



Bird Disturbance Study North Kent

2010/2011



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Summary

This report describes the results of winter fieldwork which was commissioned as part of a series of studies to assess the impact of recreational disturbance to wintering waterfowl on intertidal habitats in North Kent. The work relates to the coast between Gravesend and Whitstable, an area internationally important for wintering waterfowl and also subject to increasing pressure from development. Twenty two locations were surveyed and each was visited repeatedly between December 2010 – February 2011. The survey work comprised of bird counts and counts of people with a record of the recreational activity they undertook. Both the people and the bird counts were conducted simultaneously at each visit. The behavioural response of birds to people was recorded, as was the distance between the birds and people which allowed us to investigate whether the behavioural response of birds to people differs with distance. As the activity of each person was noted the type of response exhibited by the birds to people undertaking different activities is also explored.

The results of the work will be used in predictive models to determine the extent disturbance currently impacts on the designated sites and their ability to support the important waterfowl populations. In parallel with this report detailed visitor survey work was also undertaken, with interviews and counts of people undertaken at the same survey locations. The visitor results are presented in a separate report.

Key findings of the bird disturbance work are:

Birds

- 34 bird species comprising of 19 wader, 13 wildfowl and 2 grebe species were recorded during the fieldwork.
- Four species were present at every survey location; oystercatcher, dunlin, curlew and redshank.
- The highest counts of waders and wildfowl were recorded on the outer Swale.

Visitor numbers and activities

- 1879 observations of visitors were recorded in the vicinity of the bird survey areas accounting for 2609 people.
- The highest numbers of people were recorded at location 11 – Riverside Country Park.
- Approximately 50% of visitor groups had at least one dog with them.
- Dog walking and walking were the most frequently observed activities.
- Visitors were recorded undertaking a wide range of shore and water based activities.

Disturbance

- 1400 diary events (records of visitors in the bird survey areas) occurred within 200m of the birds.
- From these 1400 events 3248 species specific observations were noted of which:
 - 74% resulted in no response
 - 3% resulted in an alert
 - 5% resulted in a short flight
 - 5% resulted in a short walk
 - 13% resulted in a major flight
- Brent goose was the species with the highest percentage of observations relating to disturbance: 53% of observations resulted in birds becoming alert, walking or flying. Knot was the species with the highest percentage (36%) of major flights.
- High numbers of major flights were recorded location 16 (Stoke Oaze Layby) and location 7(Harty)at the Eastern sites (Oare marshes and mouth of the Swale).
- Dog walking accounted for 55% of all major flight observations with a further 15% attributed to walkers without dogs.
- 37% of potential disturbance events that occurred on the intertidal resulted in a major flight.
- 9% of potential disturbance events which took place on the shore resulted in a major flight.
- Of all the major flight observations noted 73% of these were caused by shore based visitors and 22% were associated with visitors on the intertidal/area of mudflats.
- Dog walking accounted for 55% of all major flight observations with a further 15% attributed to walkers without dogs.
- The distance between the potential disturbance event and the birds was a significant predictor of major flight, with birds more likely to fly when the source of disturbance was nearby.
- After controlling for distance, major flights were more likely to occur when activities took place on the intertidal zone (compared to events on the water or events on the shore), when dogs were present and the probability of major flight increased with the number of dogs present with a group.
- There were also significant differences between species with curlew the species with the highest probability of major flight and teal and black-tailed godwit the lowest.
- Tide state was also significant with major flights more likely at high tide, after controlling for distance. There was also a significant interaction between distance and tide, indicating that the way in which birds responded varied according to tide.

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The fieldwork was conducted in often very cold weather. We recognise the work of the dedicated team who braved the cold weather to collect the data presented here. Neil Gartshore co-ordinated the fieldwork and organised the logistics. Our thanks to Neil, Pete Akers, Nick Hopper, Kevin Lane and James Richardson for the long hours in the field. Data entry was undertaken by Kevin Lane and Jenny Goy.

1. Introduction

1.1 This report describes the results of winter fieldwork to assess the impact of recreational disturbance to wintering waterfowl on intertidal habitats in North Kent. The work relates to the coast between Gravesend and Whitstable, an area internationally important for wintering waterfowl and also subject to intense pressure from development. The results of the work will be used in predictive models which will be used to determine to what extent disturbance currently impacts on the designated sites and their ability to support the important waterfowl populations.

Disturbance to Birds

- 1.2 Human disturbance to birds is essentially any activity that results in a change in a bird's behaviour. There are a wide range of studies and a large volume of scientific literature that considers disturbance and its consequences.
- 1.3 Studies have shown disturbance effects for a wide range of activities besides simply people, for example aircraft (see Drewitt 1999), traffic (Reijnen, Foppen, & Veenbaas 1997), dogs (Lord, Waas, & Innes 1997; Banks & Bryant 2007) and machinery (Delaney *et al.* 1999; Tempel & Gutierrez 2003).
- 1.4 Disturbance can have a variety of impacts. There are studies showing behavioural effects, such as birds changing their feeding behaviour (Fitzpatrick & Bouchez 1998; Verhulst, Oosterbeek, & Ens 2001; Thomas, Kvitek, & Bretz 2003), taking flight (Burger 1998; Blumstein *et al.* 2003; Fernandez-Juricic *et al.* 2005; Webb & Blumstein 2005) or being more vigilant (Fernandez-Juricic & Schroeder 2003; Randler 2003, 2005). Other studies have focused on physiological impacts, such as changes in the levels of stress hormones (Remage-Healey & Romero 2000; Tempel & Gutierrez 2003; Walker, Boersma, & Wingfield 2005) or heart rate (Hubert & Huppopp 1993; Nimon, Schroter, & Stonehouse 1995; Weimerskirch *et al.* 2002). In very general terms, both distance from the source of disturbance and the scale of the disturbance (noise level, group size) will both influence the response (Beale and Monaghan, 2004, Delaney *et al.*, 1999).
- 1.5 Direct mortality resulting from disturbance has been shown in a few circumstances (Liley 1999; Yasue & Dearden 2006) and many (but not all) studies have shown a reduction in breeding success where disturbance is greater (Murison 2002; Bolduc & Guillemette 2003; Ruhlen *et al.* 2003; Arroyo & Razin 2006). There are also many examples of otherwise suitable habitat being under-used as a result of disturbance (Gill 1996; Liley & Clarke 2003; Kaiser *et al.* 2006; Liley & Sutherland 2007).
- 1.6 Despite this large body of work, there is still contention (see Gill 2007) as it is often difficult to understand whether there is a real issue and whether disturbance is a cause of conservation concern. For example, the fact that a bird takes flight when a person approaches is to be expected and a short flight is unlikely to have a major impact on the individual in question, let alone the population as a whole. However, repeated flushing, over extended periods or in particular circumstances may have consequences for the population as a whole (West *et al.* 2002). Very few studies have actually placed disturbance impacts in a

population context, although there are examples where the actual impact of disturbance on population size has been demonstrated (West *et al.* 2002; Liley & Sutherland 2007; Mallord *et al.* 2007; Stillman *et al.* 2007b; Kerbiriou *et al.* 2009).

North Kent context

- 1.7 This report focuses on part of the North Kent shoreline, stretching between Gravesend and Whitstable. This stretch of shoreline encompasses three Special Protection Areas (SPAs): the Thames Estuary and Marshes SPA, the Medway Estuary and Marshes SPA and the Swale SPA. All three sites are also listed as Ramsar sites, for their wetlands of international importance. The Ramsar site boundary does not quite match the SPA boundary, notably near Gravesham where the Ramsar boundary extends beyond the western boundary of the SPA.
- 1.8 The three sites are classified as SPAs in accordance with the European Birds Directive (Council Directive 79/409/EEC on the conservation of wild birds, updated by Council Directive 2009/147/EC in 2009). This European legislation requires Member States to classify sites that are important for bird species listed on Annex 1 of the European Directive, which are rare and/or vulnerable in a European context, and also sites that form a critically important network for birds on migration.
- 1.9 All three of the north Kent sites are classified for their waders and waterfowl, both Annex 1 and migratory species. The bird interest features for which each site has been classified varies slightly across the three sites, but with all three sites provide on passage, overwinter, and breeding habitat to an array of species of European Importance. The three European sites together provide a vast and linked expanse of critically important habitat to the SPA network around the British coast.
- 1.10 The additional Ramsar site listing for all three sites arises from the recognition of the international wetland importance of each, under the Ramsar Convention¹. It is common for SPAs to also be listed as Ramsar sites.
- 1.11 Strict protection requirements apply to European sites, and the Member State duties for European sites, both SPAs and Special Areas of Conservation (SACs designated for non-avian wildlife of European interest and designated in accordance with the following Directive), are set out in Article 6 of the European Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna). 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.
- 1.12 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

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.'

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.

- 1.13 In complying with the Ramsar Convention, the UK Government treats listed Ramsar sites as if they are European sites, as a matter of national planning policy, and the legislation to protect European sites is therefore equally applied to the Ramsar listing.
- 1.14 In addition to its European wildlife importance, the North Kent coast lies within an area of significant economic importance, both in terms of development and regeneration, and industry and international trade. Covering these areas are a concentration of strategies and initiatives for economic regeneration and growth, with considerable central government focus, and this is reflected in the county and district level spatial planning documents. Proposals for transport improvements, green energy development, increased tourism and regenerated towns all need to take into account the European wildlife site backdrop and rigorously assess the potential implications for the designated sites. Such assessments require an evidence base that includes scientific assessment of how European site bird interest features may be affected by existing and potential impacts.

Aims and Objectives

- 1.15 This report therefore needs to be seen as part of a series of different studies that interlink and will provide the parameters necessary to develop models of disturbance and visitor access patterns and understand the extent to which disturbance currently affects the integrity of the European Sites. Fieldwork was carried out over the mid winter period and for sampled locations determined the numbers of birds present and the extent of disturbance, recording in detail the densities of birds, how birds respond to disturbance and carefully assessing this in terms of distance moved, lost feeding time etc.
- 1.16 The principal questions addressed are:
- How does the distribution of birds vary between sites and in relation to distance from the shore?
 - What are the current levels of disturbance within the study area?
 - Which types of activities and particular circumstances result in disturbance?
 - How do birds respond to disturbance, in terms of distance from disturbance and types of response?
- 1.17 This work fits alongside detailed visitor survey work, which provides the information on patterns of access and recreational use. This visitor work was undertaken during the same winter and used the same survey locations as the bird fieldwork. Wider work will also map recreational levels across the whole shoreline, allowing the data from the detailed surveys presented here to be extrapolated and models developed (see Stillman *et al.* 2007; Stillman & Goss-Custard 2010). Also in parallel, direct contact with local clubs and other

organisations representing local recreational use will inform the extent to which different activities are changing and are linked to organised groups.

2. Methods

Overview

- 2.1 Fieldwork involved counts of birds within pre-defined areas of intertidal habitat. Simultaneous counts of people were undertaken around the same areas and detailed observations were made of the responses of the birds to the presence of people. These observations involved recording how the birds responded to different activities and at what distance they responded.

Identification of Survey Sites

- 2.2 The survey area encompassed the shoreline and intertidal habitats between Gravesend and Whitstable, encompassing the Ramsar area and the three SPAs (Medway Estuary and Marshes SPA, The Swale SPA and Thames Estuary and Marshes SPA (southern areas only). Twenty-one survey locations were selected along this shore. The choice of survey locations was a pragmatic one, driven by budget and the need to ensure a representative sample of survey locations. Locations were chosen so as to target areas around access points and where recreational use does occur, and also to ensure an even geographic spread. Specific locations were selected that provided a good vantage point for the surveyor, such that it was possible to obtain a clear view of both people present in the area and birds, and to be able to estimate the distances between potential sources of disturbance and the birds.
- 2.3 Part way through the winter fieldwork an additional survey location (point 22, Shornmead) was added, and due to the late incorporation of this point within the survey, it was subject to less survey effort. This additional location was included because a review of survey locations and preliminary results part way through the fieldwork indicated a potential gap in coverage towards the western end of the survey area.

Survey Effort

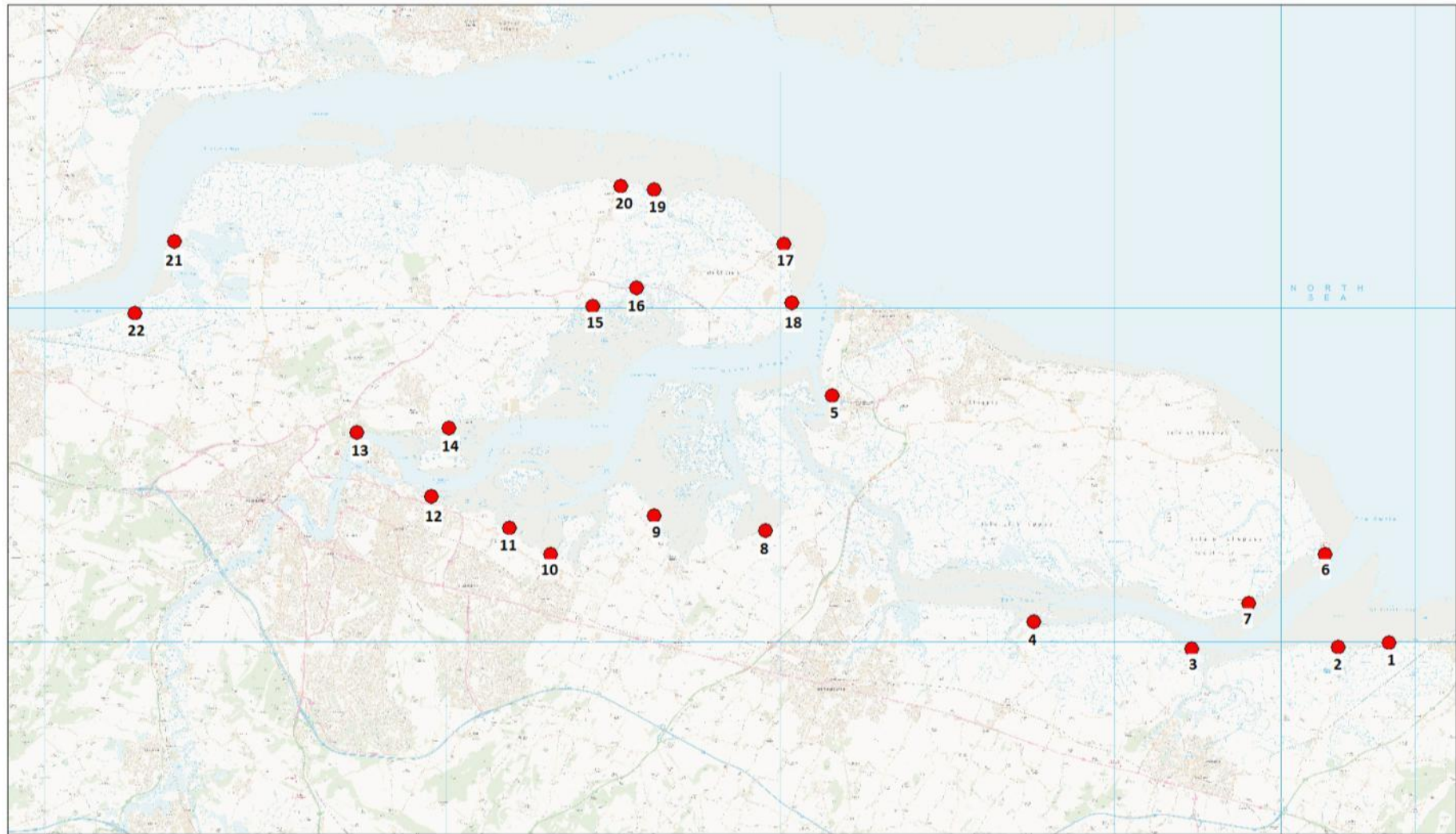
- 2.4 Twenty-one locations therefore received a standard level of survey effort, which involved 12 visits evenly spread (i.e. roughly four visits per month) over the period from mid December 2010 to 3rd March 2011. The additional site was visited five times, commencing in mid January 2011. Survey locations are summarised in Table 1 and Map 1.
- 2.5 No attempt was made to limit visits to particular states of tide or tide heights. One visit per month per location was made at a weekend. Each visit lasted around 2 hours and included the following:
- A count of all birds present within the focal area at the start and end of the count
 - A map of all people / activities taking place at the start of the visit
 - A 'diary' of all recreational events – essentially all people / activities observed over a period of 1 hour 45 minutes, recording the activity, time, duration etc.
- 2.6 Recreational events that occurred within 200m of birds within the focal area (or in a very few cases where disturbance occurred at greater than 200m) were categorised as 'potential disturbance events'. For this subset of all recreational events, a record of the response of

each species present to the activity was recorded. This included distance at which birds responded (or not), the behavioural response observed, distance displaced, etc.

2.7 In addition information was collected at each visit on the weather conditions, state of the tide, temperature, etc.

Table 1: Summary of survey locations and the number of visits to each

ID	Name	Grid Reference	No. of visits			Total visits
			Dec. 2010	Jan. 2011	Feb./Mar. 2011	
1	Seasalter-The Oaze	TR072649	3	5	4	12
2	South Oaze	TR056648	3	5	4	12
3	Oare Marshes	TR013647	3	5	4	12
4	Conyer	TQ965655	4	4	4	12
5	Queensborough	TQ905723	2	6	4	12
6	Shell Ness	TR052676	3	5	4	12
7	Harty	TR030661	3	5	4	12
8	Bedlams Bottom	TQ885683	4	4	4	12
9	Upchurch	TQ852687	4	4	4	12
10	Motney Hill turning	TQ821676	3	5	4	12
11	Riverside Country Park	TQ808684	3	5	4	12
12	The Strand, Gillingham	TQ785693	3	5	4	12
13	Lower Upnor	TQ763712	4	4	4	12
14	Hoo St. Werburgh	TQ790714	4	4	4	12
15	Middle Stoke	TQ833750	2	6	4	12
16	Stoke Ouze A228 layby	TQ846756	3	5	4	12
17	Grain Beach	TQ890769	4	4	4	12
18	Grain Power Station	TQ893751	4	4	4	12
19	All Hallows-Yantlett	TQ852785	4	4	4	12
20	All Hallows - Holiday Park	TQ842786	2	6	4	12
21	Cliff Creek	TQ708769	2	6	4	12
22	Shornmead	TQ696748		1	4	5



Map 1: Survey Locations

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Definition of a Focal Area and Counts of Birds

- 2.9 At each survey location a focal area for the bird fieldwork was defined. This area stretched up to 500m from the surveyor and included all visible areas of intertidal habitat, below MHW (mean high water mark), within this 500m radius. The 500m radius was selected as, based on other similar surveys (Liley, Stillman, & Fearnley 2010), this was the maximum distance at which surveyors felt confident counting birds at the same time as recording levels of human activity, and within which it was possible to reliably estimate distances between disturbance events and the birds.
- 2.10 On straight sections of shore this area was typically defined simply as an arc (radius 500m) drawn from the survey location. Where jetties, creeks, headlands etc meant that there were no clear sight-lines, then the boundaries of the focal area became more complex. The focal area encompassed a different total area at each survey point.
- 2.11 The focal area was then split into a series of bands, representing distance from MHW (i.e. these bands were parallel to the shore rather than concentric rings around the surveyor). These bands were defined within the GIS and plotted onto aerial photographs which each surveyor carried in the field with them. These plots provided a simple and effective means for the surveyors to establish the distances and 'layout' of each survey location and focal area. Bands used were 0-50m; 50-100m, 100-150m, 150-200m, 200-250m and 250-500m.
- 2.12 At the beginning and end of each visit all birds were counted within the focal area, and the total count was broken down so as to reflect the number of birds within each distance band. Only waders, wildfowl, divers and grebes were counted.
- 2.13 For each location the total area (in ha) of the count area was calculated. While this was broadly similar at each location, there was variation caused by the shape of the shoreline and the area visible (i.e. removing areas not visible such as behind jetties, points etc.). Count data was converted to density (birds per ha) using these area figures. Densities were not adjusted for the state of the tide at each count. Therefore where calculated, the density of birds within the recording area at a given location was always calculated using the same area figure, regardless of whether the count was made at low or high tide. This decision was made because for many species – such as brent geese or shelduck birds might well be on the water during high tide and it was too complex to calculate density in a different fashion for each species at each location.

Diary of Recreational Activity

- 2.14 All events that involved recreational access or other events that might cause disturbance were then recorded over the following 105 minutes, in chronological order. Each event was given a unique letter code (A, B, C etc), enabling diary events to be cross referenced to other data sets. All activities/people were recorded by the surveyors, regardless of whether they entered the focal area used for the bird counts. For each event the following were recorded:
- 2.15 Start and end time (i.e. when first in view to when lost from sight)
- 2.16 Whether the event came within 200m of birds within the focal area

- 2.17 Habitat (simply coded as shore, intertidal or water)
- 2.18 Group size (number of people), this was not always possible to record, e.g. with boats
- 2.19 Number of dogs
- 2.20 Activity (categorised according to activity types see Table 2)
- 2.21 Any other information / notes

Table 2: Activity Codes used during field recording.

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

- 2.22 The diary data therefore provides a description of the total amount of activity and types of activity taking place at each location. The coding allowed multiple pieces of information to be recorded for each event, and surveyors often used combinations of codes to indicate where a group or individual was undertaking different activities simultaneously (for example jogging with a dog).

Response of the Birds

2.23 All recreational events that occurred within 200m of birds within the focal area (or resulted in birds within the focal area being disturbed) were classed as 'potential disturbance events'. For these events – a subset from the diary of all recreational activity - the response of each species (waders, wildfowl, divers and grebes only, and that were present within 200m) was recorded. Each potential disturbance event could therefore be associated with more than one observation, where multiple species were present within the focal area.

2.24 For each species, and each potential disturbance event within 200m, the following were recorded:

- Species
- Count (number present within 200m)
- Behaviour of the birds (prior to the disturbance event), simply categorised as F (feeding) or R (roosting/preening/loafing)
- Response of the birds (see Table 3) ultimately observed
- Distance at which the response occurred (if "No response" this distance was the minimum distance from the potential disturbance event to the nearest individual; if disturbance occurred then this distance was the maximum distance from one individual to the disturbance event when the disturbance occurred)
- Distance displaced, i.e. the distance that the disturbed bird(s) walked/swam/flew if disturbed
- Total time until original behaviour resumed
- Notes

2.25 In order to ensure accurate and consistent estimation of distances (both the distance from the source of disturbance to the birds and the distance the birds were displaced), only a small group of surveyors were used. All surveyors spent a day jointly undertaking counts at the start of the fieldwork, this training session ensured consistency between observers. In the field surveyors used the aerial photographs with the distance bands plotted to ensure they were familiar with the 'layout' of the focal area and the distance of different features from the shore. Surveyors also used laser range finders to measure distances and at the end of fieldwork distances could be paced exactly as an additional check. The process of counting the birds within distance bands, conducted at the start and end of each visit, ensured each surveyor was familiar with how the birds were distributed, the species present etc. before any attempts were made to record behaviour and disturbance.

2.26 Where the birds flew it was not always possible to estimate distances, for example where the birds flew out of sight. In such cases the distance displaced was simply not recorded and left blank.

Table 3: Response Codes

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

2.27 Data presentation and analysis

2.28 We use box plots frequently throughout the report. These plots describe the data for particular groupings, and typically include the following:

2.29 Horizontal line: indicating the median value for that group

2.30 Box: indicating the 25th and 75th percentiles (i.e. half of all the data falls within between these two lines)

2.31 Vertical lines: "whiskers" indicating the upper and lower limits of the data

2.32 Asterisks: indicating outlier values (i.e. any data points that fall outside the upper and lower limits of the data).

2.33 All statistical analysis was conducted using Minitab (version 14). GIS data extraction and presentation was conducted using MapInfo (version 9.5).

2.34 The probabilities of a major flight taking place were modelled using logistic regression (Hosmer & Lemeshow 2000) with the flush response (i.e. major flight taking place) being the dependent variable. We tested the following independent variables:

- Distance
- Activity Type (simplified groupings – see results)
- Species (ten species with the most observations only – see results)
- Zone disturbance event occurred in (intertidal, shore or water)
- State of Tide (falling, high, low, rising)
- Group size (number of people in group)
- Number of birds present
- Number of dogs off lead
- Dog present (Yes or no)

2.35 The details of the models are presented within the report. The regression coefficients describe the size of the contribution of that factor. Positive coefficients indicate that the variable increases the probability of major flight taking place, while a negative regression

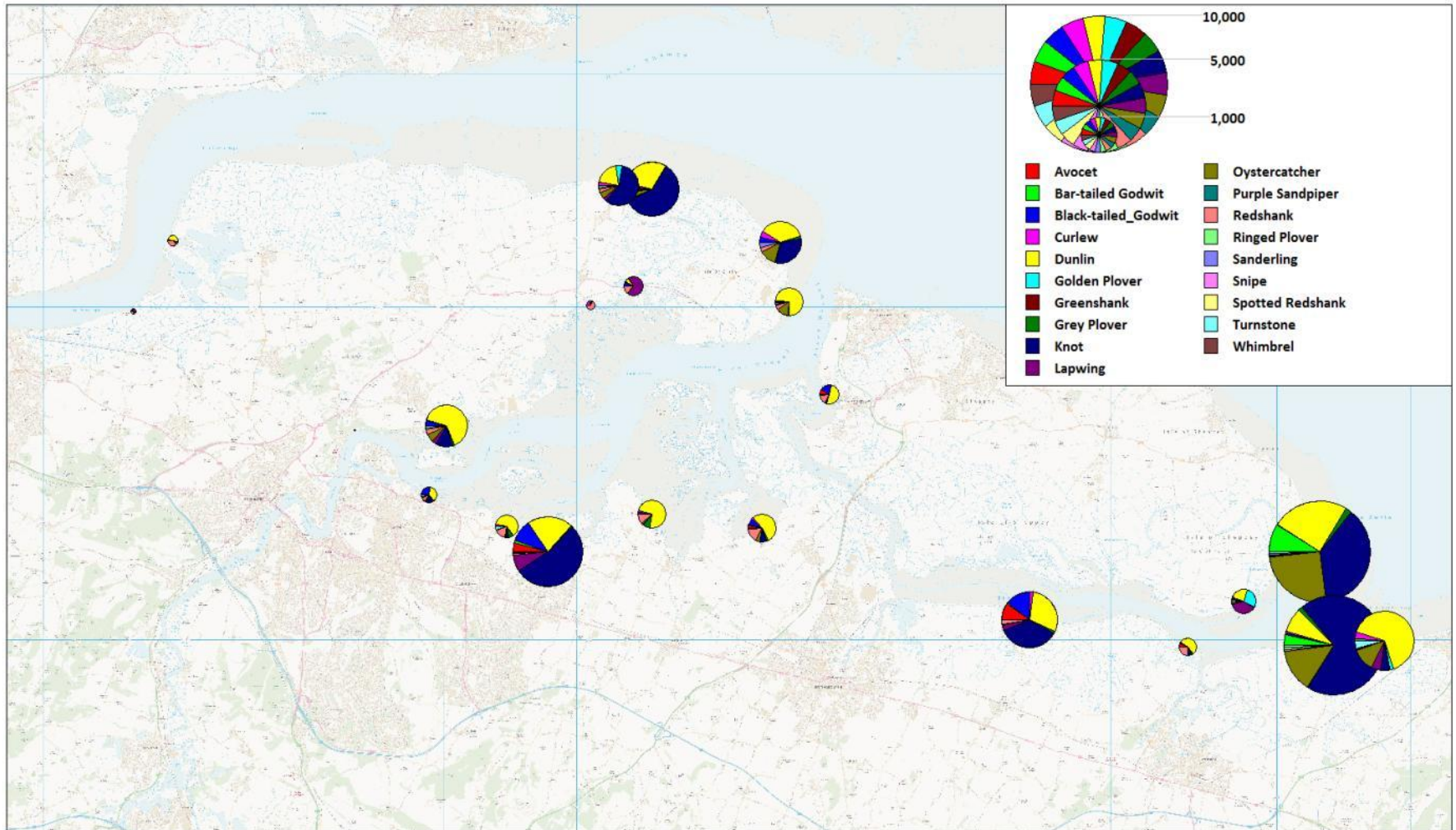
coefficient would indicate that the variable decreases the probability of major flight taking place. A large coefficient would indicate that a factor strongly influences the probability of flight taking place, while a near zero coefficient would indicate that the factor has little influence on the probability of major flight. Variables were tested individually. It makes intuitive sense that distance will be a key factor – birds are more likely to take flight when a source of disturbance is closer than further away. We therefore then tested each variable while controlling for distance (i.e. holding distance constant). We then built preliminary multivariate models following procedures in Hosmer & Lemeshow (2000), incorporating all potentially meaningful interactions and reduced these models to their most significant form with backwards stepping procedure.

3. Results

Distribution of birds in relation to sites

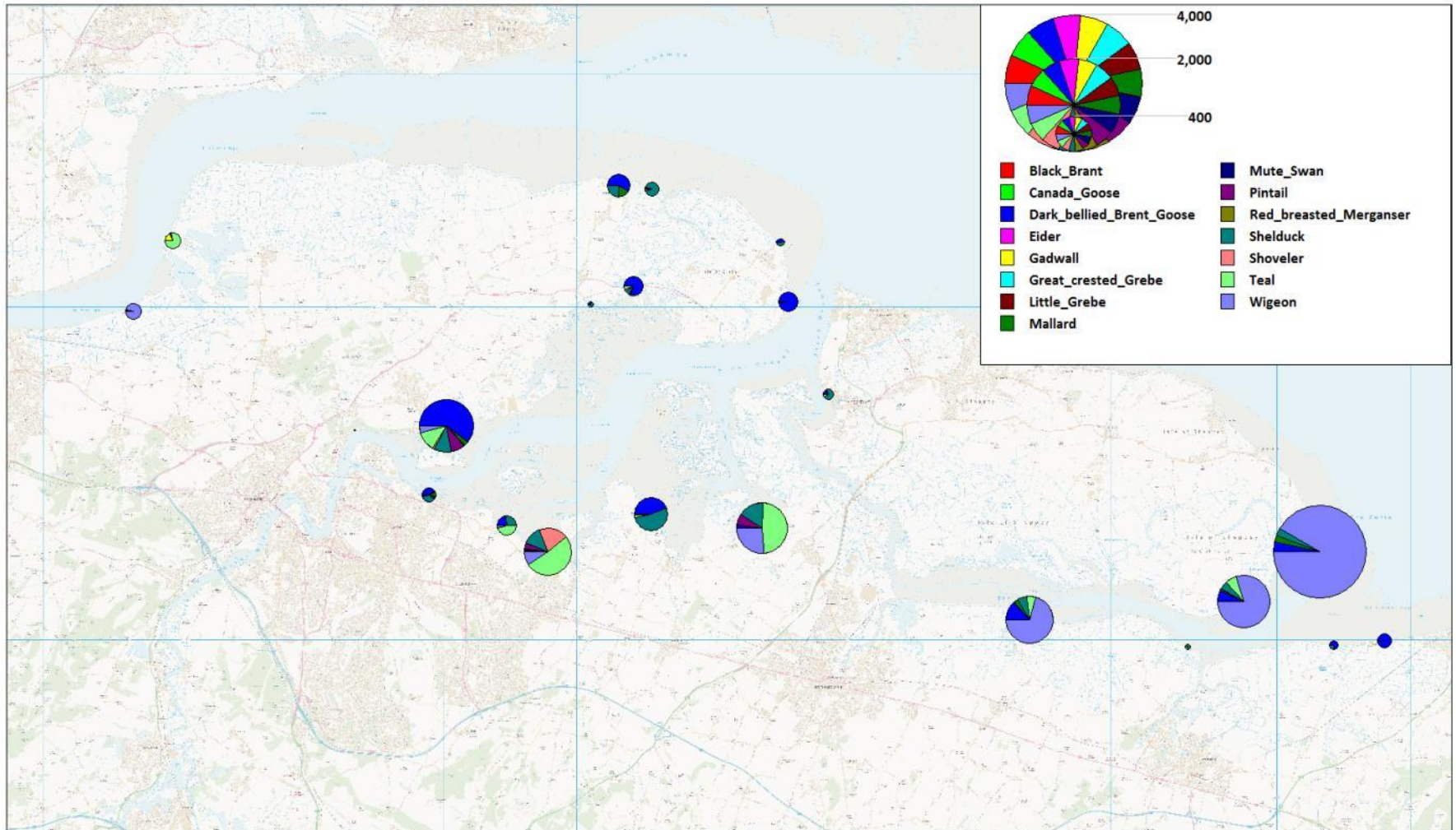
- 3.1 In total, across all counts, 34 bird species were recorded during the counts, conducted at the start and end of each survey visit. This total of 34 included 19 species of wader, 13 species of wildfowl and 2 grebes. Four species (oystercatcher, dunlin, curlew and redshank) were recorded at every location. Appendix 1 summarises the species counted by survey location.

- 3.2 Maximum counts for each species are summarised in Maps 2 (waders) and 3 (wildfowl and grebes). Peak counts within the recording areas tended to be higher for waders than wildfowl. The locations on the outer Swale had the highest counts, for both waders and wildfowl. Dunlin had the highest maximum counts and high counts were recorded at many sites. Knot were a feature of the outer Swale sites, the northern survey locations and also at location 10, Motney Hill Turning. The highest oystercatcher counts were on the outer Swale. At the outer Swale survey locations, the high numbers of wildfowl were the result of some large counts of wigeon in particular. The highest brent goose counts were made on the Medway, at location 14 (Hoo St. Werburgh).



Map 2: Maximum counts of waders at each survey location

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Map 3: Maximum counts of wildfowl and grebes at each survey location

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Levels of human activity

- 3.5 The diaries described 1879 different observations of people in the vicinity of the bird recording areas. Accounting for group size, these events involved at least 2609 people. There were, in total, 449.75 hours of fieldwork undertaken. The hourly rate of visitor activity at the surveyed locations was therefore 4.18 groups and 5.80 people.
- 3.6 There were a few observations recorded within the 'diaries' that related to multiple activities being undertaken by the same group. In order to provide simple groupings these were amalgamated as follows: Cyclists with dogs (2 observations) were grouped with the other cyclists, joggers with dogs (4 observations) were grouped with the other joggers and similarly wildfowling with dogs (1 observation) were treated as wildfowling rather than dog walkers. There were observations of people birdwatching from motor vehicles (1 observation); exercising their dog from the vehicle (3 observations) or walking alongside a moving vehicle (3 observations); these were all grouped as "motorvehicles". There was one observation of a small sailing boat that was running on an engine – this was treated as a small sailing boat rather than a motor boat. There was also one observation of a group birdwatching from a small motor boat – this observation was categorised as a small motor boat rather than birdwatchers. Finally, one observation of a group of three people, where their children were playing while the group was walking, was simply categorised as walking.
- 3.7 The number of people undertaking different activities is summarised in Table 4 and Figure 1. Dog walking was the most commonly recorded activity, with around half of all groups (892 groups, 47%) accompanied by at least one dog. Other commonly recorded activities included walking (without a dog), which accounted for approximately a quarter of all groups observed.

Table 4: Different activities recorded and breakdown of the number of people observed by activity type

Activity	Number (%) of groups observed	Mean group size (no. observations)	No. groups accompanied by dog	Total number of dogs
Air-borne (microlights, helicopters, planes etc)	10 (1)	1.67 (3)		
Bait digger (use for Crab tiling, Cockle raking or bait digging)	23 (1)	1.52 (23)		
Birdwatcher	58 (3)	1.31 (58)	3	4
Canoe on water	2 (0)	2.5 (2)		
Cycling	102 (5)	1.4 (101)	2	2
Dog off lead	1 (0)		1	1
Dog walker, all dogs on lead	231 (12)	1.29 (231)	231	270
Dog walker, one or more dogs off lead	635 (34)	1.52 (635)	635	917
Fishing (from shore)	9 (0)	1.38 (8)		
Jogger	61 (3)	1.42 (60)	5	5
Kids playing (with or without parents)	4 (0)	1.33 (3)		
Large boat on outboard motor	46 (2)			
Motor vehicle	140 (7)	1.26 (70)	4	10
Other	25 (1)	3.75 (4)		
Person accessing boat or water (inc e.g. windsurfers walking across mudflat)	18 (1)	1.82 (17)		
Person working on boat (boat stationary)	6 (0)	1.25 (4)		
Raptor	24 (1)			
Rib or similar fast small boat	19 (1)	1.78 (9)		
Rowing boat	2 (0)	1 (1)		
Small sailing boat (e.g. Laser / dinghy)	4 (0)	1 (1)		
Swimming	1 (0)	1 (1)		
Walking / rambling (without dog)	446 (24)	1.8 (446)		
Wildfowling	12 (1)	1.91 (11)	11	26
Total	1879 (100)	1.55 (1688)	892	1235

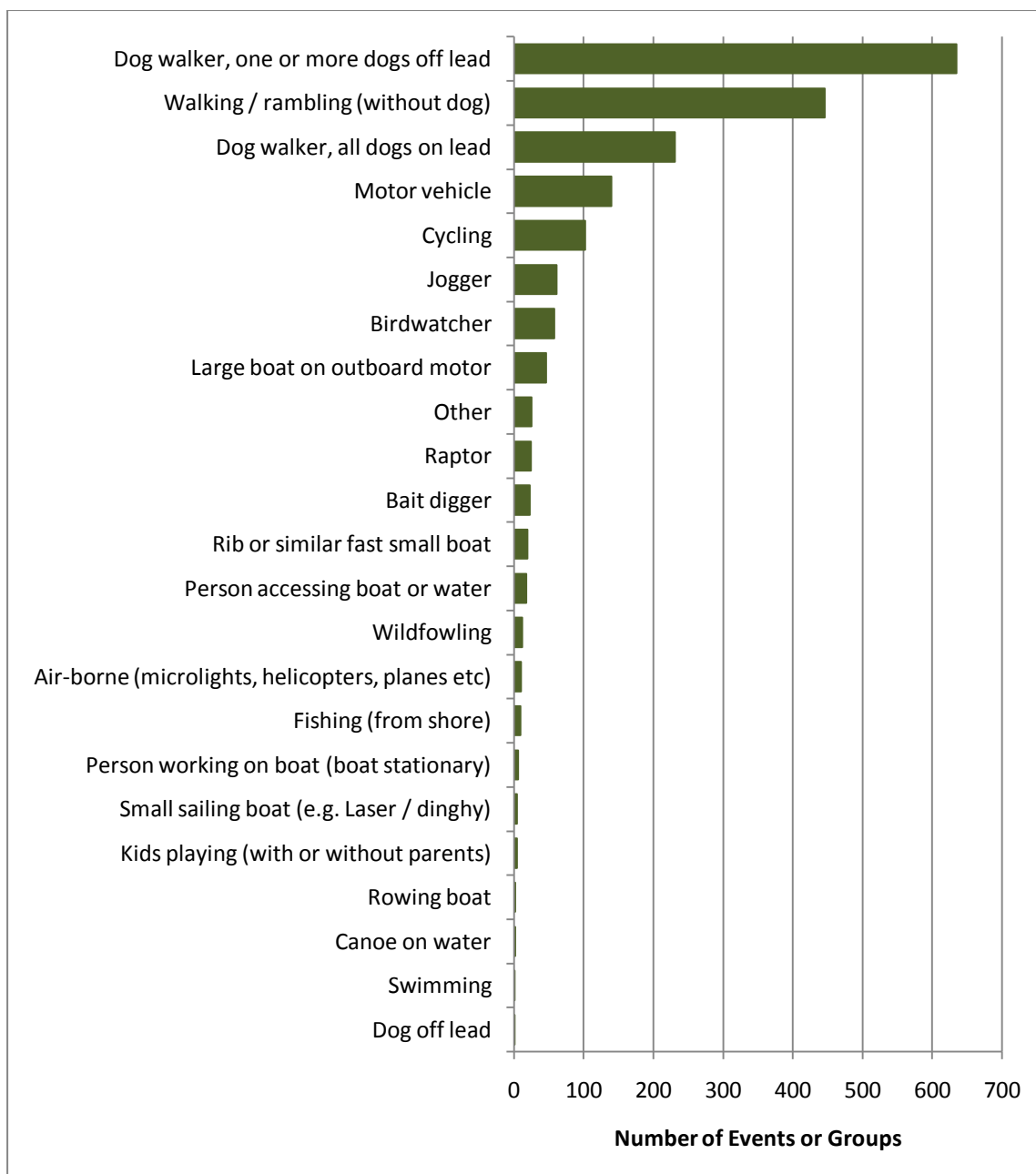


Figure 1: Summary of levels of different activities, across all sites and all visits.

3.8 In Figure 2 and Map 4, we summarise the number of groups recorded by site (note that location 22 was subject to less survey effort than the other sites). It can be seen that location 11, Riverside Country Park was the busiest site (250 groups counted) matching the results of the on-site work as the highest number of visitor interviews were also conducted here (Fearnley & Liley 2011). There were significant differences between sites in the proportions of groups undertaking different activities (grouping activities into dog walkers, walkers and ‘all others’ across the busiest 15 sites, i.e. top 15 in Figure 2; $\chi^2_{28} = 216.3$; $p < 0.001$). Notably ‘different’ sites were location 21 (Cliff Creek), where the ratio of dog walkers and walkers to other groups was low and location 12 (The Strand, Gillingham) where dog walkers accounted for a particularly high proportion of groups counted (Map 4).

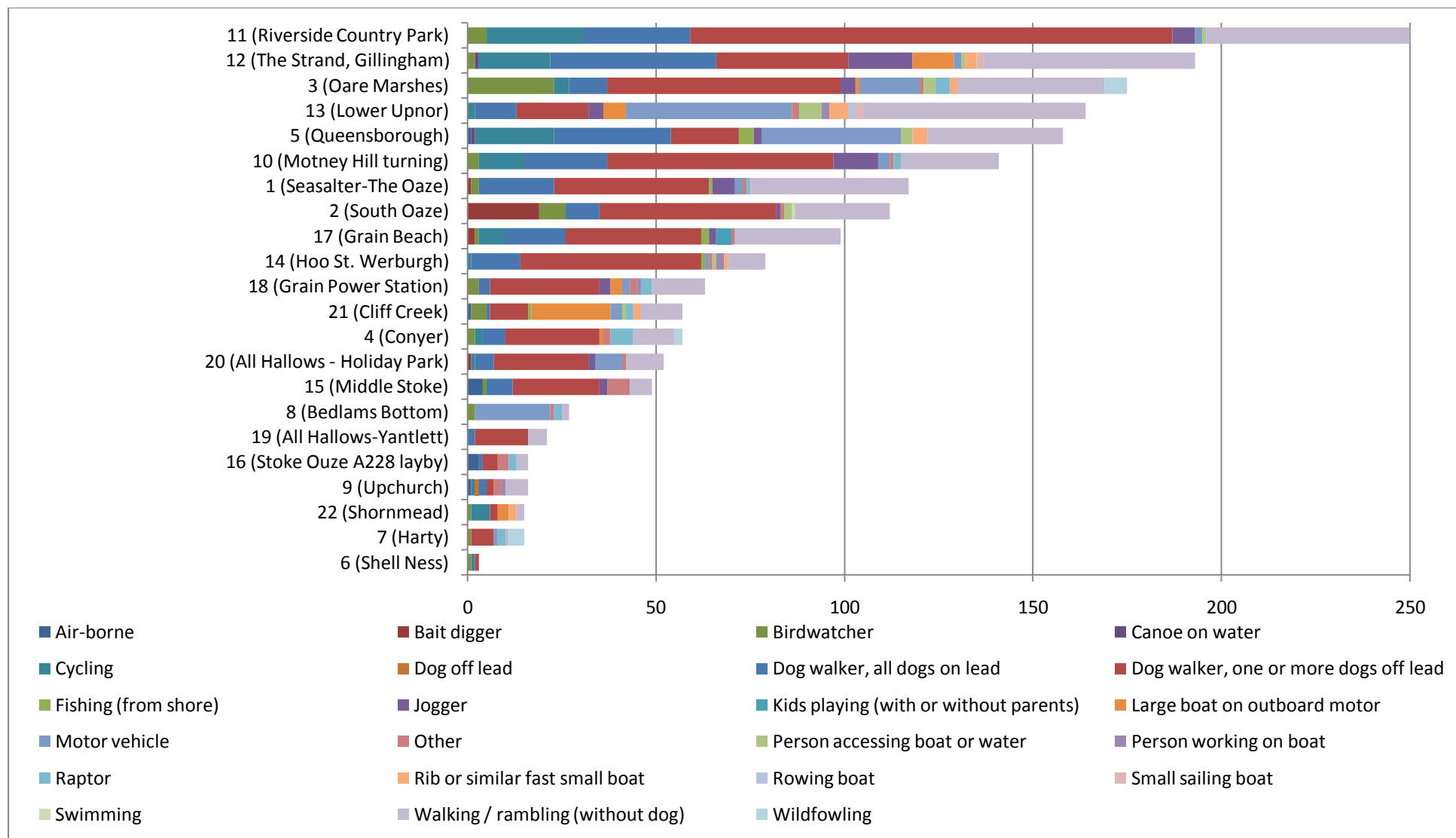
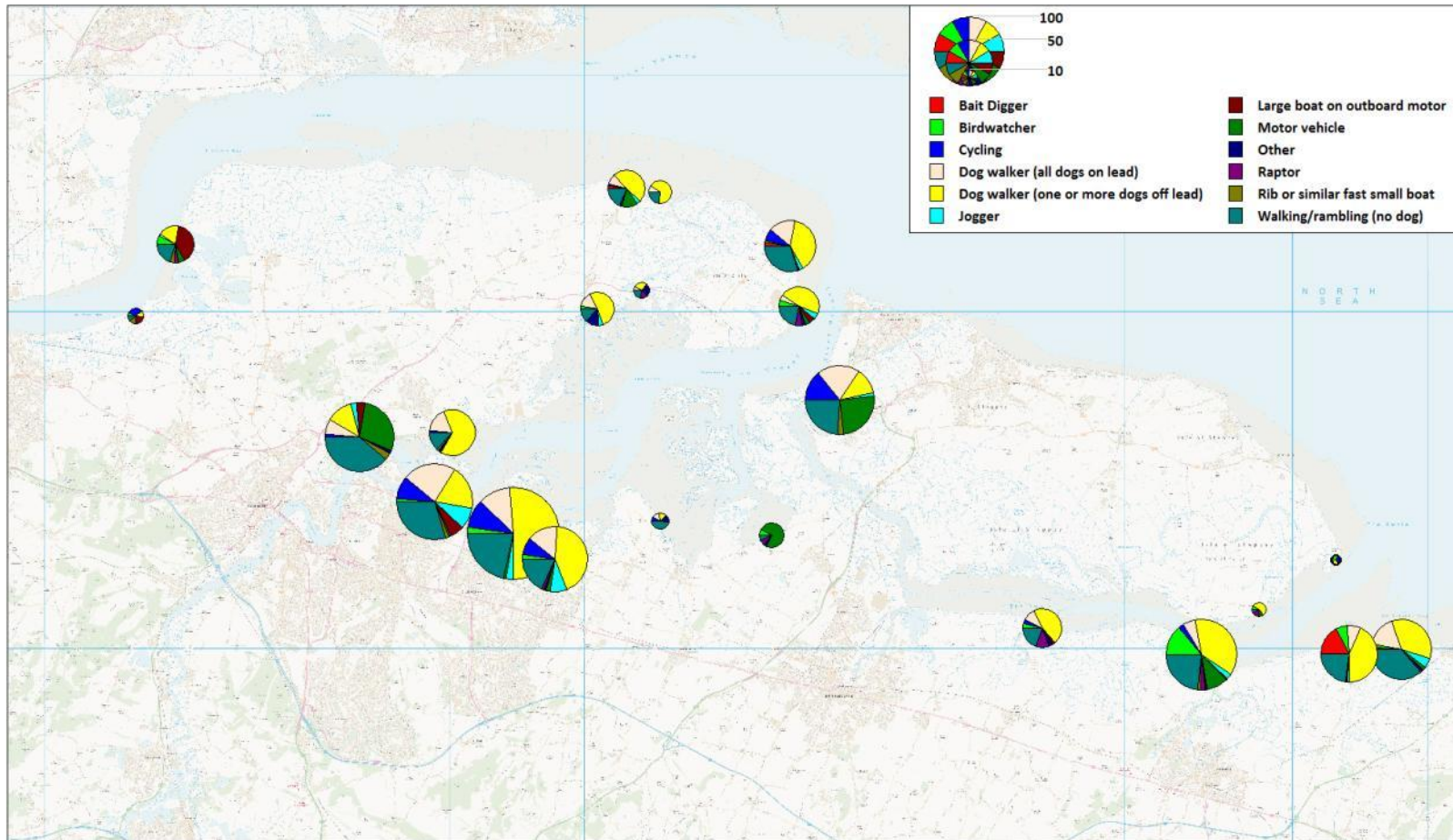


Figure 2: Total numbers of people and different activities recorded, by site. Survey effort was standard at all sites apart from location 22.



Map 4: Number of people undertaking different activities at different locations

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Effect of people on bird numbers and distribution

- 3.9 Besides disturbance resulting in birds being flushed or stopping feeding, it might also be expected that disturbance results in birds tending to avoid certain areas with high numbers of people. In Figure 3 we show a number of graphs that use the count data – i.e. the number of individual birds at the beginning and end of each survey visit – and plot these against the people counts. We have only used bird data from the low tide period, as during low tide it is expected that birds will be feeding. If disturbance were to be influencing the distribution of birds we would expect a pattern where the top right corners of each graph would be empty, indicating fewer birds where disturbance levels were higher, and the highest densities of birds would be expected at the locations with the lowest levels of disturbance.
- 3.10 While the graphs do tend to show relatively low counts of birds where disturbance levels were high, the patterns are not clear or significant. Taking the mean density of birds (all species) at each survey location for the low tide counts and the mean number of disturbance events recorded (i.e. the mean per location from the diary data) (Figure 3a), there is no significant correlation (Pearson correlation coefficient = 0.624, $p=0.111$). Similarly, taking the mean number of events recorded on the intertidal (Figure 3b), there was no significant correlation (Pearson correlation coefficient = 0.029, $p=0.897$). This would indicate that in general there is no pattern such that the sites that tended to be the busiest (in terms of people) also supported the fewest birds.
- 3.11 In Figure 3c and Figure 3d, rather than use the mean number of disturbance events at each location, we show the data from individual counts. At each survey visit we used the data for the number of birds present at the end of each visit, and from the diary data extracted the number of events recorded during that same count – i.e. the counts of people prior to the bird count taking place. The two plots differ in that c) uses the number of birds (all species) recorded and d) shows the same count data converted to density. Only the data from counts conducted at low tide is used. In neither case is there a significant correlation (using bird numbers, Pearson correlation coefficient = -0.071, $p=0.598$; using bird density, Pearson correlation coefficient = -0.020, $p=0.880$). This would suggest that the total number (or density) of birds present at a site during low tide does not vary with the level of people present during the preceding period (hour and forty-five minutes).
- 3.12 We also calculated the difference in the bird counts made at the beginning and end of each of each visit, by subtracting the number of birds at the beginning from the number of birds at the end. We show this difference (using data from low tide counts only) in relation to disturbance levels in Figure 3e (bird numbers) and Figure 3f (bird densities). In neither case is there a significant correlation (using bird numbers, Pearson correlation coefficient = -0.196, $p=0.141$; using bird density, Pearson correlation coefficient = -0.215, $p=0.105$). This would suggest that disturbance does not cause changes in the total number (or density) of birds at a site over an hour and forty-five minute period of low tide.

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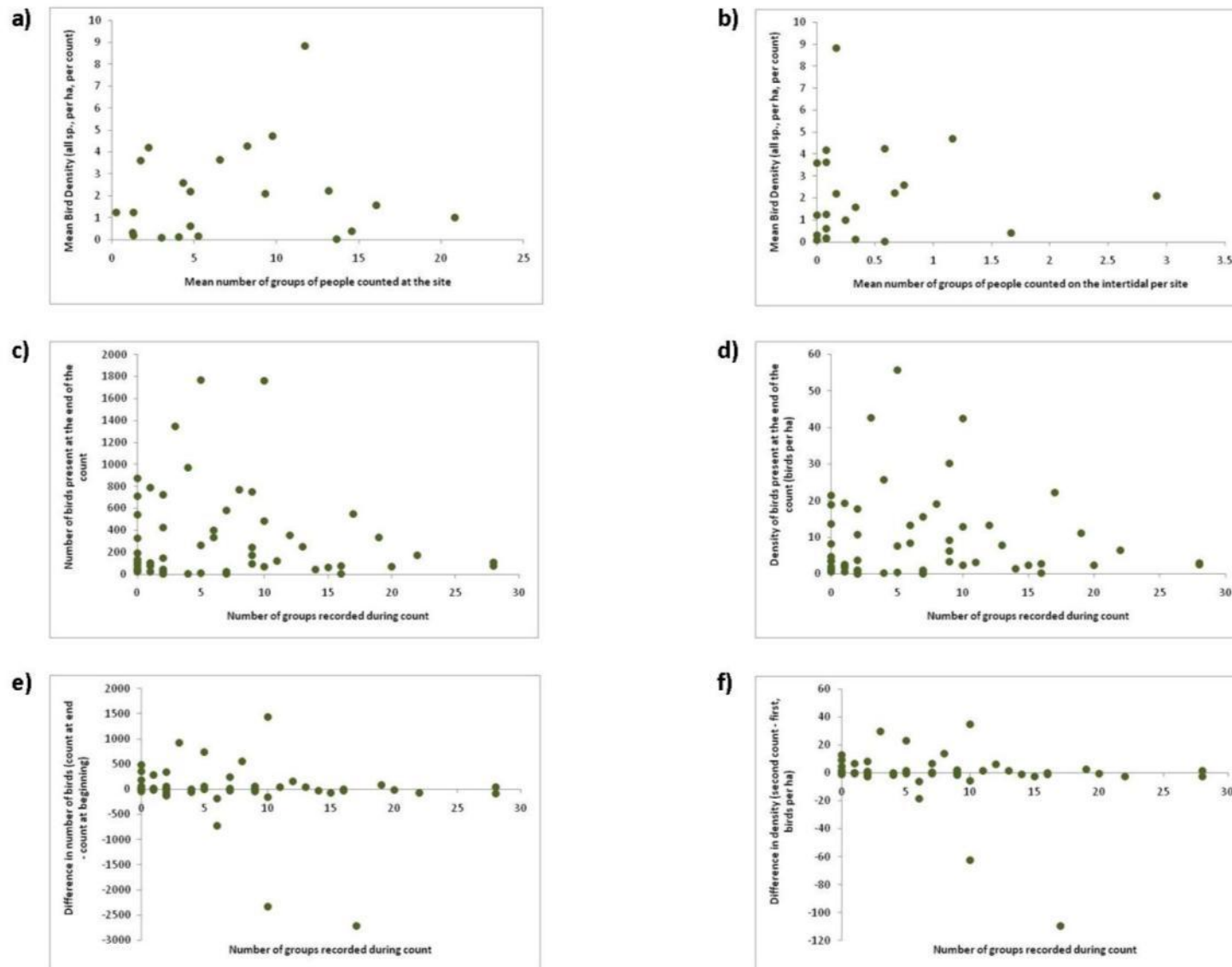


Figure 3: Bird density or numbers of birds at sites and disturbance. All plots use bird data from low tide counts only. Plots a, b, d, & f show bird density, the others the number of birds. Plots e & f use the difference in bird numbers (or density) between the end and beginning of the count.

3.13 In Figure 4 we repeat Figure 3d, using data from all states of the tide. It can be seen that the highest densities of birds² were recorded not at low tide, but during rising, falling or high tides. These high counts were all made when little or no disturbance was present. Figure 4 would seem to indicate that the high counts all took place when disturbance levels were low and equally, when disturbance levels were high, the bird densities were low. Splitting the data according to tide does not however show any significant correlation (Rank Spearman Correlation coefficients: rising tide: -0.125; low tide: 0.115; high tide: -0.164; falling tide: 0.053; all states of tide combined: -0.046; in all cases $p > 0.05$).

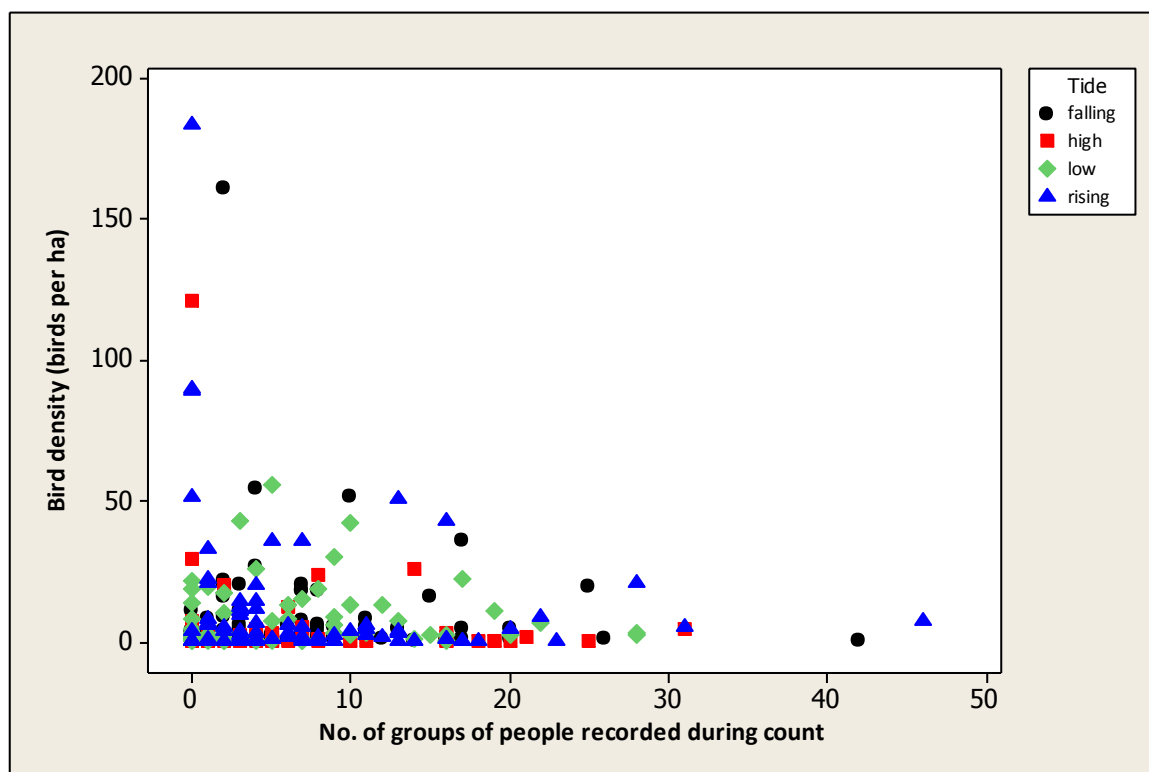


Figure 4: Bird density and disturbance levels, categorising points according to tide state

3.14 We also checked for correlations between the density of each individual species and the number of groups recorded per count. Negative correlations (Rank Spearman) with p values of less than 0.05 were found for four species (curlew, greenshank, oystercatcher and sanderling). Taking the density of all species combined we also checked for any negative correlations on a site by site basis. Location 17 was the only location where there was a negative correlation between number of groups of people with bird density (Rank Spearman $p < 0.05$).

3.15 Levels of disturbance: behavioural responses to presence of people

3.16 During each survey visit the diary element essentially recorded all human activities and potential disturbance events that might affect birds within the focal recording area. This diary was maintained even when no birds were present within the recording area (for example some prior disturbance or changes in the tide might have pushed birds out of the recording area). Some of the diary events could also result in different disturbance events, involving multiple species specific observations: a

² Note that density was calculated according to the count area, rather than exposed mud/intertidal habitat at each point – see methods

single person might disturb different birds in different parts of the survey area and different species may respond differently (e.g. some might take flight, while others show no response). The data therefore consist of a number of unique diary entries, some of which could result in multiple potential disturbance events, each of which we treat as a unique observation. We use the term potential disturbance event throughout this report to highlight those diary entries that resulted in people/activities occurring within 200m of birds within the study area. Each of these potential disturbance events could be associated with multiple observations.

- 3.17 Across all sites and all visits there were 1879 diary entries, of these 479 took place when no birds were present within the focal area or the people noted were not within 200m of birds in the focal area. The remaining 1400 entries are potential disturbance events and occurred within 200m of the birds and within the focal area. Data for these events are summarised in Table 5. These potential disturbance events generated a total of 3248 species specific observations. Of these (species-specific) observations, 2415 (74%) resulted in no visible change in behaviour or any kind of response from the birds. About one quarter (26%) of these observations resulted a disturbance of a given species, with 410 observations (13%) involving birds undertaking a major flight.

Table 5: Summary of response data. We treat each potential disturbance event as a unique event. In order to calculate the totals for the diary events we attributed a single response category to each event in the diary. If an event caused a range of responses (e.g. a major flight for one species but no response for other species, then we categorised each diary event according to the most extreme response)

Response	Number (%) Observations	Potential disturbance events: number (%) diary entries
No Response	2415 (74)	893 (64)
Alert	84 (3)	41 (3)
Walk/Swim	167 (5)	103 (7)
Short Flight	172 (5)	108 (8)
Major Flight	410 (13)	255 (18)
Total	3248 (100)	1400 (100)

Types of activities and disturbance

- 3.18 Across all counts there were 3248 observations of potential disturbance events (including birds of prey) involving an individual (or individuals) of a particular target species. Figure 5 details the response of all birds to each activity and

3.19 Table 6 shows the number of groups recorded per activity. Bait digging and fishing (note very small sample size for the latter) were the two activities which resulted in the most responses from the birds.

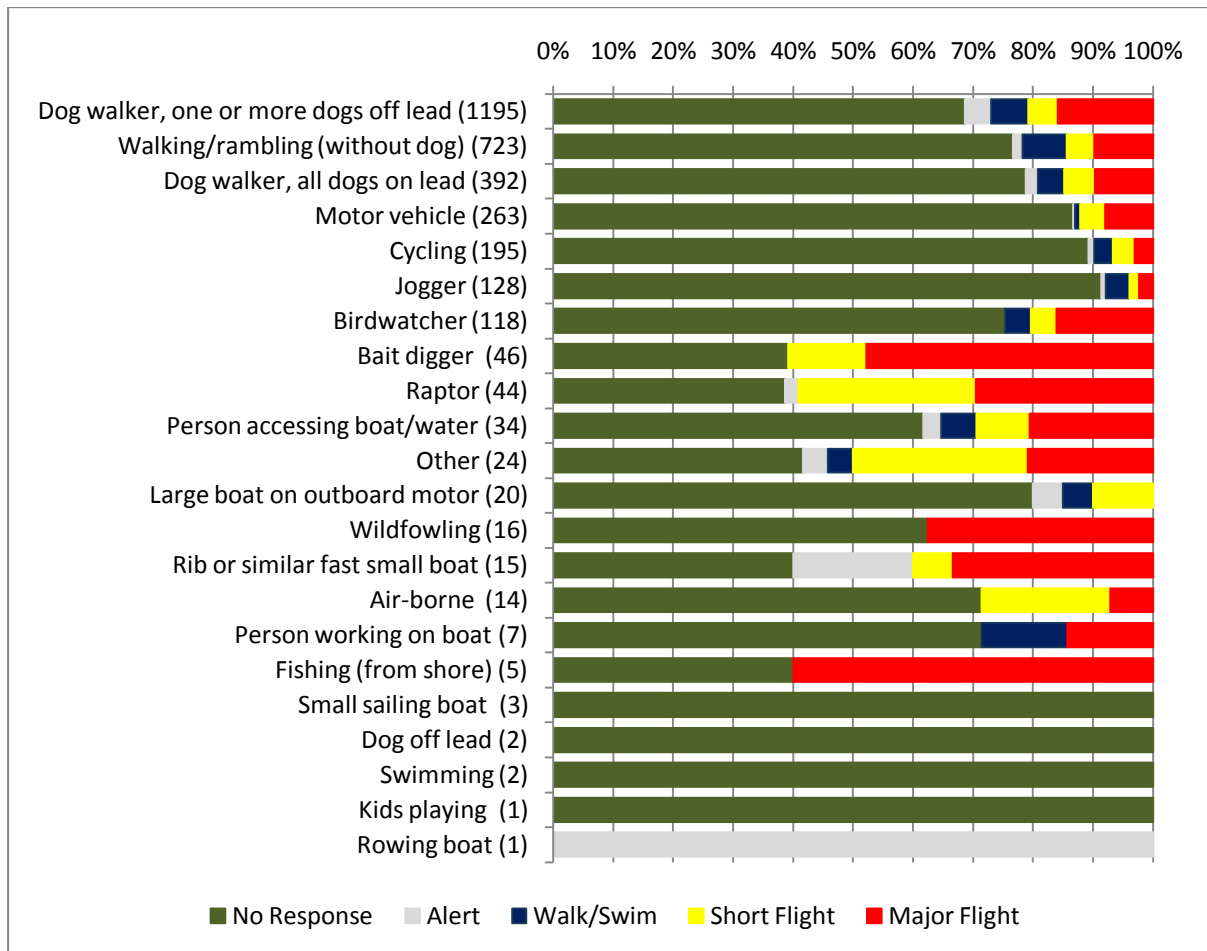


Figure 5: Responses of birds (grouped across all sites and all species) according to activity. Activities are listed in order of sample size (the sample size being the number of species specific observations, given in brackets).

3.20 In

- 3.21 Table 6 we summarise all potential disturbance events according to both zone and activity. The majority of observations involved activities on the shore (89% of observations), while 8% of observations involved activities on the intertidal and just 1% on the water. This broadly matches the on-site visitor work (Fearnley & Liley 2011) where 76% of visitors stated they remained on the paths and 23% citing their route took them onto the mudflats or open coast. With the shore-based activities (2896 potential disturbance events), 300 (9%) resulted in a major flight. By contrast there were 249 potential disturbance events observed on the intertidal and 91 (37%) resulted in major flight. Therefore over a third of activities that take place on the intertidal were observed to result in a major flight by a species, while one in ten shore-based events resulted in disturbance. Yet three times as many major flights were caused by activities on the shore compared to activities on the intertidal, simply because there were more shore based activities.
- 3.22 Looking at individual activities it can be seen that dog walking accounts for the majority of major flight events observed. Of the total of 410 major flight observations, 55% were attributed to dog walkers, and a further 15% to walkers without dogs – i.e. 70% of major flights were linked to these two activities. With the dog walkers we highlight dogs off leads, with 46% of all species-specific major flight observations linked to dog walkers with dogs off leads.

Table 6: Number (%) of potential disturbance events and response of birds, by activity and zone. Zones were classified in the field, but where events occurred across multiple zones we simplified these to a single zone: primarily this involved events that took place on both the intertidal and the shore, in which cases of which the zone was simplified as intertidal only.

Activity by Zone	No Response	Alert	Walk/Swim	Short Flight	Major Flight	Total
Shore						
Birdwatcher	88 (3)	0 (0)	4 (0)	4 (0)	16 (0)	112 (3)
Cycling	172 (5)	2 (0)	6 (0)	7 (0)	5 (0)	192 (6)
Dog off lead	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0)
Dog walker, all dogs on lead	309 (10)	8 (0)	16 (0)	20 (1)	38 (1)	391 (12)
Dog walker, one or more dogs off lead	784 (24)	44 (1)	66 (2)	48 (1)	154 (5)	1096 (34)
Fishing (from shore)	2 (0)	0 (0)	0 (0)	0 (0)	3 (0)	5 (0)
Jogger	117 (4)	1 (0)	5 (0)	2 (0)	3 (0)	128 (4)
Motor vehicle	215 (7)	1 (0)	2 (0)	10 (0)	11 (0)	239 (7)
Other	7 (0)	1 (0)	0 (0)	5 (0)	1 (0)	14 (0)
Person accessing boat or water	11 (0)	0 (0)	1 (0)	1 (0)	1 (0)	14 (0)
Person working on boat	1 (0)	0 (0)	1 (0)	0 (0)	1 (0)	3 (0)
Walking / rambling (without dog)	537 (17)	12 (0)	44 (1)	31 (1)	61 (2)	685 (21)
Wildfowling	9 (0)	0 (0)	0 (0)	0 (0)	6 (0)	15 (0)
Shore Total	2254 (69)	69 (2)	145 (4)	128 (4)	300 (9)	2896 (89)
Water						
Large boat on outboard motor	16 (0)	1 (0)	1 (0)	2 (0)	0 (0)	20 (1)
Person working on boat	4 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0)
Rib or similar fast small boat	6 (0)	3 (0)	0 (0)	1 (0)	5 (0)	15 (0)
Rowing boat	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Small sailing boat	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (0)
Swimming	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0)
Water Total	31 (1)	5 (0)	1 (0)	3 (0)	5 (0)	45 (1)
Intertidal						
Bait digger	18 (1)	0 (0)	0 (0)	6 (0)	22 (1)	46 (1)
Birdwatcher	1 (0)	0 (0)	1 (0)	1 (0)	3 (0)	6 (0)
Cycling	2 (0)	0 (0)	0 (0)	0 (0)	1 (0)	3 (0)
Dog walker, all dogs on lead	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (0)
Dog walker, one or more dogs off lead	37 (1)	8 (0)	8 (0)	11 (0)	35 (1)	99 (3)
Kids playing	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Motor vehicle	13 (0)	0 (0)	0 (0)	1 (0)	10 (0)	24 (1)
Other	3 (0)	0 (0)	1 (0)	2 (0)	4 (0)	10 (0)
Person accessing boat or water	10 (0)	1 (0)	1 (0)	2 (0)	6 (0)	20 (1)
Walking / rambling (without dog)	17 (1)	0 (0)	9 (0)	2 (0)	10 (0)	38 (1)
Wildfowling	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)
Intertidal Total	103 (3)	9 (0)	21 (1)	25 (1)	91 (3)	249 (8)
Air						
Air-borne	10 (0)	0 (0)	0 (0)	3 (0)	1 (0)	14 (0)
Raptor	17 (1)	1 (0)	0 (0)	13 (0)	13 (0)	44 (1)
Air Total	27 (1)	1 (0)	0 (0)	16 (0)	14 (0)	58 (2)
Total	2415 (74)	84 (3)	167 (5)	172 (5)	410 (13)	3248 (100)

Variations between sites

3.23 There was some variation between sites in the proportion of potential disturbance events that resulted in major flight (Table 7, Figure 6 and Map 5). The two locations with the highest proportion of major flight observations were locations 16 (Stoke Ouze A228 layby) and 7 (Harty), where 57% and 41% of observations resulted in major flight. Both these locations were comparatively 'quiet', in that levels of recreational use were actually low. By contrast, at the two busiest sites, location 11 (Riverside Country Park), and location 12 (the Strand, Gillingham) there were a low proportion of major flight events were observed (at both sites less than 5% of observations resulted in major flight events).

Table 7: Number (%) of different types of response by location

Location		No Response	Alert	Walk/Swim	Short Flight	Major Flight	Total
1	Seasalter-The Oaze	133 (69)	8 (4)	13 (7)	8 (4)	30 (16)	192 (100)
2	South Oaze	129 (53)	4 (2)	14 (6)	15 (6)	82 (34)	244 (100)
3	Oare Marshes	265 (73)	1 (0)	31 (9)	8 (2)	56 (16)	361 (100)
4	Conyer	92 (63)	2 (1)	11 (8)	19 (13)	22 (15)	146 (100)
5	Queensborough	227 (74)	10 (3)	22 (7)	22 (7)	27 (9)	308 (100)
6	Shell Ness	3 (75)	(0)	(0)	1 (25)	(0)	4 (100)
7	Harty	10 (31)	3 (9)	2 (6)	4 (13)	13 (41)	32 (100)
8	Bedlams Bottom	52 (83)	2 (3)	(0)	8 (13)	1 (2)	63 (100)
9	Upchurch	14 (70)	(0)	2 (10)	(0)	4 (20)	20 (100)
10	Motney Hill turning	255 (86)	2 (1)	7 (2)	9 (3)	22 (7)	295 (100)
11	Riverside Country Park	364 (91)	12 (3)	10 (2)	9 (2)	7 (2)	402 (100)
12	The Strand, Gillingham	353 (89)	7 (2)	20 (5)	7 (2)	10 (3)	397 (100)
13	Lower Upnor	91 (76)	5 (4)	6 (5)	9 (8)	8 (7)	119 (100)
14	Hoo St. Werburgh	82 (73)	5 (4)	4 (4)	1 (1)	20 (18)	112 (100)
15	Middle Stoke	9 (33)	(0)	(0)	10 (37)	8 (30)	27 (100)
16	Stoke Ouze A228 layby	10 (43)	(0)	(0)	(0)	13 (57)	23 (100)
17	Grain Beach	84 (69)	1 (1)	8 (7)	13 (11)	16 (13)	122 (100)
18	Grain Power Station	110 (62)	11 (6)	13 (7)	2 (1)	42 (24)	178 (100)
19	All Hallows-Yantlett	6 (29)	3 (14)	2 (10)	5 (24)	5 (24)	21 (100)
20	All Hallows - Holiday Park	76 (71)	4 (4)	1 (1)	9 (8)	17 (16)	107 (100)
21	Cliff Creek	40 (63)	4 (6)	1 (2)	13 (20)	6 (9)	64 (100)
22	Shornmead	10 (91)	(0)	(0)	(0)	1 (9)	11 (100)
Total		2415 (74)	84 (3)	167 (5)	172 (5)	410 (13)	3248 (100)

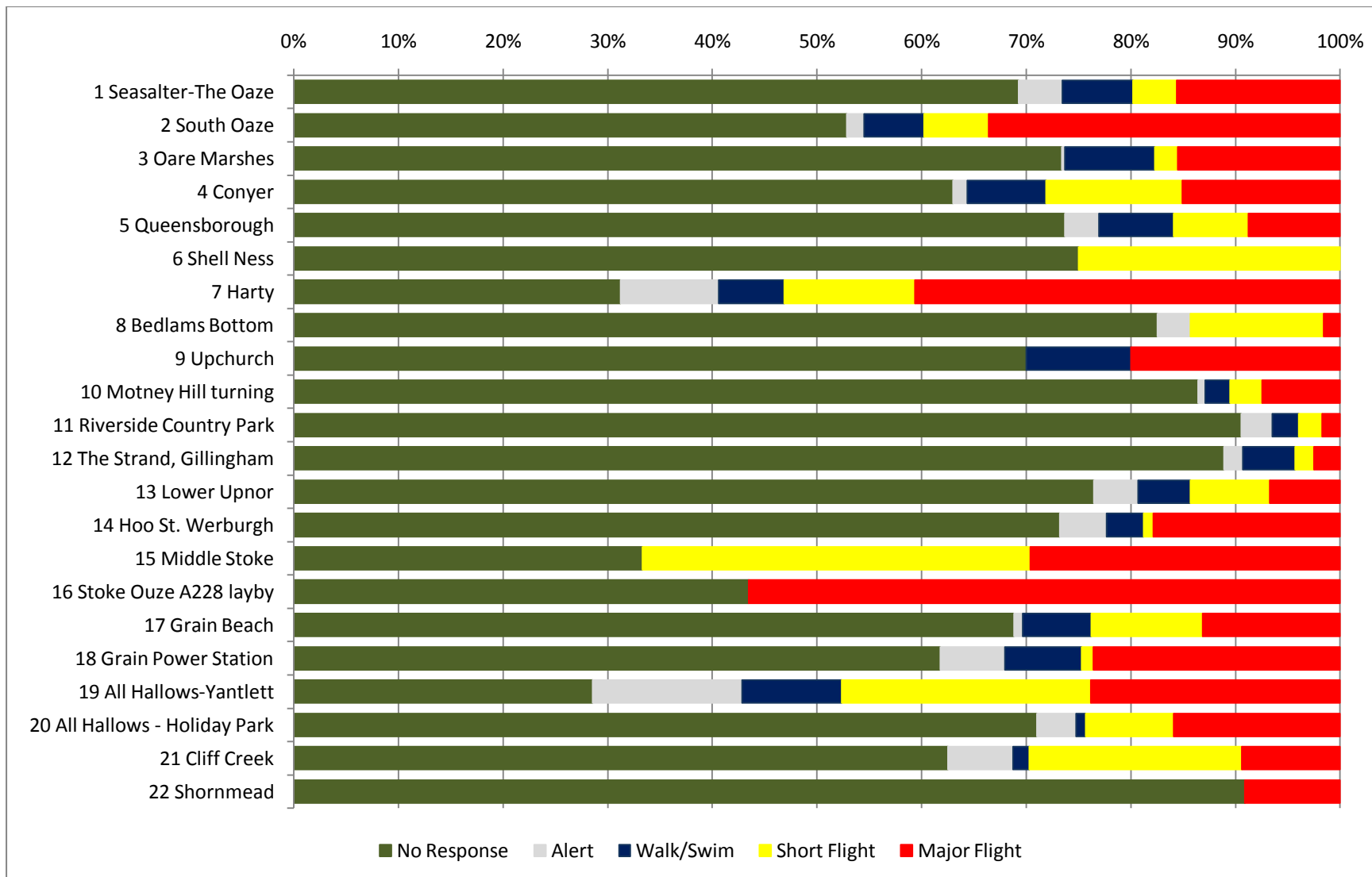


Figure 6: Percentage of potential disturbance events at each site resulting in disturbance.

3.24 A plot (Figure 7) of the percentage of observations that resulted in major flight with disturbance (we used the mean number of groups per location) suggests that, at least at the locations with high levels of recreation, there is a lower proportion of major flight events. While the correlation is not actually quite significant (Pearson Correlation Coefficient = -0.417, $p=0.054$), the plot reveals no points in the top right corner, i.e. when disturbance levels are higher, there are no locations where the birds are repeatedly flushed. However at low disturbance levels there appears to be variation between sites, with some sites seeing a high proportion of major flight events and other sites a much lower proportion. This could suggest that where disturbance levels are lower a range of other factors (for example the types of activities taking place) influence the behavioural response of the birds present.

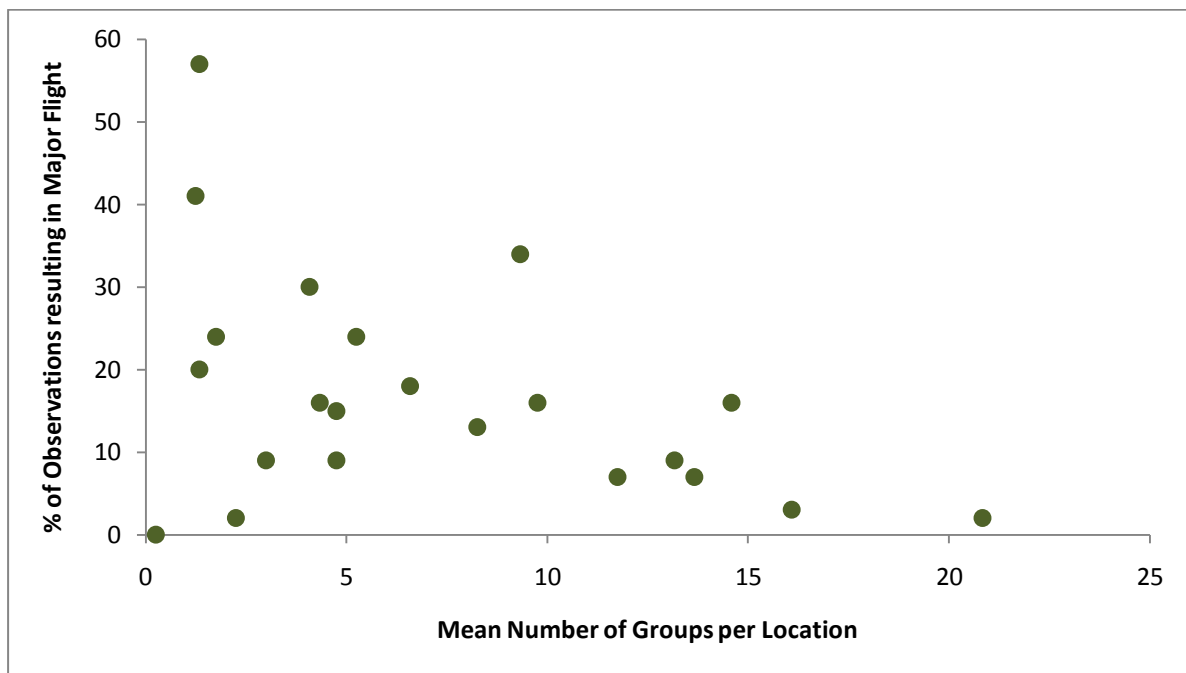
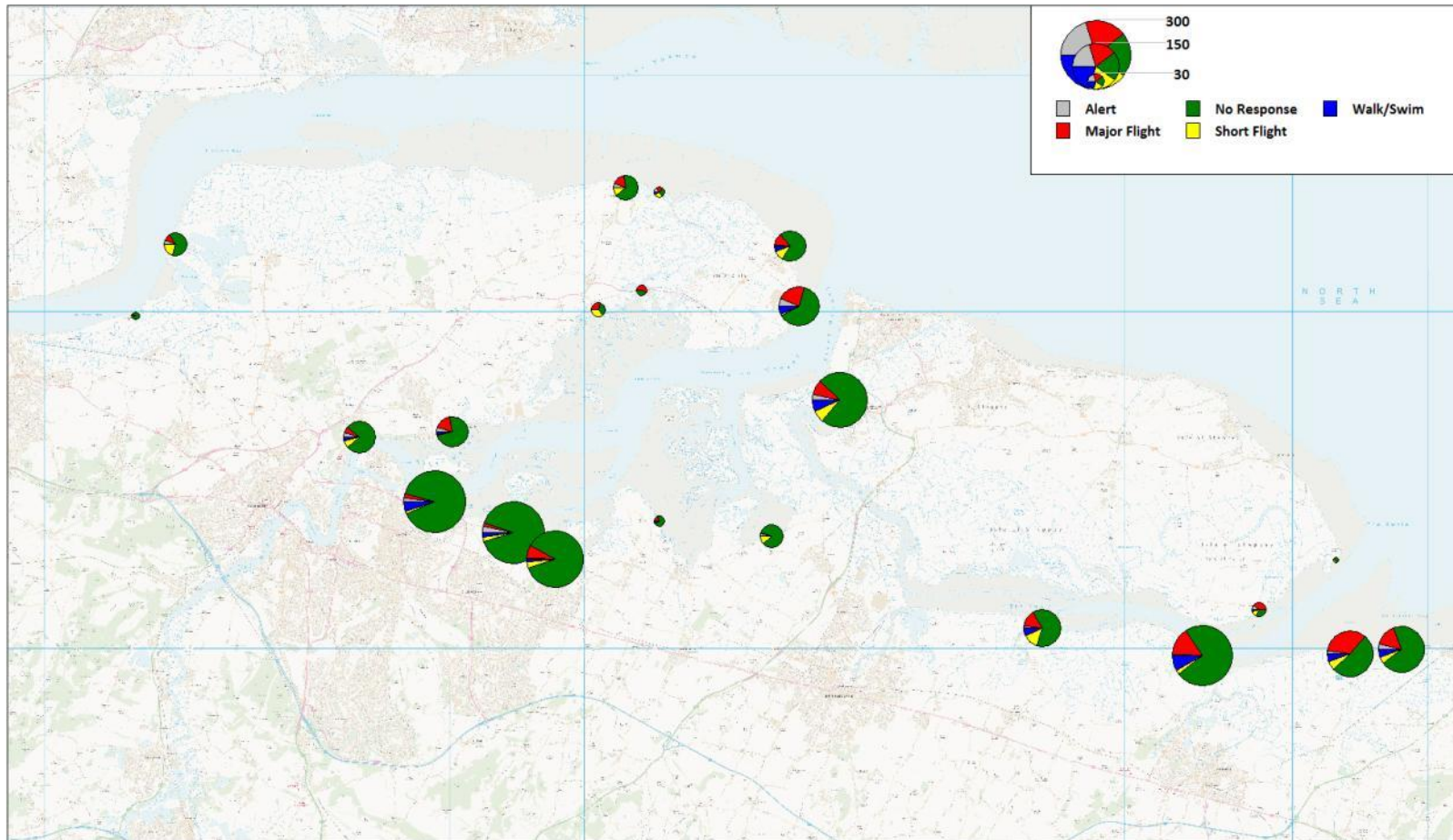


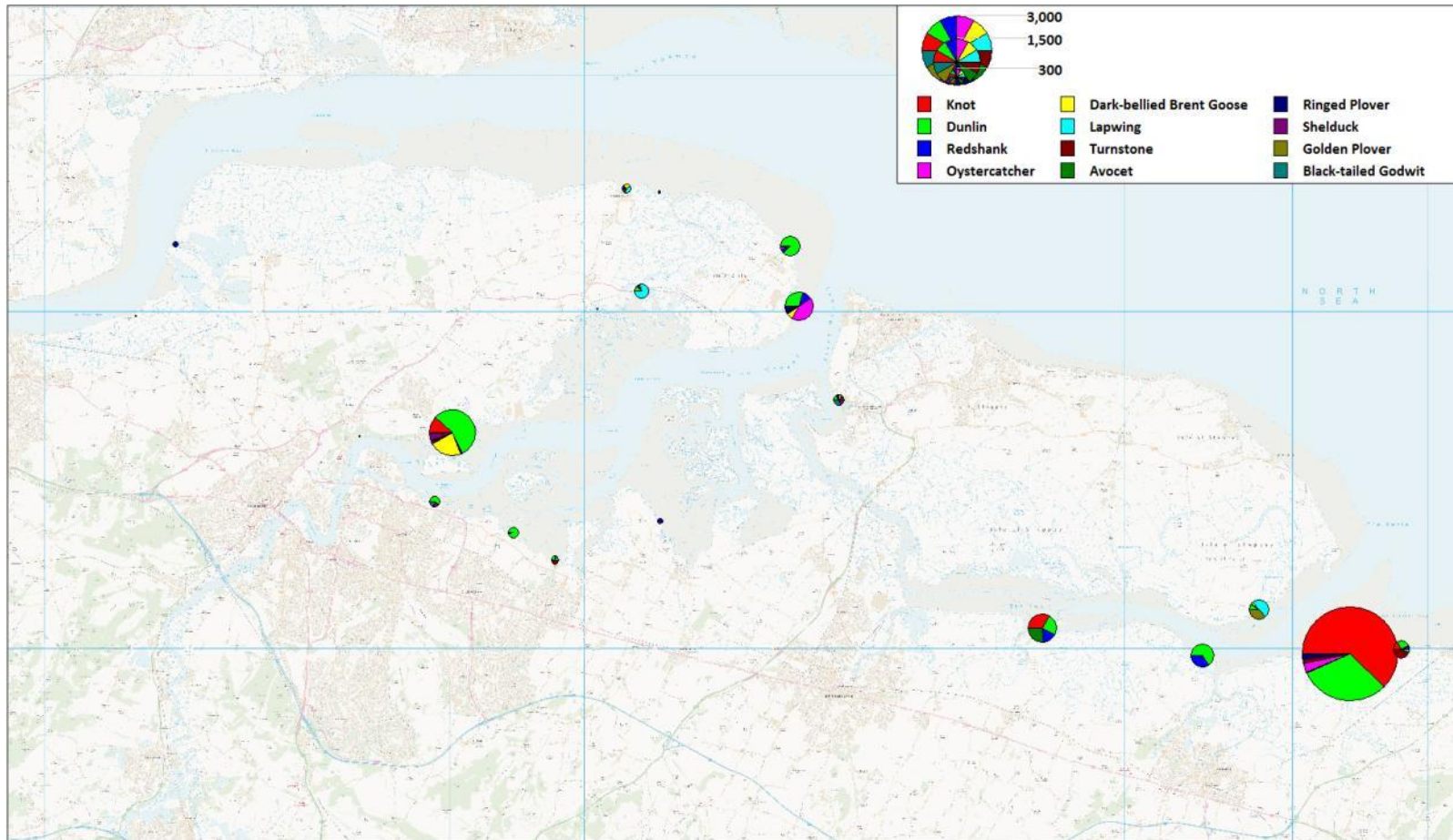
Figure 7: Percentage of major flight events at each location in relation to disturbance levels (mean number of groups per location, from the diary data). Data from all 22 locations, all counts.

3.25 The actual number of birds flushed is shown in Map 6, highlighting that – in terms of number of birds disturbed – Knot and Dunlin are the two species where major flight events involved lots of individuals and Location 2, South Oaze, stands out for the volume of birds flushed in comparison to the other sites.



Map 5: Responses by location

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Map 6: Total number of individuals recorded flushed (major flights)

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Variation in response between species

3.26 Response data for a selection of species are shown in Figure 8. There were significant differences between species in the proportion of events for which there was no response (for all species in Figure 8; $\chi^2_{15} = 91.7$; $p < 0.001$). The species where the most observations involved some kind of response was dark-bellied brent goose (46% of observations involving a response). The species with the most instances of major flight was knot (36% of observations involved major flight).

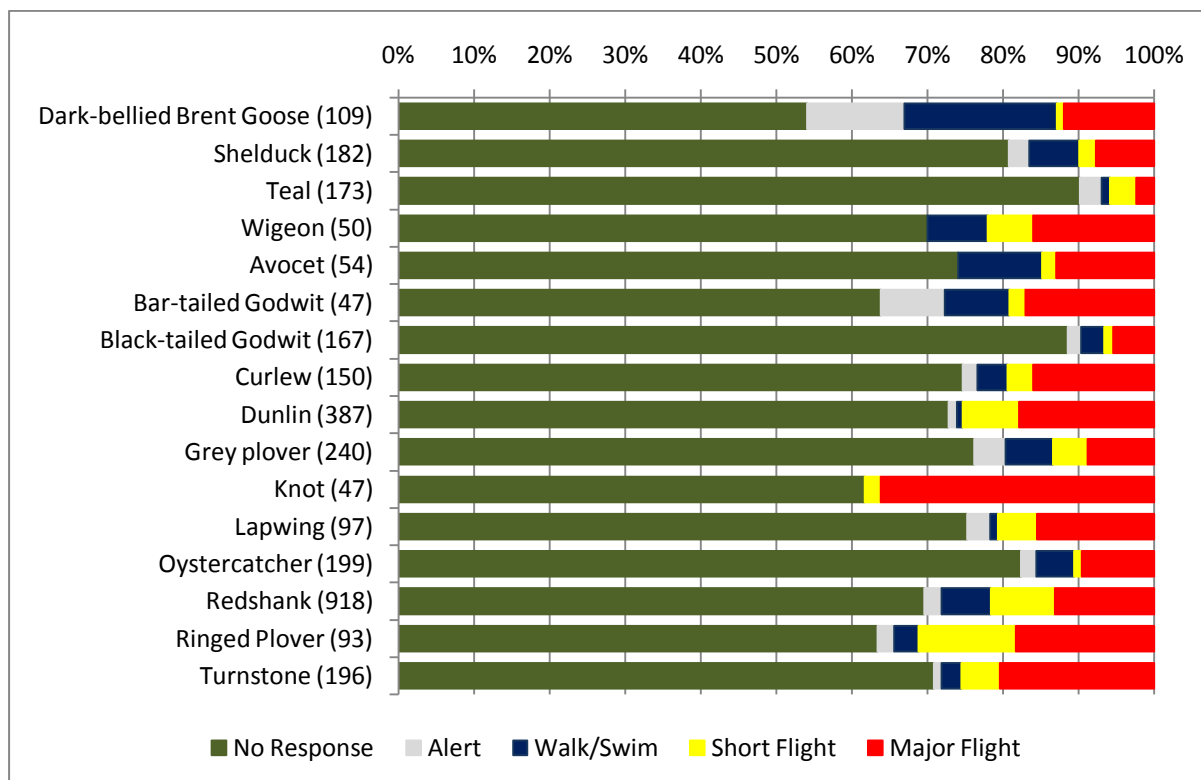


Figure 8: Response to disturbance events by species. All species for which there were data from at least 40 events are included. Species are grouped into wildfowl (top) and waders (lower part of graph) and within each group ordered alphabetically. Numbers in brackets give the number of observations for each species.

Distance from the source of disturbance

3.27 The distance from the potential disturbance event to the birds was estimated in all but 44 cases. Where no response occurred, the distance estimated was from the shortest distance from the event to the nearest individual of that species. Where the birds were disturbed – i.e. alert, short walk/swim, short flight or a major flight then the distance estimated was to the birds that were disturbed.

3.28 Looking across all species (Figure 9), birds tended to not respond when disturbance events were further away and while there was considerable overlap between the distances at which birds showed a response, there were significant differences between the distances at which birds showed the different types of response (Kruskall-Wallis $H = 552.19$ (adjusted for ties), 5 df, $p < 0.001$). As Figure 9 does however show, there were instances where no response occurred and the potential disturbance event was within a few metres of the birds and there were instances where major flight occurred and the birds were over 200m from the source of

disturbance, suggesting that there is no clear set-back distance (at least for all species at all locations) that would result in no disturbance.

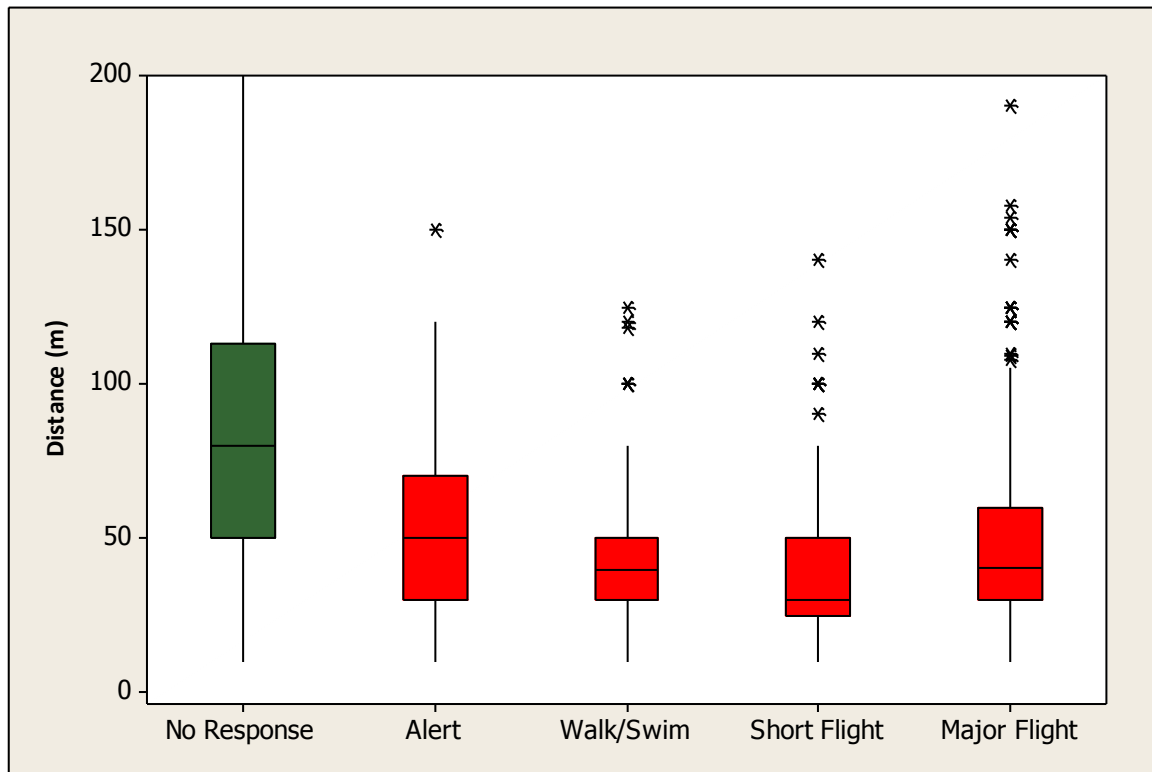


Figure 9: Distance data, for all species and events combined. The y axis is truncated at 200m. These plots show the median (i.e. the midpoint value of the data – represented by the horizontal line), the interquartile range (i.e. 25%-75% of the data) – represented by the box, while the vertical lines show the upper and lower limits of the data, with the outlying values represented by asterisks.

3.29 Data are summarised for individual species in Table 8, in all cases (apart from those instances where sample sizes are tiny) the median distance at which no response was recorded was greater than the distance at which major flight was observed.

Table 8: Summary of distances at which birds responded by species. Data for all activities combined.

Species	Total no.	No Response			Alert			Walk/swim			Short Flight			Major Flight		
		Median	Range	Count	Median	Range	Count	Median	Range	Count	Median	Range	Count	Median	Range	Count
Avocet	52	100	20-175	39			0	45	20-60	6	30	30-30	1	50	38-100	6
Bar-tailed Godwit	47	97	37-200	30	37	20-80	4	42.5	31-60	4	30	30-30	1	50	15-100	8
Black-tailed Godwit	166	70	25-200	147	60	50-80	3	50	30-80	5	60	40-80	2	40	30-50	9
Curlew	144	105	30-200	107	40	40-90	3	40	30-60	6	32.5	20-50	4	50	20-154	24
Dark-bellied Brent Goose	109	120	20-190	59	32.5	20-110	14	30	20-120	22	30	30-30	1	60	20-158	13
Dunlin	382	75	20-181	281	50	10-90	4	37.5	35-40	2	32	10-120	27	50	10-300	68
Gadwall	10	120	30-180	7	110	110-150	3			0			0			0
Golden Plover	13	137.5	50-190	12			0			0	90	90-90	1			0
Greenshank	3	130	25-130	3			0			0			0			0
Grey plover	236	80	10-200	181	50	20-105	9	40	20-100	15	27.5	20-44	10	40	20-150	21
Knot	47	68	40-180	29			0			0	140	140-140	1	50	10-140	17
Lapwing	93	100	20-175	71	10	10-60	3			0	30	20-50	5	85	30-150	14
Little Grebe	5	30	30-120	5			0			0			0			0
Mallard	38	111	20-175	33			0	40	25-125	5			0			0
Mute Swan	18	25	25-194	17	25	25-25	1			0			0			0

Bird disturbance study, North Kent, 2010/11

		No Response			Alert			Walk/swim			Short Flight			Major Flight		
Species	Total no.	Median	Range	Count	Median	Range	Count	Median	Range	Count	Median	Range	Count	Median	Range	Count
Oystercatcher	198	105	17-195	164	55	50-100	4	50	40-500	10	75	50-100	2	55	20-500	18
Pintail	23	127.5	50-180	20			0	40	40-60	3			0			0
Purple Sandpiper	1	110	110-110	1			0			0			0			0
Redshank	909	59.5	15-200	634	45	25-85	21	40	20-80	60	30	10-80	76	40	11-120	118
Ringed Plover	93	105	15-180	59	35	10-60	2	50	35-100	3	20	10-80	12	50	20-150	17
Ruff	2	185	180-190	2			0			0			0			0
Sanderling	3	170	170-170	1			0			0			0	35	20-50	2
Shelduck	178	120	40-200	146	71	30-120	5	37.5	20-70	12	30	25-35	2	60	25-125	13
Shoveler	19	130	10-150	17			0	50	50-50	1			0	100	100-100	1
Snipe	1	40	40-40	1			0			0			0			0
Teal	170	61	10-200	155	41	20-52	4	14.5	10-19	2	47.5	15-100	6	70	30-100	3
Turnstone	195	70	15-190	138	20	20-20	2	30	15-40	5	20	10-40	10	30	10-125	40
Wigeon	49	122.5	30-190	34			0	60	30-70	4	50	30-100	3	42.5	20-190	8

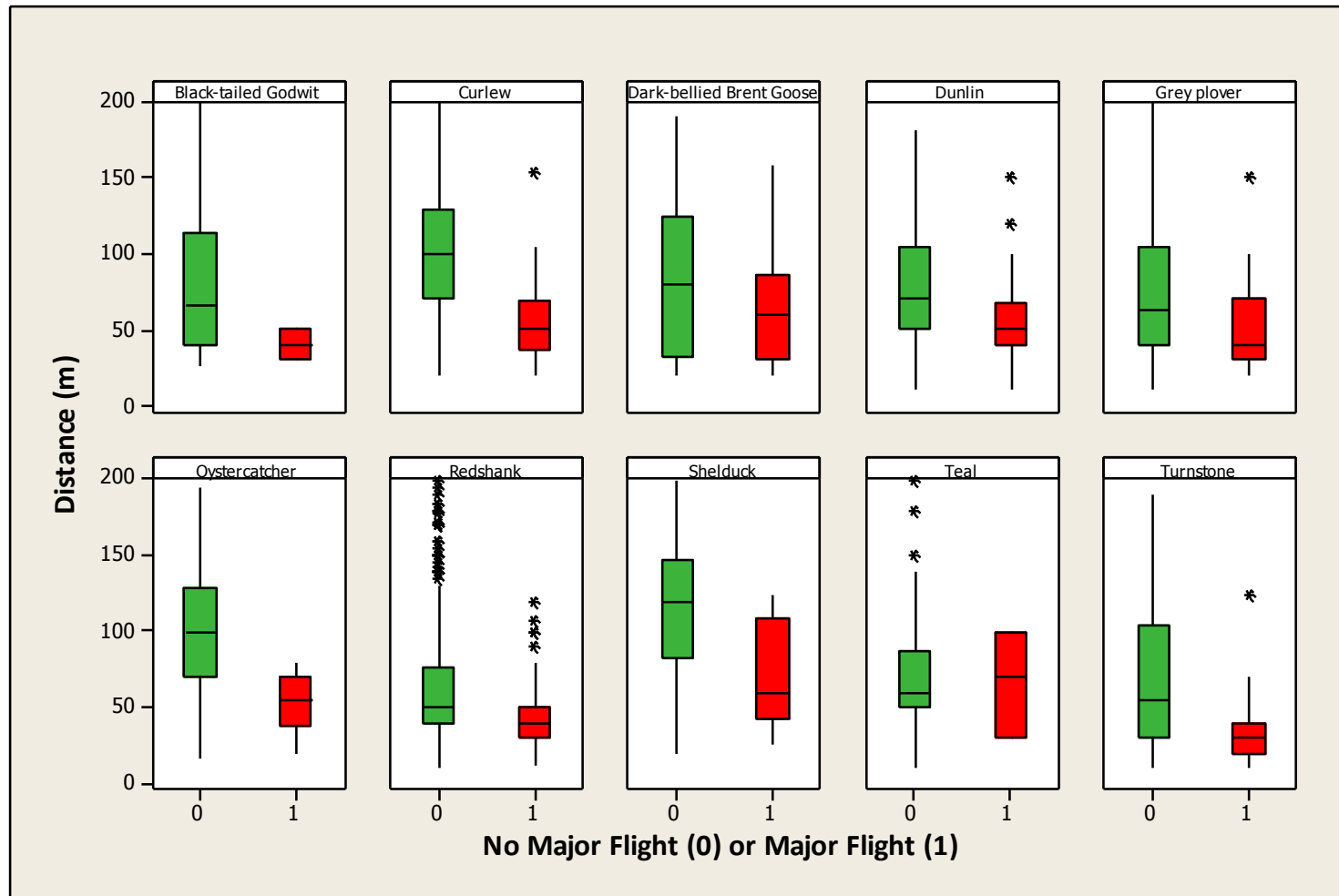


Figure 10: Distances at which birds responded for ten selected species (the ten with the highest number of observations – total n. At least 100 in all cases). These plots show the median (i.e. the midpoint value of the data – represented by the horizontal line), the interquartile range (i.e. 25%-75% of the data) – represented by the box, while the vertical lines show the upper and lower limits of the data, with the outlying values represented by asterisks.

Identifying which factors determine the response of birds

- 3.30 Univariate logistic regression results are summarised in Table 9. Unsurprisingly distance was highly significant, indicating that birds are more likely to take flight when the source of disturbance is closer. The effect of distance (across all ten species included in the analysis) was such that at 25m the probability of major flight taking place was 0.25, dropping to a probability of 0.15 at 50m. The number of birds present was also significant, with (on average) the probability of major flight occurring being less for larger groups of birds. The probability of major flight taking place dropped from 0.11 for a lone bird to 0.87 when 100 individuals were present. Dogs off leads were also significant – on average the probability that a major flight would take place with no dogs present was 0.10, rising to 0.13 if one dog was present off the lead and 0.17 if two dogs were present off leads. The number of people in a group was not significant, suggesting that a group of one, two or three people was equally likely to result in major flight.
- 3.31 With the categorical variables in Table 9, one category (the first when listed in alphabetical order) is used as a reference to which the others are compared. The presence of a dog was significant, with major flight events more likely to take place when a dog was present (this was taking all dogs, not just those on leads). The ‘zone’ in which the activity was taking place was also significant – the probability of major flight occurring was significantly higher if people were on the intertidal compared to people on the shore or on the water. The state of the tide was also significant, with major flight events more likely to take place at high tide. The effect of activity was not significant. We simplified activities into seven broad category types. Compared to air-borne events, most activities (and in particular dogs off leads) were more likely to cause a major flight, but not significantly so, with the exception of vehicles, where the probability of major flight was less compared to air-borne events. Location was also tested, but the models failed to converge. This was potentially because the data at some sites involved limited sample sizes.

Table 9: Univariate logistic regression results. Table gives the coefficients, standard error (“SE”), z score, significance (“p”) and the odd ratio (“OR”). Ten species included (see table).

Variable	Regression Coefficient	SE	Z	p	OR
CONTINUOUS VARIABLES					
Distance of birds from disturbance					
Intercept	-0.667	0.126	-5.29	<0.001	
Distance	-0.021	0.002	-10.5	<0.001	0.98
Number of birds					
Intercept	-2.045	0.063	-32.43	<0.001	
Count	-0.003	0.001	3.46	0.001	1.00
Dogs off lead					
Intercept	-2.131	0.073	-29.24	<0.001	
No. Of dogs off lead	0.271	0.065	4.15	0	1.31
Group Size (No. People)					
Intercept	-1.888	0.126	-14.92	<0.001	
Group Size	-0.0363	0.0744	-0.49	0.625	0.96
CATEGORICAL VARIABLES					
<i>Presence of a Dog: 2 categories (reference category=no dog)</i>					
Intercept	-2.227	0.091	-24.4	<0.001	

Variable	Regression Coefficient	SE	Z	p	OR
yes	0.473	0.119	3.97	<0.001	1.61
<i>Zone: 3 categories (reference category = intertidal)</i>					
Intercept	-0.665	0.144	-4.62	<0.001	
Shore	-1.485	0.158	-9.38	<0.001	0.23
Water	-2.042	0.744	-2.74	0.006	0.13
<i>Activity Type: 7 categories (reference category=air-borne)</i>					
Intercept	-2.484	1.041	-2.39	0.017	
Dog walker, dog on lead	0.175	1.0588	0.17	0.868	1.19
Dog walker, dogs off lead	0.836	1.044	0.80	0.423	2.31
Foot	0.349	1.049	0.33	0.739	1.42
Other	1.05	1.099	0.96	0.339	2.86
People	0.324	1.052	0.31	0.758	1.38
Vehicle/Vessel	-0.029	1.066	-0.03	0.978	0.97
<i>Species: 10 categories (reference category = Black-tailed Godwit)</i>					
Intercept	-2.865	0.347	-8.36	<0.001	
Curlew	1.207	0.409	2.95	0.003	3.34
Dark-bellied Brent Goose	0.866	0.452	1.91	0.056	2.38
Dunlin	1.337	0.367	3.64	<0.001	3.81
Grey plover	0.521	0.412	1.26	0.206	1.68
Oystercatcher	0.617	0.419	1.47	0.141	1.85
Redshank	0.971	0.356	2.72	0.006	2.64
Shelduck	0.38	0.441	0.86	0.389	1.46
Teal	-0.878	0.611	-1.44	0.151	0.42
Turnstone	1.504	0.386	3.9	<0.001	4.5
<i>State of Tide: 4 categories (reference category= falling)</i>					
Intercept	-2.042	0.108	-18.83	<0.001	
High	0.547	0.178	3.07	0.002	1.73
Low	-0.12	0.167	-0.72	0.471	0.89
Rising	0.061	0.149	0.41	0.684	1.06

3.32 We then tested variables including distance in all models, as the distance between the activity and the birds is likely to be fundamental in affecting how birds respond. At this stage we did not test whether there were interactions with distance and other variables just simply, whether the addition of an extra variable resulted in an improved model or changed the significance of any of the variables when considered on their own. Results are summarised in Table 10.

3.33 It can be seen that:

3.34 The effect of zone is reduced with distance, and there is no significant difference between activities taking place on the water and on the intertidal, once distance is included.

3.35 The number of dogs or presence of dogs clearly influences whether major flight takes place, regardless of distance.

3.36 Group size (number of people in group) is clearly not significant.

3.37 Including species with distance highlights differences between species

3.38 The effect of tide remains, with major flight still more likely to take place at high tide, when controlling for distance.

Table 10: Logistic regression results for model runs involving distance and a single additional variable.

Variable	Regression coefficient	SE	Z	p	OR
Distance alone: 327 major flight events; Log-likelihood=-926.367; G=137.218, 1 df, p<0.001					
Intercept	-0.667	0.126	-5.29	<0.001	
Distance	-0.021	0.002	-10.5	<0.001	0.98
Distance and Number of Birds 323 major flight events; Log-likelihood=-918.566; G=152.822, 2 df, p<0.001;					
Intercept	-0.705	0.128	-5.50	<0.001	
Distance	-0.022	0.002	-10.22	<0.001	0.98
Count	0.003	0.001	4.16	<0.001	1.00
Distance and Dogs off leads 323 major flight events; Log-likelihood=-908.410; G=152.380, 2 df, p<0.001					
Intercept	-0.840	0.134	-6.26	<0.001	
Distance	-0.021	0.002	-9.99	<0.001	0.98
No. Dogs off leads	0.279	0.068	4.07	<0.001	1.32
Distance and Group size (number of people) 313 major flight events; Log-likelihood=-875.825; G=133.342, 2 df, p<0.001					
Intercept	-0.602	0.170	-3.55	<0.001	
Distance	-0.022	0.002	-9.99	<0.001	0.98
Group size	0.005	0.075	0.06	0.948	1.00
Distance and dog present 327 major flight events; Log-likelihood=-918.278; G=153.397, 2 df, p<0.001					
Intercept	-0.939	0.146	-6.44	<0.001	
Distance	-0.021	0.002	-9.99	<0.001	0.98
Dogs present: Yes	0.491	0.124	3.98	<0.001	1.64
Distance and Zone 327 major flight events; Log-likelihood=-898.889; G=192.176, 3 df, p<0.001					
Intercept	0.388	0.183	2.13	0.034	
Distance	-0.019	0.002	-9.39	<0.001	0.98
Zone: shore	-1.310	0.168	-7.81	<0.001	0.27
Zone: water	-1.111	0.767	-1.45	0.148	0.33
Distance and Species 327 major flight events; Log-likelihood=-891.847; G=152.02, 2 df, p<0.001					
Intercept	-1.435	0.366	-3.92	<0.001	
Distance	-0.023	0.002	-10.18	<0.001	0.98
Species: Curlew	1.686	0.421	4.00	<0.001	5.40
Species: D-b Brent Goose	0.935	0.464	2.02	0.044	2.55
Species: Dunlin	1.362	0.373	3.65	<0.001	3.91
Species: Grey Plover	0.485	0.418	1.16	0.246	1.62
Species: Oystercatcher	1.069	0.432	2.47	0.013	2.91
Species: Redshank	0.714	0.361	1.98	0.048	2.04
Species: Shelduck	0.997	0.461	2.17	0.030	2.71
Species: Teal	-1.309	0.679	-1.93	0.054	0.27
Species: Turnstone	1.226	0.393	3.12	0.002	3.41
Distance and Tide					

Variable	Regression coefficient	SE	Z	p	OR
327 major flight events; Log-likelihood=-919.951; G=150.05, 4 df, p<0.001					
Intercept	-0.710	0.155	-4.57	<0.001	
Distance	-0.021	0.002	-10.11	<0.001	0.98
Tide: high	0.526	0.186	2.83	0.005	1.69
Tide: low	-0.175	0.171	-1.02	0.307	0.84
Tide: rising	0.023	0.154	0.15	0.881	1.02

3.39 Variables were combined further in order to assess potential interactions between variables and combinations. We built preliminary multivariate models containing all variables and biologically significant interactions, and reduced the number of variables and combinations manually. The best model is summarised in

3.40 Table 11. This has a reasonable fit (Hosmer-Lemeshow statistic=13.133, $p=0.107$) and is reasonably accurate (concordant pairs = 73.5%). The results indicate that distance from the bird(s) to the source of disturbance, tide and the zone where the access takes place are significant together in explaining the probability of a major flight event taking place. The inclusion of dogs present/or not or species added little to the ability of the model to predict the occurrence of a major flight event. Of particular note:

- At a given distance, major flight events are more likely to take place when the count coincided with high tide.
- There was a significant interaction between tide and distance, implying that birds respond differently (in terms of distance flushed) at different states of the tide. At high tide birds are more likely to take flight at closer distances (Figure 11).
- The zone in which the activity or event was taking place was also significant and effectively added to the ability of the model to explain the variation in response. Compared to activities on the intertidal, no response spanned a much greater range of distances for events on the shore and on the water (Figure 12).

Table 11: Reduced logistic regression model estimating probability of major flight

Variable	Regression coefficient	SE	Z	p	OR
Distance, Tide, Distance*Tide, Zone: 327 major flight events; Log-likelihood=-873.788; G=242.38, 9 df, p<0.001; AIC=-299.22.					
Intercept	0.472	0.263	1.79	<0.001	
Distance	-0.022	0.004	-5.38	<0.001	0.98
Tide (reference=falling)					
high	1.863	0.414	4.50	<0.001	6.44
low	-0.416	0.379	-1.10	0.273	0.66
rising	-0.672	0.315	-2.13	0.033	0.51
Tide*distance (reference=falling)					
high	-0.262	0.008	-3.17	0.002	0.97
low	0.005	0.006	0.75	0.451	1.00
rising	0.012	0.005	2.50	0.013	1.01
Zone (reference=intertidal)					
shore	-1.343	0.172	-7.87	<0.001	0.26
water	-1.22	0.762	-1.61	0.107	0.29

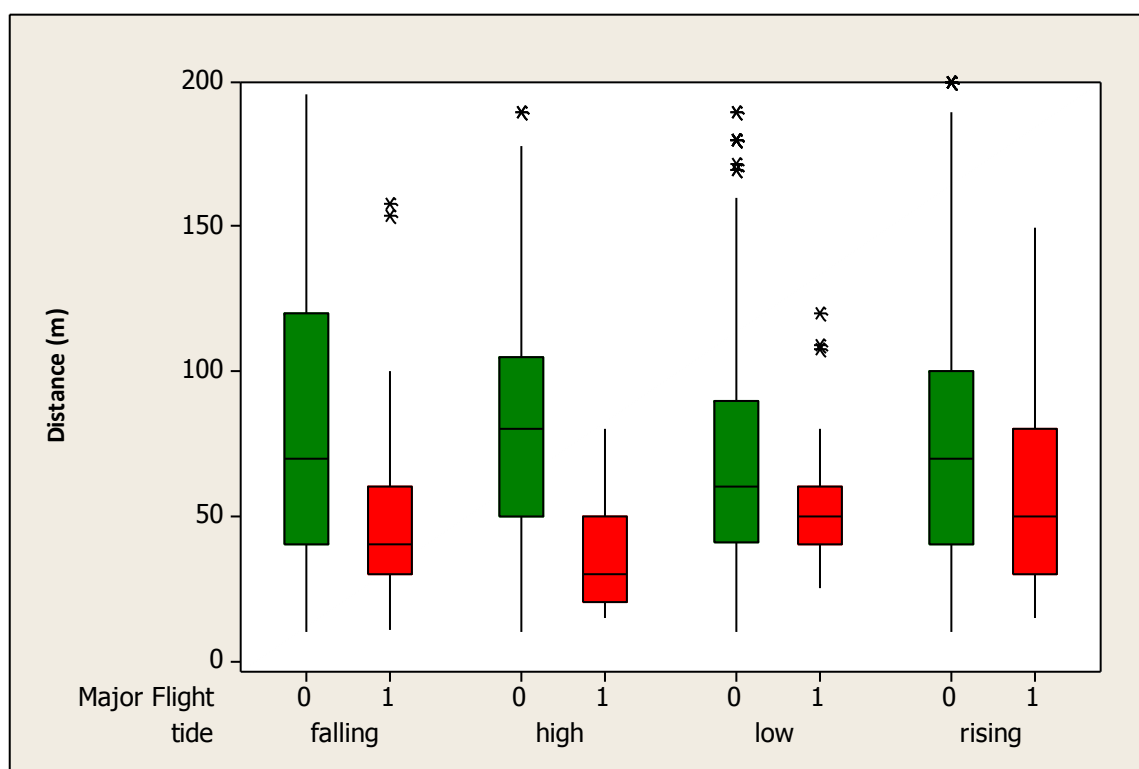


Figure 11: Response distance for major flight events according to tide state. Plot derived from all ten species, but only for those events where the zone was categorised as shore. These plots show the median (i.e. the midpoint value of the data – represented by the horizontal line), the interquartile range (i.e. 25%-75% of the data) – represented by the box, while the vertical lines show the upper and lower limits of the data, with the outlying values represented by asterisks.

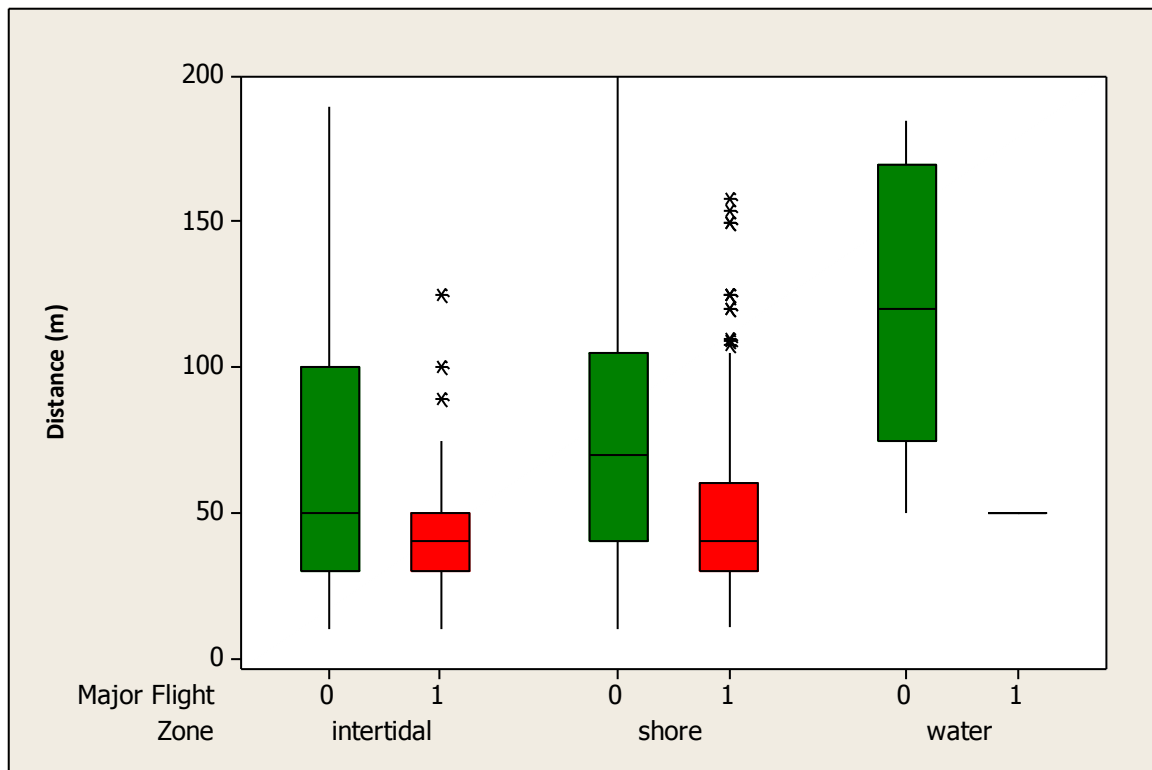


Figure 12: Response distances for major flights according to the zone in which the activity took place. Plot derived for ten species and all events. NB/ The sample size for major flights from water-based activities is just 2. These plots show the median (i.e. the midpoint value of the data – represented by the horizontal line), the interquartile range (i.e. 25%-75% of the data) – represented by the box, while the vertical lines show the upper and lower limits of the data, with the outlying values represented by asterisks.

4. Discussion

Summary of key findings

- Survey work took place at a number of different sites and focussed on a specific area of intertidal habitat at each location. A wide range of species were recorded and there were some high bird counts at particular locations.
- Dog walking (46% of groups) and walking without dogs (24% of groups) were the most common activities recorded. A wide range of other activities also took place. Location 11 (Riverside Country Park) was by far the busiest location.
- Around one quarter (26%) of species-specific observations resulted in birds being 'disturbed' – i.e. becoming alert, walking/swimming away, undertaking a short flight (<50m) or a major flight (>50m). Major flight occurred in 14% of the species specific observations. Around one fifth (18%) of disturbance events caused a major flight.
- Dog walking with dogs of leads was the activity responsible for the majority of observed species-specific major flight events. A total of 189 major flight observations were attributed to this activity – this is nearly half (46%) of all the major flight events. Grouping dog walkers with dogs off-leads with dog walkers with dogs on leads, 55% of species specific observations of major flight were attributed to dog walkers.
- The two locations with the highest proportion of major flight observations were locations 16 (Stoke Ouze A228 layby) and 7 (Harty), where 57 and 41% of observations resulted in major flight. Both these locations were comparatively 'quiet', in that levels of recreational use here were actually low.
- There was some evidence that there was a lower proportion of major flights observed at the busier sites, in other words at locations with lots of people visiting, there were fewer major flights per person counted.
- Birds typically tended to respond (whether becoming alert, walking, short flight or a major flight) to potential disturbance events at around 50m.
- The following factors were significant in predicting whether major flight would take place or not: distance (the shorter the distance, the more likely major flight); species; flock size (larger flocks less likely to take flight); number of dogs off leads (more dogs and major flight more likely); dog present or not (major flight more likely if dogs present); 'zone' in which activity occurred (major flight more likely with activities on the intertidal or on the water) and state of tide (major flight more likely at high tide).
- After controlling for distance, the presence of dogs, the number of dogs, species and tide are significant predictors of major flight occurring.
- Multivariate analysis highlighted interactions between distance and tide, suggesting that birds respond differently in terms of distance at which they respond according to the state of the tide.

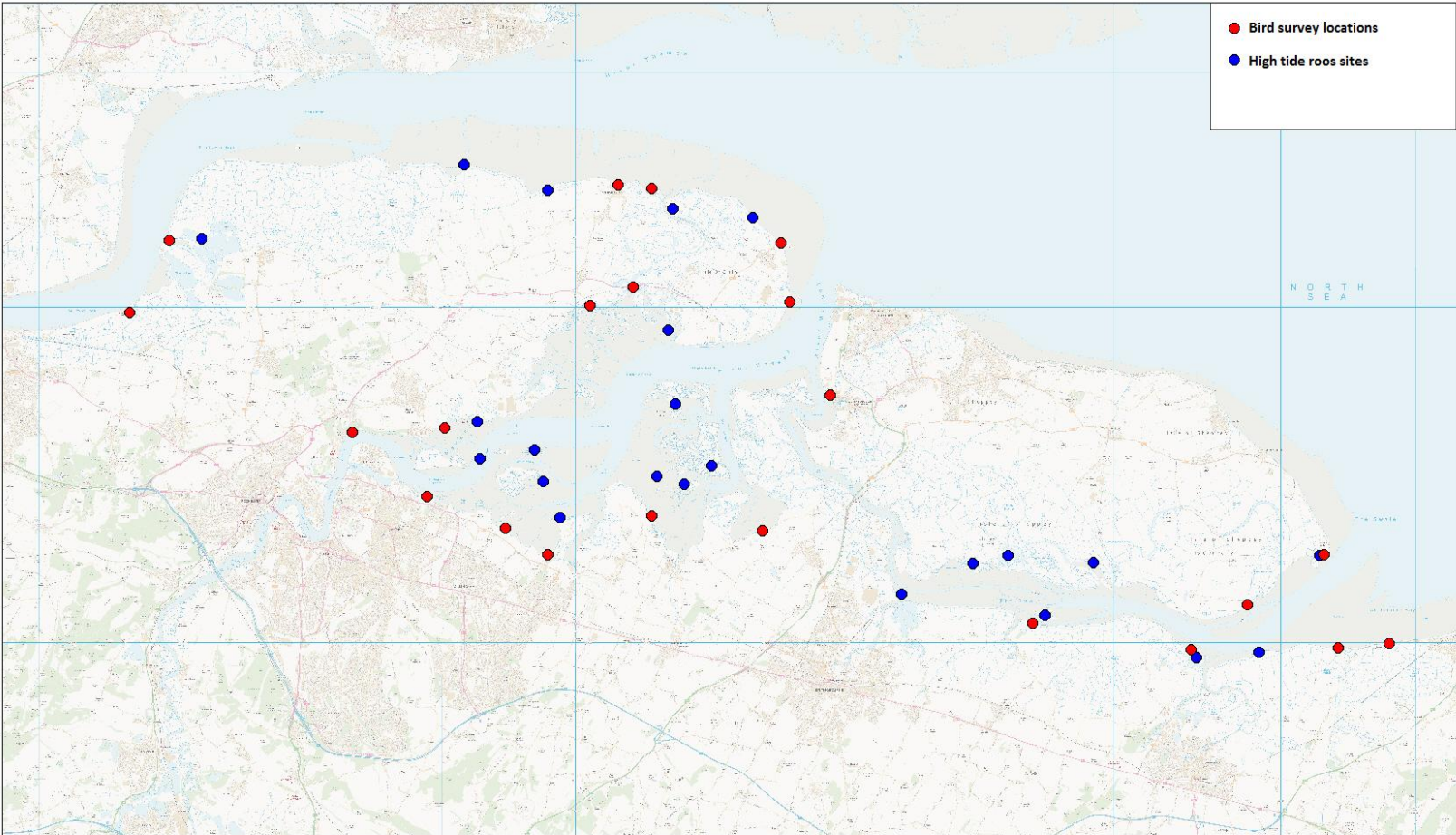
Context

- 4.1 In terms of conservation, it is the impact of disturbance on bird population size that is of most interest: we wish to understand whether the impact of disturbance affects the ability of the sites to support the number of birds for which they are designated. It is important to recognise that there are further steps to be made before we can reach this understanding. In this study we have explored how birds respond to disturbance and the extent to which the use of a sample of intertidal areas is related to disturbance. We have not considered disturbance in relation to the distribution of prey or the consequences of disturbance in terms of population size.
- 4.2 The distribution of birds within the designated sites is likely to be governed by a range of factors, in particular the abundance and distribution of their food. Many studies illustrate that the distribution of birds is related to the distribution of prey (Sutherland 1983; Kennedy & Gray 1993; Farnsworth & Beecham 1997). In addition other factors such as the availability/accessibility of the prey (Stillman *et al.* 2000a; Goss-Custard *et al.* 2002; Stillman *et al.* 2005; West *et al.* 2007), weather (Dugan 1982) or proximity to roost sites (Rehfishch, Insley, & Swann 2003) can be important. In order to understand the impact of disturbance on the distribution of birds it is therefore necessary to consider the disturbance in relation to the distribution of resources that are important to the birds (see for example Gill 1996; Gill, Sutherland, & Watkinson 1996).
- 4.3 The behavioural response of birds is not necessarily a good indication of the impact of disturbance (Gill, Norris, & Sutherland 2001; Beale & Monaghan 2004). Birds are perhaps more likely to take flight when they have alternative sites at which to feed/roost; when there is little to lose from taking flight (e.g. if full and therefore not needing to feed intensively) and therefore demonstrating that birds are flushed is not necessarily indicative that there are impacts from disturbance. The interpretation of the results relating to the birds taking flight is therefore not straightforward. For example, the probability of major flight was higher at high tide. This could be because the birds have fed through the low tide period, are full, and can easily switch between roost sites. By contrast, when the tide is not high and the birds need to feed and they may be more reluctant to fly. An alternative explanation could be that major flight is simply more likely at high tide because the options for short flight or walking/swimming away are limited due to more habitat being covered by water.
- 4.4 To fully understand the consequences of disturbance at a population scale it is therefore necessary to consider the energetic consequences of disturbance in terms of lost feeding time, reduced intake rate etc. It is necessary to consider the extent to which disturbance is concentrated at a few locations around the shore or evenly distributed. It is necessary to understand how much of a cost it is for birds to switch between different locations when disturbed – i.e. to what extent there are alternative locations for them to go to. This can only be achieved through models which consider the survival of birds over a winter in relation to prey availability, prey distribution and which can incorporate the impacts of disturbance. Such models have been developed for a number of other sites and have been tested in a range of sites and situations (Stillman *et al.* 2000b; West *et al.* 2002; see Stillman *et al.* 2007a; Stillman & Goss-Custard 2010). The data presented in this report provide the information necessary to develop the parameters relating to disturbance within such a model.

- 4.5 However, the results here can be used to start to consider how disturbance may be affecting the birds. There was little evidence to suggest that the distribution of birds was related to levels of access, at least at the surveyed sites. There was no significant correlation with bird numbers (or densities) and the mean level at sites of access or the actual count of people made during a count. However, there were no visits where high numbers of people were counted and high numbers of birds also occurred. This would suggest that birds are perhaps avoiding the busiest sites, but at the other sites other factors may be influencing distribution. Bird distributions are therefore such that people and birds overlap, and birds are being flushed. We concentrate in our analysis on major flight events – these are the most likely to involve a marked energetic cost for the birds. Other studies have shown that repeated flushing can have population consequences – a bigger impact than habitat loss as the birds (West *et al*, 2002). We cannot ascertain from this work whether the level of flushing is such that population size may be affected.
- 4.6 It is of interest to draw comparisons with other surveys. In particular the Solent Disturbance and Mitigation Project used similar survey methods and a similar scale of survey during the winter 2009/10. Of particular note, this survey recorded an hourly visitor rate of nearly 13 groups per hour (Liley *et al*. 2010), a level more than three times that recorded at the north Kent sites. Both projects sampled around 20 survey locations along a length of shoreline of around 250km – it is therefore not necessarily the case that the Solent is three times as busy as North Kent; it could simply be that busier survey locations were selected in the Solent work. However, given the scale of the difference it would appear that North Kent is quieter than the Solent. The Solent study found a negative correlation in the number of birds and the level of access – suggesting that birds were avoiding sites with high levels of disturbance – which is not shown here. Also birds were, in general, less flighty on the Solent. In the Solent work no response was recorded for 82% of observations, compared to 74% found in North Kent. Comparison of Figure 8 in this report with Figure 12 in the report for the Solent work shows that on the Solent, for all bird species there was no response for at least 70% of observations – i.e. the birds responded to disturbance in less than 30% of observations. By contrast in North Kent 6³ of the species in Figure 8 showed responses to at least 30% of observations. It would be interesting and useful to combine data for North Kent and the Solent and compare the two areas, controlling for factors such as the distance.
- 4.7 Our work has surveyed 22 sites along a stretch of shoreline of around 250km in a single winter. It is important to note that the winter was particularly cold and severe winter weather may have influenced both the numbers of people, patterns of access and the response of the birds. It is clearly important to be able to extrapolate the results beyond the individual survey locations and hopefully future monitoring should be able to achieve this.
- 4.8 As part of this project information on the location of major wader roost sites was provided to us. These roost sites are shown in Map 7, which also plots the survey locations. Survey locations were not selected with regard to high tide roosts, but it can be seen that, on the

1.1 ³ Dark-bellied Brent Goose, Wigeon, Bar-tailed Godwit, Knot, Redshank, Ringed Plover.

Swale at least, the survey locations were close to roost sites and it is therefore expected that large numbers of birds will be present in the general area around and either side of high tide.



Map 7: Survey Locations and High Tide Roost Sites
Contains Ordnance Survey data © Crown copyright and database right 2011

Implications

- 4.10 This report does not consider the population consequences of disturbance. Disturbance is clearly influencing the behaviour of birds at the sites surveyed, as birds are being flushed. Further modelling is necessary to consider the energetic consequences and possible effects on survival.
- 4.11 For those involved or responsible for ensuring the continued ecological viability of the interest features of the SPA, in accordance with Article 6(2) of the Habitats Directive (92/43/EEC), there are implications. Article 6(2) applies to SPA and SAC designations and requires: *"Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive."*
- 4.12 There will become a point at which levels of visitor pressure are so great that the ability of the site to support a given density of birds will be compromised. Without the further modelling work we do not know whether that point has yet been reached or how far off it may be.
- 4.13 In order to consider future recreational pressure local planning authorities will need to consider the potential impacts of development in terms of the additional recreational pressure that an increase in population will bring. In accordance with Regulations 61 and 102 of the Conservation and Habitats Regulations 2010, any plan or project likely to have a significant effect upon a European site must be the subject of an assessment to determine the implications of that plan or project for the conservation objectives of the European site in question.
- 4.14 Given that disturbance has been clearly shown to have an adverse impacts on species of wintering waterfowl at other sites (dit Durell *et al.* 2005; Goss-Custard *et al.* 2006), it is necessary to be cautious in the case of the North Kent marshes. There is evidence that some of the bird species have shown marked declines (Liley *et al.* 2011). Mitigation and avoidance measures are therefore necessary to ensure any potential future impacts are avoided.
- 4.15 The results highlight the activities responsible for disturbance and the kind of distances at which disturbance events occur. Dog walking stands out as a particular activity of concern. In order to effectively guide mitigation measures it is important to understand the overall patterns of recreational use across the whole area. For example any attempts to redistribute visitor numbers or draw visitors to a particular location need to be carefully assessed to ensure they will reduce any disturbance impacts.

5. References

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Appendix 1

Species present at different survey locations. "1" indicates that the species was present during the counts (conducted at the start and end of each survey visit).

	Species	Survey location																				No. Locations			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		21	22	
	Great-crested Grebe				1						1	1	1	1	1					1				7	
	Little Grebe				1								1	1	1								1		5
Waders	Avocet			1	1	1			1		1		1				1			1			1	9	
	Bar-tailed Godwit	1	1	1	1	1	1	1	1		1		1						1	1	1			13	
	Black-tailed Godwit		1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	19
	Curlew	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
	Dunlin	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
	Golden Plover	1		1				1			1												1		5
	Greenshank										1	1			1										3
	Grey Plover	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
	Knot	1	1	1	1	1	1		1	1	1	1	1		1		1	1	1	1	1	1			17
	Lapwing	1	1	1	1	1	1	1		1	1	1	1		1		1	1	1	1	1	1	1	1	19
	Oystercatcher	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22
	Purple Sandpiper																			1					1
	Redshank	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	22

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	Species	Survey location																						No. Locations
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Wildfowl	Ringed Plover	1	1		1	1	1	1			1		1	1	1	1		1	1	1		1	16	
	Sanderling						1											1	1				3	
	Snipe										1						1						2	
	Spotted Redshank							1															1	
	Turnstone	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		16	
	Whimbrel															1							1	
	Black Brant											1		1									2	
	Canada Goose				1																		1	
	Dark-bellied Brent Goose	1	1		1	1	1	1	1	1	1	1	1		1	1	1	1	1		1		17	
	Eider	1																					1	
	Gadwall							1										1	1			1	1	5
	Mallard				1	1	1	1	1		1		1	1	1					1	1	1		12
	Mute Swan												1	1	1		1							4
	Pintail				1				1		1	1			1									5
Red-breasted Merganser			1	1			1					1											4	
Shelduck		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	
Shoveler								1		1				1		1							4	
Teal			1	1	1		1	1	1	1	1	1		1	1	1					1	1	15	
Wigeon				1		1	1	1	1	1	1	1		1	1				1			1	12	
Grand Total	13	13	15	22	16	16	18	17	13	22	17	22	12	22	11	17	13	15	16	16	12	11		

