53 (10)
Dog walker, dog on lead	235 (9)	187 (10)	16 (9)	7 (2)	23 (4)
Cycling	210 (8)	197 (11)	3 (2)	0 (0)	3 (1)
Birdwatching	192 (7)	137 (7)	22 (12)	28 (8)	50 (9)
Jogging	136 (5)	107 (6)	6 (3)	14 (4)	20 (4)
Bird of Prey	73 (3)	0 (0)	11 (6)	59 (17)	70 (13)
Motor vehicle	54 (2)	45 (2)	0 (0)	2 (1)	2 (<0.5)
Large boat (outboard motor)	32 (1)	4 (<0.5)	8 (5)	11 (3)	19 (4)
Bait digging	25 (1)	10 (1)	10 (6)	5 (1)	15 (3)
Air-borne craft	24 (1)	4 (<0.5)	1 (1)	19 (5)	20 (4)
Fishing (from shore)	21 (1)	9 (<0.5)	0 (0)	12 (3)	12 (2)
Horse Riding	14 (1)	7 (<0.5)	4 (2)	3 (1)	7 (1)
Small fast boat (e.g. rib)	12 (<0.5)	2 (<0.5)	2 (1)	8 (2)	10 (2)
Other	12 (<0.5)	3 (<0.5)	0 (0)	9 (3)	9 (2)
Wildfowling	6 (<0.5)	0 (0)	0 (0)	6 (2)	6 (1)
Kids playing (with or without parents)	3 (<0.5)	3 (<0.5)	0 (0)	0 (0)	0 (0)
Metal Detecting	3 (<0.5)	2 (<0.5)	0 (0)	1 (<0.5)	1 (<0.5)
Picnic	2 (<0.5)	2 (<0.5)	0 (0)	0 (0)	0 (0)
Total	2633 (100)	1856 (100)	177 (100)	354 (100)	531 (100)

Responses by survey location

3.26 The response of birds to potential disturbance events at different survey locations is presented in Figure 8. There was a significant variation in the proportion of birds that were disturbed to any degree (any response category except 'no response') between sites (Kruskal-Wallis H=733.7, df(9), p<0.001).

3.27 Another notable trend is that the site at which the highest number of potential disturbance events were recorded (Cleethorpes Leisure Centre) had the highest proportion of birds in the 'no response' category. Conversely, sites that had relatively low number of disturbance events, such as Welwick, Saltfleet and Chowder Ness, showed a much higher proportion of birds responding to potential disturbance events. In the case of Welwick, the particularly high proportion of major flight responses was due to a high number of bird of prey disturbance events at this site, which generally elicited major flight responses from birds present.

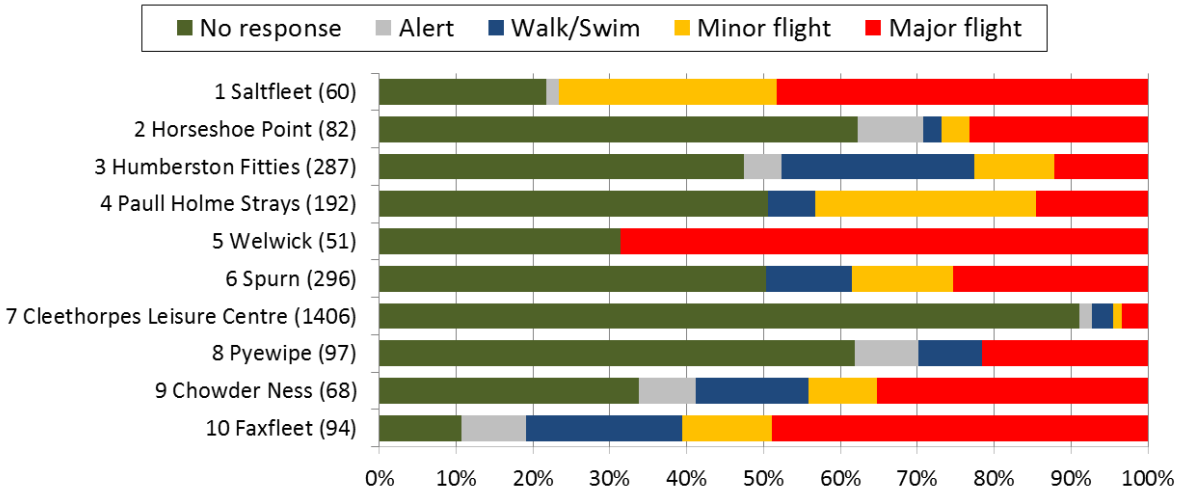
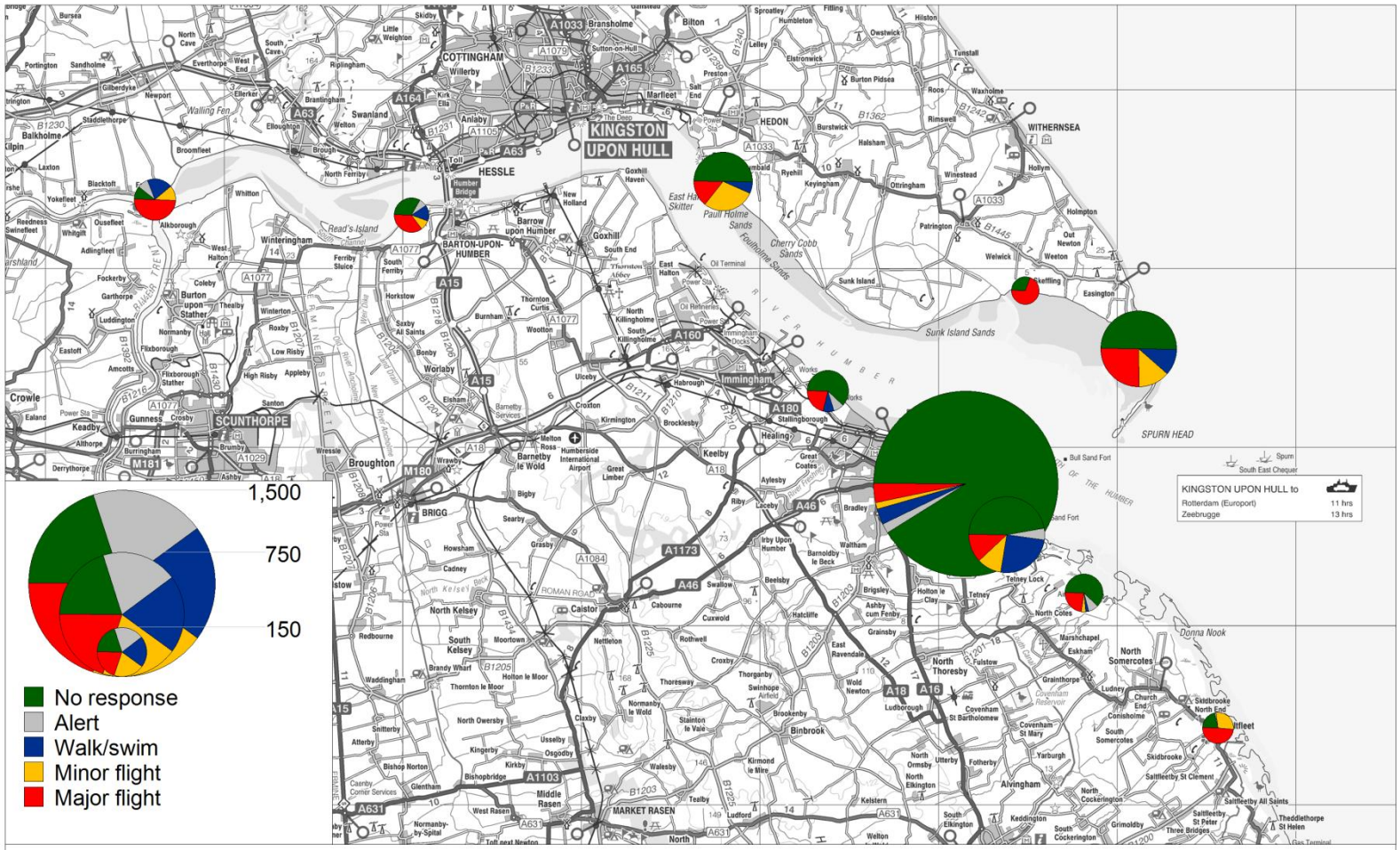


Figure 8 Response by survey location. Plot shows the percentage of responses in each category, for each survey location. The numbers in brackets indicate the total number of observations at each survey point.

3.28 Response by location is also presented in Table 9. In this table the number of flight responses (i.e. minor or major flights) was calculated for each site, and this figure was used to determine the number of flights per hour occurring at each site. Summed over all survey locations, 38.3 flights occur per hour. The highest flight rate was observed at Spurn (8.1 flights per hour) and the lowest flight rate was observed at Pyewipe (1.5 flights per hour). The spatial distribution of responses is presented in Map 7.

Table 9 Response by location. Table gives the number (%) of responses in each category (no response, alert, walk/swim, minor flight or major flight). Total flights represent the number of minor and major flights and flights per hour shows the average number of total flights over 14 hours of survey effort.

Location	No response	Alert	Walk/Swim	Minor flight	Major flight	All responses	Total flights	Survey hours	Flights/hour
1 Saltfleet	13 (21.7)	1 (1.7)	0 (0)	17 (28.3)	29 (48.3)	60 (100)	46 (76.7)	14	3.3
2 Horseshoe Point	51 (62.2)	7 (8.5)	2 (2.4)	3 (3.7)	19 (23.2)	82 (100)	22 (26.8)	14	1.6
3 Humberston Fitties	136 (47.4)	14 (4.9)	72 (25.1)	30 (10.5)	35 (12.2)	287 (100)	65 (22.6)	14	4.6
4 Paull Holme Strays	97 (50.5)	0 (0)	12 (6.3)	55 (28.6)	28 (14.6)	192 (100)	83 (43.2)	14	5.9
5 Welwick	16 (31.4)	0 (0)	0 (0)	0 (0)	35 (68.6)	51 (100)	35 (68.6)	14	2.5
6 Spurn	149 (50.3)	0 (0)	33 (11.1)	39 (13.2)	75 (25.3)	296 (100)	114 (38.5)	14	8.1
7 Cleethorpes Leisure Centre	1280 (91)	24 (1.7)	39 (2.8)	16 (1.1)	47 (3.3)	1406 (100)	63 (4.5)	14	4.5
8 Pyewipe	60 (61.9)	8 (8.2)	8 (8.2)	0 (0)	21 (21.6)	97 (100)	21 (21.6)	14	1.5
9 Chowder Ness	23 (33.8)	5 (7.4)	10 (14.7)	6 (8.8)	24 (35.3)	68 (100)	30 (44.1)	14	2.1
10 Faxfleet	10 (10.6)	8 (8.5)	19 (20.2)	11 (11.7)	46 (48.9)	94 (100)	57 (60.6)	14	4.1
Total	1835 (69.7)	67 (2.5)	195 (7.4)	177 (6.7)	359 (13.6)	2633 (100)	536 (20.30)		



Map 7: Responses to potential disturbance events recorded at each survey location.

3.29 To determine whether there were any particular activities that cause major disturbance to the birds at particular sites, we tabulated the proportion of responses that were major flights by activity and location in Table 10. Site/activity combinations for which at least 50% of the recorded responses were major responses are displayed in bold. As some of these combinations may only represent a small number of observations, we indicated the site/activity combinations for which there was a reasonable sample size by highlighting in grey where at least 10 instances of major flights were recorded.

3.30 The only activities for which at least 10 observations of major flight occurred at any individual survey location were dog off lead, bird of prey activity, birdwatching, fishing and walking without dog.

3.31 The activity that was most commonly observed to cause a high proportion of major flight responses at individual sites was dog walking off the lead and there appears marked differences between sites in how likely dog walkers with dogs off leads were to cause major flights. This activity caused at least 10 major flight responses at 5 sites. However, at three of these sites, Humberston Fitties, Paull Holme Strays and Cleethorpes Leisure Centre, only a small proportion of the observed responses were major flight responses (15% or less). Conversely at the remaining two sites, a high proportion of the observed responses to dog walking off the lead were major flight responses – 54% at Saltfleet and 63% at Faxfleet.

3.32 For birdwatching, the percentage of disturbance events that lead to major flights was 14%, suggesting that although this disturbance activity is common at Spurn (location 6), the proportion of times it leads to major disruption of the birds is relatively low. The proportion of birds disturbed by walkers without dogs that lead to major flight responses at Spurn was slightly higher, 38%.

3.33 Disturbances from birds of prey were commonly observed at Welwick (location 5) and this always led to major flight response. This site is a raptor roost and a proportion of watches were timed to coincide with when raptors were likely to be present here.

3.34 Airborne craft almost always led to major flight responses; however, there were no sites at which this activity was observed more than 10 times. Occurrences in the 'other' category tended to cause major flight responses. The 'other' disturbance events recorded at Paull Holme Strays (location 4) were due to unidentified sources of disturbance, while those recorded at Spurn (location 6) were due to a man in a high-visibility jacket working on a rooftop.

Table 10 Percentage of responses that were major flights for given activities. Grey shading indicates cells with at least 10 observations of major flight. Numbers in bold indicate ≥50% of responses recorded were major flights. Data includes all species.

Activity	Total no. observations (any response)	Location										
		1	2	3	4	5	6	7	8	9	10	All sites
Air-borne craft	24		<0.5	<0.5	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**79**
Bait digging	25		50	<0.5			<0.5					20
Bird of Prey	73	33	33	**100**	<0.5	**100**	**100**		**100**	**100**	36	**81**
Birdwatching	192		<0.5		40		14	<0.5	<0.5		<0.5	15
Cycling	210		<0.5		<0.5			<0.5	<0.5			<0.5
Dog walker, dog off lead	812	**54**	23	15	10		33	8	<0.5	<0.5	**63**	17
Dog walker, dog on lead	235	29	20	<0.5	17	<0.5	<0.5	<0.5			<0.5	3
Fishing (from shore)	21			<0.5			**100**		**100**	<0.5		**57**
Horse riding	14	43						<0.5				21
Jogging	136			<0.5	<0.5			7	**67**	<0.5	<0.5	10
Kids playing (with or without parents)	3							<0.5				<0.5
Large boat (outboard motor)	32									29	45	34
Metal detecting	3							33				33
Motor vehicle	54		10					3	<0.5	<0.5		4
Other	12				**70**		**100**					**75**
Picnic	2				<0.5							<0.5
Small fast boat (e.g. rib)	12									**100**	<0.5	67
Walking/rambling (without dog)	767	**67**	21	<0.5	<0.5	<0.5	38	1	<0.5	55	<0.5	5
Wildfowling	6										100	**100**
Total	2633	48	23	12	15	**69**	25	3	19	35	49	13

3.35 Figure 9 shows the proportion of responses that were minor or major flights by the relative levels of disturbance at each site. Each point on the plot represents a single survey location; disturbance is represented as the number of activities per hour plotted on a log scale (top row of graphs) and as the total potential disturbance events observed at that site plotted on a log scale (bottom row of graphs).

3.36 The graphs do not show any clear pattern but perhaps suggest that the proportion of responses that are major or minor flights increase as the disturbance levels at the site increase. However, the correlations were not statistically significant (for the top plots: Pearson correlation coefficients = 0.44 and 0.42; p = 0.20 and 0.23, respectively, for the bottom plots: Pearson correlation coefficients = 0.55 and 0.29; p = 0.10 and 0.42, respectively).

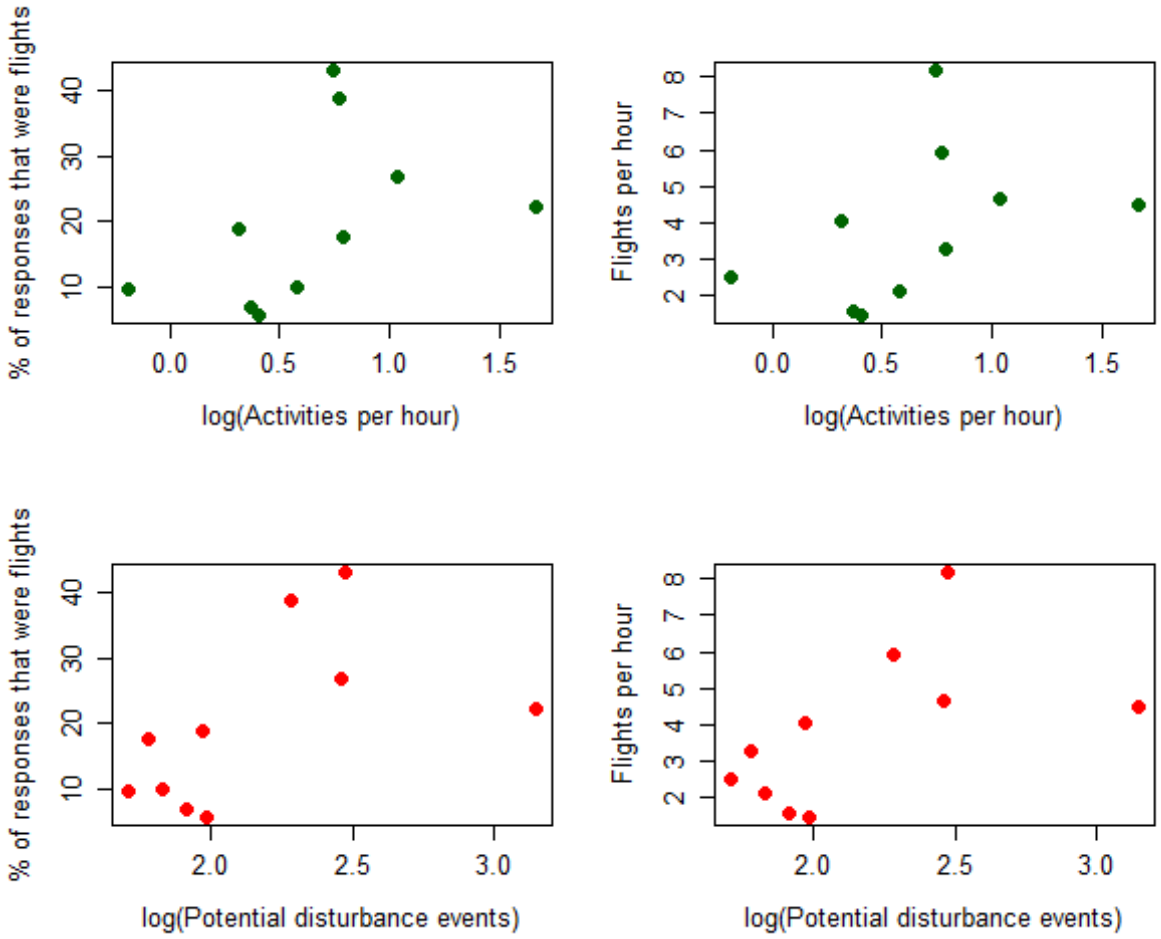


Figure 9: Disturbance in relation to access levels. Activities per hour was calculated as the total number of human activities logged in the diary occurring at each location (so did not include non-human sources of disturbance such as birds of prey). Potential disturbance events included any events that occurred when birds were present, and occurred within 200m of birds, or were seen to cause a disturbance (so included non-human sources of disturbance such as birds of prey). Flights per hour was the proportion of responses that involved major or minor flights.

Response by species

3.37 Responses by species are summarised in Figure 10. Species are ordered by the proportion of major flight responses, and split into groups (waders, wildfowl and other species). The wader species exhibiting the highest proportion of major flight responses were grey plover, turnstone and lapwing; conversely knot, redshank and golden plover had the highest proportion of responses in the 'no response' category. Of the wildfowl, mallard had the highest proportion of major flight responses and shelduck had the highest proportion of responses in the 'no response' category.

3.38 In Map 8, the number of individual birds flushed (i.e. exhibiting major or minor flight responses) divided by the number of survey hours at each location is presented. These 'flush rates' allow direct comparison between sites, as larger circles indicate a greater number of birds being flushed.

3.39 The highest number of birds being flushed was observed at Welwick, and the majority of birds flushed here were knot or dunlin, which occurred at this site in high numbers (see Table 6). High flush rates were also observed at Paull Holme Strays, but here the main species involved were Golden Plover and Grey Plover. Other sites with relatively high overall flush rates were Spurn (where the main species being flushed were knot, dunlin, golden plover and redshank) and Faxfleet (mainly involving Golden Plover, Pink-footed Goose and Teal).

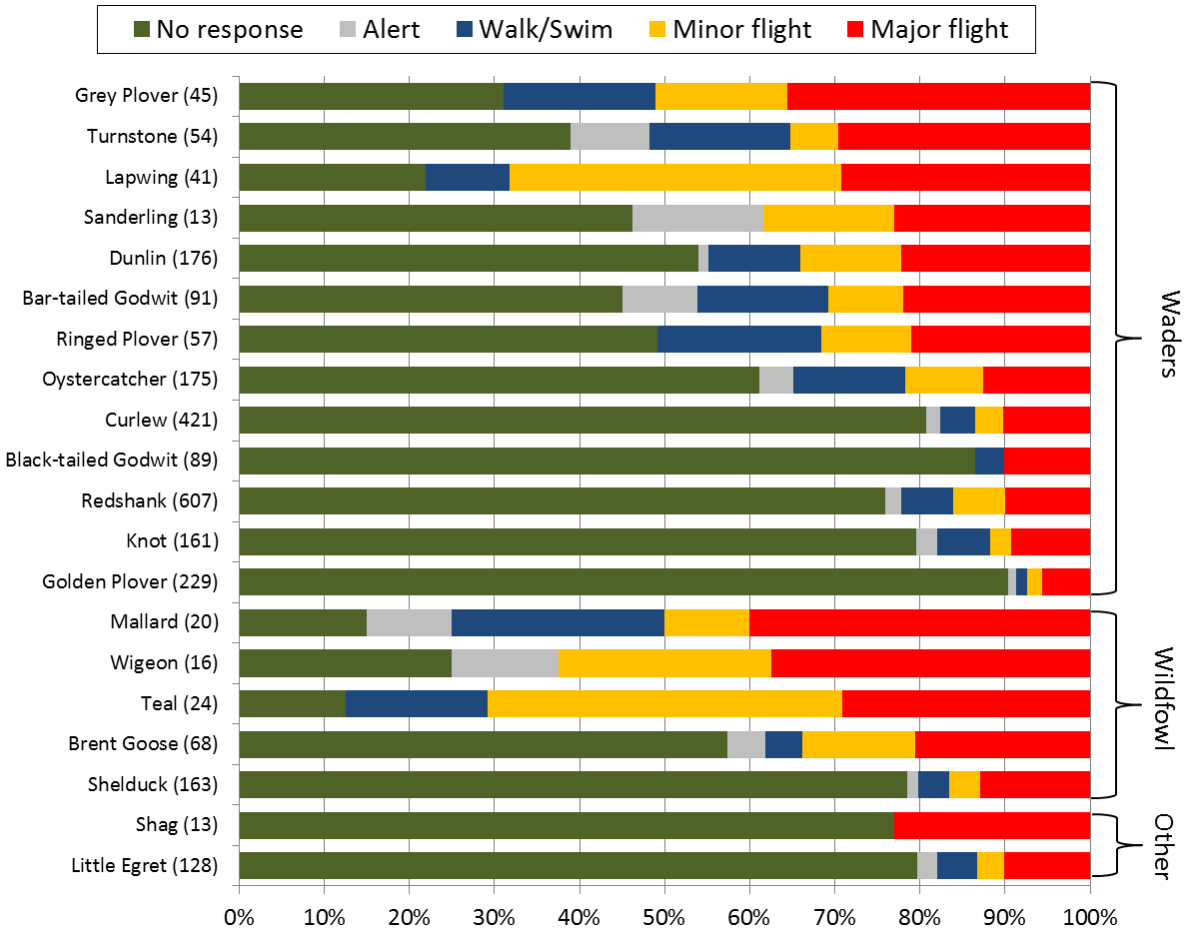
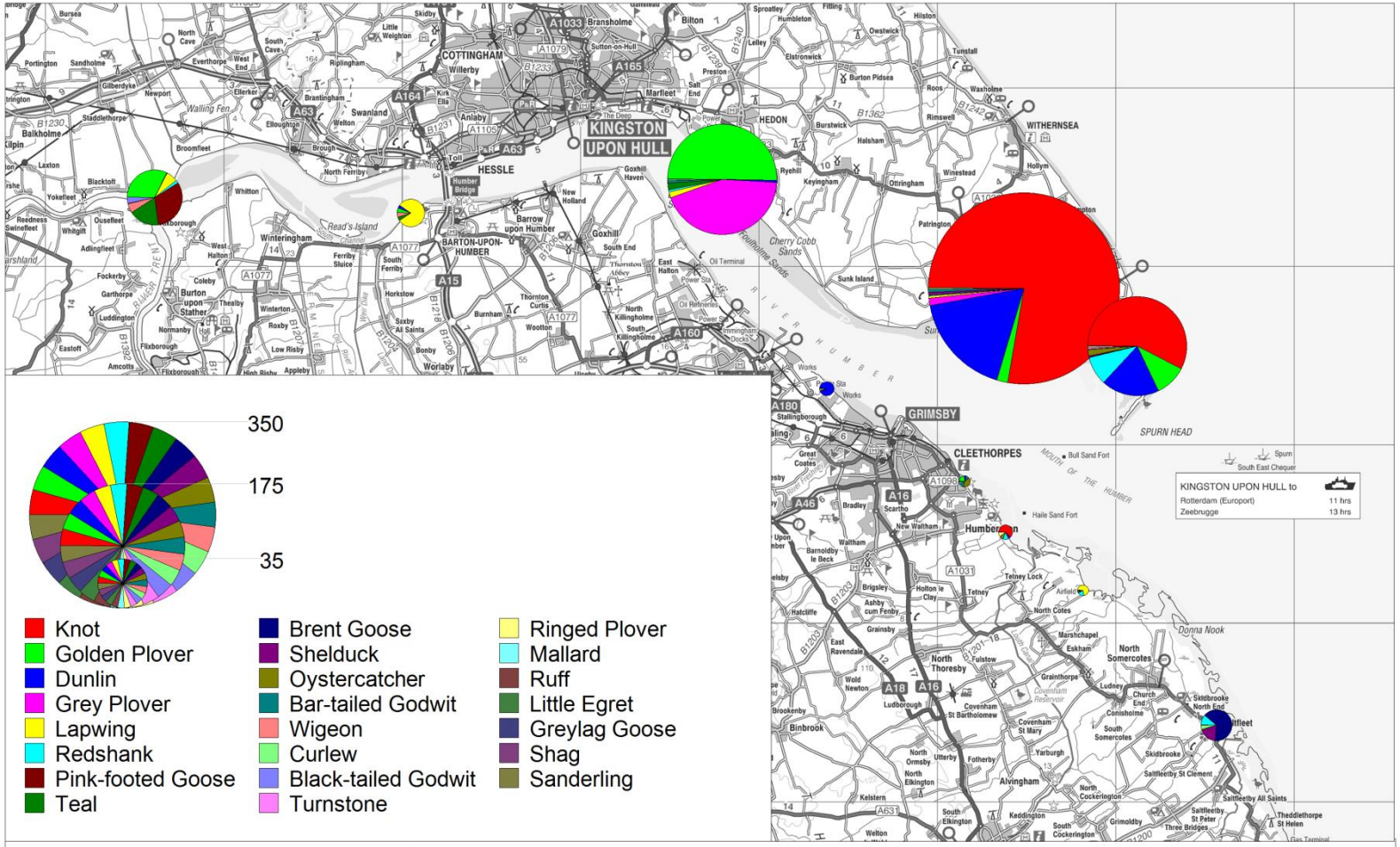


Figure 10: Response to disturbance by species. Only species with at least 10 observations are shown. Percentages calculated using total number of potential disturbance events for each species. Results are grouped as waders, wildfowl or other species, and within groups are ordered by the % of major flight responses. Numbers in brackets indicate the total number of responses recorded for each species.



Map 8: Flush rate (number of birds responding with major or minor flights) per hour

Factors influencing response of birds

3.40 A large number of variables are potentially linked to whether or not a potential disturbance event is likely to cause a disturbance. We used a logistic regression approach to determine whether individual factors were linked to the occurrence of a flight response (i.e. the response variable was 1 if major or minor flight occurred and 0 if any other response occurred).

3.41 The results of the analysis are summarised in Table 11. Survey location had a significant effect on the proportion of birds exhibiting a flight response, with the highest proportion of flight responses occurring at Location 1 (Saltfleet) and Location 5 (Welwick). The survey month had a significant effect on the proportion of flight responses ($p<0.001$), with more flight responses observed during January compared with October. Temperature showed a significant negative effect, indicating that more flight responses were observed at low temperatures. However, if this variable is examined more closely, the response was non-linear, with temperatures of 0°C or less showing extremely low flight response probability, and temperatures above 0°C showing a negative relationship with the likelihood of a flight response. Tidal state showed a significant effect, with birds at low tide having a significantly lower proportion of flight responses compared with other tidal phases.

3.42 The distance between the potential disturbance event and the birds had a significant effect on the proportion of flight responses observed ($p=0.009$). The negative relationship is shown in Figure 11, where distance between the birds and the potential disturbance events are grouped into 20m distance bands.

3.43 When activities were grouped as 'Foot/bike', 'Water-based' or 'Other', there were significant differences in the proportion of flight responses in each of these groups ($F(2,2630)=188.6$, $p<0.0001$). The highest proportion of flight responses was observed in the 'Other' category, which included activities such as motor vehicles, air-borne craft, bird of prey attacks and wildfowling. Water-based activities, which included large or small motorised boats, created a greater proportion of flight responses than foot/bike-based activities (see Figure 12).

3.44 There was no significant difference in the proportion of flight responses for activities where dogs were present, compared with activities where dogs were not present ($p=0.9$). However, if only foot/bike based activities were considered there was a significantly higher proportion of flight responses observed when dogs were present ($t(1744)=5.8$, $p<0.0001$; see Figure 14). Similarly, when only foot/bike-based activities were considered, the number of dogs off the lead had a significant effect on the proportion responses that were major or minor flights ($p<0.0001$), but the number of dogs on the lead was not significant ($p=0.07$).

3.45 There was a significantly higher proportion of flight responses on weekend survey days, compared with weekdays ($t(211)=-3.7$, $p=0.0002$).

3.46 The proportion of flight responses was greater in larger flock sizes (Kruskal-Wallis $H=188$, $df(3)$, $p<0.0001$) (see Figure 13). There were no significant differences in the proportion of major flight responses between waders and wildfowl; however, certain species were more likely to exhibit flight responses, including lapwing, teal, mallard and wigeon.

Table 11: Summary of logistic regression analysis results – factors highlighted in grey indicate that a significant effect on the proportion of responses that were major or minor flight responses.

	Variable	Details
Environmental variables	Survey location	Highest probability of flights at Saltfleet and Welwick
	Month	October<January
	Temperature	Few flight responses at temperatures <0°C. Negative relationship with distance at temperatures >0°C
	Tide	Low tide<Other tidal phases
Activity-related variables	Distance to disturbance	Negative relationship with distance
	No. of people in group	Non-linear response
	Activity type (water-based, foot/bike, other)	Other>Water-based>Foot/bike
	Dog(s) present	Significant effect on response when only Foot/bike activities were considered
	No. of dogs off lead	Significant effect on response when only Foot/bike activities were considered
	No. of dogs on lead	No significant effect
	Weekend vs weekday	Weekend>weekday
Bird-related f variables	Species	Higher flush rates for mallard, teal, wigeon and lapwing
	Species group (wader, wildfowl, other)	No significant effect
	Flock size	Positive relationship with flock size
	Behaviour (roosting/feeding)	No significant effect

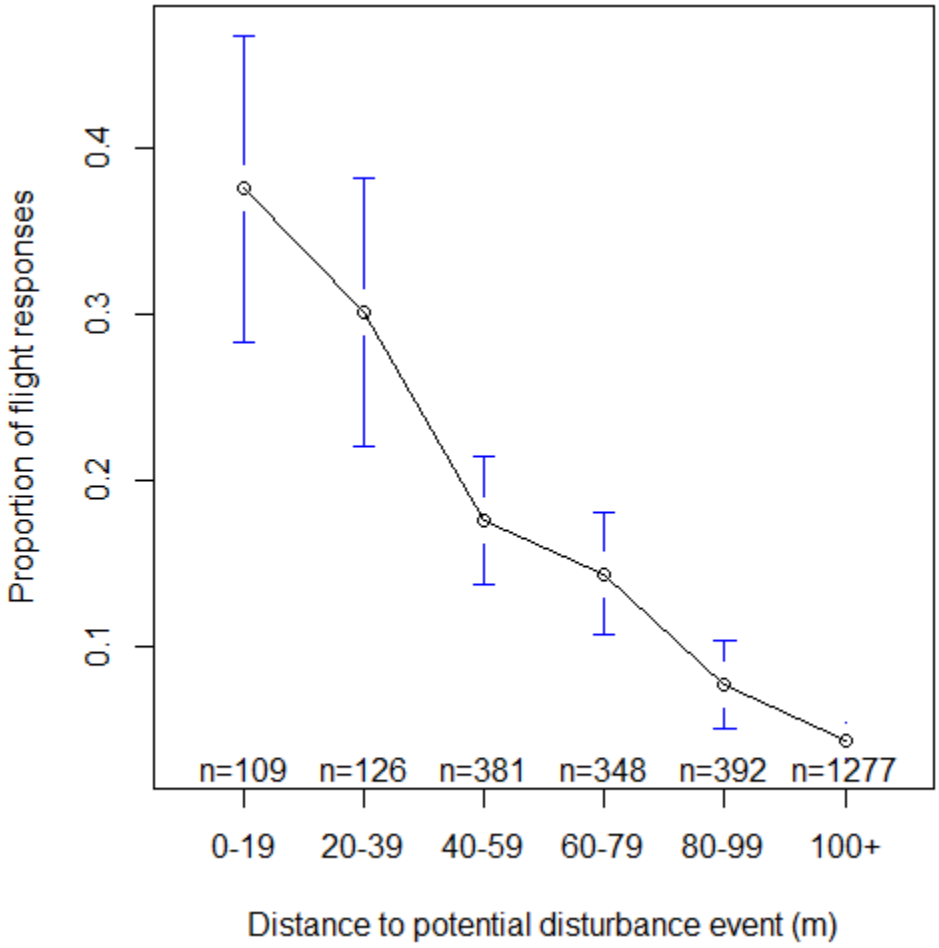


Figure 11: Negative relationship between distance of birds to potential disturbance events and proportion of flight responses that included a major or minor flight. Error bars represent 95% confidence intervals.

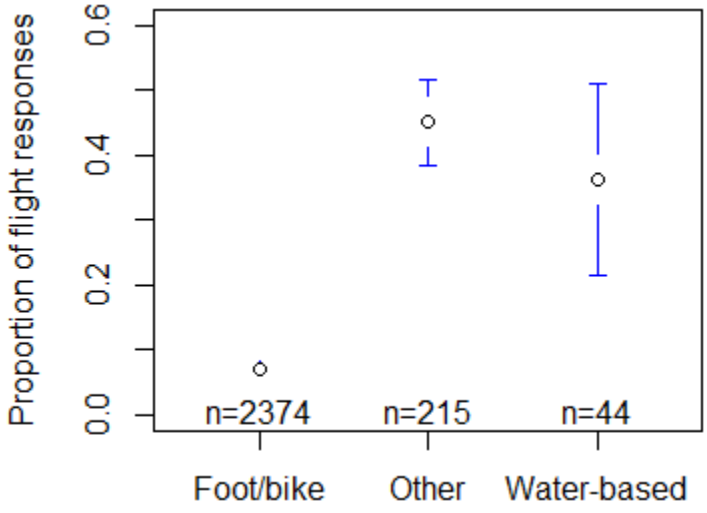


Figure 12: The proportion of responses that included a major or minor flight response in foot/bike-based activities, water-based activities and 'other' activities. Error bars represent 95% confidence intervals.

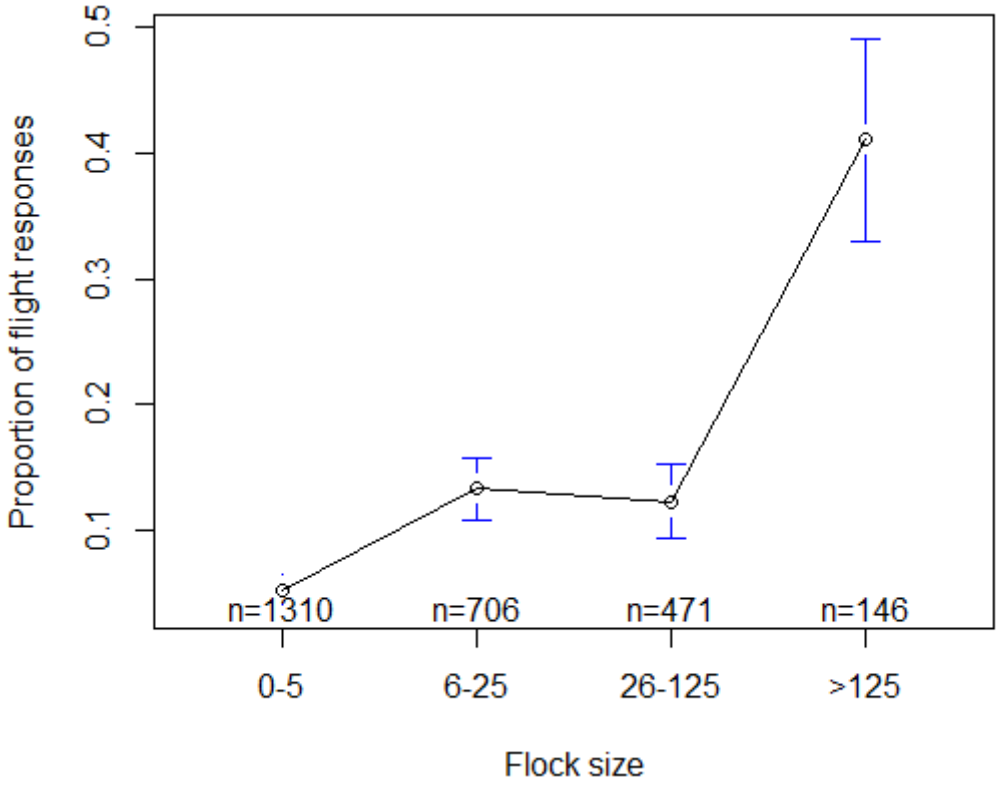


Figure 13: The proportion of responses that were major or minor flight responses for different flock sizes. Error bars represent 95% confidence intervals.

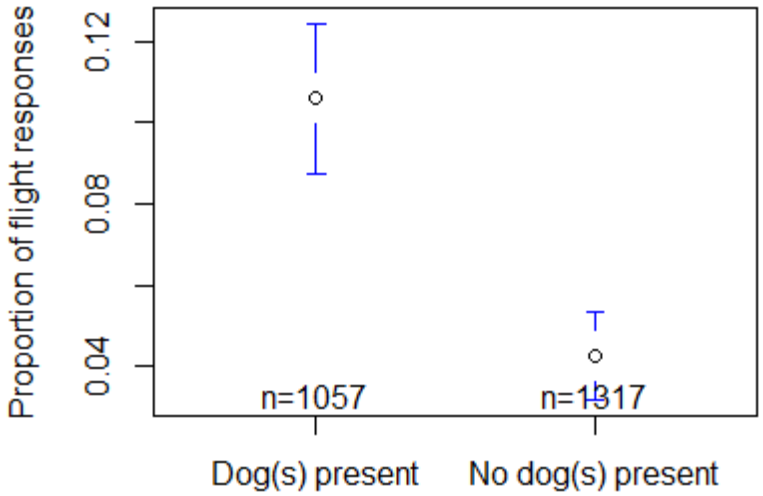


Figure 14 The proportion of responses that were major or minor flights for foot/bike-based activities where at least one dog was present or not present. Error bars represent 95% confidence intervals.

Displacement distances

3.47 Figure 15 shows the displacement distances grouped by species. There were significant differences in the distribution of displacement distances between species (Kruskal-Wallis H=34.5, df(20), p=0.02). The species with the highest median displacement distances were Brent Goose (450m) and Golden Plover (400m). The species with the lowest median displacement distances were Ringed Plover (50m), Mallard (50m) and Teal (50m).

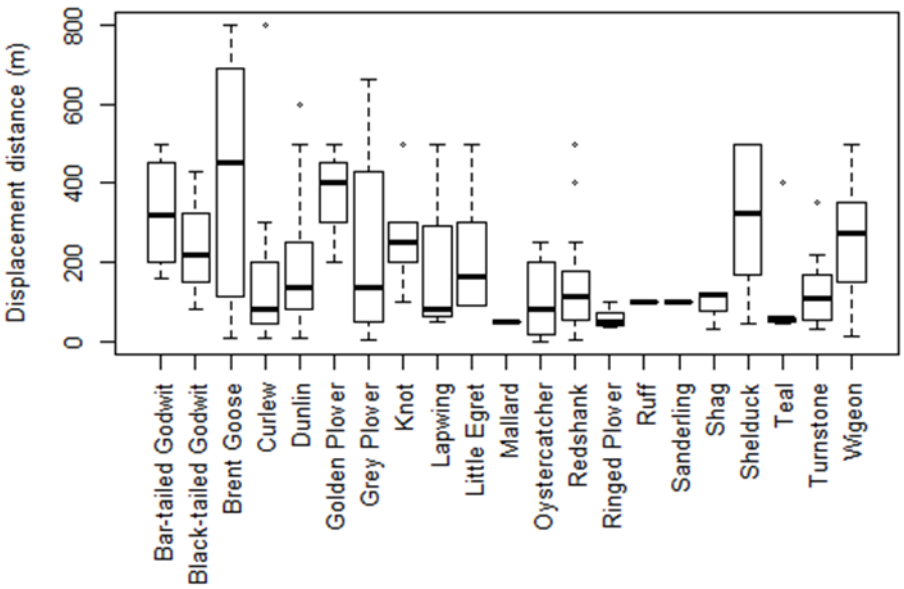


Figure 15 Displacement distances grouped by species

3.48 Displacement distances grouped according to site are presented in Figure 16. There were also significant differences in the distribution of displacement distances between sites (Kruskal-Wallis H=22.6, df(9), p=0.007). The highest median displacement distances were observed at Saltfleet (220m) and Cleethorpes Leisure Centre (200m), and the lowest median displacement distances were observed at Paull Holme Strays (50m), Humberston Fitties (80m) and Horseshoe Point (90m).

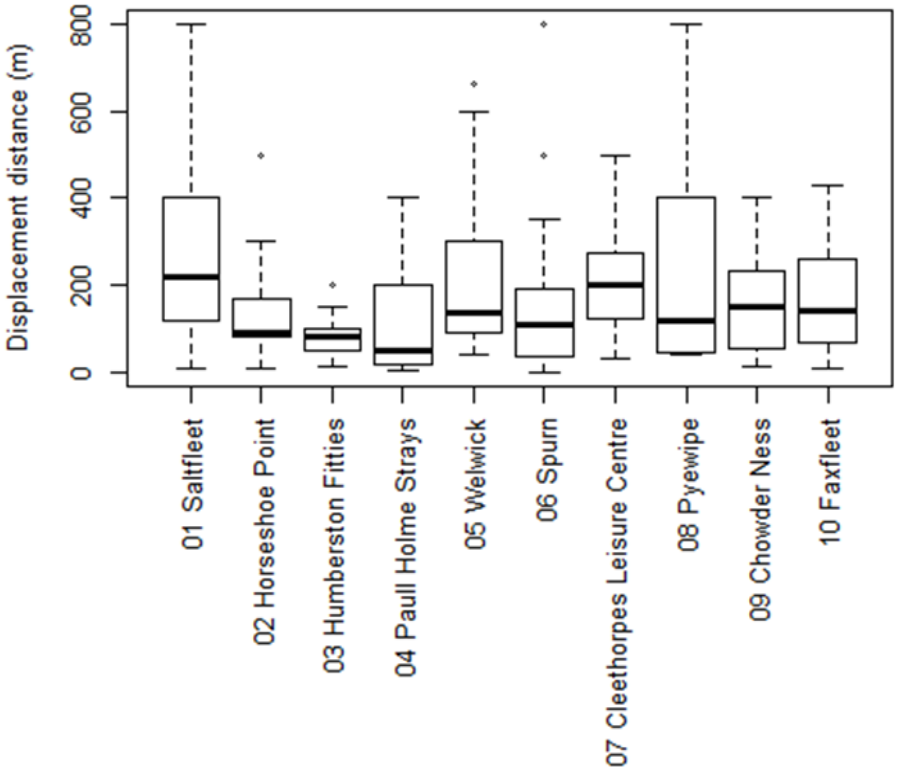


Figure 16 Displacement distances grouped by site

4 Discussion

Overview

4.1 We have focussed on ten locations around the Humber, chosen to be areas where birds and access coincide. Bird numbers at these locations were a function of access, with lower counts of birds at the end of survey visits when more people were counted.

4.2 Looking at the response of birds, as would be expected there is variation in how birds respond according to a range of factors, including tide, weather, time of year and location. This is to be expected, as the behavioural response to a potential threat is a trade-off relating to the level of perceived threat and the relative cost of fleeing (Beale & Monaghan 2004a; b). The more erratic/unusual types of activity and those that offer the greatest threat to birds seem to result in the greatest behavioural response. Dog walking (with dogs off the lead) stands out from all other activities – both in the level of occurrence and the disproportionately higher level that it caused birds to take flight.

Placing the results in context

4.3 Disturbance has a range of impacts on wintering waterfowl. Disturbance to birds can be interpreted in the context that the presence of people or pets is perceived by the birds as a threat and potential predation risk (Frid & Dill 2002; Beale & Monaghan 2004b). This context essentially views the behavioural response to disturbance as the result of a trade-off between the perceived threat from the disturbance and the cost of responding and people are essentially predation-free predators. If the cost of fleeing is high (for example birds lose a territory when they vacate it), then birds will be reluctant to flee, and therefore might be expected to respond to disturbance only when it is nearby and perceived to be particularly dangerous. Equally if food supplies are limited or cold weather places additional energetic demands then it might be expected that birds 'appear' particularly tame. When it is not costly to flee (for example food supplies are plentiful, there is little competition and alternative foraging locations exist), it would be expected that birds would respond to disturbance even when the risk is perceived to be relatively low. In such circumstances birds might fly even when the source of disturbance is some considerable distance away. Habitat, weather, tide, condition of the birds and a range of other factors will therefore interact and influence the behavioural response of birds.

4.4 We would expect many of the wintering birds to have good site knowledge and birds will distribute themselves so as to maximise their food intake (Gill *et al.* 2001) and minimise the risk (Frid & Dill 2002; Beale & Monaghan 2004a; b).

4.5 This background is useful in understanding the implications of the results presented here. Chronic disturbance would result in areas of otherwise suitable habitat being not used or holding low densities of birds. There is relatively little evidence of this effect at the surveyed sites (but it would be difficult to detect). Cleethorpes was the site with by far the highest levels of access. At this location there were very small numbers of birds flushed and very low bird densities, suggesting that at this location at least birds may be largely avoiding the upper shore area where the survey was focussed. At a number of other survey points besides Cleethorpes, there is good evidence of birds redistributing in the short-term as a

result of disturbance (see para 3.17), and this is reflected by the count data and the behavioural observations.

4.6 Compared to other estuary SPA sites in England (Ross *et al.* 2014), the Humber has particularly large areas of intertidal habitat, most of which is well away from the footpath network. There is a relatively high level of sand in the substrate, at least in places, meaning that people can easily walk over the intertidal areas in some parts of the site. The level of surrounding housing (indicating the number of people) is around the middle of the range, but the number of car-parks (shown on standard Ordnance Survey maps) is relatively high per kilometre of estuary shoreline. These metrics would indicate that the Humber Estuary is not likely to as vulnerable to disturbance impacts as some other sites, or at least that some other estuary sites around England are under greater recreation pressure. The large areas of exposed soft intertidal habitat mean that there are a range of options that birds have to feed and these are so far from the shore that redistribution is likely to be easy. For species that feed on soft sediment, there are a range of feeding locations available. Concern is therefore focused around particularly sensitive locations where birds may congregate, such as roost sites, and to some extent in the areas where access may be diffuse and spread out across important habitat to a level where there is significant habitat lost to the birds.

4.7 Birds were flushed when roosting at all the survey locations, however the most notable flushing of roosting birds was at location 4 (Paull Holme Stays) where there were multiple observations of flocks of 1,000s of roosting birds being flushed by people. Relatively high numbers of birds were flushed at Faxfleet, Welwick, Spurn and Saltfleet. Along the south shore of the estuary, running south-east of Cleethorpes in general it seems that relatively low numbers of birds were flushed. At these locations bird counts were relatively low and birds tended to be quite dispersed. Access at these locations was also quite dispersed. Humberston Fitties was the location with the most access on the intertidal. At both Humberston Fitties and Horseshoe Point the distance birds were displaced was low compared to other sites. With people walking out on intertidal habitats where birds are feeding it is perhaps to be expected that birds will make small shifts to enable them to continue feeding.

4.8 The Humber is classified as an SPA in accordance with the European Birds Directive. Strict protection requirements apply to such European sites, and the Member State duties for European sites, both SPAs are set out in Article 6 of the European Habitats Directive. Relevant duties have been transposed into UK legislation via the Conservation of Habitats and Species Regulations 2010 (SI No. 2010/490), commonly referred to as the Habitats Regulations. It is important to note that the European legislation requires two key elements of protection. Firstly there is the overall duty to avoid the deterioration of European sites (Article 6(2) of the Habitats Directive), and secondly there is the duty to properly assess plans or projects that are likely to have a significant effect upon European sites, and only allow their implementation if the European site will not be adversely affected, unless further stringent tests apply (Article 6(3) and 6(4) of the Habitats Directive). There is therefore a duty to both prevent or rectify effects from existing impacts, and to ensure that further effects do not occur as a result of new potential impacts.

4.9 The results presented in this report provide information that is relevant to the European site and protection of the site. Across all sites there was evidence that when access levels were higher fewer birds were present, indicating that levels of access are causing birds to redistribute within the estuary. Survey work was focused at times and locations when access and birds would coincide (in other words if a random selection of survey points had been chosen similar results might not have been found) and it is not possible to determine whether levels of access are reducing the ability of the site to hold a given population of birds. However, given that disturbance is causing some redistribution of birds at the sites surveyed (all of which are within the SPA and can hold high numbers of birds), there is an argument that disturbance is currently having at least a localised impact on the SPA. The combined area within the focal areas within this study accounts for around 422ha, some 3% of the SPA area as given in the SPA Review[4].

4.10 The conservation objectives[5] are to "*Avoid the deterioration of the habitats of the qualifying features, and the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive*." Consideration of access management is therefore relevant, in terms of avoiding any deterioration of the European site. Access management may also be important as avoidance or mitigation measures associated with new plans or projects. Implications for management are discussed at the end of this section.

Limitations

4.11 There are some important considerations and potential limitations with the data collection, that affect how the results should be interpreted. These are summarised below.

Variation between sites in consistency of recording

4.12 The levels of access in the Cleethorpes Leisure Centre were such that surveyors found it difficult to record all activities, and counts from this area therefore reflect a minimum level of access. On some visits there was a constant stream of visitors walking along the promenade. It is complex to record both birds and access at the same time, and where there were lots of different groups of people and different species of birds, recording all data was not always possible.

4.13 The distance birds were displaced was particularly difficult to record. Often birds would take flight and it would be impossible to record where they landed or how far they flew. As such the observed flight distances are likely to be the shorter flights, and it is therefore impossible to accurately detail the precise distance birds were flushed in all cases.

Challenges relating to particular activities

4.14 Wildfowlers were not always recorded when out on the marsh. On a number of occasions surveyors noted that (due to parked vehicles) they thought wildfowlers were present but they were not always visible. If the wildfowlers were not visible to the surveyor then no disturbance would have been attributed to their presence during the survey session. The

[4] http://jncc.defra.gov.uk/default.aspx?page=1996
[5] Taken from http://www.naturalengland.org.uk/Images/UK9006111-Humber-Estuary-SPA_tcm6-32298.pdf

survey points all provided relatively good vantage points, and if wildfowlers were not seen by the surveyors it is likely they were also largely hidden from view for any birds present. There was little evidence of birds being disturbed and the cause being unattributed, so it seems likely that impacts from wildfowlers being present and hidden from view was negligible. It is of course possible, if the wildfowlers had set up/arrived prior to the session commencing, that they could have caused some disturbance and birds already vacated the area. The relatively long survey sessions (105 minutes) should allow for most activities/events to be recorded for their full duration. For activities (perhaps wildfowling and fishing for example) where a single event can last many hours, then it is possible that the disturbance impacts are slightly underestimated.

Level of survey effort

4.15 Activities that occur rarely in very specific situations may have been missed, given that only eight visits were made to each survey point. The level of survey effort has been sufficient to pick up a range different access types, but promoted events (such as competitions) or activities linked to particular conditions (perhaps such as kite surfing) may well have been missed if the conditions/circumstances did not coincide with one of our eight visits.

4.16 Visitor fieldwork was conducted across the Humber over the winter 2012/13 (Fearnley, Liley & Cruickshanks 2012) and covered the months from November -March. It is possible to compare the results from the work here with the data gathered in that winter. The visitor fieldwork included interviews with visitors (614 face-to-face interviews across 20 different survey points), 'snapshot' counts of people from a selection of vantage points (52 vantage points, each visited ten times) and counts of parked cars around the whole estuary (ten counts in total).

4.17 Overall the level of activities recorded in the visitor survey report are similar, for example in the winter 42% of interviewees were dog walking and 24% walking (in the survey points covered in this report 40% were dog walking and 29% were walking).

4.18 Eight of the survey locations included in this report were relatively close to a vantage point included in 2012/3. Data for these eight points – for different activities – are shown in Figure 17. It can be seen that for most activities there is some consistency, for example high counts occurred at the same sites in both surveys. There are significant correlations (Pearson Correlation, $p<0.05$) for eight of the plots in Figure 17 (but note the small sample sizes for some and the likely strong influence of the outlier – Cleethorpes, with particularly high counts in both surveys). It is interesting to note that for some activities (such as bait digging, fishing, horse riding and kids playing) much higher numbers were recorded in the vantage point counts at individual sites compared to the bird disturbance work. For cycling and dog walking there were – in general - higher counts in the bird disturbance work. These differences could relate to changes in the particular activities, but are more likely to reflect the differences in survey approach. The bird disturbance work involved prolonged observations over a relatively small area, whereas the vantage point counts involved counts of all people visible over a wider area. Vantage point counts covered a wider range of months and a wider range of tide conditions etc.

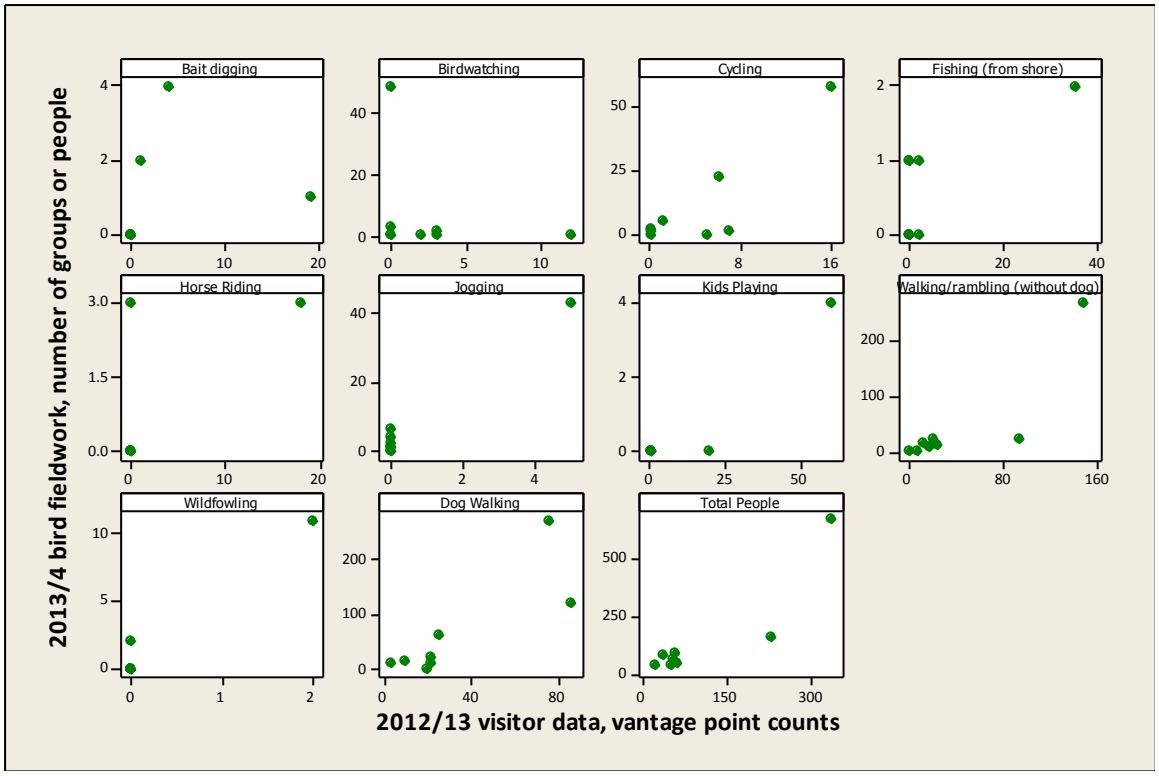


Figure 17: Comparison of vantage point data from 2012/13 and diary data from this report for specific locations (points 1-3 and 6-10 in this report are included in the plots).

4.19 In Table 12 the data for all vantage points (i.e. all parts of the estuary) are compared with the data from this study, collected at the ten survey points included in this study. From this comparison we can potentially identify activities that may have been under-recorded in the current study, and these are highlighted in grey in the table. It can be seen that picnicking, fishing and watersports in particular were largely absent from the bird disturbance work in this report yet were much more of a feature within the wider vantage point counts. These activities are ones that are likely to be very location specific and potentially very reliant on weather conditions such that they only occur in very specific conditions. These are activities for which it is not possible to draw any conclusions – based on the fieldwork presented in this report – but which should be a focus for future monitoring.

Table 12: Totals for different activities from this study and from the 2012/13 visitor work (vantage point counts). The vantage point data shown are from all vantage points across the whole estuary combined. Grey shading indicates activities absent or at very low levels within the current study in contrast to the vantage point counts in 2012/13.

Activity	2013/2014 Bird disturbance fieldwork	2012/13 vantage point
Air-borne craft	11	Not recorded
Bait digging	7	54
Bird of Prey	27	Not recorded
Birdwatching	64	131
Cycling	92	137
Dog walking	585	991
Fishing (from shore rather than from a boat)	5	224
Horse Riding	6	50
Jogging	58	17
Kids playing (with or without parents)	4	191
Kitesurfer on water	0	14
Large boat (outboard motor)	14	2
Metal Detecting	3	6
Motor vehicle	33	4
Other	11	0
Person accessing boat or water (inc e.g. windsurfers walking across mudflat)	0	1
Person working on boat (boat stationary)	0	22
Picnic	1	278
Small fast boat (e.g. rib)	4	2
Rowing boat	0	1
Shooting	0	8
Walking/rambling (without dog)	366	1814
Wildfowling	13	2
Windsurfer on water	0	2

Site specific issues

4.20 Our consideration of bird density in relation to disturbance was limited by relatively small number of survey points. Direct comparison is difficult due to the difference in tide (as the tide states selected for visits varied between sites); habitat quality will also vary between sites. Those sites that were consistently surveyed around high tide and included roosting birds are those where the highest densities of birds would be recorded. Cleethorpes had by far the highest levels of human activity. Very large numbers of birds can roost directly out from the leisure centre on the edge of the saltmarsh, but the roost is used on relatively low high tides and rising/falling tides. The large gatherings of birds are a considerable distance from where the human activity is focused (and were typically well outside the 500m arc of our focal area). The site is relatively sandy, meaning that some access does stray from the

shoreline across the intertidal, but foraging habitat is also likely to be relatively poor here due to the nature of the sediment. These factors highlight the difficulties in trying to draw direct comparisons between the survey points and Cleethorpes is a particular outlier for a range of reasons.

4.21 A proportion of visits to Welwick were timed to coincide with when raptors might be coming into roost, in order to allow for any anecdotal recording of disturbance to roosting raptors. While no observations of raptors being disturbed were made, the deliberate choice of timing at this location may have resulted in flight events being caused by raptors, and the high flush rates at Welwick may be attributable to the late afternoon survey time (with some species likely to be moving to roost sites towards dusk) combined with the presence of the birds of prey.

Birds of Prey

4.22 We made a deliberate choice to include flushing events linked to birds of prey, as it is potentially important to highlight the extent to which human activities compare to flight events linked to natural predators. In this case it is clear that the presence of humans results in a much greater number of flight events than birds of prey, which were linked to just 13% of all species specific flight observations.

Context with Other Sites

4.23 Footprint Ecology has undertaken similar surveys, using a near identical approach on a number of different SPA sites. These other surveys are not directly comparable but do provide some useful context. Direct comparison is difficult because weather conditions were different in each survey, the selection of survey points was different in each survey and the months and relative proportion of weekends to weekdays in each survey were also different. In some surveys all tide states were included in the study while on the Humber certain tide states were a focus of the work. Each survey did however involve surveyors watching focal areas (defined by a 500m arc) and recording access levels and responses of birds. Some selected results are summarised in Table 13. This study (right hand column) is notable in that the number of major flights per hour is much higher on the Humber. While raptors and the focus of the survey effort towards high tide may account for this, the difference seems large compared to other sites. The Humber appears to have a relatively high proportion of major flights and a relatively low level of access (though not as low as the North Kent survey points). A high proportion of major flights does not necessarily indicate a greater impact, as for example it may mean that there are more opportunities for birds to switch location. It may also suggest that birds are present where disturbance takes place, rather than chronically avoiding particular areas of habitat. The comparison should be treated with considerable caution and would be of more interest if undertaken at an individual survey point scale, looking for differences in the distances birds respond and the frequency of major flight in relation to overall levels of access (outside the scope of this report). It does serve to place the results in some context, suggesting that the levels of recreation on the Humber (at least at the selected survey points) is not necessarily lower than some of the south-coast sites with considerably higher local populations.

Table 13: Comparison of selected data from this survey with other similar surveys conducted by Footprint Ecology. Exe data are from Liley *et al.* (2011); Solent data from Liley *et al.* (2010); North Kent from Liley & Fearnley (2011) and Poole data from Liley & Fearnley. (2012).

Survey	Exe	Solent	N. Kent	Poole	Humber
No. hours survey	220	420	449.75	294	140
No. survey points	9	20	22	15	10
Method notes	Variable nos of visits to each survey point. Survey points distributed around shore.	Same number visits to all survey points. Survey points stratified along shore. 3 SPAs	Same number visits to all survey points. Survey points stratified along shore. 3 SPAs. Very cold weather.	Same number visits to all survey points. Survey points stratified along shore. Very cold weather	Same number visits to all survey points. Survey points distributed around shore in areas where access and birds thought to coincide
Timing	Sept 2009-March 2011	Dec 2009 – Feb 2010	Dec 2010 – March 2011	Nov 2011- Feb 2012	October 2013 and Jan 2014
Diary events	2977	5405	1879	3584	1304
% events causing major flight	14	8	13	6	14
% No response	65	82	74	87	69
Major flights per hour of observation	1.09	0.81	0.91	0.74	2.5
% Major Flights caused by dog walkers or their dogs	37	49	55	38	40
Visitor rates (diary events per hour)	13.5	12.9	4.2	12.2	9.3

Implications for Management

4.24 In this section we consider the implications of the results in terms of management of access and key points are highlighted in bold text. The data presented in this report are from a limited series of survey points and a limited time period, not reflecting all the times of year when the SPA interest are present. As such the results do provide some insights for management, but not all activities that may cause disturbance were necessarily recorded and the data are a snapshot of the issues at a selection of sites only.

4.25 In Appendix 2 we provide a general summary table of options for management to reduce disturbance at coastal sites.

4.26 The results here dovetail with the wider visitor survey work (Fearnley, Liley & Cruickshanks 2012) and recommendations for management are also provided in that report. This work adds to our understanding of issues on the Humber by:

- Showing that, across the survey areas at least, the distribution of birds is affected by disturbance
- Setting out evidence that particular activities (we highlight dog walking in particular) do flush birds and cause birds to change behaviour. The results highlight which activities have an impact and allows direct comparison. Evidence of impacts from activities such as flying was one of the knowledge gaps highlighted in the previous work.

4.27 Graphs such as Figure 7 show differences between activities and it is perhaps easy to focus on individual types of access. A wide range of activities were recorded and have been shown to flush birds, however it is the overall volume of access and levels of recreation that are also important. In this respect it is dog walking and walking that are by far the most commonly occurring activities. In Table 14 we summarise the relative volume of access that each activity accounts for (based on the diary observations at the survey points) and alongside we summarise the percentage of major flights caused by that activity. It can be seen that dog walkers with dogs off leads accounted for nearly 35% of the access observed, and the same activity caused 45% of all the major flights observed. If each activity had the same likelihood of causing a major flight, then the percentages in the two right hand columns would be the same. As the percentage of major flights for dog walkers (with dogs off leads) is considerably higher than the percentage of access they account for this indicates a disproportionate impact of the activity.

Table 14: Activities, summarising relative level of access and relative levels of disturbance. Flight responses from birds of prey are excluded from this table.

Activity	Diary observations	Number major flights	% access	% major flights
Dog off lead	443	134	35	45
Dog on lead	141	7	11	2
Walking/rambling (without dog)	366	36	29	12
Cycling	92	0	7	0
Birdwatching	64	28	5	9
Jogging	58	14	5	5
Motor vehicle	33	2	3	1
Large boat (outboard motor)	14	11	1	4
Wildfowling	13	6	1	2
Air-borne craft	11	19	1	6
Bait digging	7	5	1	2
Horse Riding	6	3	<0.5	1
Fishing (from shore)	5	12	<0.5	4
Small fast boat (e.g. rib)	4	8	<0.5	3
Kids playing (with or without parents)	4	0	<0.5	0
Metal Detecting	3	1	<0.5	<0.5
Picnic	1	0	<0.5	0
Other	11	9	1	3
Total	**1276**	**295**		

4.28 **Based on Table 14, dog walkers with dogs off leads have a disproportionate impact and account for a high volume of access.** Activities recorded at a much lower level, but which also potentially have a disproportionate impact when they occur include **birdwatching, large boats, air-borne craft, fishing from shore, small fast boats and wildfowling. These are activities where monitoring of the levels of activity in relation to the SPA interest, direct liaison with users and potentially establishing management measures may be worthwhile**.

4.29 Following from Table 14 we summarise the key types of access in Table 15. The table summarises some of the visitor data from the previous visitor survey report (Fearnley, Liley & Cruickshanks 2012), giving details for each type of access.

Table 15: Summary of key details per activity: the first three columns give a level of occurrence (based on the diary observations at 10 locations in this report; vantage point counts across the whole estuary (2012/13) and questionnaires at selected access points (in 2012/13). The distance travelled provides an indication of how local the users are (distance from users home to where interviewed) and how far users tend to stray from the access point. The final column shows the % of major flights attributed to each activity (data collected in 13/14).

	Diary observations % this report	vantage point %	Questionnaires %	Median distance postcode to interview point (km)	Median route length in winter (km)	% of major flights
Source:	table 13 this report	table 28, visitor report	table 8, visitor report	table 22, visitor report	table 24, visitor report; winter	table 13 this report
Air-borne craft	1		3	8.6	2.03	6
Bait digging	1	1	1	18.7	0.96	2
Birdwatching/ Wildlife Watching	5	3	13	40.5	2.27	9
Cycling	7	3	2	3.6	4.43	0
Dog walking	46	25	40	3	1.86	47
Fishing (from shore/intertidal)	<0.5	2	3	8.8	1.13	4
Horse Riding	<0.5	1				1
Jogging	5	17	2	1.5	4.78	5
Kids playing/family outing	<0.5	5	3	55	1.3	0
Kitesurfing/Windsurfing	0	<0.5	1	48.5	3.23	0
Large boat (outboard motor)	1	<0.5	0			4
Metal Detecting	<0.5	<0.5	0			0
Motor vehicle/4x4	3	<0.5	3	31.5	2.63	0
Picnic	<0.5	7	0			0
Small fast boat (e.g. rib)	<0.5	<0.5	0			2
Walking/rambling (without dog)	29	46	27	6.5	2.29	10
Wildfowling	1	<0.5				1

4.30 In Table 16 we summarise key points/issues on a site basis. The table highlights which activities occur at each site and key points from the analyses.

Table 16: Summary of key points relating to each survey point. Main activities gives some of the main activities recorded (numbers in brackets are numbers of groups recorded undertaking each activity).

Site	Key points relating to access and disturbance	Main Activities
1 Saltfleet	Relatively high proportion of access on the intertidal. Dog walking accounts for a high proportion of major flights. High probability of birds being flushed here compared to other sites. High proportion of events resulted in major flights. Data suggests birds can fly relatively far when flushed.	Dog walking (63), walking (23),
2 Horseshoe Point	High proportion of access on the intertidal	Relatively quiet, dog walking (13)
3 Humberston Fitties	Much busier in January than October, different to other sites	Dog walking (121), Walking (21), Bait Digging (4)
4 Paull Holme Strays	Relatively high proportion of disturbance events resulted in minor flights	Dog walking (60),
5 Welwick	Low levels but high probability of access causing disturbance and potential for large numbers of birds to be flushed when disturbed	V. low levels access
6 Spurn	Busier at weekends. Highest flush rate (i.e. number of flights per hour) of any site	Birdwatchers (49), Relatively few dog walkers (12) and 50% groups with dogs on lead
7 Cleethorpes Leisure Centre	Highest levels of access including highest number of people on intertidal; low densities of birds close to shore and few major flights when birds are present, suggesting birds avoiding areas close to shore/where likely to be disturbed	Dog walking (293), walking (267), cycling (58) and jogging (43).
8 Pyewipe	Lowest flush rate (i.e. number of flights per hour) of any site. Birds occasionally fly relatively far when flushed.	Cycling (22), motor vehicles (8), little other access
9 Chowder Ness	A range of activities were recorded, nothing on intertidal (all shore-based or on water). Around a third of events resulted in major flight.	Dog walking (24), Motor boats (10)
10 Faxfleet	Relatively high proportion of events resulted in major flights. Dog walking accounts for a high proportion of major flights	Dog walking (15), Wildfowling (11); Motor boats (7)

4.31 Across all locations the probability of birds being flushed was lower at low tide. At low tide there is plenty of open mudflat available for the birds to feed on and the birds are likely to be much further from the sources of disturbance (which are usually on the shore). At low tide disturbance is much less of a concern than at high tide. **At sites where low tide means large expanses of soft sediment and the water's edge is far from the shore, there is little need for any management measures relating to access and birds feeding. If birds gather to roost or feed on the falling/rising tide close to the shore, then measures may be appropriate.**

4.32 Sites with low levels of access (Saltfleet and Welwick for example) had the highest probability of disturbance to flush birds, suggesting that in areas with low levels of access the distribution of birds may be less influenced by access and in such areas minimising increases in access would be beneficial. Currently this part of the estuary is difficult to access and infrastructure (parking, options for walks etc.) are relatively limited here. **Maintaining such low key and quiet areas is important**.

4.33 Water based activities accounted for a very low level of activity, with just 1.5% of potential disturbance events and only recorded at two locations (Chowder Ness and Faxfleet). All but one water-based activity involved motorised boats. No kite surfing, windsurfing or canoeing were recorded. As such we cannot make any recommendations relating to management of such activities. Kite surfing does sometime take place around Cleethorpes and to the south-east of Cleethorpes. Given that water-based activities did have a high probability of flushing birds (compared to shore-based activities), **careful monitoring of watersports** such that any marked increases are picked up in the future is recommended. The visitor survey work would suggest that **watersports are more common on the Humber than the data presented here suggest** (see 4.19).

4.34 Dog walking levels were relatively constant in both months, suggesting that the levels of dog walking recorded may occur throughout the winter. There were high levels of dog walking recorded both in this study and in the wider visitor work (Fearnley, Liley & Cruickshanks 2012), and there is now clear evidence that it is the main activity flushing birds. There is therefore **justification on focussing on dog walkers and there is certainly merit in a Humber wide project relating to dogs**. Such a scheme, in the form of the Humber Hounds[6], is in place. Dogs off leads had a greater probability of flushing birds than dogs on leads and dogs off leads are a particular issue**. Effort should be focussed on promoting dogs on leads or requiring dogs to be on leads. Education, awareness raising, provision of dedicated areas where dogs can be off-lead, clear signposting aimed at dog walkers and dog control orders are measures that are relevant**. Results suggest that at Faxfleet and Saltfleet individual dog walkers are more likely to have an impact, and at such locations even small reductions in the number of dogs off lead and dog walking *per se* are likely to be beneficial.

4.35 At Paull the high flush rates and disturbance to roosting birds is of concern. **At Paull and potentially some other parts of the estuary there could be merit in directing access on the inland side of the seawall**. Such routing is only likely to work if carefully designed as people are likely to prefer to walk where they can see the estuary. **Signage, path surfacing and fencing (so that dogs off leads cannot run over the top of the bank) may be effective**. Areas where people can obtain views of the estuary but where they are perhaps slightly screened (and potentially not on the skyline) may also need to be provided. **Screening** in the form of scrub around the seawall (potentially thick and low enough to hide dogs and keep them back from the saltmarsh), perhaps combined with **low fencing** may help limit disturbance here and at similar parts of the estuary. Careful consideration of access provision should be given at the outset of future realignment schemes.

[6] http://www.humbernature.co.uk/humber-hounds.php

4.36 In more sandy areas, such as from Cleethorpes to the south-east, **measures to limit the extent to which people spread** over the sandflats and intertidal merit consideration. Particularly in the area around Humberston Fitties it would be of merit to explore low key options to limit the spread of access. Potential options at these locations would include **interpretation, provision of paths and way-marked routes away from the intertidal habitats, and possibly chestnut paling** or similar fencing in the dunes. The car-park at the sailing club and the various paths from the chalets provide numerous current locations from which people can spread. **Limiting these entry points**, potentially **reducing parking options** or even introducing **parking charges** are other measures to consider.

4.37 Finally **monitoring** is recommended. Ensuring regular counts of access in the future, in order to pick up whether access patterns, levels and types of activities being undertaken are changing is important.

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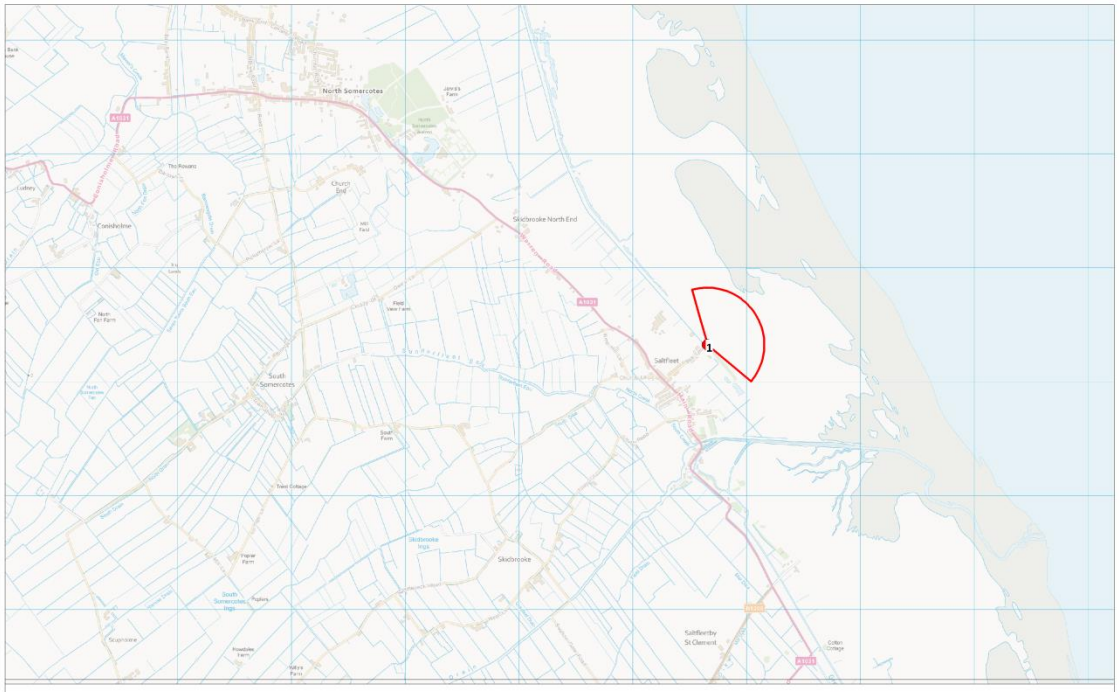
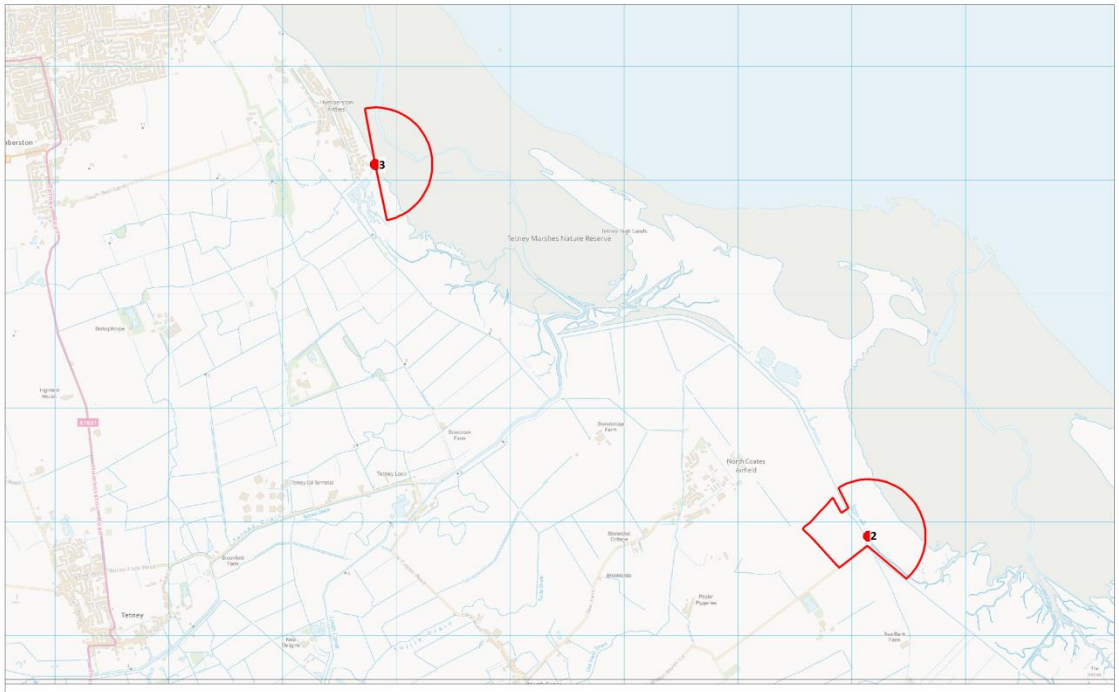
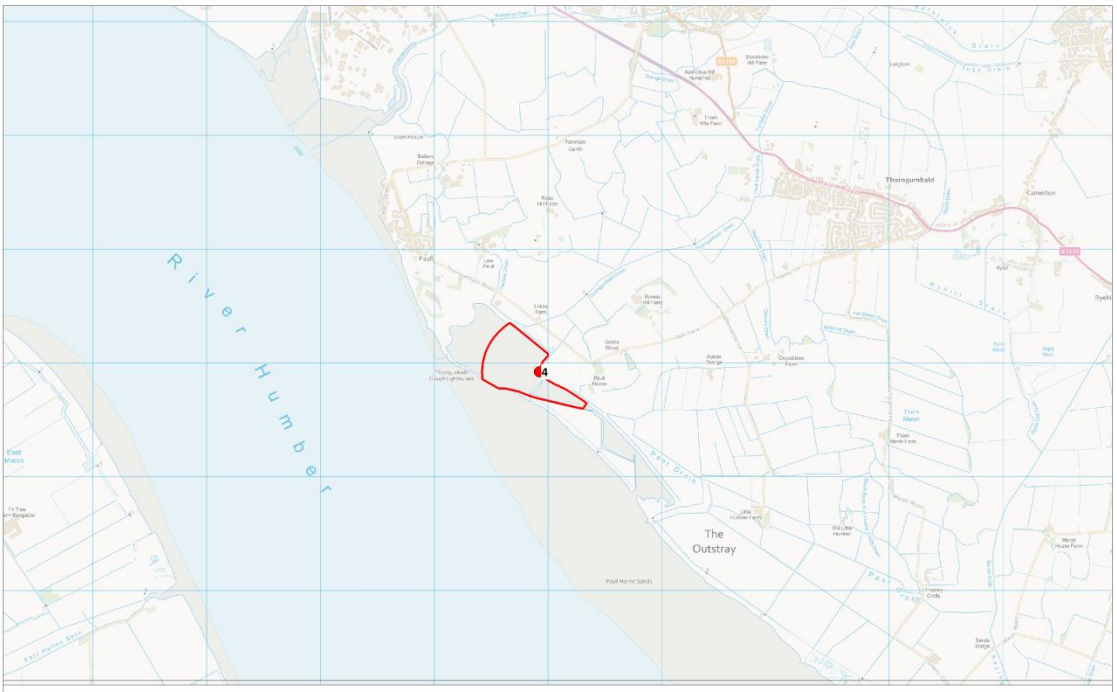
6 Appendix 1: Recording areas and survey points



Survey points and recording area: Point 1



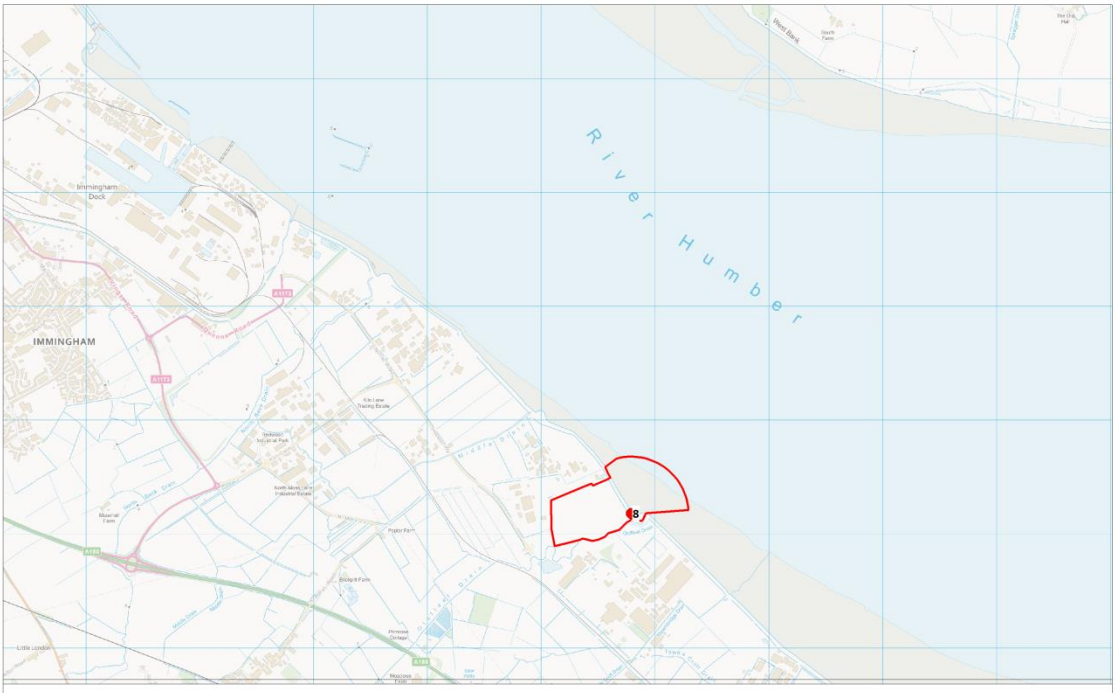
Survey points and recording area: Points 2 & 3



Survey points and recording area: Point 4

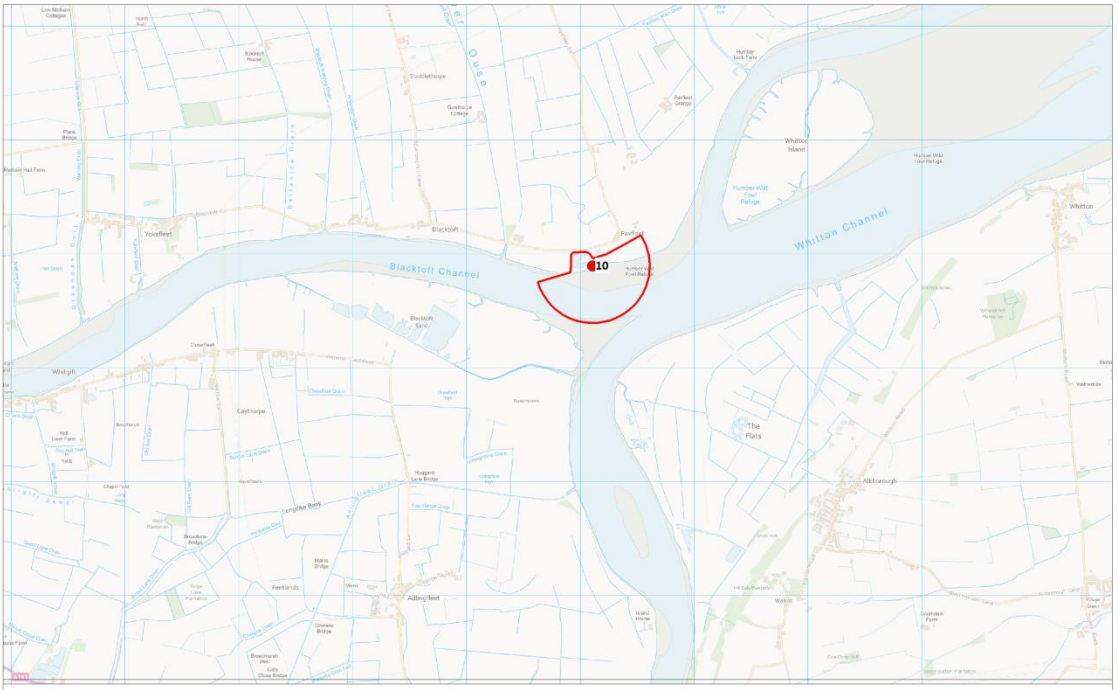
Survey points and recording area: Points 5 & 6

Survey points and recording area: Point 7



Survey points and recording area: Point 8

Survey points and recording area: Points 9



Survey points and recording area: Point 10

7 Appendix 2: Options for Management to Reduce Disturbance

This table summarises potential options to reduce disturbance. It is drawn from other work conducted by Footprint Ecology (Ross *et al.* 2014). Relevant activities and spatial scale columns are indicative and measures will vary markedly between sites.

	Management	Activities Relevant			Spatial scale	
		Shore-based activities	Water-based activities	Dogs	Local in scale	More strategic, Site-scale
1 Habitat creation						
1a	Managed retreat	✓	✓	✓	✓	
1b	Create islands for roosts	✓	✓	✓	✓	
1c	Lagoon and wetland creation	✓	✓	✓	✓	
2 Habitat enhancement						
2a	Improving existing roosts	✓	✓	✓	✓	
3 On-site access and management						
3a	Path closures and diversions	✓		✓	✓	
3b	Path blockages/temporary restrictions on unofficial paths	✓		✓	✓	
3c	Screening using hedges/scrub, fences, screens	✓		✓	✓	
3d	Hides	✓			✓	
3e	Earth or clay embankments	✓		✓	✓	
3f	Path improvement, can include surfacing, boardwalks, footbridges, steps etc.	✓		✓	✓	
3g	Car parking access, character, siting and size	✓	✓		✓	✓
3h	Car parking charges	✓	✓	✓	✓	✓
3i	Dedicated areas for particular activities	✓	✓	✓		
3j	Dedicated routes	✓		✓		
3k	Zoning for land-based activities	✓		✓	✓	
3l	Watersports zones		✓	✓	✓	
3m	Temporary exclusion fencing			✓		
3n	Vehicle restrictions	✓		✓		
4 Education/information						
4a	Signage	✓	✓	✓		
4b	Information material, leaflets	✓	✓	✓	✓	
4c	Codes of conduct	✓	✓	✓	✓	
4d	Maps, places to go, what to see	✓	✓	✓	✓	✓
4e	Guidance on specific activities	✓	✓	✓	✓	✓
4f	Educational material	✓	✓	✓	✓	✓
4g	Interpretation panels	✓	✓	✓	✓	✓
4h	Websites and social media	✓	✓	✓	✓	✓
4i	Educational material	✓	✓	✓	✓	✓
4j	Wardening	✓	✓	✓	✓	✓
4k	Local liaison	✓	✓	✓	✓	✓
4l	Enforcement through patrolling etc.	✓	✓	✓	✓	✓
4m	Direct contact with local clubs	✓	✓	✓	✓	✓
4n	General off-site information	✓	✓	✓	✓	✓
4o	Off-site events	✓	✓	✓	✓	✓
4p	Education and talks	✓	✓	✓	✓	✓
5 Off-site management						
5a	Development Exclusion Zones	✓	✓	✓		✓
5b	Planning conditions	✓	✓	✓	✓	✓
5c	Provision of alternative attractions	✓	✓	✓	✓	✓

	Management	Activities Relevant			Spatial scale	
		Shore-based activities	Water-based activities	Dogs	Local in scale	More strategic, Site-scale
5d	Alternative routes	✓	✓	✓	✓	✓
5e	Access and facilities for watersports		✓		✓	✓
5f	Alternative parking	✓	✓	✓	✓	✓
6 Legal measures and enforcement						
6a	Byelaws	✓	✓	✓	✓	✓
6b	Dog control orders			✓	✓	✓
6c	Other acts	✓	✓		✓	✓
6d	Marine and Coastal Access Act 2009 (fishing activity)		✓			✓
6e	Wardening		✓			✓
6f	Permits and licences		✓			✓