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Exe Estuary Wildlife Refuge Monitoring Programme – 1st Annual Report

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Summary

This is an interim report, part of a three-year monitoring programme for two wildlife refuges on the Exe Estuary. The refuges have been created to provide space for wildlife at a site with growing levels of recreation use. The refuges are voluntary and cover two key parts of the estuary (at Dawlish and at Exmouth), providing intertidal feeding and roosting habitat for wintering water birds, for which the Estuary is internationally important.

This report presents data from the period February 2018 – March 2019. The refuges were established on the 15th September 2018 and therefore the monitoring data covers a period before the refuges were established as well as when they were running and active. While the Dawlish refuge runs year-round, the Exmouth one is only active from mid-September to the end of December each year, coinciding with the time of year when the area is most important for birds.

Monitoring comprised of two different fieldwork elements. Core Counts involved continuous recording for one hour and forty-five minutes, logging all human activity within a set recording area, as well as the number of birds and interactions between people and birds. Core Counts were conducted at four locations. The Core Count recording areas included parts of each refuge, as well as neighbouring areas of mudflat. Vantage Point Counts were the second fieldwork thread and were undertaken much more frequently. These involved a snapshot count of all recreational activity on the intertidal and shoreline areas, with each event being mapped, and the number of birds inside and outside the refuge estimated. These counts were completed quickly, and three vantage point locations were utilised.

Key findings included:

- High numbers of birds were present in and around both refuges.
- The bird Core Counts from Exmouth were highest in the autumn/early winter (when the refuge was active) while this was less apparent at Dawlish (on the western side of estuary), providing support for the different time periods that the refuges are active.
- Vantage Point Count data showed a significant difference in the proportion of waders and of wildfowl recorded inside the Exmouth refuge during the post-refuge period, compared to outside the refuge. A greater proportion of birds were also present inside the refuge when it was active. For the Dawlish refuge, differences were not so clear and suggest a higher proportion of waders inside the refuge during the pre-refuge period, but a larger number of wildfowl inside the refuge once it was active.
- In terms of recreation use, the Exmouth side was much busier, with many more dog walkers, walkers, and watersports recorded at the Exmouth Duck Pond in particular.
- There was no evidence that the refuges are deterring visitors to the respective areas in general, for example the Core Count data showed watersports and dog walkers using the general Duck Pond area (i.e. including areas outside the refuge) when the refuge was active.
- Vantage Point Count data showed recreational use inside the refuges, particularly Exmouth, when the refuge was not active; this then dropped to a low level when the

refuge was active, suggesting that people were changing their behaviour and recognising the refuges.

- There were relatively few times that people were recorded within the refuges while they were active, but incursions were recorded; in terms of overall number of events, dog walkers and bait diggers accounted for most of the incursions into the refuge at Exmouth (but kitesurfers, windsurfers, walkers and a RIB were also recorded) and walkers, bird watchers, crab tilers and shore fishing were the main incursions into the refuge at Dawlish.
- Observations of bird responses to activities taking place within the refuges recorded a total of 66 waders and 696 wildfowl flushed, during the active period.
- Comparison of data from different time windows, when the refuges were active or not, suggests there is a higher likelihood of a behavioural response occurring when the refuges are active, with higher proportions of birds taking flight or responding.

The data therefore indicate that the refuges can support good numbers of birds and that incursions into the refuges (when they are active) are relatively infrequent, but when they do occur they can have a marked impact in terms of a behavioural response from the birds present. These results are interim and part of a three-year monitoring programme. Further monitoring will highlight whether there are changes in the number of incursions, and whether there are shifts in how the areas are used by birds, over time.

Contents

Acknowledgements

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John Waldon undertook the majority of the fieldwork, particularly the Core Counts. Sama Euridge and Amelia Davies (South East Devon Habitats Regulations Partnership) also undertook Vantage Point Counts. Data were entered and digitised by Zoe Caals (Footprint Ecology).

Cover image of a Windsurfer in the Exe cc-by-sa/2.0 - © Lewis Clarke - geograph.org.uk/p/2444545; all other images Footprint Ecology.

1. Introduction

1.1 This report is an interim report, part of a three-year monitoring programme of two recently established voluntary wildlife refuges on the Exe Estuary.

The Exe Estuary

1.2 The Exe Estuary lies between Teignbridge District to the west, East Devon District to the east and Exeter City to the north. It is designated as a Special Protection Area (SPA), Ramsar site, European Marine Site, and Site of Special Scientific interest (SSSI).

1.3 The SPA includes the estuary waters, foreshore, saltmarsh, and the sand dunes and spit of Dawlish Warren, and extends to Exeter at the top (northern part) of the estuary. The estuary includes a range of intertidal habitats, including mudflats, sandflats, Eelgrass *Zostera* sp. beds, Mussel *Mytilus edulis* beds, and saltmarsh. A number of bird roost sites at the top end of the estuary are freshwater grazing marsh, and the lagoons at Bowling Green Marsh and Exminster Marshes lie within the SPA and are also Royal Society for the Protection of Birds (RSPB) reserves.

1.4 The Exe Estuary qualifies under Article 4.1 of the Birds Directive by supporting overwintering populations of the following species, listed on Annex I of the Directive:

- Avocet *Recurvirostra avosetta* (at least 28.3% of the wintering population in Great Britain). The majority of British Avocets move from their East Anglian breeding grounds to coastal estuary sites, either in East Anglia or on the south coast. The Exe Estuary is one of only three SPAs classified for non-breeding Avocets.
- Slavonian Grebe *Podiceps auritus* (at least 5.0% of the wintering population in Great Britain). The Exe Estuary is one of only three sites in the UK classified as an SPA for non-breeding Slavonian Grebe, with the other two sites being in Scotland.

1.5 The Exe Estuary qualifies under Article 4.2 of the Birds Directive for both its overwintering populations of regularly occurring migratory species and as a site supporting an internationally important assemblage of birds.

- The estuary supports the following migratory species over winter: Dark-bellied Brent Goose *Branta bernicla bernicla,* Dunlin *Calidris*

alpina alpina, Oystercatcher *Haematopus ostralegus,* Black-tailed Godwit *Limosa limosa islandica*, and Grey Plover *Pluvialis squatarola.*

1.6 The estuary also qualifies under Article 4.2 of the Directive as it regularly supports an assemblage of at least 20,000 wintering waterfowl, including: Black-tailed Godwit, Dunlin, Lapwing *Vanellus vanellus*, Grey Plover, Oystercatcher, Red-breasted Merganser *Mergus serrator*, Wigeon *Anas penelope*, Dark-bellied Brent Goose, Cormorant *Phalacrocorax carbo*, Avocet, Slavonian Grebe and Whimbrel *Numenius phaeopus.* This list is taken from the site citation, where a range of assemblage species is normally quoted, but not the entire assemblage species list. Other species therefore also form part of the assemblage.

Legislative context and impacts from recreation

1.7 A particular issue for nature conservation in England is how to accommodate increasing demand for new homes and other development without compromising the integrity of protected wildlife sites. Wildlife sites are protected through legislation at both a national (SSSIs) and European level (European wildlife sites, often also referred to as Natura 2000 sites, which include SPAs), and these place particular duties on local authorities and government bodies.

1.8 New development in proximity to European wildlife sites must consider the potential effects that the new development may have upon them. There is now a strong body of evidence showing how increasing levels of development, even when well outside the boundary of protected wildlife sites, can have negative impacts on the sites and their wildlife interest. The issues are particularly acute in southern England, and on coastal sites (Saunders *et al.* 2000; Randall 2004; Liley & Sutherland 2007; Clarke, Sharp & Liley 2008; Liley 2008; Stillman *et al.* 2009; Ross *et al.* 2014).

1.9 The nature conservation impacts of development are varied (e.g. Underhill-Day 2005). One particularly difficult and challenging impact relates to the use of sites to meet recreational needs, and the resultant disturbance to waterfowl on coastal sites. Disturbance has been identified by Natural England as a generic issue across many European Marine Sites (see Coyle & Wiggins 2010), and can be an issue for a range of species.

1.10 Disturbance to wintering and passage waterfowl can result in:

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

1.11 Comparisons of estuary SPA sites across England highlight the Exe Estuary as potentially being particularly vulnerable to development and the impacts from recreation (Ross *et al.* 2014). That work ranks the Exe Estuary among the top five most vulnerable sites, and it is particularly vulnerable compared to other locations due to factors such as the relatively high volume of housing currently close to the SPA, it's relatively small size, and the high proportion of the shoreline which is currently accessible.

Strategic mitigation and the creation of refuges

1.12 Concern about impacts of housing growth from new development, particularly linked to considerable growth set out in relevant plans in and around Exeter (i.e. Teignbridge, Exeter and East Devon), led to a strategic mitigation approach covering the Exe Estuary and nearby European sites. The approach involved developer contributions being used to fund a broad package of mitigation work (see Liley *et al.* 2014 for details and background).

1.13 In June 2016, the South East Devon Habitat Regulations Executive Committee was formed, involving a partnership of the three local authorities. The Committee approved a review of zonation in the Exe Estuary as part of the 2016-17 Annual Business Plan and this review identified two parts of the estuary as critical to the ecological function of the SPA. As a result, these two areas were proposed as voluntary refuges, within which recreation use is minimised, and their creation was officially approved by the Executive Committee at their meeting of 23rd October 2017.

1.14 One refuge relates to Exmouth, with the other at Dawlish Warren, together encompassing around 7% of the estuary and shown in Map 1. Both refuges became operational in 2018, officially running from the 15th September 2018.

The Dawlish Warren refuge is subsequently in place year round, whilst the Exmouth refuge is only in place (active) between 15th September and the end of December each year.

1.15 There are allowances for certain activities within the refuges (see Exe Estuary Management Partnership 2017 for full details), which include crab tiling in the Dawlish refuge (9 crab tilers continue to work under permit) and shore fishing (accessing from the shore and not by boat) at Exmouth. The refuges are clearly defined on the ground through the use of large yellow buoys and signs (Figure 1).

Figure 1: Yellow buoys in a line at Exmouth, indicating the edge of the refuge, looking towards Lympstone. Inset: sign on shore indicating when the refuge is active.

Aims of this study

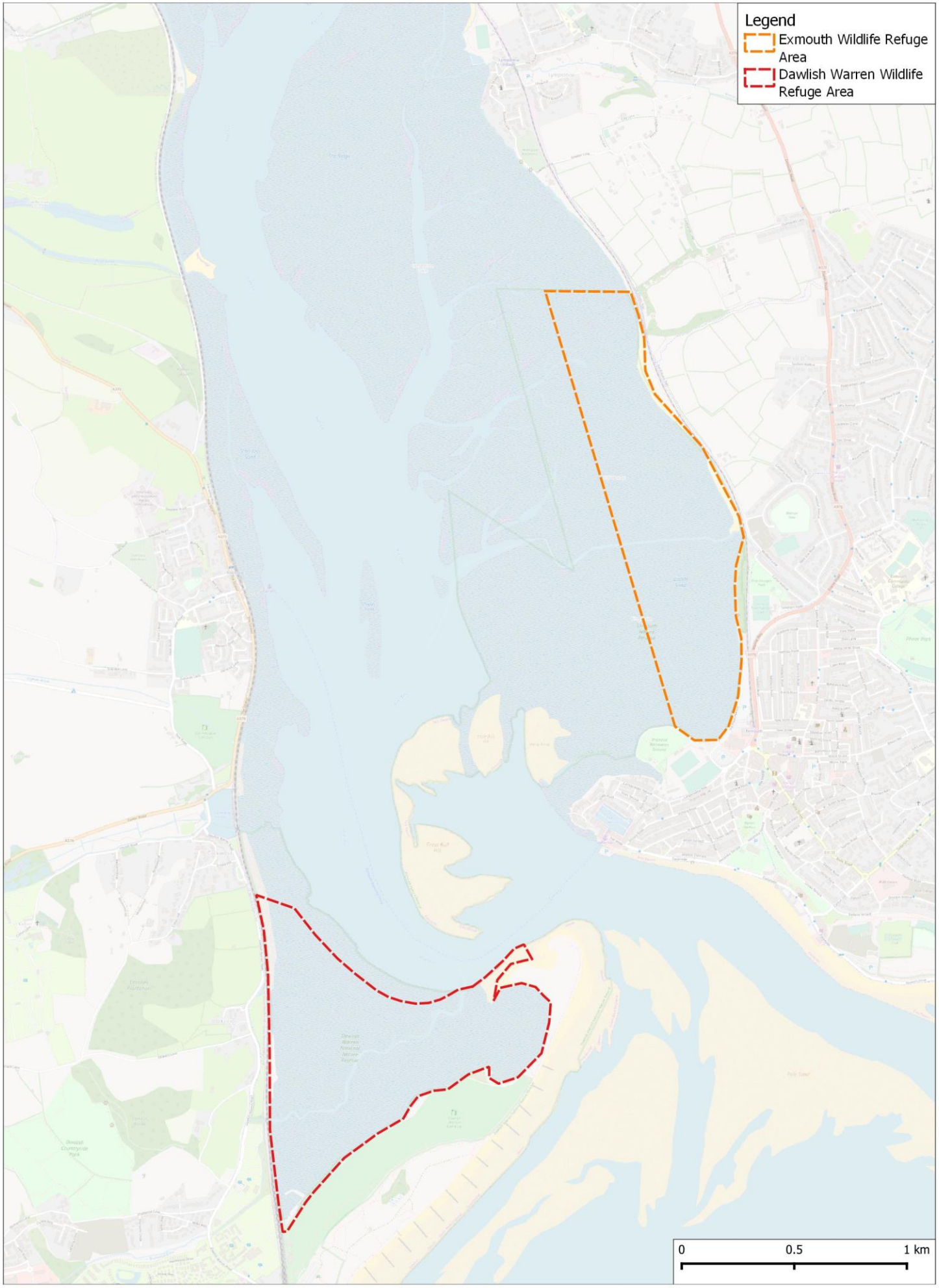
1.16 The creation of refuges such as these is a relatively novel approach in the UK to managing recreation pressure, and there are some potential challenges. It may be that the refuges are still vulnerable to disturbance from activities around the periphery, or from people straying into the refuges (which may include those that deliberately choose to ignore the refuges, those that have to enter them for safety reasons, or those that are simply unaware). Certain activities, such as wildfowling and crab tiling, will also continue to take place, and it may be that the level of use from these activities is sufficient to undermine the effectiveness of the refuges. It is therefore important to collect monitoring data to check how well the refuges are working and what further measures (if any) may be needed to ensure they work well.

1.17 Over time it might be expected that – if working well – bird use within the refuges will increase. As such, a higher proportion of the sites' birds may occur within the refuge. It may however take time for such patterns to become established, especially when the refuge is in place within a set

temporal window. Changes in bird numbers may also mean that more birds are recorded being flushed, or exhibiting other behavioural responses, and any potential changes in bird use and behaviour are therefore likely to be complex.

1.18 Robust, carefully designed, monitoring is therefore necessary to help deliver the mitigation and ensure its effectiveness. Such monitoring needs to dovetail with previous data collection (the Exe Disturbance Study) and run over a number of years, and the results and key messages from the data need to be fed back to users, and those responsible for overseeing the refuges, to ensure their success.

Map 1: Exe Estuary Wildlife Refuge Areas.



2. Methods

2.1 Two different monitoring approaches have been utilised:

- Core Counts, involving continued observation over a fixed time period (1 hour and 45 minutes), recording the birds present, human activity, and any interactions between people and birds, and;
- Vantage Point Counts, involving quick, 'snapshot', counts recording the number of birds present and the distribution of human activity.

2.2 Core Counts provide detailed data relating to the responses of birds and prolonged observation across a fixed (but relatively small) recording area. Vantage Point Counts are much quicker and easier to carry out, cover a much wider area, and are undertaken much more frequently than the Core Counts. The Vantage Point Counts therefore provide the best indication of how frequently there are people inside the refuges.

Core Counts

2.3 The approach is one that builds on the previous Exe Disturbance survey (Liley *et al.* 2011), and has been developed in line with a series of studies across the country, commissioned by Natural England and others (Liley, Stillman & Fearnley 2010; Liley & Fearnley 2011, 2012; Ross *et al.* 2014; Ross & Liley 2014; Liley *et al.* 2015, 2017).

Recording elements

2.4 Each count involved the following elements:

- Two counts of birds, one count 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, and;
- Any additional information.

2.5 These different elements are described in more detail below, but in summary the bird counts provide a detailed level of use within the core area, the diary records the levels of human activity, the response data details any behavioural response to disturbance shown by the birds present, and the additional information provides context and background.

Bird count

2.6 At the start of each survey visit, a count of the birds present was conducted, comprising all waders, gulls, 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 watch point. This area was carefully mapped for each location, using aerial photographs. 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

2.7 All recreation events (and other potential disturbance events, 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.

2.8 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.

Bird response

2.9 Events in the diary were categorised as a 'potential disturbance event' if:

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

2.10 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.

2.11 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 within various groups of birds of different species.

2.12 For each observation, 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 (less than 50m)' 'Major Flight' 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).

2.13 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. If the birds were scattered over a wide area, and all were disturbed, then the distance from the closest bird to the disturbance was noted. 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

2.14 Additional information provided context and background and included tide times, tide coverage, and weather.

Survey locations, timing and logistics (including coverage of tide states, etc.)

2.15 Four survey locations were used, two at Dawlish Warren and two at Exmouth. These are shown in Map 2. Visits were spread over different days and times of day to ensure a range of conditions and circumstances were covered. As far as possible, visits included the following:

- A range of weather conditions, including some dates with strong winds when water sports and sailing are likely to take place;
- Any particular events that were known the be taking place;
- Weekends and weekdays and different times of day, and;
- A range of tide states. At the Dawlish Warren Bird Hide survey point, most visits were targeted towards high tide. For large tides (above 3.6m) we aimed to avoid the time around 1hr before high tide to 2hrs after (as wardens were potentially in place to intercept visitors); at Cockwood and the two Exmouth survey points, visits covered a range of tide states.

Vantage Point Counts

2.16 Alongside the prolonged, detailed, watches described above, we undertook a series of Vantage Point Counts, utilising a similar approach to the original Exe Disturbance work. These consisted of 'snapshot' counts, whereby a wide expanse of the estuary was scanned with binoculars from pre-selected vantage points, and a count made of any people, activities, and birds present. The aim of these counts was to supplement the work set out above (Core Counts) with a simpler approach that ensures much wider coverage (the entire refuge area). The Vantage Point Counts were quick and easy to do, and, as such, collection of a large sample was feasible, with data collected by Footprint Ecology supplemented with data from the mitigation rangers. Prior to commencement of the surveys, the rangers were provided

with full training to ensure that the methods used by all surveyors were consistent.

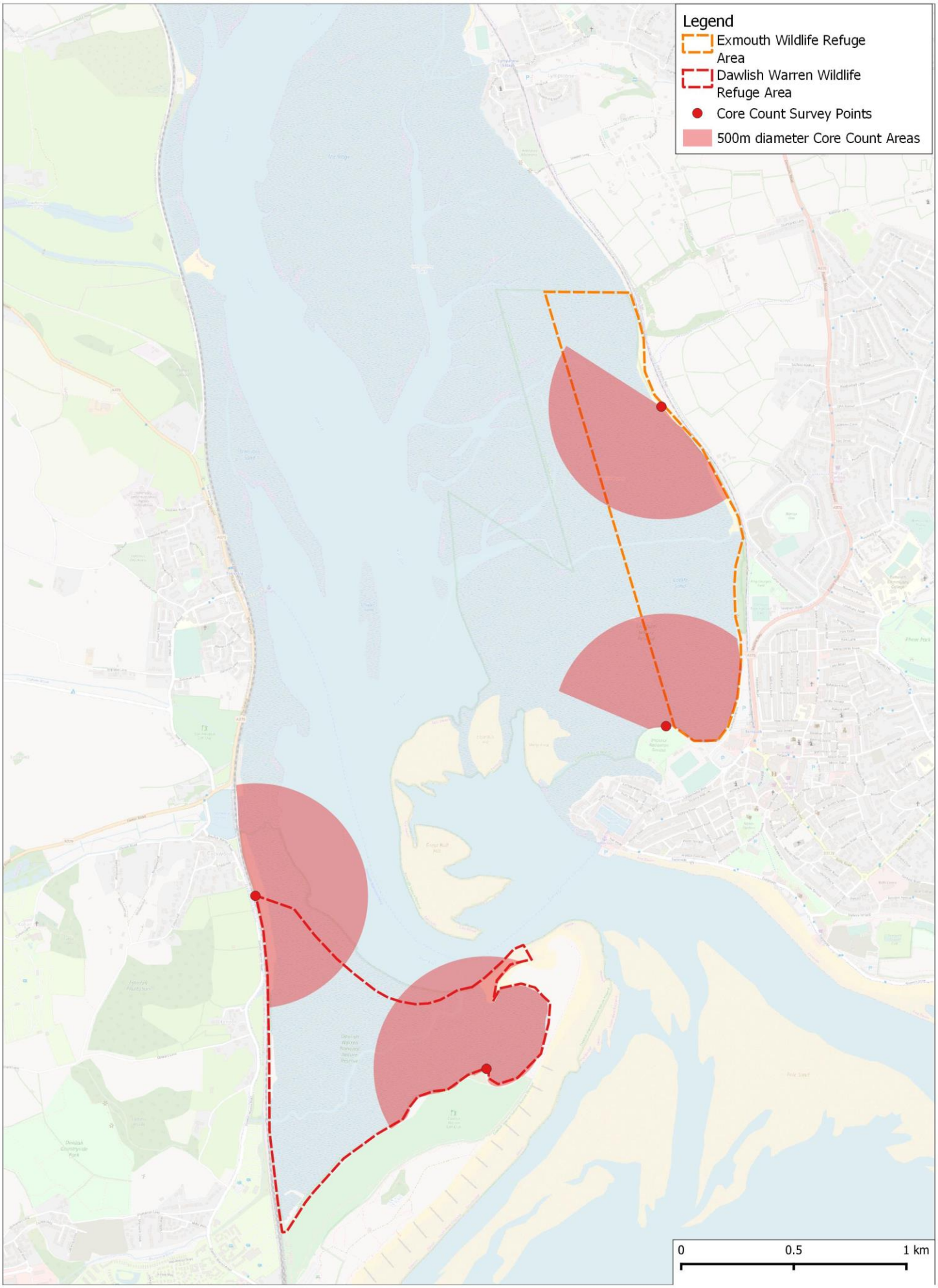
2.17 Vantage Point Counts took place at three locations (Map 3), which together provided a view of a wider area of the estuary; each location was easy and quick to access. Each Vantage Point Count visit involved the surveyor mapping all people and activities visible, recorded by scanning slowly with a single sweep of binoculars. Every effort was made to map the locations of the people/activities observed as precisely as possible. Given the difficulty in identifying the exact location of distant individuals (e.g. crab tilers) on large expanses of featureless mudflat the points as mapped are relatively approximate. Where physical demarcations existed (e.g. the buoy lines marking the boundaries of the refuge areas) it was possible to identify the exact location of people/activities within proximity to them. This was not the case however for additional areas which lacked visible boundary markers (e.g. the D&S IFCA Byelaw 24 "crab tiling" line).

2.18 A count of birds within the area was also made during the Vantage Point Counts. This bird count was relatively quick and recorded only wildfowl and waders. Large flocks were estimated rather than systematically counted and counts will be approximate in some cases (for example when there were birds roosting on the distant saltmarsh to the south of the Cockwood vantage point location). The location of the birds counted were not mapped during the Vantage Point Counts, but the number of birds inside and outside the refuge areas was noted.

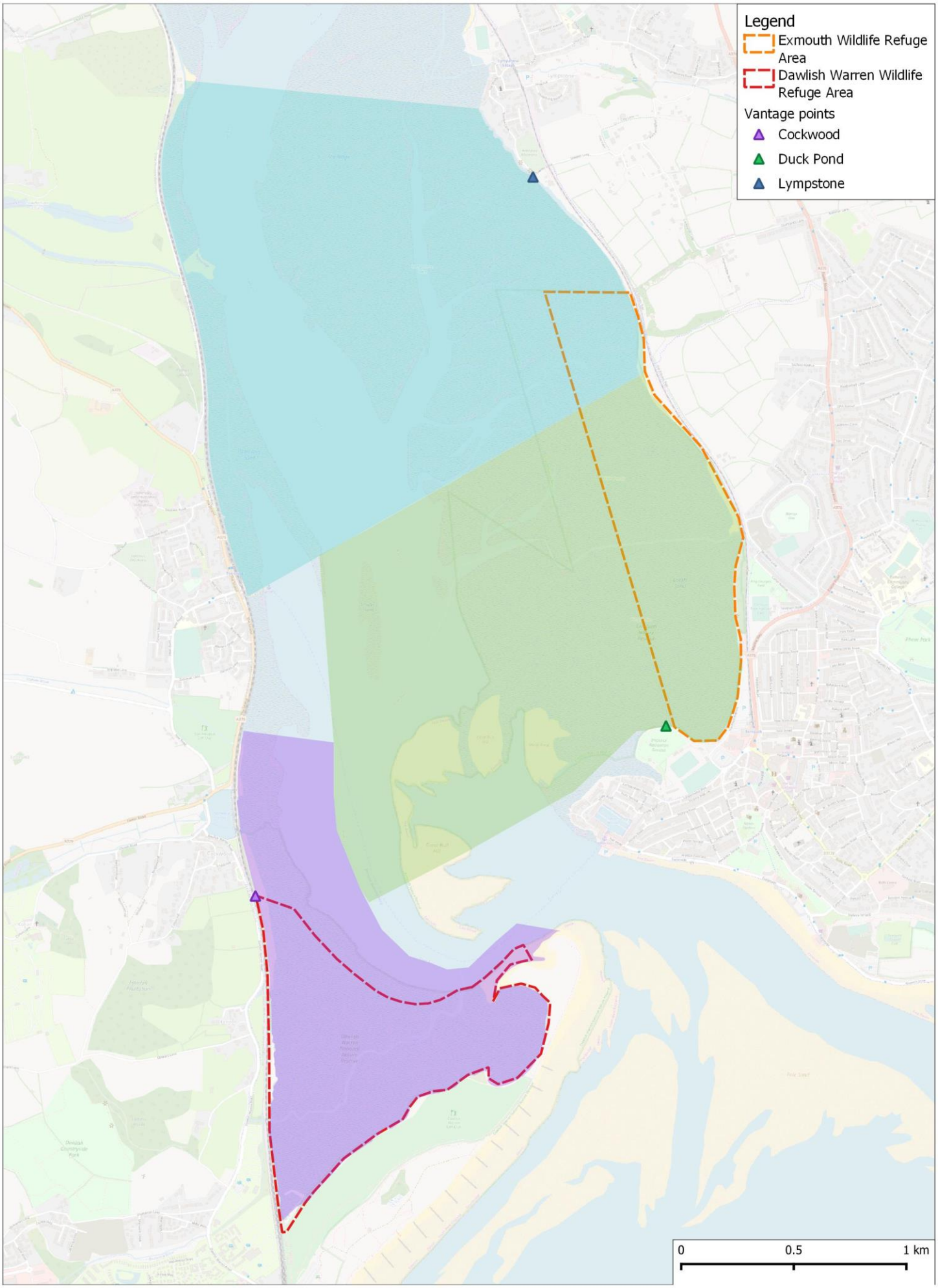
2.19 The Vantage Point Counts took up to 15 minutes to carry out, and were simple to complete, providing an easily replicated approach. We aimed for repeat counts from multiple dates and times. While not recording levels of disturbance *per se* (i.e. birds being flushed), with a reasonable sample spread over time, the Vantage Point Count data provided information on:

- Which activities took place within the refuges;
- How frequently they occured;
- How the numbers of birds in the refuges varied (e.g. when the estuary was busy, when there were events within the refuges, etc.); and,
- Vantage Point Counts were undertaken whenever a Core Count site visit was made. In addition, a number of targeted Vantage Point Count visits were made to ensure good coverage and a wide range of dates, conditions, and times of day.

Map 2: Exe Estuary Core Count locations.



Map 3: Exe Estuary Vantage Point locations and approximate field of view of each.



Timing across the year of both count types

2.20 The temporal spread of counts and total fieldwork undertaken from the start of the monitoring in early 2018 through to the end of March 2019 are summarised in Table 1. Survey effort was spread across months, and monitoring is on-going. The data presented in this report therefore relates to the counts shown in Table 1. It is important to note these data are just the initial part of a larger body of counts and this report therefore only includes data from the first part of the monitoring period.

2.21 In total, during the period February 2018-March 2019, 52 Core Counts were undertaken, involving 13 at each of the four survey points. At both the Cockwood and Dawlish Warren survey locations, 10 Core Counts took place in the post-refuge period and 3 took place in the pre-refuge period. At both of the Exmouth locations, 8 of the counts were made during the period that the refuge was active following its' instigation, and a combined total of 5 during the pre-refuge and post-refuge inactive period.

2.22 In total, 44 Vantage Point Counts were undertaken at Cockwood, with 25 of these during the period that the refuge was active. A total of 44 counts were undertaken at the Duck Pond (19 of which were during the time when the Exmouth refuge was active) and 38 were undertaken at Lympstone (12 of which were when the Exmouth refuge was active).

Data analyses and presentation

2.23 The data collected was analysed using R and Minitab statistical software packages, with graphs and tables produced using both R and Microsoft Excel. The graphs include examples of stacked barplots, histograms, and box and whisker plots. The latter graph type depicts a range of information in a single plot, including the median value (represented by a thickened central line within the box), the interquartile range (the distribution of 25% to 75% of the data) of the dataset (the box itself), the range of the dataset (the 'whiskers'), and any outlier values (represented as stand alone points).

Table 1: Summary of the number different counts by month and location, over the period February 2018-end March 2019. Ticks/shading indicate whether the refuge was operational during the month (with brackets indicating months where the refuge was operational for part of the month only).

Month	Year	Core Counts Exmouth	Core Counts Dawlish	Vantage Point Counts (Footprint Ecology)	Vantage Point Counts (South East Devon Habitats Regulations Partnership)	Total Vantage Point Counts	Exmouth refuge operational /active	Dawlish refuge operational
Feb	2018	2	2	3	0	3	x	x
Mar	2018	2	2	3	3	6	x	x
Apr	2018	0	0	3	1	4	x	x
May	2018	0	0	0	8	8	x	x
Jun	2018	0	0	0	2	2	x	x
Jul	2018	0	0	0	9	9	x	x
Aug	2018	0	2	3	10	13	x	x
Sep	2018	4	2	6	4	10	(✓)	(✓)
Oct	2018	4	4	6	12	18	✓	✓
Nov	2018	6	4	9	6	15	✓	✓
Dec	2018	4	2	6	2	8	✓	✓
Jan	2019	2	2	6	7	13	x	✓
Feb	2019	2	4	6	3	9	x	✓
Mar	2019	0	2	3	2	5	x	✓
Total		**26**	**26**	**54**	**69**	**123**		

3. Results

Bird numbers

Core Counts

3.1 Bird numbers from the Core Counts are summarised by date in Figure 2, with wildfowl and waders accounting for most of the birds counted. The higher counts at the two Exmouth locations were made during the autumn/early winter period, when the refuge was active. Counts of over a thousand birds were recorded during three of the Exmouth Core Counts, all during the period within which the refuge was active.

3.2 These high counts were from both the Duck Pond and Exmouth north, indicating the potential for both areas to support high numbers of birds (mostly wildfowl, but also a large number of waders). Large wader totals at the Duck Pond included 354 Oystercatcher and 87 Curlew on the 9th October 2018. The bird numbers recorded at both of the Exmouth locations after the end of December were relatively low in comparison, with none exceeding 400 birds in total across all species.

3.3 At the Dawlish Warren and Cockwood locations, waders accounted for a much higher proportion of the birds counted. Larger counts at these two locations were also less concentrated around the autumn/early winter period, for example there were high counts from both the Cockwood and Dawlish Warren survey locations in January 2019. The largest counts recorded for each species at each survey location are provided in the Appendix.

Vantage Point Counts

3.4 The Vantage Point Count data are summarised in Figure 3, which shows the count data inside and outside the refuges, when they were active and when not. In Figure 3 all Vantage Point Count data are used, including across different tide states and times of year. The data are also summarised in Table 2, where the median values and total counts are given. In Table 2 the initial rows summarise all Vantage Point Counts, while the lower rows exclude those visits at high tide. In both Figure 3 and Table 2, the Exmouth counts reflect the data from both vantage points on the eastern side of the estuary.

Figure 2: Maximum counts for each Core Count (maximum taken from the count at start and at end of visit, for each species), by date and location. Note the axis are different in each figure. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling.

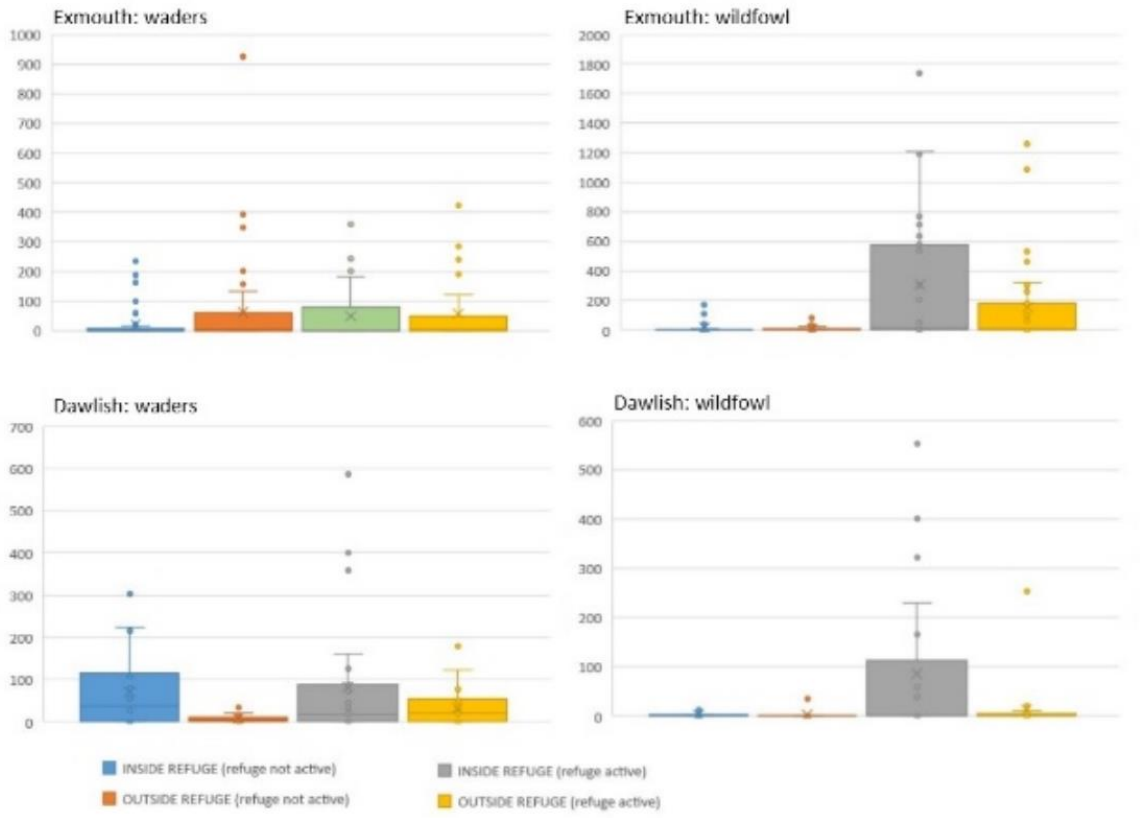


Figure 3: Vantage Point Count bird data, comparing counts from inside and outside the refuges.

Table 2: Summaries of bird counts from vantage points inside and outside refuges, when refuges were active and when not active. Grey shading reflects the higher median and higher total in each row.

Refuge	Species	Refuge active?	Birds INSIDE refuge			Birds OUTSIDE refuge		
			Median	Total	n	Median	Total	n
All counts								
Exmouth	Waders	Active	0	1529	31	4	1759	31
Exmouth	Waders	Not	0	1016	51	5	3114	51
Exmouth	Wildfowl	Active	14	9420	31	10	4862	31
Exmouth	Wildfowl	Not	0	681	51	0	522	51
Dawlish	Waders	Active	18	2097	25	20	788	25
Dawlish	Waders	Not	36	1369	19	2	145	19
Dawlish	Wildfowl	Active	1	2167	25	0	336	25
Dawlish	Wildfowl	Not	0	43	19	0	38	19
Excluding high tide counts								
Exmouth	Waders	Active	6	1505	19	30	1751	19
Exmouth	Waders	Not	1	1004	35	15	3029	35
Exmouth	Wildfowl	Active	45	7771	19	64	3216	19
Exmouth	Wildfowl	Not	0	386	35	1	491	35
Dawlish	Waders	Active	78.5	1568	12	25.5	422	12
Dawlish	Waders	Not	45.5	738	12	10.5	135	12
Dawlish	Wildfowl	Active	49	1860	12	1.5	324	12
Dawlish	Wildfowl	Not	0	31	12	0	38	12

3.5 One of the challenges with presenting and analysing count data, where birds can occur in large flocks and are mobile, is that the data are often in the form of some very high counts alongside plenty of low or zero counts. With birds clumped in space and time, such data are inevitable. With relatively small sample sizes, analysis at this interim stage is therefore limited by sample size, meaning sophisticated analysis controlling for tide state, time of year, and when the refuges are active is not possible. Nonetheless some patterns are visible.

3.6 The data show that, at Exmouth, more waders were counted outside the refuge compared to inside. However, the refuge accounts for a relatively small proportion of the intertidal habitat within the Vantage Point Count area, so this is perhaps not surprising. When the Exmouth refuge was active a total of 1,529 waders were counted inside compared to 1,759 outside (i.e. a ratio of 1:1.2). By contrast, when the refuge was not active, 1,016 waders were counted inside compared to 3,114 outside (ratio of 1:3.1). These totals indicate an overall difference in the proportionate use of the refuge by waders when the refuge was active compared to when it was not (X^2_1=389.63, p<0.001).

3.7 For wildfowl counts at Exmouth, the patterns were slightly different. Counts inside and outside were very much higher during the period the refuge was active, and the totals were roughly twice as high inside the refuge compared to outside (9,420 birds inside compared to 4,862 outside). When the refuge was not active there were roughly similar proportions inside compared to outside (681 inside compared to 522 outside). Again, these relative proportions are significantly different (X^2_1=42.76, p<0.001). At Exmouth therefore the data indicate that for both waders and wildfowl a higher proportion of individuals were inside the refuge compared to outside when the refuge was active.

3.8 At the Dawlish refuge, the total number of waders counted inside the refuge compared to outside was always much higher, whether the refuge was active or not. The overall proportions were significantly different (X^2_1=186.916, p<0.001), with a smaller proportion of the totals inside the refuge when the refuge was active.

3.9 For the wildfowl counts from the vantage point at Cockwood, when the refuge was active a total of 1,860 birds were counted inside the refuge compared to 324 outside, while when the refuge was not active the counts were much lower and relatively similar, with a total of just 31 birds inside

and 38 outside. These relative proportions are significantly different (X^2_1=80.30, p<0.001), indicating a higher proportion inside the refuge when it was active.

3.10 In the comparisons above we have pooled data for waders and wildfowl, in order to look for general patterns. Count data for a selection of different species and species groups are shown in Figure 4, here we have pooled the data across both refuges. These plots indicate some variation in species, and further data will be necessary before detailed analysis can include differences between species.

3.11 These results are therefore generally supportive that the refuges are working, in that there is evidence of a greater proportion of use within the refuges when they are active. The patterns are however potentially confounded by the time of year, as the data reflecting when the refuges are not active is from the late winter/early spring period.

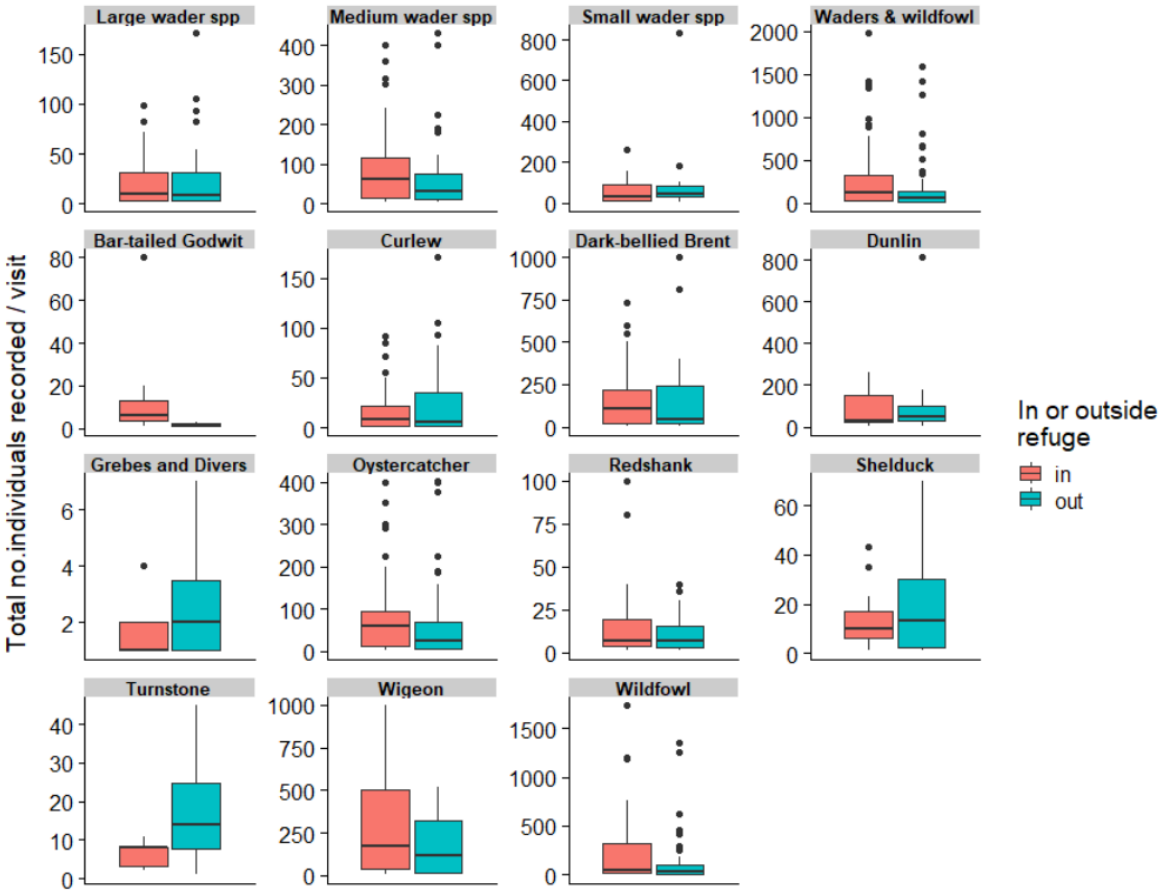


Figure 4: Number of individuals recorded in and outside of the combined refuge areas across all survey visits for a subset of recorded species/species groups *(note varying y axis scales per plot, and that the data presented in the figure corresponds solely to geographic location, and does not consider the temporal status of the Exmouth refuge area).*

Human Activity

Number of recreation events

3.12 Core Count data are summarised in Figure 5, showing the overall totals for the two sides of the estuary from all counts. These data reflect all observations of people and events that could disturb birds, both inside and outside the refuges. In general, it can be seen that the Exmouth side was much busier in terms of people on foot, with more dog walkers and walkers in particular.

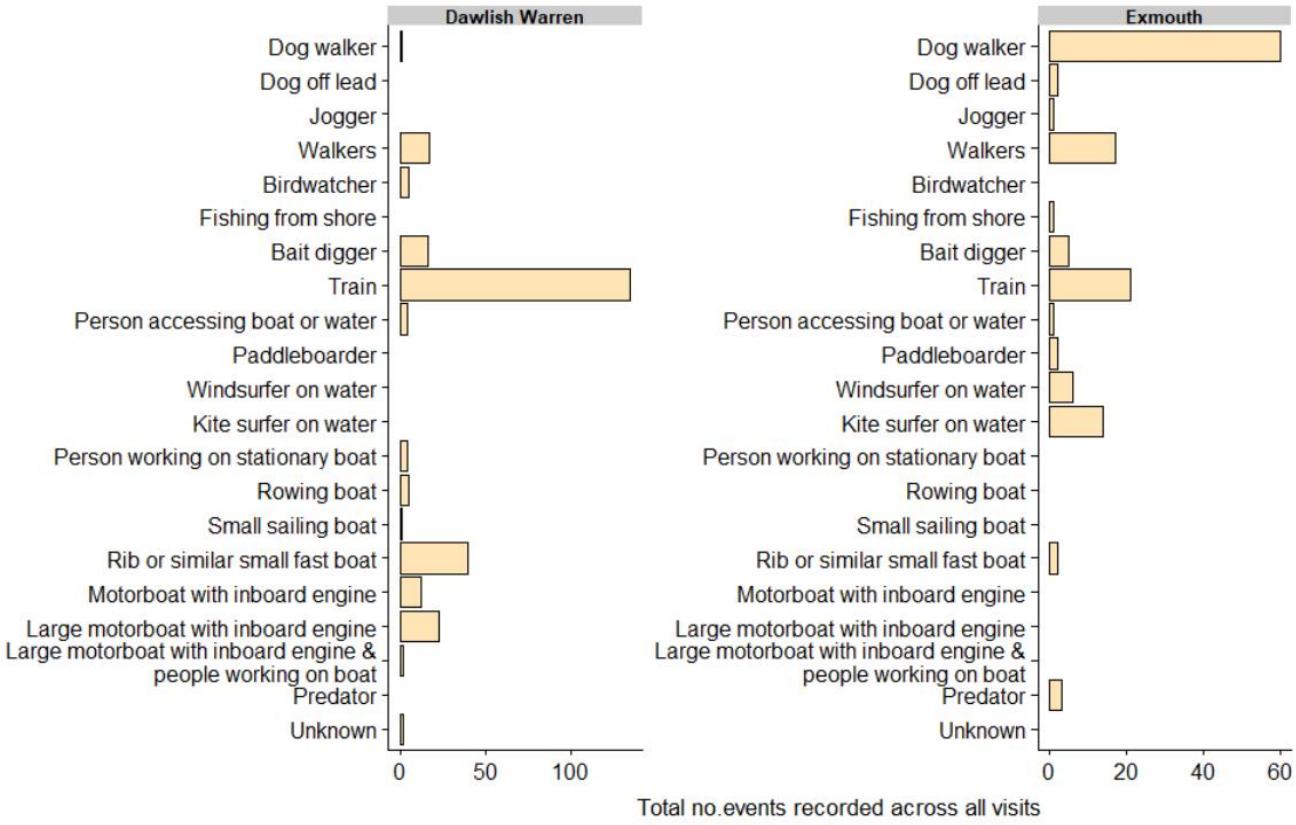


Figure 5: Total number of recreation events recorded from either side of the Exe Estuary during the survey period core counts, with Dawlish Warren corresponding to the Cockwood and Dawlish Warren Core Count survey locations, and Exmouth to those at the Duck Pond and Lympstone (*note varying y axis scales between plots, and that the figure does not differentiate between events occurring inside and outside of refuge areas*).

3.13 Core Count data are summarised by location and date in Figure 6, again these data show all activities in the recording area, regardless of whether inside or outside the refuge. The colours broadly indicate the types of activity, with blue shading representing activities on the water, allowing the

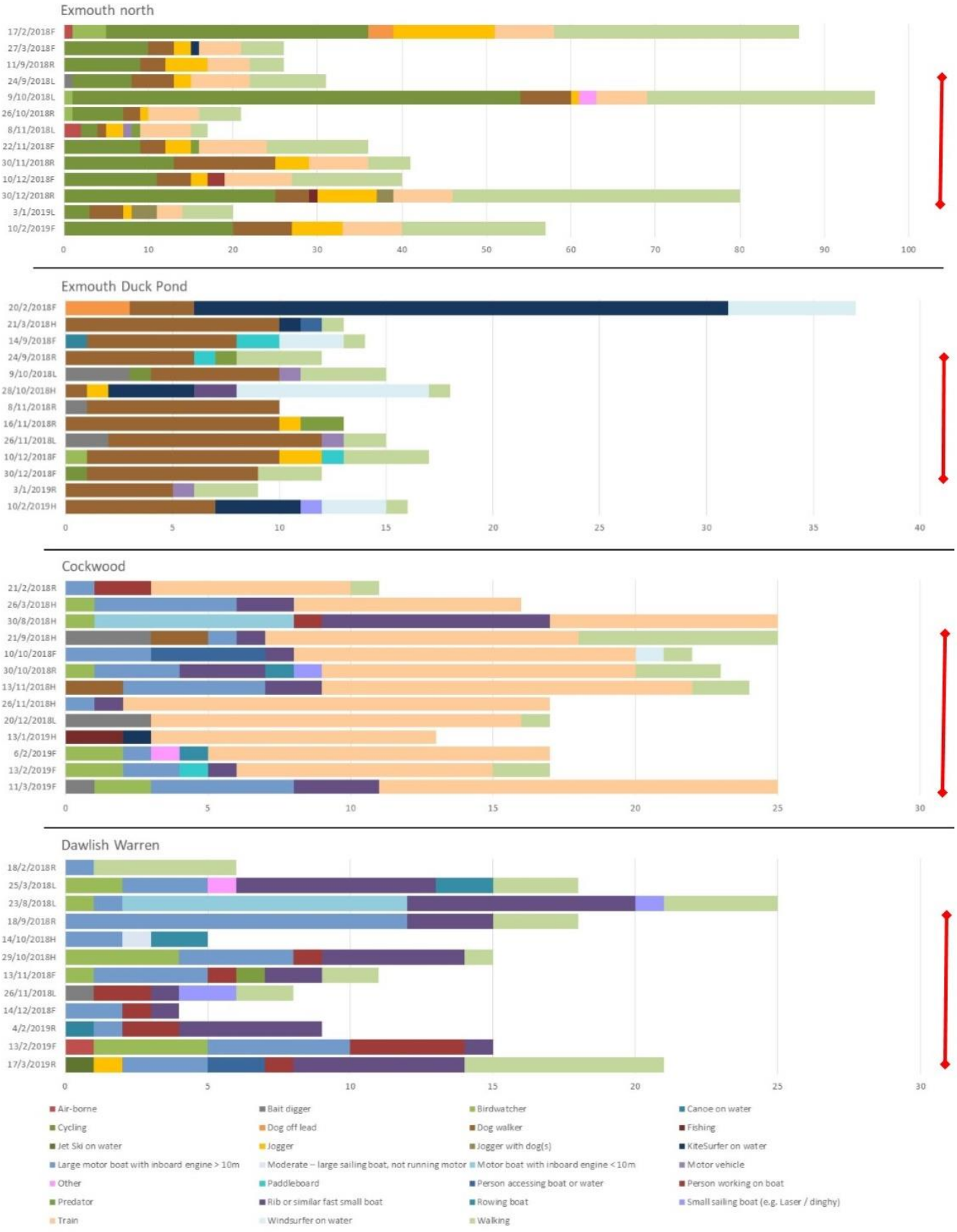


Figure 6: Diary data from the Core Counts, by date. Note the different axis scales for each location. The red vertical lines indicate the periods when the relevant refuge was active. Letters next to the dates indicate tide states: L=low; H= high, R = rising, F = falling. Bait digger also includes crab tiling and cockle raking.

eye to pick out key differences between locations. At Dawlish Warren there were a relatively high proportion of water-based events and also to some extent at Cockwood (where trains were also frequently recorded). At Exmouth north cyclists and walkers were the main activities, while dog walkers were particularly focussed at the Duck Pond.

3.14 By showing the data by date in this fashion it is possible to check that there is no particular change in access levels as a result of the refuges being active, i.e. whether the refuges deter people from visiting. For example, all the high tide counts at the Exmouth Duck Pond recorded kite surfers as present, including those when the refuge was active. Dog walkers were also recorded in all the Core counts carried out at the Duck Pond, and there is no apparent difference in their numbers when the refuge is active, suggesting the refuge is not deterring visitors.

Incursions inside the refuges: vantage point data

3.15 On the whole there were relatively few times that people were recorded within the refuges while they were active. The activities recorded within the refuges from the Vantage Point Counts are summarised in Figure 7. In terms of overall number of events, dog walkers and bait diggers accounted for most of the incursions into the refuge at Exmouth, whilst walkers, bird watchers, crab tilers, and shore fishing were the main incursions into the refuge at Dawlish.

3.16 Observations from the Vantage Point Counts of incursions into the refuges (when the refuges were active) are summarised in Table 3. We have included activities such as crab-tiling in the table, as while they are not subject to the voluntary exclusion, they are still a presence within the refuge and the table therefore shows the extent of all activity within the refuges.

3.17 In total, there were 25 vantage point observations undertaken from Cockwood while the refuge was active and there were 14 events observed within the Dawlish refuge on 10 separate dates. Only 2 of the events were beyond 50m from the shore, and therefore well within the refuge; both of these involved people shore fishing (as opposed to fishing from a boat).

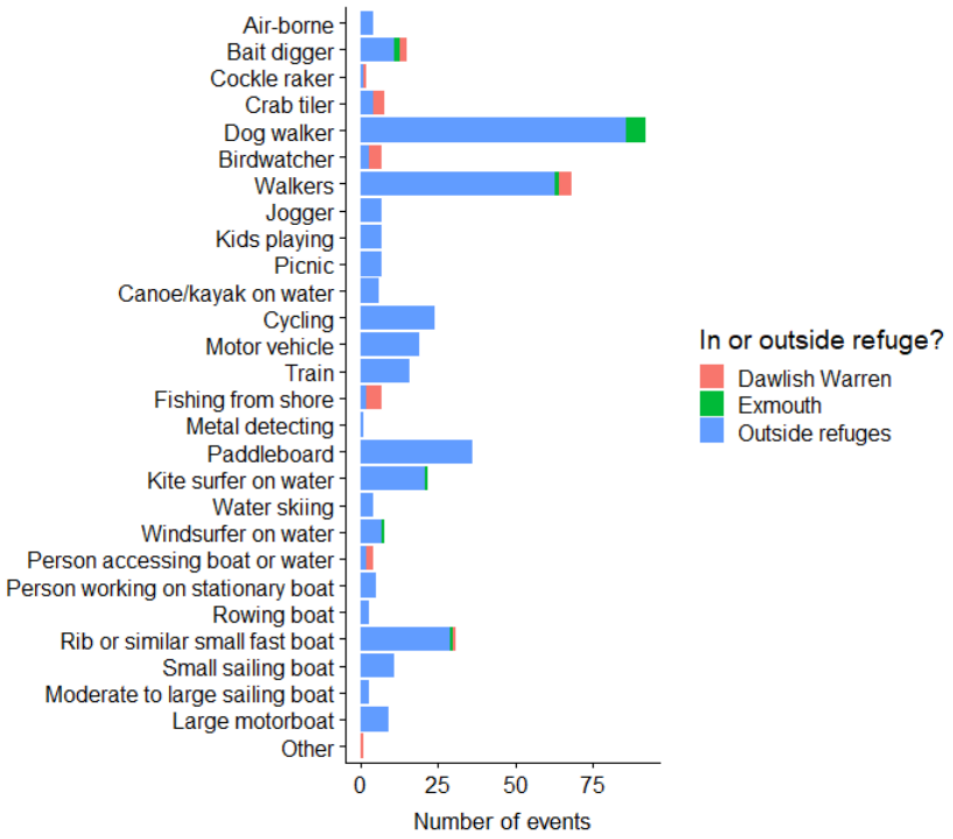


Figure 7: Total number of recreation events recorded inside and outside of refuge areas when the Exmouth refuge was active, collated from Vantage Point Count data.

3.18 Two vantage points related to the Exmouth refuge: 19 Vantage Point Counts were undertaken at the Duck Pond when the refuge was active and 12 were undertaken at Lympstone when the refuge was active. In total, 12 different events were observed within the refuge during these counts, on 11 different dates. 6 of the observations involved incursions more than 50m from the shore, i.e. well within the refuge. These involved 2 bait diggers, 2 dog walkers, 1 kite surfer and 1 windsurfer.

3.19 The Vantage Point Count data (as given in Table 3) are also summarised in Figure 8, which shows all the observations within the refuges, including the pre-refuge period for both and when the Exmouth refuge was inactive in the post-refuge period. For the Exmouth refuge in particular, there is good evidence of a decrease in incursions whilst the refuge is active (indicated by the red bar at the top of each plot). At the Duck Pond there appears to be a drop in use in September, followed by low levels of use while the refuge is active followed by a little more use in January, once the exclusion is no longer in place. For the Lympstone vantage point there

Table 3: Observations of incursions into the refuges when active, from Vantage Point Count data. Grey shading highlights those observations at least 50m from the shore – i.e. those that were well within the boundary of the refuge.

Date	Group size (no. of people)	Number dogs off lead	Number dogs on lead	Refuge	Activity	Tide	Approx. distance from shore (m)
21/09/2018	2	0	0	Dawlish	Fishing (from shore)	High	10
21/09/2018	1	0	0	Dawlish	Birdwatcher	High	10
24/09/2018	1	1	0	Exmouth	Dog walker	Low	100
14/10/2018	1	0	0	Dawlish	Birdwatcher	High	10
17/10/2018	2	0	0	Exmouth	Walking	Low	10
23/10/2018	1	0	0	Dawlish	Fishing (from shore)	Low	170
23/10/2018	1	0	0	Dawlish	Fishing (from shore)	Low	130
26/10/2018	2	2	0	Exmouth	Dog walker	High	20
26/10/2018	1	0	0	Exmouth	Windsurfer on water	High	120
26/10/2018	1	0	0	Exmouth	Kite surfer on water	High	210
26/10/2018	1	0	2	Exmouth	Dog walker	Low	60
13/11/2018	4	0	0	Dawlish	Walking	Low	30
13/11/2018	1	0	0	Dawlish	Crab tiler	Low	360
25/11/2018	2	0	3	Exmouth	Dog walker	High	40
26/11/2018	1	0	0	Exmouth	Bait digger	Falling	220
30/11/2018	1	0	0	Exmouth	Rib or similar fast small boat	High	30
10/12/2018	1	0	0	Exmouth	Bait digger	Low	190
11/12/2018	2	2	0	Exmouth	Dog walker	Low	10
14/12/2018	1	0	0	Dawlish	Other	High	40
16/12/2018	1	0	0	Dawlish	Walking	High	30
16/12/2018	3	0	0	Dawlish	Fishing (from shore)	High	20
30/12/2018	1	2	0	Exmouth	Dog walker	High	30
13/01/2019	2	0	0	Dawlish	Fishing (from shore)	High	30
21/01/2019	2	0	0	Dawlish	Birdwatcher	Falling	20
13/02/2019	1	0	0	Dawlish	Birdwatcher	High	20
19/03/2019	1	0	0	Dawlish	Crab tiler	Low	390

were few observations within the refuge, but the data shows the same pattern, with no observations while the refuge is active.

3.20 On the western side of the Estuary, use appears to show less of a change, but levels of incursion remain very low.

Figure 8: Vantage Point Count data showing all observations inside refuges, by activity. The three plots represent the three survey points, and the red lines indicate when the relevant refuge was operational/active. Note that the y axis scales differ between plots. Note also the dates differ between plots and dates with no bars indicate zero counts.

Incursions inside the refuges: Core Count data

3.21 In total, at both the Cockwood and Dawlish Warren Core Count locations, 10 Core Counts were undertaken when the refuge was active. At both the Exmouth locations, 8 of the counts were during the period the refuge was active. This gives a total of 36 counts – equivalent to 63 hours of observation (each count being an hour and 45 minutes). These 63 hours were split between the Dawlish side (35 hours) and the Exmouth side (28 hours).

3.22 Activities within the refuges during these 63 hours of observation are summarised in Table 4. The majority of events were at the Duck Pond, where 16 incursions were recorded during 14 hours of observation. At the Duck Pond 10 of the 16 incursions were dog walkers, some of which were walking along the intertidal and keeping relatively close to the shore to the east of the slipway. Others, such as the bait digger on the 26th November at Exmouth (Figure 9) were well within the refuge and present within it for an extended period.

Figure 9: Bait digger within the refuge area on November 26th 2018.

Table 4: Numbers of incursions within the refuges (when refuges active), from Core Counts.

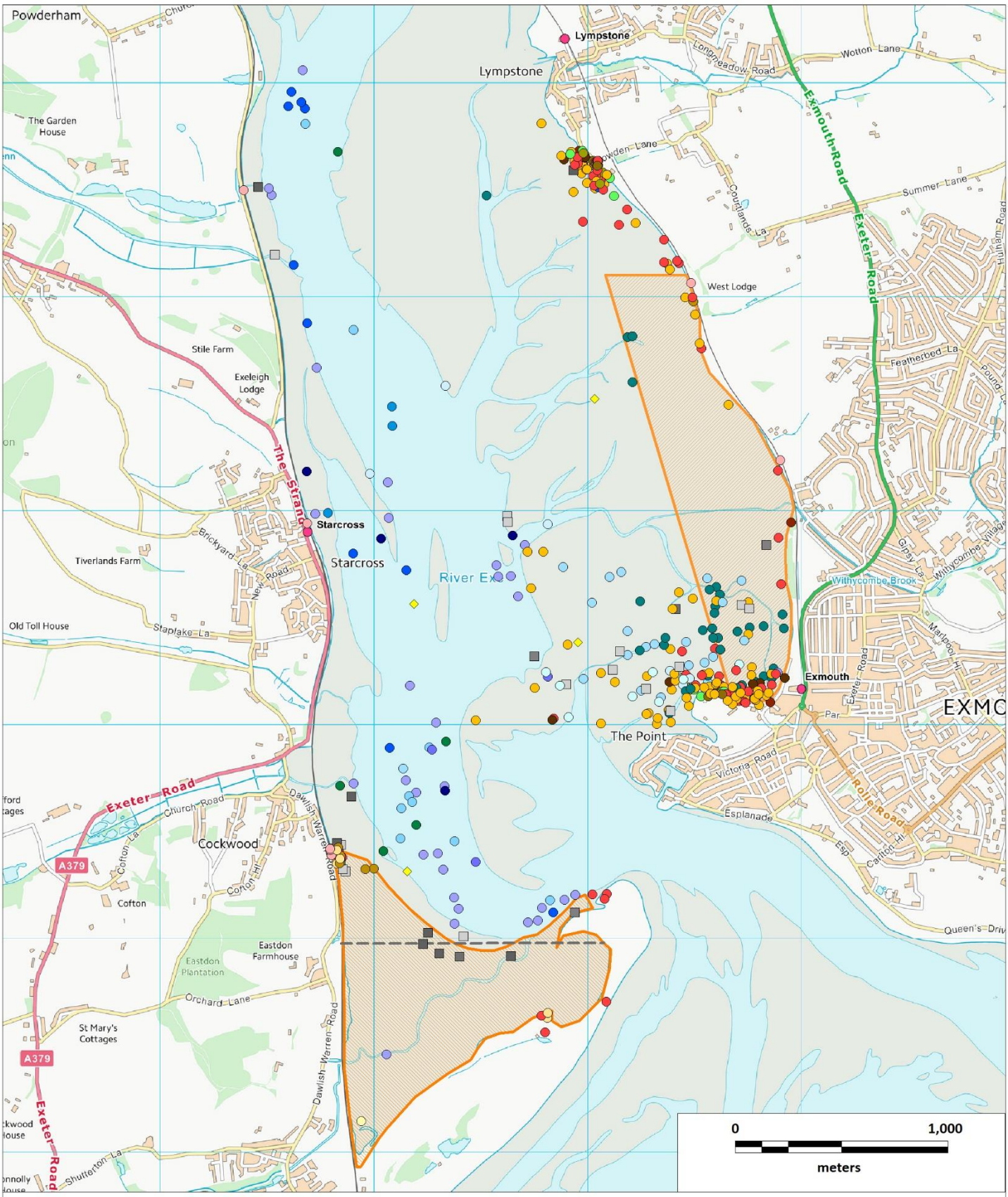
Date	Duration (mins)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
Exmouth North: a total of 1 incursion on 1 date (out of 10). 14 hours observation.						
30/11/2018	3	Dog walker	1		1	On foreshore 5m from wall
Exmouth Duck Pond: a total of 16 incursions across 5 dates (out of 10). 14 hours observation						
28/10/2018	15	Windsurfer on water				Launched on shore within refuge
28/10/2018	5	Rib or similar fast small boat				Fast speed boat/RIB
28/10/2018	19	Windsurfer on water				Same windsurfer left area and returned 4x
16/11/2018	3	Dog walker	1		1	
16/11/2018	21	Dog walker	1		1	Beachcombing/collecting on high tide line
16/11/2018	3	Dog walker	2		1	
16/11/2018	10	Dog walker	1		1	
26/11/2018	105	Bait digger	1			Well within exclusion zone. There at start and stayed in exclusion zone for whole of count. Moving around.
10/12/2018	5	Walking	28			Pre-school group with 5 adults walked onto shore
10/12/2018	2	Dog walker	1		1	
10/12/2018	3	Dog walker	1		1	B returned. No birds near
10/12/2018	32	Dog walker	1		1	Collecting from tideline
30/12/2018	10	Dog walker	2		1	Dog entered water
30/12/2018	4	Dog walker	2		1	
30/12/2018	8	Dog walker	5		1	
30/12/2018	4	Cycling	3			Boys on bikes along bottom of sea wall
Dawlish Warren: 9 incursions, including 1 crab tiling. Incursions recorded on 2 dates (out of 10). 17.5 hours observation.						
26/11/2018	6	Walking	1			
26/11/2018	35	Walking	2			Sat down - moved into dunes
26/11/2018	35	Crab tiling				turning over seaweed
17/03/2019	2	Jogger	2			rounded point into bight
17/03/2019	3	Walking	1			kept above HT line
17/03/2019	5	Walking	2			walking across bight
17/03/2019	14	Person accessing boat or water	1			Salvage operation. Man walked into refuge to sort anchor, then returned to boat.
17/03/2019	10	Person accessing boat or water	1			Salvage operation. Man returned to anchor on intertidal
17/03/2019	8	Walking	2			On far side, below Cockwood and railway
Cockwood: total of 8 incursions, including 3 crab tiling. Incursions recorded on 4 dates (out of 10). 17.5 hours observation.						
21/09/2018	50	Walking	1			
21/09/2018	55	Walking	1			fed c20 herring gulls
21/09/2018	40	Crab tiling				
21/09/2018	14	Walking	2			Moved slightly onto shore - intertidal
21/09/2018	20	Dog walker	2		1	

Date	Duration (mins)	Activity	Group size (people)	No. of dogs on lead	No. of dogs off lead	Description/notes
20/12/2018	120+	Crab tiling	1			
13/02/2019	10	Walking	2			
11/03/2019	86+	Crab tiling	1			

Spatial distribution of potential disturbance events

3.23 The spatial data resulting from the mapping of the activities recorded during the Vantage Point Counts are shown in Maps 4 to 7. Map 4 shows all the data, covering the periods before the refuges were operational, and also the period in early 2019 when the Exmouth refuge was not active. The subsequent maps split the data by relevant time periods. Map 5 shows the data for the period before mid-September 2018, i.e. before the refuges were operational and active. Map 6 then shows the period from mid-September through to the end of December, when both refuges were active. Map 7 then shows the data for January – March 2019, during which period only the Dawlish refuge was active.

Map 4: Vantage point data: all activity across all counts



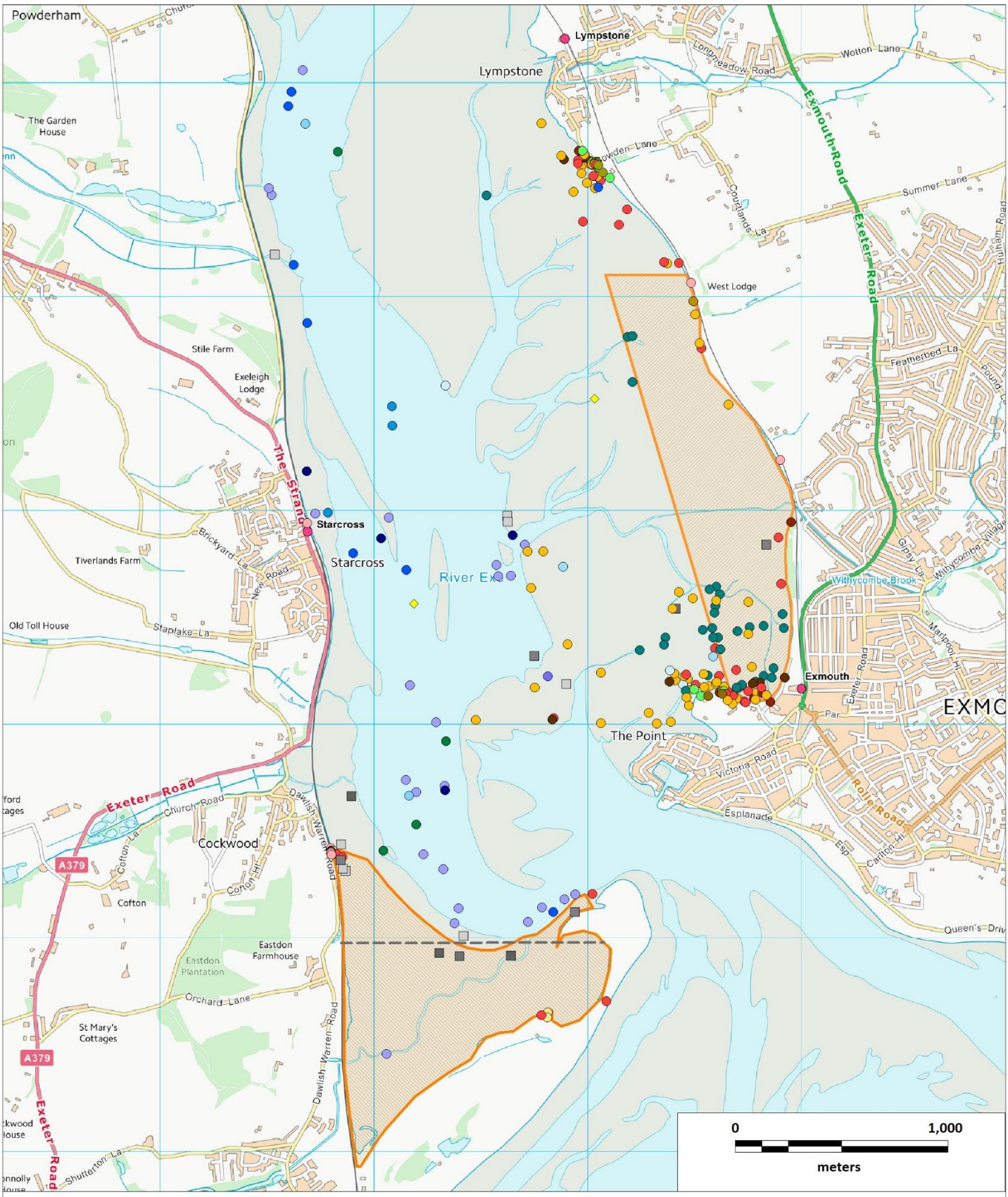
Air-borne	(4)	Kids playing	(7)	Picnic	(7)
Bait digger	(15)	KiteSurfer on water	(22)	Rib or similar fast small boat	(31)
Birdwatcher	(7)	Large motor boat with inboard engine > 10m	(9)	Rowing boat	(3)
Canoe/kayak on water	(6)	Metal Detecting	(1)	Small sailing boat (e.g. Laser / dinghy)	(11)
Cockle raker	(2)	Moderate/large sailing boat, not running motor	(3)	Train	(16)
Crab tiler	(8)	Motor vehicle	(19)	Walking / rambling (without dog)	(68)
Cycling	(24)	Other	(1)	Water skiing	(4)
Dog walker	(92)	Paddleboard	(36)	Windsurfer on water	(8)
Fishing (from shore)	(7)	Person accessing boat or water	(4)		
Jogger	(7)	Person working on boat (boat stationary)	(5)		

Dawlish Warren refuge area

Exmouth refuge area

Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)

Map 5: Vantage point data: all activity February - mid September 2018



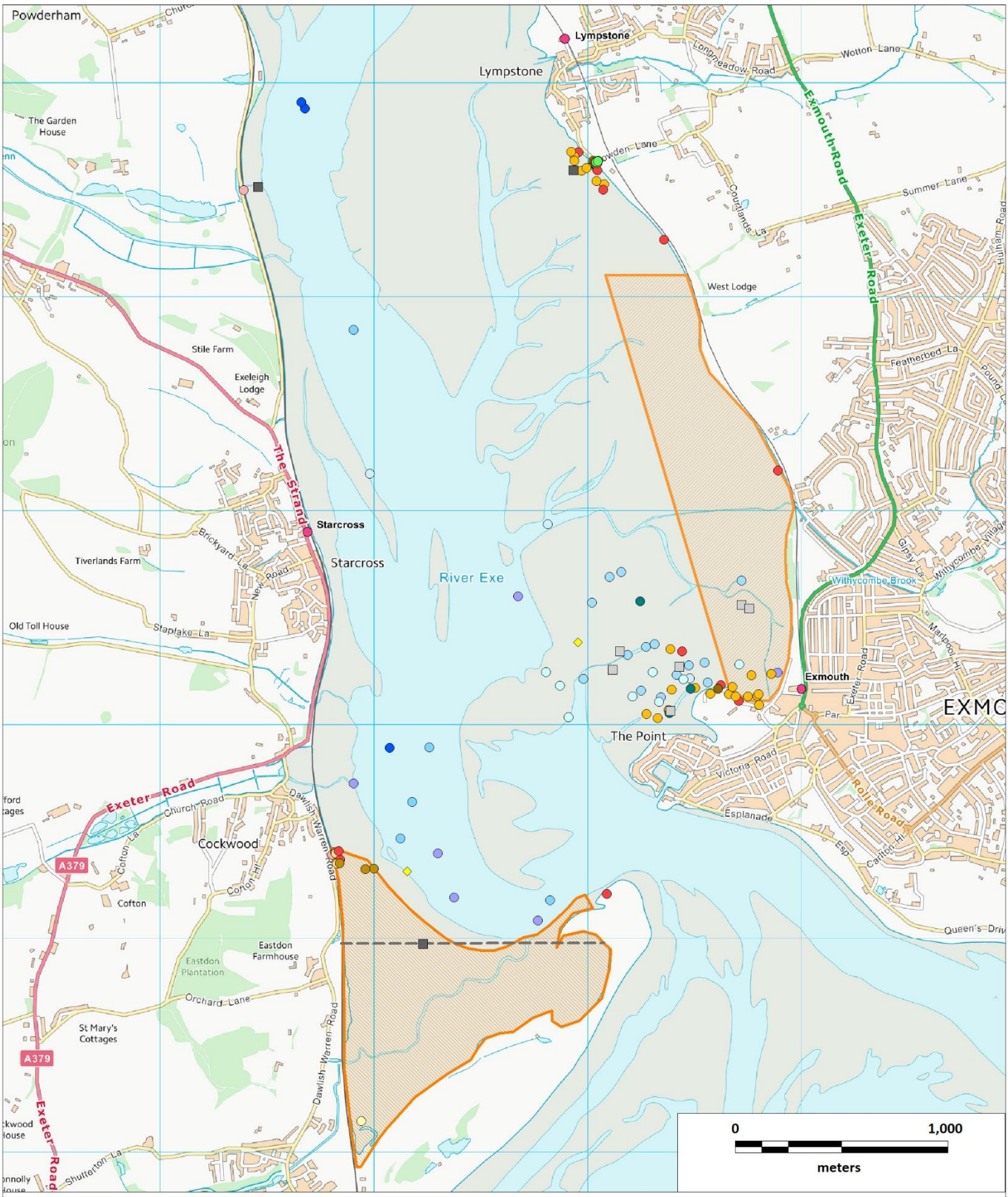
Air-borne	(2)	Jogger	(3)	Picnic	(7)
Bait digger	(8)	Kids playing	(7)	Rib or similar fast small boat	(23)
Birdwatcher	(3)	KiteSurfer on water	(2)	Rowing boat	(1)
Canoe/kayak on water	(3)	Large motor boat with inboard engine > 10m	(2)	Small sailing boat (e.g. Laser / dinghy)	(8)
Cockle raker	(2)	Moderate/large sailing boat, not running motor	(3)	Train	(11)
Crab tiler	(3)	Motor vehicle	(10)	Walking / rambling (without dog)	(40)
Cycling	(13)	Paddleboard	(33)	Water skiing	(4)
Dog walker	(54)	Person accessing boat or water	(4)		
Fishing (from shore)	(1)	Person working on boat (boat stationary)	(4)		

Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)

Dawlish Warren refuge area

Exmouth refuge area

Map 6: Vantage point data: all activity, mid September - end December 2018



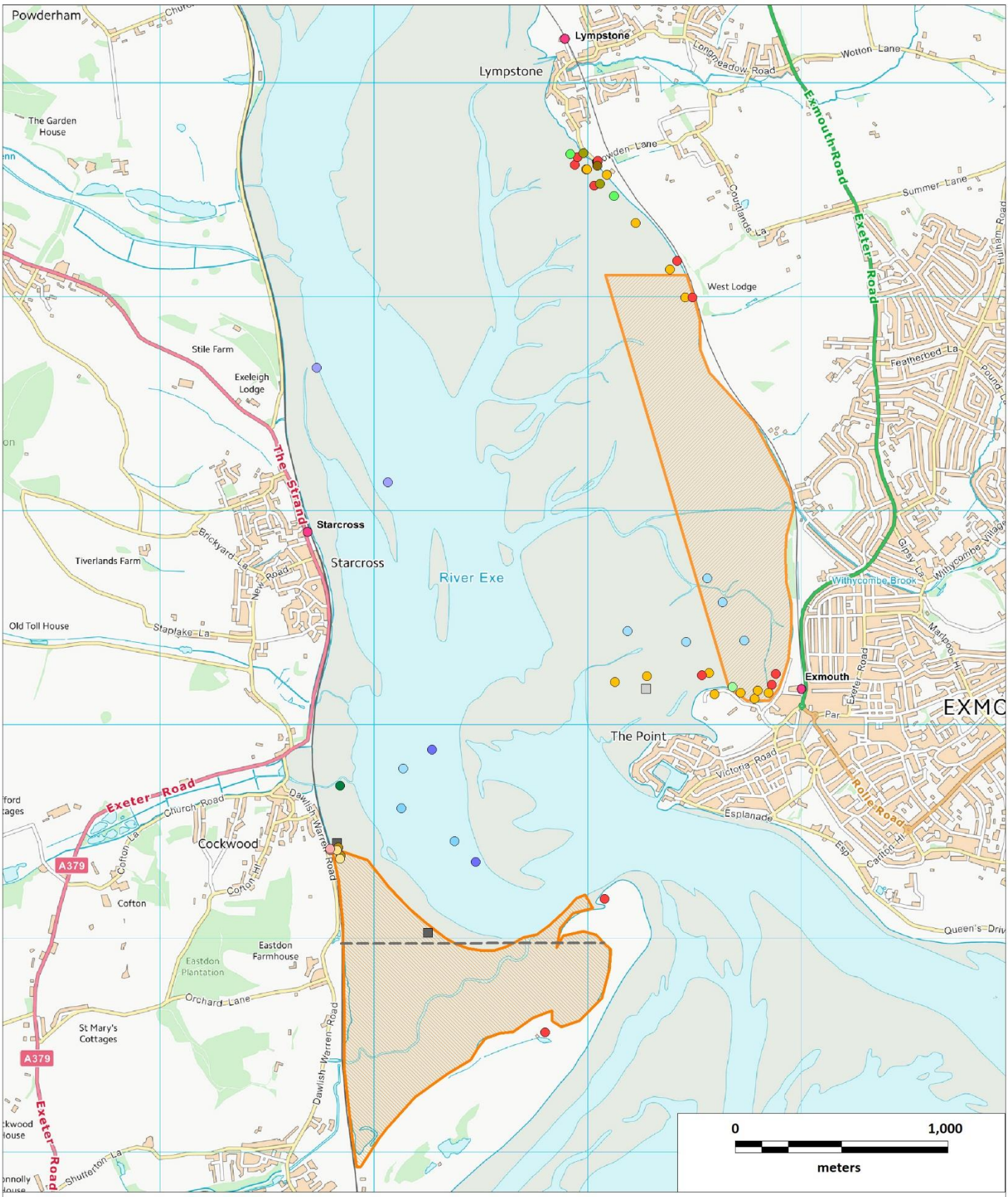
Air-borne	(2)	Fishing (from shore)	(4)	Rib or similar fast small boat	(6)
Bait digger	(6)	Jogger	(2)	Small sailing boat (e.g. Laser / dinghy)	(3)
Birdwatcher	(2)	KiteSurfer on water	(14)	Train	(2)
Canoe/kayak on water	(3)	Large motor boat with inboard engine > 10m	(5)	Walking / rambling (without dog)	(16)
Crab tiler	(3)	Motor vehicle	(6)	Windsurfer on water	(8)
Cycling	(7)	Other	(1)		
Dog walker	(24)	Paddleboard	(3)		

Dawlish Warren refuge area

Exmouth refuge area

Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)

Map 7: Vantage point data: all activity January - March 2019



Bait digger	(1)	Jogger	(2)	Rib or similar fast small boat	(2)
Birdwatcher	(2)	KiteSurfer on water	(6)	Rowing boat	(2)
Crab tiler	(2)	Large motor boat with inboard engine > 10m	(2)	Train	(3)
Cycling	(4)	Metal Detecting	(1)	Walking / rambling (without dog)	(12)
Dog walker	(14)	Motor vehicle	(3)		
Fishing (from shore)	(2)	Person working on boat (boat stationary)	(1)		

Dawlish Warren refuge area

Exmouth refuge area

Approx line for D&S IFCA Byelaw 24 (no crab tiling to south)

Bird responses to disturbance (Core Count data)

Overview of all data

3.24 The following analysis and data presentation all draw on the Core Count data, which recorded interactions between recreation events and birds present within the recording area.

3.25 Responses to different events are summarised in Figure 10, which uses the data from all observations and all time periods (i.e. both when the refuges were active and when they were not). Sample sizes were relatively small for some activities and therefore some caution is required when comparing between activities or locations. In general, however the results indicate generally lower levels of birds showing behavioural responses to events at Dawlish compared to Exmouth.

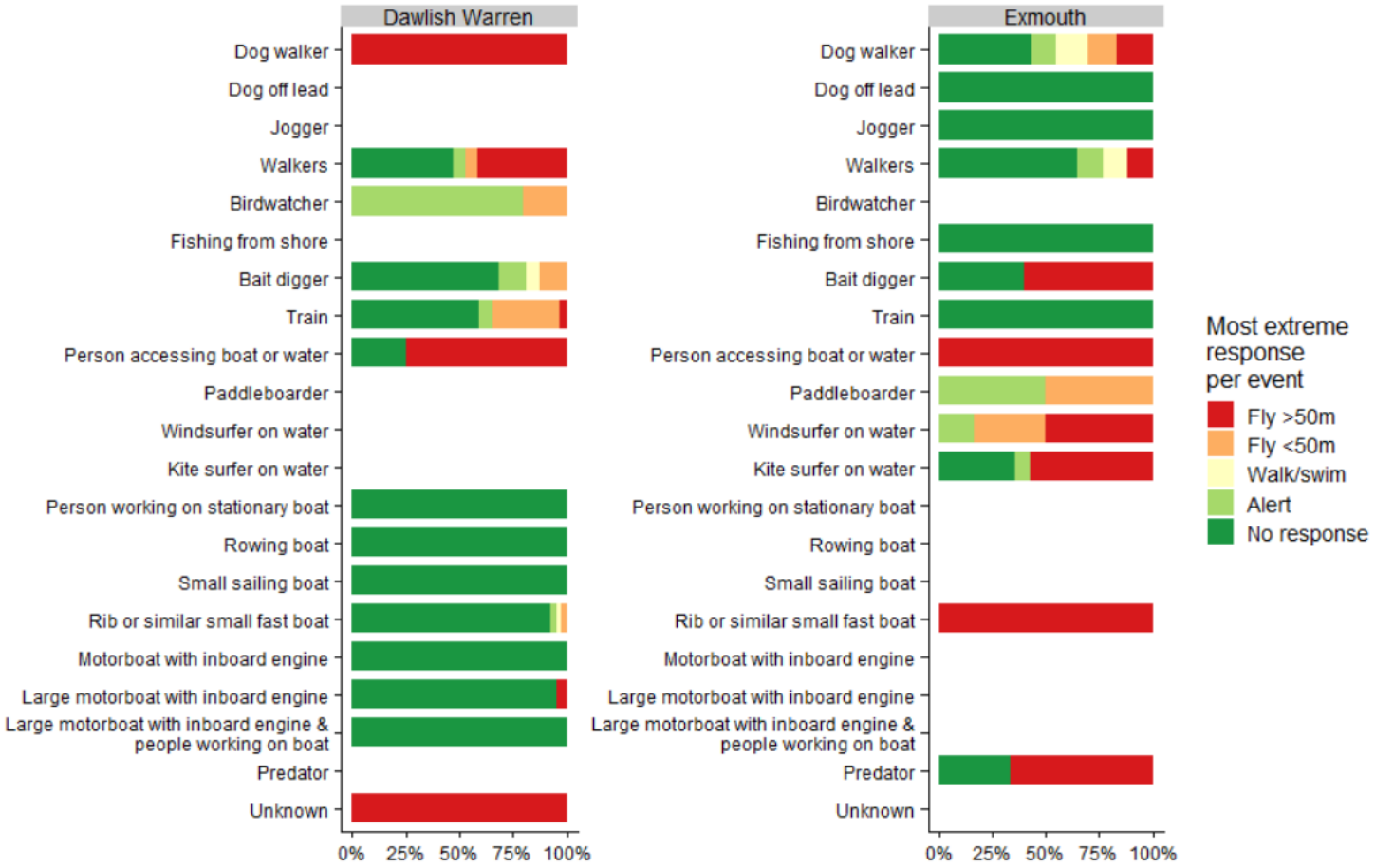


Figure 10: Bird responses to different recreation events on either side of the Exe Estuary, calculated from Core Count data. Dawlish Warren corresponds to Cockwood and Dawlish Warren survey points, and Exmouth to those at the Duck Pond and Lympstone.

3.26 The sample sizes are given in Figure 11, which provides an overview across all the data of the proportion of birds flushed by different activities. Much of the boat traffic (which is focussed in the main channel) in particular can be seen to have resulted in very low levels of birds being flushed. The species groups where the highest proportions of birds were recorded flushed were small wader species and wildfowl (Figure 12).

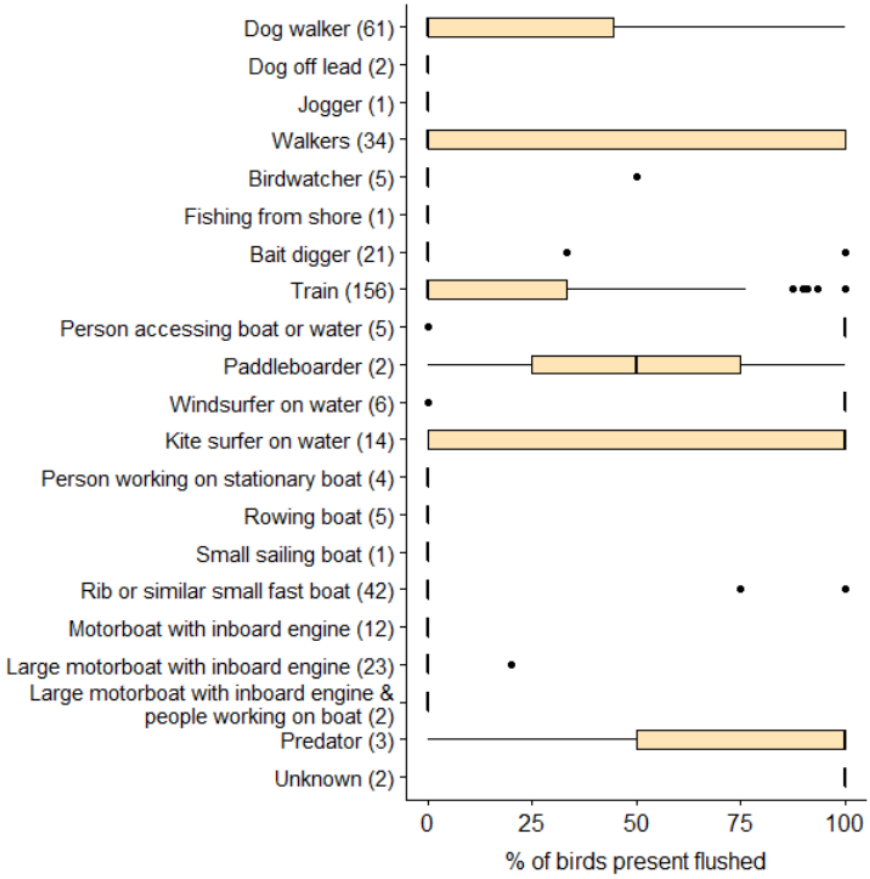


Figure 11: Percentage of birds present within 200m of each recreation event flushed (caused to fly) during Core Counts. Numbers in parentheses correspond to number of each event recorded during the survey period.

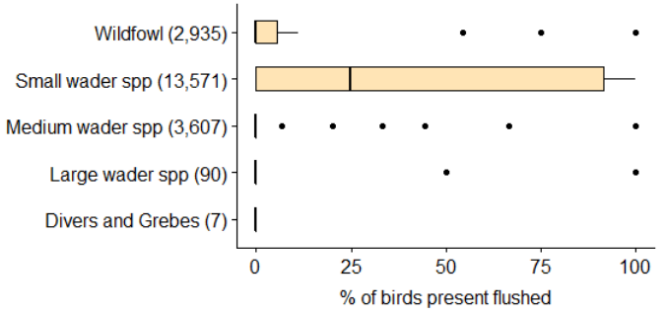


Figure 12: Percentage of birds present within 200m of each recreation event flushed (caused to fly) during Core Counts, split by species group. Numbers in parentheses correspond to total number of individual birds within each grouping recorded across all survey visits.

3.27 The number of birds flushed is summarised in Figure 13 and Figure 14. Trains resulted in some large flocks being flushed. This was related to the waders roosting on the concreted slope adjacent to the train tracks around 260m north of the Cockwood survey point (Figure 15). Occasionally the roost here was large and sometimes quite high up the slope; variations in the response of the birds here related to which side of the tracks the train was on and how fast it was going. The roost included smaller waders (e.g. Ringed Plover, Dunlin, Sanderling) which were often closer to the train tracks and flushed (Figure 14). Other activities recorded flushing large flocks included dog walkers, people accessing boats/the water, windsurfers, kite surfers, and one observation relating to a RIB.

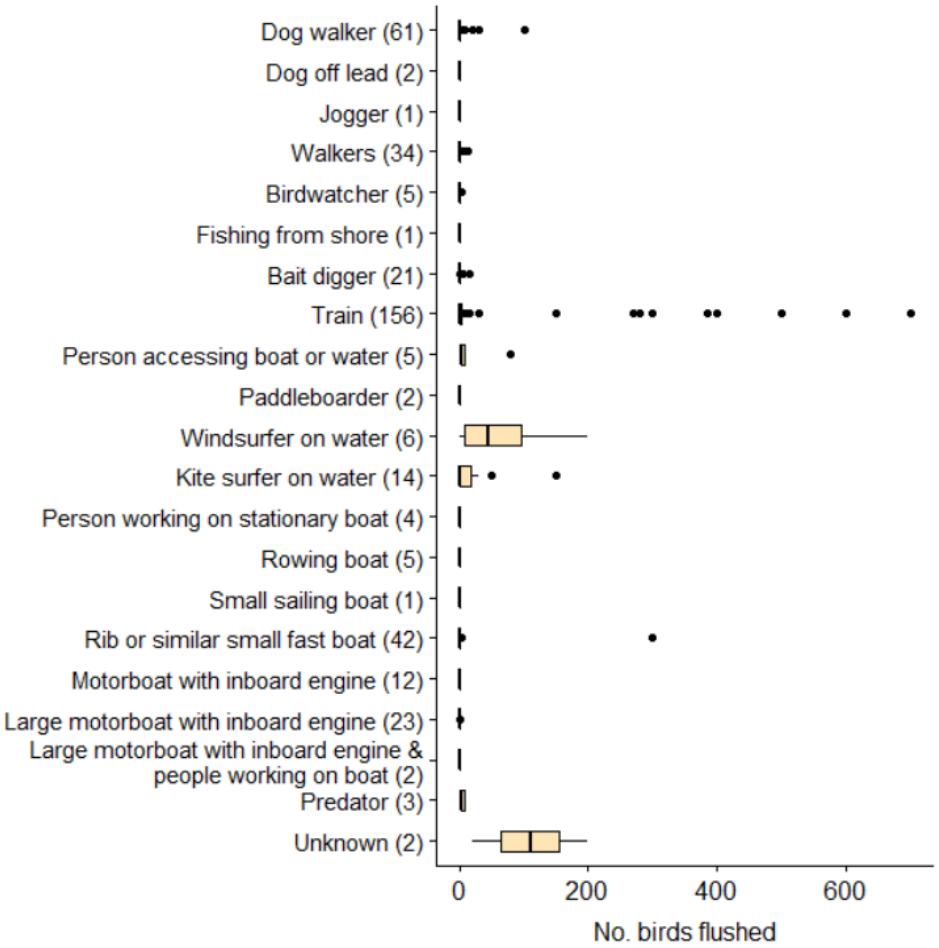


Figure 13: Total number of birds present within 200m of each recreation event flushed (caused to fly) during Core Counts. Numbers in parentheses correspond to number of each event recorded during the survey period.

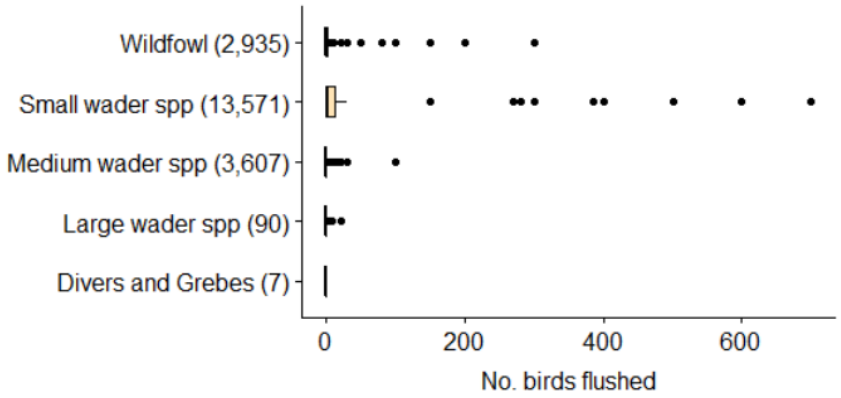


Figure 14: Total number of birds present within 200m of each recreation event flushed (caused to fly) during Core Counts. Numbers in parentheses correspond to total number of individual birds within each grouping recorded across all survey visits.

Figure 15: Redshank and Ringed Plover responding to passing train, north of Cockwood steps.

Disturbance events within refuge

3.28 All potential disturbance events that were within the refuges while they were active are summarised in Table 5. This shows all the behavioural responses (waders and wildfowl) observed that related to access events that took place within the refuges and when birds were present within the recording area. It is important to note that these relate to the responses observed during the core count and within the recording area. As the refuges extend beyond the recording areas for core counts it is possible that individual events did disturb more birds than recorded, furthermore some events were present in the area for a prolonged period, extending before and/or after the count period. For example, the bait digger shown in Figure 9 was present at the start of the count and also still present within the refuge at the end, 105 minutes later. As such any birds disturbed when he first appeared and walked out were not recorded.

3.29 It can be seen that a total of 388 wildfowl and 50 waders were seen to be flushed more than 50m (major flight) by events that were incursions into the refuge.

Table 5: Potential disturbance events within the refuges, while they were active. Table gives the number of birds (waders and wildfowl only) in each category of response.

Activity	Location	Date	Total waders					Total wildfowl				
			No response	Alert	Walk/swim	Minor flight	Major flight	No response	Alert	Walk/swim	Minor flight	Major flight
Walking	Cockwood	21/09/18					9					
Bait digger	Cockwood	21/09/18	4									
Windsurfer on water	Duck Pond	28/10/18						150	50			
Rib or similar fast small boat	Duck Pond	28/10/18							100		150	150
Windsurfer on water	Duck Pond	28/10/18										80
Windsurfer on water	Duck Pond	28/10/18									100	100
Windsurfer on water	Duck Pond	28/10/18									50	50
Windsurfer on water	Duck Pond	28/10/18									8	
Dog walker	Duck Pond	16/11/18			20							

Activity	Location	Date	Total waders					Total wildfowl				
			No response	Alert	Walk/swim	Minor flight	Major flight	No response	Alert	Walk/swim	Minor flight	Major flight
Dog walker	Duck Pond	16/11/18					30					
Dog walker	Duck Pond	16/11/18	19									
Bait digger	Duck Pond	26/11/18	20		10	10	5					
Bait digger	D. Warren	26/11/18	1	2								
Dog walker	Exmouth n.	30/11/18	2					10				
Walking	Duck Pond	10/12/18					6		20			
Dog walker	Duck Pond	10/12/18							15			
Bait digger	Cockwood	20/12/18	5					3				
Dog walker	Duck Pond	30/12/18										8
Dog walker	Duck Pond	30/12/18			2							
Dog walker	Duck Pond	30/12/18			3							
Walking	Cockwood	13/02/19				6						
Bait digger	Cockwood	11/03/19	11	1	1							
Person accessing boat or water	D. Warren	17/03/19	6									
Total			**68**	**3**	**36**	**16**	**50**	**163**	**185**		**308**	**388**

3.30 Response data are summarised in Figure 16, which gives responses by core count location. The four plots show:

a) all time periods, i.e. data pooled for each location for all observations across all dates;
b) observations during the times when the relevant refuges were active (i.e. September – December 2018 for the Exmouth refuge and September 2018 – March 2019 for the Dawlish refuge;
c) Observations from the time periods when the relevant refuge was not active (as such b and c are both a subset of a);
d) Observations relating to events that were incursions into the refuge during the time when the refuge was active (i.e. a subset of b).

3.31 The plots indicate that when incursions occur within the refuges and the refuges are active (plot d) there is a relatively high likelihood of a behavioural

response, for example some of the longest red bars indicating major flights are in this plot. Only 6% of the incursions into the refuge at the Duck Pond did not result in a behavioural response.

3.32 There is relatively little difference evident when comparing across the other plots, however at Cockwood there were no observations involving disturbance from the 35 observations during the period the refuge was not active, whereas when the refuge was active behavioural responses were recorded, including major flights.

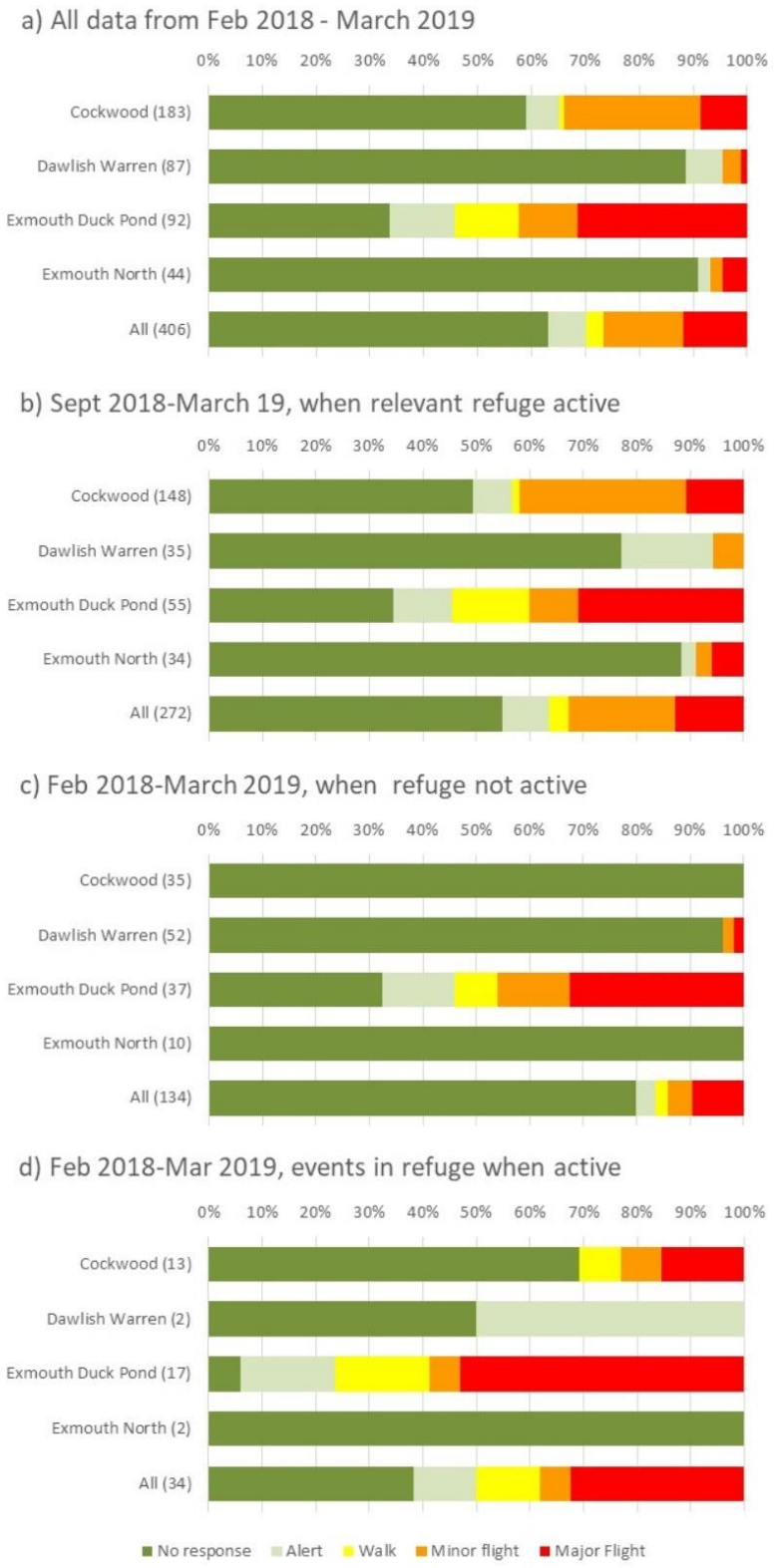


Figure 16: Responses to potential disturbance events by Core Count location, split into when different time windows when refuge active. Based on single response codes. Numbers in parenthesis are the number of observations.

4. Discussion

4.1 The results of the first 13 months of monitoring indicate that the refuges can support important numbers of birds, with the maximum count of wildfowl recorded within the Exmouth refuge on a single occasion during the survey period (9,420 individuals), equating to 41% of the 5 year mean (combined maximum count) wildfowl population for the entire Estuary (Frost et. 2019).

4.2 Incursions into the refuges (when they are active) are relatively infrequent, but when they do occur they can have a marked impact (in terms of a behavioural response) from the birds present. The results to date, while only interim, indicate that the refuges are making a difference, but a small number of visitors are either not aware or choosing to ignore the refuges.

4.3 Future monitoring will reveal whether use changes over time, for example it is difficult to anticipate whether the levels of incursions will change. It may be that visitors become more aware of the refuges and the need to keep out, or equally it may be that the novelty wears off and – once people see some incursions – more occur.

4.4 It is not possible from the monitoring to understand the motivations of those people who enter the refuges when they are not supposed to. Only direct contact with those people will inform their reasons and what future approaches are necessary to minimise the levels of incursions. It may be that there will always be a small number of incursions.

4.5 The bird data indicate that the Exmouth Duck Pond area does support good numbers of birds in the autumn/early winter period, in accordance with the recommendations in the zonation review (Exe Estuary Management Partnership 2017). The late autumn/early winter peak in wildfowl numbers within the refuge, followed by a decrease towards the end of the year, may be due to the depletion of the Eel grass beds by foraging geese and ducks. Given that bird numbers peak at this time and then drop, the monitoring data does not provide a clear picture of 'before' the refuges were in place, as the monitoring commenced in February.

4.6 The decreased variation seen in the numbers of waders using the Dawlish refuge throughout the survey period may be due to several factors. It could potentially be explained by the presence of the main channel of the Exe along its' border, with the topography and water depth on the channel edge

potentially being less suitable for foraging than the shallower/more level areas within the refuge.

4.7 The Exe Disturbance Study (Liley *et al.* 2011) did involve a similar fieldwork approach, at the Duck Pond and using the same field surveyors; therefore some comparison with that data are of relevance and provide additional context. The Exe Disturbance Study involved 50 counts following a methodology very similar to the Core Count methodology[1]. From those 50 counts, 22% of observations involved no response from birds present and 43% involved major flights[2]. In this study, across all Core Count observations 34% of observations involved no response and 32% involved major flights (see Figure 16). This would suggest a shift over time since the 2011 work.

Recommendations for the future monitoring

4.8 Monitoring is scheduled to continue and over time the data will build, allowing opportunity for more comprehensive analysis and reporting. We have identified the following as key points to note at this stage in the fieldwork:

4.9 Currently the Core Count recording does not differentiate the numbers of birds within and outside the refuge, within the recording area. The disturbance data are difficult to collect and involve multiple, simultaneous, recording, so there is little scope to add more data collection, however it should be possible to record specifically whether birds within the refuge respond to an event (whether inside or outside), and this can be added into future recording forms.

4.10 The Vantage Point Counts are important as they can be done quickly and the data shows patterns over multiple tide states, times of day, seasons and weather conditions. It is important that this continues. A relatively small number are scheduled month by month to be undertaken by Footprint Ecology and these are supplemented by data collected by the South East Devon Habitats Regulations Partnership rangers. It is important these data continue to be collected, and ideally should cover different conditions, days and tide states.

[1] Though note that each count in the previous study was of a shorter duration.
[2] Figures from table 9 in the Exe Disturbance Study.

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Appendix: Maximum counts of species at each Core Count location

This appendix gives the maximum counts for each species across the Core Counts undertaken at each survey location. The counts are for the entire recording area and therefore encompass areas inside and outside the refuge areas.

Species	Cockwood	Dawlish Warren	Exmouth Duck Pond	Exmouth North
Waders				
Avocet				2
Bar-tailed Godwit	13	30		
Black-tailed Godwit	7	2	4	45
Curlew	8	130	87	79
Dunlin	800	510		300
Greenshank	3	4	1	
Grey Plover		87		30
Oystercatcher	60	404	354	68
Redshank	272	15	3	34
Ringed Plover	22	40		4
Sanderling	2	12		
Snipe				1
Turnstone	20	15	15	17
Wildfowl				
Canada Goose	18		98	68
Dark-b. Brent Goose	216	205	655	996
Eider	3	2		
Mallard			62	55
Mute Swan	28	32	40	32
Pale-bellied Brent Goose				5
Pintail			55	169
Red-b. Merganser	10	2	4	
Shelduck	20	13	160	98
Teal	7	2		
Wigeon		110	352	1295
Divers/Grebes				
Great C. Grebe	5	1	1	13
Great N. Diver		2		
Little Grebe	1	1		3

Slavonian Grebe	1			
Gulls/Terns	80	129	50	300
Black-headed Gull	32	30	33	200
Common Gull	34		3	28
Common Tern	2			
Great Black-b. Gull		129	8	
Herring Gull	80	30	50	300
Lesser Black-b. Gull		5		
Sandwich Tern	6		2	
Other Species				
Cormorant	9	28	1	
Grey Heron	1			1
Kingfisher	1			
Little Egret	3	6	11	16
Shag	8	1		