FOOTPRINT ECOLOGY

Solent Bird Disturbance Surveys 2021-22: assessment of disturbance levels at rangered sites

Phil Saunders & Durwyn Liley

FOOTPRINT ECOLOGY, FOREST OFFICE, BERE ROAD,
WAREHAM, DORSET BH20 7PA
WWW.FOOTPRINT-ECOLOGY.CO.UK
01929 552444

FOOTPRINT
ECOLOGY

Footprint Contract Reference: 649
Date: 21st July 2022
Version: Final
Recommended Citation: Saunders, P. & Liley, D. (2022). Solent Bird Disturbance Surveys 2021-22: assessment of disturbance levels at rangered sites. Report by Footprint Ecology.

Summary

This report provides results from bird disturbance fieldwork, undertaken during winter 2021/22, comparing visitor behaviour, bird numbers, and the response of birds when rangers (part of the Bird Aware Solent Ranger Team) were present and absent. Ten locations along the Solent coast were subject to vantage point surveys between November 2021 and March 2022, with each site visited on 14 occasions (comprising 7 paired visits on consecutive days, with and without a ranger present).

During each 1.75-hour survey visit, two counts were made of any birds present within a predefined 500m recording area (at the start and end of the survey session), a diary of all human activity on site was maintained, and a record kept of the response of selected bird species to disturbance events recorded in the diary. Information on the weather and tide state during the survey was also noted.

Levels of access across the survey locations were high (10,713 diary entries, equivalent to an average of 44 events being logged per hour). A wide variety of activities was recorded from the 10 survey locations, with Ryde and Emsworth comprising the busiest sites and Newtown and Hayling Oysterbeds the quietest. Walking and dog walking comprised the two most frequently recorded activities across the sites. There was no impact of ranger presence on visitor numbers or overall visitor behaviour (including dog walkers' behaviour), indicating that the presence of rangers had no discernible impact in terms of deterring people from visiting or restricting access.

Of the 10,713 diary entries logged during fieldwork, 5,306 entries were made when a ranger was present, with just over half (52%) of the latter seen to pass within 100m of the ranger, with the ranger locations at Hurst Spit and Newtown both seeming to work particularly well at intercepting people. 12% of individuals/groups overall were seen to speak with a ranger, and 1% of individuals/groups were seen to clearly change their behaviour following an interaction with a ranger (note this is difficult to measure and doesn't necessarily reflect the influence of rangers as it is not always apparent when people have modified their behaviour as a result of speaking to a ranger, e.g. someone taking a different route or putting their dog on a lead when they saw a ranger ahead of them might not necessarily be logged as a subsequent change in behaviour).

A total of 18 wader species and 16 wildfowl species/subspecies were recorded during the surveys, in addition to 7 species of gulls and terns, and 10 'other' species (e.g. herons, cormorants, etc). The largest counts were made at Hayling Oysterbeds and the lowest counts were from Lepe, with relatively low numbers of birds also recorded at Ryde. Waders dominated the counts at Hayling Oysterbeds, Portchester, and Newtown, whereas Hurst Spit, Portchester, East Head, and Emsworth supported the largest numbers of wildfowl.

There were significantly more waders present at the end of a count when a ranger was present compared to when the rangers were absent (but no significant difference for

wildfowl, gulls/terns or other species), indicating a positive effect of ranger presence in terms of bird numbers. When rangers were present there was also a significant negative correlation between the levels of access (total number of events logged in the diary) and wader numbers, suggesting that higher levels of visitor use result in fewer birds being present, even with a ranger present.

A total of 31,628 species-specific behavioural interactions were observed in waders and wildfowl (i.e. where people and birds were within 200m), with 94% of these comprising no visible change in behaviour or any kind of response from the birds. 6% of observations resulted in a behavioural response from a given species, with 978 observations (3%) involving birds undertaking a major flight. There was no clear relationship between site busyness and the frequency of flight responses, nor in the distance at which a behavioural response was induced. A significantly smaller proportion of birds showed a behavioural response (i.e. were disturbed) when a ranger was present. The presence of rangers resulted in a smaller proportion of events causing major flight and the proportions of events causing birds to take flight were reduced for most types of recreation.

Comparison between data from surveys carried out during the first year of ranger deployment (winter 2016/17) and the current surveys suggest that ranger deployment has had a limited impact upon a range of access metrics, with marked increases in the numbers of people and number of dogs present at sites and an increase in the rate at which birds are flushed. This is to be expected, given the context of Covid and marked increases in countryside access that have occurred in recent years, and highlights the need for, and importance of, protective measures to address the impacts of increased recreation use on the birds.

Contents

Summary ii
Contents iv
Acknowledgements v
1. Introduction 1
Overview 1
2. Methods 3
Survey locations 3
Survey effort 3
Recording elements 7
Bird count 7
Diary 8
Disturbance 8
Additional Information 10
Data presentation and analysis 10
3. Results 11
Levels of human activity 11
Interaction with rangers 14
Number of birds present 18
Number of birds in relation to number of people 22
Behavioural responses of the birds 24
Observations involving disturbance 24
Rates at which birds were flushed 26
Behavioural responses and the number of birds involved 28
Behavioural responses and activity 29
Distances at which birds responded 31
Comparison with 2016/17 survey data 32
4. Discussion 34
Bird numbers 34
Behavioural responses 35
Ranger effectiveness 36
Future recommendations for monitoring 38

References 39
Appendix 1: Bird disturbance survey monitoring effort across sites and years 42
Appendix 2: Summary of sites 43
Appendix 3: Summary of survey visits, dates, etc 64
Appendix 4: Summary of diary data by activity and survey location 69
Appendix 5: Bird count data 72

Acknowledgements

This report was commissioned by Bird Aware Solent, and we are grateful to Anna Parry for overseeing the work and to Natalie Hands for co-ordinating the surveys alongside the Bird Aware Solent ranger roster. The majority of the fieldwork was carried out by Dave Chown, James Lowen, Philip Precey, and Will Soar, with assistance from Phil Saunders and Durwyn Liley (both Footprint Ecology). Data were entered and digitised by Emma Bishop.

All images Footprint Ecology.

1. Introduction

Overview

1.1 This report provides results from bird disturbance fieldwork, undertaken during winter 2021/22, comparing visitor behaviour, bird numbers and the response of birds when rangers (part of the Bird Aware Solent Ranger Team) were present and when they were absent.

1.2 The Solent shoreline between Hurst Castle and Chichester Harbour, including the north shoreline of the Isle of Wight, measures some 250km in length. The wintering bird interest includes three Special Protection Areas (SPAs): the Solent & Southampton Water SPA, Chichester and Langstone Harbours SPA and Portsmouth Harbour SPA.

1.3 Bird Aware Solent provides strategic mitigation for new housing around the Solent and addresses the impacts associated with recreational disturbance and the wintering waterbirds of the European sites. The mitigation involves a pack of measures that includes ranger presence on sites, public engagement, initiatives to encourage responsible dog ownership, access management measures and the provision of alternative greenspaces for recreation.

1.4 Deployment of rangers is a mitigation approach generally recognised to be effective (Ross et al., 2014) and the ranger team is pivotal to the work of Bird Aware Solent. Rangers were first deployed during the 2015/16 winter, with a level of ranger effort of 2.6 (full-time equivalent posts), but this has steadily grown such that during the 2021/22 winter 7.5 (full-time equivalent) rangers were employed. The rangers spend their time on the shorelines where access and bird use coincide and show people the birds while protecting them by asking visitors to modify their behaviour (e.g. putting dogs on leads). While some of the sites where the rangers work are formal nature reserves, many of the locations have no infrastructure or interpretation that might convey they are important to wildlife. Visitors use sites as they are their nearest greenspace and many parts of the shoreline are popular for a range of activities including dog walking, walking, bait digging and watersports (see Fearnley et al., 2010).

1.5 Integral to mitigation strategy is monitoring. Monitoring data provides a check as to how well different approaches are working and allows mitigation

to be honed, for example through targeting resources slightly differently. A monitoring strategy (Liley et al., 2015) recommended a range of data gathering and included a recommendation for targeted work to test the effectiveness of rangers. The aim of the work was to collect data over a number of years to enable checks relating to the level of ranger effort, the locations targeted, and the rangers' approach to be considered. This report summarises the results of the fourth year of that monitoring.

2. Methods

Survey locations

2.1 Ten survey points were selected following discussion with the Partnership team (summarised in Table 1 and Map 1). Six of the survey points comprised locations which were subject to initial surveys, carried out by Footprint Ecology, in winter 2016/17 (Liley & Panter, 2017). The remaining four survey points were first surveyed by Waterman in winter 2018/19 (Waterman Infrastructure and Environment Ltd, 2020), and five of the ten were also surveyed by the Bird Aware Solent ranger team in winter 2020/21 using a pared-down methodology due to the ongoing Covid pandemic (Saunders & Panter, 2021). Appendix 1 provides a breakdown of survey effort at each survey point across the four winter periods identified above.

2.2 The 2021/22 survey points fell into two groups:

- Open mudflats where birds feed, spread out at low tide (four survey points); and,
- Mudflat and adjacent saltmarsh/islands/banks where birds roost (six survey points). Such areas could be used by birds during all tide states, but survey visits were focussed around high tide (and ideally on rising[1] tides, when birds were gathering to feed prior to roosting).

2.3 Roost sites comprise locations where a ranger would be expected to be most effective – as the birds present are concentrated in very specific locations, and it should be easier for rangers to target visitors most likely to cause disturbance. Areas of open mudflat will be perhaps more challenging for rangers to be successful, with the four locations encompassing a range of different types of site with varying levels of access and types of recreational use.

Survey effort

2.4 Each of the survey points was surveyed on 14 occasions, producing a total of 140 survey visits across the ten locations. Monthly (paired) visits were made to all survey points between November 2021 and March 2022, with two

[1] Rising tides are targeted, especially at potentially busy locations, as there is less risk of birds being disturbed and moved on before the survey work takes place.

other paired visits undertaken at each survey point within the periods encompassing November 2021 and January to March 2022 (see Table 1). 5 (71%) of the paired survey visits at each of the survey points were carried out on weekdays, with each survey visit lasting approximately 2 hours.

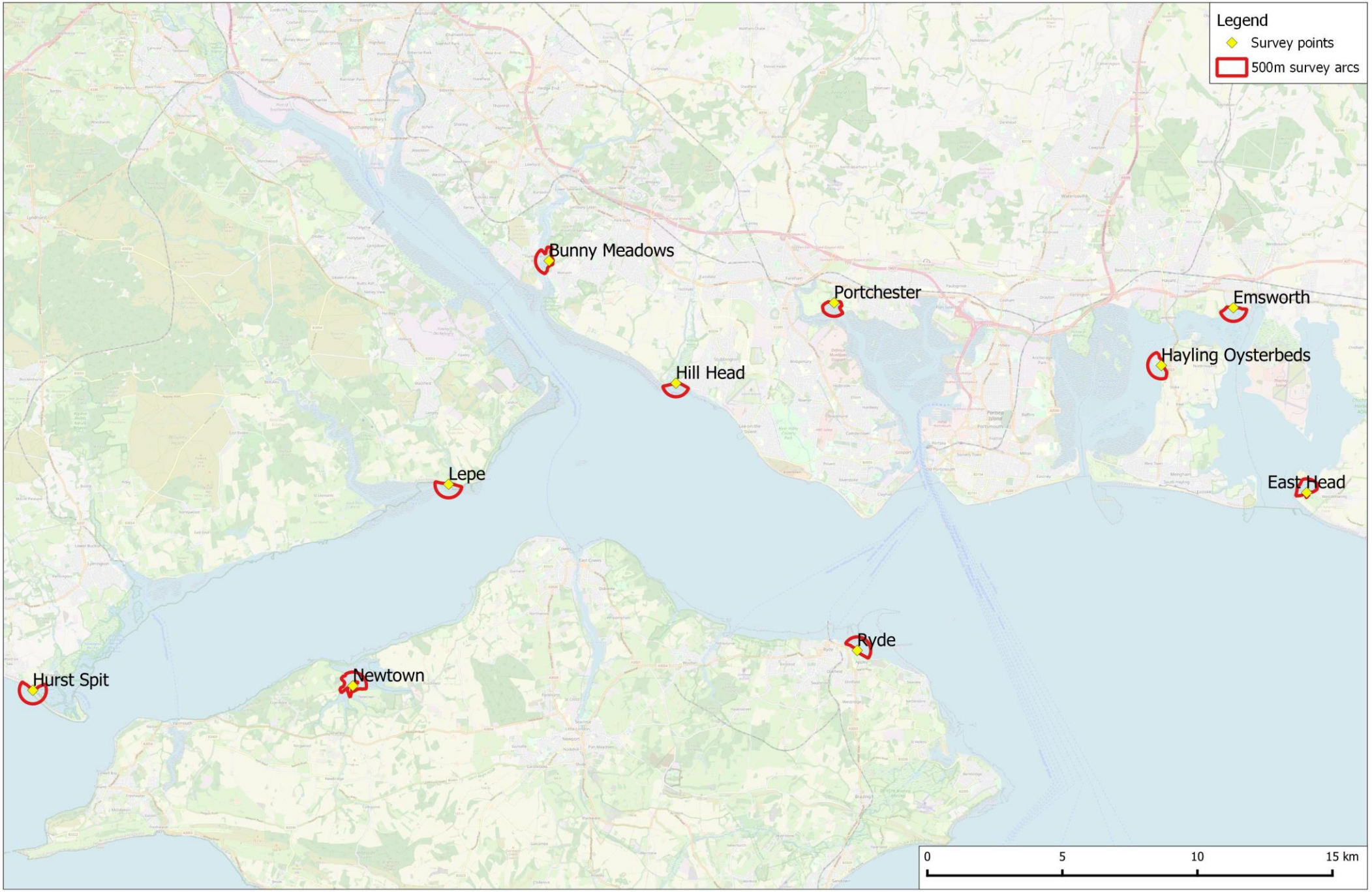
2.5 The tide state during each visit was varied, whilst still focussing efforts upon the key tide periods at each site as detailed in Table 1, and avoiding extreme high tides. In addition to varying tidal states, visits were spread to ensure a range of other conditions and circumstances were covered, including a range of weather conditions (incorporating some dates with strong winds when water sports and sailing were likely to take place). Effort was however made to avoid periods of poor weather.

2.6 Visits were paired, with the intention of one visit in each pair coinciding with a ranger being present and the other visit being at a time when rangers were not present. The paired visits were undertaken on subsequent days, with the timing on the second day matched to ensure the tide state was comparable (i.e. on the second day surveys usually started around an hour later). Paired visits were also consistent in the type of day, such that the paired visit was carried out either over a weekend or over two weekdays. The two visits within each pair were undertaken by the same surveyor, thus ensuring the visits matched as closely as possible. The survey order within each pair (in terms of ranger present versus not present) was however varied.

Table 1: Overview of survey locations

Location	Surveyed in 2016/17?	Habitats present	Number of paired monthly visits (Nov to Mar)	Number of 'additional' paired visits (Nov & Jan to Mar)	Tide states at which to survey
Areas of open mudflat/sandflat where birds feed					
Portchester	✓	Mudflats	5	2	Low/rising/falling
Hurst Spit		Mudflats, sandflats	5	2	
Newtown	✓	Mudflat, lagoon, saltmarsh	5	2	
Ryde	✓	Sandflat	5	2	
Areas of mudflat and saltmarsh where birds feed and gather to roost					
East Head	✓	Saltmarsh, mudflat, sand dune, shingle beach	5	2	High/rising/falling
Emsworth		Saltmarsh, mudflat, shingle banks	5	2	
Bunny Meadows	✓	Saltmarsh, mudflat, shingle beach	5	2	
Lepe		Stony and sandy beach	5	2	
Hill Head		Stony and sandy beach	5	2	
Hayling Oysterbeds	✓	Mudflat, lagoons, saltmarsh	5	2	

Map 1: survey locations overview



Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Recording elements

2.7 Surveyors watched from a fixed point that provided a good vantage point covering the areas used by people and by birds and the area patrolled by the Ranger. When present, Rangers tended to be visible for much or all of the session. However, this was not always the case. The Rangers conducted their normal duties and did not interact with the surveyor, who was often some distance away.

2.8 Each survey visit consisted of the following elements:

- Two counts of birds within a pre-defined 500m wide core count area, with one count made at the start and one at the end of the survey period;
- A diary of all potential disturbance events observed during the 1 hour and 45 minutes following the first count;
- A record of the response of selected bird species to each of the potential disturbance events recorded in the 'diary', including counts of birds present and the number of birds flushed, etc;
- The presence/absence of a mitigation ranger and the duration that they and/or their vehicle was visible to the surveyor;
- The number of interactions observed between the ranger and members of the public, and any resultant changes in public behaviour; and,
- Additional information.

2.9 These different elements are described in more detail below, but in summary the bird counts provided a detailed level of use within the core area, the diary recorded the levels of human activity, the response data indicates how often birds responded and the additional information provides context.

Bird count

2.10 At the start of each survey visit, a count of the birds present was conducted, comprising all waders, terns, wildfowl, grebes, divers, and herons/egrets. The count only recorded the birds present within a pre-defined recording area that extended to a maximum of 500m from the survey point. This area was carefully mapped for each location, using aerial photographs.

2.11 All mapped areas had a clear line of sight, with their entire extent (within 500m) visible to the recorder from the fixed watch point. Each fixed watch point was selected to be at a point where any disturbance caused by the

presence of the surveyor could be minimised/avoided, although the size of the recording area varied at each location due to differences in topography/hydrology, etc.

Diary

2.12 All recreation events (and events which could disturb birds, such as trains, aircraft, contractor work, birds of prey, etc.) which occurred during the following 1 hour and 45 minutes were recorded in a diary format. This diary involved all observed events that could affect birds within the recording area, including those that occurred outside (but still in the vicinity of) the recording area. This was due to the fact that activities above the Mean High Water Mark (MHWM), and events outside the recording area, could still disturb birds. Regardless of whether birds were present or not, all events were recorded in the diary, allowing comparisons of the levels of human activity in different areas.

2.13 Each activity type was categorised using pre-determined activity codes. Each diary entry was assigned a unique identifier, indicating a single unique event, with details recorded including activity (categorised to standard codes), group size, zone (intertidal, on water, or above MHWM), length of time present in area, and notes relating to behaviour.

Disturbance

2.14 Following the previously used survey methodology, events in the diary were categorised as a 'potential disturbance event' if:

- They coincided with birds being present within the count area; and/or,
- They occured within 200m of birds within the recording area; and/or,
- There was a behavioural response recorded for birds within the recording area (i.e. seen to become alert, change position, or were flushed).

2.15 For each potential disturbance event, the response of the birds was recorded, even if no behavioural response was logged – i.e. if the birds were not visibly disturbed.

2.16 The disturbance data recorded the number of birds within 200m of the potential source of disturbance, with each group of birds of a given species being recorded as an observation. There could therefore be multiple

observations for the same potential disturbance event, for example someone walking across the intertidal zone might pass various groups of birds of different species.

2.17 For each observation, bird behaviour was categorised simply as (1) feeding or (2) roosting/preening/loafing. The response of the birds was categorised, using simple categories ('Alert', 'walk/swim', 'short flight (<50m)', 'Major Flight (>50m)', or 'No Response') and the number of birds falling into each response category recorded. Each observation might therefore involve a range of responses, for example some birds in a flock might remain in situ whilst a part of the flock undertakes a major flight. To simplify the data presentation, we also used single response codes, assigning each observation a single code representing the strongest response observed (e.g. if any of the birds in a group undertook a major flight, major flight would be the single response code assigned to the observation).

2.18 For each activity/event where disturbance occurred the maximum distance from the birds to the event was estimated, as the straight-line distance from the source of disturbance to the birds. If there was no response from the birds, then the minimum distance from each species present to the disturbance event was recorded (i.e. how close the disturbance event was to the birds). If the birds were in a tight flock, or only a single individual was involved, then this distance was relatively easy to measure.

2.19 If the birds were scattered over a wide area, and all were disturbed, then the distance will be the approximate range (i.e. 20m to 50m). In all cases distances were estimated to the nearest 5m. In order to ensure consistency in recording distances we:

- Used aerial photographs, with distance bands plotted, at each location. When blown up and printed on good quality paper, with distance bands overlaid, such images show creeks, buoys, marker posts, and landmarks clearly;
- Used laser rangefinders to determine the distance to key landmarks/features and the birds;
- Triangulated or paced out some of the distances at the end of the survey – this can be helpful where distances are hard to estimate during the survey period (for example due to the angles between the observer, source of disturbance, and the birds); and,
- Ensured that observers were well trained, and occasionally did counts together to check that the data were collected in a standard fashion.

Additional Information

2.20 Additional information provided context and background and included tide times, tide coverage, and weather. A free text box allowed any anecdotal information, such as particular events or activities taking place that might make the birds jumpy (e.g. wildfowling or military training), to also be recorded.

Data presentation and analysis

2.21 Our analysis focussed on the paired data, which allowed us to directly compare results with and without a ranger present. Paired comparisons typically took the form of Pearson correlations and Wilcoxon paired rank tests. We also undertook analyses of changes between the data collected in winter 2016/17 (i.e. at the start of the Partnership mitigation measures) and that collected from the same locations in winter 2021/22.

2.22 Multiple behavioural responses were sometimes recorded from single species during individual disturbance events, when the birds present did not all behave in the same way (e.g. some might become alert whilst others walked/swam some distance). In some analyses, tables, and figures we have therefore simplified the data to a single response. This single response was the most extreme (i.e. if some birds responded with a major flight and some with a minor flight, the single coding would be major flight, allowing us to highlight activities which cause particular effects). Where we summarise data in such a way it is made clear in the text/captions.

3. Results

Levels of human activity

3.1 Across all visits and all sites, a total of 10,713 diary events were logged. Data are summarised by site and broad categories in Figure 1 and it can be seen that Ryde and Emsworth were the busiest sites, whilst Newtown and Hayling Oysterbeds were the least busy. Activities that were 'terrestrial' (i.e. dog walking, walking, etc) and took place on the shore or intertidal areas accounted for the majority (95%) of observations. Walking (without a dog) was the most frequently recorded event (5,030 diary events; 47% of total). Ryde, Portchester, Emsworth, and East Head were notable for the large numbers of dog walkers. In Appendix 4 we provide a full breakdown of the counts by site and activity.

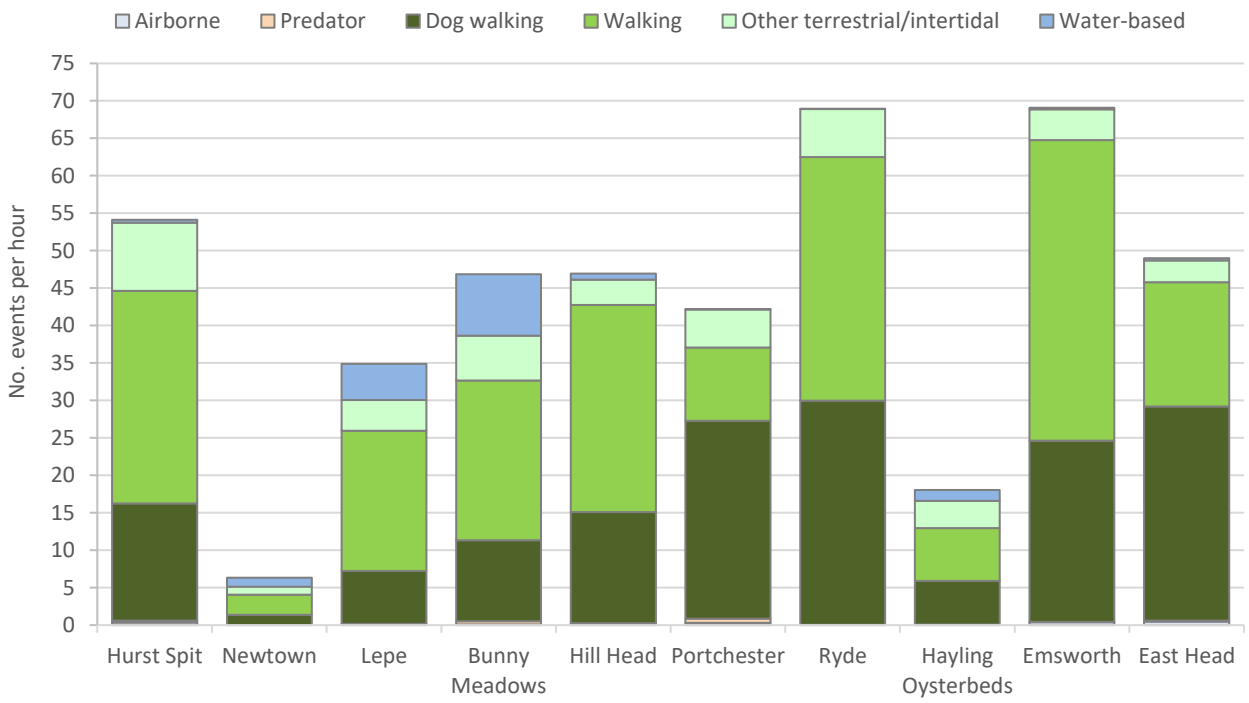


Figure 1: Diary data (all visits) adjusted to give events per hour at each survey location (arranged west to east). Activities are grouped into those that are terrestrial based (green), water-based (blue), airborne – i.e. planes, drones etc. (pale blue), or predators (peach).

3.2 There was no significant difference in the number of diary entries (i.e. events occurring in and around the study area) when rangers were present compared to when they were absent (Wilcoxon T=1122.5, N=70, p=0.760). This would suggest the presence of a ranger did not result in differences in

visitor numbers – i.e. keeping people away. Similarly, there was no significant difference in the number of diary events that occurred within 200m of birds within the focal area (Wilcoxon T=1136, N=70, p=0.988). This would suggest that there was no overall effect of the rangers in terms of diverting people when birds were present[2].

3.3 The number of dogs on leads was also not significantly different between sessions when the ranger was present compared to when the ranger was absent (Wilcoxon T=1037.5, N=70, p=0.671), and there were also no significant differences in the number of dogs off lead (Wilcoxon T=1035, N=70, p=0.976). This would suggest that there was no effect on the presence of a ranger in terms of people putting their dog on a lead or walking their dog elsewhere if they wanted it to be off-lead, and it was not possible for the surveyors to identify what was said to each visitor group. It is also important to note here that the rangers were not specifically asking people to put dogs on leads, having no enforcement powers to require them to do so. The Strategy instead focusses upon empowering people to learn and display behaviours, rather than imposing restrictions or giving out such a message.

3.4 In Figure 2 we summarise the data for dogs off lead and diary events within 200m of the birds present, stratifying the data by site and comparing when rangers are present (blue boxes) to when they are absent (red boxes). There are few individual sites where a particular difference is apparent when the rangers were present, although the number of events within 200m appear to be lower at both Emsworth and East Head (with potentially fewer dogs off lead at the former location also).

[2] Note that 200m is beyond the distance that most birds flush and this also relates to all waterbirds etc within the focal area, i.e. not necessarily large roosts or ones sensitive to disturbance (where no need to divert people).

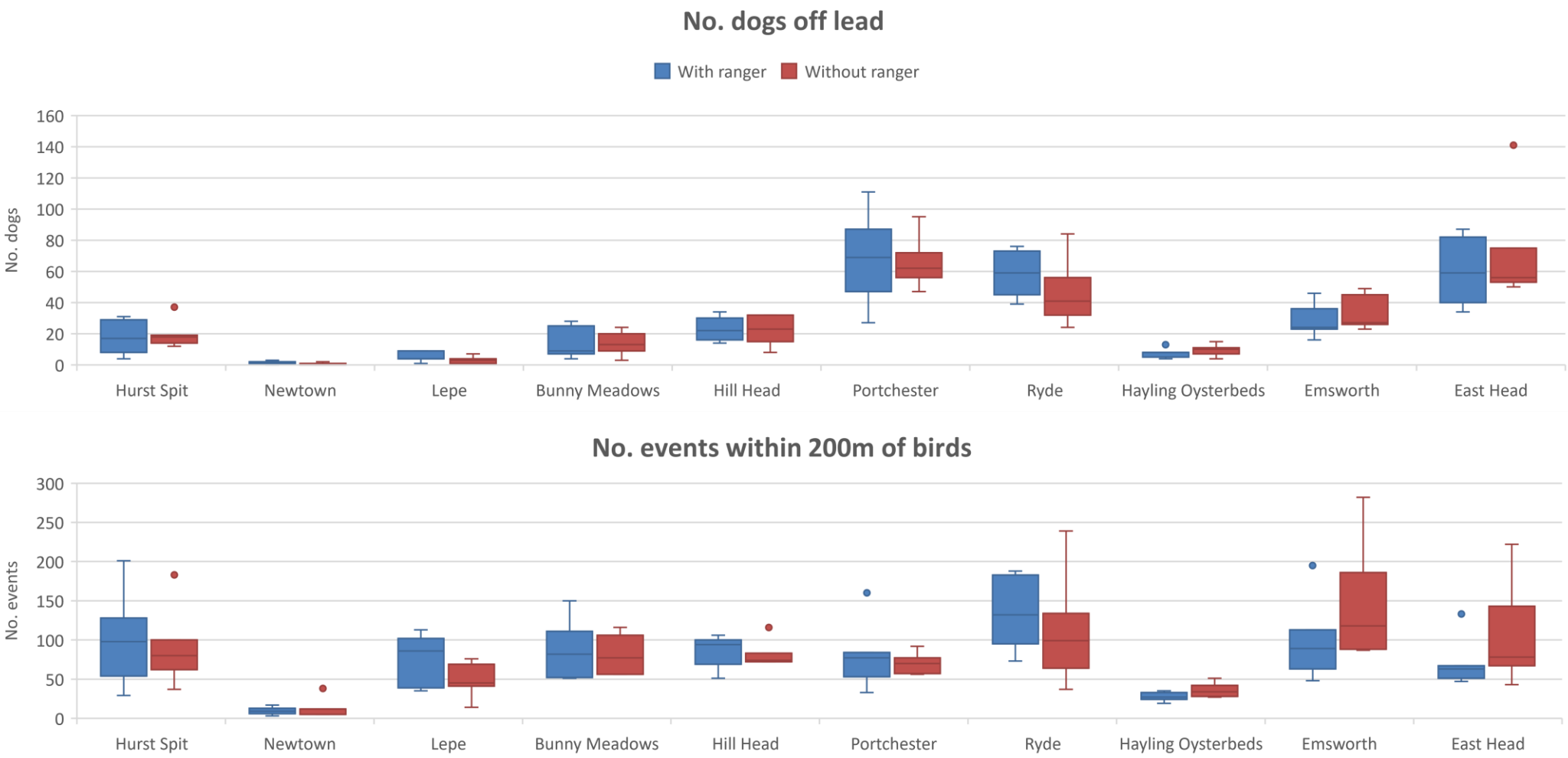


Figure 2: Boxplot showing the number of dogs off lead and diary events within 200m of birds within the recording area, stratified by survey location (arranged west to east), with and without a ranger present. Horizontal lines represent the median (i.e. the mid-point, half the data falls below this line and half above), the boxes show the 25th and 75th percentiles, and the vertical lines show the upper and lower limits of the data with outlying points shown as dots.

Interaction with rangers

3.5 For each diary entry, a note was made as to whether the event occurred within 100m of the ranger, whether the ranger spoke to the person/group (i.e. clearly stopped and had a conversation rather than saying hello in passing) and whether there was a notable change in behaviour (for example, a change of direction or putting a dog on a lead directly after talking to the ranger). It is important to note that these data are estimates only as it was sometimes difficult to record these parameters. For example, after talking to a ranger it might be hoped that people are more aware of issues relating to bird disturbance and as such modify their behaviour in certain situations, for example when approaching a roosting flock of birds. Such behaviour change might not necessarily occur directly after the interaction with the ranger and could even be on a different date. The data are simply observations of visitor behaviour, and the surveyor did not have any knowledge of what was said to each group.

3.6 There was a total of 10,713 diary entries logged during fieldwork, with a total of 5,306 entries made when a ranger was present (see Table 2). Just over half (52%) of the diary events recorded when a ranger was present were seen to pass within 100m of the ranger. The ranger locations at Hurst Spit and Newtown seemed to work particularly well with respect to the proportion of people that passed close by, comprising 66% and 69% of events at the two sites, respectively. The ranger location at Ryde was the least effective in terms of proportion of people interacted with, as only 35% of events occurred within 100m of the ranger, when present. There are therefore clear differences between sites in terms of where a ranger should base themselves, with the geography and access points present at some sites making it 'easier' to catch a greater proportion of visitors than at others.

3.7 12% of individuals/groups overall were seen to speak with a ranger, although this varied considerably between localities, with 56% seen to do so at Newtown compared to only 3% at Ryde. Only 1% of individuals/groups overall exhibited a clear behavioural change, although this again varied between locations, with 5% doing so at Newtown and none at Ryde and Hayling Oysterbeds.

3.8 Amongst those individuals/groups actually seen to pass within 100m of a ranger, more than 80% at Newtown were however engaged in conversation by the ranger present, with 55% of individuals/groups at Hayling Oysterbeds also seen to do so. Approximately a third or less of those passing in

proximity were observed in conversation with the ranger at the remaining survey locations, with the smallest number recorded again doing so at Ryde (8%). Again, site geography and access points will have played an important role in the location of the ranger base at each site however.

3.9 Relatively few visitors, at the majority of survey locations, were seen to clearly change their behaviour directly after interacting with a ranger. The notable exception was Lepe, where 26% of those spoken to were seen to change their behaviour. Also notable were Newtown (8% changed their behaviour) and Hill Head (7% changed their behaviour). The specific changes in behaviour observed comprised dog walkers putting their dogs on lead after conversing with the ranger and/or people moving off the intertidal zone and onto surfaced roads or promenades to avoid any birds present.

Table 2: Number (%) of diary events (on days when rangers were present) which; (a) occurred within 100m of the ranger, were seen to speak to a ranger, and which led to a change in behaviour expressed as a proportion of total diary events ; (b) were seen to speak to a ranger expressed as a proportion of those seen to pass within 100m; and, (c) which led to a behaviour change expressed as a proportion of those seen to speak to a ranger.

Survey location	Total no. diary events	a) As a proportion of total diary events			b) As a proportion of those passing in proximity to a ranger		c) As a proportion of those speaking to a ranger	
		Seen to pass within 100m of ranger	Seen to speak to ranger	Changed behaviour	Seen to speak to ranger	Seen to pass within 100m of ranger	Changed behaviour	Seen to speak to ranger
Hurst Spit	**693 (100)**	456 (66)	84 (12)	4 (1)	84 (18)	456 (100)	4 (5)	84 (100)
Newtown	**64 (100)**	44 (69)	36 (56)	3 (5)	36 (82)	44 (100)	3 (8)	36 (100)
Lepe	**505 (100)**	274 (54)	58 (11)	15 (3)	58 (21)	274 (100)	15 (26)	58 (100)
Bunny Meadows	**589 (100)**	275 (47)	41 (7)	2 (0)	41 (15)	275 (100)	2 (5)	41 (100)
Hill Head	**608 (100)**	310 (51)	84 (14)	6 (1)	84 (27)	310 (100)	6 (7)	84 (100)
Portchester	**544 (100)**	320 (59)	88 (16)	4 (1)	88 (28)	320 (100)	4 (5)	88 (100)
Ryde	**930 (100)**	330 (35)	27 (3)	0 (0)	27 (8)	330 (100)	0 (0)	27 (100)
Hayling Oysterbeds	**194 (100)**	102 (53)	56 (29)	0 (0)	56 (55)	102 (100)	0 (0)	56 (100)
Emsworth	**693 (100)**	396 (57)	75 (11)	2 (0)	75 (19)	396 (100)	2 (3)	75 (100)
East Head	**486 (100)**	260 (53)	85 (17)	4 (1)	85 (33)	260 (100)	4 (5)	85 (100)
TOTAL	**5,306 (100)**	**2,767 (52)**	**634 (12)**	**40 (1)**	**634 (23)**	**2,767 (100)**	**40 (6)**	**634 (100)**

3.10 The number of groups that passed within 100m of a ranger and the total diary entries[3] (with a ranger present) at each survey location were strongly correlated (Pearson correlation, n=10, $p<0.001$), indicating that the ranger came into proximity with more people/groups as the number of people/groups accessing the site increased. This suggests that the rangers are generally locating themselves at locations where the most people pass, regardless of how busy the site is.

3.11 There were however no significant correlations between the total diary entries and the number of groups seen to speak to the ranger nor between those that changed their behaviour (Pearson correlation, n=10, $p>0.05$ in both cases). This would suggest that the rangers do not necessarily talk to more people, or influence behaviour more at busier sites. Similarly, there was no strong correlation between the number of groups that passed within 100m of a ranger and the number of groups that spoke to a ranger (see Figure 3). It is likely that the absence of a correlation is largely driven by the large numbers of people/groups passing in close proximity to the ranger at Bunny Meadows and Ryde who do not engage in conversation with them.

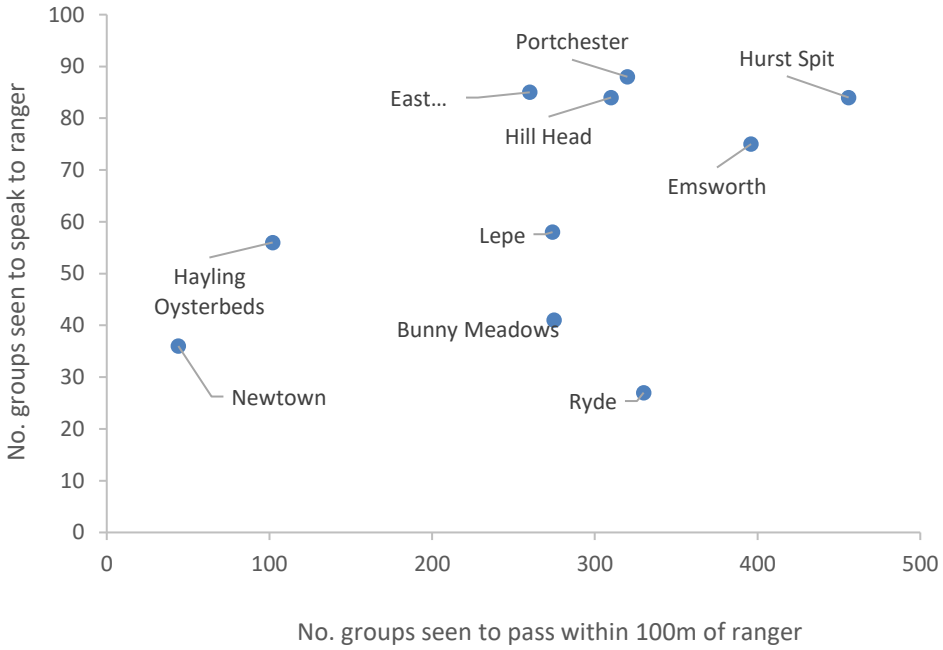


Figure 3: Relationship between the number of groups seen to pass within 100m of a ranger and the number of groups seen to speak to the ranger at each of the survey locations (summed across all survey visits).

[3] Total diary entries describes all the observations of people, events etc. that were logged in the diaries. It is therefore a measure of how busy each location was.

Number of birds present

3.12 A total of 18 wader species and 16 wildfowl species/subspecies were recorded. In addition, there were counts for 7 species of gulls and terns, and 10 'other' species, including grebes, herons, egrets, cormorants, etc.

3.13 Bird count data are summarised by location in Figure 4, and full details by site and species are provided in Appendix 5. By far the largest counts were made at Hayling Oysterbeds, which is an important roost site on the Solent. The lowest counts were from Lepe, with relatively low numbers of birds also recorded at Ryde. It can be seen that waders (red colours) dominated the counts at Hayling Oysterbeds, Portchester, and Newtown, with Dunlin in particular accounting for a large proportion of the birds counted. Hurst Spit, Portchester, East Head, and Emsworth supported the largest numbers of wildfowl (grey colours), with Dark-bellied Brent Goose, Teal, and Wigeon the most frequently recorded species. Gulls and terns (blue colours) made up a sizeable proportion of the birds counted at several locations, with Mediterranean Gulls particularly prevalent at Hayling Oysterbeds. Other species (grebes, herons, egrets, etc) made up a small proportion of species across all localities.

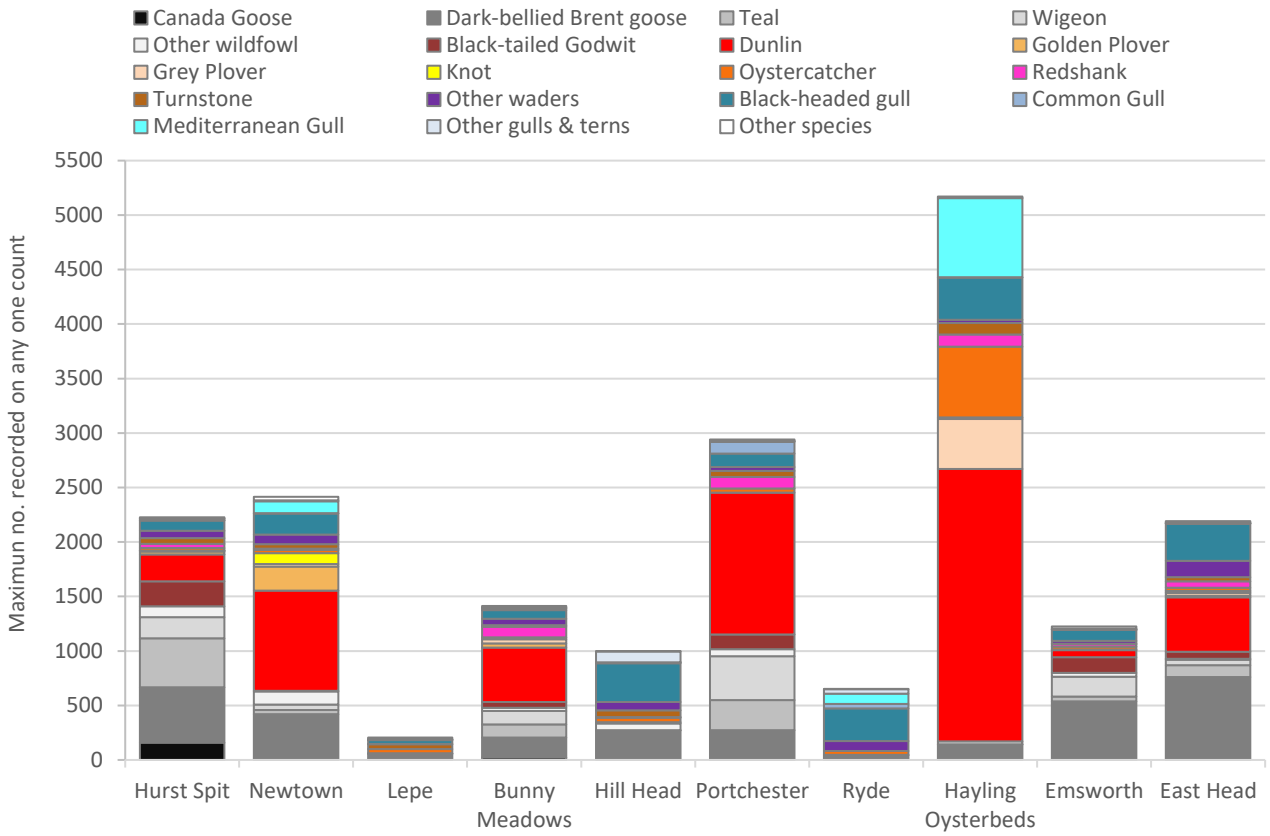


Figure 4: Maximum counts of birds at each survey location (arranged west to east). Data from all counts (with and without ranger present). Data for single species with site maxima of 100+ individuals are presented separately, with the remainder presented as species groups. For individual species the graph shows maxima, for groups of species the maximum value for each species at each site are summed. Wildfowl are identified in grey, waders in red, and gulls in blue. Counts are from the set recording area only.

3.14 Looking across all sites and paired counts there was a significant difference between the number of waders counted at the end of the survey visit when a ranger was present compared to when a ranger was absent (Wilcoxon z=-2.005, N=62, p=0.044). Out of the 70 paired comparisons, there were 39 counts with more waders present when the ranger was present, 23 counts that were higher without the ranger present, and 8 counts that were the same with and without the ranger. Counts ranged from 670 waders less with a ranger present to 1,650 birds more.

3.15 There were no significant differences in the number of other bird groups when a ranger was present compared to when a ranger was absent (wildfowl: Wilcoxon z 1.098, N=59, p=0.271; gulls and terns: Wilcoxon z = -0.0228, N=52, p=0.984; other species: Wilcoxon z = -0.41, N=40, p=0.682).

3.16 The wader counts made at the end of each survey are shown in more detail in Figure 5, which shows the paired data with the diagonal line representing tied data (i.e. the relationship which would be seen if the same number of waders were counted with and without a ranger present). Points above the line therefore indicate those counts where there were more birds present when the ranger was present. Hayling Oysterbeds is the main site with markedly higher values when the rangers were present, with at least one markedly higher count coming from Portchester too.

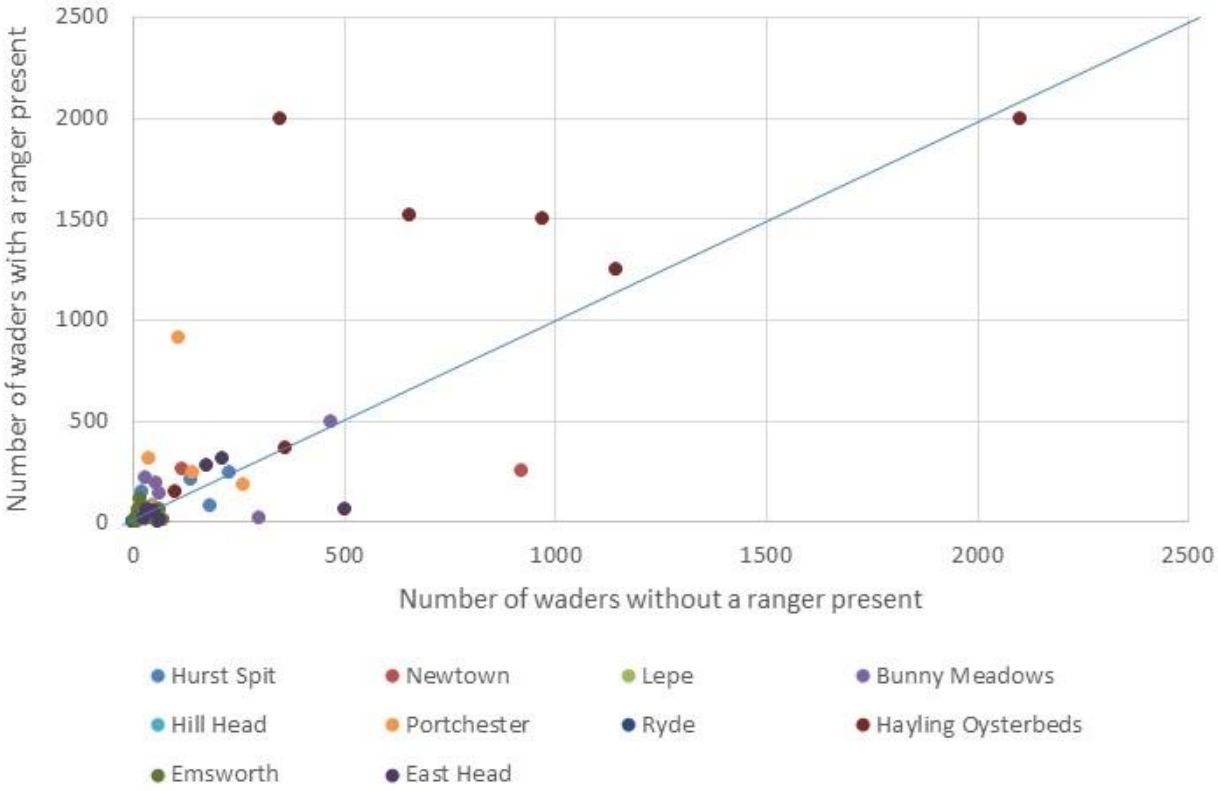


Figure 5: Scatter plot for the wader counts made at the end of each survey, with and without a ranger present. The diagonal line represents the equal values (i.e. identical counts with and without a ranger).

3.17 Data are further summarised by survey location, for waders and wildfowl (the main species relevant to the SPA designations) in Figure 6. The numbers recorded at Hayling Oysterbeds, Portchester, and Emsworth showed considerable variation between visits, indicated by the wide spread of the error bars for those localities.

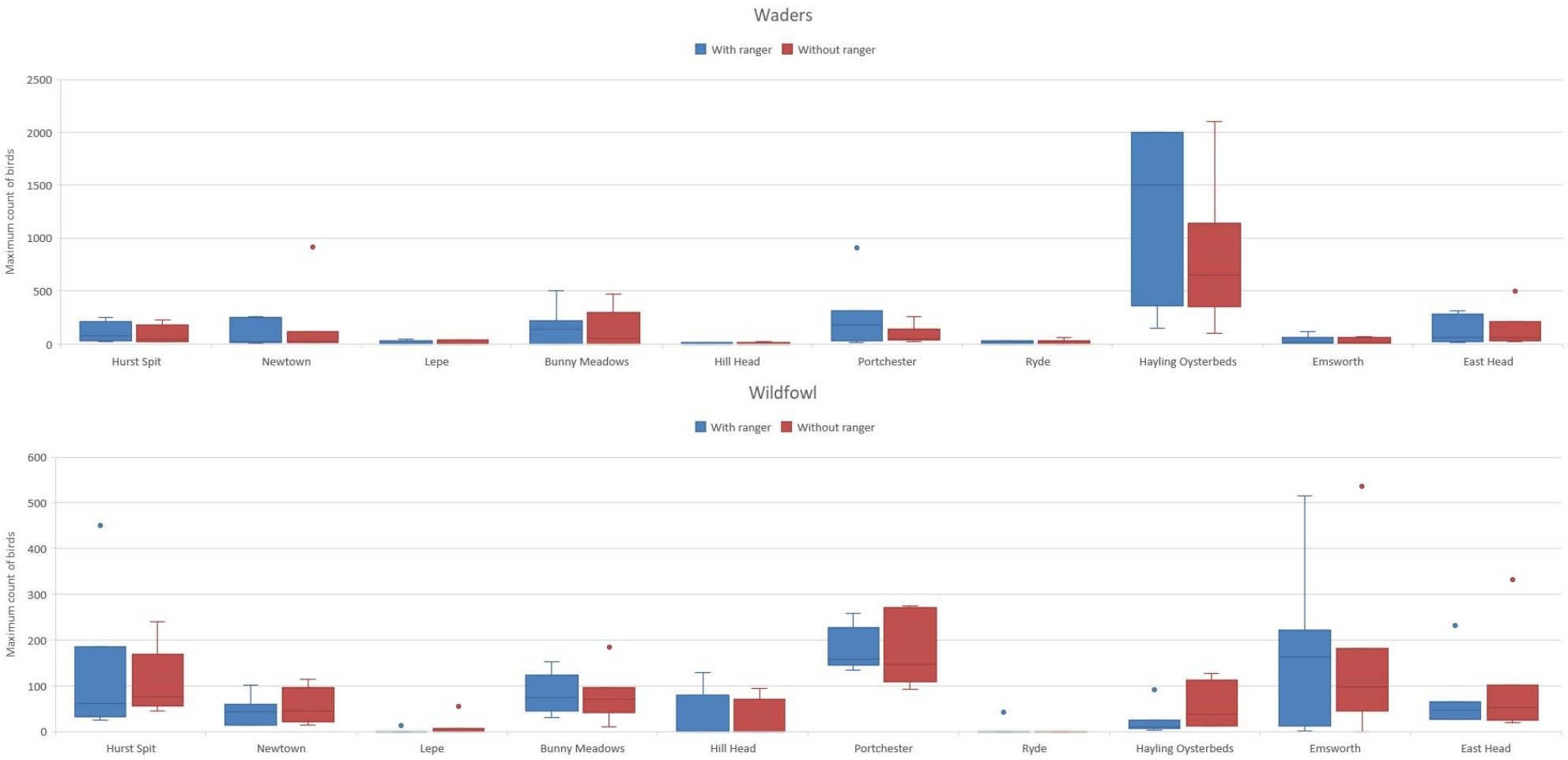


Figure 6: Boxplot showing the numbers of waders and wildfowl counted at the end of each survey visit, stratified by survey location (arranged west to east), with and without a ranger present. Bird numbers are the maxima recorded at the end of the count period. Horizontal lines represent the median (i.e. the mid-point, half the data falls below this line and half above), the boxes show the 25th and 75th percentiles, and the vertical lines show the upper and lower limits of the data with outlying points shown as dots.

Number of birds in relation to number of people

3.18 If disturbance is affecting the distribution of birds, there could be fewer birds present within the recording area when there are more people present (i.e. a negative correlation between the number of birds and the number of people). Were the rangers to make a difference then it would be potentially expected that the correlations would be weaker or less obvious, as the rangers might be reducing the impact of the people on the birds, for example through a change in visitor behaviour.

3.19 Correlation coefficients are shown in Table 3 and an example plot (for waders) is shown in Figure 7. There was a significant negative correlation between the number of waders present at the end of the count period and the total number of diary events on the day, when the ranger was present (highlighted grey in the table). No other significant correlations were found between the remaining variables. As such no clear or consistent pattern is evident.

Table 3: Spearman's Rank correlation coefficients (rho) for selected bird and visitor variables, with and without rangers present.

Ranger	Bird variable	Visitor variable	rho	p
Present	Total wildfowl at end of count	Number of diary events	-0.063	0.604
Present	Total wildfowl at end of count	Total number of dogs	0.137	0.259
Absent	Total wildfowl at end of count	Number of diary events	0.003	0.978
Absent	Total wildfowl at end of count	Total number of dogs	0.156	0.198
Present	Total waders at end of count	Number of diary events	-0.447	<0.001
Present	Total waders at end of count	Total number of dogs	-0.165	0.172
Absent	Total waders at end of count	Number of diary events	-0.194	0.108
Absent	Total waders at end of count	Total number of dogs	-0.021	0.865

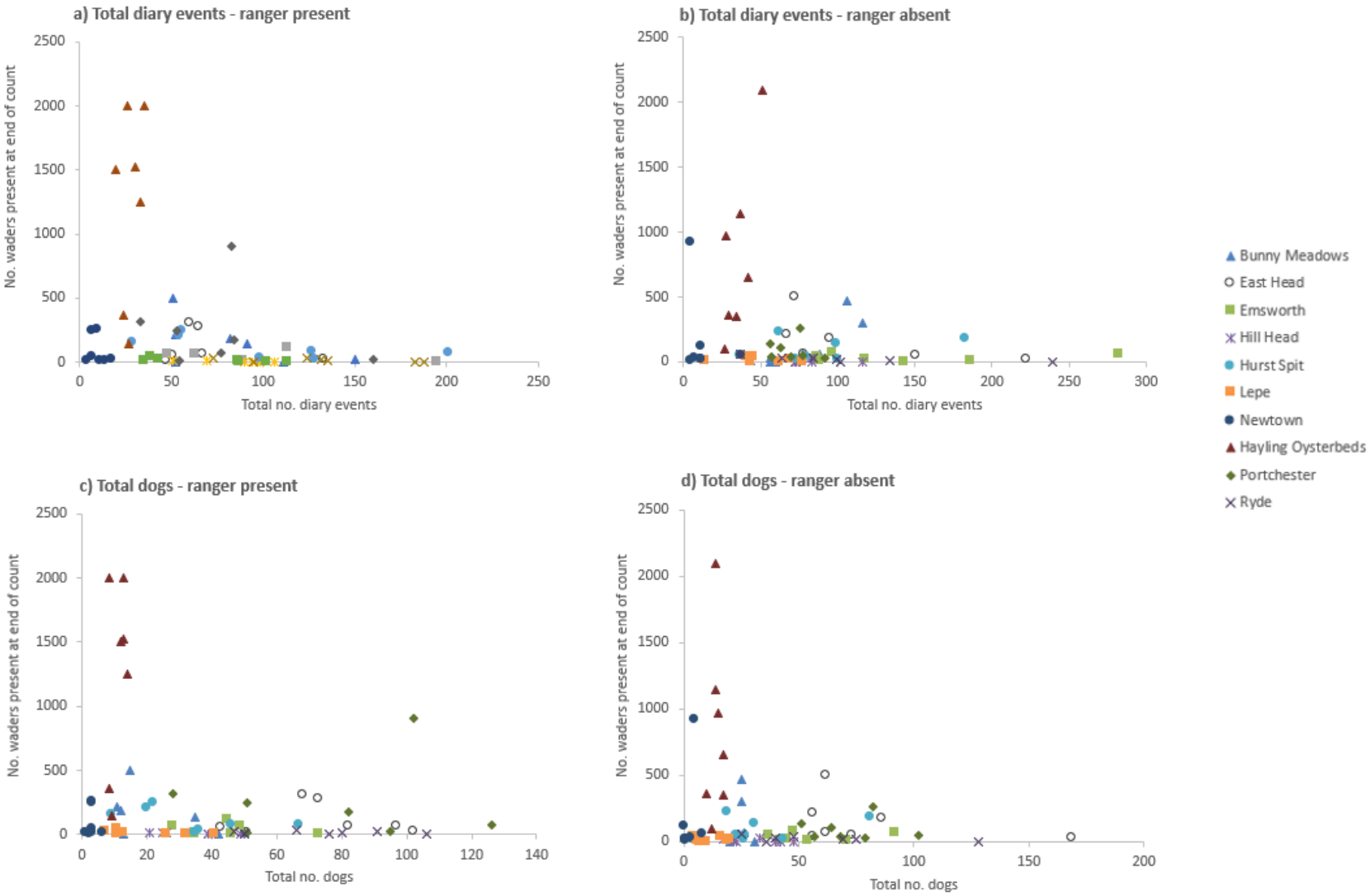


Figure 7: Numbers of waders (at the end of the count) and visitor totals (total diary events (top graphs) and total number of dogs (lower graphs); with and without ranger present

Behavioural responses of the birds

Observations involving disturbance

3.20 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. The diary was maintained even when no birds were present within the recording area (for example due to some prior disturbance or changes in the tide having pushed birds out of the recording area). Some of the diary events could also result in different disturbance events, involving multiple species-specific observations. For example, a 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).

3.21 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.

3.22 Across all sites there were 10,713 diary entries. Of these 6,761 (63%) occurred when birds were present in the focal area and either caused disturbance or were within 200m of the birds. There were therefore 6,761 different potential disturbance events. These potential disturbance events generated a total of 36,037 species-specific observations (all species) and 31,628 observations (wildfowl and waders only). Considering these 31,628 observations, 29,706 (94%) resulted in no visible change in behaviour or any kind of response from the birds, 6% of observations resulted in a behavioural response from a given species, with 978 observations (3%) involving birds undertaking a major flight (i.e. being displaced more than 50m).

3.23 There were significant (but generally small) differences in the proportion of observations resulting in a particular response in comparison with when the ranger was present to when the ranger was absent (see Table 4) (χ^2_4=320.146, p<0.0001). The main difference was in the relative proportion of birds that were categorised as undertaking a major flight, with a far larger proportion recorded doing so when a ranger was absent.

Table 4: Number (%) of species-specific observations (wildfowl and waders only) and disturbance responses with and without a ranger present (calculated using most extreme response per observation).

Response	With ranger present	Without ranger present	Total
No response	15,310 (96)	14,396 (92)	**29,706 (94)**
Alert	157 (1)	181 (1)	**338 (1)**
Walk/swim	196 (1)	226 (1)	**422 (1)**
Short flight	103 (1)	81 (1)	**184 (1)**
Major flight	223 (1)	755 (5)	**978 (3)**
Total	**15,989 (100)**	**15,639 (100)**	**31,628 (100)**

3.24 The responses of birds at each location, comparing when a ranger was present to when the ranger was absent, are presented in Figure 8. The most marked differences in terms of the presence of a ranger reducing the behavioural responses to disturbance appear to be at Hurst Spit, and to a lesser extent at Lepe, Bunny Meadows, Hill Head, Portchester, and Ryde.

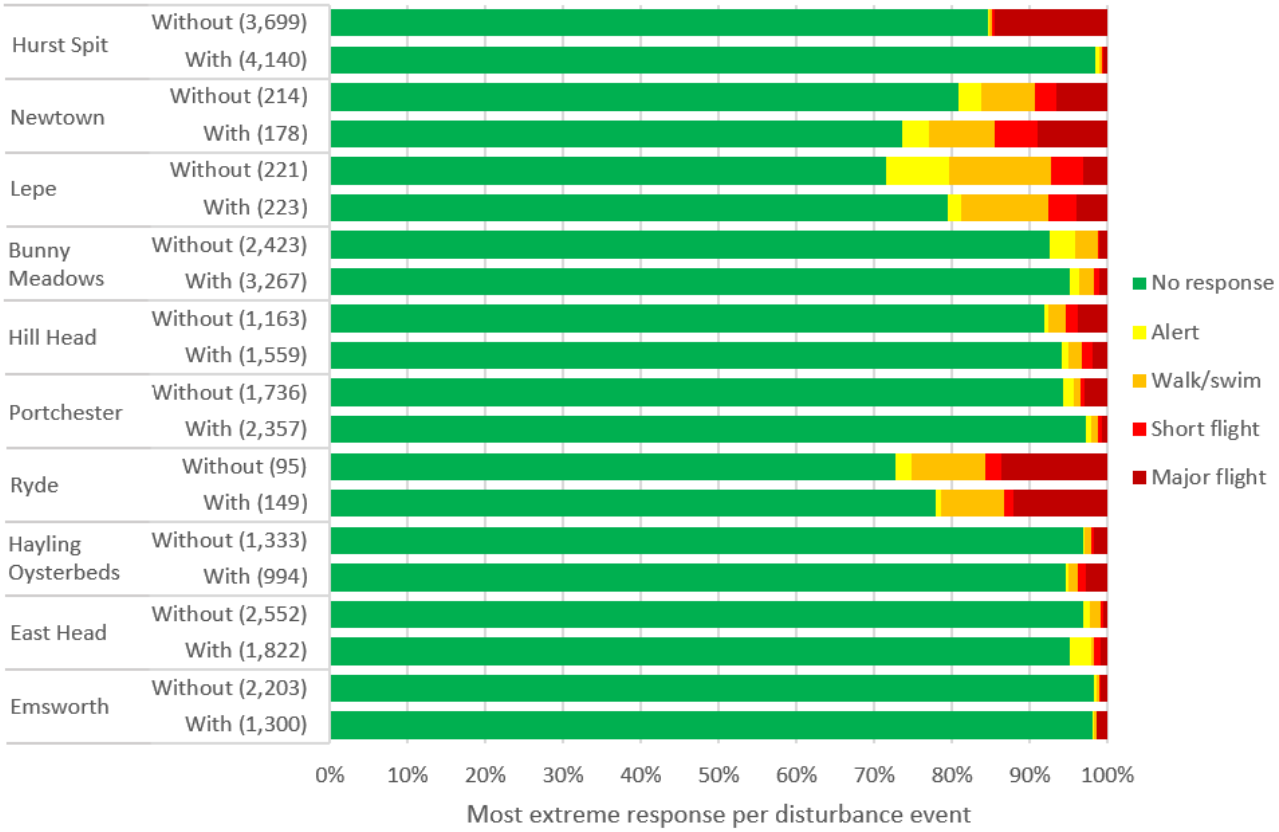


Figure 8: Responses of waders and wildfowl only at each survey location (calculated using most extreme response per observation), comparing when ranger present and absent. Numbers in brackets reflect the sample size.

Rates at which birds were flushed

3.25 The busiest sites are not necessarily the sites with the most observations of people and birds together. In Figure 9 we show the rate at which birds were flushed at each location in relation to three different measures of access/disturbance. The plots solely use data relating to waders and wildfowl and the number of flights consists of the combined totals for short and major flights. In a) we show the total number of diary events per hour (i.e. a measure of how busy each site is in terms of access); in b) we use the number of dogs off lead per hour, another measure of overall busyness and potentially particularly relevant to the birds; and in c) we use potential disturbance events per hour (i.e. the number of events that occurred when birds were present and that were within 200m of birds in the recording area).

3.26 None of the three plots show a significant correlation (Pearson correlation coefficients; n =10, $p>0.05$ in all cases), although the sample size (number of sites) is small. The plots are nevertheless useful in highlighting differences between sites. Emsworth and Ryde comprise busier sites but exhibit a relatively low number of flushing and potential disturbance events, with the much less busy Hayling Oysterbeds exhibiting a proportionately higher flush rate. The plots also suggest a slight increase in flushing events across the majority of sites as the number of dogs off lead increases, although the relationship is not clear cut.

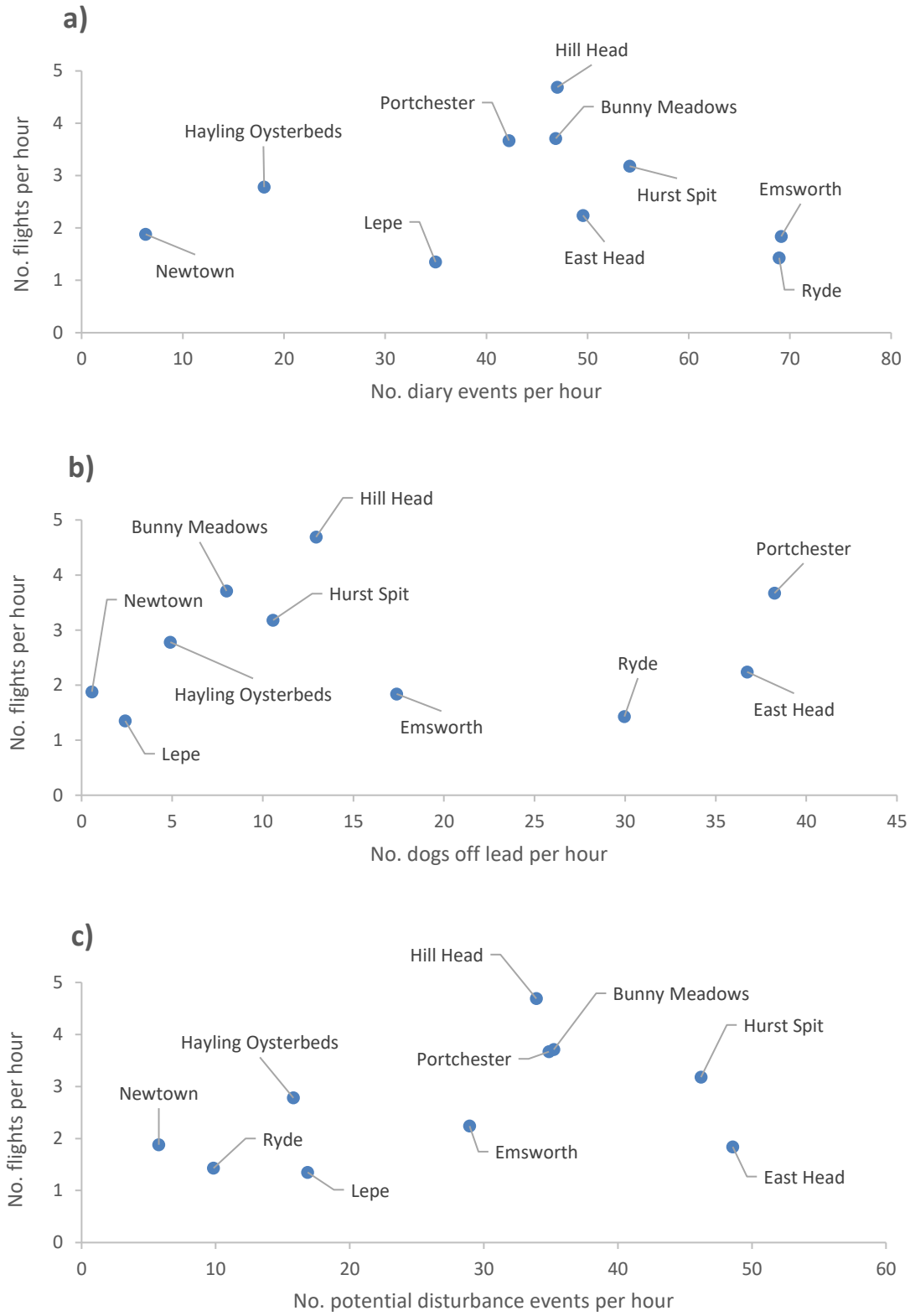


Figure 9: Number of times birds were flushed (short and major flights combined: waders and wildfowl only) and levels of disturbance at each survey location. a) uses all diary entries, b) the total number of dogs off lead, and c) the total number of potential disturbance events (i.e. diary events occurring within 200m of any birds present).

Behavioural responses and the number of birds involved

3.27 Figure 10 compares the numbers of birds (waders and wildfowl combined data) and different behavioural responses, contrasting when a ranger was present or absent during the survey. The data show the number of birds involved (rather than the number of observations). The plot indicates that fewer birds responded to disturbance (for example being flushed) when a ranger was present at Newtown, Lepe, Bunny Meadows, Portchester, Ryde, and East Head (six of the ten survey locations). Furthermore, the much larger numbers of birds flushed in the presence of a ranger at Hayling Oysterbeds consist of a small number of flushes of very large flocks.

3.28 Comparing the proportion of birds (waders and wildfowl combined) showing a behavioural response to the proportion not showing a response, with and without a ranger present, there were significant effects (Chi-square test of independence, $p<0.05$) of the presence of a ranger (i.e. fewer birds flushed when ranger present) at five sites, and no effect or a negative effect at the rest (Hurst Spit, Newtown, Hill head, Hayling Oysterbeds, and Emsworth).

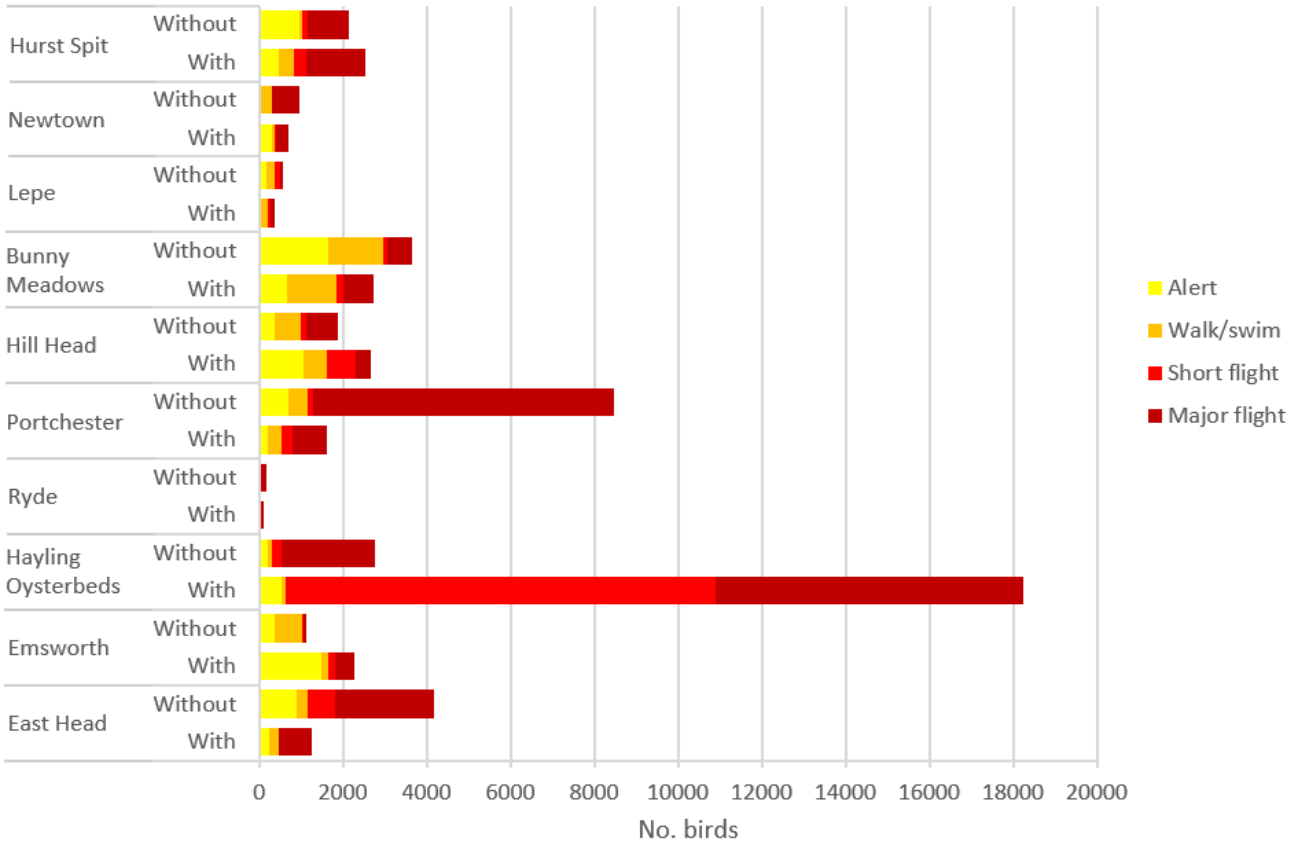


Figure 10: Numbers of birds showing a behavioural response (waders and wildfowl only) at each survey location, with and without a ranger present.

Behavioural responses and activity

3.29 Figure 11 depicts responses stratified by activity type. Note that only those activities with at least 25 observations (combined across surveys when a ranger was and wasn't present) are shown. For most activities the proportion of events resulting in a behavioural response (and in particular birds being flushed) was higher when rangers were not present. These included: walking, dog walking, jogging, birdwatching, motor vehicles, aircraft, small sailing boats, 'other' (i.e. activities that did not fit with our standard categories), people accessing boats or the water, windsurfers on the water, and fishing from shore.

3.30 These potentially comprise some of the activities that would be most easily intercepted by the rangers, although some of the categories (e.g. airborne) are those which are less likely to be relevant to rangers presence (airborne includes drones, which could be influenced by ranger presence, but mostly comprised helicopters, small planes, etc).

3.31 The activities with higher proportions of events causing disturbance with a ranger present were jogging with a dog/dogs, photography, and large boats with an outboard motor. Rangers may struggle to intercept some joggers (due to their speed), and they are perhaps less likely to want to put their dog on a lead due to the difficulty in running, and it is plausible that photographers who are intent on a particular shot (perhaps of birds) therefore cause disturbance despite the presence of a ranger. The large boats are clearly beyond the reach of shore-based rangers.

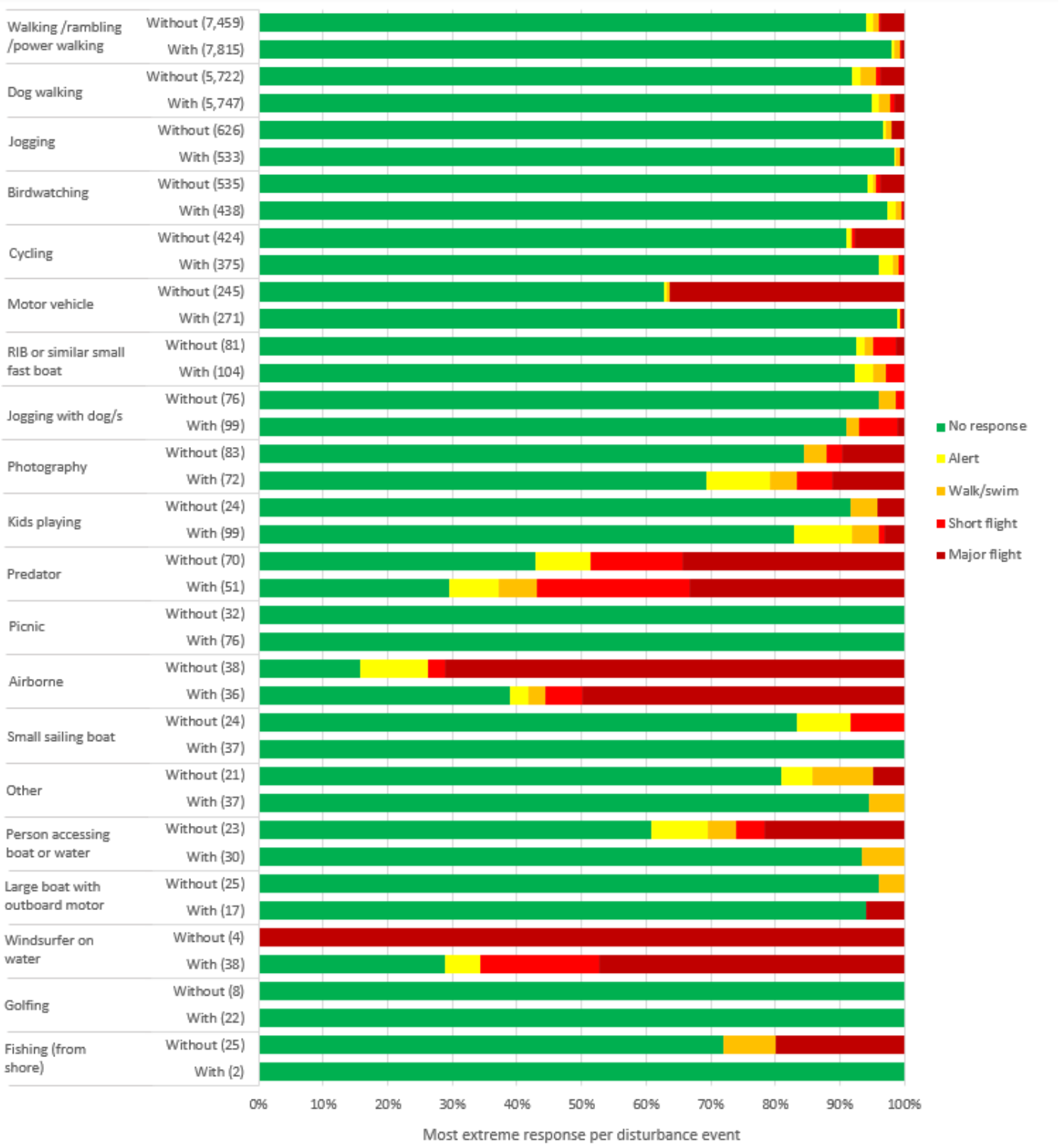


Figure 11: Responses of waders and wildfowl by activity (calculated using most extreme response per observation), with and without a ranger present. Only those activities for which a minimum of 25 species-specific observations were made (across ranger presence categories) are depicted. Numbers in brackets are the total number of observations.

Distances at which birds responded

3.32 For those observations where the single response code was no response, the median distance (for wildfowl and waders pooled) was 80m (n=28,304), i.e. half of all observations where there was no response involved people within 80m of the birds. The median distance at which waders and wildfowl became alert was 50m (n=292) and the median distance for major flight was 100m (n=910). The variation is considered indicative of the different effects and response distances shown by the different species associated with different activity types.

3.33 There were few clear differences between the distances when a ranger was present and when a ranger was absent (see Figure 12), although major flights for wildfowl and waders did differ, with a median of 50m (n=192) when a ranger was present compared to 100m (n=718) when a ranger was absent. This variation is again considered symptomatic of variation in species-specific and activity-specific responses unrelated to ranger presence.

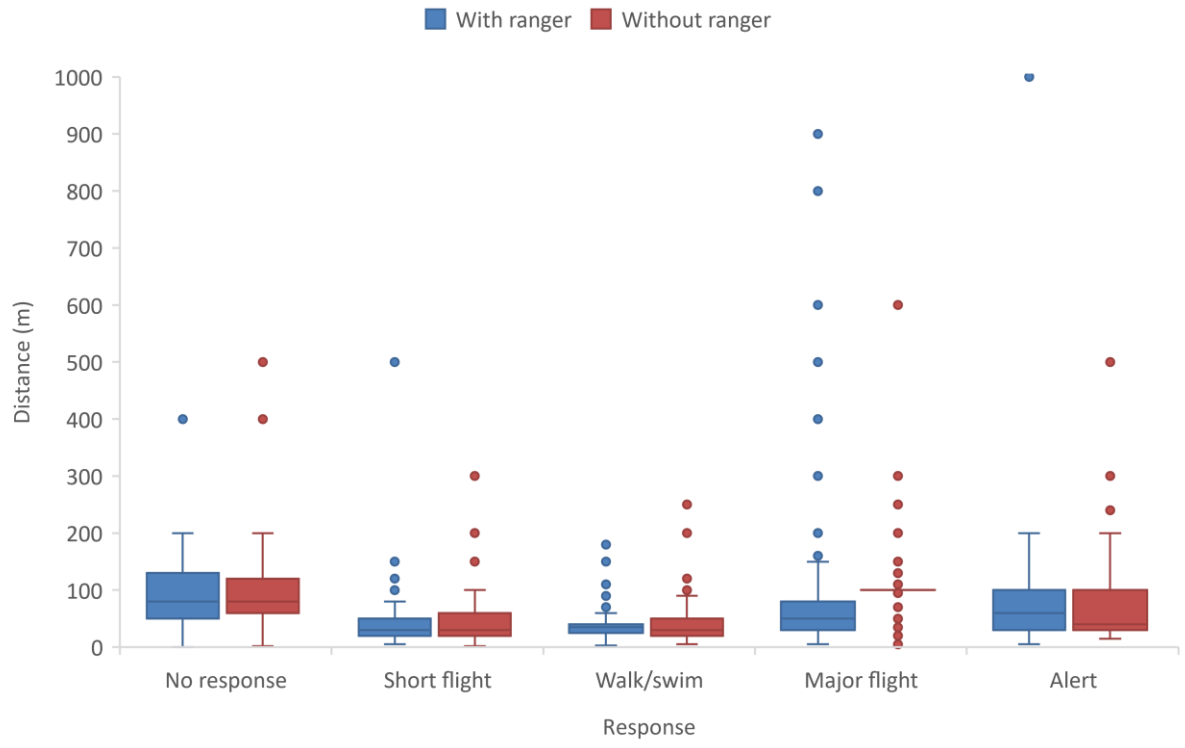


Figure 12: Distances at which the different behavioural responses were triggered (pooled for waders and wildfowl), with and without a ranger present. Horizontal lines represent the median (i.e. the mid-point, half the data falls below this line and half above), the boxes show the 25th and 75th percentiles, and the vertical lines show the upper and lower limits of the data with outlying points shown as dots.

Comparison with 2016/17 survey data

3.34 The first winter of ranger deployment in 2016/17 was monitored by Footprint Ecology across 10 survey locations (Liley & Panter, 2017). The locations subject to ranger presence and monitoring have changed in subsequent years, and only 6 of the original 10 locations were subject to survey in the winter of 2020/21 (see Appendix 1). Table 5 presents selected metrics for these 6 locations, allowing direct comparison between the first and most recent year of ranger deployment, stratified by ranger presence and absence. The figures are expressed per hour of fieldwork, to facilitate comparison, and it is important to note that different sites were subject to differing levels of survey effort in 2016/17.

3.35 Some caution is necessary, due to both differing survey effort and the impacts of the Covid pandemic upon countryside access and dog ownership. Nevertheless, the data suggests that the number of diary events recorded at Newtown per hour have decreased between the two survey periods when a ranger was present but increased when the ranger was absent. Similarly, the number of dogs recorded per hour at Hayling Oysterbeds has decreased during periods of ranger presence and increased when a ranger was absent. The data however suggests that most of the other access and response metrics depicted have increased between the two survey periods, with the number of flight events per hour also largely having increased.

3.36 It is nevertheless important to note the difficulties posed in attempting to directly relate the presence of rangers on site to the number of recreation events (including dog walking) recorded or the number of dogs present. The decision by users to visit a particular site at a specific time will be largely unaligned to ranger presence/absence, and the impact of the rangers' presence is more likely to lie in changes in behaviour on site rather than visitation rates.

Table 5: Comparison between 2016/17 and 2020/21 data, using selected metrics for those sites subject to survey in both time periods (see Appendix 1 and Liley & Panter (2017) for more information). Only data from valid pairs has been used for the 2016/17 data, with the survey effort adjusted accordingly. Metrics which have increased between the two survey periods are highlighted in red and those that have decreased are highlighted in blue. Large increases are indicated in dark red.

Survey location	Comparison metrics	Ranger present		Ranger absent	
		2016/2017	2020/21	2016/2017	2020/21
Newtown	Diary events per hour	3.0	2.6	1.8	3.7
	Total dogs per hour	0.8	0.9	0.6	0.8
	Flight events per hour (all species)	0.7	1.3	1.6	1.1
Bunny Meadows	Diary events per hour	8.3	24.0	8.8	22.8
	Total dogs per hour	3.3	7.3	2.9	6.3
	Flight events per hour (all species)	0.7	2.7	0.7	1.5
Portchester	Diary events per hour	12.1	22.2	10.9	20.0
	Total dogs per hour	15.5	21.8	16.9	20.5
	Flight events per hour (all species)	0.6	1.3	0.6	2.7
Ryde	Diary events per hour	15.9	38.0	15.8	31.0
	Total dogs per hour	14.8	21.1	14.5	17.2
	Flight events per hour (all species)	1.7	0.9	1.3	1.0
Hayling Oysterbeds	Diary events per hour	6.3	7.9	4.3	10.1
	Total dogs per hour	3.2	3.1	2.7	4.0
	Flight events per hour (all species)	0.7	1.8	0.7	1.4
East Head	Diary events per hour	13.5	19.8	15.9	29.7
	Total dogs per hour	13.7	21.1	14.7	23.0
	Flight events per hour (all species)	0.5	0.8	0.8	1.2

4. Discussion

4.1 We have provided an overview and analysis of data on visitor use, bird use, and the interactions between people and birds, comparing data from 10 locations and with/without the presence of a ranger. In this section we consider some of the key findings and implications in more depth.

4.2 It is important to note that the impact of rangers is likely to be far reaching and this study on its' own is insufficient to pick up the full impacts that the ranger team may have. Through dialogue with visitors, social media, events, and other publicity it is to be expected that visitors will change their understanding and awareness with respect to birds and disturbance issues. Such basic changes are not necessarily likely to be picked up in this kind of study, as some visitors might have chosen to visit other greenspaces (with no wintering bird interest or risks of disturbance) or changed their behaviour (e.g. modified their usual route, routinely kept their dog on a lead, etc) in a way that is not dependent on the presence/absence of a ranger.

4.3 Further complexity is added with respect to how ranger presence might affect bird use and behaviour. It could be that the presence of rangers has a sufficient effect that bird use and distribution changes. For example, birds might use an area more or use areas that are closer to paths/access routes, etc, as a result of ranger presence. Were this to be the case there is the potential for more behavioural responses (e.g. birds being flushed) simply as a result of the birds changing their distribution. For example, if a roost is only sporadically used by birds as a result of disturbance and following increased ranger presence use by the birds creeps up, we might expect higher counts. Conversely, there may be an equal risk of occasional events (perhaps where the ranger was not able to intercept or influence a particular visitor) causing more birds to be flushed. These kinds of effects are likely to vary between sites and be extremely nuanced towards particular site geography and how they are used by birds. It therefore makes sense that consistent and very clear patterns across sites may not necessarily be discernible.

Bird numbers

4.4 The results show that the survey locations continue to support a large number and variety of birds, with Hayling Oysterbeds, Portchester, and Newtown being particularly important for waders and Hurst Spit,

Portchester, East Head, and Emsworth being notable for their wildfowl numbers.

4.5 There was a significant effect of ranger presence on wader numbers, with more waders tending to be present when the rangers were deployed. Hayling Oysterbeds was one of the key sites where wader numbers were markedly higher when the ranger was present. This makes sense, as the site is a major roost and it is well documented in the general literature that disturbance can lead to birds avoiding particular roost sites as a result of increased disturbance risk (Peters & Otis, 2007; van der Kolk et al., 2022).

4.6 There were no effects of ranger presence and wildfowl numbers or numbers of gulls/terns or 'other' species. For gulls and terns, the impacts of visitor numbers are likely to be minimal and gulls are even likely to congregate where people are present (for example responding to people feeding them). For wildfowl, this result perhaps indicates that the ranger presence is not sufficient to result in these birds modifying their distribution.

4.7 There was generally little correlation between bird numbers and visitor numbers (i.e. it was not necessarily the case that the locations with the largest numbers of people had the lowest numbers of birds). A range of factors such as habitat, food availability, and whether or not sites are used as high tide roosts will influence bird numbers and so this is perhaps not surprising. The one significant correlation was with wader numbers and visitor numbers, when a ranger was present. This indicates that – at least when a ranger is present – more people do result in fewer birds being present. It is perhaps the case therefore that when it is very busy the rangers are able to have less influence or that the sheer volume of people in the area acts as a deterrent to birds. Without a ranger present it is possible that even small numbers of recreational events can influence the birds and hence the lack of a significant correlation between wader numbers and people in the absence of a ranger.

Behavioural responses

4.8 A large number of species-specific observations were made, with the vast majority of potential disturbance events (94% overall) causing no visible response in the birds present. It is important to note that this doesn't mean disturbance is having a minimal impact on the birds, as it is likely that the distribution of birds takes into account levels of recreation use. If the distribution of birds is already such that they avoid areas close to paths,

beaches where dogs run loose, etc, then it is to be expected that the proportion of potential disturbance events that cause birds to change their behaviour will be low. Furthermore, it is possible that birds may not necessarily show a response because they cannot afford the energy costs of taking flight (e.g. Beale & Monaghan, 2004) whilst still being subject to physiological costs, such as increased stress (e.g. Arlettaz et al., 2015; Viblanc et al., 2012).

4.9 Nevertheless, a sizeable minority of observations (3%) caused the birds present to undertake a major flight. Although relatively infrequent, such events can potentially impact severely upon the energy budgets of the birds concerned. The distance at which such flights were induced varied greatly and are likely to be a result of differing risk perceptions between species in relation to different activity types.

4.10 A larger proportion of major flights were recorded on days when a ranger was absent, highlighting one of the benefits of the ranger mitigation package. Ranger presence was also seen to reduce the proportion of behavioural responses overall at Hurst Spit, and to a lesser extent at Lepe, Bunny Meadows, Hill Head, Portchester, and Ryde, in comparison to days when a ranger was absent. Furthermore, fewer individual birds responded to disturbance when a ranger was present at Newtown, Lepe, Bunny Meadows, Portchester, Ryde, and East Head. A range of activities (including the most frequently recorded activities of walking and dog walking) also led to a proportionately larger incidence of behavioural responses when a ranger was absent, compared to when they were present on site.

Ranger effectiveness

4.11 Some sites were extremely busy, including Ryde and Emsworth in particular, whilst others (such as Hayling Oysterbeds and Newtown) were much quieter. There was however much variation between survey localities. Ranger presence wasn't seen to influence the number of visitors on site, indicating that visitors do not seem to be deterred from visiting a site by the presence of a ranger. The presence of a ranger also does not necessarily appear to influence the numbers of people within 200m of birds and had little apparent effect on the number of dogs observed on and off lead. These results all suggest that the ranger presence is not unduly restricting or majorly influencing visitor volumes at sites.

4.12 More than half of the events recorded involved people passing within relative proximity (100m or less) of a ranger, with the ranger locations at Hurst Spit and Newtown working well to intercept visitors (whilst the Ryde location did relatively poorly in comparison to the number of events recorded). Overall, a relatively low number of individuals (12% on average) across the full geographic spread of each survey location were seen to interact with a ranger, although this again greatly varied from site to site (with more than half of visitors to Newtown seen to converse with a ranger, for example). Low numbers of visitors were also ultimately recorded exhibiting an apparent behavioural change as a result of their interaction with the ranger.

4.13 These findings are symptomatic of the large extents of the survey areas, making it difficult for the small number of rangers present to engage with a large proportion of total site users, who are often spread widely across individual sites on any given day. The exceptions to this mainly comprise sites where visitor foot traffic is concentrated at pinch points, such as at Newtown, making it easier for a single ranger to intercept larger numbers of visitors. The efficacy of the rangers in getting their message across is further indicated by the increased proportions of visitors engaged in conversation and/or changing their behaviour when the number of visitors passing within proximity to the ranger is taken into account.

4.14 The results show that ranger presence can have a positive effect on bird numbers and can reduce the proportion of events that result in behavioural responses such as birds being flushed. It would appear that the positive effect on numbers is particularly clear at Hayling Oysterbeds, and such roost sites are ones where wardening is likely to work particularly well. It is interesting to note that there were also markedly higher numbers of birds flushed at the Oysterbeds, suggesting that as numbers of birds have increased there is the risk of single events having a more marked effect.

4.15 In terms of the behavioural responses, it would appear that rangers are having a positive effect upon a range of different activities. It is noteworthy that joggers with dogs and photographers are two activities where there is no obvious effect of the rangers and, if anything, exhibit a higher number of disturbance events with the ranger present. These two groups may therefore warrant more targeted work or different approaches. It is interesting to speculate whether the presence of the ranger results in more birds being present and fewer disturbance events, which would then make the birds more at risk from certain activities. It may be that rangers showing people

birds means photographers are then prompted to take photographs. Other studies have shown photographers to ignore particular signage and messaging in order to get their desired image (Allbrook & Quinn, 2020). Codes of conduct, or particular messaging for photographers, may therefore be appropriate.

4.16 While the results show rangers have a positive effect, they also show that disturbance does occur even when the rangers are present, and by no means does the presence of a ranger mean disturbance issues are addressed. This highlights the need for a package of mitigation measures comprising more than simply the presence of rangers on the beaches.

4.17 Comparison between monitoring data from the first year of ranger deployment and the most recent surveys (carried out four years later) suggest that visitor numbers and disturbance levels have increased, often markedly. This matches the national picture, as there has been a marked uplift in the use of local greenspaces following the pandemic (Burnett et al., 2021; Kleinschroth & Kowarik, 2020; Natural England & Kantar Public, 2021).

Future recommendations for monitoring

4.18 This study is one of the monitoring threads originally set out in the strategy by Liley et al. (2015). The original recommendations were for monitoring to cover a fixed time period (potentially around 5 years) and to provide information to help refine future mitigation delivery in terms of how rangers operate, the level of ranger coverage, and the need for other measures alongside rangers as part of a wider package of mitigation measures.

4.19 It is clear from the results that there are some very marked differences between sites, with the effect of rangers being very different at sites such as Hayling Oysterbeds. More work is needed to identify such site-specific factors and future monitoring could potentially switch to understanding in more depth the practicalities and specifics at a site level. We suggest that it would also be useful to understand in more detail the messages given to visitors at particular sites, the total amount of time rangers spend on site, and the number of people spoken to. This could then be combined with some of the bird disturbance data to provide more detailed case studies that focus on individual sites. Such studies should ultimately aim to identify the optimum level of deployment and how ranger deployment works alongside signage, site infrastructure, and visitor flows within a site.

References

Allbrook, D. L., & Quinn, J. L. (2020). The effectiveness of regulatory signs in controlling human behaviour and Northern gannet (Morus bassanus) disturbance during breeding: An experimental test. *Journal for Nature Conservation*, *58*, 125915. https://doi.org/10.1016/j.jnc.2020.125915

Arlettaz, R., Nusslé, S., Baltic, M., Vogel, P., Palme, R., Jenni-Eiermann, S., Patthey, P., & Genoud, M. (2015). Disturbance of wildlife by outdoor winter recreation: Allostatic stress response and altered activity–energy budgets. *Ecological Applications*, *25*(5), 1197–1212. https://doi.org/10.1890/14-1141.1

Beale, C. M., & Monaghan, P. (2004). Human disturbance: People as predation-free predators? *Journal of Applied Ecology*, *41*(2), 335–343.

Burnett, H., Olsen, J. R., Nicholls, N., & Mitchell, R. (2021). Change in time spent visiting and experiences of green space following restrictions on movement during the COVID-19 pandemic: A nationally representative cross-sectional study of UK adults. *BMJ Open*, *11*(3), e044067. https://doi.org/10.1136/bmjopen-2020-044067

Fearnley, H., Clarke, R. T., & Liley, D. (2010). *The Solent Disturbance and Mitigation Project. Phase II. On-site visitor survey results from the Solent Region*. Footprint Ecology/Solent Forum.

Kleinschroth, F., & Kowarik, I. (2020). COVID-19 crisis demonstrates the urgent need for urban greenspaces. *Frontiers in Ecology and the Environment*, *18*(6), 318–319. https://doi.org/10.1002/fee.2230

Liley, D., & Panter, C. (2017). *First year results of monitoring bird disturbance in the presence/absence of rangers on the Solent*. Unpublished report by Footprint Ecology for for Bird Aware Solent.

Liley, D., Stillman, R., Austin, G., & Panter, C. (2015). *Advice on how to monitor the effectiveness of the Solent Recreation Mitigation Strategy*. Footprint Ecology / Bournemouth University / BTO / Solent Recreation Mitigation Partnership.

Morgan, L., Protopopova, A., Birkler, R. I. D., Itin-Shwartz, B., Sutton, G. A., Gamliel, A., Yakobson, B., & Raz, T. (2020). Human–dog relationships during the COVID-19 pandemic: Booming dog adoption during social isolation. *Humanities and Social Sciences Communications*, *7*(1), 1–11. https://doi.org/10.1057/s41599-020-00649-x

Natural England, & Kantar Public. (2021). *Impact of Covid-19 on engagement with green and natural spaces* (Natural England Report No. PANS003). The People and Nature Survey for England. http://publications.naturalengland.org.uk/publication/4513040482697216

Peters, K. A., & Otis, D. L. (2007). Shorebird roost-site selection at two temporal scales: Is human disturbance a factor? *Journal of Applied Ecology*, *44*(1), 196–209. https://doi.org/10.1111/j.1365-2664.2006.01248.x

Ross, K., Liley, D., Austin, G., Clarke, R. T., Burton, N. H., Stillman, R. A., Cruickshanks, K., & Underhill-Day, J. (2014). *Housing development and estuaries in England: Developing methodologies for assessing the impacts of disturbance to non-breeding waterfowl*. Footprint Ecology, unpublished report for Natural England.

Saunders, P., & Panter, C. (2021). *Solent Disturbance Study 2020-21* (Unpub. Report No. 611). Footprint Ecology / Bird Aware Solent.

van der Kolk, H.-J., Ens, B. J., Oosterbeek, K., Jongejans, E., & van de Pol, M. (2022). The hidden cost of disturbance: Eurasian Oystercatchers (Haematopus ostralegus) avoid a disturbed roost site during the tourist season. *Ibis*, *164*(2), 437–450. https://doi.org/10.1111/ibi.13035

Viblanc, V. A., Smith, A. D., Gineste, B., & Groscolas, R. (2012). Coping with continuous human disturbance in the wild: Insights from penguin heart rate response to various stressors. *BMC Ecology*, *12*, 10–10. https://doi.org/10.1186/1472-6785-12-10

Waterman Infrastructure and Environment Ltd. (2020). *Solent Bird Disturbance Monitoring 2019-2020*. Report for Bird Aware Solent.

Appendix 1: Bird disturbance survey monitoring effort across sites and years

The table below depicts the survey effort at all locations (arranged west to east) subject to annual survey between the winters of 2016/17 and 2021/22. Note that the survey methodology applied in winter 2020/21 was slightly different to that used in the other years depicted. Those locations subject to survey in both the first and the most recent winter survey periods are highlighted in grey.

Survey location	No. survey visits			
	2016/17[a]	2018/19[b]	2020/21[c]	2021/22[a]
Hurst Spit		8	3	14
Pennington	14			
Newtown	16	14	3	14
Lepe		12		14
Calshot	14			
Bunny Meadows	14	12		14
Hill Head		8		14
Portchester	16	4	3	14
Ryde	16	14		14
Milton (Eastney)	14			
Hayling Oysterbeds	14	12	3	14
Emsworth		14		14
East Head	14	14	3	14
Bosham	16			

[a]Footprint Ecology; [b]Waterman; [c]Bird Aware Solent

Appendix 2: Summary of sites

In this appendix, we provide details for each site, including aerial photographs showing the recording area, distance markers used by surveyors, and the vantage point location.

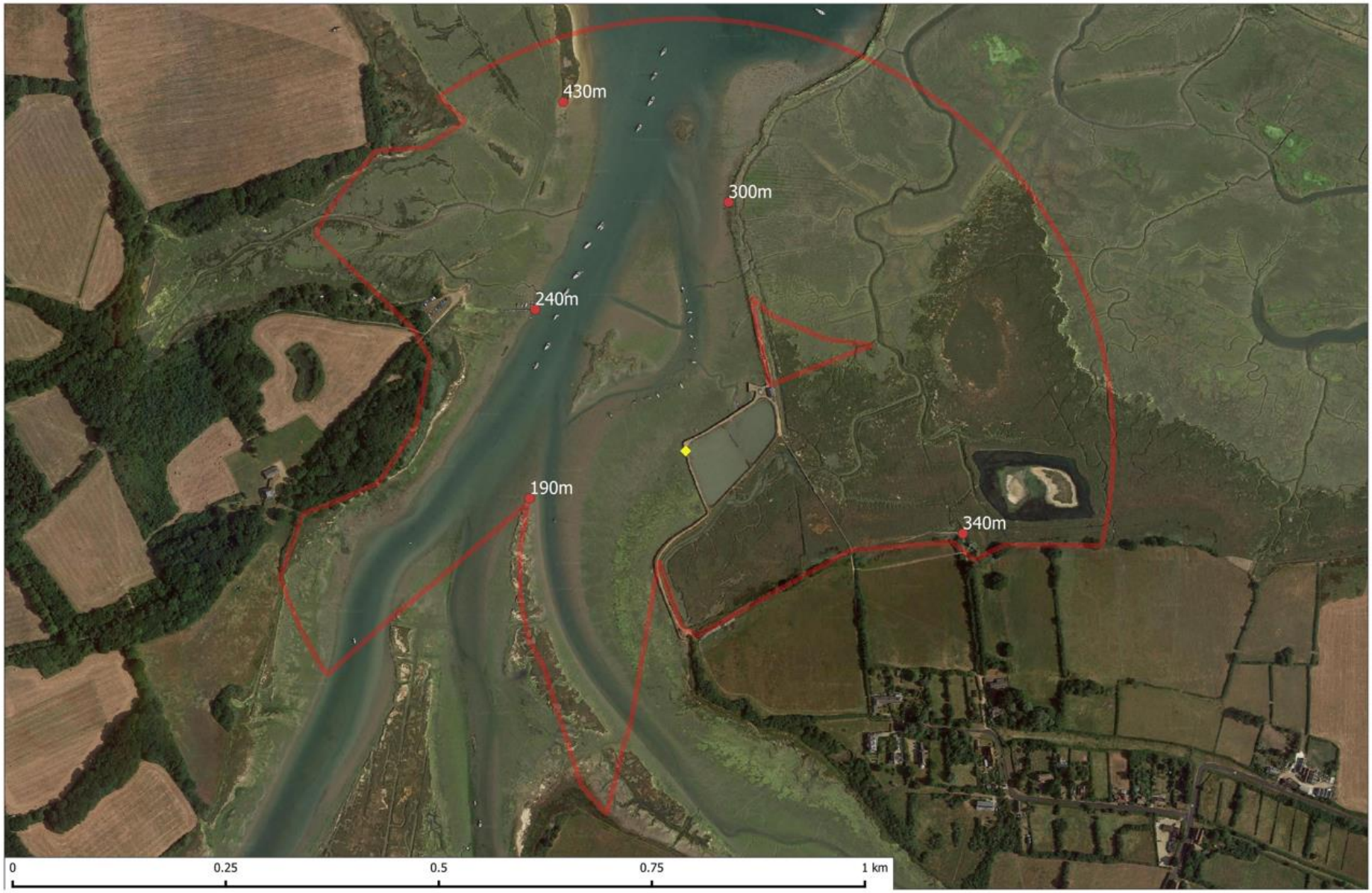
Hurst Spit

Grid Reference for vantage point	SZ 29990 90785
Key habitats present	Mudflat and sandflats
Total dogs per hour from all visits (% off lead)	19.8 (53.4)
Dog walkers per hour from all visits	15.6
Walkers (without dogs) per hour from all visits	28.4
Diary events per hour from all visits	54.2
Number of flights per hour (all species, all visits)	52.9
Top 5 bird species (max counts)	Dark-bellied Brent Goose (509); Teal (450); Dunlin (247); Black-tailed Godwit (229); Wigeon (194)
% of waders foraging	90.3
% of wildfowl foraging	69.1
Number species recorded (all species groups)	28
Number of visits with less than 25% rain	1
Number of visits with some rain	2
Access infrastructure	Parking along New Lane or Salthouse Lane, with access to the shingle bank (and on to Hurst Castle) via the shingle ridge.
Survey notes	The slope of the shingle precludes viewing to the west of the VP.

Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Newtown

Grid Reference for vantage point	SZ 41796 91079
Key habitats present	mudflat, lagoon, saltmarsh
Total dogs per hour from all visits (% off lead)	1.6 (35)
Dog walkers per hour from all visits	1.4
Walkers (without dogs) per hour from all visits	2.7
Diary events per hour from all visits	6.3
Number of flights per hour (all species, all visits)	2.4
Top 5 bird species (max counts)	Dunlin (920); Dark-bellied Brent Goose (418); Golden Plover (220); Black-headed Gull (194); Mediterranean Gull (110)
% of waders foraging	57.1
% of wildfowl foraging	55.6
Number species recorded (all species groups)	28
Number of visits with less than 25% rain	2
Number of visits with some rain	3
Access infrastructure	A National Trust car park and small car park in village. A map with highlighted walks is present in the NT car park.
Survey notes	Careful access required not to disturb/influence the distribution of birds.



Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

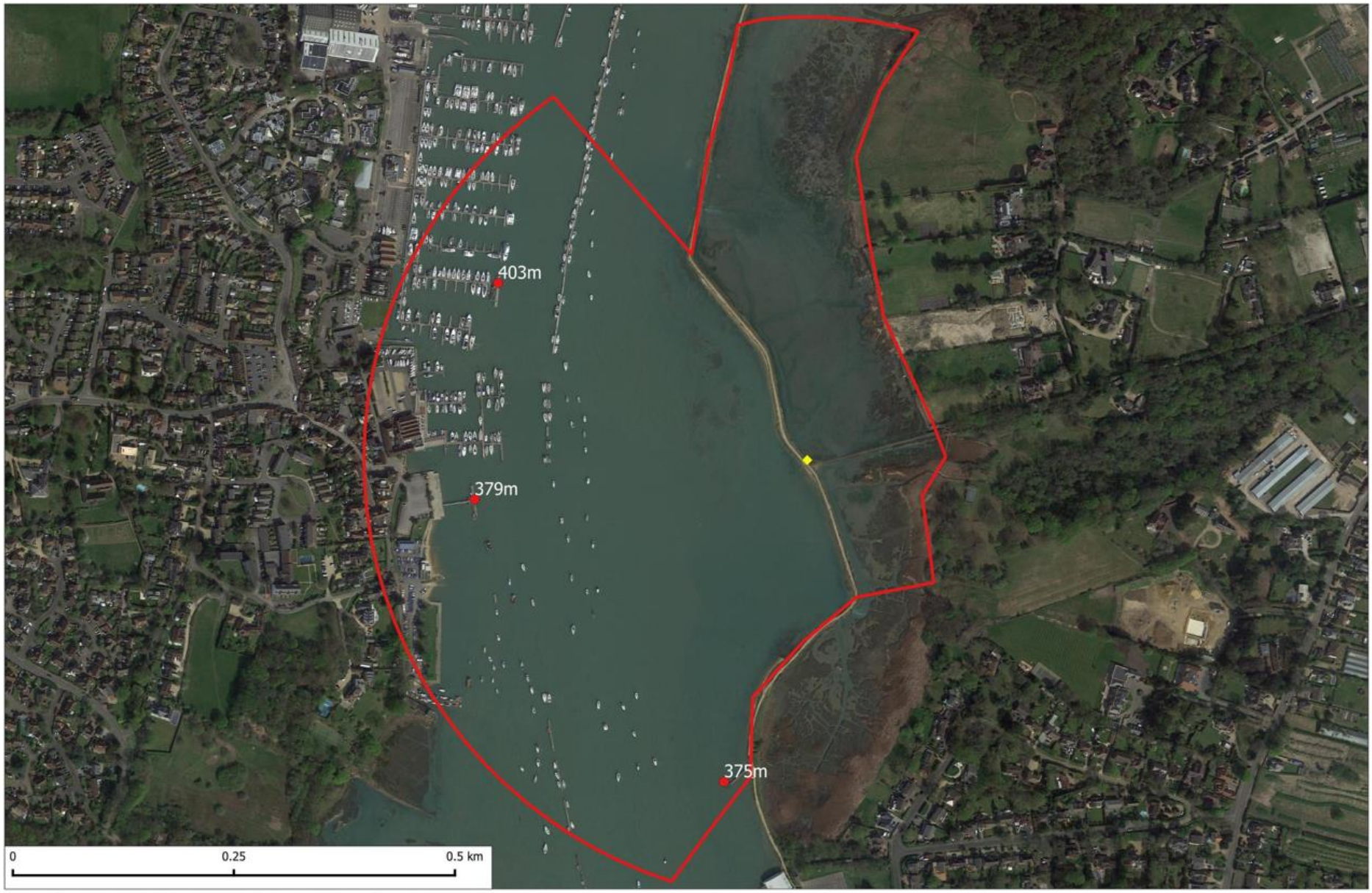
Lepe

Grid Reference for vantage point	SZ 45265 98525
Key habitats present	Stony and sandy beaches
Total dogs per hour from all visits (% off lead)	9.1 (26.5)
Dog walkers per hour from all visits	7.1
Walkers (without dogs) per hour from all visits	18.8
Diary events per hour from all visits	35.0
Number of flights per hour (all species, all visits)	1.8
Top 5 bird species (max counts)	Dark-bellied Brent Goose (56); Turnstone (44); Black-headed Gull (36); Oystercatcher (36); Razorbill (6)
% of waders foraging	77.2
% of wildfowl foraging	83.3
Number species recorded (all species groups)	19
Number of visits with less than 25% rain	0
Number of visits with some rain	3
Access infrastructure	Large car park with visitor centre/café and road/pedestrian access running parallel to the survey area.
Survey notes	Location of survey point means some surveys were looking directly into sun.

Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Bunny Meadows

Grid Reference for vantage point	SU 48890 06780
Key habitats present	Saltmarsh, mudflat, and shingle beach
Total dogs per hour from all visits (% off lead)	13.6 (58.9)
Dog walkers per hour from all visits	10.8
Walkers (without dogs) per hour from all visits	21.3
Diary events per hour from all visits	46.9
Number of flights per hour (all species, all visits)	4.2
Top 5 bird species (max counts)	Dunlin (500); Dark-bellied Brent Goose (185); Wigeon (123); Teal (120); Redshank (95).
% of waders foraging	51.5
% of wildfowl foraging	76.6
Number species recorded (all species groups)	28
Number of visits with less than 25% rain	2
Number of visits with some rain	2
Access infrastructure	A large car park is located at the south of the site, and the bund itself is subject to frequent foot traffic. Some access is also made from residential properties to the north-east of the VP via the linking bund (submerged at high tide).
Survey notes	A difficult site to survey, requiring 360 degree awareness.



Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Hill Head

Grid Reference for vantage point	SU 53623 02316
Key habitats present	Stony and sandy beaches
Total dogs per hour from all visits (% off lead)	18.9 (68.3)
Dog walkers per hour from all visits	14.8
Walkers (without dogs) per hour from all visits	27.6
Diary events per hour from all visits	47.0
Number of flights per hour (all species, all visits)	5.1
Top 5 bird species (max counts)	Black-headed Gull (354); Dark-bellied Brent Goose (270); Herring Gull (95); Turnstone (60); Sanderling (57)
% of waders foraging	85.4
% of wildfowl foraging	54.1
Number species recorded (all species groups)	21
Number of visits with less than 25% rain	3
Number of visits with some rain	3
Access infrastructure	A small car park immediately adjacent, in addition to multiple formal parking (and resident parking) along road to north and south.
Survey notes	

Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Portchester

Grid Reference for vantage point	SU 59440 05351
Key habitats present	Mudflats
Total dogs per hour from all visits (% off lead)	42.4 (90.3)
Dog walkers per hour from all visits	26.4
Walkers (without dogs) per hour from all visits	9.8
Diary events per hour from all visits	42.2
Number of flights per hour (all species, all visits)	4.0
Top 5 bird species (max counts)	Dunlin (1,300); Wigeon (405); Teal (275); Dark-bellied Brent Goose (271); Black-tailed Godwit (136)
% of waders foraging	92.8
% of wildfowl foraging	71.8
Number species recorded (all species groups)	26
Number of visits with less than 25% rain	1
Number of visits with some rain	2
Access infrastructure	Free parking at Cams Water and large area of open grass/playing fields. Golf course on immediate periphery of survey area to the west.
Survey notes	VP by large pines, with good view into creek but difficult to keep whole area in view. Large numbers of people and dogs makes recording challenging.

Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Ryde

Grid Reference for vantage point	SZ 60430 92557
Key habitats present	Sandflat
Total dogs per hour from all visits (% off lead)	38.2 (78.3)
Dog walkers per hour from all visits	29.9
Walkers (without dogs) per hour from all visits	32.5
Diary events per hour from all visits	68.9
Number of flights per hour (all species, all visits)	1.9
Top 5 bird species (max counts)	Black-headed Gull (300); Mediterranean Gull (96); Sanderling (58); Dark-bellied Brent Goose (43); Common Gull (40)
% of waders foraging	89.2
% of wildfowl foraging	0.0
Number species recorded (all species groups)	15
Number of visits with less than 25% rain	0
Number of visits with some rain	2
Access infrastructure	Parking extends along the Esplanade from c450m W of VP to c100m E of it. Comprehensive signage regarding beach use, lifeguards etc; but nothing about birds/wildlife.
Survey notes	Feeding birds spread widely and in low numbers, difficult to simultaneously view all birds and people. Changing tides and vast expanse of sandflats mean that birds are often located outside of the survey area during specific tide states. Some disturbance (not major flights) may have also been missed.

Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Hayling Oysterbeds

Grid Reference for vantage point	SU 71512 03205
Key habitats present	Mudflat, saltmarsh, and lagoons
Total dogs per hour from all visits (% off lead)	7.2 (68.2)
Dog walkers per hour from all visits	5.8
Walkers (without dogs) per hour from all visits	7.0
Diary events per hour from all visits	18.0
Number of flights per hour (all species, all visits)	3.1
Top 5 bird species (max counts)	Dunlin (2,500); Mediterranean Gull (725); Oystercatcher (650); Grey Plover (460); Black-headed Gull (388)
% of waders foraging	2.9
% of wildfowl foraging	49.0
Number species recorded (all species groups)	28
Number of visits with less than 25% rain	0
Number of visits with some rain	0
Access infrastructure	Small Billy Trail car park with interpretation.
Survey notes	Location of survey point means some surveys were looking directly into sun.

Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Emsworth

Grid Reference for vantage point	SU 74151 05341
Key habitats present	Saltmarsh, mudflat, and shingle banks
Total dogs per hour from all visits (% off lead)	28.6 (60.9)
Dog walkers per hour from all visits	24.2
Walkers (without dogs) per hour from all visits	40.2
Diary events per hour from all visits	69.1
Number of flights per hour (all species, all visits)	2.4
Top 5 bird species (max counts)	Dark-bellied Brent Goose (537); Wigeon (182); Black-tailed Godwit (143); Black-headed Gull (100); Dunlin (65)
% of waders foraging	81.5
% of wildfowl foraging	70.4
Number species recorded (all species groups)	28
Number of visits with less than 25% rain	0
Number of visits with some rain	2
Access infrastructure	On street parking available within adjacent residential areas. A surfaced footpath runs most of length of the survey area.
Survey notes	Difficult to judge distances here due to the rarity of obvious marker points.

Contains Ordnance Survey data © Crown copyright and Database Right 2020. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

East Head

Grid Reference for vantage point	SZ 77013 98608
Key habitats present	Saltmarsh, mudflat, sand dune, and shingle beach
Total dogs per hour from all visits (% off lead)	44.1 (83.3)
Dog walkers per hour from all visits	28.8
Walkers (without dogs) per hour from all visits	16.9
Diary events per hour from all visits	49.6
Number of flights per hour (all species, all visits)	2.0
Top 5 bird species (max counts)	Dark-bellied Brent Goose (760); Dunlin (500); Black-headed Gull (342); Teal (110); Black-tailed Godwit (63)
% of waders foraging	39.6
% of wildfowl foraging	48.3
Number species recorded (all species groups)	32
Number of visits with less than 25% rain	1
Number of visits with some rain	1
Access infrastructure	A very large car park (charging on entry), toilets, and other facilities are located immediately south of the survey area.
Survey notes	Difficult to survey and record accurately, particularly on weekends and in bright sunshine. Difficulties due to people moving along different paths/routes and birds spread out. Many walkers along head difficult to keep track of. People counts therefore potentially underestimates.

Contains Ordnance Survey data © Crown copyright and Database Right 2018. Contains map data © OpenStreetMap contributors. Terms: www.openstreetmap.org/copyright Designated site boundaries download from the Natural England website © Natural England.

Appendix 3: Summary of survey visits, dates, etc

In this appendix, we summarise all the visits, with details of weather and the presence/absence of a ranger.

Date	Survey location	Start time (hrs)	Wind description	Wind direction	Rainfall during survey period	Temp (°C)	Tide	Warden presence
04/11/2021	Hurst Spit	13:45	Moderate	NNW	None	8	Falling	With
05/11/2021	Hurst Spit	13:50	Light	NNW	None	11	Falling	Without
14/12/2021	Hurst Spit	13:00	Light	SW	None	12	Low	Without
15/12/2021	Hurst Spit	13:45	Light	WSW	None	12	Low	With
15/01/2022	Hurst Spit	13:15	Light	SW	None	9	Falling	Without
16/01/2022	Hurst Spit	14:00	Light	NW	None	9	Low	With
22/01/2022	Hurst Spit	08:52	Light	N	None	7	Low	Without
23/01/2022	Hurst Spit	09:43	Moderate	ESE	None	6	Rising	With
07/02/2022	Hurst Spit	10:00	Light	WSW	None	5	High	With
08/02/2022	Hurst Spit	10:45	Moderate	WSW	None	10	Rising	Without
14/02/2022	Hurst Spit	14:15	Moderate	W	None	9	Low	With
15/02/2022	Hurst Spit	15:00	Strong	WSW	<25%	9	Falling	Without
01/03/2022	Hurst Spit	14:45	Moderate	NE	100%	7	Low	With
02/03/2022	Hurst Spit	15:30	Moderate	E	None	6	Low	Without
10/11/2021	Newtown	09:30	Strong	SW	None	13	Rising	Without
11/11/2021	Newtown	10:15	Moderate	SE	None	13	Rising	With
09/12/2021	Newtown	11:37	Light	SW	None	8	Rising	Without
10/12/2021	Newtown	12:35	Moderate	WNW	None	7	Rising	With
10/01/2022	Newtown	13:15	Light	S	<25%	9	Rising	Without
11/01/2022	Newtown	14:00	Light	W	<25%		Rising	With
29/01/2022	Newtown	09:30	Moderate	W	None	11	High	With
30/01/2022	Newtown	10:15	Light	NW	None	4	High	Without
07/02/2022	Newtown	12:30	Moderate	SW	None	9	Rising	With
08/02/2022	Newtown	13:20	Moderate	WSW	None	11	High	Without
12/02/2022	Newtown	09:30	Moderate	SSW	None	7	High	With
13/02/2022	Newtown	10:15	Moderate	S	<50%	9	High	Without
03/03/2022	Newtown	08:15	Light	SSE	None	10	High	Without
04/03/2022	Newtown	09:00	Moderate	NNW	None	7	Rising	With
04/11/2021	Lepe	09:50	Light	NNW	None	7	High	With
05/11/2021	Lepe	10:15	Light	NNW	None	6	High	Without
14/12/2021	Lepe	09:15	Light	SW	None	12	Falling	Without
15/12/2021	Lepe	10:15	Light	WSW			High	With
15/01/2022	Lepe	10:00	Light	SSW	None	7	Falling	Without

Date	Survey location	Start time (hrs)	Wind description	Wind direction	Rainfall during survey period	Temp (°C)	Tide	Warden presence
16/01/2022	Lepe	10:45	Light	WNW	None	8	Falling	With
22/01/2022	Lepe	12:15	Light	NNW	None	7	Rising	Without
23/01/2022	Lepe	12:59	Light	SSE	None	7	High	With
07/02/2022	Lepe	13:30	Moderate	WSW	None	8	High	With
08/02/2022	Lepe	14:30	Moderate	WSW	None	11	High	Without
14/02/2022	Lepe	10:30	Moderate	WSW	None	8	High	With
15/02/2022	Lepe	11:15	Strong	WSW	100%	9	High	Without
01/03/2022	Lepe	11:00	Light	NE	<50%	7	High	With
02/03/2022	Lepe	11:45	Moderate	EWE	100%	8	High	Without
10/11/2021	Bunny Meadows	12:20	Light	W	None	13	Rising	Without
11/11/2021	Bunny Meadows	13:00	Light	SSW	None	14	Rising	With
01/12/2021	Bunny Meadows	10:00	Moderate	WNW	None	8	Falling	With
02/12/2021	Bunny Meadows	10:45	Light	NW	None	5	Falling	Without
29/01/2022	Bunny Meadows	08:45	Moderate	W	None	10	Falling	Without
30/01/2022	Bunny Meadows	09:30	Light	N	None	2	High	With
03/02/2022	Bunny Meadows	11:40	Light	W	None	9	High	With
04/02/2022	Bunny Meadows	12:25	Moderate	NW	None	9	High	Without
08/02/2022	Bunny Meadows	13:15	Strong	SW	None	11	Rising	With
09/02/2022	Bunny Meadows	14:00	Moderate	WSW	None	12	Rising	Without
03/03/2022	Bunny Meadows	09:00	Light	SE	None	8	Rising	With
04/03/2022	Bunny Meadows	09:45	Light	NNW	<25%	6	Rising	Without
05/03/2022	Bunny Meadows	11:50	Moderate	N	<25%	7	High	Without
06/03/2022	Bunny Meadows	12:30	Moderate	NNE	None	6	High	With
03/11/2021	Hill Head	13:01	Light	N	None	11	Falling	Without
04/11/2021	Hill Head	13:47	Moderate	NW	None	9	Falling	With
04/12/2021	Hill Head	13:20	Moderate	WNW	None	8	Falling	With
05/12/2021	Hill Head	14:05	Moderate	NNW	<25%	7	Falling	Without
05/01/2022	Hill Head	08:45	Light	WNW	None	3	Rising	Without
06/01/2022	Hill Head	09:30	Light	E	<25%	2	Rising	With
20/01/2022	Hill Head	08:53	Light	N	None	3	Rising	Without

Date	Survey location	Start time (hrs)	Wind description	Wind direction	Rainfall during survey period	Temp (°C)	Tide	Warden presence
21/01/2022	Hill Head	09:35	Light	NW	None	1	Rising	With
05/02/2022	Hill Head	10:07	Moderate	WSW	None	8	Rising	With
06/02/2022	Hill Head	10:45	Moderate	W	None	10	Rising	Without
16/02/2022	Hill Head	14:15	Strong	W	<25%	12	Falling	Without
17/02/2022	Hill Head	15:00	Moderate	W	None	12	Falling	With
08/03/2022	Hill Head	10:30	Moderate	ESE	None	7	Rising	With
09/03/2022	Hill Head	11:15	Moderate	S	None	11	Rising	Without
10/11/2021	Portchester	09:10	Light	WNW	None	14	Low	Without
11/11/2021	Portchester	09:45	Light	SSE	None	10	Rising	With
01/12/2021	Portchester	13:00	Moderate	WNW	<25%	8	Falling	With
02/12/2021	Portchester	13:45	Light	NW	None	6	Falling	Without
29/01/2022	Portchester	12:00	Moderate	W	None	12	Falling	Without
30/01/2022	Portchester	12:45	Light	N	None	7	Falling	With
03/02/2022	Portchester	15:00	Light	SW	None	9	Falling	With
04/02/2022	Portchester	15:45	Moderate	NW	None	8	Falling	Without
08/02/2022	Portchester	09:45	Moderate	W	None	11	Rising	With
09/02/2022	Portchester	10:30	Light	WSW	None	11	Rising	Without
03/03/2022	Portchester	14:00	Light	SE	<50%	8	High	With
04/03/2022	Portchester	14:45	Light	NNW	None	9	Falling	Without
05/03/2022	Portchester	08:15	Light	N	None	6	Rising	Without
06/03/2022	Portchester	09:00	Moderate	NE	None	6	Rising	With
10/11/2021	Ryde	13:15	Light	W	None	14	High	Without
11/11/2021	Ryde	14:00	Moderate	SW	None	13	High	With
09/12/2021	Ryde	08:15	Light	W	None	7	Low	Without
10/12/2021	Ryde	09:00	Moderate	NW	None	6	Low	With
10/01/2022	Ryde	09:45	Light	SE	None	8	Low	Without
11/01/2022	Ryde	10:30	Light	SW	None	10	Low	With
29/01/2022	Ryde	13:00	Moderate	W	None	13	Low	With
30/01/2022	Ryde	13:45	Light	WSW	None	8	Low	Without
07/02/2022	Ryde	09:00	Light	NW	None	6	Low	With
08/02/2022	Ryde	09:46	Moderate	W	None	10	Low	Without
12/02/2022	Ryde	13:00	Moderate	SW	None	8	Low	With
13/02/2022	Ryde	13:45	Moderate	SSW	>50%	9	Falling	Without
03/03/2022	Ryde	13:45	Light	SSE	<50%	10	Falling	Without
04/03/2022	Ryde	14:30	Light	NNW	None	9	Falling	With
03/11/2021	Hayling Oysterbeds	09:48	Moderate	NW	None	8	High	Without
04/11/2021	Hayling Oysterbeds	10:32	Light	NW	None	8	High	With

Date	Survey location	Start time (hrs)	Wind description	Wind direction	Rainfall during survey period	Temp (°C)	Tide	Warden presence
04/12/2021	Hayling Oysterbeds	10:00	Moderate	WNW	None	6	High	With
05/12/2021	Hayling Oysterbeds	10:45	Moderate	NNW	None	6	High	Without
05/01/2022	Hayling Oysterbeds	12:28	Light	NW	None	6	High	Without
06/01/2022	Hayling Oysterbeds	13:10	Moderate	SW	None	8	High	With
20/01/2022	Hayling Oysterbeds	12:22	Light	N	None	6	High	Without
21/01/2022	Hayling Oysterbeds	13:05	Light	NW	None	5	High	With
05/02/2022	Hayling Oysterbeds	13:15	Moderate	WSW	None	8	High	With
06/02/2022	Hayling Oysterbeds	14:05	Moderate	W	None	10	High	Without
16/02/2022	Hayling Oysterbeds	10:30	Moderate	W	None	12	High	Without
17/02/2022	Hayling Oysterbeds	11:15	Moderate	W	None	11	High	With
08/03/2022	Hayling Oysterbeds	14:00	Moderate	ESE	None	9	High	With
09/03/2022	Hayling Oysterbeds	14:45	Moderate	SE	None	12	High	Without
15/11/2021	Emsworth	11:30	Light	N	None	11	Falling	Without
16/11/2021	Emsworth	12:23	Light	SE	None	11	Falling	With
20/12/2021	Emsworth	14:00	Light	ENE	None	7	Falling	With
21/12/2021	Emsworth	14:15	Light	E	None	6	Falling	Without
08/01/2022	Emsworth	10:35	Moderate	SW	100%	10	Low	With
09/01/2022	Emsworth	11:15	Moderate	W	None	6	Low	Without
07/02/2022	Emsworth	09:45	Light	SW	None	8	Low	Without
08/02/2022	Emsworth	10:30	Moderate	WSW	None	11	Low	With
03/03/2022	Emsworth	13:57	Moderate	SSE	100%	9	Falling	With
04/03/2022	Emsworth	14:30	Light	NNW	None	8	Falling	Without
14/03/2022	Emsworth	13:05	Light	SSW	None	9	Low	With
15/03/2022	Emsworth	13:55	Light	SE	None	11	Low	Without
19/03/2022	Emsworth	14:00	Moderate	ESE	None	15	Falling	With
20/03/2022	Emsworth	14:45	Light	SE	None	9	Falling	Without
15/11/2021	East Head	08:15	Light	N	None	10	High	Without
16/11/2021	East Head	09:10	Light	NW	None	7	High	With
20/12/2021	East Head	09:30	Light	NE	None	7	Rising	With
21/12/2021	East Head	10:15	Light	E	None	5	Rising	Without
08/01/2022	East Head	14:00	Moderate	SW	<25%	10	High	With

Date	Survey location	Start time (hrs)	Wind description	Wind direction	Rainfall during survey period	Temp (°C)	Tide	Warden presence
09/01/2022	East Head	14:35	Moderate	W	None	7	Rising	Without
07/02/2022	East Head	13:30	Moderate	SW	None	10	Rising	Without
08/02/2022	East Head	14:15	Moderate	SW	None	10	Rising	With
03/03/2022	East Head	09:15	Light	SE	None	9	Rising	With
04/03/2022	East Head	10:05	Moderate	NNW	None	7	Rising	Without
14/03/2022	East Head	09:55	Light	SSW	None	9	Falling	With
15/03/2022	East Head	11:02	Light	ESE	None	11	Falling	Without
19/03/2022	East Head	10:10	Moderate	E	None	13	Rising	With
20/03/2022	East Head	10:55	Light	SE	None	9	Rising	Without

Appendix 4: Summary of diary data by activity and survey location

The table overleaf summarises all diary data (all visits), giving total number (%) of events for each survey location. Grey shading indicates values above 0, with pale grey shading indicating percentages below 10 and darker grey shading indicating percentages of 10 and above.

Locational grouping	Activity	Hurst Spit	Newtown	Lepe	Bunny Meadows	Hill Head	Portchester	Ryde	Hayling Oysterbeds	Emsworth	East Head	Total
Airborne	Airborne	8 (1)		4 (0)	2 (0)	6 (1)	7 (1)	1 (0)		10 (1)	12 (1)	**50 (0)**
Predator	Predator	7 (1)			11 (1)	1 (0)	15 (1)		2 (0)	1 (0)	3 (0)	**40 (0)**
Noise	Noise		3 (2)				2 (0)			1 (0)		**6 (0)**
Terrestrial	Bait digging					2 (0)						**2 (0)**
	Birdwatcher	40 (3)	11 (7)	11 (1)	24 (2)	23 (2)	4 (0)		41 (9)	7 (0)	6 (0)	**167 (2)**
	Cycling	43 (3)		9 (1)	33 (3)	4 (0)	20 (2)	78 (5)	13 (3)	14 (1)	23 (2)	**237 (2)**
	Dog off lead					2 (0)		1 (0)				**3 (0)**
	Dog walking	383 (29)	34 (22)	173 (20)	265 (23)	363 (32)	647 (63)	732 (43)	143 (32)	592 (35)	706 (58)	**4,038 (38)**
	Fishing from shore	15 (1)		5 (1)	1 (0)	1 (0)		2 (0)	2 (0)			**26 (0)**
	Golfing						27 (3)					**27 (0)**
	Horse riding							2 (0)				**2 (0)**
	Jogging / power walking /running	45 (3)		7 (1)	44 (4)	28 (2)	40 (4)	63 (4)	11 (2)	28 (2)	28 (2)	**294 (3)**
	Jogging with dog/s	4 (0)		1 (0)	5 (0)	4 (0)	13 (1)			6 (0)	6 (0)	**39 (0)**
	Kids playing (with or without parents)	13 (1)		32 (4)		1 (0)	2 (0)	1 (0)		6 (0)	2 (0)	**57 (1)**
	Metal detecting	1 (0)		1 (0)		3 (0)		1 (0)		2 (0)		**8 (0)**
	Motor vehicle	53 (4)	7 (5)	2 (0)	5 (0)		2 (0)			21 (1)	2 (0)	**92 (1)**
	Person sat on bench or wall									7 (0)		**7 (0)**
	Photography		2 (1)		4 (0)	3 (0)	1 (0)		14 (3)	2 (0)		**26 (0)**
	Picnic	3 (0)		24 (3)	20 (2)	7 (1)	10 (1)	5 (0)		1 (0)		**70 (1)**
	Resident activity				5 (0)	6 (1)						**11 (0)**
	Walking / rambling	696 (52)	66 (43)	460 (54)	522 (45)	677 (59)	240 (23)	797 (47)	172 (39)	985 (58)	415 (34)	**5,030 (47)**

Locational grouping	Activity	Hurst Spit	Newtown	Lepe	Bunny Meadows	Hill Head	Portchester	Ryde	Hayling Oysterbeds	Emsworth	East Head	Total
Water-based	Canoe / kayak on water			6 (1)	2 (0)	1 (0)				2 (0)	2 (0)	**13 (0)**
	Jet Ski on water	1 (0)										**1 (0)**
	Kite surfer on water			2 (0)		8 (1)						**10 (0)**
	Large boat with outboard motor	3 (0)	11 (7)	36 (4)	48 (4)						1 (0)	**99 (1)**
	Moderate – large sailing boat, not running motor		5 (3)	15 (2)	6 (1)							**26 (0)**
	Paddleboarding			2 (0)	7 (1)			1 (0)				**10 (0)**
	Person accessing boat or water	2 (0)		6 (1)	5 (0)			3 (0)	8 (2)	1 (0)	1 (0)	**26 (0)**
	Person working on boat (boat stationary)		3 (2)		17 (1)		1 (0)					**21 (0)**
	RIB or similar fast small boat	3 (0)	3 (2)	33 (4)	94 (8)	1 (0)			2 (0)		2 (0)	**138 (1)**
	Rowing boat	1 (0)	5 (3)		4 (0)							**10 (0)**
	Small sailing boat (e.g. Laser / dinghy)	2 (0)	2 (1)	9 (1)	21 (2)					2 (0)	2 (0)	**38 (0)**
	Swimming			12 (1)	1 (0)					1 (0)		**14 (0)**
	Water skiing				1 (0)							**1 (0)**
	Windsurfer on water			4 (0)		8 (1)			33 (7)	1 (0)		**46 (0)**
Other	Other	4 (0)	3 (2)	3 (0)	1 (0)	3 (0)	2 (0)	2 (0)			3 (0)	**21 (0)**
Unidentified	Unidentified						2 (0)		1 (0)	4 (0)		**7 (0)**
Total		**1,327 (100)**	**155 (100)**	**857 (100)**	**1,148 (100)**	**1,152 (100)**	**1,035 (100)**	**1,689 (100)**	**442 (100)**	**1,694 (100)**	**1,214 (100)**	**10,713 (100)**

Appendix 5: Bird count data

The table overleaf depicts the maximum count for each species across all visits to each survey location and the summed total across all locations. Note that gulls numbers were not noted consistently at busier sites, and the numbers presented may therefore potentially constitute undercounts.

Species group	Species	Hurst Spit	Newtown	Lepe	Bunny Meadows	Hill Head	Portchester	Ryde	Hayling Oysterbeds	Emsworth	East Head	Total
Wildfowl	Black Brant									1		**1**
	Canada Goose	158	1		22		2					**183**
	Dark-bellied Brent Goose	509	418	56	185	270	271	43	140	537	760	**3,189**
	Eider					36						**36**
	Gadwall					22	2					**24**
	Goldeneye								2			**2**
	Goosander					3			2		4	**9**
	Mallard	23	17	2	7	2	4		2	5		**62**
	Mute Swan	23	3		4	1	1			4		**36**
	Pale-bellied Brent Goose	1					1			1		**3**
	Pintail	45	22						2	20		**89**
	Red-breasted Merganser		18	1			10		13	1	2	**45**
	Shelduck	6	59		18		45		4	3	4	**139**
	Shoveler								2			**2**
	Teal	450	40		120		275			46	110	**1,041**
	Wigeon	194	50		123	2	405		3	182	49	**1,008**
Waders	Avocet										4	**4**
	Bar-tailed Godwit				1			2	3			**6**
	Black-tailed Godwit	229	7		52		136			143	63	**630**
	Curlew	11	68	2	17	1	35	9	2	16	33	**194**
	Dunlin	247	920		500	12	1,300	5	2,500	65	500	**6,049**
	Golden Plover	27	220		39						15	**301**
	Greenshank	1	1		2		2		1	6	2	**15**

Species group	Species	Hurst Spit	Newtown	Lepe	Bunny Meadows	Hill Head	Portchester	Ryde	Hayling Oysterbeds	Emsworth	East Head	Total
Waders	Grey Plover	8	24	4	37				460	5	25	**563**
	Knot	1	100						13		18	**132**
	Lapwing	45			3						62	**110**
	Oystercatcher	24	27	36	19	40	39	34	650	27	31	**927**
	Redshank	37	13		95	6	105		112	24	57	**449**
	Ringed Plover	9	20	2	37	21		22	22	3	45	**181**
	Sanderling					57		58				**115**
	Snipe										4	**4**
	Spotted Redshank									1		**1**
	Turnstone	55	41	44	15	60	56		106	3	38	**418**
	Whimbrel										1	**1**
Other	Black-throated Diver			1								**1**
	Cormorant	4	21	3	3	1	1		1	20	1	**55**
	Great Crested Grebe		2	3	2	3	4		2	2	5	**23**
	Grey Heron				3		1		1			**5**
	Little Egret	3	4	1	3		3	2	3	1	5	**25**
	Little Grebe		6		5		4		4			**19**
	Moorhen				1						2	**3**
	Razorbill			6								**6**
	Slavonian Grebe										1	**1**
	Spoonbill	1										**1**
Gulls and terns	Black-headed Gull	95	194	36	79	354	121	300	388	100	342	**2,009**
	Common Gull	1	1	2	17	8	110	40	3	3	1	**186**

Species group	Species	Hurst Spit	Newtown	Lepe	Bunny Meadows	Hill Head	Portchester	Ryde	Hayling Oysterbeds	Emsworth	East Head	Total
Gulls and terns	Great Black-backed Gull			2		3		3		1	2	11
	Herring Gull	8	7	2	5	95	5	31	3	5	4	165
	Lesser Black-backed Gull							2				2
	Mediterranean Gull	12	110	1		2	4	96	725	1	1	952
	Sandwich Tern			2				3			1	6